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Rocky Mountain Arsenal

Rocky Mountain Arsenal Information Center Commerce City, Colorado

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Remedial Investigation and Chemical Specific Applicable or Relevant and Appropriate Requirements
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Prepared for

U.S. ARMY PROGRAM MANAGER'S OFFICE FOR ROCKY MOUNTAIN ARSENAL

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TABLE OF CONTENTS

Section			Page
VOLUME I			
EXECUTIVE SUMMARY			
1.0	**INTRODUCTION**		1-1
1.1	CONDITIONS IN THE OFFPOST OPERABLE UNIT		1-5
1.2	ONGOING RESPONSE ACTIONS		1-7
	1.2.1	NORTH BOUNDARY: CONTAINMENT/TREATMENT	1-7
	1.2.2	NORTHWEST BOUNDARY: CONTAINMENT/TREATMENT	1-8
	1.2.3	IRONDALE: CONTAINMENT/TREATMENT	1-8
1.3	SUMMARY OF TECHNICAL APPROACH		1-9
2.0	**DATA COLLECTION AND ANALYSES**		2-1
2.1	GROUND-WATER MONITORING PROGRAM		2-2
	2.1.1	MONITORING NETWORK AND RATIONALE	2-3
		2.1.1.1 Alluvial Aquifer Monitoring Network	2-5
		2.1.1.2 Denver Fm Monitoring Network	2-11
	2.1.2	GROUND-WATER MONITORING	2-15
		2.1.2.1 Water Level Monitoring	2-15
		2.1.2.2 Water Quality Monitoring	2-19
	2.1.3	ANALYTICAL PROGRAM	2-19
	2.1.4	AQUIFER TESTS	2-23
		2.1.4.1 Pumping Tests	2-23
		2.1.4.2 Slug Tests	2-25
2.2	SURFACE WATER MONITORING		2-26
	2.2.1	ACCURACY OF RESULTS	2-31
2.3	SEDIMENT SAMPLING AND ANALYSIS		2-32
	2.3.1	SITE LOCATIONS	2-32
	2.3.2	FIELD SAMPLING METHODOLOGY	2-34
	2.3.3	ANALYTICAL METHODS	2-35
2.4	AIR MONITORING		2-35
	2.4.1	OFFPOST AIR MONITORING	2-36
	2.4.2	ONPOST AIR MONITORING	2-36
2.5	BIOTA		2-39
	2.5.1	METHODS OF INVESTIGATION	2-41
3.0	**GROUND-WATER CONDITIONS**		3-1
3.1	GEOLOGY		3-1
	3.1.1	CHARACTERIZATION OF ALLUVIUM	3-1
		3.1.1.1 Characterization of the Alluvium in the Offpost Operable Unit	3-2
	3.1.2	BEDROCK SURFACE	3-8
	3.1.3	CHARACTERIZATION OF THE DENVER FM	3-13
		3.1.3.1 Depositional Environment	3-13
		3.1.3.2 Stratigraphic Correlation within the Denver Fm	3-16
		3.1.3.3 Characterization and Definition of the Denver Fm	3-17

TABLE OF CONTENTS

Section			Page
	3.1.4	CHARACTERIZATION OF ARAPAHOE FM	3-31
3.2	HYDROGEOLOGY		3-32
	3.2.1	ALLUVIAL AQUIFER	3-33
		3.2.1.1 Water Table	3-34
		3.2.1.2 Saturated Alluvial Thickness	3-43
		3.2.1.3 Aquifer Parameters	3-45
		3.2.1.4 Ground-Water Flow Directions and Qualities	3-50
		3.2.1.5 Stresses to the Alluvial Aquifer System	3-53
	3.2.2	DENVER FM	3-56
		3.2.2.1 Aquifer Recharge	3-58
		3.2.2.2 Denver Fm Zones	3-58
		3.2.2.3 Potentiometric Surface	3-59
		3.2.2.4 Hydraulic Conductivity and Transmissivity	3-64
		3.2.2.5 Discharge	3-69
		3.2.2.6 Aquifer Interactions	3-69
	3.2.3	ARAPAHOE FM	3-72
3.3	GROUND-WATER CONTAMINATION		3-74
	3.3.1	NATURE AND EXTENT OF ALLUVIAL AQUIFER CONTAMINATION	3-75
		3.3.1.1 Data Presentation	3-79
		3.3.1.2 DIMP	3-87
		3.3.1.3 DBCP	3-88
		3.3.1.4 DCPD	3-89
		3.3.1.5 Organosulfur Compounds	3-89
		3.3.1.6 1,4-Oxathiane and 1,4-Dithiane	3-91
		3.3.1.7 Organochlorine Pesticides	3-91
		3.3.1.8 Volatile Organohalogens	3-93
		3.3.1.9 Volatile Aromatics	3-97
		3.3.1.10 Inorganics	3-97
	3.3.2	NATURE AND EXTENT OF DENVER AQUIFER CONTAMINATION	3-104
		3.3.2.1 Data Presentation	3-105
		3.3.2.2 Contamination in Units Identified at NBCS	3-111
		3.3.2.3 Contamination Units Not Correlated to NBCS	3-120
	3.3.3	QA/QC DATA	3-124
		3.3.3.1 DIMP, DBCP, DCPD	3-125
		3.3.3.2 1,4-Oxathiane, 1,4-Dithiane, CPMS, CPMSO, CPMSO2	3-134
		3.3.3.3 Organochlorine Pesticides	3-134
		3.3.3.4 Volatile Organohalogens	3-134
		3.3.3.5 Volatile Aromatics	3-135
		3.3.3.6 Inorganics	3-135
		3.3.3.7 Additional Inorganics	3-135
	3.3.4	GAS CHROMATOGRAPHY/MASS SPECTOMETRY RESULTS	3-135
		3.3.4.1 Well Selection	3-136
		3.3.4.2 GC/MS Analytical Methods	3-139
		3.3.4.3 Quality Assurance/Quality Control	3-139
		3.3.4.4 Confirmation of Target Analytes and Concentrations	3-142
		3.3.4.5 Nontarget Compound Analytical Results	3-143
		3.3.4.6 Nontarget Compound Occurrence	3-145
		3.3.4.7 Conclusions	3-148
		3.3.4.8 Recommendations	3-149

TABLE OF CONTENTS

Section		Page
3.4	EVALUATION OF GROUND-WATER DATA	3-150
3.4.1	ALLUVIAL CONTAMINATION NORTH OF RMA NORTH BOUNDARY	3-151
3.4.1.1	Effects of the NBCS	3-159
3.4.1.2	Effects of Surface Water Recharge	3-180
3.4.2	DENVER CONTAMINATION NORTH OF RMA NORTH BOUNDARY	3-182
3.4.3	ALLUVIAL CONTAMINATION DOWNGRADIENT OF RMA NORTHWEST BOUNDARY	3-190
3.5	CONTAMINANT TRANSPORT MODELING	3-191
3.5.1	COMPUTER PROGRAM	3-192
3.5.2	MODEL INPUT DATA	3-192
3.5.2.1	Boundary Conditions	3-193
3.5.2.2	Irrigation Recharge, Canal Leakage and Other Recharge/Discharge	3-193
3.5.2.3	Aquifer Thickness	3-194
3.5.2.4	Porosity and Storage Coefficient	3-194
3.5.2.5	Transmissivity	3-195
3.5.2.6	Dispersivity	3-195
3.5.2.7	Chemical Character	3-195
3.5.2.8	Mass Balance	3-196
3.5.3	MODEL CALIBRATION	3-196
3.5.4	MODEL SIMULATIONS	3-197
3.5.4.1	DIMP	3-198
3.5.4.2	Dieldrin	3-199
3.5.4.3	Chloroform and DCPD	3-199
3.5.5	CONCLUSIONS	3-200
4.0	**SURFACE WATER CONDITIONS**	4-1
4.1	DESCRIPTION OF SURFACE DRAINAGES	4-1
4.2	NATURE AND EXTENT OF CONTAMINATION	4-4
4.2.1	ORGANICS	4-4
4.2.2	INORGANICS	4-11
4.3	CONTAMINANT PATHWAYS TO OFFPOST SURFACE WATER	4-13
4.3.1	FIRST CREEK	4-13
4.3.1.1	First Creek Flows From Onpost	4-14
4.3.1.2	Ground Water Discharge to First Creek Offpost	4-18
4.3.2	O'BRIAN CANAL AND BURLINGTON DITCH	4-28
4.3.3	OVERLAND FLOODING	4-31
4.4	CONCLUSION	4-32
5.0	**OFFPOST SEDIMENT CONDITIONS**	5-1
5.1	NATURE AND EXTENT OF CONTAMINATION	5-2
5.1.1	ANALYTICAL SCHEDULE	5-2
5.1.2	RESULTS OF PREVIOUS SEDIMENT STUDY	5-4
5.1.3	RESULTS OF PRESENT SEDIMENT STUDY	5-10
5.2	SEDIMENT CONTAMINATION PATHWAYS	5-12
5.3	CONCLUSIONS	5-13

TABLE OF CONTENTS

Section		Page
6.0	**AIR QUALITY CONDITIONS**	6-1
6.1	CRITERIA AIRBORNE POLLUTANTS	6-1
6.2	TOXIC AIRBORNE POLLUTANTS	6-3
6.3	CONCLUSIONS	6-10
7.0	**BIOTA CONDITIONS**	7-1
7.1	RESULTS OF HOME RANGE STUDIES	7-1
7.1.1	RING-NECKED PHEASANTS	7-1
7.1.2	DESERT COTTON TAIL RABBITS	7-5
7.2	DISCUSSION OF HOME RANGE STUDY	7-5
7.3	EVALUATION OF BIOTA CONTAMINANT PATHWAYS	7-12
8.0	**POTENTIAL CHEMICAL-SPECIFIC ARARS**	8-1
9.0	**CONCLUSIONS**	9-1
9.1	GROUND WATER	9-1
9.2	SURFACE WATER AND SEDIMENTS	9-4
9.3	AIR	9-6
9.4	BIOTA	9-6
10.0	**REFERENCES**	10-1
11.0	**ACRONYMS AND ABBREVIATIONS**	11-1

VOLUME II

APPENDICES

APPENDIX A -- WELL DESIGNATION CRITERIA

APPENDIX B -- WELL COMPLETION SUMMARIES, LITHOLOGIC LOGS, AND GEOPHYSICAL LOGS

APPENDIX C -- WELL LOCATIONS, COMPLETION DATA AND SITE CONDITIONS, AND SITING RATIONAL

C.1 ALLUVIAL WELLS
C.2 DENVER WELLS

APPENDIX D -- SLUG TESTS: COOPER TYPE CURVES AND DATA CURVES, AND AQUIFER TEST ANALYSES

D.1 SLUG TESTS: COOPER TYPE CURVES AND DATA CURVES
D.2 WELL 37367 AQUIFER TEST ANALYSES

TABLE OF CONTENTS

Section — Page

VOLUME III

APPENDIX E -- GEOLOGIC AND HYDROLOGIC PRODUCTS

APPENDIX F -- CONTAMINANT DISTRIBUTION MAPS, CONTAMINANT POINT PLOTS, AND WATER QUALITY DATA

F.1 CONTAMINANT DISTRIBUTION AND POINT PLOT MAPS
F.2 WATER QUALITY DATA
F.3 GC/MS ANALYTICAL RESULTS

APPENDIX G -- CONTAMINANT TRANSPORT MODEL RESULTS

APPENDIX H -- POTENTIAL CHEMICAL-SPECIFIC ARARS FOR OFFPOST OPERABLE UNIT ROCKY MOUNTAIN ARSENAL

APPENDIX I -- CONTAMINANT DISTRIBUTION PLOTS FROM OFFPOST CONTAMINATION ASSESSMENT REPORT

APPENDIX J -- COMMENTS AND RESPONSES TO THE OFFPOST OPERABLE UNIT REMEDIAL INVESTIGATION AND CHEMICAL SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS, DRAFT FINAL REPORT (VERSION 2.1), AUGUST 1988

LIST OF FIGURES

Figure		Page
1.0-1	Location Map of Rocky Mountain Arsenal	1-2
1.0-2	Offpost Operable Unit	1-3
2.1-1	Location Map of Alluvial Wells in the Offpost Operable Unit	2-6
2.1-2	New Alluvial Sites	2-7
2.1-3	Generalized Alluvial Aquifer Monitor Well Construction	2-8
2.1-4	Location Map of Denver Wells in the Offpost Operable Unit	2-12
2.1-5	New Denver Sites	2-13
2.1-6	Generalized Bedrock Aquifer Monitor Well Construction (First Sandstone)	2-16
2.1-7	Generalized Bedrock Aquifer Monitor Well Construction (Second Sandstone)	2-17
2.1-8	Idealized Diagram of Slug-in Aquifer	2-27
2.2-1	Locations for Surface Water Sampling in the Offpost Operable Unit	2-29
2.2-2	Offpost Operable Unit Surface Water Gaging Station Locations	2-30
2.3-1	Locations for Sediment Sampling in Offpost Operable Unit	2-33
3.1-1	Geologic Map of Rocky Mountain Arsenal Area	3-3
3.1-2	Quarternary Columnar Section	3-4
3.1-3	Unified Soil Classification (ASTM D-2487)	3-5
3.1-4	Generalized East-West Alluvial Cross-Section from the South Platte River to the Northeast Corner of Rocky Mountain Arsenal	3-6
3.1-5	East-West Geologic Cross-Section NB Downgradient 30.6	3-9
3.1-6	Southwest-Northeast Geologic Cross-Section NWB Downgradient 3.5	3-10
3.1-7	Bedrock Surface Elevation Map in the Offpost Operable Unit Near the Rocky Mountain Arsenal Boundaries	3-12
3.1-8	Schematic Diagrams Depicting Denver Fm Depositional Environments	3-15

LIST OF FIGURES

Figure		Page
3.1-9	Location of Geologic Cross Sections in the Vicinity of the Offpost Operable Unit	3-18
3.1-10	Southwest-Northeast Geologic Cross Section NWB Upgradient 7.8	3-20
3.1-11	Southeast-Northwest Geologic Cross Section NWB 0.0	3-21
3.1-12	Subcrop Map of Denver Fm Zones	3-23
3.1-13	East-West Geologic Cross Section NB Slurry Wall	3-26
3.1-14	North-South Geologic Cross Section NB 0.0	3-27
3.1-15	Subcrop Map of Denver Fm Sandstone Units in the Offpost Area Downgradient of the NBCS	3-30
3.2-1	Water Table Elevation Map in the Offpost Operable Unit Near the RMA Boundaries (Spring, 1987)	3-35
3.2-2	Historical Hydrograph for Well 37309	3-38
3.2-3	Historical Hydrograph for Well 37335	3-39
3.2-4	Seasonal Hydrograph for Wells 37308 and 37309	3-41
3.2-5	1986 Seasonal Hydrograph for Well 37335	3-42
3.2-6	Saturated Thickness Map for the Alluvial Aquifer in the Offpost Operable Unit Near the Rocky Mountain Arsenal Boundaries (Summer, 1987)	3-44
3.2-7	Location of Alluvial Aquifer Tests	3-46
3.2-8	Potentiometric Surface Map of Denver Fm Zone 2 (Spring 1987)	3-61
3.2-9	Potentiometric Surface Map of Denver Fm Zone 3 (Spring 1987)	3-62
3.2-10	Potentiometric Surface Map of Denver Fm Zone 4 (Spring 1987)	3-63
3.2-11	Location of Denver Fm Aquifer Tests	3-65
3.3-1	DIMP Assessment in Alluvial Wells for Consumptive Use--Phase I and II and Revision III-360° Programs	3-76

LIST OF FIGURES

Figure		Page
3.3-2	Generalized Pre-system Alluvial Flow Pathways (February-March, 1978 water table)	3-86a
3.3-3	Water Chemistry Data for Denver Fm Unit NBW#1A, Summer Quarter, 1987	3-107
3.3-4	Water Chemistry Data for Denver Fm Unit NBW#1, Spring and Summer Quarters, 1987	3-108
3.3-5	Water Chemistry Data for Denver Fm Unit NBW#2, Summer Quarter, 1987	3-109
3.3-6	Water Chemistry Data for Offpost Denver Fm Wells Not Correlated to Sandstone Units Identified at NBCS	3-110
3.3-7	Location of Offpost Wells Sampled for GC/MS Analyses	3-138
3.4-1	Scatter Diagram Comparing Organic Carbon Concentrations Versus Medium Grain Size	3-158
3.4-2	Historical DIMP Concentrations for Well 37307	3-165
3.4-3	Historical DCPD Concentrations for Well 37307	3-166
3.4-4	Historical DIMP Concentrations for Well 37308	3-168
3.4-5	Historical DCPD Concentrations for Well 37308	3-169
3.4-6	Historical Dieldrin Concentrations for Well 37308	3-170
3.4-7	Historical DIMP Concentrations for Well 37309	3-172
3.4-8	Historical DCPD Concentrations for Well 37309	3-173
3.4-9	Historical DBCP Concentrations for Well 37309	3-174
3.4-10	Historical DIMP Concentrations for Well 37312	3-175
3.4-11	Historical DCPD Concentrations for Well 37312	3-177
3.4-12	Historical Dieldrin Concentrations for Well 37312	3-178
3.4-13	Historical DIMP Concentrations for Well 37313	3-179
4.1-1	Locations of Offpost Surface Water Sampling Locations	4-2
4.2-1	Organic Contaminants Observed in Multiple Samples at Offpost Surface Water Stations	4-8
4.2-2	Relationship Between First Creek Discharges and DIMP Concentrations	4-10

LIST OF FIGURES

Figure		Page
4.3-1	First Creek Water Quality Stations Onpost	4-16
4.3-2	Zones of Potential Ground-Water Discharge to First Creek Onpost	4-17
4.3-3	DIMP Concentration Distribution, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	4-19
4.3-4	Monthly Discharge Values at First Creek Gaging Stations	4-22
4.3-5	Change In First Creek Flows Offpost Versus Discharge at Highway 2 Station	4-24
4.3-6	Flow Frequency Histogram For First Creek at Highway 2 Station (July 1986 through August 1987)	4-25
4.3-7	Estimated Ground-Water Elevations Along First Creek from the RMA North Boundary to Highway 2	4-27
4.3-8	Estimated Ground-Water Elevations Versus Stream Bed Elevations for O'Brian Canal and Burlington Ditch	4-30
4.3-9	Surface Water Drainage Basins at RMA and in Offpost Operable Unit	4-33
5.1-1	Contaminant Volatility Versus Sorption	5-3
5.1-2	Offpost Sediment Sampling Locations (April 1986)	5-8
7.1-1	Home Ranges of Ring-necked Pheasants	7-4
7.1-2	Home Ranges of Cottontail Rabbits	7-10
7.2-1	Preliminary Vegetation Map of Rocky Mountain Arsenal	7-13
E-1	East-West Geologic Cross-Section NB Downgradient 59.0 (104th Avenue)	
E-2	Bedrock Elevation Map	
E-3	Net Sand Isopach Contour Map of Regional Denver Formation Zone 2	
E-4	Net Sand Isopach Contour Map of Regional Denver Formation Zone 3	
E-5	Net Sand Isopach Contour Map of Regional Denver Formation Zone 4	
E-6	Isopach Map of the NBW#1A and NBE#1 Sandstone Units	

LIST OF FIGURES

Figure		Page
E-7	Isopach Map of the NBW#1 Sandstone Unit	
E-8	Isopach Map of the NBW#2 Sandstone Unit	
E-9	Isopach Map of the NBW#3 Sandstone Unit	
E-10	Water Table Elevation Map, Spring 1987	
E-11	Water Table Elevation Map, Summer 1987	
E-12	Historical Hydrograph for Well 37308	
E-13	Historical Hydrograph for Well 37334	
E-14	Saturated Thickness Map for Alluvial Aquifer	
E-15	Potentiometric Surface Map of Denver Fm Unit NBW#1A, February 1988	
E-16	Potentiometric Surface Map of Denver Fm Unit NBW#1, February 1988	
E-17	Potentiometric Surface Map of Denver Fm Unit NBW#2, February 1988	
E-18	Potentiometric Surface Map of Denver Fm Unit NBW#3, February 1988	
F-1	DIMP Concentration Distribution, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-2	DIMP Concentration Distribution, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-3	DBCP Concentration Distribution, ug/l 3rd Quarter, FY87, Alluvial Aquifer	
F-4	DBCP Concentration Distribution, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-5	DCPD Concentration Distribution, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-6	DCPD Concentration Distribution, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-7	CPMSO2 Concentration Distribution, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-8	CPMSO2 Concentration Distribution, ug/l, 4th Quarter, FY87,	

LIST OF FIGURES

Figure		Page
	Alluvial Aquifer	
F-9	CPMSO Concentration Distribution, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-10	CPMSO Concentration Distribution, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-11	CPMS Concentration Distribution, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-12	CPMS Concentration Distribution, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-13	1,4-Dithiane Concentration Distribution, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-14	1,4-Dithiane Concentration Distribution, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-15	1,4-Oxathiane Concentration Distribution, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-16	1,4-Oxathiane Concentration Distribution, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-17	Dieldrin Concentration Distribution, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-18	Dieldrin Concentration Distribution, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-19	Endrin Concentration Distribution, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-20	Endrin Concentration Distribution, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-21	Organochlorine Pesticides Concentrations Exceeding Certified Reporting Limits, ug/l, p,p-DDE, p,p-DDT, Aldrin, Isodrin, 3rd Quarter, FY87, Alluvial Aquifer	
F-22	Organochlorine Pesticides Concentrations Exceeding Certified Reporting Limits, ug/l, p,p-DDE, p,p-DDT, Aldrin, Isodrin, 4th Quarter, FY87, Alluvial Aquifer	
F-23	Chloroform Concentration Distribution, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-24	Chloroform Concentration Distribution, ug/l, 4th Quarter, FY87, Alluvial Aquifer	

LIST OF FIGURES

Figure		Page
F-25	Tetrachloroethene Concentration Distribution, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-26	Tetrachloroethene Concentration Distribution, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-27	Trichloroethene Concentration Distribution, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-28	Trichloroethene Concentration Distribution, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-29	1,2-Dichloroethene Concentration Distribution, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-30	1,2-Dichloroethene Concentration Distribution, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-31	Chlorobenzene Concentrations Exceeding Certified Reporting Limits, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-32	Chlorobenzene Concentrations Exceeding Certified Reporting Limits, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-33	Volatile Organohalogens (CCL4, 12DCE, 11DCLE, 111TCE, 12TCE, CH2CL2) Exceeding Certified Reporting Limits, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-34	Volatile Organohalogens (CCL4, 12DCE, 11DCLE, 111TCE, 12TCE, CH2CL2) Exceeding Certified Reporting Limits, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-35	Benzene Concentrations Exceeding Certified Reporting Limits, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-36	Benzene Concentrations Exceeding Certified Reporting Limits, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-37	Volatile Aromatics (Ethylbenzene, m-Xylene, o,p-Xylene) Exceeding Certified Reporting Limits, ug/l, 3rd Quarter, Alluvial Aquifer	
F-38	Chloride Concentration Distribution, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-39	Chloride Concentration Distribution, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-40	Fluoride Concentration Distribution, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	

LIST OF FIGURES

Figure		Page
F-41	Fluoride Concentration Distribution, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-42	Arsenic and Mercury Concentrations Exceeding Certified Reporting Limits, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-43	Arsenic and Mercury Concentrations Exceeding Certified Reporting Limits, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-44	Sulfate Concentration Distribution, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-45	Sulfate Concentration Distribution, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-46	Calcium Concentration Distribution, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-47	Calcium Concentration Distribution, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-48	Potassium Concentration Distribution, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-49	Potassium Concentration Distribution, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-50	Sodium Concentration Distribution, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-51	Sodium Concentration Distribution, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-52	Magnesium Concentration Distribution, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-53	Magnesium Concentration Distribution, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-54	Nitrate Concentration Distribution, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-55	Nitrate Concentration Distribution, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-56	Zinc Concentration Distribution, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-57	Zinc Concentration Distribution, ug/l, 4th Quarter, FY87, Alluvial Aquifer	

LIST OF FIGURES

Figure		Page
F-58	Cadmium Concentrations Exceeding Certified Reporting Limits, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-59	Cadmium Concentrations Exceeding Certified Reporting Limits, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-60	Lead Concentrations Exceeding Certified Reporting Limits, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-61	Lead Concentrations Exceeding Certified Reporting Limits, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-62	Chromium Concentrations Exceeding Certified Reporting Limits, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-63	Chromium Concentrations Exceeding Certified Reporting Limits, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-64	Copper Concentrations Exceeding Certified Reporting Limits, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-65	Copper Concentrations Exceeding Certified Reporting Limits, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-66	Water Chemistry Data for Denver Fm Unit NBW#1A, Spring Quarter, 1987	
F-67	Water Chemistry Data for Denver Fm Unit NBW#2, Spring Quarter, 1987	
F-68	Water Chemistry Data for Denver Fm Unit NBW#3, Spring and Summer Quarters, 1987	
F-69	Water Chemistry Data for Denver Fm Unit NBE#2, Spring and Summer Quarters, 1987	
F-70	Water Chemistry Data for Denver Fm Units NBE#3 and NBE#4, Spring and Summer Quarters, 1987	
F-71	Nontarget Compounds (Bis (2-ethylhexyl) pthalate, Caprolactum) Identified by GC/MS Analysis, ug/l, Task 4 and Task 44, Alluvial Aquifer	
F-72	Nontarget Compound (Dichlorobenzene) Identified by GC/MS Analysis, ug/l, Task 4 and Task 44, Alluvial Aquifer	
G-1	Index Map of Model Area	
G-2	Finite Element Mesh	

LIST OF FIGURES

Figure		Page
G-3	Water Balance of Model Area	
G-4	Auqifer Thickness Map	
G-5a	Transmissivity Map: Contour Interval 1,000-5,000 ft^2/day	
G-5b	Transmissivity Map: Contour Interval 5,000-25,000 ft^2/day	
G-6	Measured Spring 1987 Water Table Map	
G-7	Model Calculated Steady State Water Table Map	
G-8a	DIMP 1987 Concentrations: Contour Interval 20-100 ug/l	
G-8b	DIMP 1987 Concentrations: Contour Interval 100-200 ug/l	
G-8c	DIMP 1987 Concentrations: Contour Interval 200-1,000 ug/l	
G-9a	DIMP Concentrations in 1992 (5 years) with Existing North Boundary Recharge Operations: Contour Interval (20-100 ug/l)	
G-9b	DIMP Concentrations in 1992 (5 years) with Existing North Boundary Recharge Operations: Contour Interval (100-200 ug/l)	
G-9c	DIMP Concentrations in 1992 (5 years) with Existing North Boundary Recharge Operations: Contour Interval (200-800 ug/l)	
G-10a	DIMP Concentrations in 1997 (10 years) with Existing North Boundary Recharge Operations: Contour Interval (20-100 ug/l)	
G-10b	DIMP Concentrations in 1997 (10 years) with Existing North Boundary Recharge Operations: Contour Interval (100-700 ug/l)	
G-11a	DIMP Concentrations in 2007 (20 years) with Existing North Boundary Recharge Operations: Contour Interval (20-100 ug/l)	
G-11b	DIMP Concentrations in 2007 (20 years) with Existing North Boundary Recharge Operations: Contour Interval (100-300 ug/l)	
G-12	DIMP Concentrations in 2017 (30 years) with Existing North Boundary Recharge Operations: Contour Interval (20-180 ug/l)	

LIST OF FIGURES

Figure		Page
G-13a	DIMP Concentrations in 1992 (5 years) with North Boundary Recharge Operation for Natural Flow Conditions: Contour Interval (20-100 ug/l)	
G-13b	DIMP Concentrations in 1992 (5 years) with North Boundary Recharge Operation for Natural Flow Conditions: Contour Interval (100-200 ug/l)	
G-13c	DIMP Concentrations in 1992 (5 years) with North Boundary Recharge Operation for Natural Flow Conditions: Contour Interval (200-800 ug/l)	
G-14a	DIMP Concentrations in 1997 (10 years) with North Boundary Recharge Operation for Natural Flow Conditions: Contour Interval (20-100 ug/l)	
G-14b	DIMP Concentrations in 1997 (10 years) with North Boundary Recharge Operation for Natural Flow Conditions: Contour Interval (100-700 ug/l)	
G-15a	DIMP Concentrations in 2007 (20 years) with North Boundary Recharge Operation for Natural Flow Conditions: Contour Interval (20-100 ug/l)	
G-15b	DIMP Concentrations in 2007 (20 years) with North Boundary Recharge Operation for Natural Flow Conditions: Contour Interval (100-300 ug/l)	
G-16	DIMP Concentrations in 2017 (30 years) with North Boundary Recharge Operation for Natural Flow Conditions: Contour Interval (20-180 ug/l)	
G-17a	DIMP Concentrations in 1992 (5 years) with Existing South Adams County Well Field: Contour Interval (20-100 ug/l)	
G-17b	DIMP Concentrations in 1992 (5 years) with Existing South Adams County Well Field: Contour Interval (100-200 ug/l)	
G-17c	DIMP Concentrations in 1992 (5 years) with Existing South Adams County Well Field: Contour Interval (200-800 ug/l)	
G-18a	DIMP Concentrations in 1997 (10 years) with Existing South Adams County Well Field: Contour Interval (20-100 ug/l)	
G-18b	DIMP Concentrations in 1997 (10 years) with Existing South Adams County Well Field: Contour Interval (100-700 ug/l)	
G-19a	DIMP Concentrations in 2007 (20 years) with Existing South Adams County Well Field: Contour Interval (20-100 ug/l)	

LIST OF FIGURES

Figure		Page
G-19b	DIMP Concentrations in 2007 (20 years) with Existing South Adams County Well Field: Contour Interval (100-300 ug/l)	
G-20	DIMP Concentrations in 2017 (30 years) with Existing South Adams County Well Field: Contour Interval (20-180 ug/l)	
G-21a	DIMP Concentrations in 1992 (5 years) for Proposed South Adams County Well Field: Contour Interval (20-100 ug/l)	
G-21b	DIMP Concentrations in 1992 (5 years) for Proposed South Adams County Well Field: Contour Interval (100-200 ug/l)	
G-21c	DIMP Concentrations in 1992 (5 years) for Proposed South Adams County Well Field: Contour Interval (200-800 ug/l)	
G-22a	DIMP Concentrations in 1997 (10 years) for Proposed South Adams County Well Field: Contour Interval (20-100 ug/l)	
G-22b	DIMP Concentrations in 1997 (10 years) for Proposed South Adams County Well Field: Contour Interval (100-700 ug/l)	
G-23a	DIMP Concentrations in 2007 (20 years) for Proposed South Adams County Well Field: Contour Interval (20-100 ug/l)	
G-23b	DIMP Concentrations in 2007 (20 years) for Proposed South Adams County Well Field: Contour Interval (100-300 ug/l)	
G-24	DIMP Concentrations in 2017 (30 years) for Proposed South Adams County Well Field: Contour Interval (20-180 ug/l)	
G-25	Dieldrin 1987 Concentrations	
G-26	Dieldrin Concentrations in 1992 (5 years) with Existing North Boundary Recharge Operations	
G-27	Dieldrin Concentrations in 1997 (10 years) with Existing North Boundary Recharge Operations	
G-28	Dieldrin Concentrations in 2007 (20 years) with Existing North Boundary Recharge Operations	
G-29	Dieldrin Concentrations in 2017 (30 years) with Existing North Boundary Recharge Operations	
G-30	Dieldrin Concentrations in 1992 (5 years) with North Boundary Recharge Operation for Natural Flow Conditions	
G-31	Dieldrin Concentrations in 1997 (10 years) with North Boundary Recharge Operation for Natural Flow Conditions	

LIST OF FIGURES

Figure		Page
G-32	Dieldrin Concentrations in 2007 (20 years) with North Boundary Recharge Operation for Natural Flow Conditions	
G-33	Dieldrin Concentrations in 2017 (30 years) with North Boundary Recharge Operation for Natural Flow Conditions	
G-34	Dieldrin Concentrations in 1992 (5 years) with Existing South Adams County Well Field	
G-35	Dieldrin Concentrations in 1997 (10 years) with Existing South Adams County Well Field	
G-36	Dieldrin Concentrations in 2007 (20 years) with Existing South Adams County Well Field	
G-37	Dieldrin Concentrations in 2017 (30 years) with Existing South Adams County Well Field	
G-38	Dieldrin Concentrations in 1992 (5 years) for Proposed South Adams County Well Field	
G-39	Dieldrin Concentrations in 1997 (10 years) for Proposed South Adams County Well Field	
G-40	Dieldrin Concentrations in 2007 (20 years) for Proposed South Adams County Well Field	
G-41	Dieldrin Concentrations in 2017 (30 years) for Proposed South Adams County Well Field	
G-42	Chloroform Concentrations for 1987	
G-43	Chloroform Concentrations in 1992 (5 years) with Existing South Adams County Well Field	
G-44	Chloroform Concentrations in 1997 (10 years) with Existing South Adams County Well Field	
G-45	Chloroform Concentrations in 2007 (20 years) with Existing South Adams County Well Field	
G-46	Chloroform Concentrations in 2017 (30 years) with Existing South Adams County Well Field	
G-47	DCPD Concentrations in 1987	
G-48	DCPD Concentrations in 1992 (5 years) with Existing South Adams County Well Field	
G-49	DCPD Concentrations in 1997 (10 years) with Existing South Adams County Well Field	

LIST OF FIGURES

Figure		Page
G-50	DCPD Concentrations in 2007 (20 years) with Existing South Adams County Well Field	
G-51	DCPD Concentrations in 2017 (30 years) with Existing South Adams County Well Field	
I-1	Aromatic and Halogenated Aliphatic Solvent Assessment RMA Offpost First Quarter Sampling of Wells	
I-2	Aromatic and Halogenated Aliphatic Solvent Assessment RMA Offpost Second Quarter Sampling of Wells	
I-3	Chlorinated Pesticide Assessment RMA Offpost First Quarter Sampling of Wells	
I-4	Chlorinated Pesticide Assessment RMA Offpost Second Quarter Sampling of Wells	
I-5	Organosulfur Compounds Assessment RMA Offpost First Quarter Sampling of Wells	
I-6	Organosulfur Compounds Assessment RMA Offpost Second Quarter Sampling of Wells	
I-7	DBCP Assessment RMA Offpost First Quarter Sampling of Wells	
I-8	DBCP Assessment RMA Offpost Second Quarter Sampling of Wells	
I-9	DCPD Assessment RMA Offpost First Quarter Sampling of Wells	

LIST OF TABLES

Table		Page
2.1-1	Aquifer Designations for Wells in Offpost Operable Unit	2-9
2.1-2	Completion Data for New Alluvial Wells	2-14
2.1-3	Completion Data for New Denver Wells	2-18
2.1-4	Chemical Analyses-Offpost Operable Unit Analytical Program	2-21
2.4-1	Summary of Previous Air Quality Monitoring Programs at RMA	2-38
3.2-1	Transmissivity (T), Hydraulic Conductivity (K), and Apparent Specific Yield (SYA) from Pumping Tests	3-48
3.2-2	Hydraulic Conductivity of Combined Soil Groups in the Alluvial Aquifer	3-51
3.2-3	Slug Test Results for Denver Fm Units Near the North Boundary of RMA	3-66
3.2-4	Water Elevations for Well Cluster Sites in the Offpost Operable Unit	3-71
3.3-1	Frequency of Detection and Range of Concentrations for Target Analytes--Spring 1987	3-80
3.3-2	Frequency of Detection and Range of Concentrations for Target Analytes--Summer 1987	3-82
3.3-3	Representative Concentrations for Naturally Occurring Constituents in Upgradient Alluvial Wells	3-98
3.3-4	Typical Background Water Chemistry From the Denver Fm	3-118
3.3-5	Additional Inorganic Parameters for Wells 37379 and 37380, Spring and Summer 1987	3-121
3.3-6	Field QA/QC Procedures	3-126
3.3-7	Duplicate Data: DIMP, DBCP, DCPD, (ug/l)	3-127
3.3-8	Duplicate Data: 1,4-Oxathiane, 1,4-Dithiane, CPMS, CPMSO, CPMSO2 (ug/l)	3-128
3.3-9	Duplicate Data: Organochlorine Pesticides (ug/l)	3-129
3.3-10	Duplicate Data: Volatile Organohalogens (ug/l)	3-130
3.3-11	Duplicate Data: Volatile Aromatics (ug/l)	3-131

LIST OF TABLES

Table		Page
3.3-12	Duplicate Data: Inorganics (ug/l)	3-132
3.3-13	Duplicate Data: Additional Inorganics (ug/l)	3-133
3.3-14	Offpost Wells from which Water Samples were Collected and Submitted for GC/MS Analysis	3-137
3.3-15	GC/MS Target Analytes	3-140
3.3-16	Certified Reporting Limit for GC Analyses and Apparent Method Detection Limit for GC/MS Analyses	3-141a
3.3-17	Frequency of Detection for Tentatively Identified Compounds	3-146
3.4-1	Estimated Range of K_d Values	3-156
3.4-2	Comparison of Chloride Concentrations Upgradient and Downgradient of Irrigation Canals (mg/l)	3-183
3.4-3	Selected Organic Contaminant Concentrations in Task 39 Cluster Wells (ug/l)	3-184
3.4-4	Benzene and Chlorobenzene Concentrations in Task 39 Cluster Wells (ug/l)	3-185
3.4-5	Fluoride, Chloride, and Sulfate Concentrations in Task 39 Cluster Wells (ug/l)	3-186
4.1-1	Comparison of Average Monthly Flows for South Platte River, Burlington Ditch, O'Brian Canal, and First Creek in the RMA Offpost Operable Unit (All Values in Acre-Feet)	4-3
4.2-1	Summary of Organic Contaminant Concentrations in Offpost Surface Water	4-5
4.2-2	Inorganic Concentration Ranges at Offpost Surface Water Sampling Stations (ug/l)	4-7
4.3-1	Summary of Organic Contaminant Concentrations Onpost in First Creek and Its Potential Tributaries	4-15
5.1-1	Analyte Schedule and Certified Reporting Limits for Sediment Analyses Performed for Offpost Contamination Assessment Report	5-5
5.1-2	Metal Concentrations in Offpost Sediment Samples from Offpost Contamination Assessment Report	5-7
5.1-3	Sediment Analyses (April 14, 1988 Sampling)	5-11

LIST OF TABLES

Table		Page
5.2-1	Representative Metals Concentrations in Wastewater Sludge (ug/g)	5-14
5.3-1	Metal Concentrations Commonly Found in Uncontaminated Freshwater Sediments (ug metal/gm dry sediment)	5-15
6.1-1	Summary of Air Quality Parameters in the Vicinity of the Rocky Mountain Arsenal	6-2
6.2-1	Airborne Organic Compounds at Rocky Mountain Arsenal	6-4
6.2-2	Airborne Metals at the Rocky Mountain Arsenal	6-9
7.1-1	Pheasant Home Range Estimates	7-2
7.1-2	Final Status of Animal and Transmitter	7-6
7.1-3	Cottontail Home Range Estimates	7-9

EXECUTIVE SUMMARY

Field investigations conducted over the last several years in the area offpost of RMA have examined various media to evaluate the nature and extent of contamination that may have resulted from contaminant migration from Rocky Mountain Arsenal (RMA). Consumptive Use Assessments and Contamination Assessments conducted since 1984 have indicated that ground water was the primary pathway for contaminant migration to the offpost area. Thus, much of the Remedial Investigation (RI) efforts focused on evaluating ground-water pathways and the nature and extent of ground-water contamination. However, surface water, sediments, air, and biota were also examined to evaluate potential contamination in these media and the extent to which these media may be contaminant pathways from RMA to the Offpost Operable Unit. The evaluation of soils potentially contaminated as a result of irrigation with contaminated water offpost of RMA will be addressed in the Offpost Endangerment Assessment/Feasibility Study (EA/FS).

The nature and extent of ground water and surface water contamination are sufficiently understood for the EA/FS to proceed in evaluating remedial actions for these media. Additional data collection for these media, particularly for ground water downgradient of the Northwest Boundary Containment System (NWBCS), will be outlined in a plan for a Supplemental Technical Investigation (STI). The results of the STI will be incorporated into remedial design and provided as part of preliminary design documents.

Other media, such as sediments, soils, biota, and windblown dust, were considered in the planning stages of the RI. Soils and windblown dust were not thought to represent potential exposure pathways offpost except where surficial soils are impacted by irrigation with contaminated water. However, further evaluation of offpost soils and windblown dust will be conducted to respond to comments from Colorado Department of Health (CDH) and the Environmental Protection Agency (EPA). Although data have been collected to evaluate offpost sediments, additional data collection pertaining to this media is being planned to address concerns of citizens in the Offpost Operable Unit and comments from CDH. Biota studies were conducted to determine whether potentially contaminated species could

migrate from near source areas onpost to the Offpost Operable Unit. Although one species was identified as an exposure pathway and will be addressed in the EA/FS report, additional evaluation of biota will be conducted to respond to EPA comments. All data collected pertaining to these medial will be provided in addenda to the RI report.

The ground-water investigations performed as part of the RI concentrated on the area north of the RMA north boundary because this area is downgradient of the primary onpost ground-water contaminant plumes. Data collected under the RI identified two general zones of alluvial contamination in this offpost area. These zones generally correspond to two paleochannel features in the bedrock surface. These paleochannel features are referred to as the First Creek and Northern pathways.

Recharge to the alluvial aquifer from irrigation canals both directly from seepage and indirectly from irrigation appears to be responsible for substantially reduced contaminant concentrations downgradient of the canals. This is in contrast to concentrations observed upgradient of the canals and just north of the RMA north boundary.

Contamination in the Denver Formation (Fm) generally exhibited a trend of decreasing contaminant concentrations with depth. The highest contaminant concentrations in the Denver Fm were generally observed in samples from wells completed within sandy zones of the upper Denver Fm. These zones are in direct contact with the base of contaminated alluvium.

Consumptive use studies performed by ESE during 1984 and 1985 located only three Denver Fm domestic use wells in the area north of the RMA boundary and upgradient of O'Brian Canal. None of these wells exhibited organic contamination at concentrations exceeding certified reporting limits (CRLs).

The available data indicate that much of the observed ground-water contamination north of RMA migrated to the offpost area prior to installation of the North Boundary Containment System (NBCS) and that the NBCS has had a significant effect in lowering downgradient organic contaminant concentrations. This is substantiated by lower contaminant

concentrations downgradient of the NBCS relative to upgradient contaminant concentrations.

The alluvial aquifer downgradient of the Northwest Boundary Containment System (NWBCS) was shown to be contaminated with dieldrin and chloroform. Dieldrin's presence here appears to result from contamination prior to construction and operation of the NWBCS, along with dieldrin's low mobility in ground water. Chloroform contamination in the alluvial aquifer downgradient of the NWBCS may be the result of contaminantion migration prior to construction and operation of the NWBCS or current operation practices whch may have resulted in chloroform breaking through the carbon adsorption system at the NWBCS. Efforts are currently underway to modify the operational procedures at the NWBCS to alleviate chloroform breakthrough. More mobile contaminants such as DBCP and DIMP, which have also migrated toward the NWBCS, were generally not observed in offpost samples collected downgradient of the NWBCS.

An evaluation of surface runoff patterns and chemistry data collected since 1985 indicated that First Creek was the primary pathway for surface water contaminant migration to the area offpost of RMA. Further evaluations of chemistry and ground-water level data along First Creek indicates that contamination was primarily entering First Creek via infiltration of contaminated ground water offpost.

Organic contaminants in surface water were observed only sporadically in samples collected downstream of First Creek and at levels near the CRLs. This observation was primarily attributed to fate processes, such as volatilization, and dilution from larger upstream flows from O'Brian Canal. Observed organic contamination in samples from the upstream station on the South Platte River may be attributed to contaminated flow from Sand Creek, which enters the South Platte River upstream.

The extent of sediment contamination in the Offpost Operable Unit was evaluated by assessing analytical data from two sampling events. The data from nine sampling locations showed five detections of organic contaminants

(p,p-DDT; p,p-DDE; and dieldrin). The detections of these compounds were all just above their respective CRLs.

The highest levels of metals in sediments were noted in samples from Barr Lake, particularly from a deep stratum level (20 to 24 inches). With the exception of arsenic, Barr Lake concentrations were considered to be above the levels typically found in fresh water sediments and may be attributable to the past disposal of wastewater sludge in the lake. Metal concentrations in First Creek samples were generally considered to be within the range of metals concentrations for fresh water sediments. The single detection of dieldrin in First Creek sediments may be the result of RMA contaminant migration. However, the fact that organic contaminants were not observed in the fine-grained sediments in the offpost First Creek impoundment suggest that the extent of organically contaminated sediments along First Creek is not great.

The evaluation of air conditions in the Offpost Operable Unit were evaluated by assessing onpost data for criteria pollutants and toxic airborne contaminants. Because the criteria pollutants measured onpost were well within Federal and State standards and guidelines for ambient air quality, the offpost air quality was not significantly affected by RMA operations. There are no specified Federal or State toxic air quality guidelines for the toxic airborne contaminants. However, the onpost toxic air contaminants were noted at very low concentrations. Therefore, due to dispersion, offpost levels would be as low or lower than onpost concentrations. The source of most of these toxic air contaminants, Basin F, is presently being remediated as a part of an onpost Interim Response Action (IRA).

Biota was examined as a potential pathway from RMA to the Offpost Operable Unit by identifying species that could transport onpost contaminants by migrating offpost. Most resident species occurring on RMA were found not to be potentially significant pathways of contaminant migration from RMA to the Offpost Operable Unit. This was due to infrequent contamination of individual animals, small home ranges, or small populations at RMA.

The species of greatest concern was the ring-necked pheasant. Some individuals collected from areas of contamination onpost contained detectable concentrations of organochlorine pesticides. This species also has home range sizes large enough that permitted them to move offpost.

1.0 INTRODUCTION

The Rocky Mountain Arsenal (RMA) occupies 27 square miles in southern Adams County, Colorado (Figure 1.0-1), and lies within the Denver metropolitan area north of the City of Denver and east of Commerce City, Colorado. Since RMA began operation in 1942, it has been a site for the manufacture and demilitarization of chemical and incendiary munitions, and the manufacture of industrial chemicals, primarily pesticides and herbicides. A detailed account of disposal practices associated with these operations and resulting soil contamination are presented in Contamination Assessment Reports (CARs) for each potential site. An overview of ground-water contamination is presented in the Final Screening Program (ESE, 1988a, RIC#88034R03).

The disposal practices of the Army and leaseholders occurred over approximately a 40-year period and resulted in the widespread release of organic and inorganic contaminants into the ground water; most notably, diisopropylmethyl phosphonate (DIMP), dicyclopentadiene (DCPD), dibromochloropropane (DBCP), organosulfur compounds, organochlorine pesticides, volatile aromatic compounds, volatile organohalogen compounds, arsenic, chloride, and fluoride. Ground-water monitoring programs conducted since the mid-1970's have detected some of these compounds offpost of RMA.

In order to address the contaminants in the area north and northwest of RMA, the Program Manager - Rocky Mountain Arsenal (RMA) has issued Contract No. DAAK11-84-D-0016, Task Order 39, to Environmental Science and Engineering, Inc. (ESE) to assist the Army in conducting a Remedial Investigation (RI) and Feasibility Study (FS) in the offpost area. For the purposes of this investigation, the area shown in Figure 1.0-2 is considered the Offpost Operable Unit. The primary objectives of the Offpost RI/FS are to:

- Collect additional data to refine the current understanding of ground-water flow and surface water patterns, and the nature and extent of contaminants offpost of RMA;

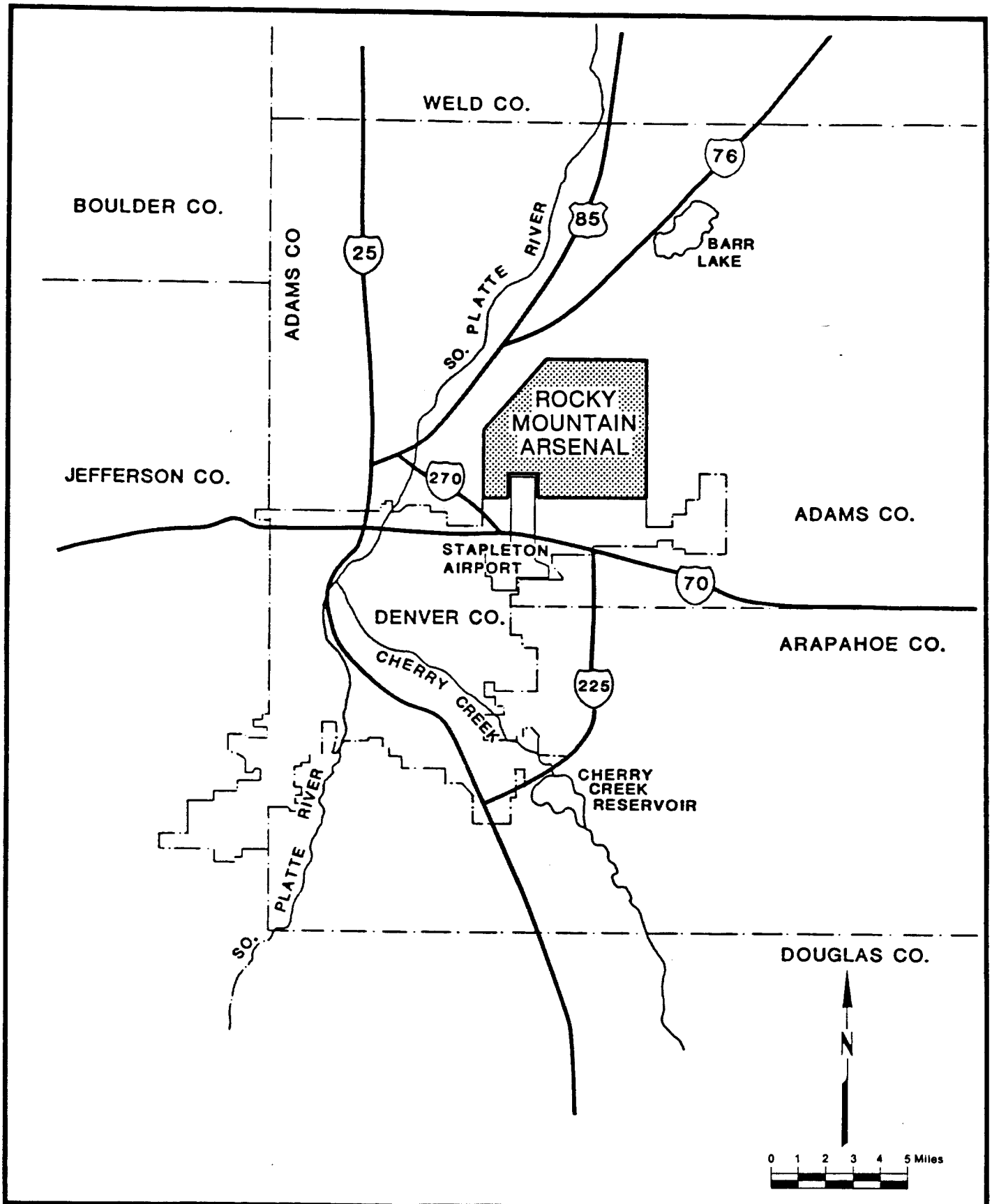


Figure 1.0-1
LOCATION MAP OF
ROCKY MOUNTAIN ARSENAL
SOURCE: ESE, 1988

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

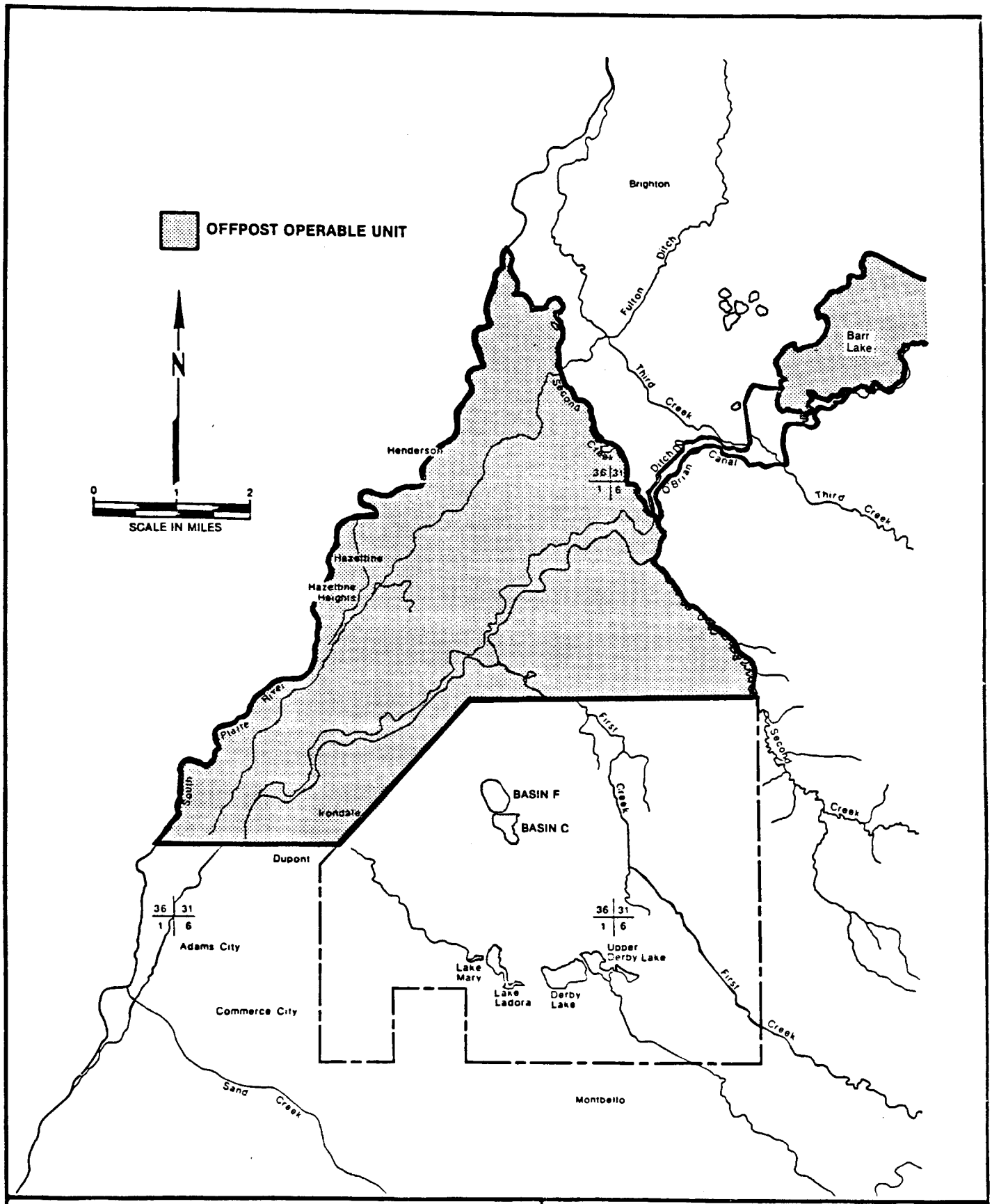


Figure 1.0-2

OFFPOST OPERABLE UNIT

SOURCE: ESE, 1988

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

- To evaluate the potential for contaminant migration to the Offpost Operable Unit in various media such as ground water, surface water, sediments, air, and biota;
- Evaluate the danger posed to humans living in the Offpost Operable Unit and also evaluate environmental impacts using current knowledge of the concentrations and distributions of contaminants in the offpost area;
- Develop a range of remedial alternatives which would mitigate public health and environmental impacts;
- Evaluate the candidate remedial alternatives with respect to technical factors, cost efficiency, and the extent to which they mitigate public health and environmental impacts; and
- Select a preferred remedial alternative based on the alternatives assessment.

The result of the RI/FS will support a Record of Decision (ROD) addressing the potential offpost contamination and justify any remedial actions that may be appropriate.

The following sections describe the conditions in the Offpost Operable Unit. The overall technical approach for conducting the RI/FS is also described with emphasis on the RI portion of the program. While the emphasis of this report is on the RI, a summary of FS activities is also included. A more detailed description of the FS will be contained in later submittals.

Following a brief description of the offpost conditions and RI/FS program, subsequent sections of this report are organized as follows:

- Section 2.0 - Data Collection and Analyses;
- Section 3.0 - Ground-Water Conditions;
- Section 4.0 - Surface Water Conditions;
- Section 5.0 - Offpost Sediment Conditions;
- Section 6.0 - Air Quality Conditions;

- Section 7.0 - Biota Conditions;
- Section 8.0 - Potential Chemical-Specific ARARs; and
- Section 9.0 - Conclusions.

In many cases the Task 39 Technical Plan is referenced as are other support documents. These publications are available at the RMA Information Center (RIC).

1.1 CONDITIONS IN THE OFFPOST OPERABLE UNIT

A number of the onpost contaminants from RMA have been detected in offpost ground water by previous studies which were conducted to assess the nature and extent of offpost contamination. In particular, the "Rocky Mountain Arsenal Offpost Contamination Assessment Report" (Offpost CAR) (ESE, 1987a, RIC#87202R01) utilized data from several studies to depict the distribution and level of offpost contamination to the north and northwest of RMA. The most widespread of the organic contaminants detected in the Offpost Operable Unit was DIMP. DIMP is suspected of migrating off of RMA along the northern boundary via ground water and surface water. Because of its high mobility and persistence in the Offpost Operable Unit and the fact that it is solely related to RMA, DIMP is a good delineator of migration pathways. Other organic contaminants have also been detected in the Offpost Operable Unit. These include organochlorine pesticides, organosulfur compounds, volatile organics, DBCP, and DCPD. With the exception of isolated concentrations observed downgradient of the RMA northwest boundary, these contaminants have generally been noted in areas north of the RMA north boundary.

Chloride and fluoride, naturally occurring inorganic constituents, were generally observed at concentrations exceeding background levels in the Offpost Operable Unit. In particular, chloride migrated from RMA's northern boundary and has been routinely found exceeding background levels in the areas to the north and northwest of the RMA northern boundary.

In the offpost area north of 80th Avenue, and south of 88th Avenue, volatile organohalogens, most notably trichloroethylene were sporadically detected in samples collected from alluvial monitoring wells and alluvial domestic wells (ESE, 1985, RIC#872016R02, and the present report). The levels of trichloroethylene generally ranged from just above the certified reporting limit (CRL) of 1.3 ug/l to a concentration of 9.1 ug/l observed in a domestic well sample. However, the majority of trichloroethylene detections were less than 5.0 ug/l which is the MCL. The presence of compounds which would be strictly related to RMA in this area, such as DBCP, were not observed in samples collected from the area.

Several sources of trichloroethylene have been documented south of the Offpost Operable Unit in or near Commerce City. Also, recent investigations by the Army along the western sections of RMA have detected the presence of a trichloroethylene plume entering Section 9 along the southern boundary of RMA. Although trichloroethylene has been detected in selected dewatering wells of the Irondale system, no trichloroethylene has been detected in the influent or effluent sumps of the system. Because of the potential for multiple trichloroethylene sources upgradient from the Offpost Operable Unit, trichloroethylene observed in the area between 80th and 88th Avenues falls under the jurisdiction of the EPA as per an Executive Order No. 12580. 52 CFR 2923 (1987). A summary of the findings of the most recent EPA studies in the area south of 80th Avenue is provided in Section 3.0 of this report.

Based upon known areas of onpost and offpost contamination and the predominant ground- and surface water flow patterns, the operable unit for the offpost RI/FS is the area between the north and northwest boundaries of RMA and the South Platte River. The specific boundaries of the unit are the same as for the offpost CAR as shown in Figure 1.1-1 and described below:

- Southeast Boundary - north and northwest boundaries of RMA:
- Southwest Boundary - 80th Avenue:

- o West and Northwest Boundary - the South Platte River; and
- o Northeast Boundary - Second Creek.

The area chosen was based upon a conservative estimate of the area within which contaminants from the Arsenal may now or eventually exist. However, based upon hydrologic and hydrogeologic considerations, most of this area is not expected to be contaminated by materials originating from RMA. In order to emphasize areas where impact to the public and environment is most likely, the study focuses on those areas that were defined in the offpost CAR as being zones of higher contamination. Barr Lake has also been included in the Offpost Operable Unit because of the potential for contaminant migration through surface water features and the unique habitat it provides for wildlife in the area.

1.2 ONGOING RESPONSE ACTIONS

A number of contamination control measures have been implemented at RMA and additional control measures have been planned or are proposed. With regard to controlling the migration of contaminants to offpost areas, three major containment/treatment systems have been installed at the arsenal boundaries. Based upon the chemical analyses performed on the systems' influent and effluent, it is apparent these systems have been successful in removing organic ground-water contaminants and recharging treated ground water at RMA boundaries. These systems are described briefly in the following paragraphs.

1.2.1 NORTH BOUNDARY: CONTAINMENT/TREATMENT

The containment system installed at the north boundary of RMA consists of a physical soil-bentonite barrier, dewatering wells to intercept the natural flow of ground water approaching the northern boundary, a ground-water treatment system to remove organic contaminants, and recharge wells to return treated water to the alluvial aquifer.

A comprehensive evaluation of the North Boundary Containment System (NBCS) has just been concluded under Task 36. The purpose of this evaluation was to identify problems with the system and to propose interim actions which

will improve system performance. As a result of this study, the following interim actions were recommended to enhance system performance:

- o Installation of recharge trenches to improve the recharge capabilities of the system and to reduce high hydraulic gradients across the soil-bentonite barrier;
- o Abandonment of poorly constructed bedrock wells to reduce the potential for cross-contamination between the alluvial aquifer and the Denver Fm;
- o Improvement of carbon washing procedures to reduce the amount of carbon fines generated in the plant effluent;
- o Refinements in the operation of dewatering system to enhance the performance of this component.

1.2.2 NORTHWEST BOUNDARY: CONTAINMENT/TREATMENT

The containment system at the northwest boundary utilizes a physical soil-bentonite barrier, dewatering wells, a ground-water treatment system to remove organic contaminants, and recharge wells. The system at the northwest boundary is similar to that of the north boundary system, except that the soil-bentonite barrier does not extend the entire length of the system.

The nature and distribution of contaminants upgradient and downgradient of the Northwest Boundary Containment System (NWBCS) was assessed by the Boundary Systems Monitoring program, Task 25. The results of this task indicate that the NWBCS has been effective in reducing downgradient concentrations of the majority of organic contaminants detected in this area. The only apparent deficiency of the system is its inability to effectively remove chloroform from the influent water. Operational improvements are currently underway to correct this deficiency.

1.2.3 IRONDALE: CONTAINMENT/TREATMENT

A hydrologic control system is installed at the southern end of the RMA northwest boundary, referred to as the Irondale area. This control system consists of two rows of dewatering wells, one row of recharge wells, and a ground-water treatment system to remove organic contaminants.

The Irondale Boundary Control System (ICS) was installed to mitigate the migration of DBCP to offpost areas. The most recent monitoring conducted in this area during the Consumptive Use Phase III program (ESE, 1987f) and during the RI did not indicate the presence of detectable levels of DBCP offpost downgradient of the system. This data suggets that the ICS has been effective in preventing the offpost migration of this compound.

1.3 SUMMARY OF TECHNICAL APPROACH

In order to adequately evaluate the nature and extent of contamination in the Offpost Operable Unit, to determine risk to humans and the environment, and to plan remedial measures, an RI/FS program was developed as described in the Task 39 Technical Plan (ESE, 1987e, RIC#87204R15) and the Technical Program Plan (TPP) (ESE, 1988, RIC#88131R01). The program is consistent with the Comprehensive Environmental Response and Compensation Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA), and not inconsistent with the National Contingency Plan (NCP) and guidance by the U.S. Environmental Protection Agency (EPA) that is not inconsistent with CERCLA, SARA, and the NCP.

Because this report only summarizes RI activities, the following technical approach concentrates on the RI portion of the RI/FS program. Separate reports will document EA and FS activities. The potentially contaminated media of concern in the Offpost Operable Unit are water, sediments, biota, and air. The evaluation of soils as a potentially contaminated media of concern in the Offpost Operable Unit will be addressed in the EA. The primary migration pathways appear to be ground and surface waters. For this reason, the RI activities concentrate on the evaluation of these pathways although all media pathways are addressed in the RI.

The ground water and surface water data presented in this report are considered sufficient to define the genral nature and extent of contamination and to conduct an EA/FS for these media. Additional data collection for these media, particularly for ground water downgradient of

the NWBCS, will be outlined in a plan for a Supplemental Technical Investigation (STI). The results of the STI will be incorporated into the remedial design and provided as a part of preliminary design documents.

The offpost program was developed to supplement data from the Offpost CAR and to more specifically define the extent and concentrations of contamination that has migrated to the Offpost Operable Unit. For the evaluation of ground water, the placement of the well and borehole network was designed to meet the following objectives:

- Further definition of offpost geology;
- More specific delineation of known contaminated alluvial ground-water concentrations and plume boundaries;
- Delineation of suspected offpost contaminated alluvial ground-water concentration and plume boundaries;
- Characterization of Denver Fm ground-water quality in contaminated areas near the RMA boundary;
- Characterization of the extent and quality of discharge from Denver Fm aquifers to the alluvium in areas downgradient of the RMA northern boundary;
- Characterization of ground-water quality in population centers and other locations of ground water used by humans, crops, and livestock;
- Description of the aquifer systems affecting contaminant transport; and
- Definition of aquifer characteristics necessary for input into ground-water models and for evaluation of remedial action alternatives.

The monitoring program for the offpost area involved elements of the evaluations in the boundary systems monitoring tasks (Tasks 25 and 36). Ground-water sampling methodology and techniques conformed to USATHAMA Geotechnical Requirements with respect to decontamination, collection, preservation, shipment, and chain-of-custody requirements.

Additionally, surface water and sediment samples were collected in the offpost area in order to define contaminants in these media. Samples were collected in surface features that were suspected pathways for migration of

onpost contamination to the Offpost Operable Unit. These features included streams, creeks, impoundments, and lakes. The data were used to evaluate contamination in surface waters and sediments as well as to evaluate surface water and ground-water interaction.

Biota and air quality conditions were evaluated using onpost and offpost information collected during past and current studies. Input from the Offpost CAR was used to assess transport of contaminants and impacts on biota in the offpost area from onpost conditions. Likewise, data from the Air Remedial Investigation Report (ESE, 1988c) were used to assess the potential for migration of airborne contaminants to the Offpost Operable Unit.

The water, sediments, biota, and air quality information was organized so that a comprehensive evaluation of RMA contaminants in all media could be made in the Offpost Operable Unit. The information collected during the RI was integrated with historical data as well as data being collected during other ongoing RMA investigations.

Other media, such as sediments, soils, biota, and windblown dust, were considered in the planning stages of the RI. Soils and windblown dust were not thought to represent potential exposure pathways offpost except where surficial soils are impacted by irrigation with contaminated water. However, further evaluation of offpost soils and windblown dust will be conducted to respond to comments from CDH and the EPA. Although data have been collected to evaluate offpost sediments, additional data collection pertaining to this media is being planned to address concerns of citizens in the Offpost Operable Unit and comments from CDH. Biota studies were conducted to determine whether potentially contaminated species could migrate from near source areas onpost to the Offpost Operable Unit. Although one species was identified as an exposure pathway and will be addressed in the EA/FS report, additional evaluation of biota will be conducted to respond to EPA comments. All data collected pertaining to these medial will be provided in addenda to the RI report.

In conjunction with the RI data collection activities, a preliminary evaluation of applicable or relevant and appropriate requirements (ARARs) for RMA contaminants found in the offpost area was made. This was conducted as an initial step in the EA process in order to make a preliminary evaluation of the significance of the RI data. The contaminant-specific ARARs are presented in Section 8.0.

2.0 DATA COLLECTION AND ANALYSES

The data collection efforts under the offpost RI were an extension of work performed over the past several years in the Offpost Operable Unit. Because of the extensive ground- and surface water data base that existed previous to the initiation of this study, the first step in the data collection effort was to compile and analyze data and results from past and ongoing programs. This work involved reviewing all pertinent information on file at the RIC and the Program Managers PMO-RMA, and interviewing technical experts in the PMO-RMA, U.S. Corps of Engineers (COE), U.S. Army Engineer Waterways Experiment Station (WES), EPA, and other agencies with a knowledge of the Offpost Operable Unit.

The review of past studies provided the data to evaluate wells that have been sampled in the past, utilize results from previous aquifer tests, analyze historic onpost and offpost contaminant plumes, and examine and develop an overall geologic and hydrologic understanding of the offpost area. Additionally, biota and air quality information was reviewed in the offpost area and was used to assess the human and environmental systems that may be at risk and to define airborne pollutant pathways.

As a result of the review of the past and ongoing programs, limitations to the ground-water, surface water, and sediment data bases were identified. For this reason, the primary focus of the Task 39 data collection program was oriented to the water and sediments media. The following section explains the objectives of the monitoring program and the procedures used to collect and analyze data.

Data collection consisted of compiling new hydrogeologic and contaminant data relevant to the offpost area. Data were obtained by drilling new wells and borings, collecting ground water and surface water quality samples, measuring ground-water levels and surface water flows, conducting aquifer tests, and obtaining sediment samples for analysis. An overview of the data

obtained, the rationale for the various investigations, and the techniques used to obtain information in the field are described in this section of the report.

An overview of the environmental setting in the Offpost Operable Unit was presented in the Task 39 Technical Plan. The plan provided a preliminary description of the area geology, hydrogeology, and preliminary siting rationale for well installations and borings. Detailed assessments of ground water, surface water, and sediment conditions offpost of RMA, which incorporate all data collected under current programs, are presented in Sections 3.0, 4.0, and 5.0 of this report, respectively.

2.1 GROUND-WATER MONITORING PROGRAM

There were three primary objectives of the ground-water monitoring program. The first was to delineate suspected offpost contaminated alluvial ground-water plumes downgradient of the RMA north boundary. This included further definition of the known contaminant plume extending northwestward from the northern boundary along the inferred First Creek paleochannel described in the Offpost CAR (ESE, 1987a, RIC#87202R01). It also included determining whether contaminant plumes extend from the RMA north boundary to remote areas directly north of RMA where isolated detections of several RMA contaminants such as DIMP and DBCP have been documented.

A second major objective of the monitoring program was to assess the quality of ground water in Denver Fm aquifers downgradient of the RMA north boundary. Of particular concern was whether these units were acting as contaminant migration pathways which bypass the North Boundary Containment System (NBCS). The data from these wells were also used to determine whether ground water from the Denver Fm may be contributing to alluvial aquifer contamination. This possibility is being addressed in the Task 39 study because many of the Denver Fm units are projected to subcrop and discharge water into the alluvial aquifer immediately downgradient of the RMA northern boundary.

The third major objective of the monitoring plan was to supplement existing wells downgradient of the Northwest Boundary Containment System (NWBCS). Although the primary plumes onpost extend from source areas to the north boundary, additional monitoring was needed to substantiate an apparent absence of contamination in the offpost area downgradient of the NWBCS.

To accomplish these objectives, monitoring wells were completed in both the alluvial aquifer and sandstones of the Denver Fm. Alluvial wells were installed primarily to the north of the RMA north boundary in Sections 13 and 14. Several wells were also installed downgradient of the NWBCS. Cluster wells were installed to assess the potential for vertical flow between the alluvial and Denver Fm aquifers. These sites consisted of one alluvial well paired with one or two Denver Fm wells. At sites with two Denver wells, the wells were completed within the first and second sandstone aquifers encountered during drilling.

The installation of Denver Fm monitoring wells were concentrated within an area immediately north of RMA and between 96th Avenue and Colorado Route 2. The Denver wells were installed in this area to assess the ground-water quality in Denver sandstones which subcrop offpost of RMA and are the uppermost units onpost. The following sections describe the ground-water monitoring program by explaining the rationale in selecting monitoring locations and by documenting the sample collection and analyses procedures.

2.1.1 MONITORING NETWORK AND RATIONALE

The Task 39 Technical Plan describes the initial thought process for selection of ground-water monitoring locations. The selection of new monitoring locations was based upon an initial review of the existing monitoring network. Each existing well utilized in the monitoring network was carefully examined to determine the relationship between screened intervals and hydrogeologic setting. The primary objective of this review was to confirm the specific hydrogeologic unit that each well was monitoring. Upon examination of the alluvial well network, it was found that some of these wells extended into the Denver Fm beyond the 1 to 2 feet (ft) currently specified for construction of RMA alluvial monitoring wells.

Although the overwhelming majority of these wells were thought to yield data representative of alluvial water chemistry and water levels, wells producing ground water which might be partially representative of Denver Fm characteristics were identified. This work was conducted to generate accurate products such as potentiometric surface and contaminant distribution maps for the alluvial and Denver Fm aquifers.

All monitoring wells were assigned a designation category based upon whether data collected from them were believed to be representative of the alluvial aquifer, Denver aquifers or a composite of both. The percentage of screen length intersecting the Denver Fm and alluvial aquifer units was determined and compared to the approximate transmissivity of each strata encountered within the screened interval.

After performing a preliminary review of the well completion and lithologic data, five well designation categories were generated. These designations, identified by Categories 1 through 5, are described in detail in Appendix A. A general description of the numbered categories is provided below:

- Category 1 - These wells were considered strictly alluvial wells. Wells assigned to this category were screened across the alluvium and extend less than 3 ft into fine-grained bedrock. The majority of alluvial wells in the Offpost Operable Unit were designated as Category 1 wells.
- Category 2 - These wells were considered alluvial wells, but are either screened 3 ft to 6 ft into fine-grained bedrock, or have a minor percentage of the screened interval in direct contact with a subcropping bedrock sand zone.
- Category 3 - These wells had a significant percentage of the screened interval within the Denver Fm, but because of the relative transmissivity of the alluvial and Denver materials screened, water levels and water chemistry were believed to be mostly indicative of the alluvium.
- Category 4 - These wells also had a significant percentage of their screened interval within the Denver Fm. Because of the

similar transmissive characteristics of the alluvial and Denver Fm materials screened at these sites, these wells were thought to represent a composite of Denver and alluvial water levels and water chemistry.

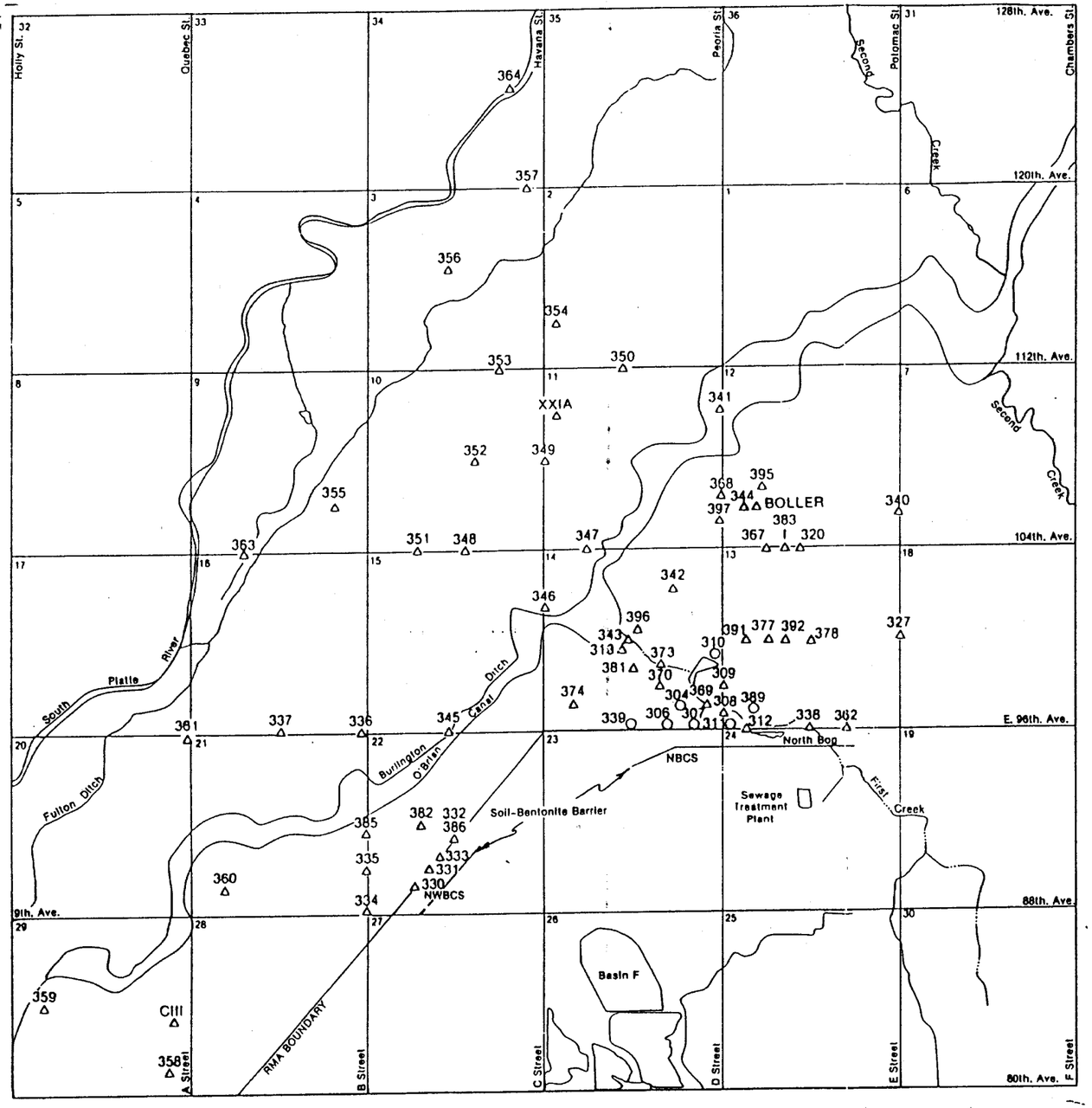
- o Category 5 - These wells were screened entirely within the Denver Fm.

All data from wells categorized as 1 through 4 have been considered in the generation of alluvial water table and contaminant distribution maps. Similarly, data from wells designated as Categories 4 and 5 have been evaluated for inclusion into Denver Fm work products. Denver wells are further delineated in Section 3.2 as to the specific sandstone unit in which they were screened.

2.1.1.1 Alluvial Aquifer Monitoring Network

The alluvial monitoring network developed for this study is shown in Figure 2.1-1. This map shows all existing and newly installed wells and indicates whether they were used to monitor water quality and water levels, or only water levels. Three domestic alluvial wells are also plotted and were used to supplement the network used to describe chemical distributions. The aquifer designation number assigned to each well is provided in Table 2.1-1.

All alluvial wells installed under the current Composite Well Program (ESE, 1987b, RIC#88104R04) in the Offpost Operable Unit are shown in Figure 2.1-2. All alluvial wells were installed in accordance with the Task 39 Draft Final Technical Plan. Boreholes for well installation in the alluvial aquifer were drilled using hollow-stem augers. At new water quality well sites, continuous samples were collected in polybutyrate tubes for logging as the augers were advanced during drilling. Water quality wells were completed inside the hollow-stem augers across the entire saturated thickness of the aquifer. A typical alluvial well completion is shown schematically in Figure 2.1-3.



EXPLANATION

△	Alluvial Well Sampled For Water Quality And Measured For Water Levels
O	Alluvial Well Measured For Water Levels Only
339	Well Number
XXIA CII BOLLER	Tap Sample From Domestic Site
NBCS	North Boundary Containment System
NWBCS	Northwest Boundary Containment System
— —	Denotes Location Of Hydrologic System

N

0 2000 4000

SCALE IN FEET

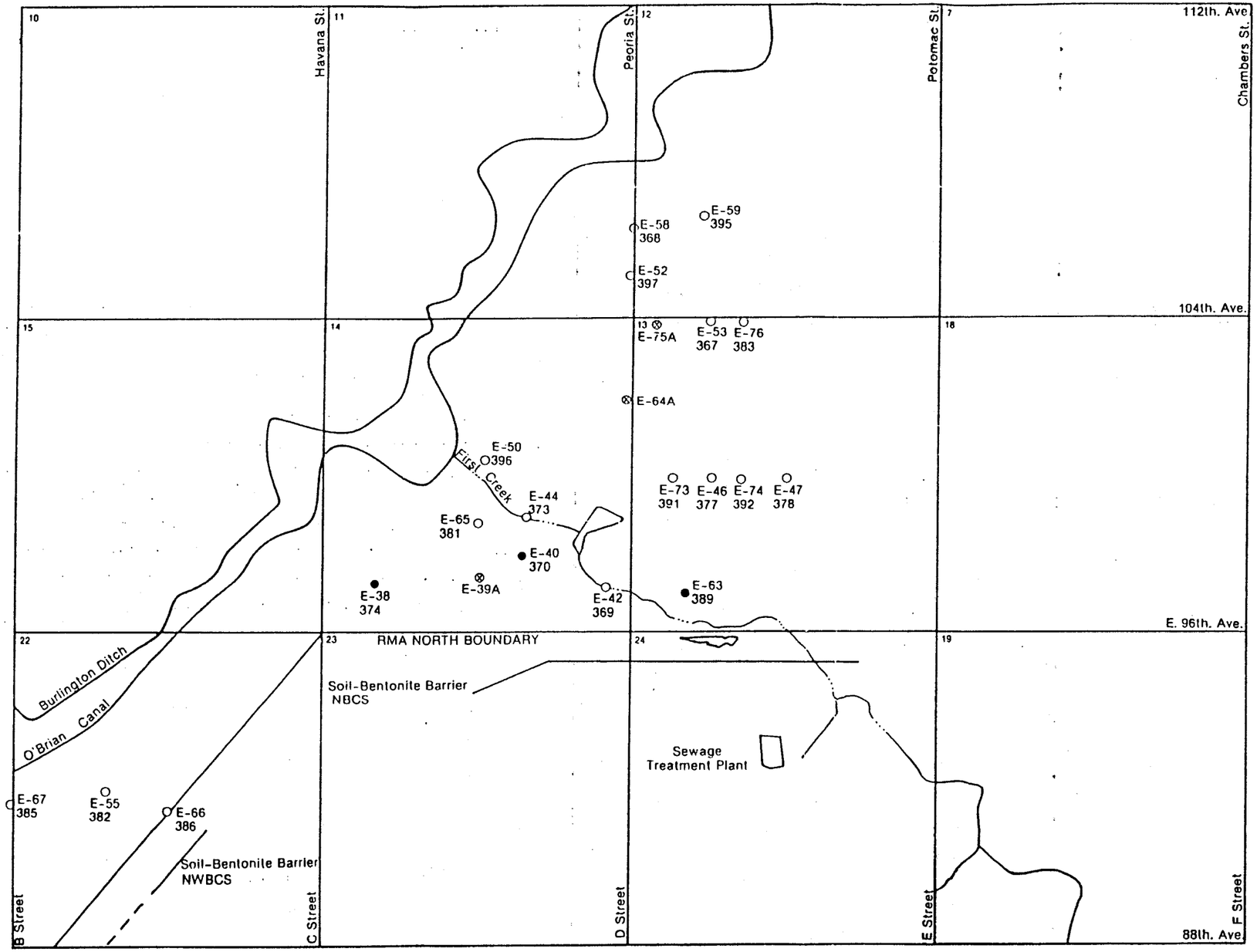
Figure 2.1-1

LOCATION MAP OF ALLUVIAL WELLS IN THE OFFPOST OPERABLE UNIT

SOURCE: ESE, 1988

Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland



EXPLANATION

○	Alluvial Well Site
●	Alluvial Well Paired With Denver Well(s)
⊗	Alluvial Boring
E-38	Site Number
374	Well Number
NBCS	North Boundary Containment System
NWBCS	Northwest Boundary Containment System
— —	Denotes Location Of Hydrologic System

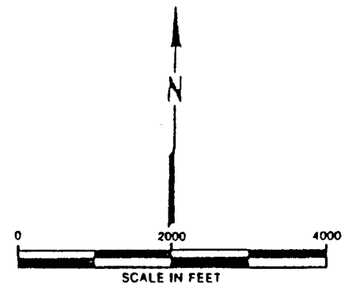


Figure 2.1-2

NEW ALLUVIAL SITES

SOURCE: ESE, 1988

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland

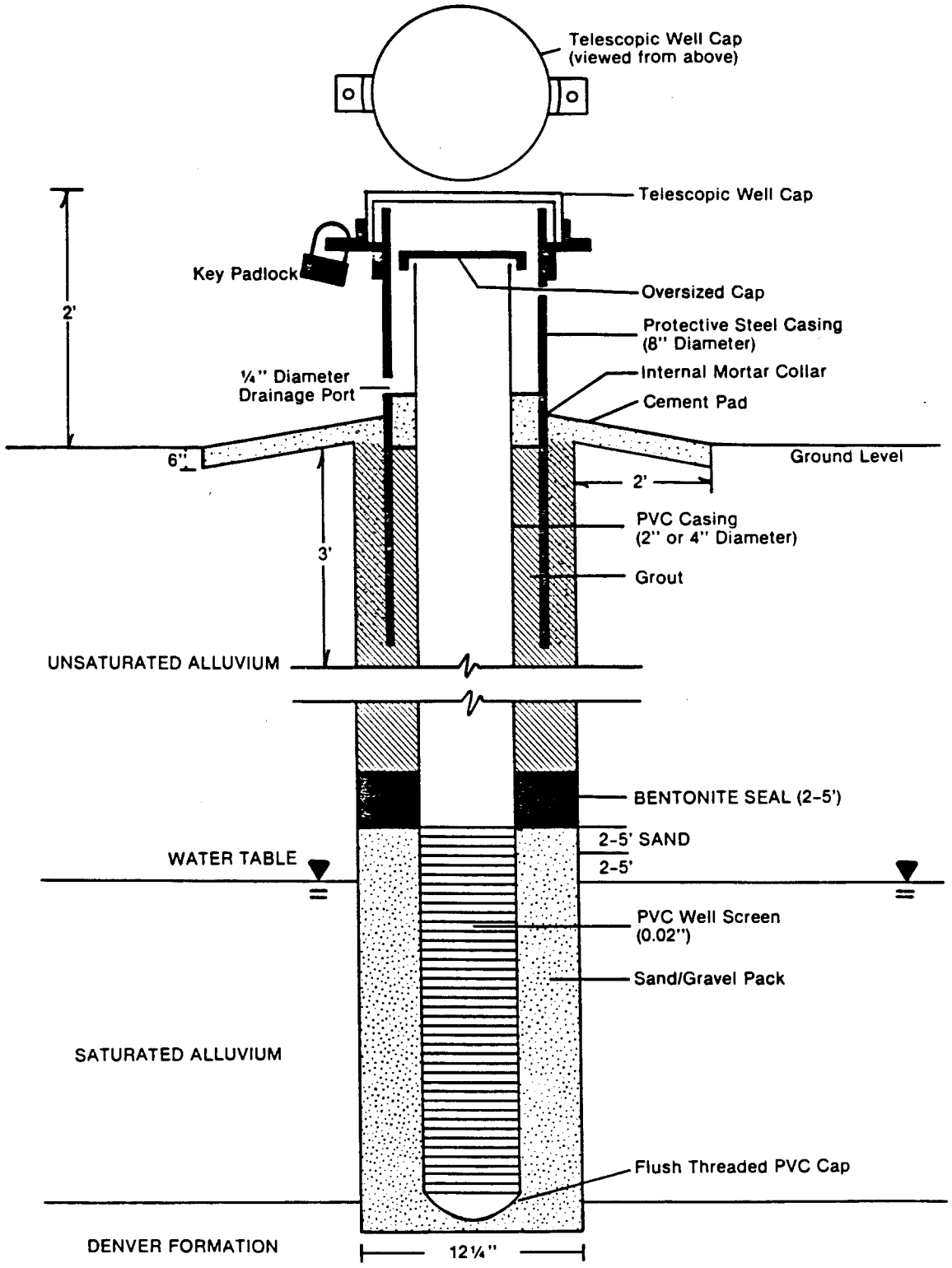


Figure 2.1-3
GENERALIZED ALLUVIAL MONITOR WELL CONSTRUCTION

SOURCE: ESE, 1988

Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

Table 2.1-1. Aquifer Designations for Wells in Offpost Operable Unit (Page 1 of 2)

Well No.	Aquifer Designation Category	Well No.	Aquifer Designation Category
37304	1	37356	
37306	1	37357	1
37307	1	37358	1
37308	4	37359	1
37309	1	37360	1
37310	5	37361	1
37311	1	37362	1
37312	1	37363	1
37313	5	37364	2
37316	5	37365	5
37317	5	37367	5
37318	5	37368	1
37319	5	37369	1
37320	5	37370	1
37321	5	37371	1
37322	5	37372	5
37323	5	37373	5
37327	1	37374	1
37330	1	37376	1
37331	1	37377	5
37332	1	37378	1
37333	2	37379	1
37334	3	37380	5
37335	1	37381	5
37336	3	37382	2
37337	2	37383	3
37338	1	37385	1
37339	1	37386	1
37340	2	37387	1
37341	1	37388	5
37342	1	37389	5
37343	2	37390	3
37344	1	37391	5
37345	1	37392	1
37346	1	37395	1
37347	1	37396	1
37348	1	37397	1
37349	1		2
37350	2		
37351	1		
37352	1		
37353	1		
37354	1		
37355	1		

Table 2.1-1. Aquifer Designations for Wells in Offpost Operable Unit.
(Page 2 of 2)

Note:
1 Alluvial well with screen < 3 ft into claystone bedrock.
2 Alluvial well with screen 3 to 6 ft into claystone bedrock.
3 Screened mostly in Denver Fm but due to relative transmissivity of the alluvial and Denver materials, screen considered to be representative of alluvial water levels and water chemistry.
4 Composite of Denver and alluvial water levels and water chemistry
5 Screened entirely in Denver Fm.

Source: ESE, 1988.

Each alluvial borehole was logged during drilling by the drill site geologist. Soil descriptions and depths contained on the logs conform to the requirements and procedures outlined in the Task 39 Draft Final Technical Plan. All logs and well completion diagrams for each site are presented in Appendix B.

The Universal Transverse Mercator (UTM) coordinates and specific well completion data at each new drill site location are provided in Table 2.1-2. The general well locations, descriptions of the geologic conditions encountered, and siting rational are discussed for each well in Appendix C.

2.1.1.2 Denver_Fm_Monitoring_Network

The Denver monitoring network developed for this study is shown in Figure 2.1-4. This map shows all existing and newly installed wells and whether they were used to monitor water quality and water levels, or water levels only. All Denver Fm wells installed under current drilling programs in the Offpost Operable Unit are shown in Figure 2.1-5. All Denver Fm wells were installed in accordance with the guidelines of the Task 36 Final Technical Plan (ESE, 1988b, RIC#88063R08).

Boreholes for bedrock wells were drilled using direct water-rotary drilling. Before well installation, pilot coreholes were drilled and logged at all sites to determine lithology and facilitate well construction. Downhole geophysical loggings, including spontaneous potential, natural gamma, and resistivity, were performed at each corehole to further define lithology and to help determine appropriate intervals for well completion. All corehole and geophysical logs are provided in Appendix B.

Precautions were taken for all bedrock wells to prevent the possibility of cross-contamination between aquifers. The alluvial aquifer was sealed from lower aquifers by grouting conductor casing in place before drilling into bedrock. Similarly, upper Denver Fm aquifers were sealed from lower Denver aquifers by telescoping smaller conductor casing in place before drilling further into the Denver Fm. During well completion, lower units were isolated from upper units by placing a 5-ft bentonite plug above the well

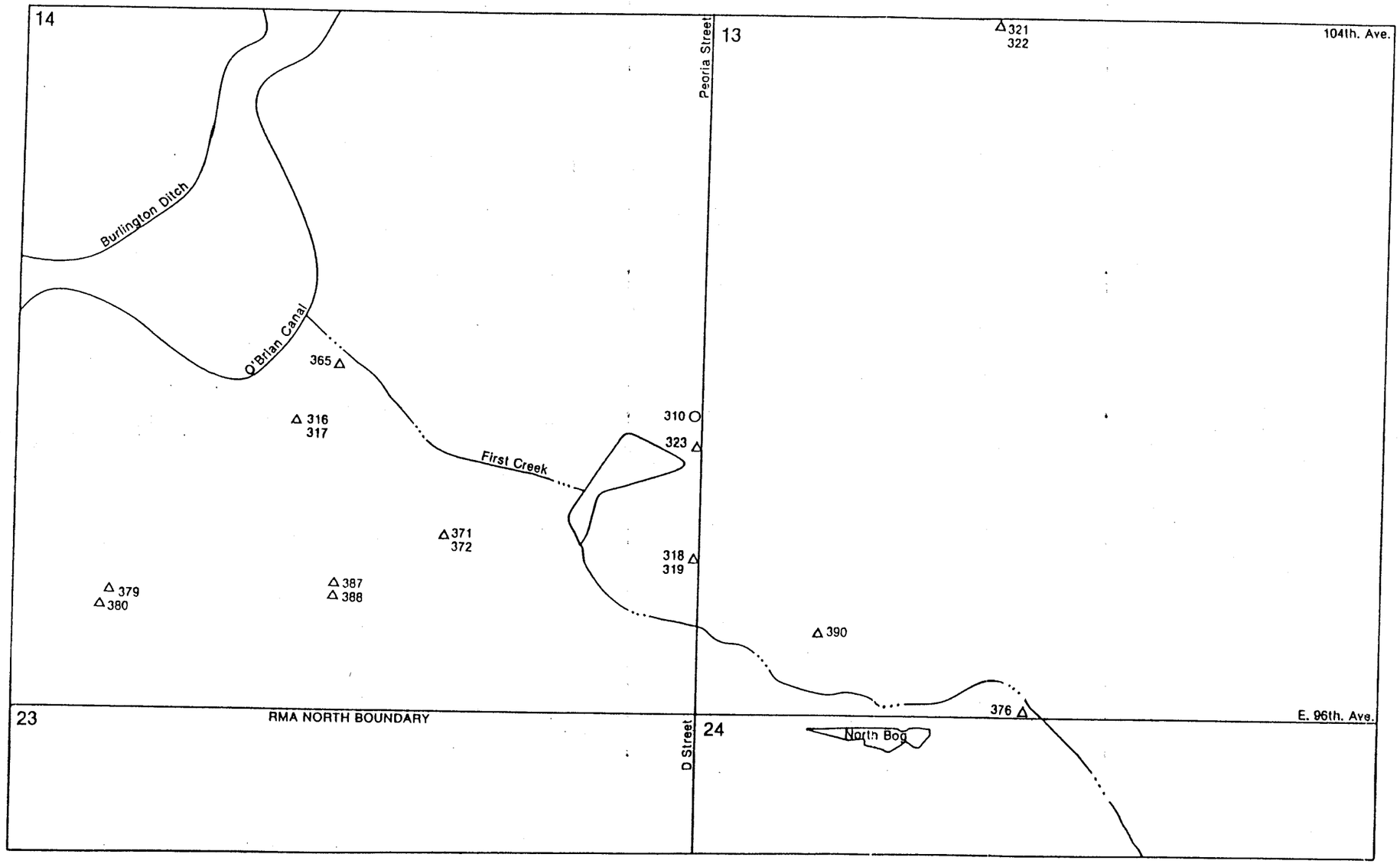


Figure 2.1-4

LOCATION MAP OF DENVER WELLS IN THE OFFPOST OPERABLE UNIT

SOURCE: ESE, 1988

Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland

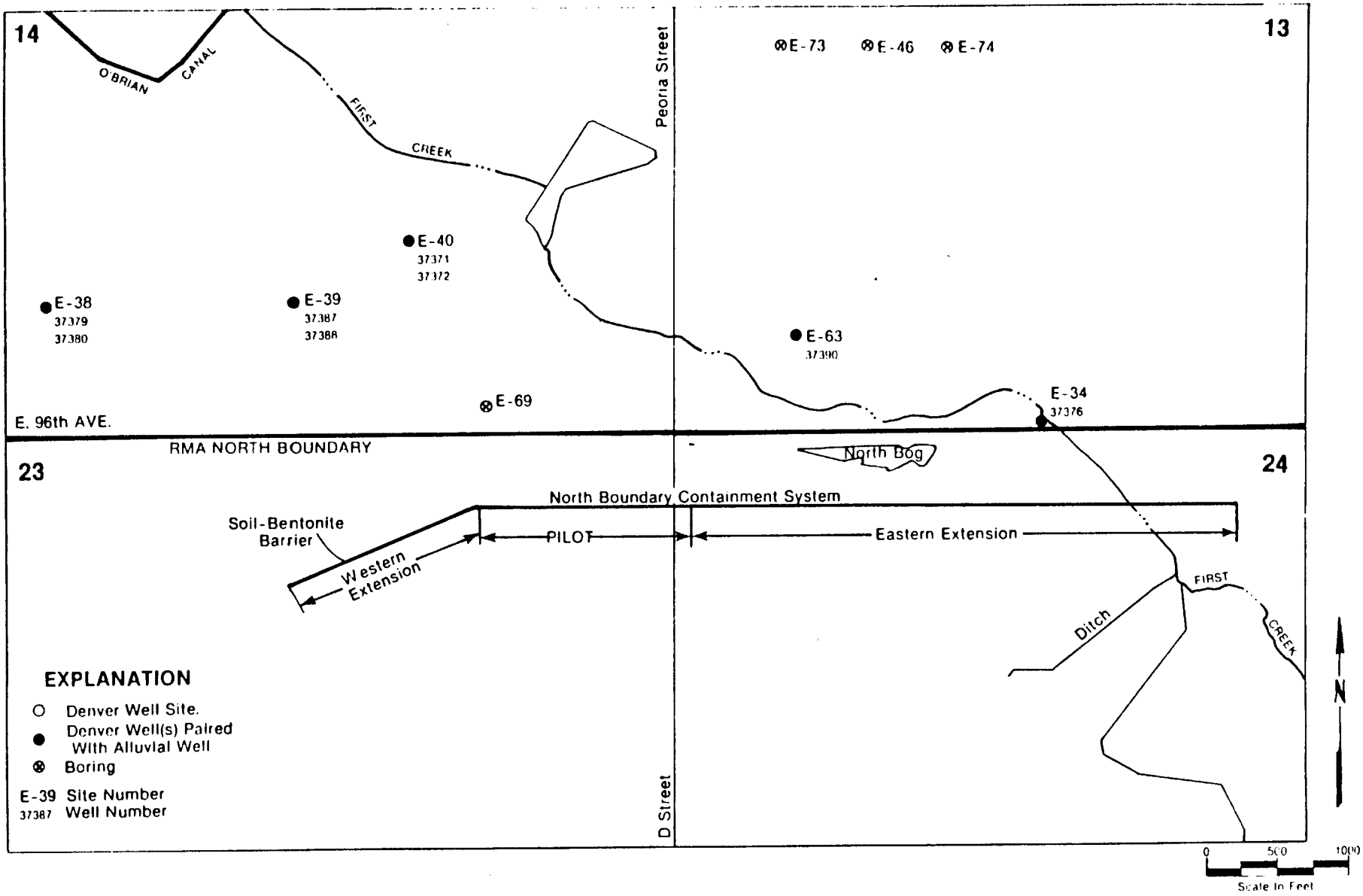


Figure 2.1-5

NEW DENVER SITES

SOURCE: ESE, 1988

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

Table 2.1-2. Completion Data for New Alluvial Wells

Site Number	Well Number	Location Coordinates UTM North	Location Coordinates UTM East	Ground Level Elevation* (ft)	Elevation Top of PVC* (ft)	Screen Interval** (ft/BGL)	Top of Bentonite** (ft)	Top of Sand** (ft)	Depth to Bedrock** (ft/BGL)
E-38	37374	4413460.0	511822.4	5,117.97	5,120.63	9.0-25.0	5.0	8.0	26.0
E-39	Dry	4413477.8	512358.2	5,134.62	N/A	N/A	N/A	N/A	18.0
E-40	37370	4413610.4	512595.7	5,117.30	5,119.89	4.5-26.0	2.0	3.0	26.0
E-42	37369	4413448.2	513023.6	5,122.09	5,124.70	4.0-25.5	2.0	3.0	25.5
E-44	37373	4413808.5	512613.1	5,112.28	5,114.57	4.5-25.5	2.0	3.5	25.0
E-44	37398	4413813.9	512601.9	5,112.36	5,114.53	3.5-24.0	1.5	2.5	23.5
E-44	37399	4413819.8	512591.8	5,112.50	5,114.97	4.0-24.0	0.5	2.0	23.0
E-46	37377	4414016.7	513568.6	5,136.67	5,139.24	23.0-39.0	18.0	22.0	39.5
E-47	37378	4414015.2	513956.5	5,137.73	5,140.07	24.0-35.0	19.0	23.0	35.0
E-50	37396	4414111.7	512387.9	5,108.9	5,110.48	7.5-28.5	1.50	3.5	28.5
E-52	37397	4415064.0	513132.0	5,115.6	5,117.36	18.5-35.0	9.0	14.0	32.0
E-53	37367	4414828.1	513554.7	5,119.0	5,120.05	11.5-38.5	4.0	8.0	39.5
E-53	37400	4414840.0	513553.5	5118.36	5,120.06	16.5-41.5	7.5	12.0	38.5
E-53	37401	4414852.6	513551.5	5,117.92	5,119.42	17.0-42.0	3.0	9.0	41.0
E-55	37382	4412393.0	510433.2	5,121.82	5,123.40	33.5-50.0	23.5	28.5	44.0
E-58	37368	4415307.6	513146.2	5,108.83	5,110.44	18.0-34.5	8.0	13.0	34.0
E-59	37395	4415381.3	513516.5	5,116.2	5,117.86	18.5-45.0	6.0	13.0	44.50
E-63	37389	4413396.0	513435.6	5,128.03	5,129.38	8.5-35.0	3.0	7.0	23.5
E-64	Dry	4414401.8	513149.3	5,131.95	N/A	N/A	N/A	N/A	20.5
E-65	37381	4413770.0	512355.8	5,110.73	5,112.04	7.5-28.5	3.0	4.0	28.0
E-66	37386	4412278.8	510743.6	5,132.69	5,134.18	39.5-50.5	30.0	35.0	50.0
E-67	37385	4412334.9	509934.0	5,115.13	5,116.69	30.0-51.5	19.0	24.0	51.0
E-73	37391	4414015.6	513383.2	5,136.77	5,138.53	19.5-41.0	10.0	15.0	40.0
E-74	37392	4414012.7	513737.9	5,135.81	5,137.00	13.0-29.5	3.5	8.5	28.0
E-75	Dry	4414827.1	513231.3	5,122.28	N/A	N/A	N/A	N/A	13.0
E-76	37383	4414828.8	513719.7	5,121.05	5,122.37	17.5-39.0	7.5	12.5	50.0

* Surveyed elevations.

** Screened intervals, depth to bedrock, and well completion data rounded to ± 0.5 ft. BGL = Below Ground Level.

N/A = Not Applicable. No well completed.

Source: ESE, 1988.

sand pack. These two precautions provide assurances that the water samples and water levels obtained from Denver Fm wells are indicative of the desired water bearing zone and that cross-contamination will not occur as a result of well installation.

Several different Denver well completion designs were described in the Task 39 Draft Final Technical Plan for each of the unique hydrogeologic conditions expected at the site. The two most prevalent well completion designs were those for first and second sandstone wells where the sandstones were geologically distinct from overlying and underlying aquifers. These two completion designs are shown in Figures 2.1-6 and 2.1-7. Typical completion details for Denver wells are shown in the schematic of Figure 2.1-6.

The UTM coordinates and specific well completion data at each site are provided in Table 2.1-3. The general site locations, descriptions of the geologic conditions encountered and siting rational are discussed for each drill site location in Appendix C.

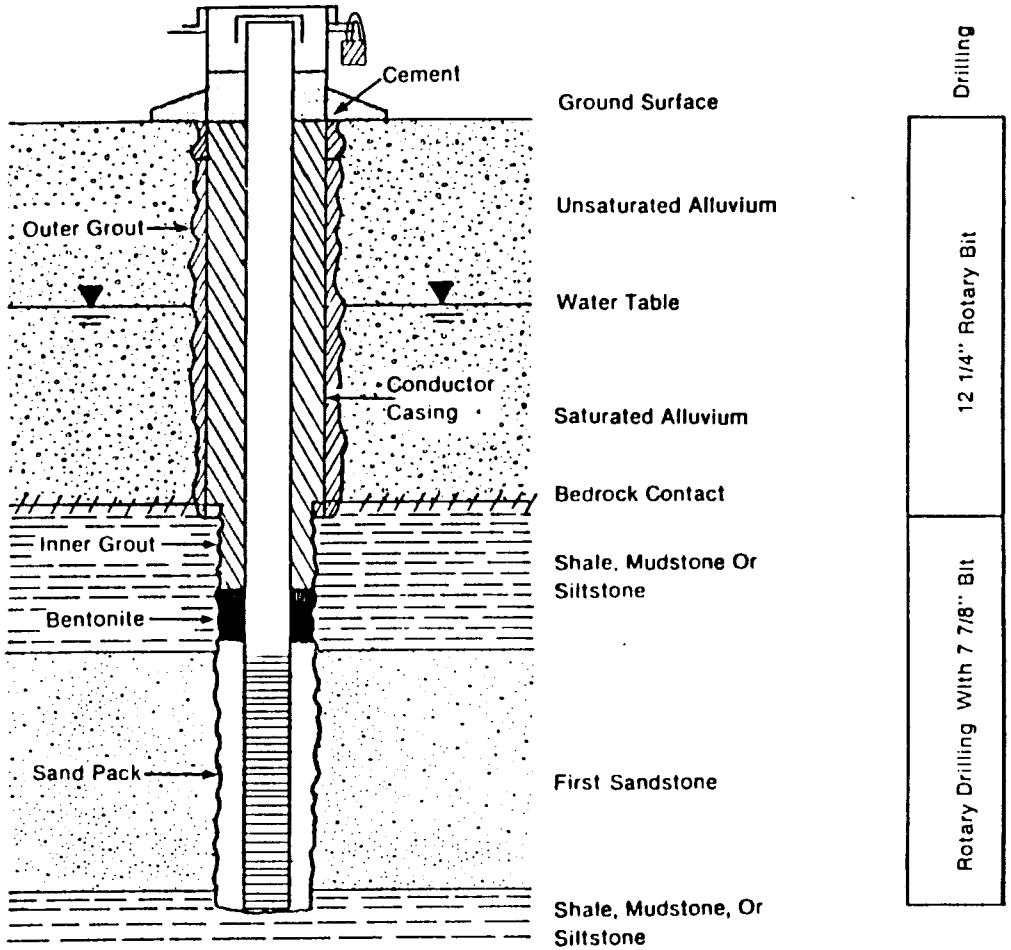
2.1.2 GROUND-WATER MONITORING

The water level and water quality monitoring programs were designed to provide the water chemistry and hydrologic data required to support the offpost RI. An overview of the water level and water quality monitoring program, along with the analytical program, is provided below.

2.1.2.1 Water Level Monitoring

Water levels were measured at each of the network wells within the Offpost Operable Unit as shown in Figures 2.1-1 and 2.1-4 for the alluvium and Denver Fm, respectively. These measurements were obtained during the spring (3rd quarter-May, June) and summer (4th quarter-August, September) of 1987.

Water level measurements were coordinated to obtain data in the shortest possible time span. This was done to approximate an instantaneous set of measurements for each period so that resulting potentiometric maps are indicative of a distinct point in time. All water level measurements were



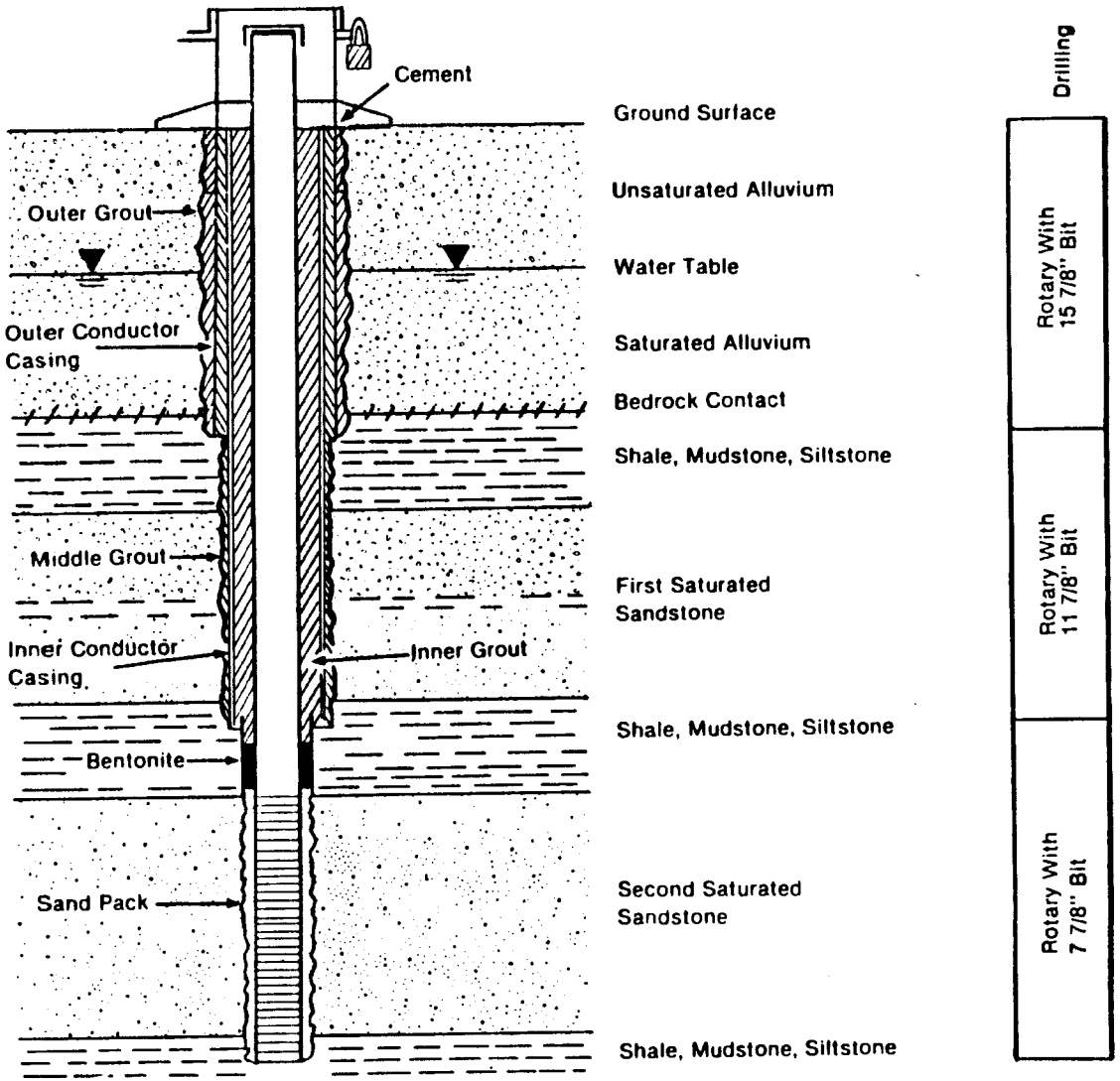
CENTRALIZERS WERE PLACED ON ALL BLANK CASINGS AT INTERVALS OF NO MORE THAN 40 FEET.

Figure 2.1-6

GENERALIZED BEDROCK AQUIFER MONITOR WELL CONSTRUCTION (DENVER FM. WELL COMPLETED IN FIRST SANDSTONE, ALLUVIUM SATURATED, SHALE AT THE ALLUVIAL-BEDROCK CONTACT).

SOURCE: ESE, 1988

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland



CENTRALIZERS WERE PLACED ON ALL BLANK CASINGS AT INTERVALS OF NO MORE THAN 40 FEET.

Figure 2.1-7

GENERALIZED BEDROCK AQUIFER MONITOR WELL CONSTRUCTION (DENVER FM. WELL COMPLETED IN SECOND SANDSTONE, ALLUVIUM SATURATED, SHALE AT THE ALLUVIAL-BEDROCK CONTACT).

SOURCE: ESE, 1988

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

Table 2.1-3. Completion Data for New Denver Wells

Site Number	Well Number	Location Coordinates UTM North	Location Coordinates UTM East	Ground Level Elevation* (ft)	Elevation Top of PVC* (ft)	Screen Interval** (ft/BGL)	Top of Bentonite** (ft)	Top of Sand** (ft)	Depth to Bedrock** (ft/BGL)
E-34	37376	4413227.2	513943.9	5,136.65	5,138.07	40.5 - 51.0	34.5	39.0	31.0
E-38	37379	4413470.3	511831.2	5,118.30	5,120.21	39.5 - 55.5	33.5	38.0	27.0
E-38	37380	4413480.9	511841.2	5,119.00	5,120.72	64.5 - 75.0	54.0	59.0	27.0
E-39	37387	4413477.8	512358.2	5,135.24	5,137.07	37.0 - 43.0	28.0	32.5	17.0
E-39	37388	4413490.3	512358.4	5,135.40	5,137.03	70.0 - 86.0	60.0	64.0	17.0
E-40	37371	4413607.5	512586.5	5,117.34	5,119.93	28.5 - 39.0	23.0	27.5	26.0
E-40	37372	4413610.1	512577.4	5,117.47	5,119.41	61.5 - 88.5	56.0	60.5	26.0
E-46	N/A	4414016.7	513568.6	5,316.67	N/A	N/A	N/A	N/A	39.5
E-63	37390	4413412.6	513416.7	5,127.37	5,128.96	40.0 - 46.0	34.0	39.0	23.5
E-69	N/A	4413264.8	512760.9	5,140.07	N/A	N/A	N/A	N/A	27.0
E-73	N/A	4414015.6	513383.2	5,135.49	N/A	N/A	N/A	N/A	40.0
E-74	N/A	4414012.7	513737.0	5,134.93	N/A	N/A	N/A	N/A	28.0

* Surveyed elevations.

** Screening intervals, depth to bedrock, and well completion data rounded to ± 0.5 ft. BGL = Below Ground Level.

N/A = Not Applicable. No well completed at this site.

Source: ESE, 1988.

obtained in accordance with the methodology and techniques described in the Technical Plans for Task 4 (ESE, 1986a, RIC#87013R01) and Task 39.

2.1.2.2 Water Quality Monitoring

Water quality sampling was conducted during the spring and summer of 1987 under this program. However, offpost water quality data collected from other programs exist since December, 1984. The water quality wells within the study area are shown in Figures 2.1-1 and 2.1-4 for the alluvial aquifer and Denver Fm, respectively. The spring and summer 1987 sampling events were coordinated to obtain all applicable water chemistry data in the shortest possible time frame. Water sampling was performed in accordance with the technical guidelines outlined in the Technical Plans for Tasks 4 and 39. Adherence to these guidelines established uniform procedures by which samples could be consistently collected to accurately reflect the water chemistry from the hydrologic zone of interest.

Several specific objectives of the water quality monitoring network were established at the outset of this program. The primary objectives were to:

- Further define specific chemical concentrations and distributions in the alluvial aquifer in the Offpost Operable Unit;
- To define water chemistry in the Denver Fm near highly contaminated alluvial areas to assess potential contaminant transport between aquifers.

2.1.3 ANALYTICAL PROGRAM

Analysis of water quality samples were conducted jointly by ESE laboratories in Gainesville, Florida and Denver, Colorado. Both laboratories underwent a series of rigorous U.S. Army Toxic and Hazardous Materials Agency (USATHAMA) certification procedures designed to ensure accurate and precise determination of the analytes of interest. The laboratories also implemented USATHAMA Quality Assurance procedures to continuously monitor the quality of these data. These steps assured that the Army was provided with reliable and statistically supportable chemical data regarding the type and level of contamination in ground water offpost of RMA. A detailed

discussion of analyst certification and quality assurance criteria is presented in the Task 4 Technical Plan.

The analyte schedule for the Offpost Operable Unit well network was determined in coordination with ongoing monitoring programs at RMA. These programs have identified the primary contaminants present in the ground water that have been targeted for analysis in all Army monitoring programs. The target analyte list has been updated periodically to incorporate additional analytes at the request of the memorandum of agreement (MOA) parties and the State.

The analyte schedule for the offpost RI was chosen in September 1986 based upon evaluation of all applicable monitoring data. In particular, contaminant distribution data from the Final Screening Program, Task 4 (ESE, 1988, RIC#88034R03), and the first quarter results from the Boundary Control Systems Assessment Remedial Investigation (ESE, 1988, Draft), Task 25, (August through September, 1986) were used to define which organic and inorganic compounds may be present offpost of RMA. Data from these tasks were the most recent ground-water quality data available at project initiation.

Based upon these evaluations, all RMA target organic analytes certified for water at that time were incorporated into the analytical schedule for the Offpost Operable Unit. All target inorganic analytes were also analyzed in the offpost monitoring program. Field measurements of pH, temperature, and conductance were taken to aid in obtaining representative water samples and in assessing the potential communication between aquifers. Table 2.1-4 contains the final list of analytes, sample holding times, a reference to the specific methods utilized for each parameter, and method CRLs for the ESE laboratories in Denver and Gainesville.

Certified Reporting Limits, as employed by USATHAMA, are used to define a range of analyte concentrations over which a given method can generate analysis results with well defined accuracy and precision. The lower CRL of a USATHAMA method corresponds to the classical analytical chemistry term of

Table 2.1-4. Chemical Analyses - Offpost Operable Unit Analytical Program (Page 1 of 2)

Analysis/Analytes	Hold Time	Level of Certification	Reference Methods	RMA Method GNV	RMA Method DEN	Analytical Method	Certified Reporting Limit (µg/l) GNV	Certified Reporting Limit (µg/l) DEN
Organochlorine Pesticides		Quantitative	EPA 608	S8	MM8A	CAP-GC/ECD		
Aldrin	Extract as quickly as possible (no more than 7 days). Analyze within 30 days of extraction.						0.0700	0.0830
Endrin							0.0520	0.0600
Dieldrin							0.0600	0.0540
Isodrin							0.0600	0.0560
Hexachlorocyclopentadiene							0.0700	0.0830
p,p'-DDE							0.0500	0.0460
p,p'-DDT							0.0700	0.0590
Chlordane								0.1520
Volatile Organohalogens		Quantitative	EPA 601	Y8	TT8	PACK-GC/Hall		
Chlorobenzene	14 days						0.58	1.40
Chloroform	14 days						1.40	1.90
Carbon Tetrachloride	14 days						1.40	1.70
trans-1,2-Dichloroethylene (12DCE)	14 days						1.20	1.80
Trichloroethylene (TRCLE)	14 days						1.20	1.30
Tetrachloroethylene (TCLEE)	14 days						1.10	2.80
1,1-Dichloroethylene (11DCE)	14 days						1.10	1.85
1,1-Dichloroethane (11DCLE)	14 days						1.20	1.90
1,2-Dichloroethane (12DCLE)	14 days						0.61	2.10
1,1,1-Trichloroethane (111TCE)	14 days						1.70	1.10
1,1,2-Trichloroethane (12TCE)	14 days						1.00	1.63
Methylene Chloride	14 days						5.00	2.50
Organosulfur Compounds		Quantitative	EPA 609	U8	PP8A	PACK-GC/FPD-S		
P-Chlorophenylmethyl sulfone (CPMSO2)	Extract as quickly as possible (no more than 7 days). Analyze within 30 days of extraction.						4.70	2.24
P-Chlorophenylmethyl sulfoxide (CPMSO)							1.30	1.98
P-Chlorophenylmethyl sulfide (CPMS)							4.20	1.08
1,4-Dithiane							1.10	3.34
1,4-Oxathiane							2.00	1.35
Dimethyldisulfide (DMDS)							1.80	1.20
Benzothiazole							2.00	1.20
Volatile Aromatics		Quantitative	EPA 602	W8	SS8	PACK-GC/PID		
Toluene	14 days						1.21	2.10
Benzene	14 days						1.34	1.92
Xylene (m-)	14 days						1.35	1.04
Xylene (o,p)	14 days						2.47	1.34
Ethylbenzene	14 days						1.00	0.62

Table 2.1-4. Chemical Analyses - Offpost Operable Unit Analytical Program (Page 2 of 2)

Analysis/Analytes	Hold Time	Level of Certification	Reference Methods	RMA Method GNV	RMA Method DEN	Analytical Method	Certified Reporting Limit (µg/l) GNV	Certified Reporting Limit (µg/l) DEN
DCPD/MIBK		Quantitative	EPA 608	Z8	R8	CAP-GC/FID		
Dicyclopentadiene	Extract as quickly as possible (no more than 7 days). Analyze extract within 30 days of extraction.						5.12	9.31
Methylisobutyl ketone (MIBK)							5.74	12.9
DIMP/DMMP		Quantitative	EPA 622	T8	QQ8	PACK-GC/FPD-P		
Diisopropylmethyl phosphonate	Extract within 7 days of sampling. Analyze within 30 days of extraction.						10.00	10.1
Dimethylmethyl phosphonate							15.20	16.3
DBCP		Quantitative		V8	Q8	CAP-GC/ECD		
Dibromochloropropane	14 days						0.112	0.130
Inorganics		Quantitative	EPA 300	X8	NN8			
Chloride	28 days					Ion Chromatography	4,800	1,590
Fluoride	28 days					Ion Chromatography	1,200	1,000
Sulfate	28 days					Ion Chromatography	10,000	5,000
Nitrate	28 days		EPA 353.2	K8	—	Auto Analyzer-GNV	10.0	—
Metals								
Arsenic	6 months	Quantitative	EPA 206	A8	W8	AA-Hydride Furnace-GNV AA-Graphite Furnace-DNV	3.90	2.50
Calcium	6 months	Quantitative	EPA 200.7	B8	—	ICAP	500	—
Sodium	6 months					ICAP	764	—
Magnesium	6 months					ICAP	500	—
Zinc	6 months					ICAP	20.1	—
Cadmium	6 months					ICAP	5.16	—
Lead	6 months					ICAP	18.6	—
Chromium	6 months					ICAP	5.96	—
Copper	6 months					ICAP	7.93	—
Potassium	6 months	Quantitative	EPA 258.1	AA8	XX8	Flame-AA	1,256	590
Mercury	28 days	Quantitative	EPA 245.1	L8	WW8	Cold Vapor-DNV Auto Analyzer-GNV	0.242	0.5

Source: ESE, 1988.

Limit of Quantification (LOQ). It is possible to detect the presence of an analyte at concentrations that are below the lower CRL, but the quantification of the analyte at these concentrations is subject to potentially large errors. Analyte concentrations above the lower CRL have well defined accuracy and precision values that can be used to gauge the significance of the analytical data generated for this project. Since these analytical data are to be used in support of RI/FS engineering efforts, the reliability and accuracy of these data are of paramount importance. For this reason, the use of CRL's rather than "Limits of Detection" was required for the reporting of analytical data.

2.1.4 AQUIFER TESTS

Aquifer tests were conducted in the Offpost Operable Unit to further characterize aquifer parameters such as transmissivity, hydraulic conductivity, and storativity in the alluvial and Denver Fm aquifers. Pumping tests were performed and analyzed for the alluvial aquifer to obtain estimates of aquifer parameters along the major flow paths emanating from the RMA north boundary. Slug tests were used to estimate hydraulic conductivity for Denver Fm sandstone units identified downgradient of the RMA north boundary. A brief description of the test locations, field testing methods, and data analysis techniques is provided below.

2.1.4.1 Pumping Tests

Two pumping tests were proposed for the alluvial aquifer in the Offpost Operable Unit. These tests were to be performed on monitoring Wells 37373 and 37367. Well 37373 is approximately 2,000 ft north of 96th Avenue and about 1,500 ft west of Peoria Street. First Creek is approximately 20 ft south of the well. Well 37367 is approximately 10 ft north of 104th Avenue and about 900 ft east of Peoria Street. Testing of Well 37373 was postponed because of flow in First Creek. Testing during periods of flow in First Creek may have yielded data not representative of the alluvial aquifer zone near the well.

Pumping tests were performed at Well 37367 during the week of April 11, 1988. Three tests were conducted at Well 37367: a step test, a constant-

rate test, and a recovery test. The step-test was used to provide data to select a pumping rate appropriate for the constant-rate test. Analysis of the step-test data also supplied an estimate of potential well losses. Data from both the constant-rate and recovery tests were used to estimate aquifer parameters, as well as to assess potential effects of delayed yield and nearby aquifer boundaries.

The step-test consisted of three 60-minute constant-rate discharge periods at varying discharge rates. The initial discharge rate was 10 gallons per minute (gpm), and subsequent discharge rates and number of steps were determined based upon available drawdown. The well was allowed adequate time to recover before further testing was performed.

The constant-rate test was performed for 24 hours. The test was conducted at a rate of 32.3 gpm. This rate was determined from the step-test data as the rate that could be sustained over the duration of the test. Recovery was monitored when the pump was shut off. Monitoring was continued until water levels recovered to 90 percent of their former level. Recovery only required 4 hours at the site.

Two observation wells were installed 40 ft and 80 ft to the north of Well 37367. The observation wells had screened intervals similar to that of the Well 37367. The pumped well and the two monitoring wells were monitored during the tests, in addition to monitoring before the start of the test to provide background data. The wells were monitored with pressure transducers and an In-Situ SE2000 datalogger. Data were collected at logarithmically-spaced time intervals. The smallest time intervals were at the beginning of the test, when changes occurred most rapidly. The time intervals between measurements increased as the test proceeded until a maximum interval of 30 minutes was reached. After the tests were completed, data from the data logger were transferred to computer for analysis. Additionally, barometric pressure was monitored during the test period to estimate barometric effects, if any, on the well. Corrections were made as necessary to the data to account for barometric fluctuations.

A 50-gpm submersible pump was used for the pumping test. During testing, a calibrated flow meter was placed in the discharge line and discharge rates were monitored frequently throughout the testing period. All discharge water was pumped to three 20,000-gallon (gal) tanks that were left on site for the duration of the tests. Subsequently, discharge water was pumped from the tanks and transported by tankers to the South Adams County Water and Sanitation District (SACWSD) sewage treatment facility at 97th Avenue and Monaco Street.

Values for transmissivity (T) and storativity (S) were determined from pumping test data by solving the differential equation applicable to the transient flow conditions near the pumped well. Three different methods were used for analysis of the test data. These methods are the unconfined aquifer type curve method (Prickett, 1965), the modified non-equilibrium method (Jacob, 1950) and the residual drawdown method (Theis, 1935). The results of the testing and analysis are provided in Section 3.2 and details of the analyses performed are provided in Appendix D.

2.1.4.2 Slug Tests

Slug tests were performed on all newly installed Denver Fm wells in the Offpost Operable Unit as shown in Figure 2.1-5. These tests were conducted to obtain order-of-magnitude estimates for hydraulic conductivity for the Denver sandstone units identified in the offpost area downgradient of the NBCS. Slug-in and slug-out tests were conducted on all wells to provide two hydraulic conductivity values for comparison.

Slug tests were performed by lowering or raising the water level in the well by rapidly removing or adding a fixed volume and measuring the resulting change in water levels with time. A nearly instantaneous rise or decline in water levels was simulated by displacing a known volume of water by adding (slug in) or withdrawing (slug out) a stainless steel cylinder. This cylinder was 10.2 ft long, had a 3-inch diameter, and displaced 0.5 cubic feet (ft^3) of water. The water levels were measured with a 25 pounds per square inch (psi) pressure transducer and the data recorded on an Envirolab data logger directly in feet of water above the transducer. The data logger

allowed measurements to be taken at intervals as frequently as one second. Figure 2.1-8 is a schematic diagram illustrating the conditions in the well during a slug-in aquifer test.

Data from the slug tests were evaluated using analytical procedures appropriate for the field boundary conditions encountered at individual Denver well sites. The field conditions encountered during drilling and testing of Denver wells were:

- o Confined flow conditions;
- o Water bearing sandstones of finite thickness and infinite extent, with respect to the radius of the wells;
- o Fully penetrating well screens; and
- o Transient or nonsteady state flow conditions during tests.

The Cooper et al. (1967) method of slug test analysis addresses all of the above boundary conditions and has been utilized for evaluation of test data in this study. This solution method is based upon the following assumptions:

- o The aquifer is homogeneous, isotropic, of uniform thickness and infinite areal extent;
- o The aquifer is confined;
- o The well is screened throughout the entire thickness of the aquifer; and
- o Non-steady state flow conditions exist during the test.

For these assumptions, Cooper developed a solution of the basic equation for transient flow to a well, and prepared type curves to match with field data to determine transmissivity. The graphs, calculations, and Cooper-type curves used for the slug test analyses can be found in Appendix D. The results of the slug tests are presented in Section 3.2.

2.2 SURFACE WATER MONITORING

Monitoring of surface water in the Offpost Operable Unit over the last 3 years has consisted of water quality sampling and analysis and stream gaging. The water quality sampling program is an extension of a previous

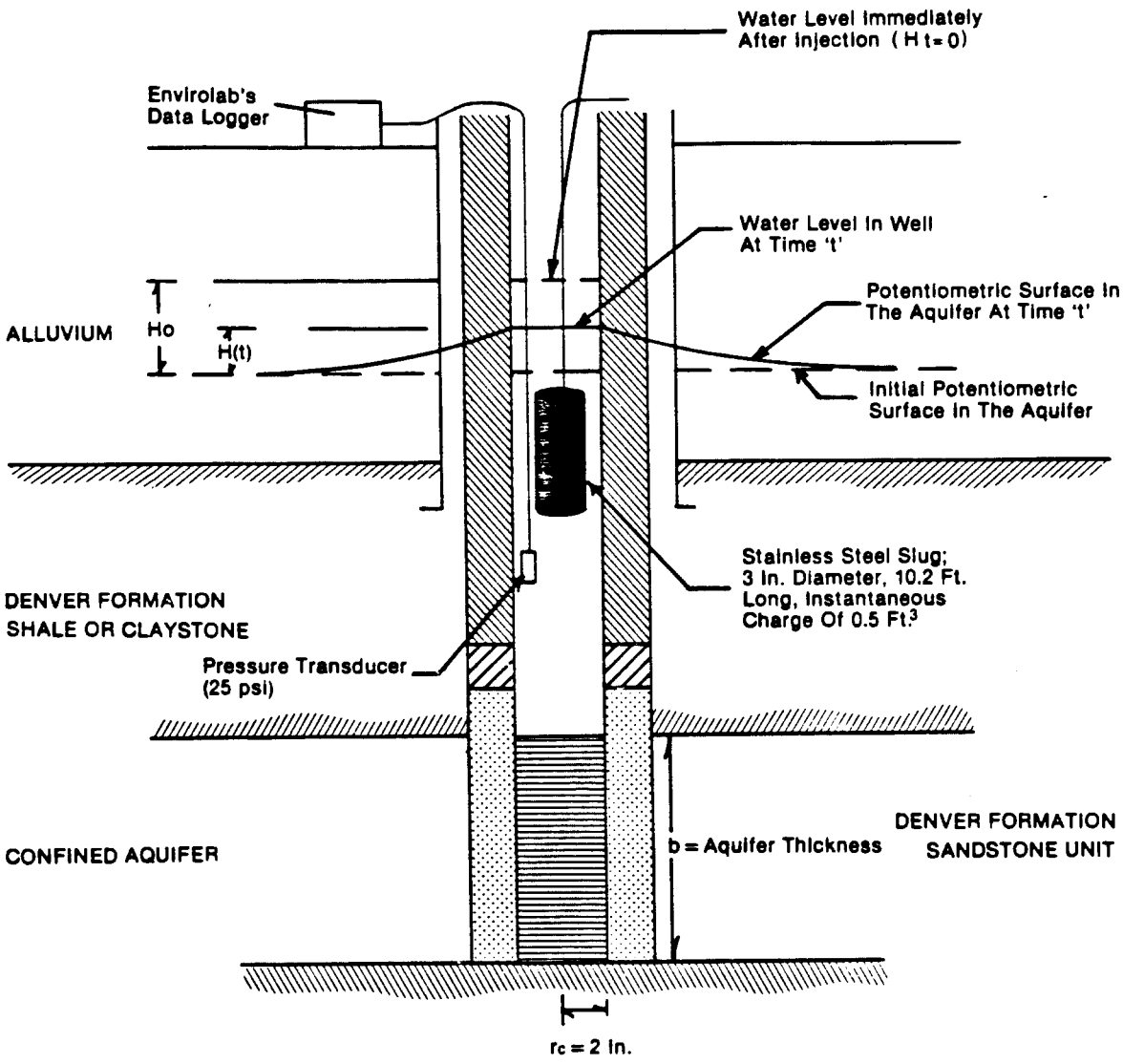


Figure 2.1-8

IDEALIZED DIAGRAM OF SLUG-IN AQUIFER TEST (after Cooper et al, 1967)

SOURCE: ESE, 1988

Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

program conducted by the Army known as the 360° Program (RMA, 1978, RIC#81352M037). This program was developed by the U.S. Army to investigate the potential for offpost ground-water and surface water contaminant migration.

The surface water quality portion of the 360° Program employed the sampling network illustrated in Figure 2.2-1. The network was utilized in this study and quarterly sampling was conducted from the winter of 1985 through the winter of 1987. This network design provides for sampling of all significant surface channels both upstream and downstream of RMA.

The network shown in Figure 2.2-1 consists of 11 sampling sites. Three sites were located upstream of RMA and are on the South Platte River (01CDD), Burlington Ditch (01DCC), and First Creek (08ADD). Since the flows in O'Brian Canal are diverted from Burlington Ditch, an additional upstream site on O'Brian Canal was considered unnecessary. Downstream locations for the O'Brian Canal include a site on Barr Lake (22CAA) and at the Barr Lake inlet channel (33ABB). The Burlington Ditch downstream site was located just above the Second Creek confluence (06CBB), and the South Platte River downstream site (12AAB) was located just west of Brighton. First Creek sites were also located where First Creek exits RMA at 96th Avenue (13DCC), and where it terminates at the O'Brian Canal (14BDD). The final site was located on the O'Brian Canal just upstream of the Second Creek confluence (07BAA). This site allows for the analysis of O'Brian Canal waters just downstream of RMA but prior to mixing with water from Second Creek and Third Creek. The sampling network allows for an examination of the origins of contaminants found in offpost surface water. Since Second Creek is not suspected of being a pathway for RMA contaminants, it is only sampled as it enters the O'Brian Canal (07ABB).

There has not been an extensive surface water gaging network set up for all surface water features the Offpost Operable Unit. However, several gages were installed to monitor surface water flows in areas where RMA contamination was suspected (Figure 2.2-2). First Creek flows are monitored at gaging stations located where First Creek enters RMA (southeast boundary

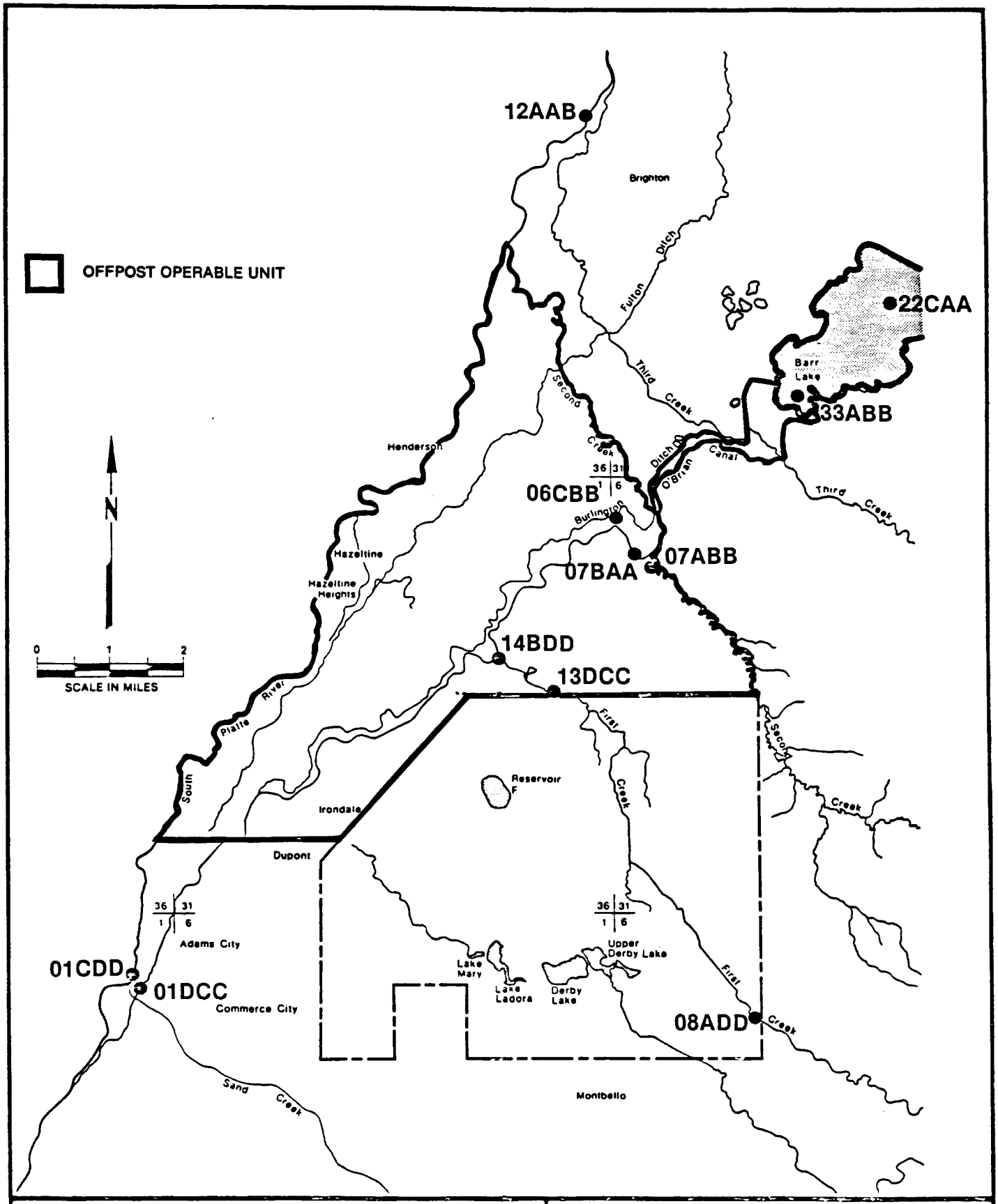


Figure 2.2-1

LOCATIONS FOR SURFACE WATER SAMPLING IN THE OFFPOST OPERABLE UNIT

SOURCE: ESE, 1988

Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

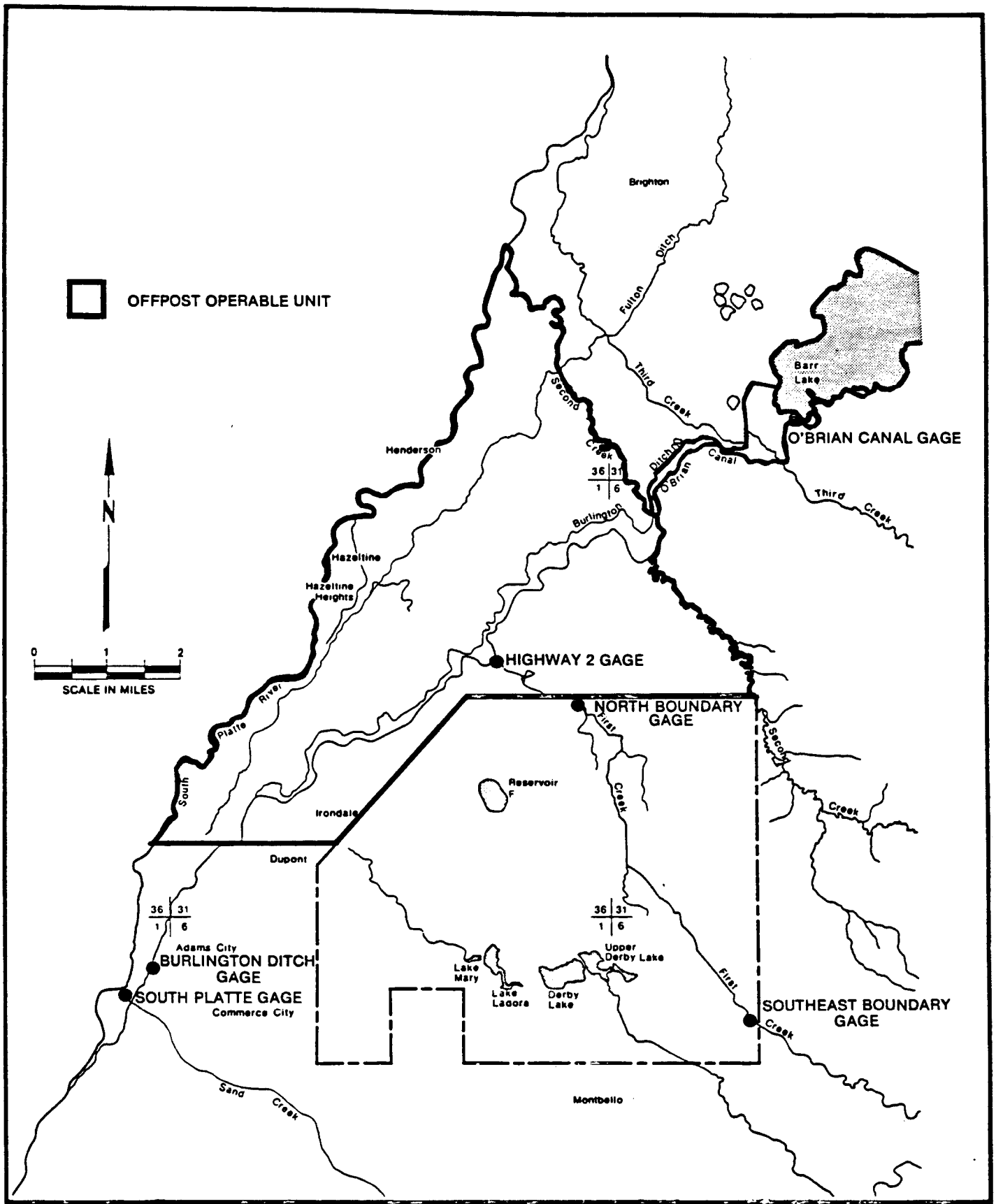


Figure 2.2-2

OFFPOST OPERABLE UNIT SURFACE WATER GAGING STATION LOCATIONS

SOURCE: ESE, 1988

Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

gage), First Creek exits RMA (North Boundary gage), and at a site located just upstream of its confluence with the O'Brian Canal (O'Brian gage). Data for the Southeast Boundary gage and North Boundary gage dates back to October 1985 and data for the O'Brian gage date back to July 1986.

Platte River flows are monitored by the USGS at a site 1,900 ft upstream of the Sand Creek confluence by the Colorado Department of Water Resources (CDWR) near Henderson. The Burlington Ditch is also gaged by the CDWR in the vicinity of its headgate with the South Platte River. The only downstream gages are located in the O'Brian Canal just upstream of Barr Lake where the diversion into Barr Lake is located. There are also gages located on the Barr Lake inlet channel and on the O'Brian Canal downstream of the diversion structure. These flow data were obtained for the last 5 years to delineate general flow patterns in offpost surface water features other than First Creek. The location of these gages is shown in Figure 2.2-2.

2.2.1 ACCURACY OF RESULTS

Although the data are considered to be the best collected to date, the stream flow monitoring was not continuous. The conversion from stream stage to discharge or lake stage to area or volume is dependant upon stream rating, stage-volume, and stage-area relationships which are typically not 100 percent accurate.

Generally, errors need to be defined for stream discharge calculations, instrument error, rating curve development, data reduction, and recorder downtime. The reported accuracy of the Stevens Recorders is 0.05 ft for stage, and within two hours per week for time. These errors are considered less significant as those attributable to the data reduction.

Rating curve errors are attributable to both the gaging measurements and curve extrapolation. The stream gaging measurements used to determine the discharges at different stages are accurate within 10 percent. Due to the infrequency of, and the short peaks associated with, flood occurrences at RMA, verification of extreme discharge events was tenuous. Therefore, the

rating curves were extrapolated for higher flows using the HEC-2 computer program as outlined by the U.S. Army Corps of Engineers Water Resources Support Center Manual, HEC-2 (1982).

Even though a continuous stream discharge record has been generated for the gaging sites, there have been periods when the gages were not in operation or the data were considered misrepresentative. The most extensive period for which the gages were inoperative occurred each winter as a result of freezing conditions. The gages were shutdown for freezing conditions from December 3, 1985 to March 4, 1986 and from December 8, 1986 to March 30, 1987. During this period, stream staff gages were read on a weekly basis. The hourly data were assumed to be a linear interpolation of the weekly readings. This is generally not a bad assumption because flow conditions are typically low and constant for this period.

2.3 SEDIMENT SAMPLING AND ANALYSIS

As part of the RI, sediments from the surface waters in the Offpost Operable Unit were collected for analysis to determine the nature and extent of offpost sediment contamination. Sampling was concentrated in and downstream of First Creek because First Creek was identified as the primary surface water pathway for contaminant migration from RMA. The following discussion summarizes the sampling site locations, field sampling techniques, and methods of analysis used during the study.

2.3.1 SITE LOCATIONS

Nine sampling sites were selected on the Offpost Operable Unit in First Creek, O'Brian Canal, and Barr Lake. The locations of these sites are shown in Figure 2.3-1. Three sites along First Creek were sampled between the RMA north boundary and O'Brian Canal. The first site, labelled FCS1, was located 10 to 15 ft downstream of the culvert passing beneath 96th Avenue. A sample from the second site, labelled FCIS, was collected from an impoundment (approximately 8 acres in surface area) located just west of Peoria Street through which First Creek flows. A field duplicate was collected at this site. The last site on First Creek, labelled FCS2, was

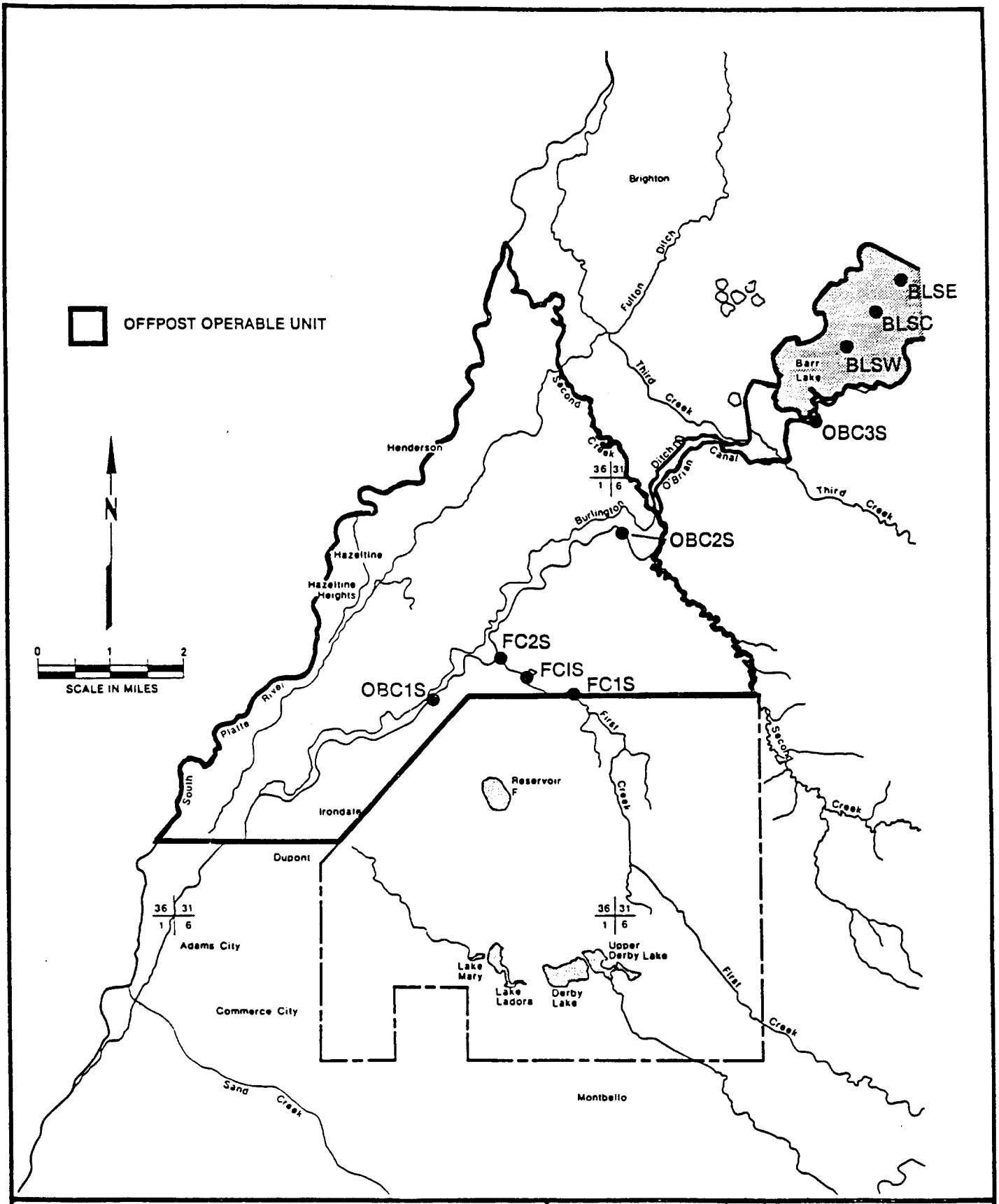


Figure 2.3-1

LOCATIONS FOR SEDIMENT SAMPLING IN OFFPOST OPERABLE UNIT

SOURCE: ESE, 1988

Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

located 15 to 23 ft downstream of the culvert passing under Highway 2 and about 250 ft upstream of the confluence with O'Brian Canal.

Sediments at three sites along O'Brian Canal were sampled. The first site, OBCS1, was originally intended to be immediately upstream of the First Creek confluence, but due to high water, was relocated to the 96th Avenue bridge, about one and one-quarter mile further upstream. The second site on O'Brian Canal, OBCS2, was located at the Highway 2 bridge over a half mile upstream of its confluence with Second Creek. The last site was just upstream of the Barr Lake State Park boundary before the headwater gates diverts O'Brian Canal flow to Barr Lake.

Three sites in Barr Lake were sampled for sediments. Samples from two sites, BLSNE and BLSC, were collected in the northeast section of the Lake, and a sample from site BLSSW, was collected in the southwest wildlife refuge area. Water depths at these sites were 33.8 ft, 28.9 ft, and 24.6 ft, respectively.

2.3.2 FIELD SAMPLING METHODOLOGY

Two techniques were used for sampling the sediments in lakes and streams. The techniques selected were based primarily upon expected differences in texture and biological activity at the different sites. Stream sediments were collected with a 6 inch x 6 inch Ponar dredge and then passed through a 1 millimeter (mm) polypropylene sieve to remove coarse sand, gravel, and twigs. Water from the dredged material was used to wet-sieve the samples. The sieved material was then allowed to settle and the supernatant water discarded before sample transfer to amber bottles and storage on ice. Loss of some colloidal material was observed in the discarded water.

Lake sediment sampling was performed using a 1.97-inch diameter gravity corer fitted with a polycarbonate sample tube. The corer was allowed to slowly penetrate the sediments, and only those cores with distinct sediment-water interfaces were kept for sectioning. Cores were immediately extruded, sectioned and placed in amber glass bottles. About five cores at each site were necessary to obtain an adequate sample mass for analysis. At Barr

Lake, only the top 6 inches were retained for analysis. These upper sediments represent the most biologically active strata. At the First Creek impoundment, the top 8 inches were retained. Because lake sediments are finer-grained than stream sediments, no sieving was necessary for samples from Barr Lake or the First Creek impoundment.

2.3.3 ANALYTICAL METHODS

Because of the fine-grained nature of lake and sieved stream sediments, collected samples exhibited a high water content. Therefore, samples were centrifuged to remove excess water prior to extraction and analysis. Samples were extracted by the USATHAMA-approved SS-9 method and analyzed to Level 2 standards at the ESE Gainesville analytical laboratories. The analytical suite for samples consisted of organochlorine pesticides, DBCP, DIMP, organosulfur compounds, inductively-coupled argon plasma spectrometry (ICAP) metals, arsenic, mercury, and organic carbon. All analyte concentrations were determined in terms of the dry weight of the sediment. Organic carbon was measured as that fraction lost on ignition at 550°C. The rationale for the analytical suite will be discussed in Section 5.0 of this report.

2.4 AIR MONITORING

Air quality monitoring was not conducted as part of this investigation in the offpost area. Rather, characterization of air quality north and northwest of RMA was determined from existing offpost information as well as from simulation of impacts from onpost airborne contaminant sources that were evaluated during other recent RMA investigations.

The airborne contaminants of concern at RMA are the criteria pollutants and the toxic pollutants such as asbestos, organics, and metals. Total suspended particulates (TSP), particulate matter less than 10 microns in diameter (PM-10), carbon monoxide (CO), nitrogen oxides (NO_x), sulfur oxides (SO_x), ozone (O_3), and lead (Pb) are the criteria pollutants for which there are National Ambient Air Quality Standards (NAAQS). The criteria pollutants have been monitored onpost and offpost of RMA with the majority of offpost

monitoring having been conducted by Federal and State agencies. Onpost monitoring for both criteria and toxic airborne contaminants has been conducted by the U.S. Army.

2.4.1 OFFPOST AIR MONITORING

The criteria pollutants are monitored by the EPA and CDH throughout the Denver-metro area. The monitoring stations nearest to RMA are located at 4301 East 72nd Avenue and at 78th Avenue and Steel Street in Adams County. The data are published in an annual summary report prepared by CDH.

Because PM-10 has only recently been added to the list of criteria pollutants, there is a minimal data base for this airborne contaminant offpost of RMA. However, there appears to be a general proportional relationship between TSP and PM-10, and until more PM-10 data are collected, applying this correlation will be appropriate for estimating PM-10 concentrations.

Toxic airborne contaminants have not been monitored offpost of RMA on a routine basis. EPA has, however, sampled for organic and inorganic toxic contaminants through special investigations as part of the Denver Air Toxics Study (DATS). The results of DATS will be published in 1988.

2.4.2 ONPOST AIR MONITORING

Observations of airborne contaminants have been documented by various agencies and personnel at RMA since the 1960's. Studies have been undertaken as response actions to RMA operations, as well as to establish background levels of ambient contaminants at RMA. The data indicate that some emissions had resulted from specific operations and that the contaminants are no longer being emitted to the atmosphere since operations ceased. Examination of ambient air data also indicates that dust and vapor emissions from known fugitive sources within RMA contain contaminants specific to the source.

The U.S. Army Environmental Hygiene Agency (USAEHA) has been the primary agency responsible for monitoring airborne contaminants at RMA. In addition to monitoring standard criteria pollutants, USAEHA monitored toxic contaminants including organics and metals. Table 2.4-1 summarizes air quality sampling programs at RMA.

A sample of the blowing dust was obtained from the southern part of Basin A during a wind storm in September 1977 (Witt, 1978). The chemical analysis of this sample detected a number of organic and inorganic contaminants. The Environmental Division Contamination Migration Branch sampled air near Basin F in November 1980 (Engineering Laboratory, 1980). This sampled contained dimethyl acetamide, DMMP, toluene, and benzaldehyde or benzyl alcohol. In January of 1981, the Environmental Division Contamination Migration Branch again sampled the air near Basin F and found airborne organic compounds (U.S. Army, 1981, RIC#81293R04).

An ambient air quality assessment was conducted southeast of Basin F in 1980 (Hanson, 1981). From April to September 1980, arsenic, mercury, cadmium, copper, lead, aldrin, dieldrin, and endrin were sampled and analyzed. During this time arsenic, mercury, cadmium, copper, and lead were detected. From September through December 1980 the air was sampled for pesticides. Aldrin, endrin, and dieldrin were detected.

In April to August 1982, the USAEHA conducted tests for airborne emissions from Basin F liquids (USAEHA, 1982, RIC#81392R02). The USAEHA evaluated various adsorption media for collecting Basin F emissions. Although this study did not attempt to characterize ambient air emissions near the basin, the findings indicated the potential for observing many organic contaminants, including pesticides.

Based upon these previous investigations and upon current RI activities at RMA, the Army recently conducted and completed an air quality and meteorological monitoring program at RMA. The objective of the air monitoring program under Task 18 was to establish a quality data base on the ambient air quality at RMA. The program was designed to support RI/FS activities and, to a lesser extent, support future remedial actions.

Table 2.4-1. Summary of Previous Air Quality Monitoring Programs at RMA.

Contaminant	Sampling Event	Responsible Organization	Reference
TSP	1969	Moss, E.	Moss, 1969
	1969	USAEHA	USAEHA, 1970
	1980	USAEHA	USAEHA, 1981
	Historical	CDH	CDH, 1984 and 1985
Pb, As, Cd, Hg, Cu	1980	USAEHA	USAEHA, 1981
Pb	Historical	CDH	CDH, 1984 and 1985
SO_x	1969	USAEHA	USAEHA, 1970
	Historical	CDH	CDH, 1984 and 1985
NO_x	1969	USAEHA	USAEHA, 1970
	Historical	CDH	CDH, 1984 and 1985
O_3	Historical	CDH	CDH, 1984 and 1985
CO	Historical	CDH	CDH, 1984 and 1985
Organic Compounds	1976	USAEHA	RMA 0120 2864 FL
	1977	USAEHA	RMA, 1978
	1978	Hartman, F.	Hartman, 1979
	1980	USAEHA	USAEHA, 1980a
	1980	NSTL	CSC, 1980
	1980	USAEHA	USAEHA, 1980b
	1981	USAEHA	RMA, 1981
	1982	USAEHA	USAEHA, 1982
Hydrochloric Acid	1969	USAEHA	USAEHA, 1970

Source: ESE, 1988.

Specifically, air quality parameters were monitored to provide data in order to evaluate if there were imminent hazards to public health and the environment, or if these contaminants may have implications on future remedial actions. Likewise, meteorological parameters were measured and evaluated as to their impact on air quality conditions at RMA. Based upon previous air quality investigations, potential contaminant sources, possible future remedial actions, and other RI tasks at RMA, the monitoring program was established under the Task 18 Technical Plan (ESE, 1987c). The following parameters were monitored:

- o TSP;
- o PM-10;
- o Asbestos;
- o Volatile Organic Compounds (VOCs);
- o Semi-Volatile Organic Compounds (SVOCs);
- o Metals.

The Army is continuing to monitor these parameters as well as to expand the air quality program on RMA to monitor CO, NO_x, SO_x, and O_3 under the Continuous Monitoring Program.

Section 6.0 of this report discusses the significance of air quality north of the RMA, based upon offpost data and upon a simulation of migration to the offpost area from onpost sources. Where applicable, airborne contaminant concentrations are compared to appropriate Federal and State standards and guidelines. If standards and guidelines do not exist, the EA portion of this study will evaluate the significance of a contaminant relative to human and environmental impacts.

2.5 BIOTA

Of the potential pathways to humans from RMA contaminants in the Offpost Operable Unit, four involve biota. Domesticated plants and animals may be exposed to contaminated surface and ground water in the offpost area. Offpost wildlife and vegetation may be similarly exposed, but the opportunities for this exposure are limited. Investigations of these pathways have been undertaken as part of the Offpost Operable Unit FS.

The levels of some contaminants (e.g., dieldrin, mercury) in the flesh of game animals and edible fish on RMA exceed the Food and Drug Administration (FDA) action levels for animal and fish tissue (Food and Drug Administration, undated). The U.S. Fish and Wildlife Service has expressed concern to the CDH regarding the potential health hazard to humans of contaminated wildlife moving off of RMA (U.S. Fish and Wildlife Service, 1981). Concern has also been expressed by the Colorado Division of Wildlife over the movement of pheasants contaminated with pesticide residues off RMA onto private lands to the north and east of RMA where they can be hunted. These birds were reportedly contaminated above levels acceptable for human consumption (U.S. Fish and Wildlife Service, 1981). Data on contaminant levels in the tissues of pheasants and cottontail rabbits from onpost locations have been collected as part of the Biota Assessment studies and are incorporated into the Biota RI (ESE, 1988, draft).

Although contamination of resident game species on RMA has been documented for several years (Thorne, 1982, RIC83042R01), information on local animal home range and movements is lacking, and wide variation exists in home range size in other regions of the country (Dalke and Sime, 1938; Allen, 1939; Ingles, 1941; Schwartz, 1941; Haugen, 1942; Fitch, 1947; Lord, 1963; Hanson and Progulske, 1973; and Trent and Rongstad, 1974). The movement of these game species of wildlife from RMA into the Offpost Operable Unit comprise potentially important pathways for the movement of RMA contaminants into the offpost environment. Absence of sufficient water in streams crossing RMA boundaries precludes movement of contaminated fish from RMA; however, terrestrial game species are not restricted from moving off RMA.

Desert cottontail rabbits (Sylvilagus audubonii) were evaluated for study because of their abundance in habitats on and near RMA, and because they may provide a regular food source for some area residents (Howard, 1984). The movement of ring-necked pheasants (Phasianus colchicus) was also evaluated. Because pheasant chicks eat large numbers of insects (Baxter and Wolfe, 1973), the chicks may contain higher contaminant levels than adult pheasants or other herbivorous species. As these chicks mature and disperse from the nesting area, they may carry significant levels of contaminants offpost. Contaminant uptake by both desert cottontails and ring-necked pheasants has

been demonstrated at RMA (Thorne, 1982, RIC#86058R01, RMA 031 0751F, RMA 046 1751F, RMA 045 1797, RMA 046 2040, RMA 076 0736, RMA 117 1364, RMA 162 0821F, RSH 855 1544 F).

Resident game species (e.g., cottontail rabbits and ring-necked pheasants) were also selected for investigation because they are known to be hunted in the vicinity of RMA. All possible biota pathways to humans were reviewed prior to the initiation of field studies. Investigations of migratory species (e.g., waterfowl and mourning dove) were not conducted because these species appear to present a lesser potential hazard to humans due to the large range movements. Migrating game species such as waterfowl and mourning dove that visit RMA move hundreds of miles from RMA and become dispersed among individuals from other locations, thus reducing the likelihood that a hunter would take more than an occasional RMA bird.

The objective of this portion of the offpost RI was to determine the offpost movement of resident small game species which may have become contaminated on RMA and which might subsequently pose a threat to human health offpost. Estimated home range area, greatest distance moved, and seasonal movements were the parameters selected for this purpose. This information will be used in conjunction with analysis of tissue samples collected from these species onpost to delineate the extent to which these animals may present a pathway for contamination to the offpost area. Data will be presented in the RMA Biota RI Report and subsequently the effects of this pathway in the Offpost Operable Unit will be addressed as part of the FS.

2.5.1 METHODS OF INVESTIGATION

A preliminary study was conducted during the spring and early summer (April to July) of 1985, to determine the type of biota in the Offpost Operable Unit, to evaluate trapping methods, and to ascertain signal detectability and the feasibility of radiotracking in an area with high radiowave activity (ESE, 1987a, RIC87202R01). In this preliminary study, two desert

cottontails received radio collars and two pheasants were fitted with transmitters.

Following the completion of the preliminary study, cottontails and ring-necked pheasants were captured and marked during mid-summer 1985, and then again during a period in late October 1985. All trapping occurred in the northern portion of RMA within one mile of the northern boundary. The area adjacent to this boundary is primarily agricultural and provides public hunting opportunities.

Pheasants were captured using night lighting procedures (Labisky, 1968). A field vehicle equipped with floodlights was driven through predetermined portions of the capture area at dusk and in the early evening. A second team member captured spotlighted birds with a long-handled net. Live trapping was the principal method used to capture desert cottontails. Wire mesh traps (Tomahawk collapsible traps, 9 by 9 by 32 in) were set in the evening and checked the following morning. Fresh, sliced apples and carrots were used as bait.

Sex, age, and date of capture were recorded for both species, and weights were also obtained for cottontails. All pheasants received a sequentially numbered metal leg band offering a $10.00 reward for its return, and each rabbit received a sequentially numbered metal ear tag. All pheasants were fitted in summer with bib-mounted transmitters, because the pilot study indicated this mount was less likely to come off or interfere with the pheasants' movements. Neck-mounted transmitters were used on the cottontails. Miniature two-stage transmitters with a range of 3 to 4 miles and a battery life of 150 days were used for pheasants, while subminiature one-stage transmitters with a range of 0.5 to 0.75 mi were placed on rabbits. Each transmitter weighed 20 to 25 grams and had a separate frequency in the 150 to 151 MHz range. Transmitters and receivers were obtained from Wildlife Materials, Inc. of Carbondale, Illinois. Handling of animals was minimal and all were released at the point of capture. Several transmitters recovered during field monitoring were later used on animals caught in the second capture period.

A lightweight, portable TRX 24 receiver or a Falcon Five receiver and a folding directional, hand-held yagi antenna were used for radiotracking. Monitoring occurred in summer (June through August, 1985), fall (September through November, 1985), and winter (December 1985 through January 1986) and included day and night readings. Pheasants and rabbits were located primarily by triangulations (Cochran, 1980; Mech, 1983) and occasionally by homing in on the signal. An effort was made to approach within 0.5 mile of collared animals before triangulation. Only locations resulting from a triangulation angles of 45° to 135° were used in analysis (Springer, 1979).

Accuracy was evaluated by placement and relocation of transmitters in the field with observed signal azimuths compared to known azimuths to determine error (Heezen and Tester, 1967). Maximum error was estimated at ±4° and resulted in an error polygon of about 8 acre at a distance of 0.5 mile. All acceptable locations were plotted and home range size estimated by the convex polygon method (Mohr, 1947).

The length of the major axis of each pheasant polygon was measured and represents the greatest distance moved within the home range. All home range and movement parameters are minimum values, because readings were not taken continuously. The results of this study are provided in Section 7.0 of this report along with an assessment of contaminant levels found in tissue samples from these species onpost.

3.0 GROUND-WATER CONDITIONS

3.1 GEOLOGY

As part of the investigation of the ground-water conditions present in the Offpost Operable Unit, the necessity to establish an understanding of the local geology has been recognized. Of primary importance is to develop a working knowledge of this natural frame work, for the components which comprise it control the behavior and fate of the hydrologic and chemical systems imposed upon the geology. At RMA, the geology is characterized by complex erosional and depositional histories and the resulting stratigraphic relationship of the surficial deposits, the alluvium, and the uppermost bedrock stratum, the Denver Fm.

The geology as presented in this section progresses from a regional to a more local description of the geologic conditions encountered in the Offpost Operable Unit. The two geologic units of primary concern are the unconsolidated alluvial/eolian surficial deposits and the Denver Fm. The Arapahoe Fm which underlies the Denver Fm will also be discussed in Section 3.1.4 in regard to the Offpost Operable Unit.

3.1.1 CHARACTERIZATION OF ALLUVIUM

The alluvium in this report refers to the unconsolidated surficial deposits that are present in the Offpost Operable Unit. The alluvium has been characterized by first presenting a general description as it appears regionally at RMA. This is followed by a more localized characterization that focuses on the alluvial stratigraphic units that are present in the Offpost Operable Unit.

Sediments at the land surface in the vicinity of RMA consist of unconsolidated alluvial and eolian deposits of Quaternary age (May, 1982, RIC#82295R01). The material is composed primarily of terrace gravel, colluvium, eolian sand, loess, and fluvial sediments (Romero, 1976, RIC#81266R69). The exact composition varies physiographically across RMA.

The age of the alluvial material is Pleistocene and Holocene. The pre-Wisconsin aged deposits contain fluvial silts, sands, and gravels and occur

in valleys and at higher elevations. More recent Wisconsin alluvium was deposited as glacial outwash (May, 1982; RIC#82295R01). The eolian sediments are Holocene, and are composed of wind-worked glacial outwash.

RMA is almost entirely blanketed by alluvium except for the Denver Fm exposures in the north central part of RMA (Figure 3.1-1). Borehole data indicates thickness of alluvium up to approximately 100 ft is present in the Offpost Operable Unit near the NWBCS (Lindvall, 1981b, RIC#81352M022). The thickest deposits are located in the paleostream channels eroded into the underlying Denver Fm.

The alluvial deposits have been classified in the literature according to age, origin, and physical characteristics. These include the Verdos, Slocum, Louviers, Broadway, Eolian Deposits, Piney Creek and Post-Piney Creek. As shown in Figure 3.1-2 the oldest unit is the Verdos which unconformably overlies the Denver Fm. Younger alluvial units, including Slocum through Post-Piney Creek overlie the Verdos. The alluvial deposits at RMA have been logged in soil borings using the Unified Soil Classification System (USCS) as shown in Figure 3.1-3.

The generalized east-west cross section shown in Figure 3.1-4 illustrates the stratigraphic relationships of alluvial units as they appear from the South Platte River to the northeast corner of RMA. The units that are present in the Offpost Operable Unit are the Slocum, Louviers, Broadway, Piney Creek, Post-Piney Creek, and the eolian deposits.

3.1.1.1 Characterization of the Alluvium in Offpost Operable Unit

The maximum alluvial thickness in the Offpost Operable Unit is approximately 100 ft and the average thickness is about 40 ft. This alluvium is comprised of two dominant lithostratigraphic units. The sequence consists of an upper unit of fine-grained eolian silt and clay deposits which mantle lower units of well-sorted fluvial sand and gravel. The lower, coarser units may be Slocum, Louviers, Broadway or Piney Creek Alluvium depending on location.

These lower units are important from a ground-water standpoint because they transmit more water regionally than the upper unit. The Slocum Alluvium of

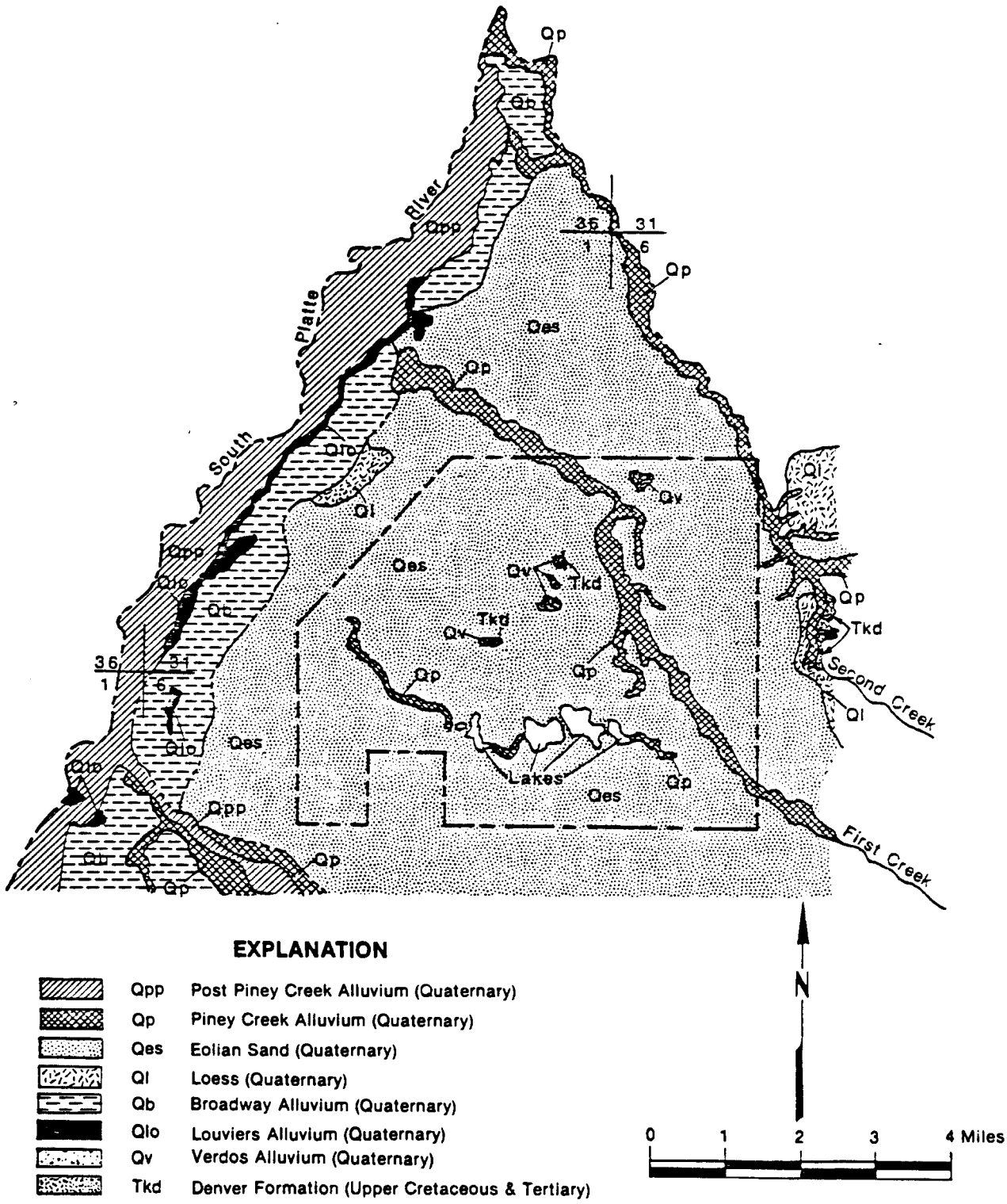
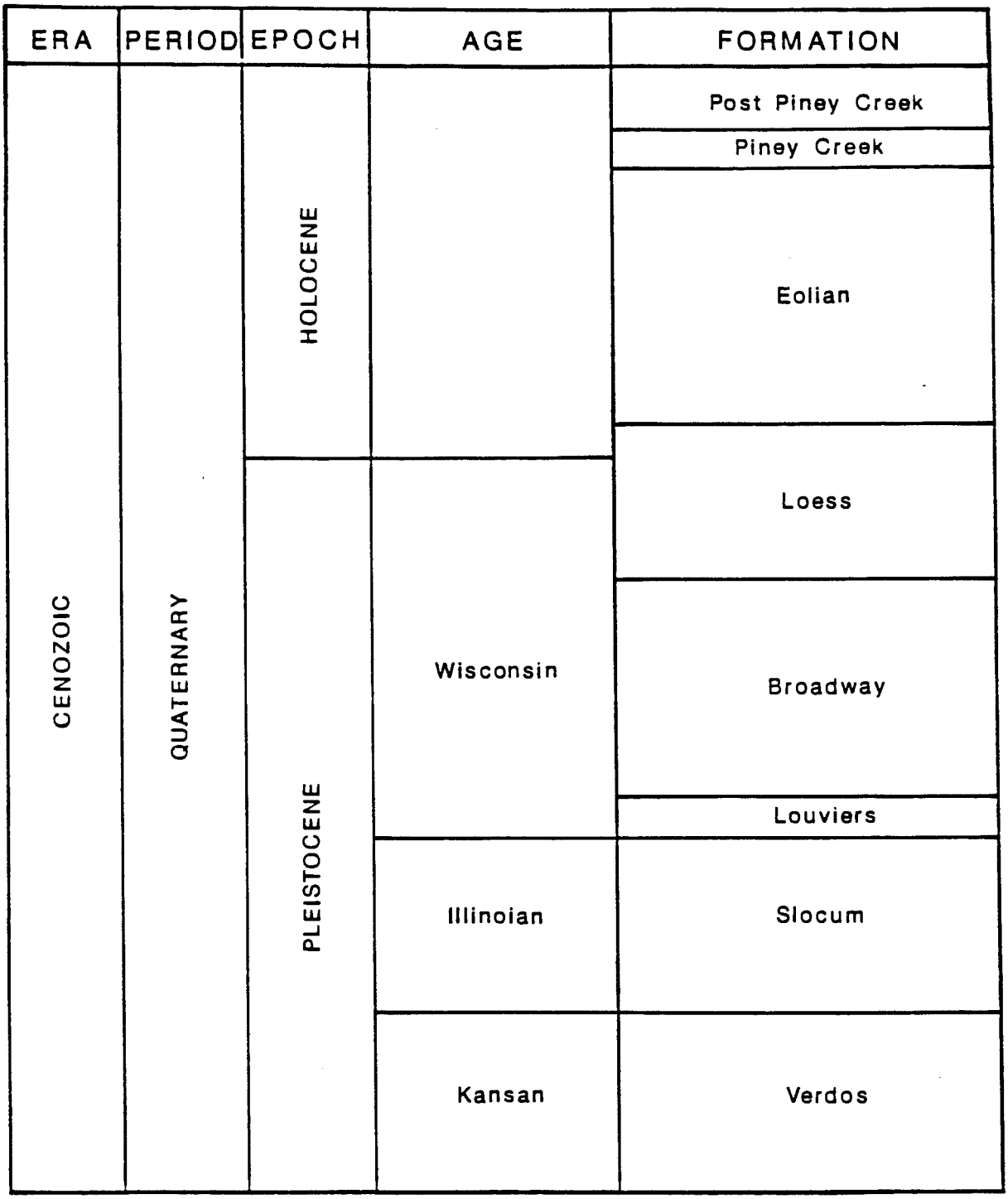


Figure 3.1-1

GEOLOGIC MAP OF ROCKY MOUNTAIN ARSENAL AREA

SOURCE: LINDVALL (1980, 1983)

Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland



NOT TO SCALE

Figure 3.1-2

QUATERNARY COLUMNAR SECTION

SOURCE: Modified From MKE (1988)

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

MAJOR DIVISIONS			TYPICAL NAMES	
COARSE-GRAINED SOILS (MORE THAN HALF IS COARSER THAN NO. 200 SIEVE)	GRAVELS (MORE THAN HALF COARSE FRACTION IS LARGER THAN NO. 4 SIEVE SIZE)	CLEAN GRAVELS WITH LITTLE OR NO FINES	GW	WELL GRADED GRAVELS WITH OR WITHOUT SAND, LITTLE OR NO FINES
			GP	POORLY GRADED GRAVELS WITH OR WITHOUT SAND, LITTLE OR NO FINES
		GRAVELS WITH OVER 12% FINES	GM	SILTY GRAVELS, SILTY GRAVELS WITH SAND
			GC	CLAYEY GRAVELS, CLAYEY GRAVELS WITH SAND
	SANDS (MORE THAN HALF COARSE FRACTION IS SMALLER THAN NO. 4 SIEVE SIZE)	CLEAN SANDS WITH LITTLE OR NO FINES	SW	WELL GRADED SANDS WITH OR WITHOUT GRAVEL, LITTLE OR NO FINES
			SP	POORLY GRADED SANDS WITH OR WITHOUT GRAVEL, LITTLE OR NO FINES
		SANDS WITH OVER 12% FINES	SM	SILTY SANDS WITH OR WITHOUT GRAVEL
			SC	CLAYEY SANDS WITH OR WITHOUT GRAVEL
FINE-GRAINED SOILS (MORE THAN HALF IN FINER THAN NO. 200 SIEVE)	SILTS AND CLAYS (LIQUID LIMIT 50% OR LESS)		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTS WITH SANDS AND GRAVELS
			CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, CLAYS WITH SANDS AND GRAVELS, LEAN CLAYS
			OL	ORGANIC SILTS OR CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS (LIQUID LIMIT GREATER THAN 50%)		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS, FINE SANDY OR SILTY SOILS, ELASTIC SILTS
			CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
			OH	ORGANIC SILTS OR CLAYS OF MEDIUM TO HIGH PLASTICITY
HIGHLY ORGANIC SOILS			Pt	PEAT AND OTHER HIGHLY ORGANIC SOILS

Figure 3.1-3

UNIFIED SOIL CLASSIFICATION SYSTEM

SOURCE: ASTM D-2487

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

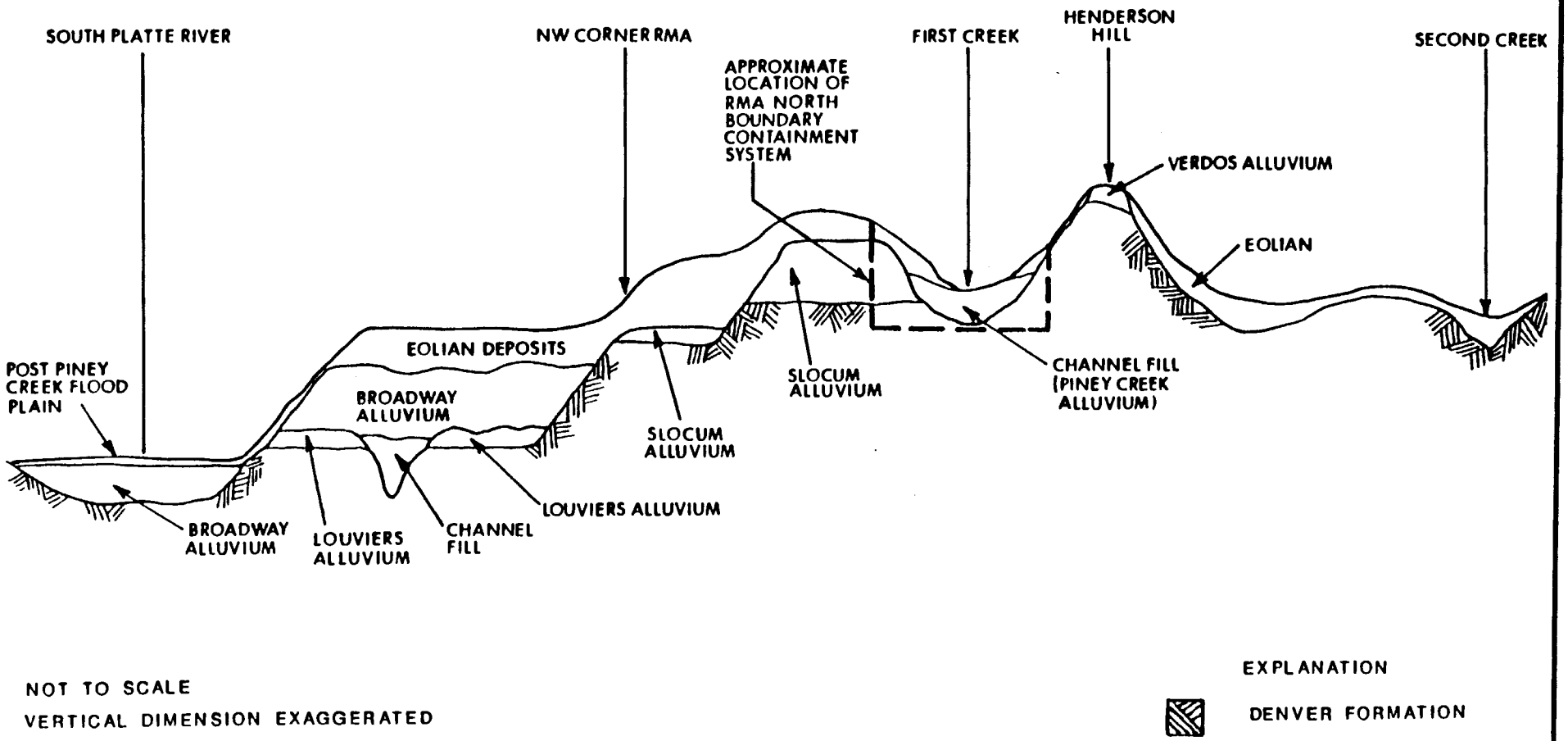


Figure 3.1-4
GENERALIZED EAST-WEST CROSS-SECTION FROM THE SOUTH PLATTE RIVER TO THE NORTHEAST CORNER OF THE ROCKY MOUNTAIN ARSENAL
SOURCE: ESE, 1988

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

Illinoian age is generally 10 to 15 ft thick (Lindvall, 1971b, RIC#81352M022). The Slocum has been subdivided into the younger and older Slocum (MKE, 1988). The Slocum Alluvium generally consists of coarse gravel interlayered with thin lenses of fine- to medium-grained arkosic sands.

The Louviers Alluvium (Wisconsin Age) is stratigraphically above the Slocum Alluvium and outcrops in the Offpost Operable Unit along the South Platte River. At depth, the Louviers Alluvium unconformably overlies large areas of the weathered bedrock surface (MKE, 1988). The Louviers Alluvium varies in thickness, up to 35 ft in the South Platte River Valley, and is a reddish-to yellowish-brown coarse-grained arkosic sand and gravel with occasional boulders and minor lenses of silt and clay (DeVoto, 1968, RIC#84291R01).

The Broadway Alluvium (Wisconsin Age) outcrops along the west edge of the Offpost Operable Unit in a nearly mile-wide terrace immediately east of the South Platte River. Thickness of the unit ranges from 0 to 15-ft. The Broadway alluvium is pink to light brown and consists of fine- to medium-grained arkosic sand and gravel generally less than 1 inch in size, with scattered cobbles as large as 4 inches (MKE, 1988).

Following deposition of the Broadway Alluvium, loess-like sediments were windblown to variable depths over large areas of RMA during the late Pleistocene and early Holocene Epochs. The Loess is commonly a yellowish brown to light grayish brown, sandy silt and is generally less than 10 ft thick (Lindvall, 1971b, RIC#81352M022). Eolian sands were similarly deposited during the Holocene Epoch and today dominate the surficial cover of the Offpost Operable Unit. The eolian sands are generally 10 to 20 ft thick, light brown fine sand, sandy silt and clay.

The Piney Creek Alluvium (Holocene Epoch) is present in the First Creek and Second Creek drainages as well as the major tributaries to these streams. The Piney Creek Alluvium is generally less than 5 ft in thickness and consists of brown, light brown, light- to dark-gray interbedded sand, silt and clay. Gravelly channel lag deposits are common at the base of the Piney Creek Alluvium.

The Post-Piney Creek Alluvium (Holocene Epoch) is the most recently accumulated sediment in the area and comprises the present day South Platte River floodplain. This deposit consists of light- to dark-grayish brown clay, silt, sand and small amounts of gravel (Lindvall, 1971b, RIC#8135M022).

In the Offpost Operable Unit, the coarser lower unit is thickest in the paleochannels eroded into the underlying Denver Fm. An east-west cross section located approximately 3,000 ft downgradient of the NBCS in Section 13, illustrates the lower unit is thickest in the paleochannel and wedges out against a bedrock high near Peoria Street (Figure 3.1-5). In this area the maximum alluvial thickness averages 40 ft and the lower unit of fine- to coarse-grained poorly graded sands averages 15 to 20 ft thick. An east-west cross section located along 104th Avenue in Section 12 also illustrates the lower coarser unit wedging out against a bedrock high near Peoria Street. This cross-section is provided in Appendix E.

A southwest-northeast cross section along Highway 2 from the area of the NWBCS to the northeast of First Creek is represented in Figure 3.1-6. In the vicinity of the NWBCS, the maximum alluvial thickness averages 55 ft and the coarser lower unit of fine to coarse grained gravelly sand averages 20 ft thick. In the area between the NWBCS and First Creek the maximum alluvial thickness averages 25 ft and the thickness of the coarser lower unit averages 10 ft or less. In the vicinity of First Creek, the lower unit thickens to an average of 20 ft. A more detailed description of the alluvium-filled paleochannels is presented in the following description of the bedrock surface.

3.1.2 BEDROCK SURFACE

This section describes the bedrock surface underlying the alluvial sediments at RMA and in the Offpost Operable Unit. The description of the bedrock surface presented in the following paragraphs addresses bedrock topography, the location of alluvium filled paleochannels, and the general lithologic character of the bedrock surface. The bedrock elevation map in the Offpost Operable Unit near the RMA north and northwest boundaries has been provided

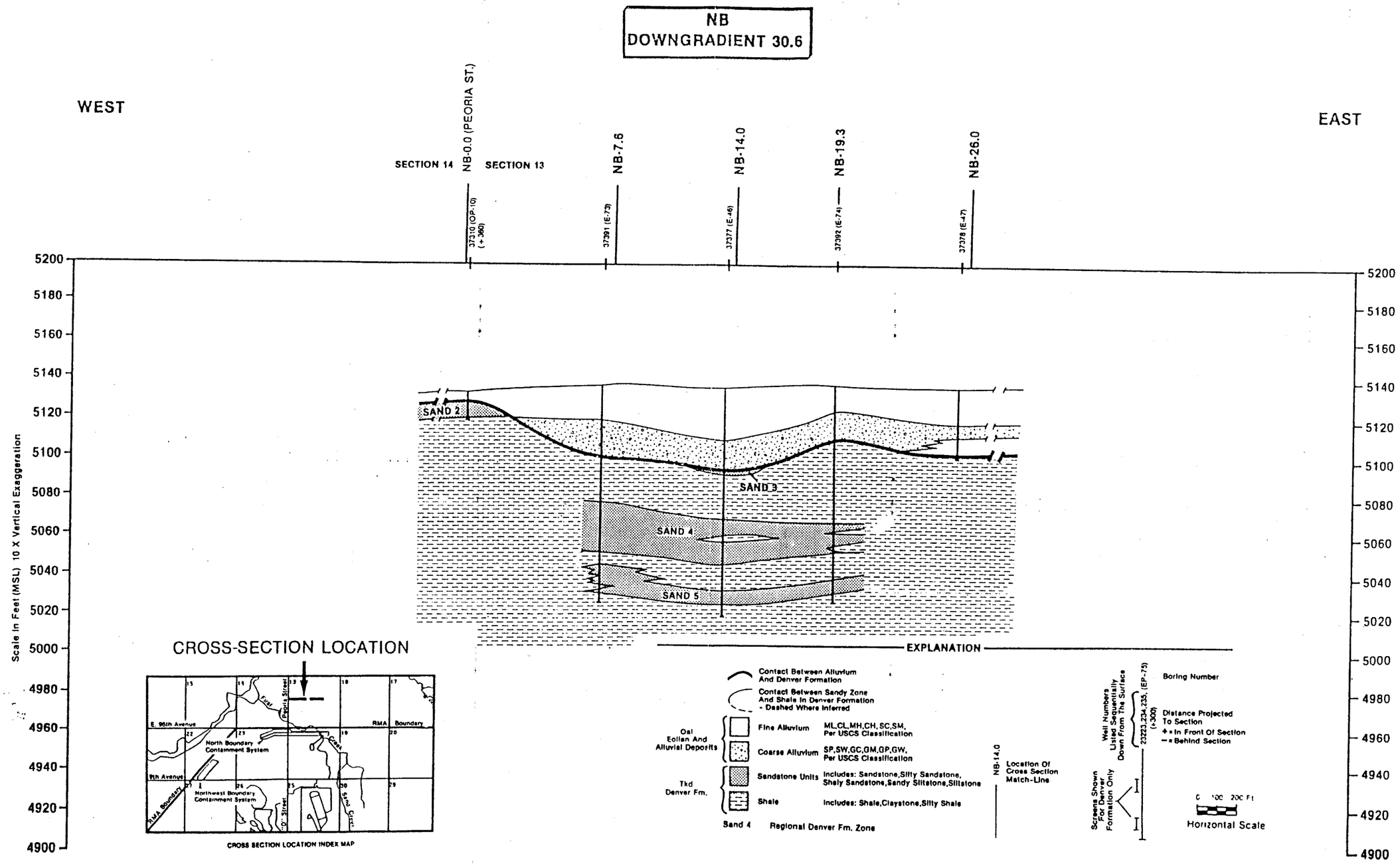
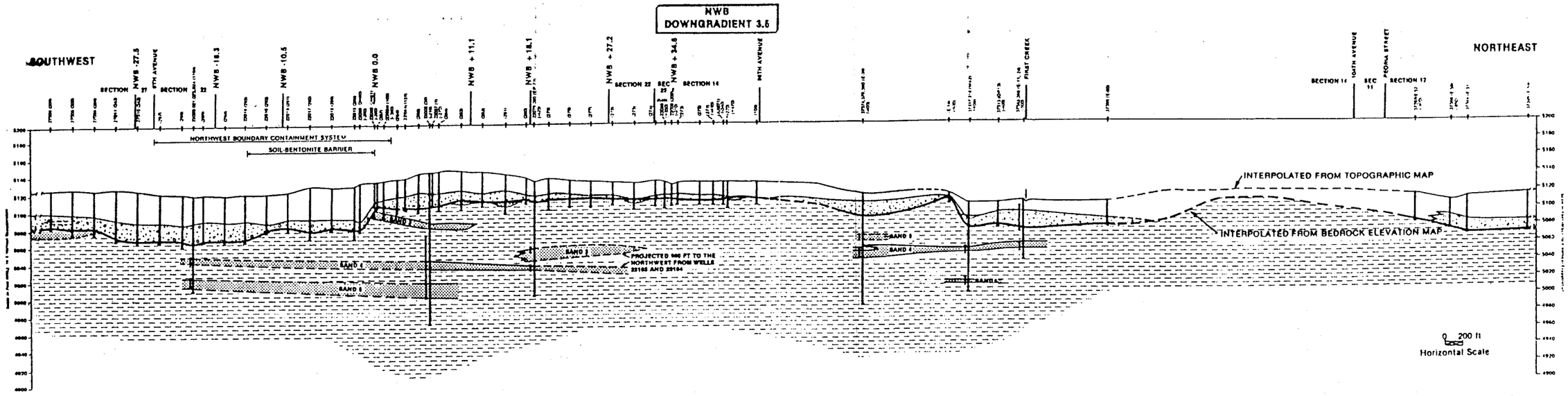


Figure 3.1-5
EAST-WEST GEOLOGIC CROSS-SECTION NB DOWNGRADIENT 30.6

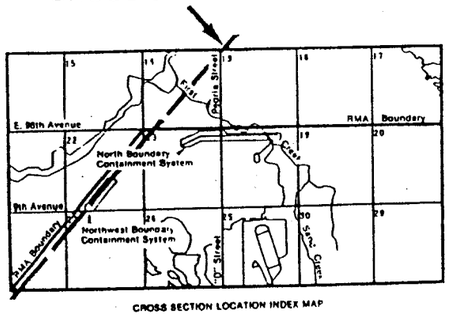
SOURCE: ESE, 1988

Prepared for:
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CROSS-SECTION LOCATION



CROSS SECTION LOCATION INDEX MAP

EXPLANATION

Contact Between Alluvium And Denver Formation

Contact Between Sandy Zone And Shale In Denver Formation - Dashed Where Inferred

Qal Eolian And Alluvial Deposits

Tkd Denver Fm.

Fine Alluvium — ML,CL,MH,CH,SC,SM, Per USCS Classification

Coarse Alluvium — SP,SW,GC,GM,GP,GW, Per USCS Classification

Sandstone Units — Includes: Sandstone,Silty Sandstone, Shaly Sandstone,Sandy Siltstone,Siltstone

Shale — Includes: Shale,Claystone,Silty Shale

Sand 4 Regional Denver Fm. Zone

NWB 11.1 — Location Of Cross Section Match-Line

Well Numbers Listed Sequentially Down From The Surface — 23223,234,235, (EP-75) (+300)

Boring Number

Distance Projected To Section
+ = In Front Of Section
− = Behind Section

Screens Shown For Denver Formation Only

Figure 3.1-6

SOUTHWEST-NORTHEAST GEOLOGIC CROSS-SECTION NWB DOWNGRADIENT 3.5

SOURCE: ESE, 1988

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in Figure 3.1-7 for discussion. The entire bedrock elevation map for the Offpost Operable Unit is provided in Appendix E.

The surface of the Denver Fm reflects the erosional development of the South Platte River Valley during the Quaternary Period. Consequently, the bedrock surface configuration is largely a result of the paleodrainage system and its overall degrading nature. As such, the bedrock surface is characterized by isolated bedrock and numerous paleochannels. In general, the bedrock surface exhibits a regional northwest slope with maximum elevations occurring at the southeast portion of RMA and minimum elevations in the offpost area immediately northwest of the RMA boundaries. The topographic relief of the bedrock surface in the Offpost Operable Unit is greatest immediately northwest of RMA (Figure 3.1-7). In this area, paleochannels that are tributary to an ancestral South Platte River are deeply incised into the ancient bedrock stream terraces. Steep-walled paleochannels in this area are as much as 60 ft deep and less than 1,000 ft wide. The most significant of these paleochannels is one that originates from the NWBCS area as shown in Figure 3.1-7.

A number of other paleochannels are eroded into the bedrock surface in the central portion of the Offpost Operable Unit. Two of the most dominant paleochannels in terms of contaminant transport extend from the RMA north boundary. The paleochannel trending to the northwest is referred to as the First Creek paleochannel. The First Creek paleochannel follows an orientation that approximately corresponds to the present day course of First Creek. The other paleochannel trends northward through the western half of Section 13 and is referred to as the Northern paleochannel. This paleochannel is observed in the east-west cross section shown in Figure 3.1-5. An upgradient portion of the Northern paleochannel encroaches upon the First Creek paleochannel just downgradient of the NBCS.

The bedrock surface is, in part, deeply weathered. Following deposition of the Denver Fm the surface was exposed to erosional processes. This is evident in the fact that the bedrock surface slopes toward the northwest despite the fact that the regional dip of the Denver Fm is gently to the

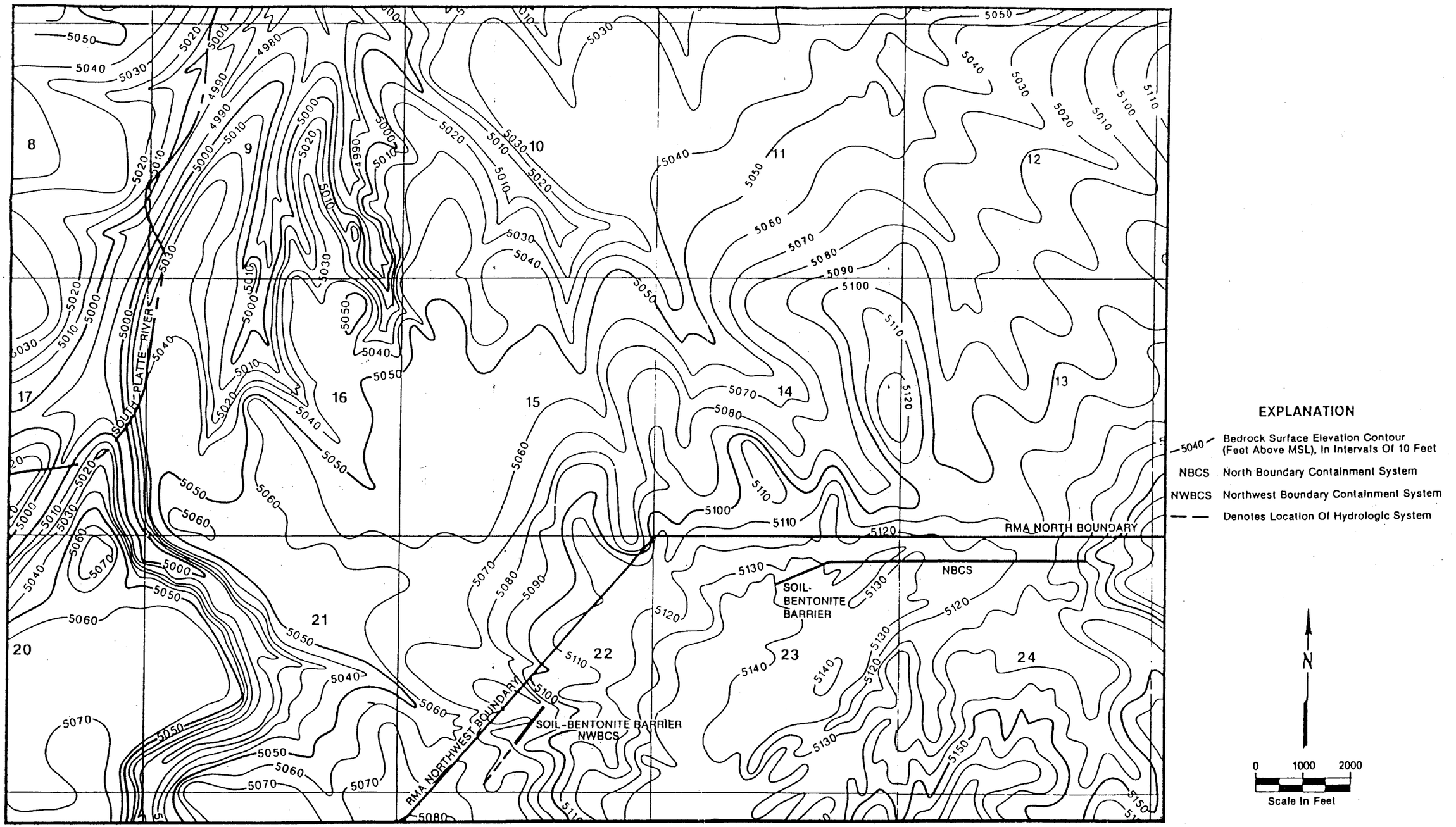


Figure 3.1-7

BEDROCK SURFACE ELEVATION MAP IN THE OFFPOST OPERABLE UNIT NEAR THE ROCKY MOUNTAIN ARSENAL BOUNDARIES

SOURCE: ESE, 1988

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Aberdeen Proving Ground, Maryland

southeast. Weathering of the surface has left upper portions of the fine-grained Denver Fm disaggregated. As such, it is often difficult to pinpoint the precise contact between the Denver Fm and the overlying alluvium based upon grain size and friability only. This is especially true where subcropping Denver Fm sandstones are encountered as opposed to Denver Fm clayshales. Observing changes in texture, color, composition, and mineralogy is often necessary to discern this interface.

3.1.3 CHARACTERIZATION OF THE DENVER FM

The other geologic unit of primary concern in the Offpost Operable Unit is the Denver Fm. In this portion of the report, the Denver Fm is first characterized by describing its depositional environment, and second by describing methods used for stratigraphic correlation. The resultant sandstone morphologies are fundamental to an understanding of ground-water flow in the formation. This discussion focuses on the local characterization of the Denver Fm and the definition of Denver Fm sandstone units in the area offpost of RMA. The definition of Denver Fm sandstone units has been conducted primarily through the assessment of geologic cross sections and geologic isopach and subcrop maps that were prepared under boundary system monitoring tasks and will be presented in the forthcoming Task 25 and 36 reports.

3.1.3.1 Depositional Environment

The Denver Fm is composed of 250 to 300 ft of interbedded clayshale, claystone, siltstone, and sandstone. The Denver Fm is thickest in the southern portion of RMA and thins to the west and the north due to erosion. The base of the Denver Fm is taken as the top of a "buffer zone" that consists of 50 to 100 ft of clayshale at the top of the Arapahoe Fm. This clayshale "buffer zone" provides hydraulic separation between the Arapahoe and Denver Fm aquifer systems (Romero, 1981).

Continuous regression of the inland sea, rise of the Laramide Rockies, and Denver Basin subsidence during the late Cretaceous-early Tertiary resulted in the deposition of the Denver Fm. Sediments were derived from orogenic sources and were deposited under low-energy, continental conditions by

fluvial processes in a distal alluvial plain environment (Kirkham and Ladwig, 1979, RIC#82314R02) as shown in Figure 3.1-8(a). As such, the environment is characterized by numerous sedimentary accumulations which include a variety of overbank and channel deposits.

An example of point-bar sand accretion in which a stream meandering across a floodplain deposits units of varying morphology and lithology is portrayed in Figure 3.1-8(b). High-water episodes in this setting can lead to breaching of the natural levee and deposition of locally continuous, sheetlike deposits of silts, clays, and sands known as crevasse-splay deposits.

The clayshale of the Denver Fm is hard and bentonitic ranging in texture from blocky to fissile with laminated fossiliferous members. The clayshales are usually interbedded with layers of very fine sandstone or siltstone. The sandstones are often lenticular and shoestring or sinuous in nature. These lenses are distributed within thick clayshale sequences and are poorly defined where the sandstones grade into clay and shale. The sandstones are discontinuous to semi-continuous and are difficult to correlate over distances of even a few hundred feet.

An illustration of how a low-gradient meander belt can result in stacked sequence sandstone bodies encompassed by siltstones and claystones is presented in Figure 3.1-8(c). These morphologies have been observed on both a local and regional scale at RMA.

The depositional environments and resultant morphologies of the Denver Fm sandstone units strongly influence ground-water flow patterns. Ground-water flow is greatest in areas of highest hydraulic conductivity and therefore, the contaminant flux will be greater over time in these areas. At RMA, the more permeable sediments of the Denver Fm are the sands of channel and crevasse-splay deposits. The depositional environment provides the framework for the complex ground-water flow paths through the sandstone units in the Denver Fm.

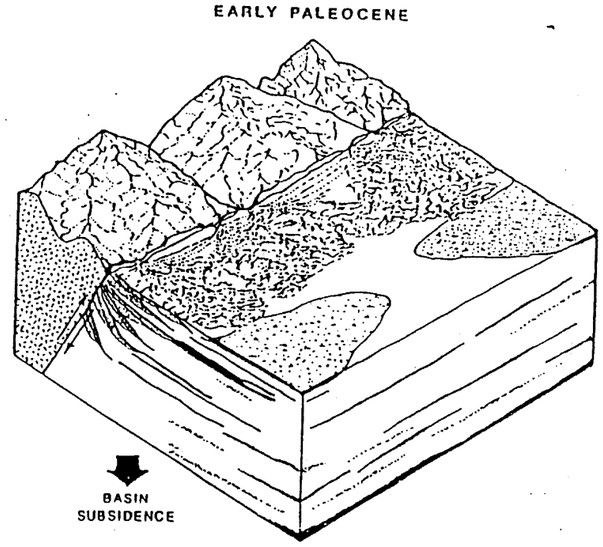


Figure 3.1-8a

From Kirkham and Ladwig (1979)

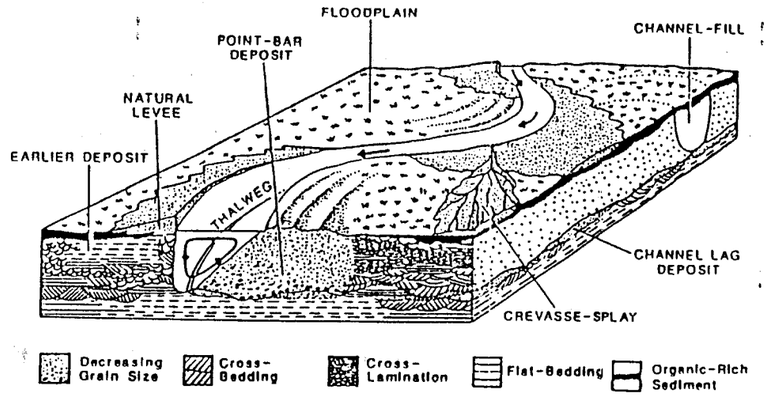


Figure 3.1-8b

Modified from Allen (1965)

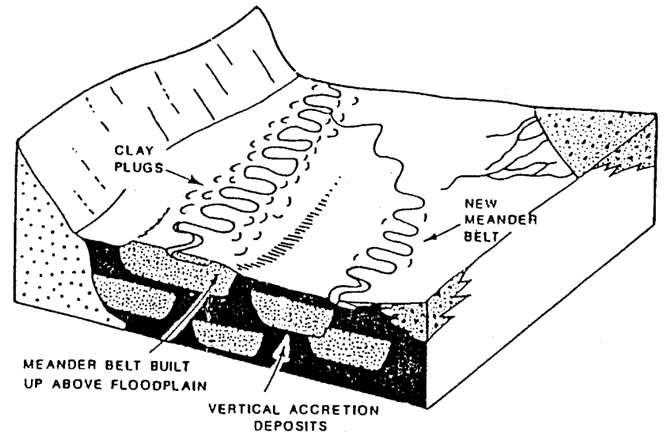


Figure 3.1-8c

From Allen (1965)

Figure 3.1-8

SCHEMATIC DIAGRAMS DEPICTING DENVER FM DEPOSITIONAL ENVIRONMENTS

SOURCE: HLA, 1987

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Aberdeen Proving Ground, Maryland

3.1.3.2 Stratigraphic Correlation Within the Denver Fm

Correlating stratigraphic units for moderate to long distances across RMA is difficult and is further complicated by the erosional truncation of the individual strata. The Denver Fm at RMA has a regional strike from southwest to northeast and an average regional southeasterly dip of less than one degree. Thus, a Denver Fm unit that may subcrop and lie in direct contact with the alluvium in the northwest portion of RMA will occur, or its time stratigraphic equivalent will occur, at greater depth toward the southeast. Greater depths to stratigraphically equivalent units to the southeast are also the result of higher topographic elevations onpost. Denver Fm units subcropping beneath alluvial overburden have been documented from the central area of RMA to the north and to the northwest and west (May et al., 1980, RIC#81226R48).

To facilitate a regional correlation of Denver Fm strata, larger distinct units and zones have been identified at RMA. A continuous lignite (coal) seam with an average thickness of 8 ft has been used as a marker bed from which all other zones, above or below, have been referenced. Denver Fm zones correlated above the lignite marker bed have been designated A and B in ascending order. Denver Fm zones correlated beneath the lignite marker have been designated 1, 2, 3, and 4 in descending order.

In the Offpost Operable Unit, the sandstone units of concern are those that subcrop in the area and generally correlate to regional zones 2, 3, and 4. All other stratigraphic units in the Denver Fm identified in the regional study have been removed by erosion. These three zones have been characterized by the geologic study conducted under the Boundary Systems Monitoring Task (Task 25, ESE, 1987d, RIC#87014R24) and will be discussed in the following subsection. This discussion will focus on the regional characterization of Denver Fm zones 2, 3, and 4.

Stratigraphic control from the numerous wells in and around the NBCS has facilitated a further localized subdivision of regional Denver Fm zones 2, 3, and 4 in the NBCS area. A localized description of the Denver Fm in the vicinity of the NBCS and a definition of the local sandstone units is presented in the North Boundary System Component Response Action Assessment

(Task 36, ESE, 1988b, RIC#88063R08). The local sandstone units that were identified in the Task 36 study and that subcrop in the RMA offpost area north of the NBCS, will be discussed in Section 3.1.3.3.

3.1.3.3 Characterization and Definition of the Denver Fm

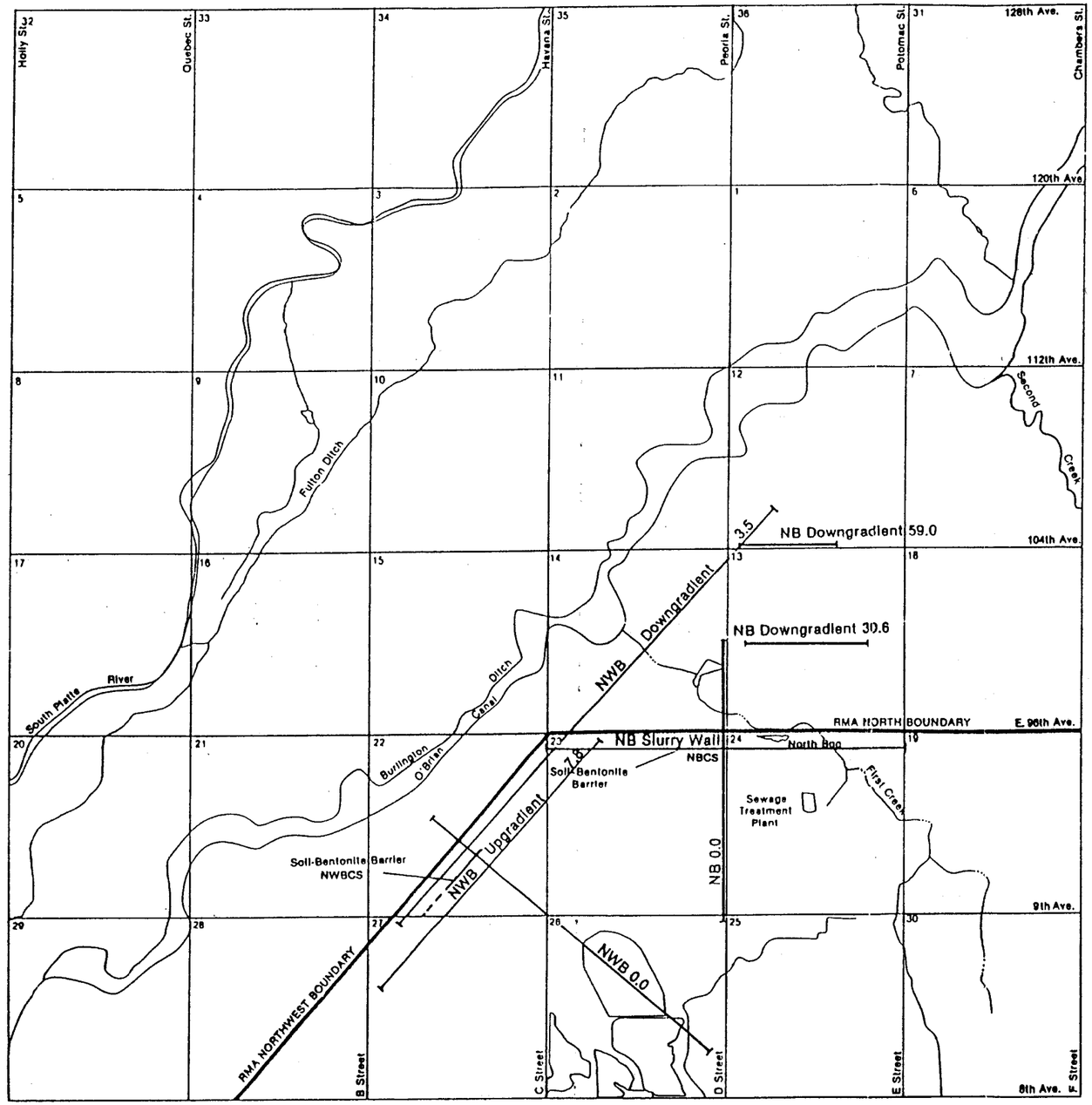
In the Offpost Operable Unit, the Denver Fm generally consists of carbonaceous clayshales, claystones, and siltstones interbedded with lenticular sandstone units. The Denver Fm sandstone units are micaceous, locally lignitic, and contain dark-colored minerals such as augite and hornblende. The sandstone units are generally weakly lithified, although locally they may be well-cemented with calcium carbonate and silica.

Regional Characterization and Definition of Denver Fm Sand Zones

To accomplish the regional correlation of Denver Fm sand zones in the Offpost Operable Unit, the geologic cross sections that were constructed under the boundary monitoring tasks (Task 25 and 36) were assessed. The locations of the cross sections referenced in this text are shown in Figure 3.1-9. The Task 25 cross sections are oriented northwest to southeast parallel to dip, and northeast to southwest along the strike. The cross sections constructed in the Task 36 study area are oriented east-west and north-south.

Due to the limited geologic data on the Denver Fm in the immediate vicinity of the NWBCS, Denver Fm zones have been projected in the direction of dip to the RMA offpost area from borings that are located upgradient of the NWBCS. This was done to indicate general locations of subcrop areas. Denver Fm zones 3 and 4 can be projected to subcrop in the RMA offpost area near the RMA northwest boundary. Denver Fm zones 2, 3, and 4 are present in the offpost area north of the NBCS.

Each zone consists of a major alluvial channel sandstone and associated crevasse-splay sandstones. The total thickness of these deposits may be as great as 30 ft. The intervals between these zones generally consist of 0 to 30 ft of sandy clay, clayey sand or clayey silt depending on location. The low permeability clayshale aquitards act as a confining layer and inhibit



EXPLANATION

NB Downgradient 30.6	East-West Cross-Section Located Approximately 3060 Feet North Of The North Boundary Soil-Bentonite Barrier
NB Slurry Wall	East-West Cross-Section Located Approximately Along The Line Of The North Boundary Soil-Bentonite Barrier
NWB Upgradient 7.8	Southwest-Northeast Cross-Section Located Approximately 780 Feet Southeast Of The Northwest Boundary Soil-Bentonite Barrier
NWB Downgradient 3.5	Southwest-Northeast Cross-Section Located Approximately 350 Feet Northwest Of The Northwest Boundary Soil-Bentonite Barrier
NBCS	North Boundary Containment System
NWBCS	Northwest Boundary Containment System
— — —	Denotes Location Of Hydrologic System

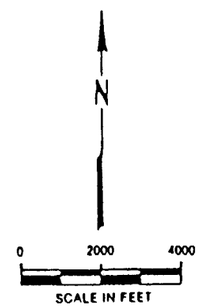


Figure 3.1-9

LOCATION OF GEOLOGIC CROSS-SECTIONS IN THE VICINITY OF THE OFFPOST OPERABLE UNIT

SOURCE: ESE, 1988

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vertical migration of ground water between the sandstone units. In the upper Denver Fm, the aquitards may be fractured and weathered, and communication between the alluvial aquifer and the Denver Fm may exist.

Interpreted lateral correlations of zones within the Denver Fm near the NWBCS are shown in Figure 3.1-10. These zones have been correlated over significant distances between boreholes based on the geologic data available. Figure 3.1-11 shows a southeast-northwest cross section illustrating the projection of Denver Fm zones beneath the NWBCS updip to the northwest of the NWBCS. A summary of the depositional history, occurrence, and extent of Denver Fm zones 2, 3, and 4 as they appear in the Offpost Operable Unit are presented below.

Denver Fm Zone 2--Sandstone units within zone 2 are generally fine-to medium-grained, silty, poorly sorted, partially cemented and contain organic and micaceous material. These sandstone units grade laterally and vertically into siltstones and clayshales.

Denver Fm Zone 3--Sandstone units within zone 3 are generally fine-to medium-grained, silty and shaley, poorly sorted, and partially cemented. These sandstone units grade laterally and vertically into siltstones and clayshales.

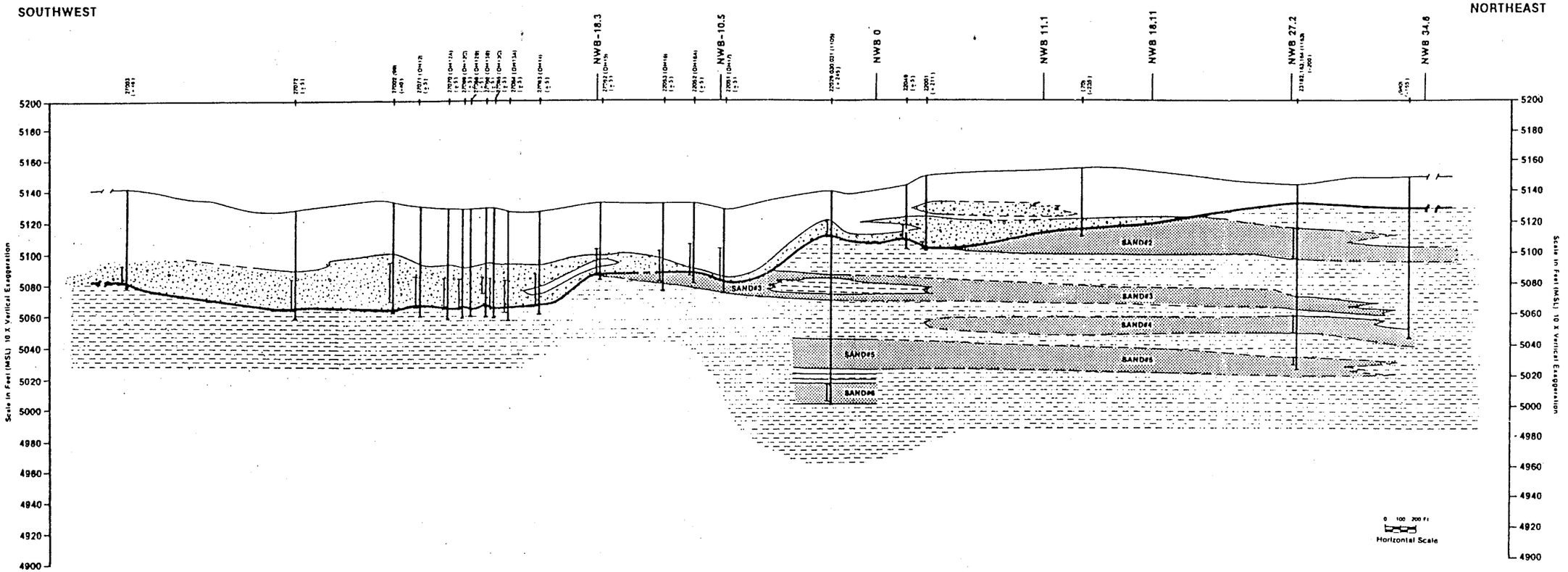
Denver Fm Zone 4--Sandstone units in zone 4 are generally fine-to medium-grained, fair to poorly sorted, and well cemented to uncemented. These sandstone units grade laterally and vertically into siltstones and clayshales.

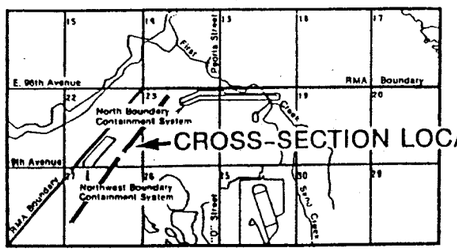
Isopach Maps--Isopach maps showing the net sand thickness, lateral extent, and trend of Denver Fm zones 2, 3, and 4 are located in Appendix E. Zone 2 appears to be present in the offpost area north of the NBCS. The general trend of the zone north of the NBCS is to the north and the thickness ranges from 10 to 20 ft. Projections of zone 2 indicate it to be completely eroded in the offpost area downgradient of the NWBCS.

7.8
NW BOUNDARY
LOOKING NW

SOUTHWEST

NORTHEAST





CROSS SECTION LOCATION INDEX MAP

EXPLANATION

- #1 Sandy Zone #1
- Contact Between Alluvium And Denver Formation
- Contact Between Sandy Zone And Shale In Denver Formation - Dashed Where Inferred
- Qal Eolian And Alluvial Deposits
  - Fine Alluvium — ML,CL,MH,CH,SC,SM, Per USCS Classification
  - Coarse Alluvium — SP,SW,GC,GM,GP,GW, Per USCS Classification
- Tkd Denver Fm.
  - Sandstone Units — Includes: Sandstone,Silty Sandstone, Shaly Sandstone,Sandy Siltstone,Siltstone
  - Shale — Includes: Shale,Claystone,Silty Shale
  - Lignitic Interval
  - Vc Volcaniclastic
- NWB 11.1 — Location Of Cross Section Match-Line
- Well Numbers Listed Sequentially Down From The Surface — Boring Number
- Screens Shown — Distance Projected To Section: + = In Front Of Section, − = Behind Section

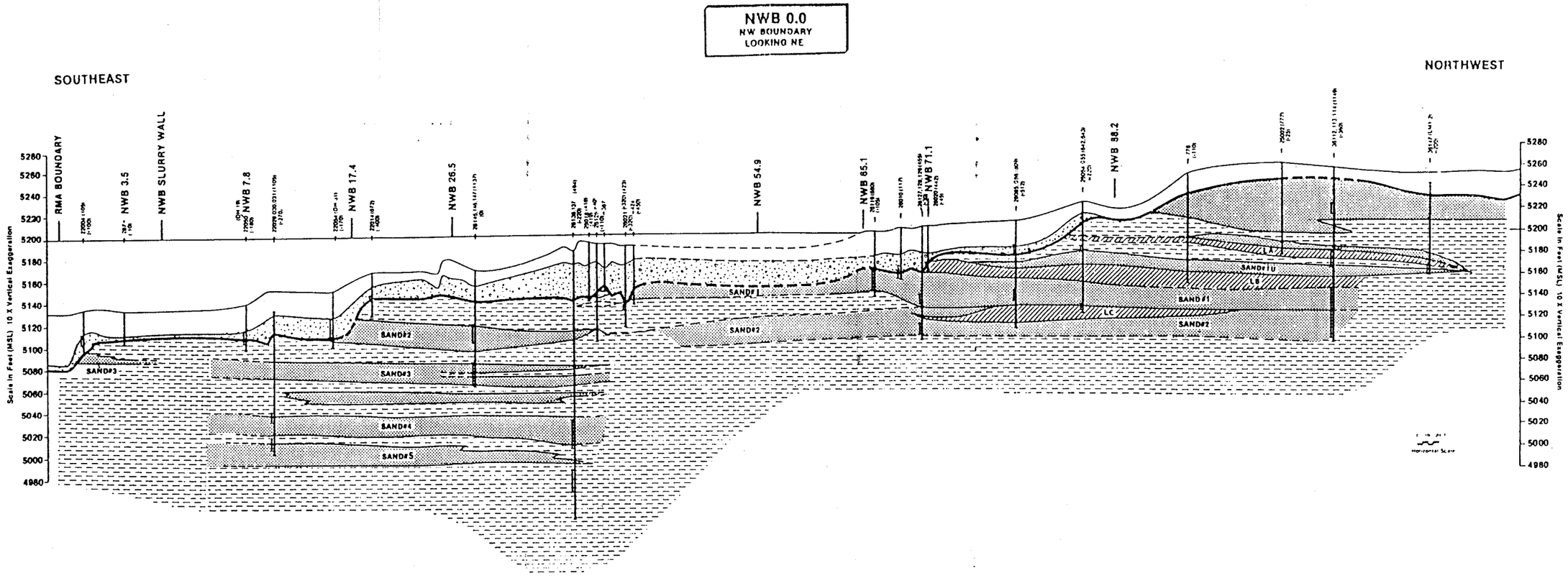
Figure 3.1-10

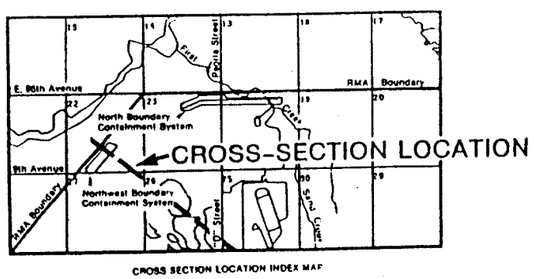
SOUTHWEST-NORTHEAST GEOLOGIC CROSS-SECTION NWB 7.8

SOURCE: ESE, 1988

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Aberdeen Proving Ground, Maryland





CROSS SECTION LOCATION INDEX MAP

EXPLANATION

- #1 Sandy Zone #1
- Contact Between Alluvium And Denver Formation
- Contact Between Sandy Zone And Shale In Denver Formation - Dashed Where Inferred
- Qal Eolian And Alluvial Deposits
  - Fine Alluvium — ML,CL,MH,CH,SC,SM, Per USCS Classification
  - Coarse Alluvium — SP,SW,GC,GM,GP,GW, Per USCS Classification
- Tkd Denver Fm.
  - Sandstone Units — Includes: Sandstone,Silty Sandstone, Shaly Sandstone,Sandy Siltstone,Siltstone
  - Shale — Includes: Shale,Claystone,Silty Shale
  - Lignitic Interval
  - Vc Volcaniclastic
- NWB 11.1 — Location Of Cross Section Match-Line
- Well Numbers Listed Sequentially Down From The Surface — 23223,234,235,(EP-75) (+300) — Boring Number
- Distance Projected To Section: + = In Front Of Section; − = Behind Section
- Screens Shown

Figure 3.1-11

SOUTHEAST-NORTHWEST GEOLOGIC CROSS-SECTION NWB 0.0

SOURCE: ESE, 1988

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3-21

In the vicinity of the NWBCS, Denver Fm zone 3 appears to be relatively thin with a thickness less than 10 ft, but geologic data are sparse in this area and variations in thickness are not well defined. Offpost, in the vicinity of the NWBCS, there are few geologic borings that penetrate zone 3 and its configuration is therefore not well defined. North of the NBCS, zone 3 generally trends to the north and shows thinning to the west in Section 14. The channel of zone 3 is located in the eastern portion of Section 13 and the thickness is approximately 20 ft. Just north of the RMA north boundary, near Peoria Street, two stacked sandstone units comprise zone 3 and the thickness of the unit is again about 20 ft.

Based upon the limited borehole information near the NBCS, it appears that the axial trend of the channel of Denver Fm zone 4 is to the northeast. The zone is thickest, approximately 30 ft, in the area beneath the pilot portion of the NBCS. Overbank deposits of this channel have been correlated to Boreholes E-39 and E-40, which are located approximately 1,000 ft north of 96th Avenue and to the west of Peoria Street. The net sandstone thickness at these locations is approximately 10 ft. There are no boreholes that penetrate zone 4 in the vicinity of the NWBCS, therefore this zone can not be characterized in this area.

Subcrop Maps--The projected locations of subcrops for Denver Fm zones 2, 3, and 4 are shown in Figure 3.1-12. This subcrop map was generated by plotting the locations where the top of the unit and base of the unit are projected to intersect the bedrock surface. These subcrop zones were defined using a grid of cross sections, and projecting the zones onto the bedrock contour map, consistent with the regional dip of less than one degree.

In some areas the subcrops have been verified with geologic borings. The location of the alluvial and Denver Fm sites that were used to help verify the subcrop areas are shown in Figures 2.1-1, 2.1-2, 2.1-4, and 2.1-5. In areas where there was limited borehole data, the limits to the extent of the subcrop was inferred based on knowledge of the depositional environment, geologic boring control in three dimensions, and experience in the onpost

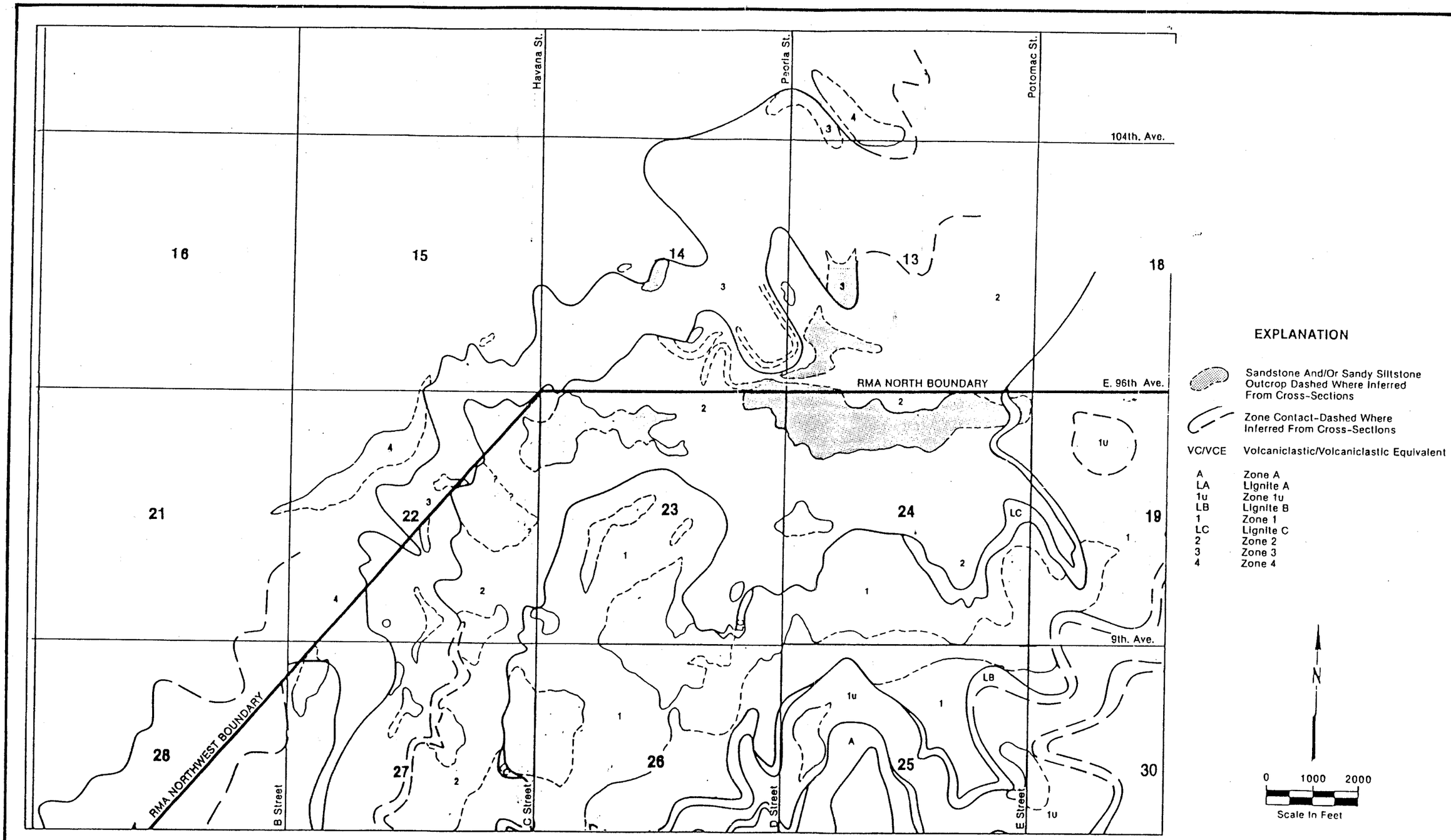


Figure 3.1-12

SUBCROP MAP OF DENVER FORMATION ZONES

SOURCE: ESE, 1988

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area where there is more geologic data. The location of the inferred subcrops is subject to interpretation, and therefore uncertainty, due to the projection of the sandstones for distances up to 2,000 ft.

Denver Fm zones 2, 3, and 4 subcrop successively in the Offpost Operable Unit from southeast to northwest. The subcrop map also includes the subcrops of identified sandstone lenses within the zones as well as those general areas where channel sandstones subcrop.

Denver Fm zone 2 is not present in the Offpost Operable Unit downgradient of the NWBCS. In the northern portion of the Offpost Operable Unit, zone 2 subcrops in the First Creek paleochannel to the north of the NBCS. Denver Fm zone 3 subcrops just northwest of the NWBCS in the vicinity of the RMA northwest boundary and north of the NBCS.

The subcrop area for Denver Fm zone 4 is projected to occur just onpost in sections 22 and 27 southwest of the NWBCS. The northwesterly extent of the subcrop area for zone 4 is based on projection of sand thickness from the cross sections updip to the intersection with the bedrock surface. Based on the available data, the lateral extent of the subcrop of zone 4 can not be defined.

Local Definition of Denver Fm Sandstones in the Offpost Area Downgradient of the NBCS

To help correlate Denver Fm sandstone units in the offpost area north of the NBCS, 31 geologic cross-sections were constructed under the North Boundary System Component Response Action Assessment (Task 36). The locations of the cross sections in relation to the NBCS are presented in the Task 36 report. Fifteen of these cross sections are oriented north-south, and 16 are oriented east-west. An east-west cross section and a north-south cross section are provided for discussion in Figures 3.1-13 and 3.1-14, respectively. These cross sections and the locally defined sandstone units near the NBCS are being discussed here to describe the relationship with the regional zones.

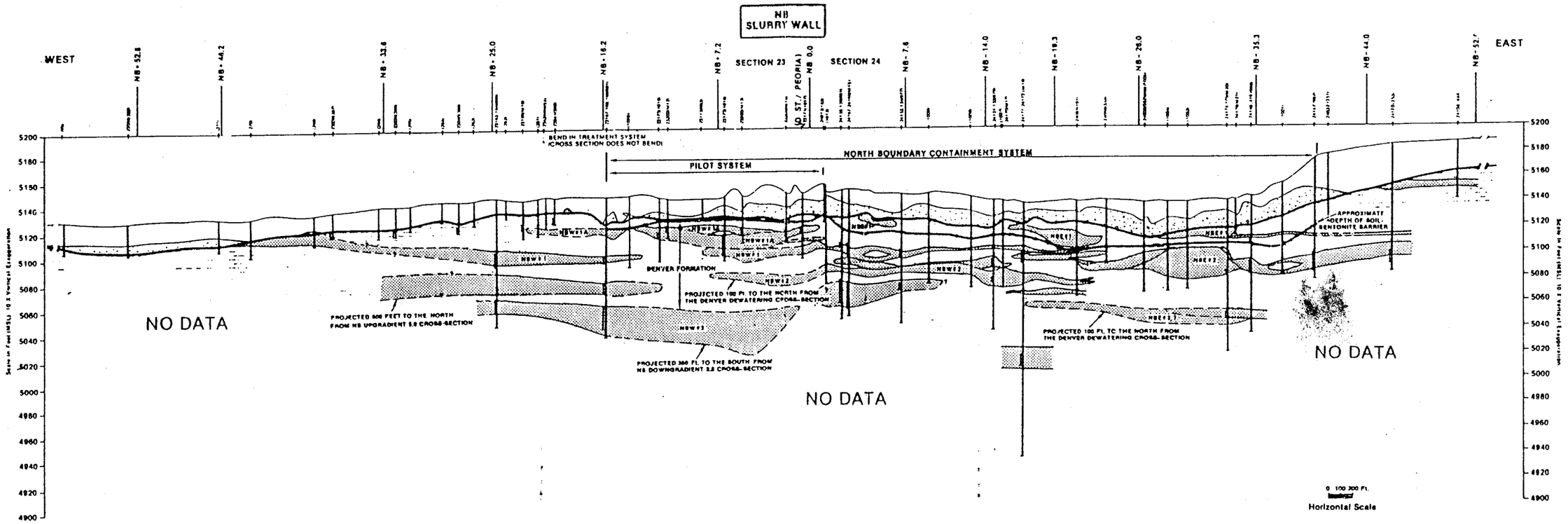
Numerous lenticular Denver Fm sandstone units were identified locally near the NBCS, ranging in thickness from a few inches to 30 ft. These sandstone units generally represent alluvial channel and crevasse-splay deposits which grade laterally and vertically into finer materials. The thickest sandstone units occur in the deeper portions of former active channels, whereas crevasse-splay deposits appear to be thinner. The crevasse-splay deposits have a sheetlike morphology and are more laterally continuous.

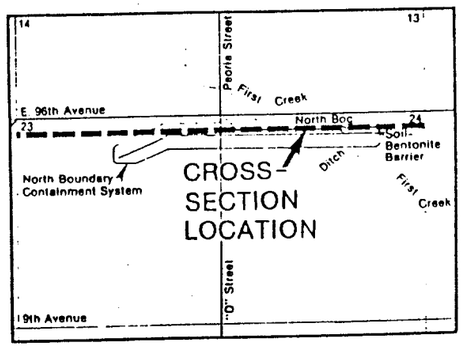
Because of the irregular nature of the sandstones and the lateral changes in these units, correlation in cross sections can be difficult. Four sandstone units have been identified primarily beneath the pilot portion of the NBCS west of D Street, and three sandstone units have been identified predominately east of D Street. The sandstone units are locally named based upon their location relative to D Street [e.g., North Boundary West (NBW) and based on their relative positions beneath the base of the alluvium, beginning with 1-A (e.g., NBW#1A).

Interpreted lateral correlations within the Denver Fm beneath the soil-bentonite barrier at the NBCS are shown in Figure 3.1-13. These sandstone units have been correlated over significant distances between boreholes. Figure 3.1-14 contains a north-south cross section illustrating how the sandstone units below the soil-bentonite barrier are projected updip and subcrop to the north of the NBCS in the RMA Offpost Operable Unit.

The Denver Fm zones identified under Task 25 have been correlated to the local sandstone units identified under Task 36. Denver Fm zone 2 correlates to sandstone units NBW#1A, NBW#1, and NBE#1 shown in Figure 3.1-13. Denver Fm zone 3 correlates to sandstone units NBW#2 and NBE#2, and zone 4 correlates to sandstone unit NBW#3 shown in Figure 3.1-13.

The following paragraphs provide brief descriptions of sandstone units NBW#1A, NBW#1, and NBW#2 that have been identified at the NBCS. The discussion has been limited to these sandstone units because the geologic subcrops of these units can be identified north of the NBCS in the Offpost Operable Unit. The geologic subcrops of additional sandstone units





CROSS SECTION LOCATION INDEX MAP

EXPLANATION

Contact Between Alluvium And Denver Formation

Contact Between Sandy Zone And Shale In Denver Formation - Dashed Where Inferred

Approx. Depth Of Soil-Bentonite Barrier

Boring Number

Qal Eolian And Alluvial Deposits

Fine Alluvium — ML,CL,MH,CH,SC,SM, Per USCS Classification

Coarse Alluvium — SP,SW,GC,GM,GP,GW, Per USCS Classification

Tkd Denver Fm.

Sandstone Units — Includes: Sandstone,Silty Sandstone, Shaly Sandstone,Sandy Siltstone,Siltstone

Shale — Includes: Shale,Claystone,Silty Shale

NBW#1 North Boundary West #1 Sandstone Unit

NB UPGRADIENT 11.5

Location Of Cross Section Match-Line

Well Numbers Listed Sequentially Down From The Surface

23223,234,235, (EP-75) (-300)

Distance Projected To Section
+ = In Front Of Section
− = Behind Section

Screens Shown For Denver Formation Only

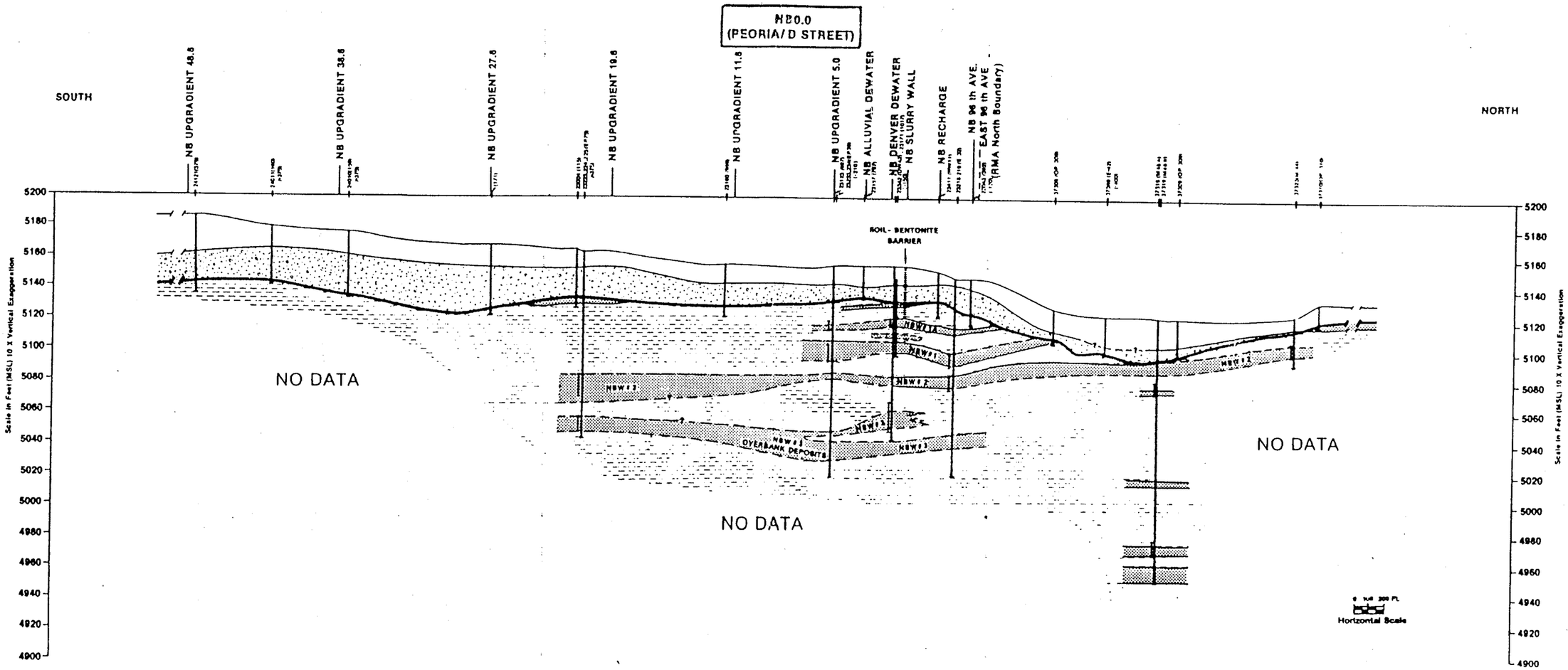
Figure 3.1-13

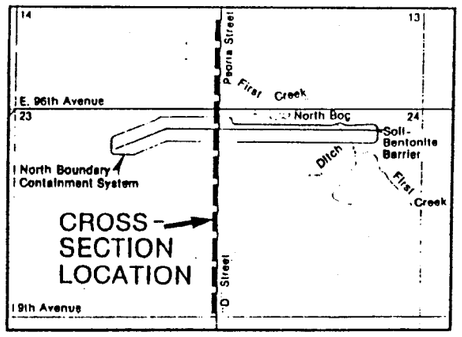
EAST-WEST GEOLOGIC CROSS-SECTION NB SLURRY WALL

SOURCE: ESE, 1988

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For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland





CROSS SECTION LOCATION INDEX MAP

EXPLANATION

- Contact Between Alluvium And Denver Formation
- Contact Between Sandy Zone And Shale In Denver Formation - Dashed Where Inferred
- Qal Eolian And Alluvial Deposits — Fine Alluvium: ML,CL,MH,CH,SC,SM, Per USCS Classification
- Coarse Alluvium: SP,SW,GC,GM,GP,GW, Per USCS Classification
- Tkd Denver Fm. — Sandstone Units: Includes: Sandstone,Silty Sandstone, Shaly Sandstone,Sandy Siltstone,Siltstone
- Shale: Includes: Shale,Claystone,Silty Shale
- NBW#1 North Boundary West #1 Sandstone Unit
- Location Of Soil-Bentonite Barrier
- NB UPGRADIENT 11.6 — Location Of Cross Section Match-Line
- Well Numbers Listed Sequentially Down From The Surface: 23223,234,235, (EP-75) (+300) — Boring Number
- Distance Projected To Section: + = In Front Of Section, − = Behind Section
- Screens Shown For Denver Formation Only

Figure 3.1-14

NORTH-SOUTH GEOLOGIC CROSS-SECTION NB 0.0

SOURCE: ESE: 1988

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identified at the NBCS were not determined in the field offpost but, because the updip direction of the Denver Fm is to the northwest, these sandstone units are projected to subcrop within the Offpost Operable Unit.

Sandstone Unit NBW#1A--Due to the sheet-like morphology and lateral continuity, sandstone unit NBW#1A appears to be crevasse-splay and/or overbank flood deposits. The sandstone unit is generally fine- to medium-grained, occasionally silty and shaley, poorly sorted, and uncemented to partially cemented. Sandstone unit NBW#1A grades laterally and vertically into siltstones and shales.

Sandstone Unit NBW#1--Sandstone unit NBW#1 also has a sheet-like morphology and lateral continuity and therefore, appears to be crevasse-splay and/or overbank flood deposits. The sandstone unit is generally fine- to coarse-grained, silty, poorly sorted, and partially cemented. Sandstone unit NBW#2 grades laterally and vertically into siltstones and shales.

Sandstone Unit NBW#2--Based on its sheet-like morphology and lateral continuity, sandstone unit NBW#2 appears to be crevasse-splay and/or overbank flood deposits. The sandstone unit is generally fine- to coarse-grained, silty, poorly sorted, and partially cemented. Sandstone unit NBW#1 grades laterally and vertically into siltstones and shales.

Sandstone Unit NBW#3--Sandstone unit NBW#3 appears to be a fluvial channel deposit. This interpretation is based on the shape and thickness of the deposits, the documentation of gravelly lag deposits in boring logs, and the appearance of interbedded claystone, siltstone, and sandstone proximal to the deposit margins.

Isopach Maps--Isopach maps showing the thickness, lateral extent, and trend of sandstone units NBW#1A, NBW#1, NBW#2, and NBW#3 are located in Appendix E.

The trend of sandstone units NBW#1A is to the north. NBW#1A shows a relatively constant thickness, which is consistent with the crevasse-splay interpretation of its origin. NBW#1A is thickest, up to 17 ft beneath the

pilot barrier portion of the NBCS where units have been stacked upon one another.

Sandstone unit NBW#1 trends to the north-northeast and has an average thickness of 7 ft. This relatively uniform thickness is typical of a crevasse-splay deposit. The NBW#1 sandstone unit is separated into two isopached units, one that pinches out to the west beneath the pilot barrier and is continuous to the east, and one that pinches out to the east in the area of the western extension barrier and is continuous to the west. These two units were similarly named because both are within the same time-stratigraphic interval of the Denver Fm.

Sandstone unit NBW#2 trends to the north and shows some thinning to the west in the area beneath the pilot barrier. This unit has an average thickness of 7 ft and shows a fairly uniform thickness consistent with a crevasse-splay deposit. Sandstone unit NBW#2 pinches out approximately 900 ft west of D Street and to the east approximately 2,200 ft east of D Street beneath the soil-bentonite barrier.

Sandstone unit NBW#3 is the thickest sandstone unit described near the NBCS. Based upon limited borehole information, it appears that the axial trend of this channel is to the northeast and that the unit is thickest, approximately 30 ft, in the area beneath the pilot barrier. Overbank deposits of this channel have been correlated to Boreholes E-39 and E-40, which are located approximately 1,000 ft north of 96th Avenue and to the west of Peoria Street. The isopach map for sandstone unit NBW#3 is presented in Appendix E.

Subcrop Map--The locations of Denver Fm sandstone unit subcrops in the offpost area downgradient of the NBCS are shown in Figure 3.1-15. This Denver Fm subcrop map was generated by plotting the bedrock surface, as taken from the bedrock contour map, on the north-south cross sections and projecting the sandstone units to the north at an angle consistent with the regional dip of approximately one degree, to the southeast.

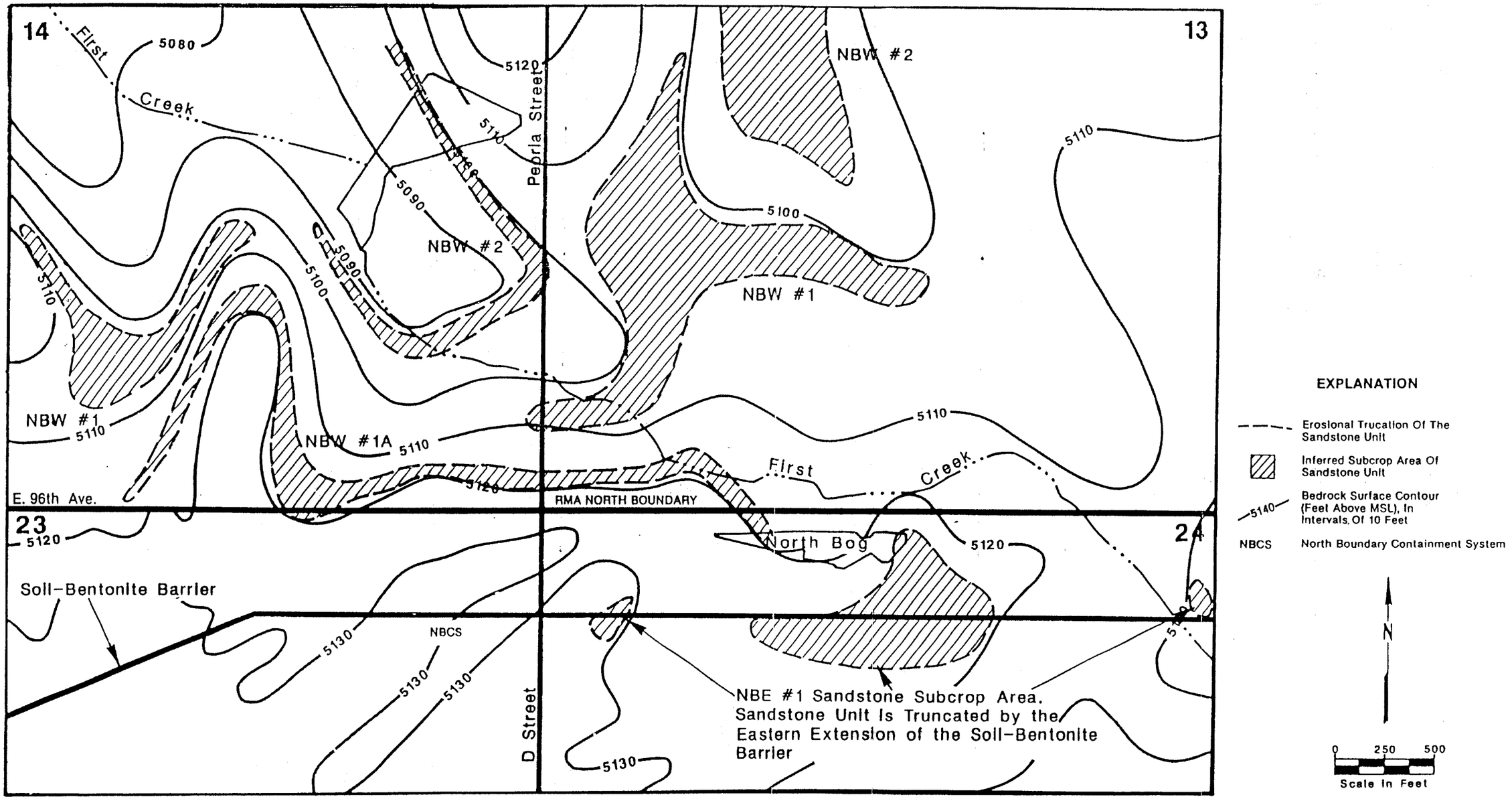


Figure 3.1-15

SUBCROP MAP OF DENVER FORMATION SANDSTONE UNITS IN THE OFFPOST AREA DOWNGRADIENT OF THE NBCS

SOURCE: ESE, 1988

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In some areas the subcrops have been verified with geologic borings. The location of the alluvial and Denver Fm sites that were used to help verify the subcrop areas are shown in Figures 2.1-1, 2.1-2, 2.1-4, and 2.1-5. In areas where there was limited borehole data, the limit to the extent of the subcrop was inferred based on knowledge of the depositional environment, geologic boring control in three dimensions, and experience in the onpost area where there is more geologic data. The location of the inferred subcrops is subject to interpretation, and therefore, uncertainty, due to the projection of the sandstones for distances up to 2,000 ft.

Sandstone units NBW#1A, NBW#1, and NBW#2 subcrop in the First Creek paleochannel to the north of the NBCS. Based upon the limited geologic information available to the north of RMA, projections of sandstone units NBW#3, NBE#2, and NBE#3 indicate that they would subcrop inside the northern limits of the Offpost Operable Unit.

3.1.4 CHARACTERIZATION OF THE ARAPAHOE FM

The Arapahoe Fm conformably underlies the Denver Fm in the Offpost Operable Unit and the top of the formation is estimated to be approximately 250 ft to 300 ft below ground surface at RMA north boundary. This estimate was based upon sample analysis by John Romero of the Colorado Division of Water Resources. Romero picked the top of the Arapahoe at a depth of 239 ft and 295 ft in two different geologic borings at the north boundary (May, 1980). These picks were based primarily on color differences and subtle weathering characteristics and are, therefore, subject to interpretation. The Arapahoe Fm is a 350- to 650-ft thick sequence of interbedded conglomerate, sandstone, siltstone, and shale. The Arapahoe Fm can be divided into two parts. Sandstone and conglomerate with thin beds of shale characterize the lower portion, while a predominantly blue to gray shale with minor lenses of sandstone and ironstone concretions marks the upper portion. The conglomerates, sandstones, and siltstones range from white to medium gray with some local yellow-green beds. Shales are commonly silty. The larger proportion of conglomerate and sandstone with respect to shale, the absence of significant carbonaceous materials, and an overall lighter color distinguish the Arapahoe Fm from the overlying Denver Fm.

The base of the Denver Fm is taken as the top of a "buffer zone" that consists of 50 to 100 ft of clayshale at the top of the Arapahoe Fm. This clayshale buffer zone provides hydraulic separation between the Arapahoe and Denver Fm aquifer systems (Romero, 1976, RIC#81266R69).

Individual conglomerate and sandstone beds in the Arapahoe Fm are commonly lens shaped and range in thickness from a few inches to about 35 ft. The beds may be so closely spaced that they form a single hydrostratigraphic unit that is 180 to 270 ft thick in some areas. Generally, the conglomerates and sandstones are only moderately consolidated. This allows ground water to flow through the void spaces between grains of gravel and sand in the conglomerate and sandstone, while little or no water is able to flow through the siltstone and shale (Robson et al., RIC#82293M02).

3.2 HYDROGEOLOGY

A hydrogeologic evaluation was conducted as a part of this study to aid in assessing primary ground water contaminant migration pathways in the Offpost Operable Unit. A general discussion of the onpost hydrogeology in the vicinity of the NWBCS and the NBCS is presented along with a regional description of the hydrogeologic conditions present in the Offpost Operable Unit. A more detailed discussion of the hydrogeologic conditions at the NWBCS and NBCS is presented in the Task 25 and Task 36 reports, respectively. This study also includes an evaluation of the interactions between aquifers in the offpost area and an assessment of the impact of surface water on ground-water flow patterns.

The character and spatial distribution of the aquifers within the Denver Basin have been previously investigated and reviewed by several different authors. The hydrogeologic background information utilized in this study is largely based upon previous investigations performed by Robson and Romero (1981, RIC#82350M02), Konikow (1975, RIC#8432M01), D'Appolonia (1979, RIC#81266R45), May (1982, RIC#82295R01), and Vispi (1978, RIC#81266R70). Additional hydrogeologic information was obtained during the study by installing piezometers and wells, measuring water level elevations, preparing detailed geologic cross-sections, and conducting aquifer tests.

The resulting data were used to estimate ground-water flow directions and quantities and to help evaluate the influence of the containment systems with respect to the movement of contaminants in the offpost area.

RMA lies in the northwest portion of the Denver Ground-Water Basin. The two primary water-bearing units of interest in the Offpost Operable Unit are the unconsolidated Quaternary alluvium and the underlying Late Cretaceous-Tertiary Denver Fm. Although these two units are in physical contact, their hydrologic properties are distinctly different and they generally behave as independent aquifers. As a result, they are discussed separately in this section. Although field investigations during this study have not collected additional hydrogeologic data on the Araphaoe Fm, a brief discussion of the hydrogeologic relationship between the Arapahoe Fm and the overlying Denver Fm has been provided.

For the alluvial and Denver Fm aquifers, a discussion of the potentiometric surfaces is provided. This evaluation includes a characterization of potentiometric surface gradients and a general overview of the potentiometric surface patterns throughout the Offpost Operable Unit. The hydrogeology discussion is supplemented by a description of the vertical and lateral extent of the alluvial aquifer, and of the water-bearing units within the Denver Fm. For the alluvial aquifer, this consists primarily of defining saturated and unsaturated areas. For the Denver Fm, the discussion involves the identification of units that are readily differentiated from the alluvial aquifer and one another. The different aquifer properties are also presented so that estimates of ground-water flow rates and travel times can be evaluated. Finally, a discussion of aquifer interactions is presented to preface assessment of contaminant migration between aquifers.

3.2.1 ALLUVIAL AQUIFER

The alluvial aquifer is composed predominantly of clay and silt deposits containing fine sands near ground surface and grading with depth to coarser sands and sandy gravels. The alluvial aquifer in the Offpost Operable Unit is generally classified as unconfined, heterogeneous and transversely isotropic (i.e., $Kx = Ky \neq Kz$). In some areas, the water level extends

above the upper fine-grained clay and silty sand layers of the aquifer. The low permeability of the upper fine-grained deposits can locally create artesian conditions. In this type of aquifer, the hydraulic conductivity of the upper fine-grained deposits is notably lower than the hydraulic conductivity of the lower sands and gravel. However, the hydraulic conductivity of the upper deposits is not so low that the horizontal flow component can be ignored. An aquifer under these conditions can be described as a combination of the traditional semi-confined and unconfined aquifers or semi-unconfined (Kruseman and DeRidder, 1983).

Locally, the bedrock composition directly underlying the alluvium may consist of poorly cemented subcropping sandstone and siltstone lenses (May 1982, RIC#82295R01). In these areas the alluvium and the upper Denver Fm are sometimes considered hydraulically connected and can act as one hydrogeologic unit. This behavior is primarily due to the relatively high hydraulic conductivity of the Denver Fm sandstones and minimal contrast in hydraulic conductivity values between the Denver Fm and alluvium in these areas. Local hydrologic conditions just upgradient of these areas typically show an upward vertical flow potential from the Denver Fm to the alluvium.

3.2.1.1 Water Table

The regional unconfined water table configuration in the alluvial aquifer across RMA has remained relatively unchanged since 1956. This is probably due in part to the influence of hydraulic pressures from the underlying Denver Fm (May 1982, RIC#82295R01). Locally, the hydrologic characteristics of the alluvial aquifer and stresses to the aquifer system influence the direction of the primary ground water flow routes. External stresses to the alluvial aquifer have caused significant localized water table gradient fluctuations over time. To facilitate a better understanding of the water table configuration in the Offpost Operable Unit, water elevation maps were constructed for the spring and summer quarters of 1987. These maps include the most recent data collected for this project in the Offpost Operable Unit. The spring 1987 and summer 1987 maps are provided in Appendix E. The spring 1987 water table map for the Offpost areas just downgradient of the RMA north and northwest boundaries is shown in Figure 3.2-1.

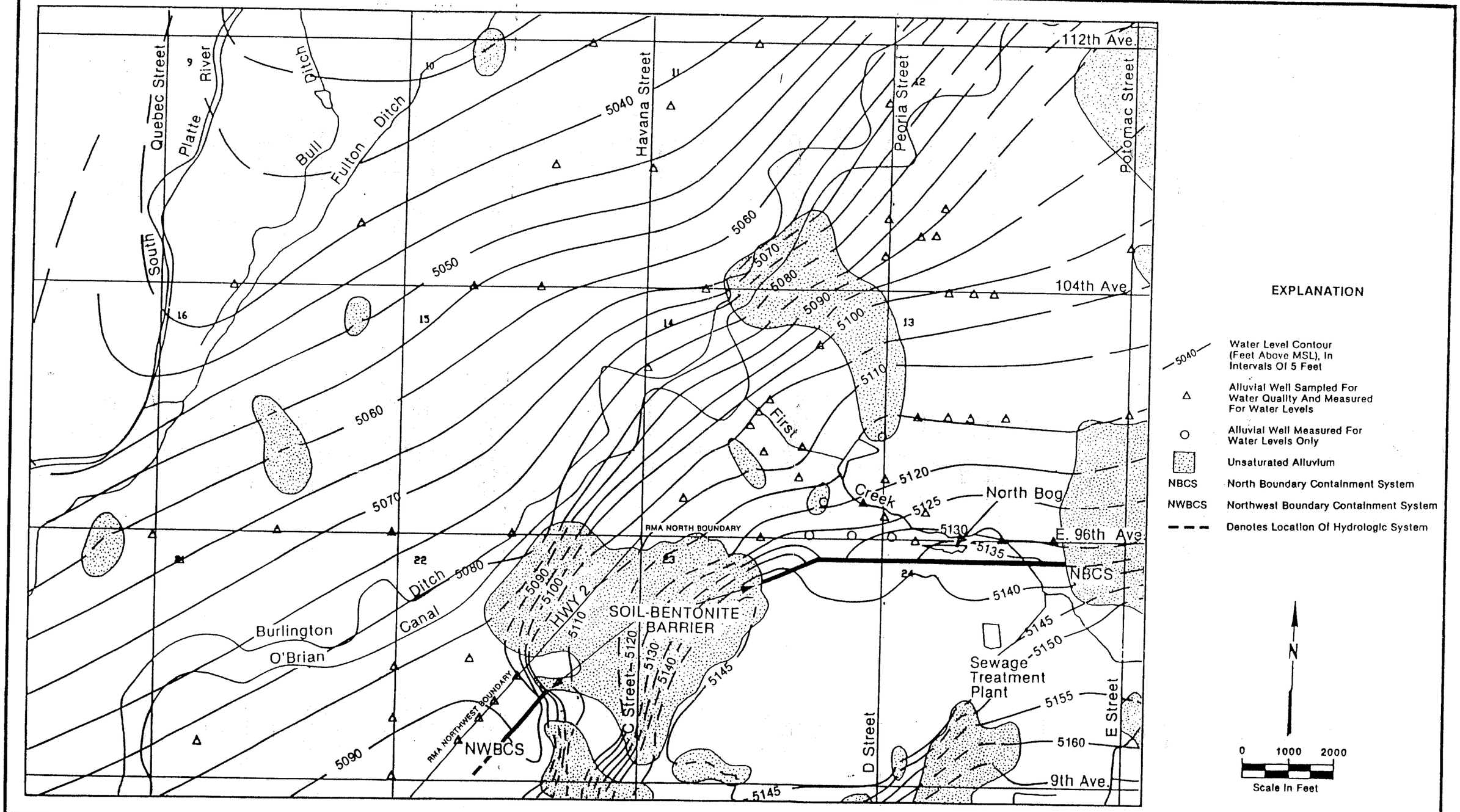


Figure 3.2-1

WATER TABLE ELEVATION MAP IN THE OFFPOST OPERABLE UNIT
NEAR THE RMA BOUNDARIES (SPRING, 1987)

SOURCE: ESE, 1988

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Aberdeen Proving Ground, Maryland

The potentiometric surface maps indicate the primary lateral flow direction in the Offpost Operable Unit is to the north and northwest toward the South Platte River. The hydraulic gradients vary significantly across the Offpost Operable Unit. Low gradients are commonly present along the central axes of deeply buried alluvial paleochannels containing coarse sediments with high hydraulic conductivities. The lowest alluvial aquifer gradients in the Offpost Operable Unit occur along the First Creek paleochannel in Sections 10 and 14, along the northern paleochannel in the western portion of Section 13, and in Section 21 between the NWBCS and the O'Brian Canal. The average gradient in these areas of the Offpost Operable Unit is 0.004 ft/ft.

Onpost, in the vicinity of the NBCS, the lowest gradients occur west of D Street and between Basin F and the NBCS in the middle portion of Section 23. Gradients as low as 0.0007 ft/ft, are present in this area. Onpost near the NWBCS, the lowest gradients occur in the western portion of Section 22 where gradients as low as 0.002 ft/ft are noted.

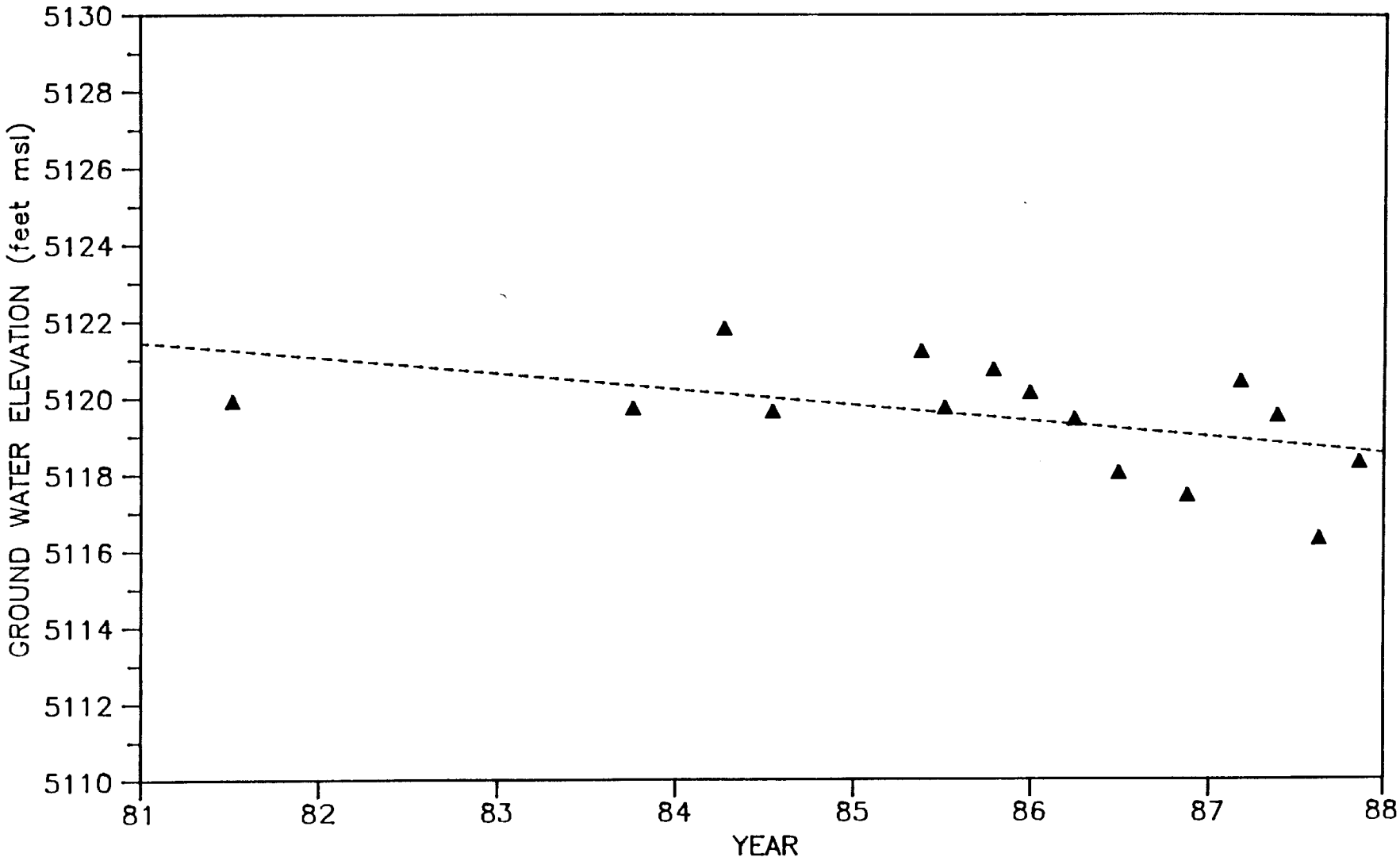
The steepest gradients in the alluvial aquifer near RMA are present where ground water is moving through less permeable alluvial material. Also, steep gradients can occur in the uppermost Denver Fm in areas underlying unsaturated alluvium. In the Offpost Operable Unit, the steepest hydraulic gradients, approximately 0.022 ft/ft, are present in the unsaturated alluvial area located in the northeast portion of Section 22. Onpost, near the west side of the NBCS barrier, these conditions are prevalent and the hydraulic gradient is approximately 0.024 ft/ft. Gradients are also steep along the edges of paleochannels where water table contours reflect the bedrock-slope configuration.

The slope of the bedrock surface steepens near the RMA north boundary as shown in Figure 3.1-7. This slope change results in relatively high water table gradients in the area immediately north of the NBCS. Offpost gradients along First Creek, and just downgradient of the NBCS, slope to the northwest, again reflecting the bedrock configuration in this area. These gradients may also reflect seasonal recharge from First Creek and, to a lesser extent, inflow from subcropping Denver sandstone units.

Average hydraulic gradients in the Offpost Operable Unit generally coincide with gradients observed by Konikow (1975, RIC#84324M01). Average hydraulic gradients during 1977 in the vicinity of the NBCS were estimated to be 0.006 ft/ft near the pilot portion of the NBCS and 0.0076 ft/ft near the eastern extension of the system. Average hydraulic gradients during 1981 in the vicinity of the NWBCS were estimated to be 0.0015 ft/ft (Anderson and Bergeron, 1981, RIC#85154R18).

Currently, observed gradients beyond about 1,000 ft upgradient and downgradient of the NBCS and the NWBCS generally coincide with gradients observed under pre-system conditions even though the average water table elevations have declined. Within the NBCS area, water table gradients across the soil-bentonite barrier have been relatively steep. These hydraulic gradients are due primarily to dewatering and recharge operations and the relatively low hydraulic conductivity of the soil-bentonite barrier. Gradients close to the NBCS and the NWBCS vary from pre-system natural conditions because of the influence of individual dewatering and recharge wells. These local deviations can be observed in Figure 3.2-1.

Offpost near the RMA north and northwest boundaries, the water table elevations have declined an average of about 1 to 2 ft since the late 1970's and early 1980's. This evaluation is based upon hydrographs for Wells 37308, and 37309 located downgradient of the NBCS, and hydrographs for Wells 37334 and 37335 located downgradient of the NWBCS. The hydrographs for Wells 37309 and 37335 are shown in Figures 3.2-2 and 3.2-3, respectively. Hydrographs for Wells 37308 and 37334 are shown in Appendix E. A comparison of spring and summer 1987 water elevation maps with water elevation maps prepared by Konikow (1975, RIC#84324M01) and Robson and Romero (1981, RIC#82350M02) also shows an average decline of about 1 to 2 ft. These downgradient water level declines are thought to be primarily attributable to decreased infiltration from upgradient onpost recharge sources since the 1960s and 1970's (e.g., storage of irrigation water in Basin C from 1965 to the early 1970s).



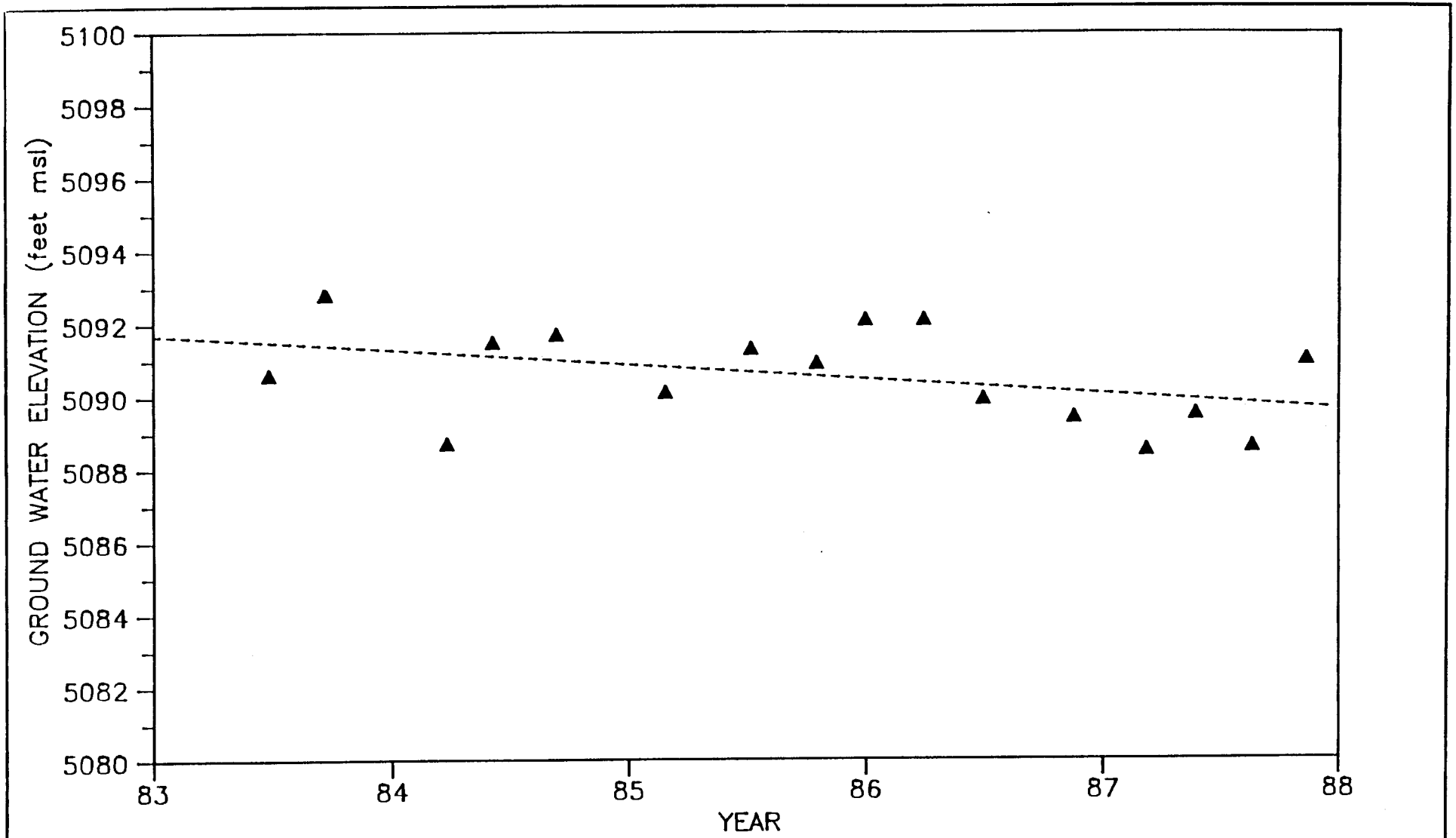
Note : Regression line equation is Y = -.42X + 5155.1

Figure 3.2-2
HISTORICAL HYDROGRAPH
FOR WELL #37309

SOURCE: ESE, 1988

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For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland



Note : Regression line equation is Y = -.41X + 5125.9

Figure 3.2-3
HISTORICAL HYDROGRAPH
FOR WELL #37335

SOURCE: ESE, 1988

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland

Onpost, the water table elevations near the RMA north boundary have declined during the same time period. Decline in water levels from spring 1977 to spring 1987 averaged 5 to 6 ft in the central portions of Section 23, and 3 to 4 ft in Section 24. Water levels immediately upgradient of the NBCS have also declined an average of 3 to 4 ft in Sections 23 and 24 but vary considerably because of differing pumping rates associated with the operation of the NBCS. These declines are also thought to be attributable to decreased infiltration from upgradient recharge sources.

In the onpost area, downgradient of the NBCS, water level fluctuation trends are complicated by the uneven distribution of NBCS recharge operations relative to natural pre-system flow rates in the area. This general trend shows an overall decline, however, there are areas near the North Bog (Figure 3.2-1) where substantial amounts of NBCS effluent water are presently being discharged and these areas actually exhibit a higher water table than in 1977. The elevation of the water table west of D Street, however, has exhibited declines as much as 9 ft. These areas correspond to the location of NBCS recharge wells that historically have been unable to return natural flow rates to the aquifer.

Seasonal water table trends are reflective of differing amounts of recharge to the alluvial aquifer during different times of the year. Generally, the water table elevations vary seasonally from 1 to 2 ft with more extreme fluctuations observed close to First Creek, and offpost irrigation ditches. The highest water levels are generally noted in the late winter and spring of each year and reach a low during late summer or fall. This is shown in the seasonal hydrographs of Figures 3.2-4 and 3.2-5 for Wells 37308 and 37309, and 37335, respectively. Near First Creek, the water table elevations in the winter months may exceed that of the spring months. Higher water table conditions in the winter and spring months are indicative of increased snowmelt and rainfall. Although the trends may differ somewhat from year to year, varying recharge from indirect infiltration of precipitation and other surface water bodies during different times of the year are primarily responsible for the seasonal water table fluctuations.

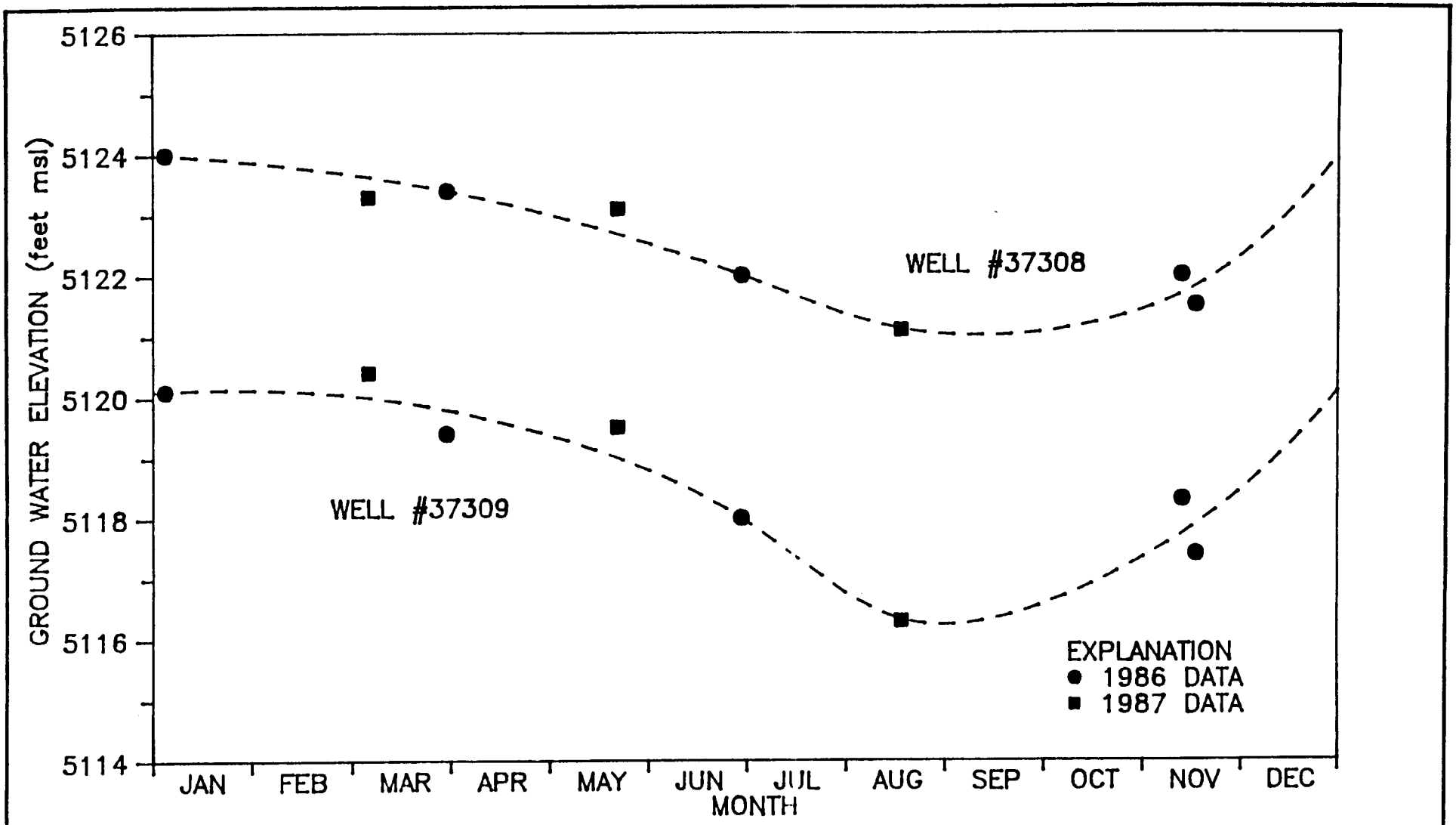


Figure 3.2–4
SEASONAL HYDROGRAPHS
FOR WELLS #37308 & #37309

SOURCE: ESE, 1988

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland

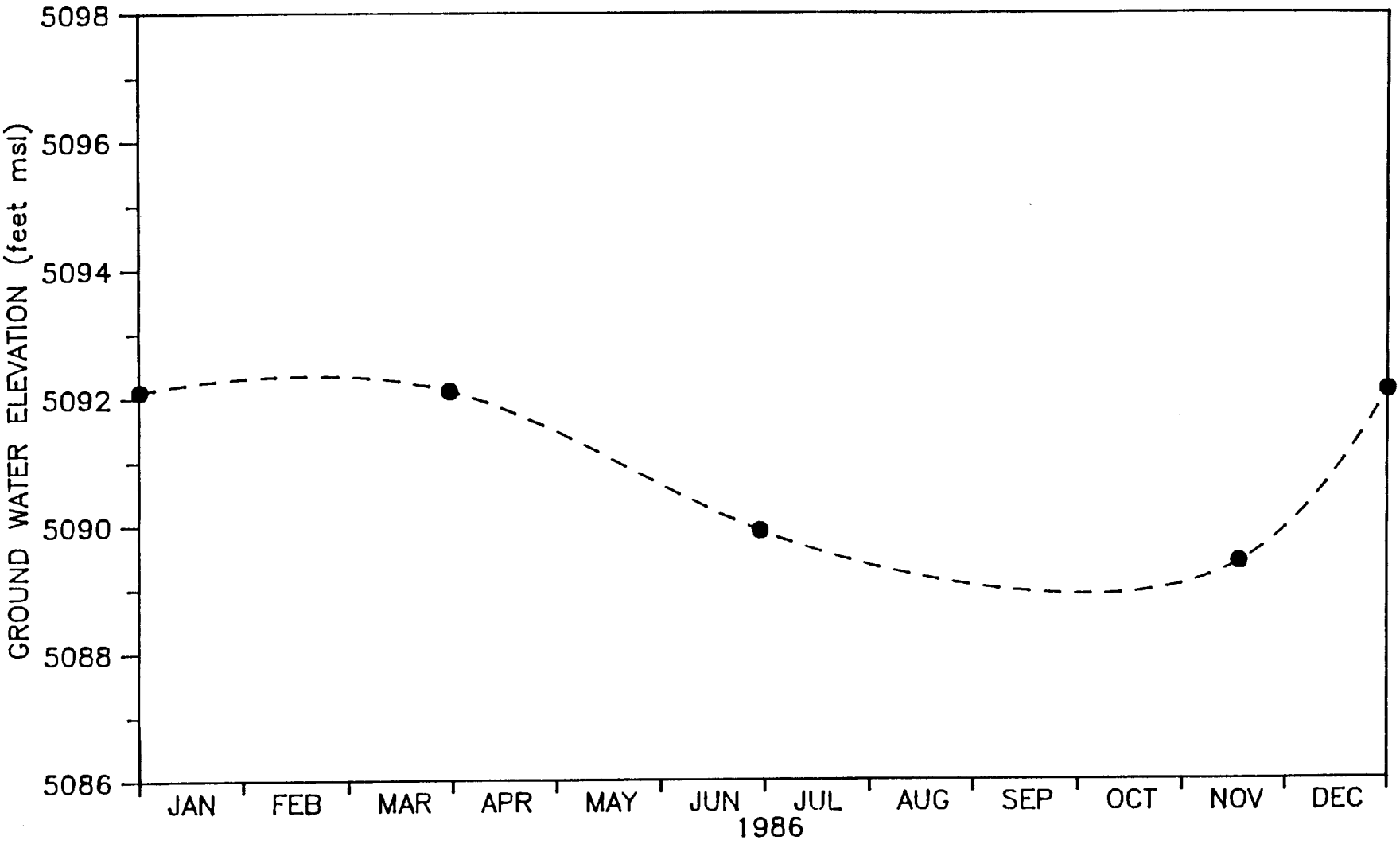


Figure 3.2–5
1986 SEASONAL HYDROGRAPH
FOR WELL #37335

SOURCE: ESE, 1988

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland

3.2.1.2 Saturated Alluvial Thickness

The saturated thickness of the alluvial aquifer varies from 0 to 60 ft over the Offpost Operable Unit. The summer 1988 saturated thickness map for the offpost areas just downgradient of the RMA north and northwest boundaries has been provided in Figure 3.2-6 for discussion. The summer 1987 saturated thickness map for the entire Offpost Operable Unit is provided in Appendix E. These maps were constructed using water level data obtained in the summer of 1987 and the bedrock surface map presented in Section 3.1.2.

Saturated alluvium is thin or absent near high bedrock areas and where bedrock outcrops. Thick sequences of saturated alluvium occur within paleochannels scoured into the bedrock surface. The saturated horizon generally includes basal sands and sandy gravels as well as overlying clays and silty clays. About 55 to 60 percent of the saturated, unconsolidated sediments are sand and gravel, and 40 to 45 percent are silt and clay. The coarser alluvial sediments are more significant because of their hydraulic conductivity compared to finer-grained sediments.

The greatest amount of saturated thickness, approximately 60 ft, occurs about 5,000 ft northwest of the NWBCS as shown in Figure 3.2-6. At the RMA northwest boundary the saturated thickness varies from 10 to 30 ft. North of the RMA north boundary, the saturated thickness varies from 0 to 30 ft.

Directly adjacent to the NBCS soil-bentonite barrier, the saturated thickness varies from an average of 2 ft downgradient of the pilot portion of the system to 20 ft upgradient of the eastern extension barrier and near First Creek. The alluvial aquifer becomes unsaturated toward the eastern and western ends of the system near bedrock highs.

In the vicinity of the RMA north and northwest boundaries, the saturated region is bounded by three distinct unsaturated alluvial areas as shown in Figure 3.2-6. The unsaturated areas located to the east and west of the NBCS and the unsaturated area to the northeast of the NWBCS were considered in the design of the containment systems. The ends of the NBCS soil-bentonite barrier were designed to key into bedrock highs corresponding to these unsaturated alluvial aquifer areas. Likewise, the northeast end of

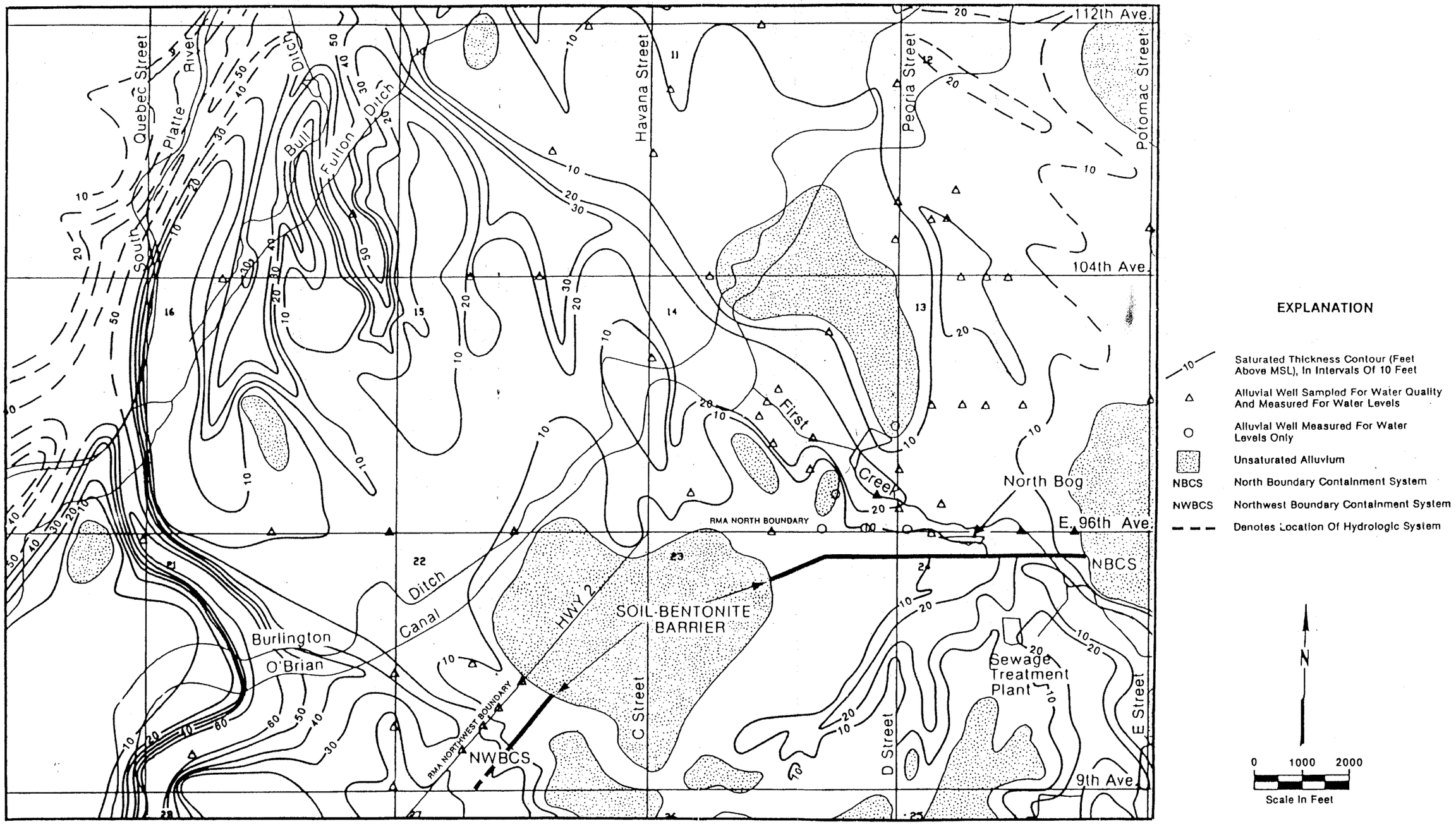


Figure 3.2-6
SATURATED THICKNESS MAP FOR THE ALLUVIAL AQUIFER IN THE OFFPOST OPERABLE UNIT NEAR THE ROCKY MOUNTAIN ARSENAL BOUNDARIES (SUMMER, 1987)
SOURCE: ESE, 1988

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal

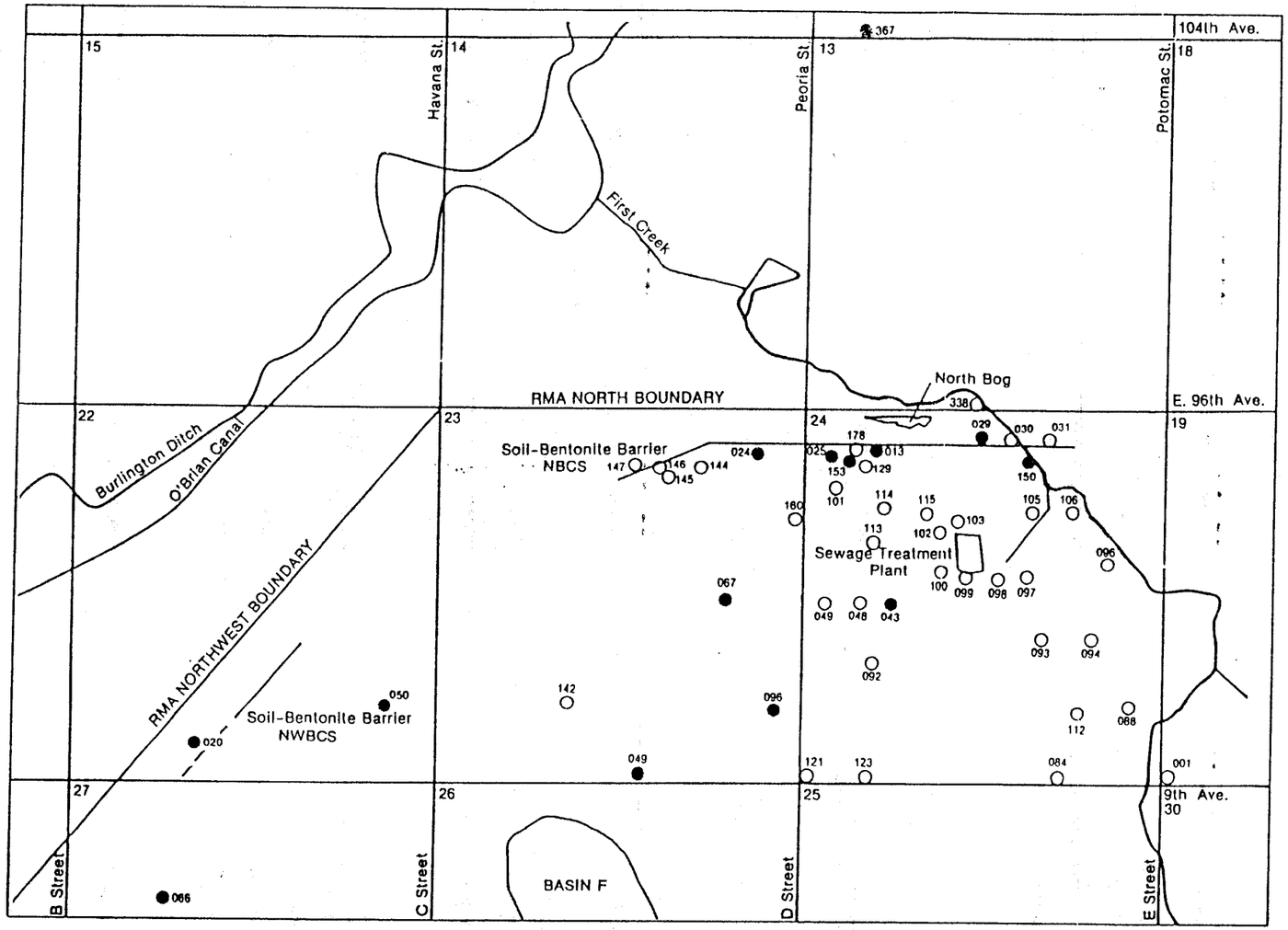
Aberdeen Proving Ground, Maryland

the soil-bentonite barrier at the NWBCS was designed to key into an area of bedrock high. Another area of unsaturated alluvium, very influential in controlling ground-water flow directions, is present downgradient of the NBCS in the northeast quadrant of Section 14 and the northwest quadrant of Section 13. This area of unsaturated alluvium separates two distinct alluvial flow pathways along First Creek and to the north through Section 13. These two pathways will be referred to in this report as the First Creek pathway and the Northern pathway, respectively. Also, downgradient of the NBCS in Section 14, two smaller isolated areas of unsaturated alluvium are present as shown in Figure 3.2-6.

The saturated thickness in the Offpost Operable Unit is dependent upon seasonal water level fluctuations that average approximately 2.5 ft, as described in Section 3.2.1.1. The saturated thickness is greatest in the winter and spring, and lowest during summer and fall. Close to the NBCS and the NWBCS, the saturated thickness is influenced by the operation of dewatering and recharge wells and by the presence of the soil-bentonite barrier. A detailed assessment of stresses imposed by the NBCS and the NWBCS on the alluvial aquifer and their effects on the saturated thicknesses are described in the forthcoming Boundary Control Systems Assessment Remedial Investigation Report, Task 25, and the North Boundary System Component Response Action Assessment, Task 36 Draft Final Report (ESE, 1988b, RIC#88063R08).

3.2.1.3 Aquifer Parameters

In previous studies, the hydrogeologic properties of hydraulic conductivity and apparent specific yield of the alluvial aquifer near the NBCS were determined by slug and pumping tests (Zebell, 1979, RIC#81266R19; Mitchell, 1976, RIC#81281R04; Vispi, 1978, RIC#81266R70; Black and Veatch, 1980, RIC#81266R25; May, 1982, RIC#82295R01; COE, 1983a, RIC#84066R01; COE, 1986). The location of these aquifer tests are shown in Figure 3.2-7. A determination of hydraulic conductivities and transmissivities for the alluvial aquifer is essential for determining ground-water flow rates. An understanding of the apparent specific yield of the aquifer is necessary for predicting water table fluctuations due to stresses on the aquifer.



EXPLANATION

- ○ Alluvial Slug Test
- ● Alluvial Pumping Test
- NBCS North Boundary Containment System
- NWBCS Northwest Boundary Containment System
- – – – Denotes Location Of Hydrologic System

N

0 2000 4000

SCALE IN FEET

Figure 3.2-7

LOCATION OF ALLUVIAL AQUIFER TESTS

SOURCE: ESE, 1988

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland

One alluvial aquifer test was performed under this study at Well 37367 shown in Figure 3.2-7. The aquifer test was performed at this location to obtain representative alluvial aquifer parameters along the Northern pathway. Aquifer test results from other studies have been extrapolated to the Offpost Operable Unit to provide a general range of aquifer parameters for other contaminant migration pathways such as the First Creek paleochannel and the paleochannel emanating from the NWBCS.

Reanalysis and evaluation of onpost aquifer test data near the NBCS was performed to confirm previously calculated values (ESE, 1988). Previously reported aquifer hydraulic conductivities and the apparent specific yields varied significantly. ESE performed reanalysis of data for seven onpost pumping tests, five performed by WES (Vispi, 1978, RIC#81266R70) and two additional tests conducted by Black and Veatch (1980, RIC#81266R25). Interpretation of these data indicate that the alluvial aquifer responds as an unconfined aquifer in most cases but in some areas acts as an unconfined aquifer with a delayed yield phenomena. This phenomena may occur in stratified unconfined aquifers where a homogeneous coarse-grained unit is bounded below by a relatively impervious layer and above by a fine-grained layer. When an unconfined aquifer shows the characteristics mentioned above, it is classified as semi-unconfined (Kruseman and DeRidder, 1983).

Analysis of aquifer test data under the geologic conditions described can be misleading if the use of conventional methods for confined and/or semi-confined aquifers are used. Although such methods can be applied, certain conditions and assumptions are required. Reanalysis of onpost pumping test data was conducted by ESE using the Neuman method, which accounts for anisotropic, unconfined aquifers that undergo delayed gravity response during pumping tests (Neuman, 1975).

The results of alluvial aquifer tests conducted in the vicinity of the NBCS are given in Table 3.2-1. Also listed in this table are the results of a pumping test performed by WES (May, 1982, RIC#82295R01) and two pumping tests performed by the COE (1983b, RIC#85176R01 and 1986) in the vicinity of the NWBCS. In the north and northwest boundary area, the transmissivity (T) values are generally higher in buried and incised paleochannels. These

Table 3.2-1. Transmissivity (T), Hydraulic Conductivity (K), and Apparent Specific Yield (SYA) from Pumping Tests

Site Well No.	(Bore No.)	Aquifer Test By	T gpd/ft	K*** gpd/ft^2 K_H	K_V	SYA
24029	(345)	WES (Vispi 1978)*	30,000	3,000	2.0-100	0.18
24043	(549)	WES (Vispi 1978)*	15,500	1,550	--	0.01
23049	(368)	WES (Vispi 1978)*	45,000	7,250	--	0.25
23096	(529)	WES (Vispi 1978)*	79,000	7,500	--	0.21
23067	(548)	WES (Vispi 1978)*	20,000	2,000	--	0.03
24153	(1036)	Black & Veatch (1980)*	18,500	1,760	0.80	0.02
24150	(1032)	Black & Veatch (1980)*	19,400	1,760	12-84	0.01
24025	(221)	WES (Mitchell 1976)**	8,020	1,670	--	0.048
23024	(203)	WES (Mitchell 1976)**	6,210	887	--	0.050
24013	(209)	WES (Mitchell 1976)**	19,100	1,270	--	0.054
22020	(1104)	WES (May 1982)	405,000	17,690	--	0.0005
22050	(DH19)	USACE (1986)	33,000	4,390	--	0.085
27066	(DH13B)	USACE (1986)	210,000	8,560	--	0.25

* Transmissivity (T) and apparent specific yield (SYA) from ESE reanalysis.

** Transmissivity and apparent specific yield from reanalysis by Battelle-Moody Thomas et al., 1977).

*** K_H and K_V denote horizontal and vertical hydraulic conductivity, respectively.

Source: ESE, 1988.

relatively high T values are primarily associated with a thickening of coarse-grained basal sands and gravels within the erosional bedrock channels.

North of the NBCS the T and K values for the Northern pathway have been estimated from the results of the test performed on Well 37367. The average T obtained from this pumping test was 49,000 gpd/ft and the average K was 2,500 gpd/ft^2. The apparent specific yield value of 1.7×10^{-3} indicates that the aquifer responded as a semi-unconfined aquifer at this location.

Two pumping tests have been performed along First Creek onpost, in the vicinity of the NBCS. These tests were performed at Wells 24029 and 24150 as shown in Figure 3.2-7. The results of these pumping tests have been used to provide a range of T and K values that may be observed in the First Creek paleochannel offpost. The T values for Wells 24150 and 24029 were 19,000 and 30,000 gpd/ft, respectively. The K values for Wells 24150 and 24029 were 1,760 and 3,000 gpd/ft^2, respectively. The apparent specific yield values of 0.01 and 0.18 obtained from pumping tests at Wells 24150 and 24029, respectively, indicate that the aquifer responds as an unconfined aquifer at each of these locations.

Aquifer parameters for alluvial materials in the vicinity of the NWBCS are based on previous pumping tests conducted by May (1982, RIC#82295R01) and COE (1983b, RIC#85176R01 and 1986). The T values for the three tests range from 33,000 to 405,000 gpd/ft and the K values range from 4,390 to 17,690 gpd/ft^2. The higher T and K values were obtained from Well 22020 that is completed in the paleochannel where the NWBCS intercepts alluvial ground water. These T and K values are considered representative of the aquifer parameters that may be observed in this same paleochannel offpost, northwest of the NWBCS. The storativity value of 0.0005 calculated for the test at Well 22020 indicates that the alluvial aquifer responded as a confined aquifer at this location. This is probably due to 30 ft of fine-grained clay that overlies the coarse-grained aquifer material in this area. The apparent specific yield values of 0.25 and 0.085 obtained from pumping tests

at Wells 27066 and 22050, respectively, indicates that the aquifer responds as unconfined at the location of Well 27066 and as semi-unconfined at each of these locations.

The reanalysis of aquifer tests conducted in Sections 23 and 24 on RMA have been used to provide estimates of hydraulic conductivity for different combinations of different USCS soil groups comprising the alluvial aquifer in the study area. These average values are shown in Table 3.2-2. These values were obtained by correlating the hydraulic conductivity determined from aquifer tests to the lithologies observed in pumping and observation wells.

The Neuman analysis method also allows for a determination of vertical hydraulic conductivities. The values computed during aquifer test analysis were on average at least two orders of magnitude lower than horizontal hydraulic conductivities. Several of these values are shown in Table 3.2-1.

3.2.1.4 Ground-Water Flow Directions and Quantities

Flow through the alluvial aquifer is strongly influenced by the paleodrainage patterns and associated stream channel deposits as described in Section 3.1.2. Ground-water flow is enhanced along paleochannels because of higher transmissivities associated with a relative thickening of coarse basal sands and gravels along the axes of the paleochannels. As ground water flows from the NBCS area, into the Offpost Operable Unit, it follows two distinct alluvial pathways. These two flow pathways are separated by a ground-water divide present near the surface water impoundment located along First Creek and approximately one third of a mile north of the RMA north boundary. The bifurcation of flow paths is caused in part by a Denver Fm high located just north of this impoundment. Ground water traveling to the east of this impoundment flows north through the central and western portions of Section 13. Near the northern portion of Section 13, the ground-water flow direction changes to the northwest toward O'Brian Canal. Ground water traveling to the west of the First Creek impoundment flows northwest along the First Creek paleochannel. Both flow paths are bounded by large unsaturated alluvial areas in Sections 13 and 14, as shown in Figure 3.2-6.

Table 3.2-2. Hydraulic Conductivity of Combined Soil Groups in the Alluvial Aquifer.

Classification	Description	Hydraulic Conductivity (gpd/ft^2)
(SP-GW)	Well-graded gravels or gravel-sand mixtures with little or no-fines combined with poorly graded sands.	7,000 - 7,500 (928 to 1008 ft/day)
(SP-GP)	Poorly graded gravels, or gravel sand mixtures with little or no fines combined with poorly graded sands.	3,000 (389 ft/day)
(SP-SW)	Poorly to well-graded sands or gravelly sands with little or no fines	1,850 (245 ft/day)
(SP)	Poorly graded sands or gravelly sands, little or no fines	1,700 (230 ft/day)
(SM-SP)	Silty sands, sand-silt mixtures combined with poorly graded sands or gravelly sands	1,500 (202 ft/day)

Source: ESE, 1988.

Onpost, as ground water approaches the NBCS area, it flows along two distinct pathways. These pathways are separated by a bedrock high associated with the ridge near North Plants located in the southeast and southwest quadrants of Sections 23 and 24, respectively. This bedrock high is shown in Figure 3.1.6. In Section 24, the larger flow component follows the First Creek paleochannel in a north-northwest direction.

The second major flow pathway enters the NBCS study area from the vicinity of Basin F through the south-central portion of Section 23. This flow pathway has an important influence on contaminant migration in the area and follows a northeast trending paleochannel which intersects the First Creek near the east end of the NBCS. However, midway between Basin F and the north boundary, the primary flow direction turns abruptly away from the paleochannel and toward the pilot barrier area. Large ground water influx in Section 24 from the alluvial aquifer and/or the Denver Fm, in combination with high driving heads and gradients in the northwest direction, are the main cause for this change in ground water flow direction (Thompson et al., 1985, RIC#86078R01).

According to Thompson et al. (1985, RIC#86078R01), the total ground-water flow approaching the NBCS area ranges between 250 to 325 gpm. This estimate was based upon NBCS flow measurements and hydrologic data in the vicinity of the NBCS. Due to seasonal fluctuations, the flow approaching the NBCS is expected to be higher during winter and spring, and lower during summer and fall. Total seasonal flow variations are expected to be no more than about 20 percent of the total flow based upon observed water table fluctuations.

As water flows from the NWBCS area, into the Offpost Operable Unit, it follows the direction of the paleochannel that originates from the NWBCS area. The general direction of flow in this area is to the northwest. Ground-water flow approaching the NWBCS follows paleodrainages that are isolated by unsaturated alluvial areas as shown in Figure 3.2-6. The predominant direction of ground-water flow is to the northwest. The total ground-water flow being intercepted by the NWBCS is estimated to be about 185 gpm. This estimate was based upon a two-dimensional ground-water flow model performed by Warner et al. (1986, RIC#87085R01). Due to seasonal

fluctuations, the flow approaching the NBCS is expected to be higher during winter and spring, and lower during summer and fall. Total seasonal flow variations are expected to be no more than 20 percent of the total flow based upon observed water table fluctuations.

Ground-water velocities in the Offpost Operable Unit vary with local changes in hydraulic conductivity, hydraulic gradient, and porosity. In the Offpost Operable Unit near the NBCS, estimates of average linear velocities of ground water range from 1.5 ft/day to 10.0 ft/day. In the Offpost Operable Unit near the NWBCS, ground-water average linear velocities range from 5.5 ft/day to 22.5 ft/day. These estimates are based upon the previously discussed hydraulic conductivity values and water table gradients observed during this study and an average porosity of 30 percent.

3.2.1.5 Stresses to the Alluvial Aquifer System

Stresses to the alluvial aquifer system have influenced the overall hydrology to the Offpost Operable Unit. Natural and man-made stresses to the alluvial aquifer include various recharge and discharge events. Onpost man-made stresses were mainly derived from RMA operations or actions which were carried out in the late 1960's and 1970's (Thompson et al., 1985, RIC#86078R01). These actions included the use of Basins C, D, E, and F to dispose of wastewater, the operation of the Sewage Treatment Facility in Section 24, numerous pumping tests, irrigation pumping and spraying in Sections 23 and 24, and operation and testing of the North Boundary Pilot Containment System. These actions resulted in a higher ground-water table in Sections 22, 23, and 24 during the 1970's than at present.

Currently, stresses to the alluvial aquifer are caused by the operation of the NBCS and the NWBCS. The physical presence of the soil-bentonite barriers and the operation of the dewatering and recharge wells have significantly altered the potentiometric surface and hydraulic gradients within 5,000 ft of the containment systems.

In the Offpost Operable Unit, pumping for irrigation and domestic uses during the summer months can cause deviations in the natural ground-water

flow directions. The majority of the pumping occurs in the offpost area between Burlington Ditch and the South Platte River. However, the majority of irrigation water in this area comes directly from the irrigation canals. Areas between O'Brian Canal and the RMA north and northwest boundaries are primarily used for dry-land farming and the demands on the alluvial aquifer for irrigation are virtually nonexistent (Konikow, 1975, RIC#84324M01).

Natural stresses to the alluvial aquifer are primarily attributable to interactions with streams, canals, surface water impoundments, and the discharge/recharge relationship with the underlying Denver Fm. First Creek is an intermittent stream that transects the NBCS area and is thought to have a significant influence on the alluvial aquifer. Stream gaging has been conducted since July, 1986 at the north boundary where First Creek exits RMA and since October, 1985 at the confluence with O'Brian Canal near Highway 2. Evaluation of these data delineates some definitive trends for the offpost reach of First Creek. First, during high flow periods, the upstream gage station recorded significantly higher flows than at the Highway 2 station. The majority of this water appears to be lost to the alluvial aquifer via infiltration from First Creek and the surface impoundment located in the eastern portion of Section 14.

From July 1986 to June 1987, losses between these two points exceeded 100 gpm. Much of the noted losses were observed during storm events during which the Highway 2 gage was inundated. During these storms, the Highway 2 gage probably underestimated flows and, thus, First Creek losses could be overstated. However, considering that evaporation would only represent a small fraction of flow during base flow periods, it is evident that First Creek is overall losing water to the alluvial aquifer along this reach. The relative contribution, specifically from the surface impoundment, as opposed to First Creek itself, is thought to be significant because the impoundment can retain water during storm events and act as a "spreading basin" during no flow periods in First Creek. Since the impoundment covers approximately eight acres, substantial recharge to the alluvial aquifer could be occurring throughout the year. This is substantiated by observed water level declines in the impoundment of about 1.5 ft/month during periods when no flow was entering or exiting in First Creek.

During no flow periods at the north boundary gage, small flows have been measured at the Highway 2 station. These data indicate that during low flow periods First Creek may gain water from the alluvial aquifer. Surface runoff during these low flow periods, primarily during the summer and fall, is generally nonexistent and is not believed to be responsible for the downstream flows. This assessment is substantiated by the presence of ground water contaminants at the offpost Highway 2 surface water sampling station that have not been detected in First Creek onpost. A more detailed assessment of alluvial aquifer/First Creek interactions is provided in Section 4.0 of this report.

Infiltration of surface water from Burlington Ditch and O'Brian Canal also contributes significant recharge to the alluvial aquifer in the Offpost Operable Unit. Based upon a study conducted by Konikow (1977, RIC#84192R02) the amount of recharge to the alluvial aquifer from these two canals in the Offpost Operable Unit is estimated at 180 gpm/mile.

As reported by Konikow (1977, RIC#84192R02) the average rate of application of irrigation water in the South Platte River valley is about 4.2 ft/yr and about 45 to 50 percent of the applied water recharges the aquifer. Based upon Konikow's data, about 18 percent of irrigation water is from the alluvial aquifer and the remainder is from irrigation canals. Thus, estimates of recharge to the alluvial aquifer are about 23 to 25 inches per year. These values seem reasonable, but may be decreasing with time as pumping costs increase. Currently, much of the irrigation water is diverted from canals and does not require pumping (MKE, 1987). The alluvial aquifer discharges to the South Platte River to the northwest of the Offpost Operable Unit. The amount of discharge has been estimated at 1,300 gpm/mile (MKE, 1987).

Recharge to the aquifer also results from the operation of the recharge system at the NBCS. The North Bog currently receives treated water from the NBCS and recharges water to the alluvial aquifers. Leakage from the alluvium to the Denver Fm is occurring near the NBCS as evidenced by the downward vertical gradients observed at several cluster well sites in the area. Locally, recharge to the alluvial aquifer from the underlying Denver

Fm is occurring in areas where sandstone units subcrop beneath the alluvium (May, 1982, RIC#82295R01). (A discussion of alluvial/Denver aquifer interactions will be given in Section 3.2.3.5).

3.2.2 DENVER FM

Regionally, the Denver Fm consists of a system of interconnected beds of permeable and relatively impermeable sediments with a high degree of variability in hydraulic conductivity and storativity values both laterally and vertically. Ground water primarily flows laterally and updip through sandstone lenses under confined conditions and primarily discharges locally to the alluvial aquifer. The driving head for this updip flow results from recharge into outcropping and subcropping Denver Fm sandstones to the south of RMA. Structural mapping by Robson and Romero (1981, RIC#82350M02) indicates that the altitudes of the base of the Denver Fm range from more than 6,400 ft above mean sea level (msl) in the southern part of the Basin to less than 4,600 ft above msl in the lowest part of the structure. The base of the Denver Fm is at about 5,000 ft above msl in the vicinity of RMA.

The Denver Fm consists of approximately 250- to 300-ft-thick series of carbonaceous clay-shales, claystones, and siltstones, near the boundaries of RMA and thins to the northwest toward the South Platte River (May et al., 1980, RIC#81266R48). In areas near the South Platte River, the Denver Fm subcrops and is completely absent due to erosion, in areas to the northwest of the subcrop zones (Robson, 1984). These fine-grained sediments are interbedded with weakly lithified, more permeable, lenticular sandstone units. The sandstone units may be locally unconsolidated, but cementing with calcium carbonate, silica, or other minerals can decrease the hydraulic conductivity of these sandstone units by two orders of magnitude or more (Ertec, 1981, RIC#81352R35). Where sandstone units are uncemented or partially cemented, these bodies act as the dominant pathway for transmitting ground-water flow laterally through the Denver Fm.

In the Offpost Operable Unit, the water-bearing sandstone units are confined and heterogeneous, and the upper units generally have a potentiometric surface a foot or two below the alluvial water table surface. In areas

where Denver Fm sandstones subcrop into the alluvium, the water levels of the subcropping units are similar to that of the alluvial water table which may indicate an area of potential discharge or an area where a flow in the Denver Fm is controlled by water table conditions.

The dominant ground-water flow direction within the Denver Fm is to the north-northwest. Potentiometric surface maps prepared for Denver Fm units characterized in the Offpost Operable Unit, show this flow direction. Potentiometric differences between sandstone units in the study area generally indicate downward ground-water movement. Vertical hydraulic gradients observed between distinct units range from 0.002 to 0.4 ft/ft. Generally, sandstone units that are geologically connected by coarse, permeable materials exhibit coincident water levels and can be considered as one unit.

In the Offpost Operable Unit, the water-bearing sandstone units generally represent fluvial channel and crevasse-splay type deposits that grade laterally and vertically into finer materials. Due to the nature of deposition of these sediments, the sandstone units differ in their capacity to store, transmit, and yield water. In general, the Denver Fm sandstones near the RMA boundaries and in the Offpost Operable Unit have a hydraulic conductivity three orders of magnitude less than the coarsest alluvial sediments. Slug tests and laboratory hydraulic conductivity tests show that the hydraulic conductivity of fractured and weathered clay shale of the upper Denver Fm can be of similar magnitude to that of the Denver Fm sandstones (May et al., 1980, RIC#81266R48). However, with depth the hydraulic conductivity of the clayshale is generally two orders of magnitude less than that of the Denver Fm sandstones. A more thorough discussion of the hydraulic conductivities for the Denver Fm units is given in Section 3.2.2.3.

The following discussion of the Denver Fm hydrogeology in the Offpost Operable Unit focuses on aquifer recharge, ground-water movement, and aquifer discharge. The emphasis has been placed on describing the potentiometric surfaces and aquifer properties of zones within the Denver

Fm. Several zones, separated by less permeable lignitic shale intervals, have been identified at RMA. Of these zones, 2, 3, and 4 subcrop in the Offpost Operable Unit, i.e., are uppermost units and are therefore, of the most interest to the offpost RI.

3.2.2.1 Aquifer Recharge

Regional recharge to the Denver Fm occurs to the south of RMA where the Denver Fm outcrops and is subject to direct infiltration of precipitation. The elevation of these recharge areas is sufficiently high topographically and causes updip ground-water flow at RMA. Other recharge to the Denver Fm occurs as a result of the overlying saturated unconsolidated materials having a higher water level elevation than the Denver Fm. This mode of recharge is a key factor in the interpretation of contaminant movement beneath RMA. Recharge to the Denver Fm can also occur directly from surface water sources in areas where the alluvial aquifer is unsaturated.

Recharge that results indirectly from the activities of man, is less significant than natural recharge, but is important in terms of contaminant migration. At RMA, these activities include well construction, and any excavation work that intercepts Denver Fm units, such as utility trenches. In the areas adjacent to the NBCS, recharge to the Denver has resulted from the pumping of dewatering wells completed in the formation. These wells, in operation only during 1984, induced flow downward from the overlying saturated unconsolidated materials having a higher water level elevation than the Denver Fm.

3.2.2.2 Denver Fm Zones

In the Offpost Operable Unit, three Denver Fm zones which correlate to onpost zones have been described. The subdivision of the upper Denver Fm is based primarily on the geologic interpretation presented in Section 3.3.1, but also on an assessment of water levels and contaminant distribution including inorganic chemistry data. An attempt was made to use inorganic chemistry data to differentiate between Denver Fm zones. However, no verifiable correlation was observed between concentrations and Denver Fm

zones. Due to the regional description of these zones, they include varying amounts of permeable sands and less permeable siltstones and shales. The more permeable sandstone units vary in thickness and lateral extent within a particular regional zone.

In the vicinity of the NBCS, geologic, water level, and water chemistry data have made it possible to subdivide regional zones 2, 3, and 4 into more localized units. A detailed description of the local units identified at the NBCS is presented in the Task 36 report. A brief description of these more localized units has been provided in this report to describe how the localized units relate to the regional zones. The four primary Denver Fm units identified in the vicinity of the NBCS are NBW#1A, NBW#1, NBW#2, and NBW#3. These units at the NBCS are similar to the sandstone units described in Section 3.1.3. Denver Fm zone 2 includes units NBW#1A and NBW#1, and zones 3 and 4 include units NBW#2 and NBW#3, respectively.

The following discussion of hydrologic characteristics of the Denver Fm has concentrated on the aforementioned regional zones and localized units identified near the NBCS. These regional and localized units are the uppermost zones in the Offpost Operable Unit in the area north and northwest of the RMA boundary. The discussion of potentiometric surface, hydraulic conductivity and transmissivity will focus on the regional Denver Fm zones and will incorporate a discussion of the local units at the NBCS where appropriate.

3.2.2.3 Potentiometric Surface

Potentiometric surface maps for Denver Fm zones 2, 3, and 4 were constructed under Task 25 using water level measurements taken during the spring of 1987. Potentiometric surface maps for the Denver Fm units identified at the NBCS, NBW#1A, NBW#1, and NBW#2 were constructed using water level measurements taken during February 1988. The February 1988 sampling period was chosen for the NBCS units because it was the most complete water level data set available.

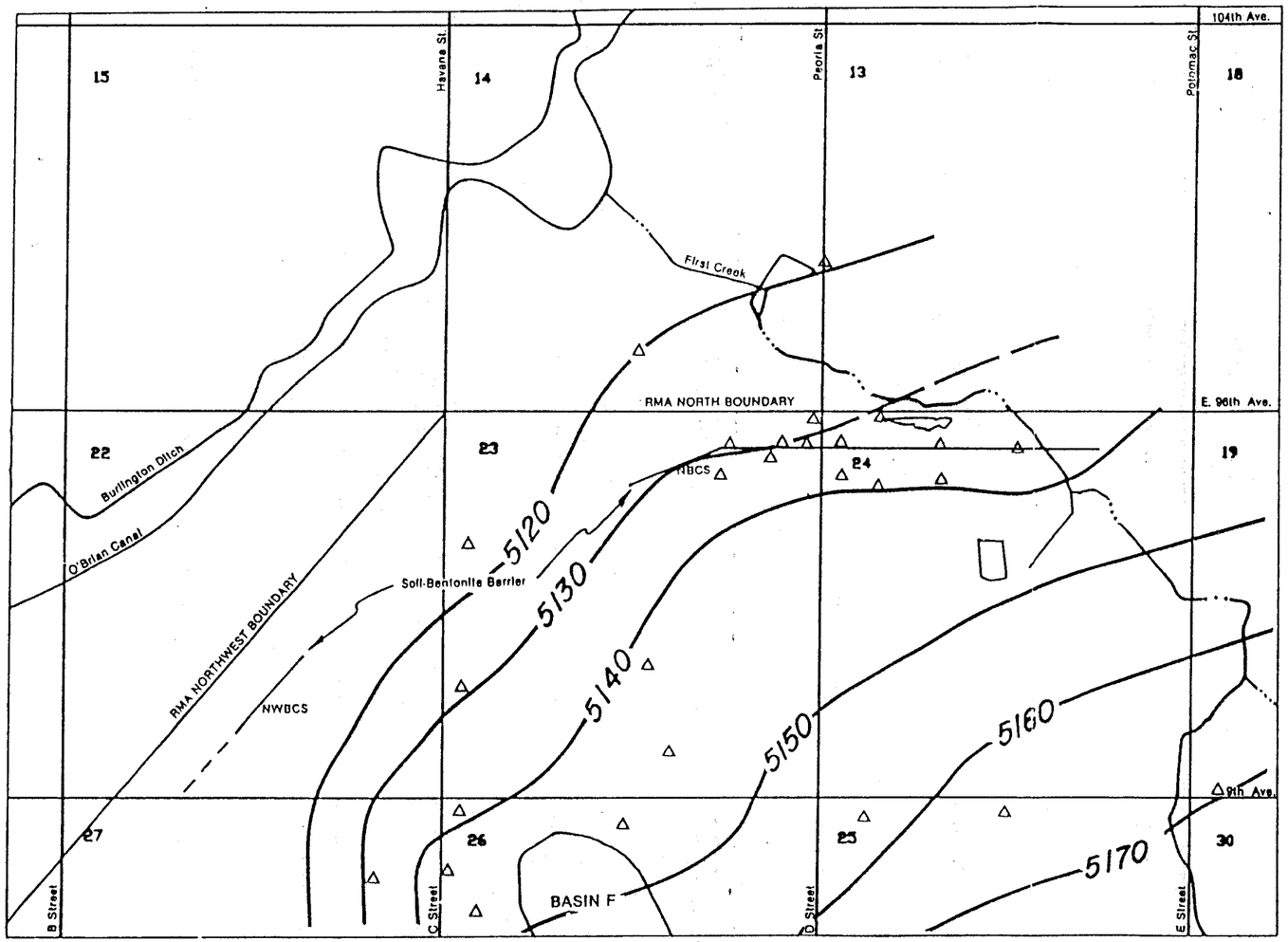
The potentiometric surface maps were evaluated to assess flow directions and hydraulic gradients within each regional zone and localized units within these zones. Figure 3.2-8 illustrates the generalized flow directions in regional zone 2. The flow direction in zone 2 is to the north in the offpost area just north of the NBCS in Sections 13 and 14. The average hydraulic gradient in this offpost area is approximately 0.005 ft/ft. Near the NWBCS, in Section 26 and Section 27, flow directions are to the west and the gradient is slightly greater at about 0.01 ft/ft.

In the vicinity of the north boundary of RMA, Denver Fm units NBW#1A and NBW#1 have been identified within zone 2. More detailed potentiometric surface maps for these units are presented in Figure E-15 and E-16, respectively. The dominant flow direction within these units is to the north and the hydraulic gradients average about 0.005 ft/ft.

In Denver Fm zone 3, flow is nearly due west along the northwest portion of RMA in Sections 22 and 27, as shown in Figure 3.2-9. Gradients range from about 0.013 to 0.02 ft/ft in these sections. Approaching the north boundary of RMA in Sections 23 and 24, flow is to the northwest and gradients range from about 0.003 to 0.008 ft/ft. In the Offpost Operable Unit, downgradient of the north boundary of RMA, flow is also to the northwest and the average gradient is about 0.01 ft/ft. Near the NBCS, Denver Fm unit NBW#2 is within zone 3 and the dominant flow direction within this unit is to the northwest and the average gradient is also 0.01 ft/ft. The potentiometric surface map for this unit is shown in Figure E-17.

The potentiometric surface map of Denver Fm zone 4 indicates flow toward the north in Section 24 and toward the northwest in Sections 22, 23, 26, and 27 as shown in Figure 3.2-10. Hydraulic gradients in this zone range from 0.01 ft/ft in the northern area of Sections 22, 23, and 24, and the northeast portion of Section 27, to 0.002 ft/ft in the Southern portion of Section 23 and 24 .

In Sections 13 and 14 of the Offpost Operable Unit, the direction of flow in zone 4 is to the north and the average gradient is 0.010 ft/ft. Local Denver Fm unit NBW#3 is within zone 4. A more detailed potentiometric



EXPLANATION

△	Well Completed In A Sandstone Unit Within Zone 2
5140	Potentiometric Elevation Contour (Feet Above MSL), In Intervals Of 10 Feet
NBCS	North Boundary Containment System
NWBCS	Northwest Boundary Containment System
— — —	Denotes Location Of Hydrologic System

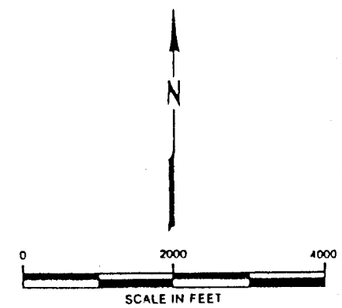


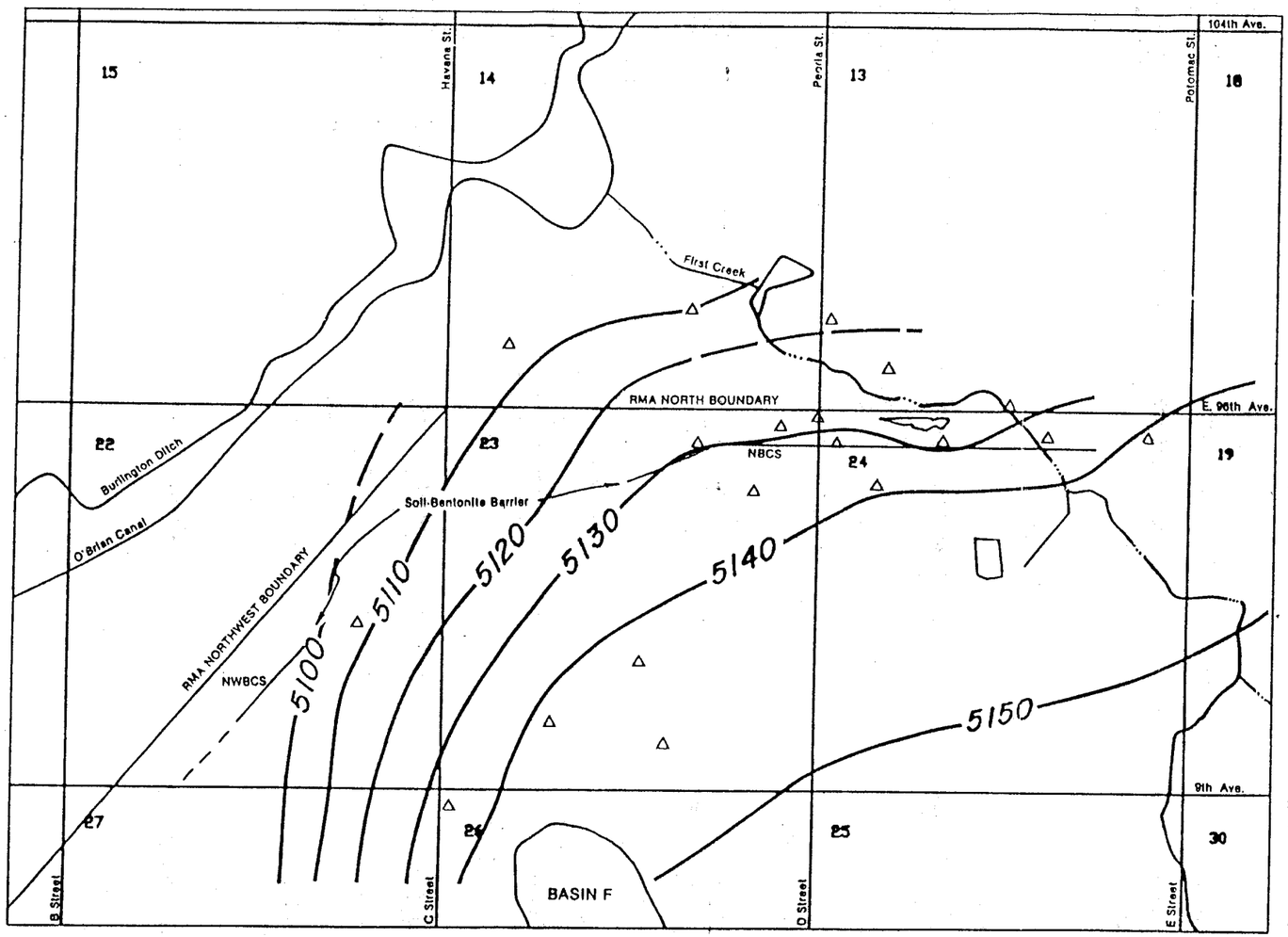
Figure 3.2-8

POTENTIOMETRIC SURFACE MAP OF DENVER FORMATION ZONE 2
(SPRING, 1987)

SOURCE: ESE, 1988

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland



EXPLANATION

△	Well Completed In A Sandstone Unit Within Zone 3
—5140—	Potentiometric Elevation Contour (Feet Above MSL), In Intervals Of 10 Feet
NBCS	North Boundary Containment System
NWBCS	Northwest Boundary Containment System
— — —	Denotes Location Of Hydrologic System

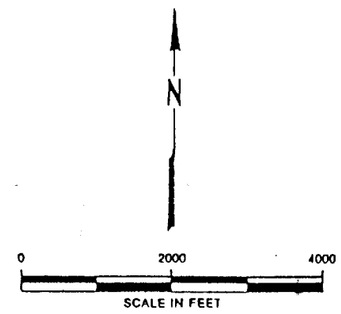


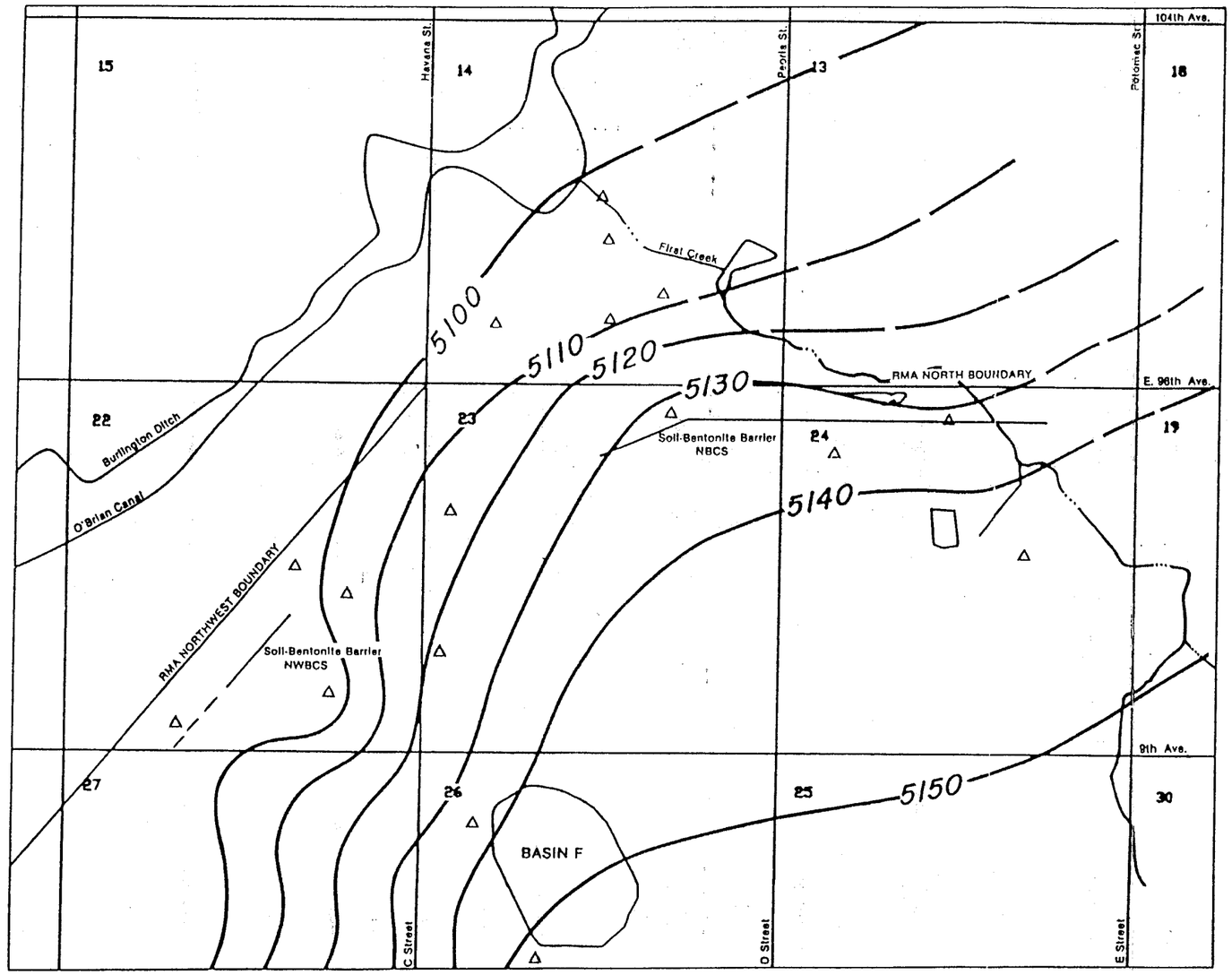
Figure 3.2-9

POTENTIOMETRIC SURFACE MAP OF DENVER FORMATION ZONE 3 (SPRING, 1987)

SOURCE: ESE, 1988

Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland



EXPLANATION

- △ Well Completed In A Sandstone Unit Within Zone 4
- —5140— Potentiometric Elevation Contour (Feet Above MSL), In Intervals Of 10 Feet
- NBCS North Boundary Containment System
- NWBCS Northwest Boundary Containment System
- – – – Denotes Location Of Hydrologic System

N

0 2000 4000

SCALE IN FEET

Figure 3.2-10

POTENTIOMETRIC SURFACE MAP OF DENVER FORMATION ZONE 4
(SPRING, 1987)

SOURCE: ESE. 1988

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland

surface map for unit NBW#3 is shown in Figure E-18. The flow direction in this unit is to the north and northwest and the average gradient is about 0.01 ft/ft.

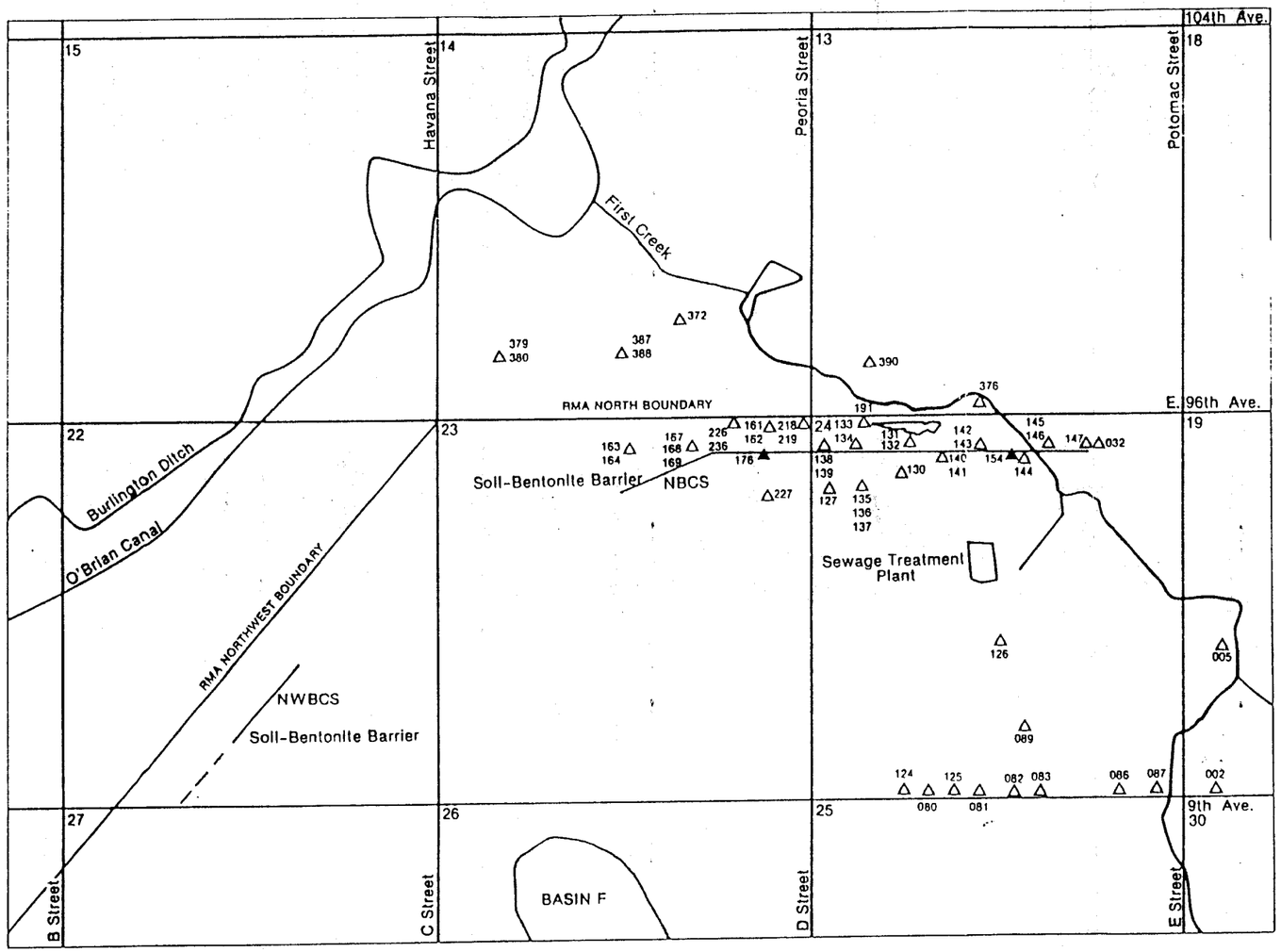
3.2.2.4 Hydraulic Conductivity and Transmissivity

Hydraulic conductivity (K) and transmissivity (T) were estimated for Denver Fm zones from two pumping tests performed by Black and Veatch (1980, RIC#81266R25) and from 35 slug tests performed by May et al. (1980, RIC#81266R48) and by ESE in 1988. ESE performed slug tests on six Denver Fm monitoring wells installed in the Offpost Operable Unit and six Denver Fm monitoring wells onpost installed near the NBCS. The location of Denver Fm aquifer tests are shown in Figure 3.2-11. Although the estimation of K and T from a slug test is representative only the water-bearing material close to the well (Cooper et al., 1967), slug tests were used for this study to provide order of magnitude estimates for K at a large number of sites.

The values of K and T obtained from the slug test analyses of May et al. (1980, RIC#81266R48) and ESE, are presented in Table 3.2-3. The May et al. (1980, RIC#81266R48) slug test data were reanalyzed and correlated to ESE results for comparative purposes. Close agreement exists between the results of the two studies.

A wide distribution of K and T values resulted from the different Denver Fm wells tested. The heterogeneous and anisotropic nature of the Denver Fm sandstone units near the NBCS is believed to be partially responsible for varying K and T values. With slug tests, the portion of the aquifer tested for hydraulic conductivity is smaller than for a pumping test. Most of the head loss occurs within a relatively small distance of the well and the resultant transmissivity primarily reflects the aquifer conditions near the well. This fact may partially be responsible for the large range of K values noted.

The values for K and T are reported for zones 2, 3, and 4. There are no data available offpost for the hydraulic properties of Denver Fm zone 2, therefore, values reported are for onpost wells near the NBCS. Values of T



EXPLANATION

△	Denver Slug Test
▲	Denver Pumping Test
NBCS	North Boundary Containment System
NWBCS	Northwest Boundary Containment System
– – –	Denotes Location Of Hydrologic System

N

0 2000 4000

SCALE IN FEET

Figure 3.2-11
LOCATION OF DENVER FM AQUIFER TESTS

SOURCE: ESE, 1988

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland

Table 3.2-3. Slug Test Results for Denver Fm Hydrostratigraphic Units near the North Boundary of RMA

Zone	Unit	Site Number	Well Number	Screen Interval (ft)	Hydraulic Conductivity (gpd/ft²) Slug In	Hydraulic Conductivity (gpd/ft²) Slug Out*	Hydraulic Conductivity (cm/sec 10⁻⁶) Slug In	Hydraulic Conductivity (cm/sec 10⁻⁶) Slug Out	Aquifer Thickness (ft)	Transmissivity gpd/ft Slug In	Transmissivity gpd/ft Slug Out	Reference
2	NBW#1A	EP-27	23227	33.25-39.00	0.041	0.045	1.9	2.10	4.0	0.163	0.179	ESE, 1988
		EP-20	23226	24.98-36.67	4.9	4.5	229.0	214.0	13.67	66.47	61.88	ESE, 1988
	NBE#1	979	24135	31.0-35.0	—	255.7	—	12100	4.0	—	1022.25	May, 1980
		983	24140	25.0-30.0	—	2.8	—	131.0	5.0	—	13.84	May, 1980
	NBW#1	E-32	23218	47.3-58.00	0.051	0.050	2.4	2.4	8.0	0.41	0.40	ESE, 1988
		E-33	24191	33.1-44.00	1.9	1.0	91.6	48.0	11.0	21.35	11.21	ESE, 1988
		979	24136	51.0-64.0	—	0.038	—	14.5	13.0	—	4.10	May, 1980
		981	24138	41.0-45.0	—	0.60	—	28.5	4.0	—	2.41	May, 1980
		977	24133	46.0-50.0	—	0.34	—	16.2	4.0	—	1.38	May, 1980
		885	23163	42.0-54.0	—	1.7	—	80.7	10.0	—	17.1	May, 1980
		991	23167	47.0-52.0	—	0.56	—	26.2	3.0	—	1.67	May, 1980
3	NBW#2 (Upper)	E-32	23219	63.26-74.00	0.59	0.42	27.7	19.7	10.74	6.30	4.49	ESE, 1988
		E-63	37390	40.12-46.00	4.9	4.5	231.0	210.0	7.0	34.18	21.21	ESE, 1988
		E-38	37379	39.26-55.50	4.6	4.8	218.0	227.0	16.24	74.78	77.89	ESE, 1988
		978	23161	64.0-74.0	—	0.37	—	17.3	7.0	—	2.80	May, 1980
		976	24131	48.0-53.0	—	1.67	—	78.8	3.0	—	5.01	May, 1980
		976	24132	61.0-66.5		0.52		24.3	5.5		2.84	May, 1980
	(Lower)	983	24141	60.0-65.0	—	0.16	—	7.61	5.0	—	0.81	May, 1980
		979	24137	81.0-100.0	—	.10	—	4.76	19.0	—	0.835	May, 1980
		981	24139	70.0-77.0	—	1.3	—	62.5	7.0	—	1.45	May, 1980
		977	24134	70.0-88.0	—	0.21	—	9.9	18.0	—	23.9	May, 1980
		991	23168	68.0-75.0	—	3.5	—	166.0	7.0	—	24.62	May, 1980
		E-39**	37387	36.7-42.66	4.2	4.5	199.0	212.0	5.88	24.75	26.39	ESE, 1988
	NBE#2	E-34	37376	40.30-51.00	2.9	2.3	138	109	12.0	35.19	27.61	ESE, 1988
		986	24146	52.0-62.0	—	0.30	—	14.2	10.0	—	3.01	May, 1980
		987	24147	75.0-90.0	—	4.3	—	202	14.0	—	59.8	May, 1980
		984	24142	45.0-53.0	—	1.2	—	58.6	8.0	—	9.94	May, 1980
		985	24144	40.0-58.0	—	8.9	—	419.0	18.0	—	159.94	May, 1980
4	NBW#3	E-38	37380	64.29-75.00	0.51	0.13	24.2	61.7	14.0	7.18	1.83	ESE, 1988
		E-39	37388	69.78-86.00	0.90	0.69	42.7	32.6	16.22	14.65	11.2	ESE, 1988
		E-40	37372	61.50-88.50	2.7	2.3	126.0	108.0	28.0	74.78	64.09	ESE, 1988
		978	23162	105.0-110.0	—	0.19	—	9.19	5.0	—	0.97	May, 1980
		991	23169	85.0-103.0		0.64		30.1	18.0		11.47	May, 1980
		885	23164	80.0-90.0	—	0.014	—	0.66	10.0	—	0.14	May, 1980
	NBE#3	984	24143	70.0-80.0	—	0.58	—	27.2	6.5	—	37.41	May, 1980

* Hydraulic conductivity values for May, 1980 results estimated by dividing screened aquifer thickness into transmissivity.
** Does not correlate with sandstone units.
— No slug in test was performed for these wells.

Source: ESE, 1988.

for zone 2 range from 0.160 to 1,022 gpd/ft and K values range from 0.041 to 260 gpd/ft^2. The minimum K value was determined from a slug test corresponding to Well 23227 which is located upgradient of NBCS and is screened in silty sandstone. The maximum K value corresponds to a slug test performed on Well 24135 which is screened in NBE#1. This relatively high value of K is likely to be the result of direct physical connection of unit NBE#1 with the alluvial aquifer at this location. In other instances, relatively high K values are indicative of flood basin crevasse-splay deposits. These deposits are typically coarser-grained at the base of the deposits and fine upward.

The results of the slug tests conducted at Well 23226 are of the same order of magnitude as the nearby pumping test conducted in zone 2 at Well 23176 by Black and Veatch (1980, RIC#81266R25). The average K value determined by Black and Veatch was 12 gpd/ft^2 and the average T value was 200 gpd/ft. Reanalysis of the pumping test data using the Jacob method for late drawdown data yielded similar results. However, Black and Veatch stated that the test was conducted in a very complex geologic area that could create boundary effects obscuring the test results. Thus, test results should be considered approximate because of these boundary conditions.

In the Offpost Operable Unit, T values in Denver Fm zone 3 range from 21.2 to 77.9 gpd/ft. K values range from 2.3 to 4.9 gpd/ft^2. The lowest K values were obtained from tests performed on Well 37376. This well is screened in silty sandstones on the margins of a main channel for zone 3. The highest value was obtained from a test performed on Well 37390. This well is screened over the entire aquifer in medium grained sandstone that is conglomeritic at the base of the deposit. The K values for offpost wells are of the same order of magnitude as the K value obtained by Black and Veatch (1980, RIC#81266R25) from a pumping test on Well 24154. The average K value obtained by Black and Veatch was 8.3 gpd/ft^2. K and T values obtained from slug tests conducted in units NBW#2 and NBE#2, that are within zone 3, are presented in Table 3.2-3.

In the Offpost Operable Unit, the T values obtained from slug tests for zone 4 range from 1.8 to 74.8 gpd/ft. K values range from 0.13 to 2.7 gpd/ft^2. The lowest K value in zone 4 corresponds to a slug test performed in Well 37380. This well is located about 800 ft downgradient of the RMA north boundary and about 2,500 ft west of D Street. The low K value is attributable to the fact that the well is screened in sandstone and clayey sandstone overbank deposits distal to a main fluvial channel of zone 4. The highest K value for zone 4 was determined from a slug test from Well 37372, which is screened in overbank deposits of hydrostratigraphic unit NBW#3. This relatively high K value of 2.7 gpd/ft^2 may be attributable to permeable sandstone lenses within the interbedded sequence, as identified in the bore log for this well (see Appendix C).

Vertical ground-water flow through confining layers between Denver Fm sandstones may also occur at RMA. As previously discussed, the Denver Fm consists of a complex system of interbedded sandstones and claystones. Ground-water flow within sandstones is predominantly in the lateral direction, although vertical migration of ground water through confining layers may also occur. Vertical ground-water flow rates associated with aquitard leakage depend upon the effective vertical hydraulic conductivity (K') of the aquitard materials as well as the vertical hydraulic gradient. Limited in-situ tests to measure vertical K' have been conducted in the Denver Fm because aquifer tests have focused on more permeable intervals of the Denver Fm that are considered the predominant media through which ground-water contamination will migrate. However, based on generic values and a pumping test performed near the NBCS, a probable range of values has been estimated. Each method used to estimate vertical hydraulic conductivity is subject to uncertainty and no single method can be considered diagnostic.

A pumping test performed near the NBCS at Denver Well 24154 (Black and Veatch, 1980, RIC#81266R25) was used to estimate vertical hydraulic conductivity for clayshale using the type-curve graphical method devised by Walton (1960) for a leaky artesian aquifer. The equation and method used to

estimate vertical hydraulic conductivity is presented in the Task 36 RI Report. A value of 4.1×10^{-5} ft/day was obtained using this approach. The confining layer between the alluvium and the sandstone unit that was tested was 20-ft thick.

Aquitards in the Denver Fm are composed of semiconsolidated clayshales and claystones. Typical horizontal hydraulic conductivities for these materials range from 3×10^{-2} to 3×10^{-4} ft/day (10^{-5} to 10^{-7} cm/sec) and the vertical hydraulic conductivities may be two orders of magnitude less than the horizontal hydraulic conductivity (Freeze and Cherry, 1979). Therefore, typical vertical hydraulic conductivities for these materials range from 3×10^{-4} to 3×10^{-6} ft/d (10^{-7} to 10^{-9} cm/s). The value obtained from the aquifer test falls within this range. If secondary permeability exists, the effective hydraulic conductivities may be significantly higher. However, there is no site hydraulic data upon which the effect of secondary permeability on in-situ hydraulic conductivity can be quantified.

3.2.2.5 Discharge

In the Offpost Operable Unit, water moving through the Denver Fm is discharged from the aquifer in two primary ways. First, discharge from the Denver Fm occurs through dewatering wells which pump water from the formation for domestic use in offpost areas, and locally as recharge to the alluvial aquifer. There are indications that recharge to the alluvium is occurring in the offpost area north and northwest of the RMA boundaries, and in localized subcrops upgradient of the boundaries. Based upon the regional dip of the Denver Fm, and geologic mapping done by Robson (1984), a significant portion of the Denver Fm is projected to subcrop in the Offpost Operable Unit and, thus, discharges to the alluvial aquifer in this area.

3.2.2.6 Aquifer Interactions

Local interactions between the alluvial aquifer and the Denver Fm are means by which the Denver Fm can potentially become contaminated. Understanding the potential for intraformational, vertical ground-water movement between Denver Fm sandstone units is important for assessing the potential for vertical contaminant migration within the Denver Fm. Water level data

obtained during the study, and presented in Table 3.2-4, have been used to assess the potential for flow between aquifers and are discussed in the following sections.

Alluvial Aquifer and Denver Fm Sandstone Unit Interactions

The potential for vertical ground-water movement between the alluvial aquifer and the Denver Fm was assessed by evaluating the differences in water elevations and water chemistry between wells at cluster sites. Lower water level elevations in wells screened within Denver Fm units as compared to elevations in the alluvial aquifer indicate a potential for the downwardmovement of water. Higher potentiometric levels in the Denver Fm units as compared to elevations in the alluvial aquifer indicate a potential for upward movement.

Downward gradients between the alluvial aquifer and the upper Denver Fm units were observed in the Offpost Operable Unit at clustered Wells 37374, 37379, and clustered Wells 37389, and 37390. Downward gradients averaging 0.14 and 0.06, respectively have been noted. Both of these cluster sites are located about 1,000 ft north of 96th Avenue in Sections 14 and 13, respectively. Downward gradients between the alluvial aquifer and the upper Denver Fm units were also observed at cluster site 37320 and 37321. This cluster site is located along 104th Avenue in Section 12. A slight upward vertical gradient exists between offpost alluvial Well 37370 and Denver Fm Well 37371. Well 37371 is screened in subcropping Denver Fm sandstone.

Denver Sandstone Units Interactions

In the Offpost Operable Unit and near the RMA boundaries, vertical gradients were generally downward between adjacent Denver Fm units. This implies that ground water within the upper Denver Fm sandstones in this area has the tendency to flow to lower units before ultimately discharging to the alluvium near subcrop areas. This potential for vertical ground-water movement between Denver Fm sandstone units was assessed by evaluating differences in water elevations between clustered wells constructed in adjacent sandstone units.

Table 3.2-4. Water Elevations For Well Cluster Sites in the Offpost Operable Unit.

Well Number	Denver Fm Zone	Equivalent Task 36 Denver Fm Unit	Water Elevations by Sampling Period		
			3rd Qtr FY87	4th Qtr FY87	Feb 1988
37313	All	All	5106.2	5102.7	5105.1
37317	4	***	5106.3	5104.7	5105.2
37316	5	***	5102.7	5102.4	5102.8
37320	All	All	5101.5	5101.5	*
37321	4	***	5100.3	5099.6	*
37322	5	***	5100.1	5099.6	*
37338	All	All	5129.7	5126.7	5130.3
37376	3	NBE#2	5129.8	5128.6	5128.8
37343	All	All	5106.4	5102.4	5105.4
37365	4	***	5105.6	5100.9	5104.4
37370	All	All	5110.4	5108.5	5109.6
37371	3	NBW#2	5110	5108.2	5109.6
37372	4	NBW#3	5109.1	5108.3	5109.3
37374	All	All	5108.9	5108.6	5108.8
37379	3	NBW#2	5107.3	5106.7	5107.3
37380	4	NBW#3	5106.8	5106.5	5106.8
37389	All	All	**	5123	5123.8
37390	3	NBW#2	**	5122.4	5123.3

All - Alluvial well.
* Water level not measured during this sampling period.
** Well not installed at the time of this sampling period.
*** Unable to correlate to Denver Fm unit.

Source: ESE, 1988.

Downward gradients between Denver Fm units are observed at clustered Wells 37371 and 37372 and clustered Wells 37379 and 37380. These sites are located approximately 1,000 ft north of 96th Avenue in Section 13 and 14, respectively. Downward gradients averaging 0.05 ft/ft have been noted at wells that are screened in units NBW#2 and NBW#3, respectively.

3.2.3 ARAPAHOE FM

The Arapahoe Fm underlies the Denver Fm in the Offpost Operable Unit. The top of the Arapahoe Fm is approximately 250 to 300 ft below ground surface at the RMA north and northwest boundaries and subcrops about 3 miles downgradient of the boundary in the Offpost Operable Unit near the South Platte River. The base of the Denver Fm is taken as the top of a "buffer zone" that consists of 50 to 100 ft of clayshale at the top of the Arapahoe Fm. This clayshale provides hydraulic separation between the Arapahoe and Denver Fm aquifer systems (Romero, 1976, RIC#81266R69).

Water bearing zones in the formation are restricted to sandstone lithologies that are lenticular in nature. These lenses are irregularly distributed within thick clayshale sequences. They are discontinuous and therefore, difficult to trace, and are poorly defined where sandstones grade into encompassing clay and shale. Sandstone lenses range in thickness from a few centimeters to as much as 20 m. Ground-water flow occurs within void spaces between coarser sand grains in sandstones, while little water is able to flow through finer silt and mud components of clay and shale.

Water from the Arapahoe Fm has proven to be a reliable source of good to excellent quality water and is tapped by about 6,000 wells in the Denver basin. Well yields range from 100 to 500 gpm. Of these wells, 90 percent are used for stock and domestic use. The aquifer is used by some 130 municipal wells, including those of the Cities of Westminster and Arvada. A structure contour map of the top of the Arapahoe Fm in the Denver area was presented by Stollar and Van Der Leeden (1981, RIC#81293R05). At RMA, depth to the Arapahoe decreases from about 700 ft below land surface along the southern boundary of RMA to about 300 ft along the northwest boundary.

Pumping test data indicate that the transmissivity of Arapahoe Fm aquifers range from 80 to 3,600 gpd/ft. High values occur where the wells penetrate thick sections of sandstone. A tentative estimate of natural recharge (including vertical leakage) to the Arapahoe-Denver sequence in the entire Denver Basin is about 100 mgd. As estimated pumpage from these aquifers is close to 150 mgd, it is clear that an imbalance exists. Ground water has been taken from storage within the aquifers resulting in a water-level decline of 100 to 200 ft in the Denver metropolitan area (Stollar and Van Der Leeden, 1981, RIC#81293R05).

Recharge to the water-bearing formations to the Arapahoe Fm is from both natural and artificial sources. Natural recharge is from precipitation (11 to 17 inches per year) on the outcrop area, infiltration of surface water in fault zones and stream valleys, and vertical leakage from confining beds. Artificial recharge is from leaking water-storage reservoirs and infiltration of sewage effluent, irrigation, and industrial water.

Studies carried out by the Colorado Division of Water Resources and the USGS show that aquifers in the Arapahoe Fm are artesian: that is, in all wells, the water level rises above the bottom of the upper confining bed. Regional ground-water flow in the Arapahoe Fm is generally from south to north. The natural ground-water flow pattern in the formation has been modified as a result of artificial discharge from numerous wells. Pumping of large quantities of water has led to considerable potentiometric decline in the major aquifers. In the metropolitan area, both the Laramie-Fox Hills and the Dawson Group (Arapahoe and Denver Fm) have experienced declines in head ranging from 100 to 600 ft. However, according to Romero (1976, RIC#81266R69), the aquifers have not lost their capacity to deliver large quantities of water to wells, and some additional water-level decline can be tolerated.

The basin-wide ground-water flow in the Arapahoe Fm is north/northwest, but there are several cones of depression south of RMA which affect the flow system (Robson, 1984). Below RMA, the potentiometric surface of the

Arapahoe Fm in 1978 appeared to be at an elevation of 5,000 to 5,100 ft, but heads were 100 ft lower in the Aurora-Denver area, reflecting local pumpage (Stollar and Van Der Leeden, 1981, RIC#81293R05). It should be noted that no Arapahoe observation wells exist at RMA and potentiometric maps were prepared from a limited number of control wells. However, it seems likely that water in the Arapahoe moves west below the RMA and then north or south in response to hydraulic gradients.

3.3 GROUND-WATER CONTAMINATION

As part of the RI, a program for ground-water quality monitoring of the alluvial and Denver Fm aquifers has been conducted for the Offpost Operable Unit. In addition, water quality in the alluvial aquifer, Denver Fm, and Arapahoe Fm has been historically monitored with private domestic wells. The monitoring networks for the alluvium and Denver Fm were described in Section 2.1.1 of this report, and methods used for analyses of ground-water samples were presented in Section 2.1.3. Water chemistry data for this task were obtained for the spring and summer sampling quarters of 1987. The results of these chemical analyses are provided in Appendix F.

This section of the report has been organized to present a summary of the distribution and concentrations of target analytes detected in the Offpost Operable Unit. Discussion of contaminant distribution will generally be limited to the spring and summer 1987 quarters. A separate discussion has been provided for the alluvial and Denver Fm aquifers. An evaluation of the relationship between chemical distributions in the alluvium and observed chemical distributions in the Denver Fm is presented at the end of this section.

During the Consumptive Use-Phase I investigation, there were 19 Arapahoe wells sampled (ESE, 1987, Offpost CAR, RIC#87202R01). Analytical results from Consumptive Use-Phase I were presented in the RMA Offpost Assessment Ground-Water Quality Report for Sampling Period December 1984 through January 1985 (ESE, 1985). Only two of these samples, collected from Wells 2-67-10-03 and 2-67-11-20, exhibited detectable levels of organic compounds. In both samples, the only organic compound detected was DIMP at concentrations of 5.2 and 11.9 ug/l, respectively. An evaluation of the

specific conductivity of the two samples suggested a mixing of alluvial and bedrock water. The field sampling team also recorded that the well casings were in poor condition which may have led to a mixing of water before sampling.

3.3.1 NATURE AND EXTENT OF ALLUVIAL AQUIFER CONTAMINATION

Over the last several years, significant efforts have been undertaken to describe the nature and the extent of offpost alluvial aquifer contamination north and northwest of RMA. Several monitoring wells north of RMA have been monitored routinely since 1978. Monitoring has also been performed as part of Operational Assessment Reports to evaluate the concentrations and distribution of specific contaminants downgradient of the NBCS and NWBCS (Thompson et al., 1985, RIC#86078R01). The contaminants evaluated in these studies were generally confined to DIMP, DBCP, DCPD, combined organosulfur compounds, endrin, aldrin, dieldrin, chloride, and fluoride. The Offpost CAR (ESE, 1985, RIC#87202R01) incorporated an offpost monitoring network of more than 40 monitoring wells and examined an expanded analyte list. This study provided the most comprehensive assessment of contamination in the offpost area to date. This study also incorporated data from the Consumptive Use Phase I and II programs (ESE, 1985 and ESE, 1986b) which identified private wells and their use. This data has been used in the EA to evaluate potential exposure pathways.

An evaluation of alluvial contamination described in the Offpost CAR (ESE, 1985, RIC#87202R01) delineates some overall patterns in the Offpost Operable Unit. The inferred offpost alluvial aquifer flow paths can be seen by examining the distribution of DIMP as presented in Figure 3.3-1. This figure was presented in the Offpost CAR and represents data from the Consumptive Use--Phase I and II and Revision III-360° programs. DIMP was chosen as a good delineator of the extent of contamination and contaminant flow paths because it is the most widespread and one of the most mobile organic contaminants detected in the Offpost Operable Unit.

Results of this study indicated a zone of DIMP contamination northwest from the RMA north boundary toward Henderson. A comparison with the bedrock surface map indicated an excellent correlation between contaminant

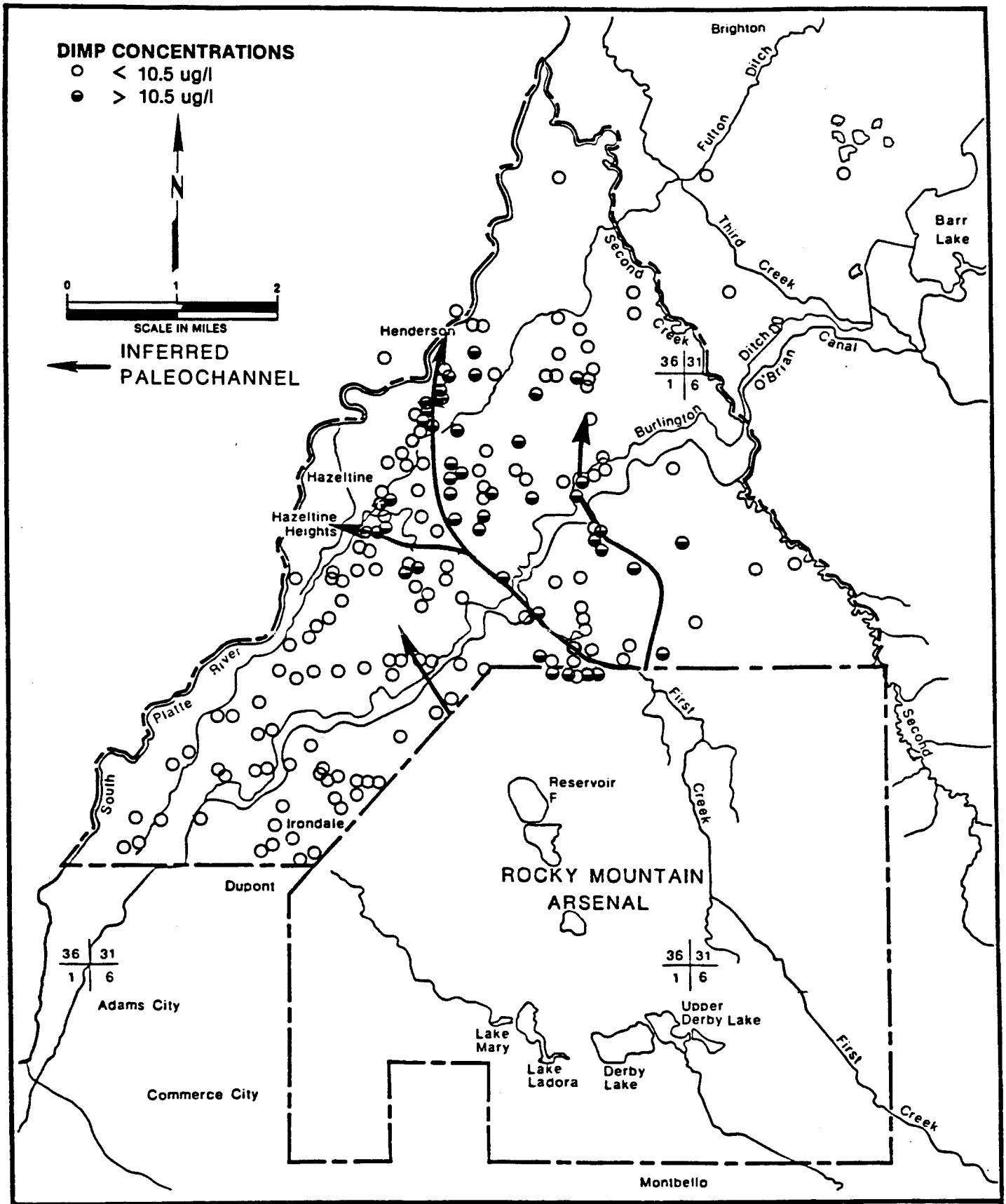


Figure 3.3-1
DIMP ASSESSMENT IN ALLUVIAL WELLS FOR CONSUMPTIVE USE-PHASE I AND II AND REVISION III-360° PROGRAMS
SOURCE: ESE, 1986

Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

concentrations exceeding CRLs and a paleochannel which is clearly traced from the RMA north boundary along First Creek (First Creek pathway). A second alluvial migration pathway was implied north from the RMA north boundary through Section 13 toward the "Boller" well (Northern pathway). The "Boller" well was documented as contaminated with several RMA contaminants, including DIMP, DBCP, and organosulfur compounds, as part of the Offpost CAR. However, the number of wells monitored in Section 13 prior to this study was not sufficient to determine the specific migration pathway to the "Boller" well. The Offpost CAR documented some movement of DIMP from RMA along the northwest boundary, but the highest onpost concentrations in the area upgradient of the NWBCS were generally just in excess of CRLs.

Offpost detections of volatile organohalogens, organochlorine pesticides, organosulfur compounds, DBCP, and DCPD were also documented in the Offpost CAR. An indication of the distribution of these contaminants can be obtained by examining the figures contained in Appendix I. These figures represent the first and second quarters of sampling from the Revision III - 360° Monitoring Program (ESE, 1986c, RIC#87016R05) conducted during December 1985 and January 1986, and March 1986 and April 1986, respectively. Review of contaminant distributions indicated that the most significant contamination offpost of RMA was found within 0.5 mi of the RMA north boundary. Other contamination was detected near the RMA northwest boundary. Detections of volatile organohalogens, organochlorine pesticides, organosulfur compounds, and DBCP were also noted as much as 1.5 mi beyond the RMA north boundary. However, it was not clear if all detections of volatile organohalogens and organochlorine pesticides were attributable to RMA.

Several volatile organohalogen plumes were identified by the EPA in the area south of 80th Avenue (EPA, 1987). The contaminants noted in the area included dichloroethane, trans-1,2-dichloroethylene, trichloroethane, trichloroethylene, and tetrachloroethylene. A distinctive higher concentration plume of trichloroethylene and other volatiles is present in the vicinity of the main north-south trending bedrock paleochannel that

extends from the South Adams county well field at 77th Street to south of 48th Avenue. Several of these plumes appear to extend north of 80th Avenue and into the Offpost Operable Unit.

Currently, several investigations are underway to evaluate potential sources south of the Offpost Operable Unit. These investigations include the Sand Creek Industrial site RI/FS Phase II activities, the EPA-FIT source identification studies (at E. 48th Avenue and Leyden, E. 50th Avenue and Ivy, I-270 and Quebec, and 56th and Magnolia) and Chem Sales, Inc. investigations (EPA, 1987). Work is also still in progress on the Western Study Area Report which is addressing potential trichlorethylene sources at RMA. A draft final version of the Western Study Area Report will be available early in 1989.

The Irondale Boundary Control System (ICS) was constructed in 1981 to mitigate the migration of a DBCP plume that historically extended through Section 33 and into the Offpost Operable Unit. The most recent monitoring downgradient of the ICS, conducted during the Consumptive Use Phase III program (ESE, 1987f), did not detect the presence DBCP. Because there are several other potential sources for the volatile organic compounds detected in this area, the study of this contamination falls under the jurisdiction of the EPA per an Executive Order signed in 1982.

The monitoring program for the Offpost Operable Unit RI has been developed to evaluate the extent and nature of contamination to the north and northwest of RMA (Figure 2.1-1). Most of the emphasis of this program has been placed on delineating the contaminant distributions along the known or suspected alluvial pathways downgradient of the RMA north boundary. This is primarily because of offpost contaminants which migrated from the RMA north boundary prior to the implementation of the NBCS. Wells have also been installed downgradient of the NWBCS to monitor the potential for migration of contaminants in this area. Specifically, the following objectives have been established for the RI ground-water monitoring in the Offpost Operable Unit:

- To further delineate the concentrations and distribution of contamination along the First Creek pathway offpost;

- o To determine the concentrations and extent of target analytes along the inferred Northern pathway toward the "Boller" well;
- o To monitor the water chemistry downgradient of the NWBCS to delineate the potential for contaminant migration in this area; and
- o To evaluate whether nontarget compounds are present in the Offpost Operable Unit.

3.3.1.1 Data Presentation

A discussion of the chemical distribution of observed target analytes or groups of organic compounds in the alluvial aquifer of the Offpost Operable Unit is presented in this section. A listing of the frequency of detection and range of concentrations for target analytes during the spring and summer 1987 sampling quarters is provided in Tables 3.3-1 and 3.3-2, respectively. All data presented in Tables 3.3-1 and 3.3-2 are for alluvial wells in the Offpost Operable Unit.

Quality Assurance (QA) and Quality Control (QC) data obtained during this task are presented and discussed in Section 5.3. Generally, duplicate data yielded results within the precision QC acceptance criteria for the Applicable EPA methods (EPA, 1985).

For ease of interpretation and summarization of ground-water chemistry, chemical distribution maps have been prepared for the spring and summer 1987 quarters. These maps represent the distribution of target analytes and were prepared by plotting the concentration of analytes exceeding laboratory CRLs. Isoconcentration lines were used to illustrate areas of elevated concentrations of target analytes observed in the ground water in the Offpost Operable Unit. The CRL contour on these maps represents the highest CRL for a given quarter. Maps were extended approximately one mile onpost to provide a means of assessing the effects of the NBCS and NWBCS on offpost contaminant migration.

Individual chemical distribution maps were prepared for the following target analytes, which were frequently observed in samples from the alluvial aquifer in the Offpost Operable Unit:

Table 3.3-1. Frequency of Detection and Range of Concentrations for Target Analytes--Spring 1987 (Page 1 of 2)

Analyte	Number of Sample Concentrations Exceeding CRLs	Range of Concentrations (ug/l)**
DIMP	28	10.1 - 2170
DMMP	0	<16.3
DBCP	7	0.130 - 10.6
DCPD	5	9.31 - 475
MIBK	0	<12.9
CPMSO2	8	2.24 - 32.6
CPMSO	11	1.98 - 148
CPMS	4	1.08 - 4.16
1,4-Dithiane	5	1.10 - 19.3
1,4-Oxathiane	1	1.36 - 5.1
DMDS	0	<1.80
Benzothiazole	0	<2.00
Organochlorine Pesticides*		
Dieldrin	14	0.0540 - 1.62
Endrin	3	0.0520 - 1.51
Aldrin	0	<0.0700
Isodrin	0	<0.0560
p,p'-DDE	1	0.046 - 0.113
p,p'-DDT	1	0.059 - 0.110
Hexachlorocyclopentadiene	0	<0.083
Chlordane	0	<0.152
Volatile Organohalogens*		
Chloroform	17	1.40 - 1370
Tetrachloroethylene	15	1.30 - 115
Trichloroethylene	11	1.20 - 7.06
1,2-Dichloroethane	8	0.610 - 18.2
Chlorobenzene	30	0.580 - 27.3
Carbon tetrachloride	1	1.70 - 9.88
Trans-1,2-Dichloroethylene	1	1.20 - 1.26
1,1-Dichloroethylene	0	<1.85
1,1-Dichloroethane	1	1.20 - 2.31
1,1,1-Trichloroethane	2	1.10 - 9.59
1,1,2-Trichloroethane	0	<1.63
Methylene chloride	1	2.50 - 9.97
Volatile Aromatics*		
Benzene	14	1.34 - 15.1
Toluene	0	<2.10
Ethylbenzene	1	0.620 - 1.42
m-Xylene	1	1.04 - 1.14
o,p-Xylene	1	1.34 - 1.94

Table 3.3-1. Frequency of Detection and Range of Concentrations for Target Analytes--Spring 1987 (Page 2 of 2)

Analyte	Number of Sample Concentrations Exceeding CRLs	Range of Concentrations (ug/l)**
Inorganics*		
Chloride	57	31,800 - 2,020,000
Fluoride	39	1,000 - 4,230
Arsenic	9	2.50 - 6.20
Sulfate	56	54,400 - 2,180,000
Additional Inorganics***		
Calcium	46	36,200 - 600,000
Potassium	36	1,260 - 16,000
Sodium	46	57,400 - 1,060,000
Magnesium	46	7,410 - 400,000
Nitrate	45	59.6 - 10,300
Zinc	28	20.1 - 161
Cadmium	1	5.16 - 8.58
Lead	2	18.5 - 24.5
Chromium	1	5.96 - 52.4
Copper	5	7.90 - 26.7
Mercury	0	<0.48

* A total of 57 alluvial wells were sampled and 56 samples were analyzed.
** Lowest concentration of listed range corresponds to lower of two certified reporting limits if values less than the CRL were observed. When all values less than CRL the higher CRL is listed
*** A total of 47 alluvial wells were sampled and analyzed.

Source: ESE, 1988

Table 3.3-2. Frequency of Detection and Range of Concentrations for Target Analytes--Summer 1987 (Page 1 of 2)

Analyte	Number of Sample Concentrations Exceeding CRLs	Range of Concentrations (ug/l)**
DIMP	29	10.1 - 3850
DMMP	0	<16.3
DBCP	7	0.130 - 13.3
DCPD	6	9.31 - 529
MIBK	0	<12.9
CPMSO2	7	2.24 - 39.3
CPMSO	12	1.98 - 135
CPMS	2	1.08 - 3.28
1,4-Dithiane	5	1.10 - 11.0
1,4-Oxathiane	3	1.35 - 4.40
DMDS	0	<1.80
Benzothiazole	0	<2.00
Organochlorine Pesticides*		
Dieldrin	16	0.0540 - 1.02
Endrin	4	0.0520 - 0.411
Aldrin	0	<0.0700
Isodrin	0	<0.0560
p,p'-DDE	0	<0.0700
p,p'-DDT	2	0.059
Hexachlorocyclopentadiene	0	<0.0700
Chlordane	0	<0.152
Volatile Organohalogens*		
Chloroform	20	1.40 - 1180
Tetrachloroethylene	16	1.30 - 112
Trichloroethylene	8	1.10 - 7.71
1,2-Dichloroethane	8	0.610 - 5.28
Chlorobenzene	30	0.580 - 21.9
Carbon tetrachloride	0	<2.40
Trans-1,2-Dichloroethylene	0	<1.80
1,1-Dichloroethylene	1	1.10 - 2.67
1,1-Dichloroethane	1	1.20 - 1.95
1,1,1-Trichloroethane	2	1.10 - 29.4
1,1,2-Trichloroethane	0	<1.63
Methylene chloride	0	<5.00
Volatile Aromatics*		
Benzene	2	1.34 - 3.98
Toluene	0	<2.10
Ethyl benzene	0	<1.28
m-Xylene	0	<1.35
o,p-Xylene	0	<2.47

Table 3.3-2. Frequency of Detection and Range of Concentrations for Target Analytes--Summer 1987 (Page 2 of 2)

Analyte	Number of Sample Concentrations Exceeding CRLs	Range of Concentrations (ug/l)**
Inorganics*		
Chloride	60	37,300 - 1,990,000
Fluoride	41	1,000 - 4,650
Arsenic	10	2.50 - 5.80
Sulfate	60	51,000 - 2,020,000
Additional Inorganics***		
Calcium	50	32,000 - 668,000
Potassium	47	1,110 - 9,430
Sodium	50	49,100 - 1,220,000
Magnesium	50	6,800 - 174,000
Nitrate	47	57.1 - 10,700
Zinc	29	20.1 - 152
Cadmium	12	5.16 - 9.50
Lead	15	18.6 - 44.2
Chromium	34	5.96 - 45.7
Copper	5	7.94 - 44.7
Mercury	1	0.24 - 0.36

* A total of 60 alluvial wells were sampled and 60 samples were analyzed.
** Lowest concentration of listed range corresponds to lower certified reporting limit if values less than the CRL were observed.
*** A total of 50 wells were sampled and analyzed.

Source: ESE, 1988

- DIMP;
- DBCP;
- DCPD;
- CPMSO;
- CPMSO2;
- 1,4-Dithiane;
- 1,4-Oxathiane;
- Dieldrin;
- Endrin;
- Chloroform;
- Trichloroethylene;
- Tetrachloroethylene;
- 1,2-Dichloroethane;
- Chloride;
- Fluoride;
- Sulfate;
- Calcium;
- Potassium;
- Sodium;
- Magnesium;
- Nitrate; and
- Zinc.

The spring and summer 1987 chemical distribution maps for these target analytes are provided in Appendix F. For compounds or groups of compounds that exhibit limited numbers of detections or widely dispersed detections and for which contouring is not appropriate, concentration point plots are provided. The following compounds are presented on point plots in Appendix F with concentrations posted for detections exceeding the CRL:

- CPMS;
- Organochlorine pesticides (p,p'-DDE, p,p'-DDT, aldrin, isodrin);
- Chlorobenzene;
- Volatile organohalogens (Carbon tetrachloride, trans-1,2-dichloroethylene, 1,1-dichloroethylene, 1,1-dichloroethane, 1,1,1-trichloroethane, 1,1,2-trichloroethane, methylene chloride;
- Benzene;

- o Volatile aromatics (ethylbenzene, m-xylene, sum of o-xylene and p-xylene);
- o Arsenic and mercury;
- o Cadmium;
- o Lead;
- o Chromium; and
- o Copper.

The chemical distribution maps for calcium, cadmium, potassium, sodium, magnesium, nitrate, lead, chromium, copper, zinc, and mercury are shown only for the Offpost Operable Unit because these analytes were not incorporated into the analyte schedule for onpost boundary monitoring programs. Full size contaminant distribution maps, that incorporate the entire Offpost Operable Unit, are available upon request. These maps were not included in the report because they are bulky and contaminant concentrations were generally below CRLs outside the area shown in the smaller maps provided in this report. Several target organic analytes were not observed at concentrations exceeding CRLs in samples from wells in the Offpost Operable Unit. These organic compounds are:

- o DMMP;
- o MIBK;
- o DMDS;
- o Benzothiazole;
- o Aldrin;
- o Isodrin;
- o Hexachlorocyclopentadiene;
- o Chlordane;
- o 1,1,2-Trichloroethane; and
- o Toluene.

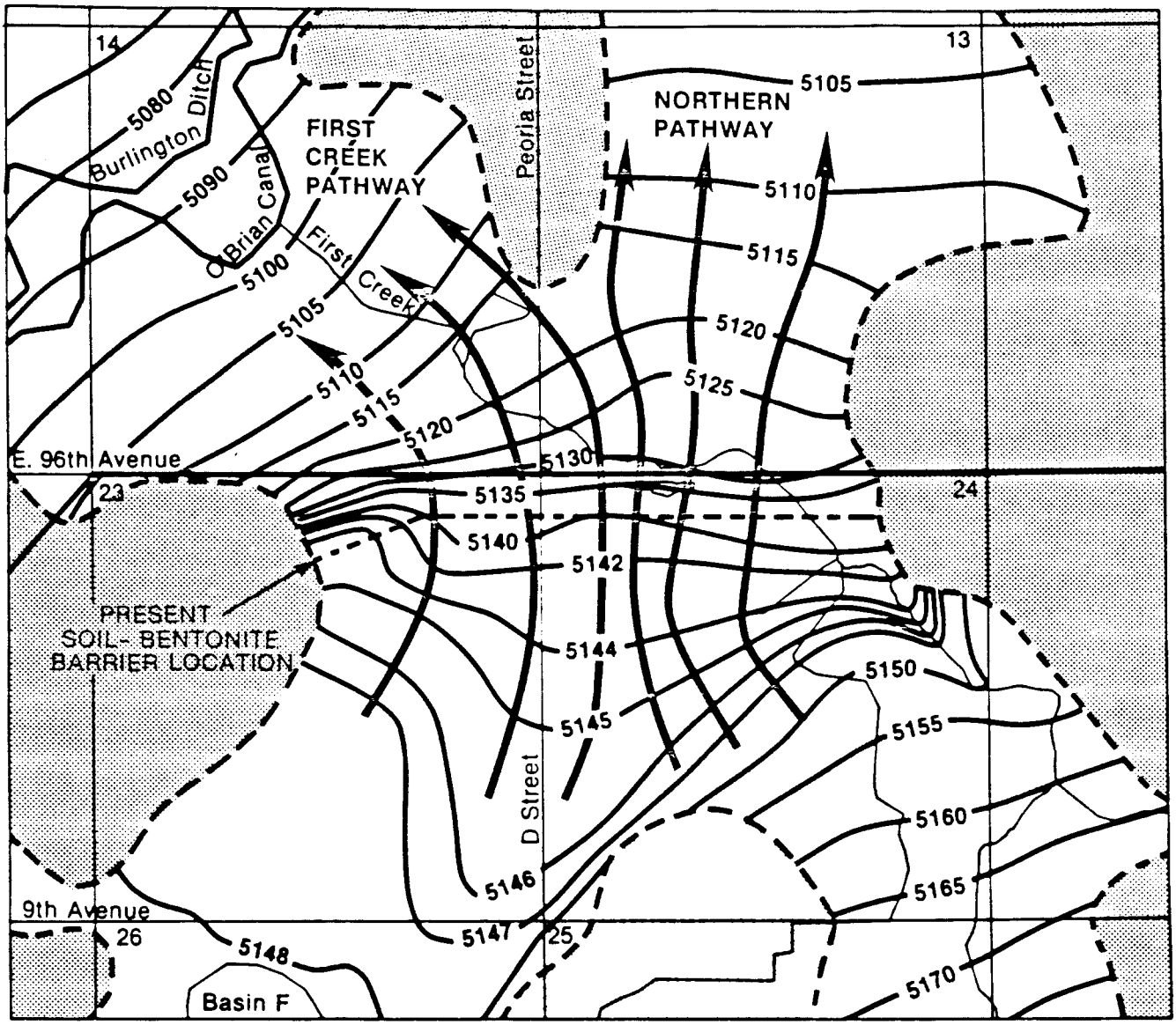
Aldrin was observed at concentrations exceeding CRLs in analyses from a previous sampling episode conducted during 1985, 1986, and the Winter 1987 Quarter (March, April 1987). Offpost data from the Winter Quarter and previous sampling quarters will be provided in the forthcoming Water Remedial Investigation Report (WRIR). Although aldrin will not be discussed further here, it will be addressed in the EA. A preliminary review of GC/MS

screening data collected during the summer of 1986 is presented in the Final Screening Program (ESE, 1988a, RIC#88034R03) for several monitoring wells in the Offpost Operable Unit. The results of GC/MS analyses conducted on offpost samples collected during the summer of 1987 will be presented in the forthcoming WRIR. An evaluation of offpost GC/MS data from these two programs has been provided in Section 3.3.4.

A review of the contaminant distribution maps depicts some general contaminant trends in the Offpost Operable Unit and onpost near the RMA boundaries. Onpost, a pattern of contaminant distribution extends from the vicinity of Sections 26 and 36 to the north and northeast across 9th Avenue and then north to the NBCS. The distribution of the different contaminants vary with their particular sources and migration characteristics. Generally, contaminants appear to have followed the alluvial flow paths depicted in the February and March 1978 water table map presented in Figure 3.3-2. It is also evident that the paleochannel feature, inferred from bedrock surface maps, which trends northeast from the area of Section 26 to the NBCS exercises a significant influence on the overall migration patterns (see Figure 3.1-6). The contaminants observed along this onpost pathway include, but are not limited to: DIMP; DCPD; DBCP; organosulfur compounds; 1,4-oxathiane; 1,4-dithiane; 1,2-dichloroethane; chloroform; dieldrin; and endrin.

In the offpost area downgradient of the NBCS, contaminants have been observed along the two distinct alluvial pathways described in the Offpost CAR (ESE, 1987a, RIC#87202R01). The first of these pathways corresponds to the inferred paleochannel feature in the bedrock surface, which is located along First Creek and the flow along this pathway is to the northwest from the RMA north boundary towards O'Brian Canal, as shown in Figure 3.3-1. Contaminants observed along this pathway are DIMP; DCPD; 1,4-oxathiane; 1,4-dithiane; organosulfur compounds; 1,2-Dichloroethane; and dieldrin.

Along the second pathway, ground-water flow is directed from the RMA north boundary to the north through the central portion of Section 13. This pathway is referred to as the Northern pathway, as shown in Figure 3.3-1.



EXPLANATION

- Unsaturated Alluvium
- 5140 — Water Level Contour (Feet Above MSL), In Intervals Of 5 Feet
- Alluvial Flow Pathways

N

0 1000 2000

Scale In Feet

Figure 3.3-2
GENERALIZED PRE-SYSTEM ALLUVIAL FLOW PATHWAYS (FEBRUARY-MARCH, 1978 WATER TABLE)
SOURCE: Modified from CARR, 1987

Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

Organic contaminants observed along this pathway include: DIMP; DBCP; chloroform; tetrachloroethylene; organosulfur compounds; and dieldrin. These two alluvial flow paths are separated offpost by an area of unsaturated alluvium which is present in the northeast quadrant of Section 14 and northwest quadrant of Section 13. Contaminants that were observed at the "Boller" well are believed to have migrated along this alluvial pathway.

Onpost, organic contaminant migration toward the NWBCS has generally been limited to DIMP, chloroform, DBCP, endrin, chlorobenzene, and dieldrin. In general, the concentrations of these compounds are orders of magnitude less than concentrations observed upgradient of the NBCS. In the offpost area downgradient of the NWBCS, well samples exhibiting relatively low concentrations of chloroform and dieldrin were noted. These were the primary organic contaminants noted in this offpost area to the northwest.

Contaminant concentrations in samples collected downgradient of O'Brian Canal and Burlington Ditch in the Offpost Operable Unit are generally an order of magnitude less than contaminant concentrations just upgradient of O'Brian Canal and closer to the RMA boundaries. Contaminant concentration declines are most likely attributable to the diluting effects of infiltration from the canals and irrigation activities northwest of Burlington Ditch and downgradient from the NBCS. A brief discussion of the concentrations and distributions of each analyte or group of analytes detected in the Offpost Operable Unit area is provided below.

3.3.1.2 DIMP

In the offpost area, downgradient of the NBCS, DIMP follows the two distinct alluvial pathways described previously. Concentrations observed from well samples collected along the Northern pathway were generally higher in samples from wells located over one-half mile north of the NBCS than in samples from wells located along 96th Avenue. The highest concentrations observed in samples from wells along this pathway were noted at Wells 37344 and 37391 at concentrations exceeding 1,000 ug/l. Concentrations from well samples collected along the First Creek pathway ranged from less than

100 ug/l to 3,850 ug/l at well 37313. Downgradient of Burlington Ditch the highest DIMP concentration was observed at Well 37349 during the spring 1987 sampling quarter at a concentration of 456 ug/l. This well is downgradient of the highest DIMP concentrations noted offpost and was inferred to be along an extension of the First Creek paleochannel feature in the Offpost CAR (ESE, 1987a, RIC#87202R01). An evaluation of historical DIMP data for offpost wells will be addressed in Section 3.3.3.

DIMP concentrations observed in well samples collected immediately downgradient of the NBCS were generally less than those observed in upgradient samples. The highest levels of DIMP detected in samples from downgradient wells along 96th Avenue were found west of D Street, with concentrations exceeding 500 ug/l. East of D Street, DIMP was observed at a concentration exceeding CRLs in only one well sampled along 96th Avenue. This sample was collected form Well 24161, which is approximately 500 ft east of D Street. Lower DIMP concentrations immediately downgradient of the NBCS relative to upgradient concentrations and concentrations further offpost, indicate that the NBCS has begun to reduce offpost DIMP concentrations.

DIMP was generally not observed at concentrations exceeding CRLs in the offpost area downgradient of the NWBCS. However, a concentration of 12.0 ug/l was observed in a sample from Well 37386 which is located along the RMA northwest boundary.

3.3.1.3 DBCP

In the offpost area, downgradient of the NBCS, concentrations of DBCP exceeding CRLs appear to be primarily confined to sampled wells located east of D Street along the Northern pathway. Concentrations were higher in downgradient samples collected over one-half mile north of the NBCS than in those collected near 96th Avenue. Samples collected from wells located in the middle and eastern portion of Section 13 exhibited concentrations exceeding 4.00 ug/l compared to concentrations less than 1.00 ug/l in samples collected near 96th Avenue. The highest concentration of DBCP was observed in a sample from Well 37344 at 13.3 ug/l. DBCP was generally not observed at concentrations exceeding CRLs in samples collected along the

First Creek pathway. DBCP was also not observed at concentrations exceeding CRLs in samples from wells downgradient of the NWBCS or in the area downgradient of O'Brian Canal.

Historically, a DBCP plume extended through Section 33 and offpost into Sections 28 and 29. The ICS was installed in 1981 to prevent the migration of DBCP across the RMA boundary. Extensive monitoring conducted downgradient of the ICS in 1986 and 1987 during the Consumptive Use Phase III Program (ESE, 1987f) did not indicate the presence of detectable levels of DBCP in this area. Also, monitoring of wells downgradient of the ICS during the RI do not indicate that DBCP persists in this area. As discussed previously, full size chemical distribution maps which include the area downgradient of the ICS are available upon request.

3.3.1.4 DCPD

In the offpost area, downgradient of the NBCS, DCPD concentrations in samples from wells located along 96th Avenue were generally less than CRLs. Samples from only one well along 96th Avenue, Well 24161, exhibited a concentration of DCPD exceeding CRLs. Further downgradient, concentrations exceeding 500 ug/l were observed in samples from wells located along the First Creek pathway, but no DCPD was observed at concentrations exceeding CRLs in samples collected from wells along the Northern pathway. The highest concentration of 529 ug/l was observed in a sample from Well 37309 which is about one-quarter mile north of the RMA north boundary along Peoria Street. DCPD was not observed at concentrations exceeding CRLs in samples collected from wells in the area downgradient of O'Brian Canal. DCPD was also not observed at concentrations exceeding CRLs in the offpost area downgradient of the NWBCS.

3.3.1.5 Organosulfur Compounds

CPMSO

CPMSO was the most frequently observed organosulfur compound in the Offpost Operable Unit. In the offpost area downgradient of the NBCS, CPMSO concentrations were highest in well samples collected along the Northern

pathway and more than one-half mile downgradient of the 96th Avenue. The highest concentration was observed in samples from Well 37391 at 148 ug/l. Concentrations just exceeding 100 ug/l were observed in samples from Well 37344 located more than a mile downgradient of 96th Avenue along the Northern pathway.

Concentrations of CPMSO in samples from wells located along the First Creek pathway were generally less than 10.0 ug/l. Also, concentrations observed in samples from wells along 96th Avenue were generally less than CRLs. CPMSO was not observed at concentrations exceeding CRLs wells sampled downgradient of the NWBCS or in the area downgradient of O'Brian Canal.

CPMSO2

CPMSO2 was observed at concentrations exceeding CRLs in samples collected from wells along both the First Creek and Northern pathways. The highest concentrations of CPMSO2 was observed in a sample from Well 37309 at 39.3 ug/l. Concentrations in samples from other wells long both pathways generally ranged from less than CRLs to 15 ug/l.

The highest offpost concentrations of CPMSO2 were noted in samples collected about one-quarter mile downgradient of the RMA north boundary. Samples collected closer to the RMA north boundary or further downgradient generally exhibited lower CPMSO2 concentrations. CPMSO2 was not observed at concentrations exceeding CRLS in wells samples collected in wells along the NWBCS or in the area downgradient of O'Brian Canal.

CPMS

CPMS was the least frequently detected organosulfur compound in the Offpost Operable Unit. The highest offpost concentration of CPMS was observed in a sample from Well 37367 at 4.16 ug/l. This well is located along the Northern pathway and about one mile north of the RMA north boundary. CPMS was not observed at concentrations exceeding CRLs in samples from wells along the First Creek pathway. CPMS was also not observed at concentrations exceeding CRLs in samples collected downgradient of the NWBCS or in the area downgradient of O'Brian Canal.

3.3.1.6 1,4-Dithiane and 1,4-Oxathiane

In the offpost area, downgradient of the NBCS, 1,4-dithiane concentrations exceeding 10.0 ug/l were observed in well samples collected about a half-mile downgradient of the NBCS along the First Creek pathway. 1,4-Dithiane was generally not observed at concentrations exceeding CRLs in samples collected from wells along the Northern pathway. Only one concentration of 1,4-dithiane was noted greater than CRLs in samples from wells along 96th Avenue. This detection was from a sample collected from Well 24161 at a concentration just exceeding 2.00 ug/l. 1,4-Dithiane was not observed at concentrations exceeding CRLs in samples collected from wells downgradient of the NWBCS or in the area downgradient of O'Brian Canal.

1,4-Oxathiane was only observed sporadically in offpost samples collected donwgradient of the RMA north boundary. Concentrations exceeding CRLs were not observed in samples from wells along the Northern pathway. Samples from these wells along the First Creek pathway exhibited 1,4-oxathiane concentrations exceeding CRLs. The highest concentration of 5.10 ug/l observed in a sample from Well 37373. 1,4-Oxathiane was not observed at concentrations exceeding CRLs in samples collected downgradient of the NWBCS or in the area downgradient of O'Brian Canal.

3.3.1.7 Organochlorine Pesticides

Dieldrin and endrin were the most frequently detected organochlorine pesticides in the Offpost Operable Unit. A summary of the concentrations and distribution of these two analytes and the other organochlorine pesticides is discussed below.

Dieldrin

Detections of dieldrin in samples collected offpost and downgradient of the NBCS were generally confined to the area immediately downgradient of the system. Dieldrin was noted in samples collected from wells along the Northern pathway and over one-half mile downgradient of the NBCS. The highest concentration along this pathway was observed in a sample from Well 37320 at 0.14 ug/l. Concentrations of dieldrin exceeding CRLs noted in samples from wells along the First Creek pathway were generally observed within one-half mile downgradient of the RMA north boundary. However, a

detection of dieldrin, at a concentration of 0.0861 ug/l, was noted in a sample from offpost Well 37313 which is approximately one mile downgradient of the NBCS.

Dieldrin was also noted in samples collected downgradient of the NWBCS at concentrations exceeding CRLs. Concentrations in samples collected along the RMA northwest boundary generally ranged from less than CRLs to values exceeding 1.00 ug/l. Concentrations of dieldrin exceeding CRLs were also noted downgradient of O'Brian Canal. There appears to be a correlation between dieldrin concentrations immediately downgradient of the NWBCS and concentrations observed downgradient of O'Brian Canal at Wells 37336 and 37337. However, concentrations observed in samples from Wells 37336 and 37337 were less than 0.10 ug/l.

Dieldrin was also observed at concentrations exceeding CRLs at Wells 37355 and 37353 which are more than a mile and a half downgradient of RMA. Dieldrin contamination at these wells does not correlate well with upgradient concentrations that are attributable to RMA.

Endrin

In the offpost area downgradient of the NBCS, endrin was observed at concentrations exceeding CRLs within one-half mile of the RMA boundary. Endrin was generally observed in samples collected from wells along the First Creek pathway. The highest offpost concentration of 1.51 ug/l was observed in a sample from Well 37312 which is located along the RMA north boundary.

Endrin was observed in one sample collected from Well 37392 which is located along the Northern pathway. The concentration in this sample was 0.234 ug/l. Endrin was not observed at concentrations exceeding CRLs in samples collected downgradient of the NWBCS or in the offpost area downgradient of O'Brian Canal.

p,p'-DDE and p,p'-DDT

p,p'-DDE was observed at a concentration exceeding CRLs in only one sample collected from the offpost monitoring network. This concentration of 0.113 ug/l was observed in a sample from Well 37373 which is about one-half mile downgradient of the RMA north boundary along the First Creek pathway.

p,p'-DDT was observed at concentrations exceeding CRLs in three samples from the offpost network. Two of these detections were observed in samples from Wells 37373 and 37369 which are along the First Creek pathway and within one-half mile of the RMA north boundary. The concentrations of p,p'-DDT in these samples were 0.110 ug/l and 0.081 ug/l, respectively, The other observed concentrations of p,p'-DDT was noted in a sample from Well 37391 at 0.148 ug/l. Well 37391 is about one-half mile downgradient of the RMA north boundary along the Northern pathway.

3.3.1.8 Volatile Organohalogens

In the Offpost Operable Unit, chloroform, tetrachloroethylene, trichloroethylene, 1,2-Dichloroethane, and chlorobenzene were the most frequently observed volatile organohalogens in alluvial ground-water samples. The concentrations and distribution of the analytes and the other volatile organohalogens observed are summarized below.

Chloroform

In the offpost area, downgradient of the NBCS, chloroform concentrations exceeding 100 ug/l were detected in samples from wells located over a half-mile downgradient of the NBCS along the Northern pathway. Detections of chloroform from samples collected offpost along the First Creek pathway were generally less than 10.0 ug/l. Concentrations of chloroform in samples from wells along 96th Avenue were generally less than concentrations further downgradient, with the highest concentrations of over 10.0 ug/l occurring in samples from wells just east of D Street.

Chloroform was observed at concentrations exceeding CRLs downgradient of O'Brian Canal. The highest concentration of 24.3 ug/l was observed in a sample from Well 37357 which is more than 3 miles downgradient of the RMA north boundary. Chloroform concentrations in this area are downgradient of

chloroform noted in samples from the "Boller" well and Well 37344 which are located along the Northern pathway. Thus, these chloroform detections may be the result of migration along the Northern pathway.

Chloroform was also observed in offpost samples collected downgradient of the NWBCS. The highest concentrations were observed in samples collected from wells along the RMA northwest boundary and generally ranged from about 10.0 ug/l to 20.0 ug/l. Further to the northwest, in the area downgradient of O'Brian Canal, chloroform was observed at concentrations ranging from 5.0 ug/l to 10.0 ug/l in samples from Well 37336. This well is about one mile downgradient of the NWBCS.

Tetrachloroethylene

In the offpost area, downgradient of the NBCS, tetrachloroethylene concentrations ranged from less than 10.0 ug/l from well samples collected along 96th Avenue to over 50.0 ug/l from wells sampled along the Northern pathway over one-half mile north of the NBCS. The highest offpost concentration of tetrachloroethylene was observed in a sample from Well 37344 at 115 ug/l. Concentrations of tetrachloroethylene in samples collected from wells along the First Creek pathway were generally less than 10.0 ug/l.

Tetrachloroethylene was not observed at concentrations exceeding CRLs in samples collected downgradient of the NWBCS. Isolated concentrations of tetrachloroethylene less than 4.0 ug/l were observed in samples collected in the offpost area downgradient of O'Brian Canal, but these observed concentrations did not exhibit an apparent spatial correlation with tetrachloroethylene contamination noted closer to the RMA north boundary.

Trichloroethylene

In the offpost area downgradient of the NBCS, trichloroethylene was not observed at concentrations exceeding CRLs in samples collected from wells along 96th Avenue. Isolated concentrations of trichloroethylene exceeding CRLs were noted in samples from wells located beyond 1,000 ft downgradient of the NBCS along the Northern pathway. The highest concentrations of 7.71 ug/l was observed in Well 37344 which is over a mile downgradient of

the RMA north boundary. Trichloroethylene was generally not noted at concentrations exceeding CRLs in samples from wells along the First Creek pathway or downgradient of the NWBCS.

Isolated concentrations of trichloroethylene ranging from 5.13 ug/l to 6.56 ug/l were noted in samples from Well 37359 which is just north of 80th Avenue in the offpost area. Ground-water flow directions in this area suggest that this contamination could be attributable to the northward migration of contaminants through Commerce City. Also, an isolated concentration of 2.12 ug/l was noted in the summer 1987 sample from Well 37355. This well is located north of 104th Avenue near Hazeltine Heights.

1,2-Dichloroethane

In the offpost area, downgradient of the NBCS, concentration from wells sampled along 96th Avenue were generally less than CRLs. Concentrations of 1,2-Dichloroethane exceeding CRLs were noted in offpost samples from wells located along the First Creek pathway and wells along the Northern pathway. The highest offpost concentration of 18.2 ug/l, was observed in a sample from Well 37373, located along the First Creek pathway.

The only concentrations exceeding CRLs observed in samples collected along the Northern pathway were from Well 37391 at concentrations less than 3.0 ug/l. 1,2-Dichloroethane was not observed at concentrations exceeding CRLs in samples collected downgradient of the NWBCS or in the area downgradient of O'Brian Canal.

Chlorobenzene

In the offpost area downgradient of the NBCS, chlorobenzene was consistently observed in samples collected from wells along the First Creek pathway and the Northern pathway. The highest chlorobenzene concentration was 27.3 ug/l, in a sample from Well 37370. Concentrations of chlorobenzene exceeding CRLs offpost, however, did not exhibit an apparent spatial correlation with onpost concentrations near the NBCS.

Chlorobenzene was consistently observed at samples collected offpost and downgradient of the NWBCS at concentrations ranging from 1.0 to 7.0 ug/l.

Chlorobenzene was also observed sporadically in samples collected in the area downgradient of O'Brian Canal at concentrations generally less than 3.0 ug/l.

Carbon Tetrachloride

Carbon tetrachloride was observed in only one offpost sample at a concentration exceeding CRLs. This concentration of 9.88 ug/l was observed in the spring 1987 sample from Well 37344, which is over 1 mile downgradient of the RMA north boundary along the Northern pathway.

Trans-1,2-dichloroethylene

Trans-1,2-dichloroethylene was observed in only one offpost sample in a concentration exceeding CRLs. This concentration of 1.26 ug/l was observed in the spring 1987 sample from Well 37359 which is located about one-half mile north of 80th Avenue in the offpost area.

1,1-Dichloroethane

1,1-Dichloroethane was observed in only one sample from the offpost network at a concentration exceeding CRLs. This concentration of 2.67 ug/l was observed in a sample from Well 37355 which is located in the southeast quadrant of Section 9, about 2 miles downgradient of the RMA north boundary.

1,1,1-Trichloroethane

1,1,1-Trichloroethane was observed in samples from two offpost wells at concentrations exceeding CRLs. These observed concentrations were from samples collected from Wells 37355 and 37359 which are located about 2 miles downgradient of RMA in Section 9 and 29, respectively. Concentrations in samples from Well 37355 ranged from 9.59 ug/l to 29.4 ug/l. Concentrations in samples from Well 37359 ranged from 3.70 to 4.54 ug/l.

Methylene Chloride

Methylene chloride was observed at concentrations exceeding CRLs in only one sample collected from the offpost monitoring network. This concentration of 9.96 ug/l was observed in a sample from Well 37352 which is located about 2 mi downgradient of the RMA north boundary in Section 10.

3.3.1.9 Volatile Aromatics

Benzene

Benzene was the most frequently observed volatile aromatic in samples obtained from the Offpost Operable Unit. Concentrations of benzene were noted in samples collected along both the Northern pathway and the First Creek pathway. Concentrations of benzene observed in offpost samples were generally less than 10.0 ug/l but a concentration of 15.1 ug/l was noted in a sample from Well 37392. Concentrations of benzene exceeding CRLs in Denver Fm samples were more consistently observed and will be discussed in Section 3.3.2. Benzene was only sporadically observed at concentrations exceeding CRLs in the offpost area downgradient of the NWBCS. Generally, these concentrations were less than 5.0 ug/l.

Ethyl Benzene and m-,o-,p- Xylene

Ethyl benzene, m-xylene, and o,p-xylene (sum of o-xylene and p-xylene) were each observed in one offpost sample at concentrations exceeding CRLs. Each of these contaminants was observed in the spring 1987 sample from Well 37392. The ethyl benzene, m-xylene, and o,p-xylene concentrations in this sample were 1.42, 1.14, and 1.94 ug/l, respectively.

3.3.1.10 Inorganics

Several inorganic analytes have been observed in ground water samples from the Offpost Operable Unit. Many of these analytes are naturally occurring ground water constituents in the area of RMA. The background concentrations for each constituent in uncontaminated wells are dependant upon the aquifer sampled. Some indication of background concentrations of ground water constituents can be obtained by examining the water chemistry from wells located upgradient of RMA.

For this study, inorganic chemistry data were evaluated in samples from five upgradient alluvial wells to provide an indication of background inorganic concentrations. The results of these analyses are summarized in Table 3.3-3. It is apparent by comparing concentrations of inorganic analytes in the Offpost Operable Unit with those concentrations in upgradient wells that the concentrations of certain analytes are elevated above upgradient levels. On the other hand, the concentrations of many of the inorganic constituents are

Table 3.3-3. Representative Concentrations For Naturally Occurring Constituents in Upgradient Alluvial Wells (Values are in µg/l).

Analyte	Well Number 37366			Alluvial Well (Approximately 0.5 miles south east of RMA)**	Well Number***			Well Number+					Range From Upgradient Wells
	Spring 1986	Spring 1987	Summer 1987		12001	11001	08002	01021	02011	03002	06003	12002	
Chloride	46,700	45,200	46,900	*	34,000	52,000	60,000	58,700	79,300	34,700	73,100	102,000	34,000 - 102,000
Fluoride	<1,200	<1,200	<1,220	1,000	690	570	960	1,220	<1,220	<1,200	<1,220	<1,220	570 - <1,220
Sulfate	138,000	106,000	98,700	48,000	63,000	132,000	43,000	83,100	187,000	49,000	220,000	149,000	43,000 - 220,000
Calcium	139,000	137,000	121,000	51,000	67,000	139,000	112,000	85,000	120,000	67,100	77,600	95,900	51,000 - 139,000
Potassium	5,560	3,850	4,680	*	*	*	*	2,850	4,110	3,740	4,010	4,540	3,740 - 5,560
Sodium	108,000	127,000	131,000	36,000	44,000	68,000	60,000	65,500	86,700	38,000	106,000	82,900	36,000 - 131,000
Magnesium	23,200	25,600	23,300	9,200	*	*	*	17,100	24,600	8,450	27,200	19,300	8,450 - 27,200
Nitrogen	6,670	7,240	8,080	8,300	3,500	700	22,900	1,600	7,370	6,970	2,500	3,810	700 - 22,900
Zinc	112	72.0	<20.1	*	*	*	*	<20.1	<20.1	<40.2	111	29.5	<20.1 - 112
Cadmium	<5.20	<5.16	<5.16	*	*	*	*	<5.16	<5.16	<5.16	<5.16	<5.16	<5.20
Lead	<18.5	<18.6	<18.6	*	*	*	*	<18.6	<18.6	<37.2	<18.6	<18.6	<18.6 - <37.2
Chromium	<6.00	*	18.2	*	*	*	*	10.8	11.1	<5.96	17.3	17.1	<5.96 - 18.2
Copper	<7.94	<7.94	<7.94	*	*	*	*	<7.94	<7.94	<7.94	<7.94	<7.94	<7.94
Arsenic	<3.9	<3.9	*	*	*	*	*	<2.50	<2.50	<2.50	<2.50	<2.50	<2.50
Mercury	<0.240	<0.240	<0.240	*	*	*	*	<0.359	<0.359	<0.359	<0.359	<0.359	<0.359

* Not analyzed.
** Irrigation well, 70 ft deep, in T35 R66W, Section 17 (McConaghy et al., 1964).
*** Alluvial wells near southern boundary of RMA, samples collected 1975 and 1976 (Army, RIC#82160R12).
\+ Alluvial wells near southern boundary of RMA, samples collected spring 1987 (ESE)

Source: ESE, 1988.

within the range of concentrations observed in upgradient wells. A brief discussion of the concentrations and distribution of each inorganic constituent and a comparison to upgradient concentrations is provided below.

Chloride

Alluvial aquifer chloride concentrations in samples collected from wells in the Offpost Operable Unit generally exceeded background concentrations. An approximate background concentration can be estimated in samples from upgradient wells as listed in Table 3.3-3. These samples generally exhibited chloride concentrations of 40,000 to 50,000 ug/l. In the offpost area downgradient of the NBCS, concentrations of chloride were of similar magnitude to those observed in samples collected immediately upgradient of the system. The highest offpost concentrations of chloride were noted in samples downgradient of the western end of the NBCS and along the First Creek pathway. The highest offpost concentrations, at levels exceeding 1,000,000 ug/l, were observed in samples from Well 37313.

Chloride concentrations in samples collected along the Northern pathway also appeared to be elevated above upgradient levels with concentrations generally ranging from 100,000 ug/l to 500,000 ug/l. The highest concentrations along this pathway were present in well samples collected in the western portion of Section 13.

Chloride concentrations in the offpost area downgradient of the NWBCS were also generally greater than upgradient levels. In samples collected from wells directly downgradient of the NWBCS, concentrations generally ranged from 200,000 ug/l to 700,000 ug/l. The highest concentration of chloride in this area was observed in a sample from Well 37332 at 714,000 ug/l.

In samples collected from the offpost area downgradient of O'Brian Canal, chloride concentrations generally ranged from 30,000 ug/l to 250,000 ug/l. The highest concentrations downgradient of O'Brian Canal were observed in samples collected from wells downgradient of the highest concentrations near the RMA boundaries.

Fluoride

Background concentrations of fluoride can be approximated from water quality data obtained from samples collected from upgradient wells as listed in Table 3.3-3. The range of fluoride concentrations observed in these samples was 570 ug/l to 1,000 ug/l.

Downgradient of the NBCS, the highest concentrations of fluoride exceeded 4,000 ug/l. These concentrations were noted in samples collected downgradient of the extreme western end of the NBCS and offpost, in the western portion of Section 14. Concentrations from well samples collected along the First Creek pathway generally ranged from 2,000 to 4,000 ug/l. Concentrations of fluoride along the Northern pathway generally ranged from 1,200 ug/l to 3,000 ug/l with the highest concentrations observed in samples collected form the western portion of Section 13 and Section 12.

In samples collected in the offpost area downgradient of the NWBCS, concentrations generally ranged from less than 1,200 ug/l to values exceeding 3,500 ug/l. Fluoride concentrations in samples collected in the area downgradient of O'Brian Canal ranged from less than 1,200 ug/l to 2,000 ug/l.

Sulfate

Concentrations of sulfate in wells upgradient of RMA ranged from 43,000 ug/l to 138,000 ug/l. Sulfate concentrations in samples collected downgradient of the NBCS were greater than upgradient concentrations. Concentrations in samples along the First Creek pathway generally ranged from 500,000 ug/l to values exceeding 2,000,000 ug/l. The highest concentration observed in a sample from the Offpost Operable Unit was 2,180,00 ug/l from Well 37339, which is just downgradient of the RMA north boundary in Section 14.

Sulfate concentrations in samples from the offpost area downgradient of the NWBCS were generally just above upgradient concentrations with values ranging from about 50,000 ug/l to 300,000 ug/l. Sulfate concentrations observed in samples collected downgradient of O'Brian Canal were generally within the range of concentrations observed in samples collected upgradient of RMA.

Calcium

Calcium concentrations observed in samples collected upgradient of RMA ranged from 51,000 ug/l to 139,000 ug/l. In the offpost area downgradient of the NBCS, samples generally exhibited calcium concentrations ranging from 100,000 ug/l to 350,000 ug/l. Higher concentrations were generally observed in samples collected along the First Creek pathway when compared to samples collected along the Northern pathway. The highest calcium concentration in a sample collected in the Offpost Operable Unit was 668,000 ug/l from Well 37339 which is just downgradient of the NBCS in Section 14.

Calcium concentrations in samples collected directly downgradient of the NWBCS were generally less than 100,000 ug/l. Calcium concentrations in samples from the offpost area downgradient of the O'Brian Canal were generally within the range of concentrations observed in samples collected upgradient of RMA.

Potassium

Potassium concentrations in samples from wells in the Offpost Operable Unit were generally within the range of concentrations (3,850 to 5,560 ug/l) observed in well samples collected upgradient of RMA. Concentrations exceeding the range of background concentrations were generally observed in samples from only two offpost wells. Samples from these wells, Wells 37313 and 37338, exhibited potassium concentrations of 12,300 ug/l and 16,000 ug/l, respectively during the spring 1987 sampling period.

Sodium

Sodium concentrations in well samples collected upgradient of RMA ranged from 36,000 ug/l to 131,000 ug/l. Concentrations in samples from the offpost area downgradient of the NBCS were generally greater than the highest upgradient concentrations. Concentrations in samples collected along the First Creek pathway generally ranged from 250,000 ug/l to 1,000,000 ug/l. The highest sodium concentration observed in an offpost sample was noted from Well 37339 at 1,20,000 ug/l. Concentrations in samples collected from wells along the Northern pathway were generally less than those along the First Creek pathway with concentrations generally ranging from about 150,000 ug/l to 3,150,000 ug/l.

Sodium concentrations in samples form the offpost area downgradient of the NWBCS were generally greater than the highest concentrations observed in samples collected upgradient of RMA. Concentrations in samples from this area generally ranged from about 75,000 ug/l to 500,000 ug/l. Sodium concentrations in samples collected in the area downgradient of O'Brian Canal were generally within the range of concentrations observed in upgradient well samples.

Magnesium

Magnesium concentrations in samples from wells upgradient of RMA ranged from 9,200 ug/l to 25,600 ug/l. In offpost samples collected in areas downgradient of the NBCS, magnesium concentrations generally exceeded this range of upgradient levels. The highest concentrations, generally ranging from 50,000 ug/l to 175,000 ug/l, were observed in samples collected along the First Creek pathway. Concentrations observed in samples collected along the Northern pathway were only slightly greater than the range of upgradient levels and generally averaged about 50,000 ug/l. Magnesium concentrations in samples collected in the areas downgradient of the NWBCS and O'Brian Canal were generally within the range of upgradient sample concentrations.

Nitrate

Nitrate concentrations in samples from wells within the Offpost Operable Unit were within the range of concentrations (700 ug/l to 22,900 ug/l) observed in upgradient well samples. The highest nitrate concentration was observed in the summer 1987 sample from Well 37357 at 10,700 ug/l. Samples form this well exhibited the only nitrate concentrations exceeding 10,000 ug/l.

Zinc

Zinc concentrations in samples from upgradient wells ranged from less than 20.1 ug/l to 112 ug/l. Zinc concentrations in samples from wells in the Offpost Operable Unit were generally within this range, with most sample concentrations less than 100 ug/l. The highest concentration of zinc was observed in a sample from Well 37339 at 152 ug/l.

Cadmium

Cadmium was not observed at concentrations exceeding 5.20 ug/l in well samples collected upgradient of RMA. Cadmium was observed only sporadically in samples from the Offpost Operable Unit at concentrations exceeding the CRL of 5.16 ug/l. The highest cadmium concentration of 9.50 ug/l was observed in a sample from well 37339 during the summer 1987 sampling. With the exception of samples from Well 37339, all observed cadmium concentrations were less than 6.0 ug/l.

Lead

Lead concentrations in samples from wells upgradient of RMA were less than the CRL of 18.6 ug/l. In samples from the Offpost Operable Unit during the spring 1987 sampling quarter, only two samples exhibited concentrations exceeding the CRL. These concentrations were observed in samples from Wells 37314 and 37355 at 23.3 ug/l and 24.5 ug/l, respectively. During the summer 1987 sampling quarter, 15 samples exhibited lead concentrations exceeding the CRL. The majority of concentrations exceeding the CRL were noted in samples collected along the First Creek pathway and in samples from areas downgradient of O'Brian Canal. The majority of the observed concentrations were less than 40.0 ug/l, but the highest concentration of 44.2 ug/l was observed in a sample from Well 37313.

Chromium

Chromium concentrations in samples from wells upgradient of RMA ranged from less than 6.00 ug/l to 18.2 ug/l. Although only two concentrations exceeding the CRL of 5.16 ug/l were noted in spring 1987 samples, 34 samples from the summer 1987 sampling quarter exhibited chromium concentrations exceeding the CRL. The majority of chromium concentrations were less than 20.0 ug/l, but a high concentration of 45.7 ug/l was observed in the sample from Well 37374.

Copper

Copper concentrations observed in upgradient wells were less than the CRL of 7.94 ug/l. In samples from the Offpost Operable Unit, copper was observed at concentrations exceeding the CRL in five samples from both the spring

1987 and summer 1987 sampling quarters. The concentrations of copper were sporadically observed with no apparent spatial distribution pattern noted. In fact, the observed concentrations during the spring 1987 quarter were from different wells than the observed concentrations during the summer 1987 quarter. The highest concentration of 41.3 ug/l was observed in the summer 1987 sample from Well 37332.

Arsenic

Arsenic was not observed at concentrations exceeding CRLs in samples from wells upgradient of RMA. Concentrations of arsenic exceeding CRLs were sporadically observed in well samples collected from the Offpost Operable Unit. Downgradient of the NBCS, collected samples exhibited concentrations of arsenic from less than CRLs to a concentration 3.65 ug/l observed from Well 37373.

Generally, higher arsenic concentrations were noted in samples collected downgradient of the NWBCS. The highest concentration observed in this area was 5.80 ug/l in a sample from Well 37332. Average concentrations of arsenic in samples collected downgradient of O'Brian Canal were generally less than CRLs. However, the highest arsenic concentration observed in samples collected in the Offpost Operable Unit was noted in Well 37364 at 6.2 ug/l. This well is over 3 miles downgradient of RMA along the South Platte River.

Mercury

Mercury was not observed at concentrations exceeding 0.24 ug/l in well samples collected upgradient of RMA. In the Offpost Operable Unit, the only observed concentration of mercury exceeding the CRL was a concentration of 0.36 ug/l in the summer 1987 sample from Well 37342.

3.3.2 NATURE AND EXTENT OF DENVER AQUIFER CONTAMINATION

The evaluation of Denver Fm contamination in this report was conducted by examining water chemistry data from an offpost monitoring network that incorporates 16 wells, as shown in Figure 2.1-4. The objectives of this assessment was formulated primarily to address issues not evaluated by previous studies. Some of the major objectives were:

- To characterize Denver Fm ground-water quality in contaminated areas near the RMA north boundary;
- To assess whether Denver Fm sandstone units are acting as contaminant migration pathways which bypass the NBCS; and
- To characterize the nature and extent of aquifer contamination in Denver Fm aquifers which may potentially discharge to the alluvial aquifer in areas downgradient of the RMA north boundary.

3.3.2.1 Data Presentation

Contaminant point plots were constructed for Denver Fm hydrostratigraphic units and sandstone units near the NBCS to illustrate the types and concentrations of contaminants detected during the study. The following analytes will be presented on a point plot map for each Denver Fm unit with concentrations posted for values exceeding CRLs:

- DIMP;
- DBCP;
- DCPD;
- CPMS;
- CPMSO;
- 1,4-Dithiane;
- 1,4-Oxathiane;
- Dieldrin;
- Endrin;
- Aldrin;
- Chlorobenzene;
- Chloroform;
- Trichloroethylene;
- Tetrachloroethylene;
- 1,2-Dichloroethane;
- Methylene chloride;
- Benzene;
- Ethylbenzene;
- m-Xylene;
- o,p-Xylene (sum of o-xylene and p-xylene);
- Fluoride;

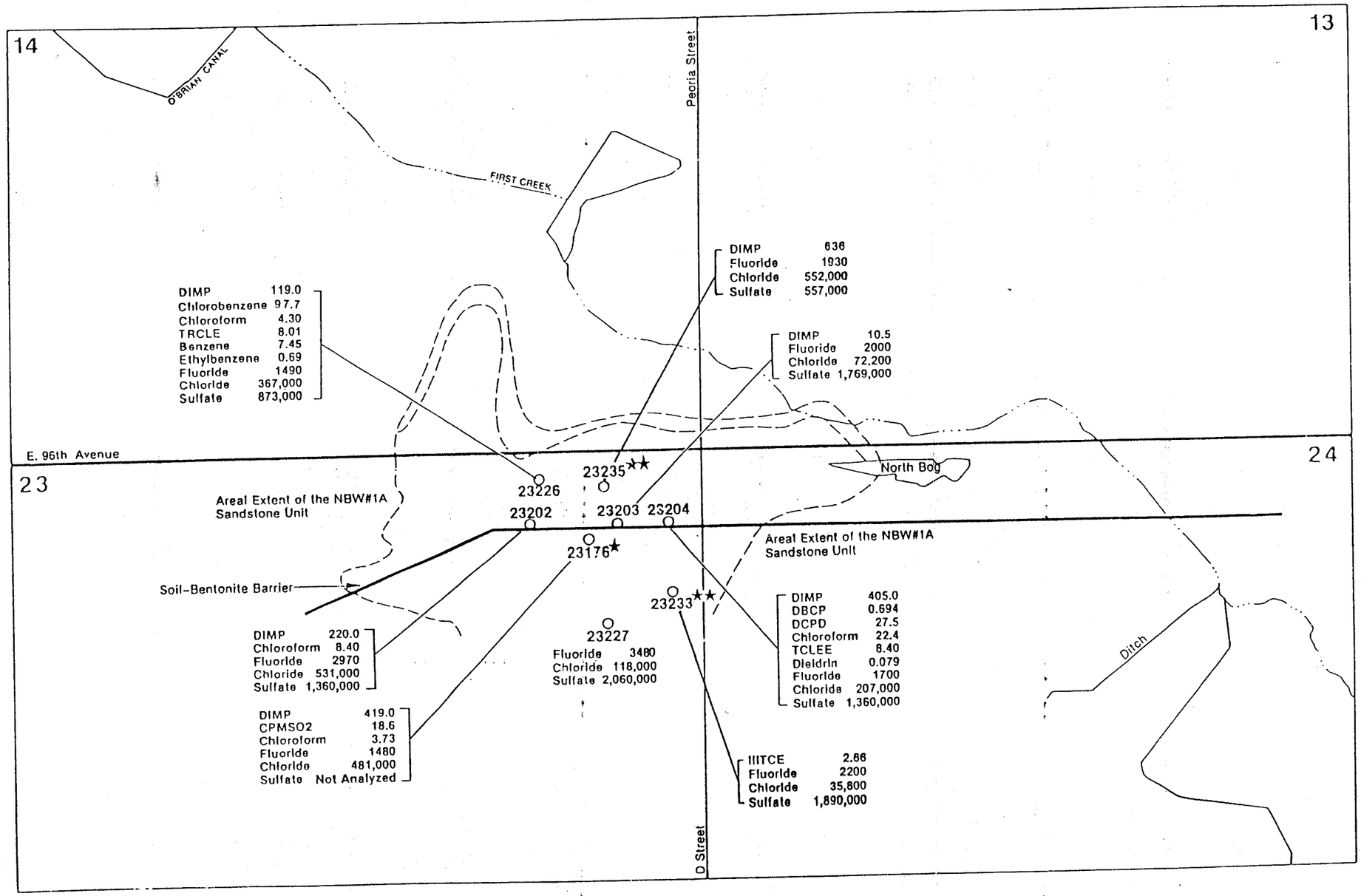
- o Chloride;
- o Sulfate; and
- o Arsenic.

These analytes were the only contaminants detected at concentrations exceeding CRLs in samples obtained from the Denver Fm in the Offpost Operable Unit during the spring and summer 1987 sampling quarters.

Because of the availability of data, the discussion of the nature and extent of Denver Fm contamination focuses on the offpost area north of RMA. Denver Fm monitoring wells north of RMA have generally been completed in the uppermost sandstone units at each site. These sandstone units have been correlated to units NBW#2 and NBW#3 at the NBCS. A summary of the concentrations and distribution of the primary contaminants in units NBW#2 and NBW#3 is provided in this section . No wells have been completed in units NBW#1A and NBW#1 in the Offpost Operable Unit north of RMA. However, since these units are projected to subcrop in the Offpost Operable Unit, the onpost contaminant concentrations within these units will also be discussed in this section.

The summer 1987 contaminant point plots for units NBW#1A and NBW#2, which correlate to Denver Fm zones 2 and 3, respectively, have been included in this section and are shown in Figures 3.3-3 and 3.3-5, respectively. The spring 1987 contaminant point plots for units NBW#1A and NBW#2 are provided in Appendix F. The spring and summer 1987 contaminant point plots for unit NBW#1, which correlates to Denver Fm zone 2, is shown in Figure 3.3-4. The spring and summer 1987 contaminant point plots for unit NBW#3 and sandstone units NBE#2, NBE#3, and NBE#4 are provided in Appendix F.

Shown in Figure 3.3-6 are the spring and summer 1987 contaminant point plots for Denver Fm wells located in the Offpost Operable Unit that were not correlated to the sandstone units identified at the NBCS. A discussion of the nature of contaminants detected in samples from these wells will be discussed separately at the end of this section. A summary of the concentrations and distribution of the primary contaminants observed in Denver Fm units correlated to units at the NBCS is provided below.



EXPLANATION

★ Initial Screening Program (ISP) Data.

★★ Sampled In March, 1988.

All concentrations in micrograms per liter (ug/l).

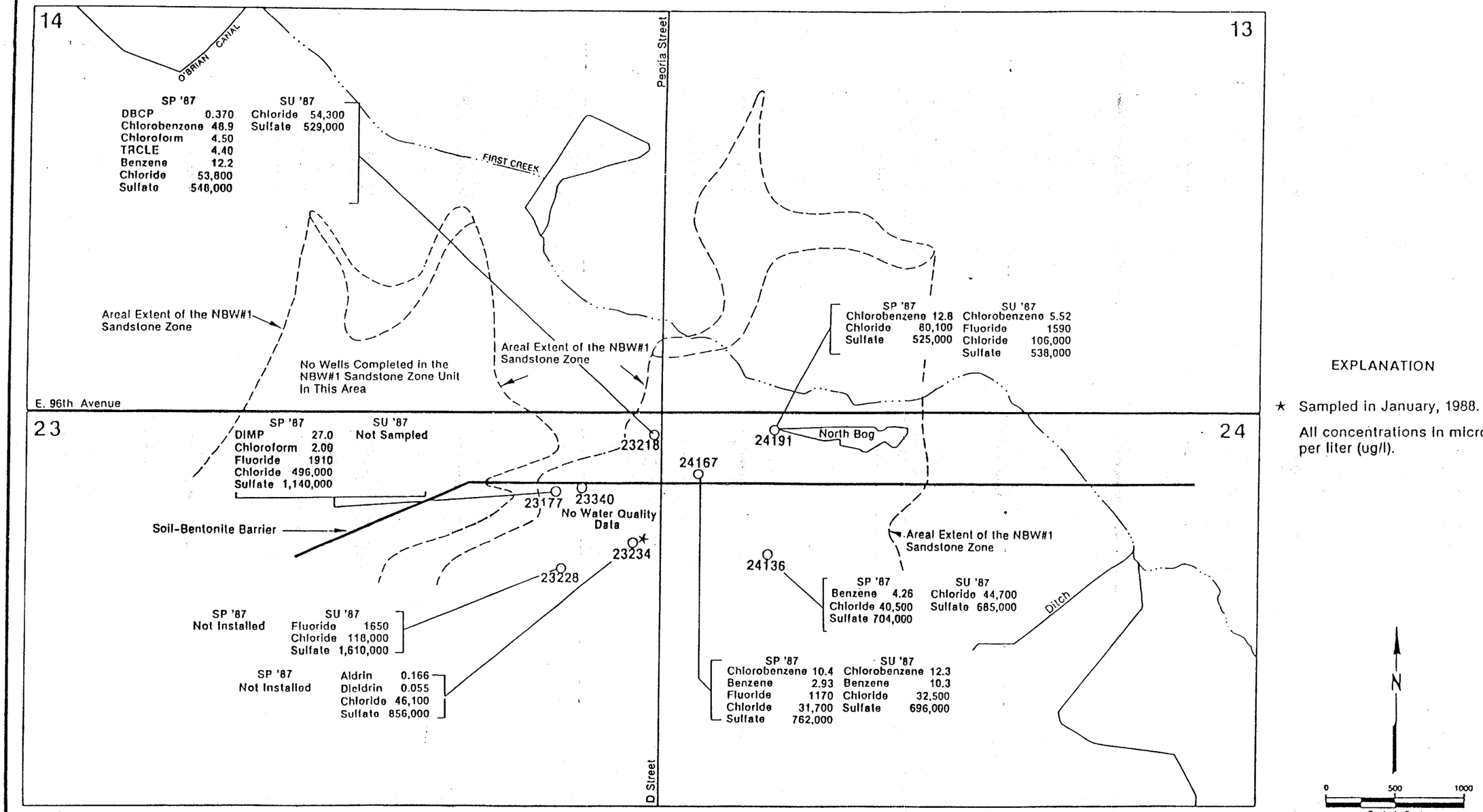
NOTE: Chemical concentrations presented are above certified reporting limits

Figure 3.3-3
WATER CHEMISTRY DATA FOR DENVER FM UNIT NBW#1A
SUMMER QUARTER, 1987

SOURCE: ESE, 1988

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland



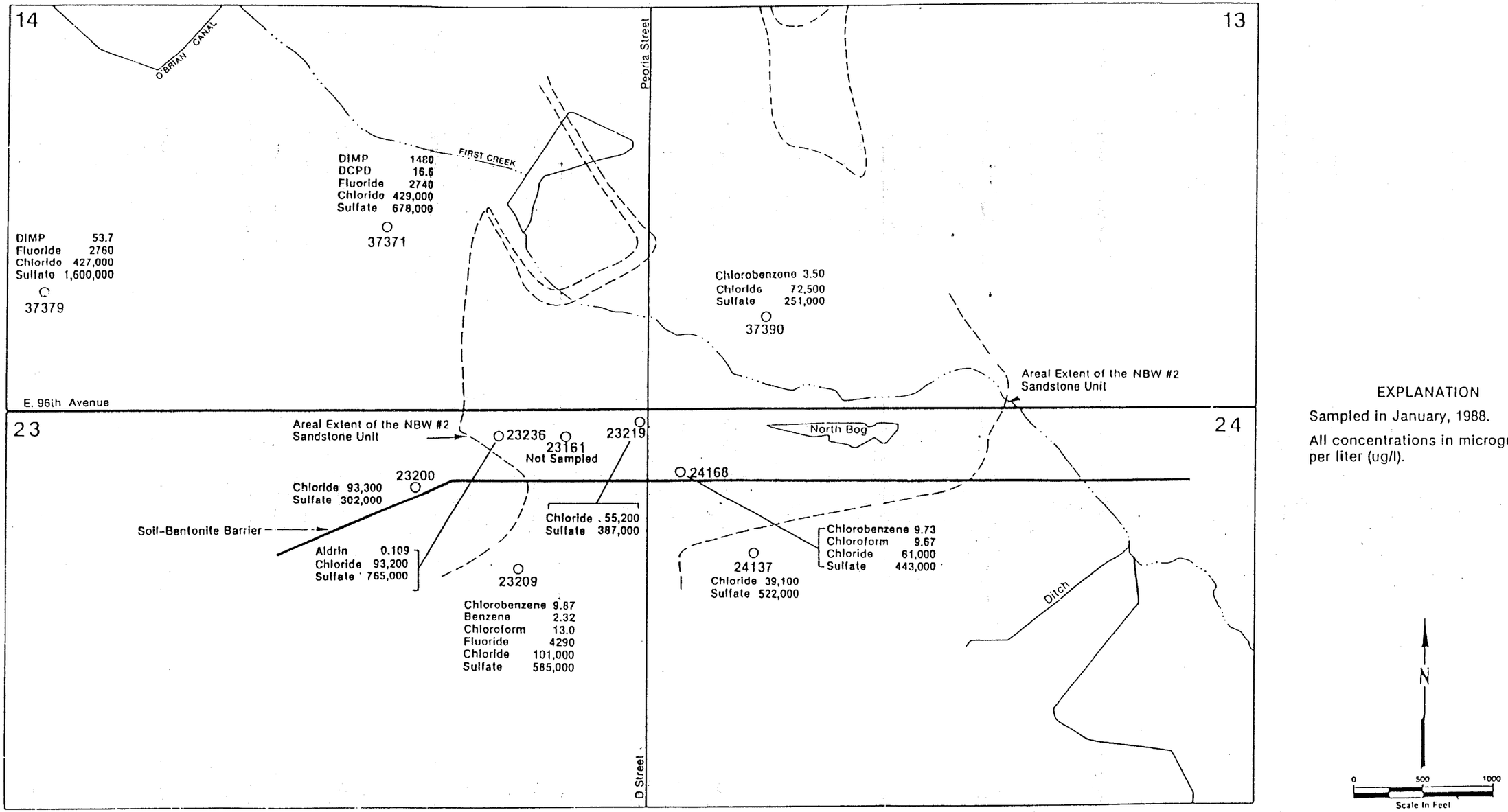
NOTE: Chemical concentrations presented are above certified reporting limits

Figure 3.3-4
WATER CHEMISTRY DATA FOR DENVER FM UNIT NBW#1,
SPRING AND SUMMER QUARTERS, 1987

SOURCE: ESE, 1988

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland



EXPLANATION

Sampled in January, 1988.

All concentrations in micrograms per liter (ug/l).

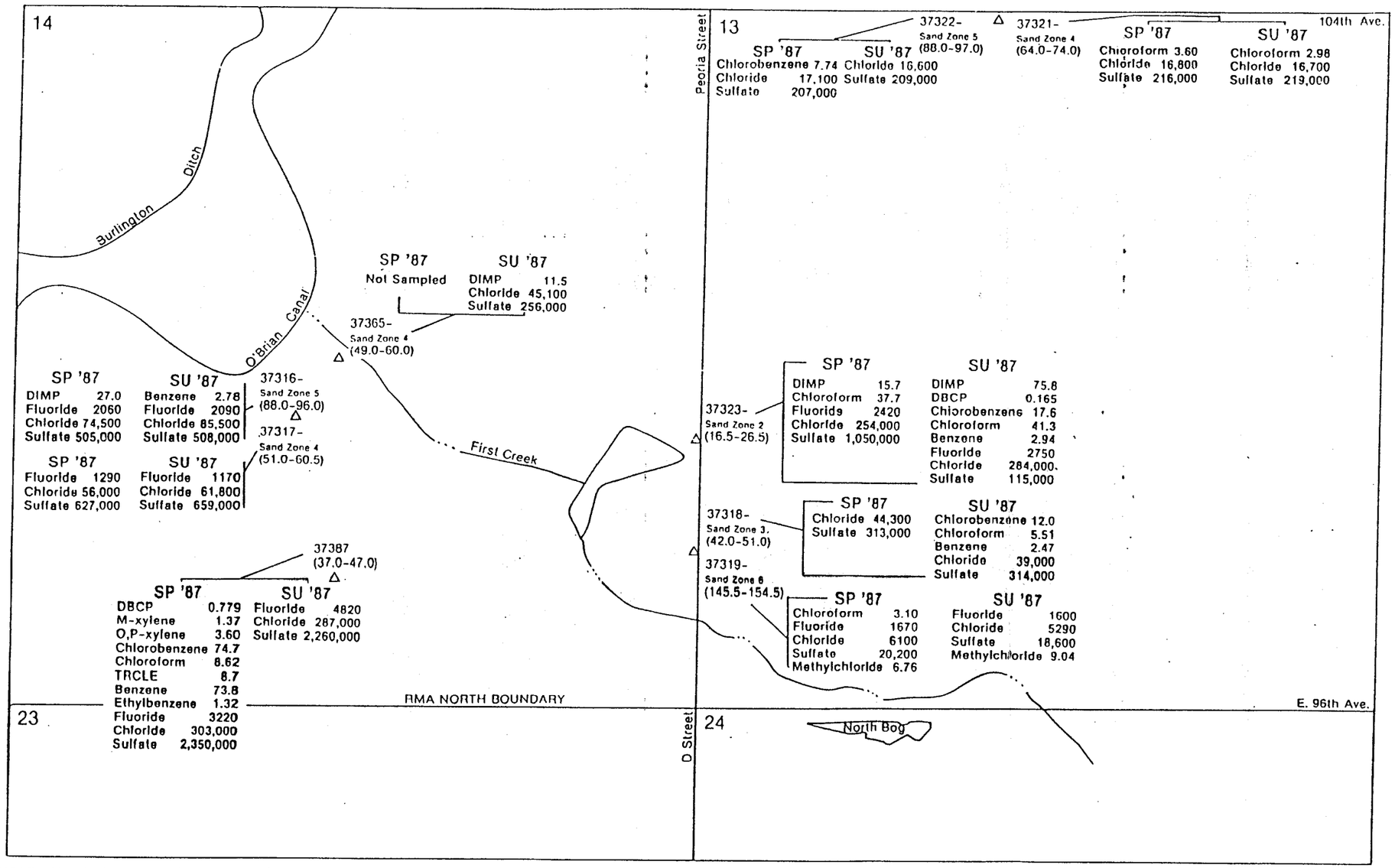
NOTE: Chemical concentrations presented are above certified reporting limits.

Figure 3.3-5
WATER CHEMISTRY DATA FOR DENVER FM UNIT NBW#2, SUMMER QUARTER, 1987

SOURCE: ESE, 1988

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland



NOTE: Chemical concentrations presented are above certified reporting limits.

Figure 3.3-6

WATER CHEMISTRY DATA FOR OFFPOST DENVER FORMATION WELLS NOT CORRELATED TO SANDSTONE UNITS IDENTIFIED AT NBCS

SOURCE: ESE, 1988

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland

3.3.2.2 Contamination_in_Units_Identified_at_NBCS

DIMP

Offpost DIMP concentrations in samples from unit NBW#2 range from approximately 45.0 ug/l to 1,000 ug/l. The highest concentration was observed in a sample from Well 37371, located near the inferred geologic subcrop of unit NBW#2, and may be partially representative of alluvial water chemistry. There were no DIMP concentrations exceeding CRLs in samples from onpost wells completed within unit NBW#2. There were also no DIMP concentrations exceeding CRLs in samples from wells completed within unit NBW#3.

Concentrations of DIMP in samples from onpost wells completed in unit NBW#1A range from less than CRLs to 405 ug/l, as shown in Figure 3.3-2. Concentrations of DIMP have been detected at levels exceeding CRLs in only one sample from a well screened in unit NBW#1, as shown in Figure 3.3-4. This detection was observed in a sample from a well immediately upgradient of the soil-bentonite barrier at a concentration of 27.0 ug/l. At this well location, boring logs indicate that units NBW#1A and NBW#1 are in hydrologic communication.

DBCP

There were no DBCP concentrations exceeding CRLs in samples from wells completed within unit NBW#2. In samples collected from offpost wells completed within unit NBW#2, there were two detections of DBCP at concentrations exceeding CRLs noted during the spring 1987 sampling quarter. These detections were noted in samples from Wells 37372 and 37380 at concentrations of 0.207 ug/l and 0.192 ug/l, respectively. During the summer of 1987 quarter, DBCP levels were less than CRLs in samples from both wells. There were no DBCP concentrations exceeding CRLs in samples from onpost wells completed within unit NBW#3.

Concentrations of DBCP in samples from onpost wells completed in unit NBW#1a range from less then CRLs to values exceeding 1.00 ug/l. In samples from onpost wells completed in unit NBW#1, concentrations of DBCP range from less than CRLs to more than 0.300 ug/l.

DCPD

In samples from offpost Well 37371, which is located approximately 3,500 ft downgradient of the soil-bentonite barrier and screened within unit NBW#2, a concentration of DCPD of 16.6 ug/l was observed during the summer 1987 quarter. DCPD concentrations were less than CRLs in all other samples collected from offpost wells screened within unit NBW#2. In samples from onpost wells screened within unit NBW#2, there were no observed concentrations of DCPD at concentrations exceeding CRLs in unit NBW#2. In samples from wells screened within unit NBW#3, there were no DCPD concentrations noted at levels exceeding CRLs.

Concentrations of DCPD in samples from onpost wells completed in unit NBW#1a range from less than CRLs to above 49 ug/l. In samples from wells screened within unit NBW#1, there were no detections of DCPD at concentrations exceeding CRLs.

Organosulfur Compounds

In samples from wells screened within units NBW#1, NBW#2, and NBW#3, organosulfur compounds were not detected at concentrations exceeding CRLs. Concentrations of organosulfurs were detected exceeding CRLs in samples from onpost wells screened within unit NBW#1A, which is projected to subcrop in the Offpost Operable Unit. Concentrations of CPMS in samples from onpost wells completed in unit NBW#1A ranged from less than CRLs to 7.23 ug/l. CPMSO was detected in two onpost wells completed in unit NBW#1A. The concentrations of CPMSO were 12.9 ug/l and 47.32 ug/l in Wells 23203 and 23204, respectively, during the spring 1987 sampling quarter. CPMSO2 was detected in one onpost well completed in NBW#1A. The concentration of CPMSO2 was 18.6 ug/l in Well 23176 during the Initial Screening Program.

1,4-Dithiane and 1,4-Oxathiane

In samples from wells screened within units NBW#1, NBW#2, and NBW#3, there were no observed concentrations of 1,4-dithiane and 1,4-oxathiane exceeding CRLs. Concentrations of 1,4-dithiane and 1,4-oxathiane were observed to exceed CRLs in samples obtained from onpost wells screened within unit NBW#1A that is projected to subcrop in the Offpost Operable Unit.

1,4-Dithiane concentrations averaging 3.4 ug/l were detected in samples from wells downgradient of the NBCS and screened within unit NBW#1A. Concentrations of 1,4-oxathiane in samples from wells screened within unit NBW#1A ranged from less than CRLs to a concentration of 2.40 ug/l in the spring 1987 sample from Well 23203.

Organochlorine Pesticides

Dieldrin and endrin were the only organochlorine pesticides observed at concentrations exceeding CRLs in samples from the Denver Fm within the Offpost Operable Unit. The concentrations and distribution of the analytes are described briefly below. In samples from wells screened within units NBW#1, NBW#2, and NBW#3, there were no detections of organochlorine pesticides noted at concentrations exceeding CRLs.

Concentrations of dieldrin and endrin were detected above CRLs in samples obtained from onpost wells screened within unit NBW#1A. Dieldrin concentrations in this unit ranged from less than CRLs to 0.89 ug/l. Endrin concentrations ranged from less than CRLs to 0.122 ug/l.

Volatile Organohalogens

Chloroform, trichloroethylene, tetrachloroethylene, 1,2-dichloroethane, and chlorobenzene were the only volatile organohalogens detected at concentrations exceeding CRLs in samples from the Denver Fm within the Offpost Operable Unit. The concentrations and distribution of these contaminants are discussed in the following paragraphs. The remaining volatile organohalogens were not observed at concentrations exceeding CRLs in well samples obtained from the Denver Fm in the Offpost Operable Unit.

Chloroform

There have not been any chloroform concentrations exceeding CRLs in samples from offpost wells completed within units NBW#2 and NBW#3. Concentrations of chloroform in samples from onpost wells completed in unit NBW#2 ranged from less than CRLs to 137 ug/l. Concentrations of chloroform in samples from onpost wells completed in unit NBW#3 ranged from less than CRLs to 12.4 ug/l.

Concentrations of chloroform in samples from onpost wells completed in unit NBW#1A range from less than CRLs to 24.5 ug/l. Chloroform was detected at concentrations exceeding CRLs in samples from two onpost wells completed in unit NBW#1 during the spring 1987 sampling quarter. The concentrations of chloroform in these samples were 2.0 ug/l and 4.5 ug/l in Wells 23177 and 23218, respectively.

Trichloroethylene

In samples collected from offpost wells completed within unit NBW#2, there was one observed concentration of trichloroethylene exceeding CRLs. This concentration of 1.38 ug/l was noted in a sample from Well 37379. In samples collected from onpost wells completed within unit NBW#2, concentrations of trichloroethylene ranged from less than CRLs to 1.30 ug/l.

Samples from two offpost wells completed in unit NBW#3 exhibited trichloroethylene concentrations exceeding CRLs. The trichloroethylene concentrations observed in samples from Wells 37372 and 37388 were 2.8 ug/l and 1.8 ug/l, respectively, during the Spring 1987 sampling quarter. In both instances, trichloroethylene concentrations exceeding CRLs were not observed in a second sampling from the wells. Trichloroethylene was not detected at concentrations exceeding CRLs in samples from onpost wells screened within unit NBW#3.

Concentrations of trichloroethylene in samples from onpost wells screened within unit NBW#1A ranged from less than CRLs to 8.00 ug/l. One sample from a well completed in unit NBW#1 exhibited a trichloroethylene concentration exceeding CRLs. This concentration of 4.40 ug/l was noted in a sample from Well 23218, which is located 400 ft downgradient of the pilot barrier and adjacent to D Street.

Tetrachloroethylene

Tetrachloroethylene concentrations exceeding CRLs have not been reported in samples from wells completed within units NBW#1, NBW#2, and NBW#3. Concentrations of tetrachloroethylene were observed exceeding CRLs in

samples obtained from onpost wells screened within unit NBW#1A. Concentrations of tetrachloroethylene in samples from this unit ranged from less than CRLs to 22.1 ug/l.

1,2-Dichloroethane

There were no 1,2-dichloroethane concentrations exceeding CRLs in samples from wells completed within units NBW#1, NBW#2, and NBW#3. Concentrations of tetrachloroethylene were observed exceeding CRLs in samples obtained from onpost wells screened within unit NBW#1A. Concentrations of 1,2-dichloroethane in samples from this unit ranged from less than CRLs to 2.7 ug/l.

Chlorobenzene

Concentrations of chlorobenzene exceeding CRLs were observed in several well samples collected from unit NBW#2. The highest chlorobenzene concentration was observed in the spring 1987 sample from monitoring Well 37390 at 23.70 ug/l. Concentrations of chlorobenzene in samples from onpost wells screened in unit NBW#2 ranged from less than CRLs to 23.70 ug/l.

Chlorobenzene was consistently observed at concentrations exceeding CRLs in samples from offpost wells screened within unit NBW#3. The highest concentration of chlorobenzene was observed at 42.4 ug/l in the spring 1987 sample from Well 37342. Concentrations of chlorobenzene in samples from onpost Well 23201, which is also screened within unit NBW#3, averaged 8.32 ug/l during spring and summer 1987 sampling quarters.

Concentrations of chlorobenzene in samples from onpost wells completed in unit NBW#1A ranged from less than CRLs to 97.7 ug/l. In samples from onpost wells completed in unit NBW#1, concentrations of chlorobenzene ranged from less than CRLs to 48.9 ug/l.

Volatile Aromatics

Benzene and ethylbenzene were the only volatile aromatics observed at concentrations exceeding CRLs in samples collected from Denver Fm wells in the Offpost Operable Unit. Benzene was more frequently observed than

ethylbenzene and was generally noted in samples from wells completed in the lowest Denver Fm units defined in the Offpost Operable Unit. The concentrations and distribution of benzene and ethylbenzene within the Denver Fm will be discussed in the following paragraphs.

Benzene

Benzene was detected at a concentration exceeding CRLs in only one sample collected from offpost wells completed within unit NBW#2. This concentration of 8.50 ug/l was noted in a sample from Well 37390. Benzene concentrations ranged from less than CRLs to 2.3 ug/l in samples collected from onpost wells completed within unit NBW#2.

All three offpost monitoring wells completed in unit NBW#3 yielded samples with concentrations of benzene exceeding CRLs. Benzene concentrations in samples from these wells ranged from 3.78 ug/l to 10.3 ug/l during the spring 1987 sampling quarter. Benzene concentrations were less than CRLs in samples from all three wells during the summer 1987 sampling quarter. Concentrations of benzene in samples from Well 23201, which is screened within unit NBW#3 onpost, did not exceed CRLs during spring and summer 1987 sampling quarters.

Concentrations of benzene in samples from onpost wells competed in unit NBW#1A ranged from less than CRLs to 7.45 ug/l. In samples from onpost wells completed in unit NBW#1, concentrations of benzene ranged from less than CRLs to 12.2 ug/l.

Ethylbenzene

Ethylbenzene concentrations have not exceeded CRLs in samples from wells completed within units NBW#1, NBW#2, and NBW#3. Concentrations of ethylbenzene were observed exceeding CRLs in only one sample from Well 23226 completed in unit NBW#1A at a level of 0.690 ug/l.

Inorganic Parameters

The concentrations and distribution of the inorganic parameters fluoride, chloride, sulfate, and arsenic have been assessed for units identified at the NBCS because they were included in the analyte schedule of the boundary

monitoring tasks (Task 25 and 36). In addition to these analytes, other organic parameters were analyzed in samples from offpost Denver Fm Wells 37379 and 37380. These additional analytes are: calcium, potassium, magnesium, sodium, chromium, cadmium, copper, nitrate, lead, zinc, and mercury. To provide a basis for comparison, typical concentrations of these inorganic parameters for the Denver Fm, as presented by Robson (1984), Van der Leeden, et al. (1975), and McConaghy, et al. (1964), are presented in Table 3.3-4. These typical concentrations provide a range of concentrations for these naturally occurring analytes that can be considered background levels. In the vicinity of the NBCS, fluoride concentrations in the Denver Fm were generally of similar magnitude or slightly greater than the typical concentrations presented in Table 3.3-4. Chloride and sulfate concentrations observed in the NBCS area are generally much higher than typical concentrations presented in Table 3.3-4. There were no arsenic concentrations exceeding CRLs in samples from Denver Fm wells in the Offpost Operable Unit. A summary of the concentrations and distribution of fluoride, chloride, and sulfate in Denver Fm units identified at the NBCS is presented in the following paragraphs.

Fluoride

Offpost monitoring wells completed within unit NBW#2 yielded samples with fluoride concentrations ranging from less than CRLs to 3,000 ug/l. Concentrations of fluoride in samples from onpost wells completed in unit NBW#2 ranged from less than CRLs to 4,330 ug/l.

All three offpost monitoring wells completed in unit NBW#3 yielded samples with concentrations of fluoride exceeding CRLs. Fluoride concentrations in samples from these wells ranged from 2,100 ug/l to 3,700 ug/l. Concentrations of fluoride in samples from Well 23201, which is screened within unit NBW#3 onpost, ranged from less than CRLs to 1,300 ug/l.

Concentrations of fluoride in samples from onpost wells completed in unit NBW#1A ranged from less than CRLs to 3,480 ug/l. In samples from onpost wells completed in unit NBW#1, concentrations of fluoride ranged from less than CRLs to 1,920 ug/l.

Table 3.3-4. Typical Background Water Chemistry From the Denver Fm

	Denver Aquifer Near Denver* (Robson, 1984)	Denver Aquifer Denver Basin** (Van der Leeden, 1975)	Denver Aquifer Well Located Upgradient/RMA*** (McConaghy, 1964)
Fluoride	1,600	1,200	1,400
Chloride	3,800	6,000	14,000
Sulfate	13,000	20,000	2,300
Arsenic	NA	NA	NA
Calcium	11,000	NA	51,000
Cadmium	NA	NA	NA
Chromium	NA	NA	NA
Copper	NA	NA	NA
Potassium	1,000	NA	3,000
Magnesium	400	NA	9,200
Sodium	57,000	82,000	36,000
Nitrate	50	30	8,300
Lead	NA	NA	NA
Zinc	NA	NA	NA

* From selected chemical analysis of ground water from the Denver Aquifer near the city of Denver.
** From selected chemical anlayses of ground water in the Denver Basin, Colorado.
*** Single Denver FM well located approximately 0.5 mile southeast of RMA, T35 R66W, Section 17.
NA Not analyzed.

Source: ESE, 1988.

Chloride

Wells completed within unit NBW#2 offpost yielded samples with chloride concentrations ranging from 55,700 ug/l to 467,000 ug/l. The highest concentrations were detected in Wells 37371 and 37379 located to the east of Peoria Street. Concentrations of chloride in samples from onpost wells completed in unit NBW#2 ranged from 34,500 ug/l to 101,000 ug/l.

Concentrations of chloride in samples from offpost wells screened within unit NBW#3 ranged from 57,800 ug/l to 412,000 ug/l. The highest concentrations were observed in samples from Well 37380. Concentrations of chloride in samples from onpost Well 23201 screened within unit NBW#3 averaged 96,500 ug/l.

In samples from wells completed within unit NBW#1A, chloride concentrations ranged from 72,163 ug/l to 530,908 ug/l. Concentrations of chloride in samples from wells completed within unit NBW#1 ranged from 31,700 ug/l to 496,000 ug/l.

Sulfate

In samples from offpost wells completed within unit NBW#2, sulfate concentrations ranged from 242,000 ug/l to 1,600,000 ug/l. The highest concentrations were observed in samples from offpost Well 37379. Concentrations of sulfate in onpost wells screened within unit NBW#2 ranged from 290,000 ug/l to 1,044,000 ug/l.

Sulfate concentrations in offpost wells screened within unit NBW#3 ranged from 345,000 ug/l in Well 37372 to 1,580,000 in Well 37388. In samples from onpost Well 23201 completed in unit NBW#2, concentrations of sulfate ranged from 105,000 ug/l to 344,000 ug/l.

Concentrations of sulfate in samples from onpost wells screened in unit NBW#1A ranged from 190,000 ug/l to 2,060,000 ug/l. In samples from onpost wells screened in unit NBW#1 concentrations of sulfate ranged from 525,000 ug/l to 1,610,000 ug/l.

Additional Inorganic Parameters

Wells 37379 and 37380 were also analyzed for calcium, cadmium, chromium, copper, potassium, magnesium, sodium, nitrate, lead, zinc, and mercury. The results of these analyses for spring and summer 1987 are presented in Table 3.3-5. A comparison of these results to the background water quality data shown in Table 3.3-4 depicts the following general relationships. Calcium and sodium concentrations were typically much higher than the concentrations listed in Table 3.3-4. Potassium and magnesium concentration were within the range of typical values that were presented in Table 3.3-4. Nitrate concentrations for Wells 37379 and 37380 were less than the value reported by McConaghy, et al. (1964) but greater than the values reported by Robson (1984) and Van der Leeden, et al. (1975).

Cadmium, copper, lead, and mercury concentrations were all less than the respective CRLs. Chromium was observed at concentrations of 12.0 ug/l and 25.4 ug/l for Wells 37380 and 37379, respectively. Zinc concentrations were less than CRLs in the samples from Well 37380 but was noted at a concentration of 210 ug/l in Well 37379.

3.3.2.3 Contamination in Units Not Correlated to NBCS

There are nine offpost Denver Fm monitoring wells that were not correlated to the sandstone units identified at the NBCS. These are Wells 37316, 37317, 37318, 37319, 37321, 37322, 32723, 37365, and 37387. These wells were, however, correlated to the Denver Fm zones identified in Section 3.1. Of these nine wells, Wells 37316, 37317, 37321, 37322, and 37365, were too far north of existing geologic data and the degree of uncertainity of correlating them to NBCS units was high. Wells 37323 and 37387 are located on bedrock highs and the sandstones that these wells are screened in are above the NBCS units. Well 37318 is screened in a sandstone that is between NBCS units NBW#2 and NBW#3. Well 37319 is screened in a sandstone that is below the units that could be identified at the NBCS with the current geologic data.

The spring and summer 1987 contaminant point plots for these wells are shown in Figure 3.3-5 along with the sand zone designation and the screen interval for each well. The analytes exceeding CRLs in samples obtained from these

Table 3.3-5. Additional Inorganic Parameters for Wells 37379 and 37380--Spring and Summer 1987 (ug/l)

	Well #37379		Well #37380	
	Spring 1987	Summer 1987	Spring 1987	Summer 1987
Calcium	272,000.0	251,000.0	NA	133,000
Cadmium	<5.16	<5.16	NA	<5.16
Chromium	<5.96	25.4	NA	12.0
Copper	<7.94	<7.94	NA	<7.94
Potassium	NA	2,330.0	5,580.0	3,210.0
Magnesium	41,900.0	45,100.0	NA	6,580.0
Sodium	729,000.0	577,000.0	NA	589,000.0
Nitrate	2,070.0	1,940.0	NA	147.0
Lead	<18.6	<18.6	NA	<18.6
Zinc	210.0	37.9	NA	<20.1
Mercury	NA	<0.5	<0.359	<0.5

NA = Not Analyzed.

Source: ESE, 1988.

wells are discussed in the following paragraphs. The remaining target analytes will not be addressed further in this section.

DIMP

DIMP was detected in levels exceeding CRLs in Wells 37316, 37323, and 37365. In Well 37316, DIMP concentrations were 27.0 ug/l during the spring 1987 sampling quarter. During the summer 1987 quarter, DIMP levels were less than the CRL. In Well 37323, concentrations of DIMP exceeded CRLs in both the spring and summer 1987 sampling quarters. The concentrations were 15.7 ug/l and 75.8 ug/l, respectively. The concentration of DIMP in Well 37365 exceeded CRLs only in the samples from the summer 1987 sampling quarter. The DIMP concentration was 11.5 ug/l.

DBCP

DBCP was detected exceeding CRLs in samples obtained from Wells 37323 and 37387. The concentrations of DBCP were 0.165 ug/l in the summer 1987 sample from Well 37323 and 0.779 ug/l in the spring 1987 sample from Well 37387.

Chlorobenzene

Chlorobenzene concentrations exceeding CRLs were observed in samples from Wells 37318, 37321, 37322, 37323, and 37387. In samples from Well 37318, chlorobenzene was detected at 12.0 ug/l during the summer 1987 sampling quarter. In Well 37321, the concentration of chlorobenzene ranged from 3.60 ug/l to 2.98 ug/l during the summer and spring 1987 sampling quarters, respectively.

The concentration of chlorobenzene in samples from Well 37322 exceeded CRLs only in the sample from the spring 1987 sampling quarter. The concentration of chlorobenzene was 7.74 ug/l. Concentrations of chorobenzene exceeded CRLs in samples obtained from Wells 37323 and 37387 during the summer and spring 1987 sampling quarters, respectively. The concentrations of chlorobenzene were 17.6 ug/l and 74.7 ug/l, for Wells 37323 and 37387, respectively.

Chloroform

The concentration of chloroform exceeded CRLs in samples obtained from Wells 37318, 37319, 37323, and 37387. Chloroform was observed exceeding CRLs in samples obtained from Well 37318 during the summer 1987 sampling quarter (5.51 ug/l) and 37319 during the summer and spring 1987 sampling quarter (3.10 ug/l).

In Well 37323, the concentration of chloroform ranged from 37.7 ug/l to 41.3 ug/l during the spring and summer sampling quarters, respectively. A concentration of chloroform exceeding CRLs was observed in a sample obtained from Well 37387 during the spring 1987 sampling quarter. The concentration of chloroform was 8.62 ug/l.

Tetrachloroethylene

The only concentrations of tetrachloroethylene exceeding CRLs was noted in the spring 1987 sample from Well 37387. The concentration of tetrachloroethylene in this sample was 8.7 ug/l.

Methylene Chloride

Methylene chloride was observed exceeding CRLs only in samples from Well 37319. The concentration of methylene chloride ranged from 6.76 ug/l to 9.04 ug/l during the spring and summer sampling quarters, respectively.

Benzene

Concentrations of benzene exceeding CRLs were observed in samples obtained from Wells 37316, 37318, 37323, and 37387. Benzene was noted exceeding CRLs in samples obtained from Wells 37316 and 37318 during the summer 1987 sampling quarter. The concentrations of benzene were 2.78 ug/l and 2.47 ug/l for Wells 37316 and 37318, respectively.

The concentrations of benzene exceeded CRLs in samples from Wells 37323 and 37387 during the summer and spring 1987 sampling quarters, respectively. The concentrations of benzene were 2.94 ug/l and 73.8 ug/l for Wells 37323 and 37387, respectively.

Ethylbenzene

A concentration of ethylbenzene exceeding the CRLs was detected only in Well 37387 during the spring 1987 sampling quarter. The concentration of ethylbenzene was 1.32 ug/l.

m-Xylene

The compound m-xylene was detected exceeding CRLs in samples obtained from Well 37387. The concentration of m-xylene was 1.37 ug/l during the spring 1987 sampling quarter.

o,p-Xylene (sum of o-xylene and p-xylene)

O,p-xylene was detected exceeding CRLs in samples obtained from Well 37387 only during the spring 1987 sampling quarter. The concentration of o,p-xylene was 3.60 ug/l.

Fluoride

Fluoride concentrations exceeding CRLs were detected in samples from Wells 37316, 37317, 37319, and 37387. The maximum concentration was 4,820 ug/l in Well 37387, and the minimum fluoride concentration was 1,290 ug/l in Well 37317.

Chloride

Concentrations of chloride exceeding CRLs were detected in all of the wells that were not correlated to Denver Fm sandstone units identified at the NBCS. The concentrations of chloride ranged from 5,290 ug/l in Well 37319 to 303,000 ug/l in Well 37387.

Sulfate

Sulfate concentrations exceeding CRLs were detected in all of the wells that were not correlated to Denver Fm sandstone units identified at the NBCS. The concentration of sulfate ranged from 2,350,000 ug/l in Well 37387 to 18,600 ug/l in Well 37319.

3.3.3 QA/QC Data

Field Quality Assurance/Quality Control (QA/QC) procedures were conducted to provide documentation of the limits of precision and accuracy of all

analytical systems generating data and to provide mechanisms for documentation of the validity of all reported data. Field QC procedures were consistent with EPA and USATHAMA approved methodologies. A summary of these procedures for all trip blanks, rinseate blanks, field blanks, and duplicate samples are summarized in Table 3.3-6.

Trip blanks, rinseate blanks, and field blanks were analyzed for all target analytes. The concentrations of organic compounds were below the certified reporting limits in all cases. However, there were two rinseate blanks that had measurable detections of chloride and sulfate. The concentration of chloride ranged from 12,000 to 13,100 ug/l for the rinseate blank samples, and the concentration of sulfate waas 17,000 ug/l for both samples.

The duplicate data that were obtained during this study is presented in Tables 3.3-7 through 3.3-13. The compounds have been separated into groups according to the analytical techniques used. A brief discussion on each of these groups is provided for documentation of the validity of the data presented in the preceding paragraphs.

In general, the duplicate samples fell within the EPA QC acceptance criteria for precision. This is based on the Code of Federal Regulations (40 CFR) part 136, Appendix A, Method 601, 602 and 608 (EPA, 1985). The volatile aromatics and volatile organohalogens had the greatest variance. This was expected due to their high volatility.

3.3.3.1 DIMP, DBCP, DCPD

The duplicate data for DIMP, DBCP, and DCPD are shown in Table 3.3-7. The ranges of DIMP, DBCP, and DCPD values for duplicate samples were within plus or minus (±) 10 percent with the exception of samples from Well 37367 and Well 37350. Duplicate samples from these two sites had different DBCP and DIMP concentrations of negative 13 percent and negative 11 percent, respectively. At this time, no EPA precision criteria exist for these compounds. However, the duplicate data listed in Table 3.3-7 show that the sampling procedures and analytical methodology generated analytical results that have adequate precision for the interpretations presented in this report.

Table 3.3-6. Field QA/QC Procedures

QA Sample Type	Analytical Method*	Required Frequency	Preparation
Volatile Trip Blank	W8, Y8, TT8, SS8	1 paint can with 3 volatile septum vials each week, each week samples for GC analysis are collected.	Transport filled blank volatile septum vials to field, open paint can and return to laboratory with samples.
Rinseate Blank	S8, U8, T8, W8, Y8, X8, K8, R8, Q8	1 suite per week, each week samples are submitted	Decontaminate bailer used to collect samples. Pour deionized water into cleaned bailer, then transfer to sample bottles. Perform while onsite. Not applicable if dedicated bailer is used.
Field Blank	S8, U8, T8, W8, Y8, X8, K8, Q8, R8	1 suite per week, each week samples are submitted	Pour organic free deionized water directly into sample bottles. Perform while onsite.
Duplicates	S8, U8, T8, W8, Y8, X8, K8, R8, Q8	1 suite per week, each week samples are submitted	Collect 2 suites of sample bottles while onsite.

* See Table 2.1-4.

Source: ESE, 1988.

Table 3.3-7. Duplicate Data: DIMP, DBCP, DCPD (ug/l)

Well Number	Collection Date	DIMP	DBCP	DCPD
37338	06/17/87	<	<	<
DUP	06/17/87	<	<	<
37350	06/19/87	16.6	<	<
DUP	06/19/87	14.7	<	<
37367	06/15/87	397	2.57	<
DUP	06/15/87	417	2.24	<
37369	06/24/87	251	<	59.4
DUP	06/24/87	244	<	65.8
37370	09/29/87	1130	<	<
DUP	09/29/87	1200	<	<
37372	10/02/87	<	<	<
DUP	10/02/87	<	<	<

Note: < Denotes values less than CRLs as specified in Table 2.1-4.

Source: ESE, 1988.

Table 3.3-8. Duplicate Data: 1,4-Oxathiane, 1,4-Dithiane, CPMS, CPMSO, CPMSO2 (ug/l).

Well Number	Collection Date	1,4-Oxathiane	1,4-Dithiane	CPMS	CPMSO	CPMSO2
37367	06/15/87	<	<	4.16	113	4.31
DUP	06/15/87	<	<	4.31	124	4.38
37369	06/24/87	<	<	<	8.59	4.11
DUP	06/24/87	<	<	<	8.74	4.20
37370	09/29/87	<	<	<	<	<
DUP	09/29/87	<	<	<	<	<
37372	10/02/87	<	<	<	<	<
DUP	10/02/87	<	<	<	<	<

Note: < Denotes values less than CRLs as specified in Table 2.1-4.

Source: ESE, 1988.

Table 3.3-9. Duplicate Data: Organochlorine Pesticides (ug/l)

Well Number	Collection Date	HCCPD	Aldrin	Isodrin	p,p'-DDE	Dieldrin	Endrin	p,p'-DDT	Chlordane
37367	06/15/87	<	<	<	<	<	<	<	<
DUP	06/15/87	<	<	<	<	<	<	<	<
37369	06/24/87	<	<	<	<	0.333	0.429	<	<
DUP	06/24/87	<	<	<	<	0.277	0.109	<	<
37370	09/29/87	<	<	<	<	<	<	<	<
DUP	09/29/87	<	<	<	<	<	<	<	<
37372	10/02/87	<	<	<	<	<	<	<	<
DUP	10/02/87	<	<	<	<	<	<	<	<

Note: < Denotes values less than CRLs as specified in Table 2.1-4.

Source: ESE, 1988.

Table 3.3-10. Duplicate Data: Volatile Organohalogens (ug/l)

Well Number	Collection Date	Analyte: Methylene Chloride	11DCE	11DCLE	12DCE	Chloroform	12DCLE	111TCE	Carbon Tetrachloride	TRCLE	112TCE	TCLEE	Chlorobenzene
37338	06/17/87	<	<	<	<	2.12	<	<	<	<	<	<	8.37
DUP	06/17/87	<	<	<	<	<	<	<	<	<	<	<	12.4
37339	06/19/87	<	<	<	<	<	<	<	<	<	<	<	<
DUP	06/19/87	<	<	<	<	<	<	<	<	<	<	<	<
37367	06/15/87	<	<	<	<	127	<	<	<	4.1	<	36	9.23
DUP	06/15/87	<	<	<	<	146	<	<	<	4.4	<	36	12.4
37369	06/24/87	<	<	<	<	<	<	<	<	<	<	9.0	8.88
DUP	06/24/87	<	<	<	<	<	3.00	<	<	<	<	9.4	8.13
37370	09/29/87	<	<	<	<	<	3.04	<	<	<	<	<	<
DUP	09/29/87	<	<	<	<	<	<	<	<	<	<	<	<
37372	10/02/87	<	<	<	<	<	<	<	<	<	<	<	5.43
DUP	10/02/87	<	<	<	<	<	<	<	<	<	<	<	4.98

Note: < Denotes values less than CRLs as specified in Table 2.1-4.

Source: ESE, 1988.

Table 3.3-11. Duplicate Data: Volatile Aromatics (ug/l).

Well Number	Collection Date	Benzene	Toluene	Ethylbenzene	m-Xylene	o,p-Xylene
37338	06/17/87	1.49	<	<	<	<
DUP	06/17/87	2.08	<	<	<	<
37339	06/19/87	<	<	<	<	<
DUP	06/19/87	<	<	<	<	<
37367	06/15/87	2.92	<	<	<	<
DUP	06/15/87	3.80	<	<	<	<
37369	06/24/87	<	<	<	<	<
DUP	06/24/87	<	<	<	<	<
37370	09/29/87	<	<	<	<	<
DUP	09/29/87	<	<	<	<	<
37372	10/02/87	<	<	<	<	<
DUP	10/02/87	<	<	<	<	<

Note: < Denotes values less than CRLs as specified in Table 2.1-4.

Source: ESE, 1988.

Table 3.3-12. Duplicate Data: Inorganics (ug/l).

Well Number	Collection Date	Fluoride	Chloride	Sulfate	Arsenic	Potassium	Mercury
37338	06/17/87	1,400	148,000	392,000	<	16,000	<
DUP	06/17/87	1,460	132,000	389,000	<	18,800	<
37339	06/19/87	<	86,100	218,000	<	3,660	<
DUP	06/19/87	<	83,800	214,000	<	<	<
37367	06/15/87	2,050	201,000	578,000	<	4,170	<
DUP	06/15/87	2,030	199,000	580,000	<	4,170	NRQ
37369	06/24/87	2,690	210,000	391,000	<	<	NRQ
DUP	06/24/87	2,720	215,000	401,000	<	<	NRQ
37370	09/29/87	2,810	518,000	932,000	3.39	NRQ	NRQ
DUP	09/29/87	2,770	525,000	908,000	3.61	<	NRQ
37372	10/02/87	2,540	59,800	345,000	<	<	NRQ
DUP	10/02/87	2,530	59,600	345,000	<	<	NRQ

NRQ - Not Requested.
Note: < Denotes values less than CRLs as specified in Table 2.1-4.

Source: ESE, 1988.

Table 3.3-13. Duplicate Data: Additional Inorganics (ug/l)

Well Number	Collection Date	Analyte								
		Calcium	Sodium	Magnesium	Nitrate	Zinc	Cadmium	Lead	Chromium	Copper
37338	06/17/87	162,000	213,000	49,400	1,040	25.6	<	<	<	<
DUP	06/17/87	123,000	177,000	40,700	961	36.5	<	<	12.2	<
37350	06/19/87	148,000	109,000	37,900	7,010	<20.1	<	<	<	<
DUP	06/19/87	138,000	112,000	38,100	6,930	<20.1	<	<	<	<

Note: < Denotes values less than CRLs specified in Table 2.1-4.

Source: ESE, 1988.

3.3.3.2 1,4-Oxathiane, 1,4-Dithiane, CPMS, CPMSO, CPMSO2

The duplicate data for 1,4-oxathiane, 1,4-dithiane, CPMS, CPMSO, and CPMSO2 are presented in Table 3.3-8. The range between values for these compounds for the duplicate samples were within ± 10%. At this time, no EPA precision criteria exist for these compounds. However, the duplicate data listed in Table 3.3-8 show that the sampling procedures and analytical methodology generated adequate results for the interpretations presented in this report.

3.3.3.3 Organochlorine Pesticides

The duplicate data for the organochlorine pesticides are shown in Table 3.3-9. Only one duplicate sampling from Well 37369, exhibited detectable levels of organochlorine pesticides. The duplicate sample from Well 37369 exhibited an endrin concentration that was -75 percent of the original sample. The desireable range of precision for endrin using Method 608 is -70 percent to +47 percent (EPA, 1985). Thus, the concentration of endrin in the duplicate sample was slightly outside the EPA specified range. Although substantive conclusions cannot be drawn from one duplicate sample, this data may indicate that other measured endrin detections could be expected to vary outside the specified EPA range. Thus, the magnitude of some endrin concentrations may be questionable. However, at all other wells, duplicate samples consistently reproduced concentrations less than CRLs.

Dieldrin was also detected in the duplicate sample from Well 37369. The measured concentration in the duplicate sample was well within the EPA 608 range of precision of -64 percent of 46 percent. Also, the remaining duplicate samples consistently reproduced concentrations that were less than CRLs. Thus, based upon the data available, the accuracy of measured dieldrin data is considered adequate to describe the offpost levels and extent of this contaminant.

3.3.3.4 Volatile Organohalogens

The duplicate data for the volatile organohalogens are presented in Table 3.3-10. The range of values for these compounds for duplicate samples were within EPA acceptance criteria (EPA, 1985).

3.3.3.5 Volatile Aromatics

The duplicate data for the volatile aromatics are presented in Table 3.3-11. Benzene was the only volatile aromatic compound that was detected above CRLs. The range of values for benzene duplicate samples were within EPA acceptance criteria. The precision criteria for benzene using the EPA Method 602 is -61% to +50% (EPA, 1985).

3.3.3.6 Inorganics

The duplicate data for fluoride, chloride, sulfate, arsenic, potassium, and mercury are presented in Table 3.3-12. The range of values for fluoride, chloride and sulfate for duplicate samples were within about ± 10%. The detection of arsenic for duplicate samples were within ± 20%. The potassium concentration for the duplicate sample from Well 37367 was within -64%. At this time, no EPA precision criteria exists for these analytes. However, the duplicate data listed in Table 5.3-7 show that the sampling procedures and analytical methodology generated analytical results that have adequate precision for the interpretations presented in this report.

3.3.3.7 Additional Inorganics

The duplicate data for calcium, sodium, magnesium, nitrate, zinc, cadmium, lead, chromium, and copper are presented in Table 3.3-13. The range of values for nitrate, cadmium, lead, and copper for duplicate samples were within ±10%. The detections of sodium and magnesium were within ± 20%, and the detections of calcium and zinc for duplicate samples were within ± 30%. The chromium concentration for the duplicate sample from Well 37338 was within -50%. At this time, no EPA precision criteria exists for these analytes. However, the duplicate data listed in Table 3.3-13 show that the sampling procedures and analytical methodology generated analytical results with adequate precision for this project.

3.3.4 GAS CHROMATOGRAPHY/MASS SPECTROMETRY RESULTS

GC/MS analyses were performed on ground-water samples collected from selected onpost and offpost wells. The primary objectives of these GC/MS analyses were to:

- Confirm the occurrence of target analytes previously and concurrently identified by GC analytical methods; and

- Tentatively identify nontarget analytes to assess possible modifications to the target analyte list which may require eventual remediation.

Additionally, the chemical concentrations reported for the GC/MS analyses were compared to the GC results to assess any systematic differences in the data from the two methods.

The remaining portions of this discussion have been divided into several sections. Well selection procedures are described in section 3.3.4.1. Section 3.3.3.2 describes the GC/MS analytical procedures used and discusses the method detection limits. Section 3.3.4.3 briefly describes Quality Assurance/Quality Control (QA/QC) procedures and discusses the analytical results for external QA/QC samples. The confirmation of target analytes and their concentrations are described in Section 3.3.4.4. The identification of nontarget analytes is presented in Section 3.3.4.5. Sections 3.3.4.7 and 3.3.4.8 present the conclusions and recommendations, respectively.

3.3.4.1 Well Selection

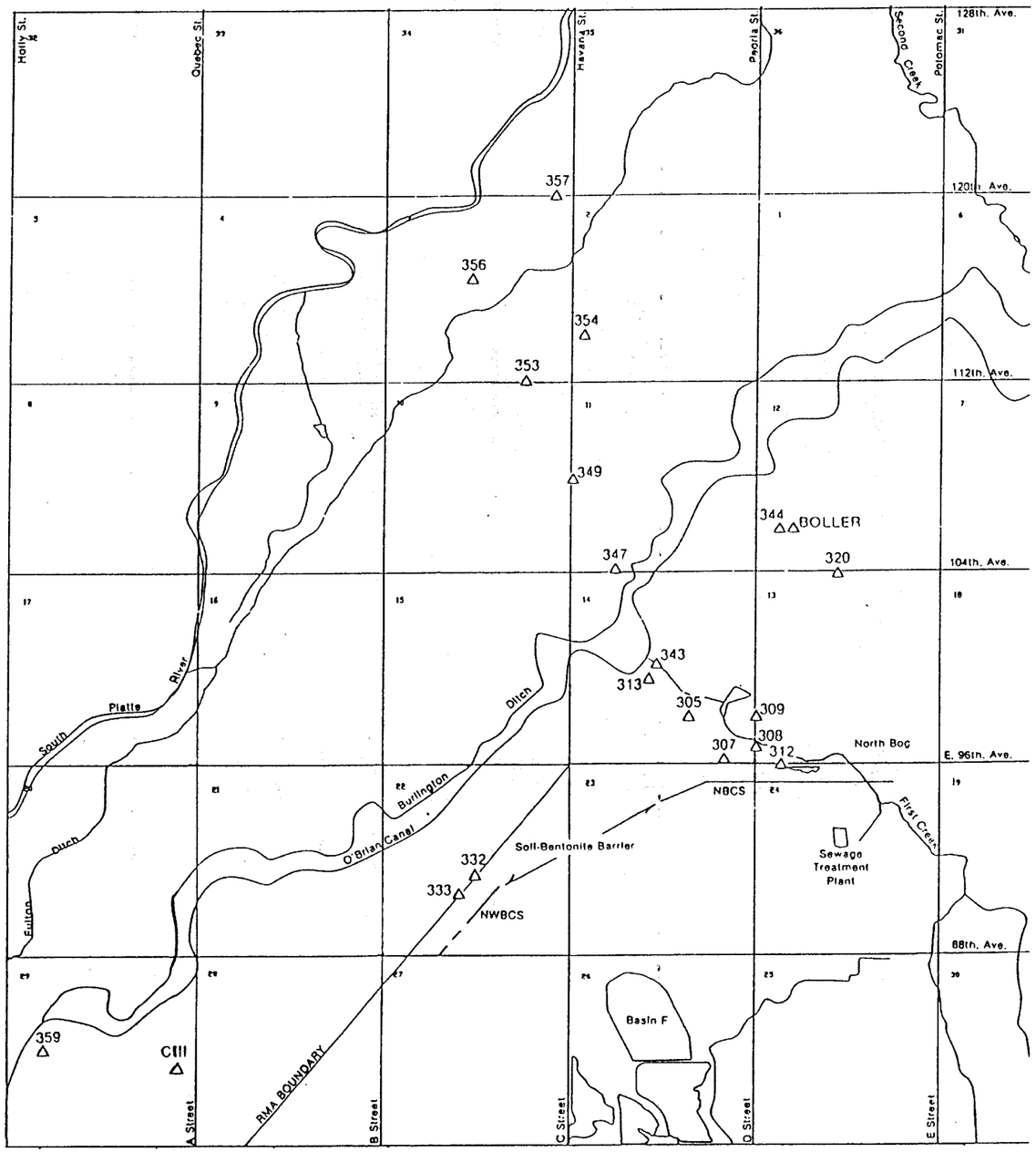
Wells were selected for GC/MS analyses based on the well's historical chemical data and location. Initially, wells with historically high concentrations of multiple target analytes were chosen because they provided perhaps the greatest opportunity for GC/MS confirmation of target analyte results and the tentative identification of nontarget analytes. In the subsequent sampling rounds, the well's location was also considered an effort to cover a wide geographic area.

The GC/MS analyses were performed on ground-water samples collected from 20 offpost wells, during the spring and summer of 1986 and the summer of 1987. The locations of all offpost wells from which samples were collected for GC/MS analyses are shown in Figure 3.3-7. All offpost wells are completed in the alluvial aquifer. Table 3.3-14 lists the wells sampled, and the quarterly round in which samples were collected.

Table 3.3-14. Offpost Wells from which Water Samples Were Collected and Submitted for GC/MS Analysis

Well	Spring 1986	Summer 1986	Summer 1987
37305		X	
37307	X		
37308	X		
37309			X
37312	X		
37313		X	
37320		X	
37332	X		X
37333			X
37343	X		
37344			X
37347		X	
37349		X	
37353	X	X	
37354	X		
37356		X	
37357		X	
37359			X
BOLLER	X		
CIII			X

Source: ESE, 1988.



EXPLANATION

△	Alluvial Well Sampled For GC/MS Analysis
339	Well Number
CIII BOLLER	Tap Sample From Domestic Site
NBCS	North Boundary Containment System
NWBCS	Northwest Boundary Containment System
— —	Denotes Location Of Hydrologic System

N

0 2000 4000

SCALE IN FEET

Figure 3.3-7

LOCATION MAP OF OFFPOST ALLUVIAL WELLS SAMPLED FOR GC/MS ANALYSIS.

SOURCE: ESE, 1988

Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland

3.3.4.2 GC/MS Analytical Methods

The GC/MS analytical methods used included EPA Method 624 (USATHAMA Method M-8) and EPA Method 625 (USATHAMA Method BB-8). Target analytes determined by these analytical methods are presented in Table 3.3-15. Extraction procedures used were those specified in the respective analytical method.

For EPA method 624, the extraction procedure was EPA Method 5030: however, for EPA Method 624, only the base neutral fraction was extracted. An acid extraction step was not performed.

Appendix F contains all analytical results for ground-water analyses performed by GC/MS. The GC/MS data from the third and fourth quarter 1987 sampling rounds were previously presented in the Task 4 Draft Final Report (ESE, 1988, RIC#88034R03). The GC/MS data from the Task 44 sampling round have not been previously reported.

Table 3.3-16 lists certified reporting limits (CRLs) for the target analytes. As the table shows, different CRLs exist for each analyte, although a few compounds have identical GC and GC/MS CRLs. Approximately 17 compounds have lower GC CRLs. For the remaining analytes, the GC/MS CRLs are higher than the respective GC CRLs. GC CRLs for each of the volatile organohalogens and aromatics are similar or equal to the respective GC/MS CRL. The greatest deviation for this group of compounds is for chlorobenzene, which has a GC CRL of 0.58 ug/l and a GC/MS CRL of 2.0 ug/l. The CRLs for the organochlorine pesticides show the greatest differences between the GC and GC/MS methods. The GC CRLs for these compounds range from 0.05 to 0.07 ug/l, whereas the GC/MS CRLs range from 4.7 to 10 ug/l. Thus, the GC CRLs are approximately 100 times lower than the GC/MS CRLs. These wide differences can have an impact on compound quantification, as described in Sections 3.3.4.3 and 3.3.4.4.

3.3.4.3 Quality Assurance/Quality Control

Quality Assurance/Quality Control (QA/QC) procedures for ground-water sampling and GC/MS analyses are described in the RMA Water Quantity/Quality Survey, Task 4 Final Draft Report (ESE, 1987, RIC#87253R01), and Task 44 Final Technical Plan (ESE, 1988, RIC#88063R11). External QC samples,

Table 3.3-15. GC/MS Target Analytes

Analytes by EPA Method 624 (USATHAMA Method M-8)

Ethylbenzene (ETHYLBENZ)*
Benzene (BENZENE)
Methylisobutyl Ketone (MIBK)
Dimethyldisulfide (DMDS)
1,1-Dichloroethane (11DCLE)
1,2-Dichloroethane (12DCLE)
1,1,1-Trichloroethane (111TCE)
1,1,2-Trichloroethane (112TCE)
Methylene chloride (METHYLCL)
Chloroform (CHCL3)
Carbon tetrachloride (CCL4)
trans-1,2-Dichloroethylene (T12DCE)
Chlorobenzene (CLC6H5)
Tetrachloroethylene (TCLEE)
Trichloroethylene (TRCLE)
m-Xylene (m-XYL)
o- and/or p-Xylene (o&p-XYL)
DBCP (DBCP)
Dichloropentadiene (DCPD)
Toluene (TOLUEN)

Analytes by EPA Method 625** (USATHAMA Method BB-8)

Aldrin (ALDRIN)
Chlorophenylmethyl sulfide (CPMS)
Chlorophenylmethyl sulfoxide (CPMSO)
Chlorophenylmethyl sulfone (CPMSO2)
DBCP (DBCP)
Dichloropentadiene (DCPD)
p,p'-DDE (p,p'=DDE)
p,p'-DDT (p,p'=DDT)
Dieldrin (DIELDRIN)
DIMP (DIMP)
1,4-Dithiane (1,4-DITH)
Endrin (ENDRIN)
HCCPD (HCCPD)
Isodrin (ISODRIN)
1,4-Oxathiane (1,4-OXAT)

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* Compound name abbreviation used in data tables.
** Neutral extraction fraction.

Source: ESE, 1988.

Table 3.3-16. Certified Reporting Limits for GC Analyses and Apparent Method Detection Limits for GC/MS Analyses (Page 1 of 2)

Analysis/Analytes	GC Certified Reporting Limit (ug/l) Task 4	GC Certified Reporting Limit (ug/l) Task 44	GC/MS* Certified Reporting Limit Limit (ug/l) Task 4 and Task 44
Organochlorine Pesticides			
Aldrin	0.07	0.07	4.7
Endrin	0.05	0.05	7.6
Dieldrin	0.06	0.06	4.7
Isodrin	0.06	0.06	5.9
Hexachlorocyclopentadiene	0.07	0.07	11.0
p,p'-DDE	0.05	0.05	4.7
p,p'-DDT	0.07	0.07	10.0
Volatile Organohalogens			
Chlorobenzene	0.58	0.58	2.0
Chloroform	1.4	1.40	1.0
Carbon Tetrachloride	2.4	1.4	2.0
trans-1,2-Dichloroethylene	1.2	1.20	2.0
Trichloroethylene	1.2	1.20	1.0
Tetrachloroethylene	1.1	1.10	1.0
1,1-Dichloroethylene	1.1	1.10	--
1,1-Dichloroethane	1.2	1.20	2.0
1,2-Dichloroethane	0.61	0.61	1.0
1,1,1-Trichloroethane	1.7	1.70	1.0
1,1,2-Trichloroethane	1.0	1.0	1.0
Methylene Chloride	5.0	5.0	5.0
Organosulfur Compounds			
Chlorophenylmethyl sulfone ($CPMSO_2$)	4.7	4.7	8.0
Chlorophenylmethyl sulfoxide (CPMSO)	1.3	1.3	17.0
Chlorophenylmethyl sulfide (CPMS)	4.2	4.2	14.0
1,4-Dithiane	1.1	1.1	11.0
1,4-Oxathiane	2.0	2.0	6.1
Dimethyldisulfide (DMDS)	1.8	1.80	3.0
Volatile Aromatics			
Toluene	1.21	1.21	1.0
Benzene	1.34	1.34	1.0
Xylene (m-)	1.35	1.35	1.0
Xylene (o,p)	2.47	2.47	2.0
Ethylbenzene	1.00	1.00	1.0

Table 3.3-16. Certified Reporting Limits for GC Analyses and Apparent Method Detection Limits for GC/MS Analyses (Page 2 of 2)

Analysis/Analytes	GC Certified Reporting Limit (ug/l) Task 4	GC Certified Reporting Limit (ug/l) Task 44	GC/MS* Certified Reporting Limit Limit (ug/l) Task 4 and Task 44
DCPD/MIBK			
Dicyclopentadiene	9.31	5.12	2.0; 4.7*
Methylisobutyl ketone	13.0	5.24	2.0
DIMP/DMMP			
Diisopropylmethyl phosphonate	10.0	10.0	5.7
Dimethylmethyl phosphonate	15.2	15.2	**
DBCP			
Dibromochloropropane	0.13	.112	4.0; 15.0*

* GC/MS detection limits for EPA Methods 624; 625, respectively.
** No GC/MS analytical method exists.

Source: ESE, 1988.

consisting of trip blanks, were submitted to the laboratories for GC/MS analysis of selected volatiles, aromatics, and pesticides by EPA Method 624. The blanks were generally submitted to the laboratories at a frequency of one per day; however, they were not submitted for six of the 48 sampling dates. Additionally, duplicate trip blanks were submitted on three sampling dates.

A total of 45 trip blanks were submitted to the laboratories for chemical analysis. The analytical results for the trip blanks are provided in Appendix F. Onpost trip blank data has also been included to provide a larger database from which to evaluate the validity of results.

As can be seen, target analytes were generally not found in the trip blanks, although, a few target compounds, including 1,1,1-trichloroethane, methylene chloride, chloroform, toluene, and m-xylene, were inconsistently detected. Detectable levels of 1,1,1-trichloroethane, chloroform, and m-xylene were individually found in three different blank samples. Methylene chloride and toluene were found more frequently. Nine blanks contained methylene chloride ranging from 4.72 to 15.9 ug/l. Toluene was found in four blanks at concentrations of from 1.1 to 1.7 ug/l. In general, the concentrations of all compounds detected in the blanks were less than twice the compound's respective detection limits. Most of the blanks found to contain low levels of the target analytes were from the summer 1986 sampling round.

The trip blank data indicate low level contamination by a few compounds, but do not appear to indicate a serious contamination problem exists that would warrant corrective actions. The source of contamination is not specifically known; however, the low levels of methylene chloride and toluene may be related to laboratory extraction and cleanup procedures.

3.3.4.4 Confirmation_of_Target_Analytes_and_Concentrations

GC/MS methods were used to confirm the occurrence of target analytes identified by GC methods. The concentration of the target analytes reported by GC methods were also verified by semi-quantitative GC/MS methods. Concentrations were considered confirmed if the GC and GC/MS values were within an order of magnitude. In general, the GC/MS results confirm target

analyte identification and concentration reported by GC methods. In some cases confirmation of analyte identification was not possible because the GC/MS detection limits were higher than the concentration reported by the GC method. This situation was most frequently seen for the semivolatile fraction, particularly the organochlorine pesticides, which had GC/MS detection limits that were up to 100 times higher than the GC detection limits.

The analytical results were fairly consistent between the GC and GC/MS methods, although systematic deviations were noted for some compounds, including chloroform, DIMP, CPMSO, and $CPMSO_2$. Chloroform showed concentrations of 20 to 40 percent higher for the GC/MS method. The results for DIMP, CPMSO, and $CPMSO_2$ showed GC results typically 20 to 50 percent higher than the reported GC/MS value. These systematic relationships were not evaluated statistically because the number of samples in which these compounds were detected were relatively small and the analytical results were sometimes low in concentration (in the range of 10 to 20 ug/l). The data for other target analytes were also reviewed and possible trends evaluated. Systematic deviations in the concentrations of other target analytes were not noted for the GC and GC/MS methods.

3.3.4.5 Nontarget Compound Analytical Results

Uncertainities in Nontarget Identification

Identification of target analytes can be performed by several different analytical procedures, which contain specific protocols for target compound identification and quantification. For each analytical method, there is a different degree of certainty associated with the identification process. Although the term "identification" is sometimes used without qualifications, a more accurate description of a method's results should involve qualifiers. The term "tentatively identified" is the most common terminology for indicating lower degree of certainty associated with the identification of an organic compound.

According to standard analytical chemistry practice, compound identification requires several different types of confirming analytical evidence. In GC/MS, an unknown is said to be "identified" if its mass spectrum matches

the mass spectrum in a library database, and/or its mass spectrum and retention time matches those of an authentic standard. Tentative identification usually means that a compound was identified based on a comparison between its mass spectrum and the mass spectrum of a library compound. This library matching process is conducted by a computer program that automatically assigns a compound identification based on a probability factor. In this procedure, authentic standards are not analyzed so it is not possible to compare retention times and mass spectra, therefore, there exists a much higher degree of uncertainty in the tentatively identified compound (TIC) information. It is inappropriate to draw conclusions based on a "single" TIC result or set of TIC results without the support of confirmed compound identification information.

The TIC information can be useful in a general sense but it can also be unreliable and misleading if the data is without regard for the associated uncertainties. TICs are most useful for determining the course of future sampling/analytical activities and as supportive information in ideas that have been previously demonstrated using confirmed identified compound results.

Nontarget Compound Identification

Appendix F presents the analytical results for nontarget compounds identified by GC/MS analysis. The identification and quantification of these nontarget analytes were performed by ESE personnel. Nontarget compounds in each GC/MS analysis were reported if they met or exceeded a certain criteria based on the abundance of the most intense ion in the internal standard. The approach that has been used to report these unknowns consists of keying them to their relative retention times.

The following two examples demonstrate the method of reporting unknowns. For the first example, assume two unknowns are present in sufficient quantities in a volatiles analysis to satisfy criteria such that they must be reported and that they elute with relative retention times of 0.85 and 2.13 compared to the internal standard 1,2-dibromethane-D4. These two unknowns will be identified as UNK085 and UNK213. Because relative retention times for the volatiles are unable to exceed 5.0, no values above

UNK500 will be encountered. UNK501 through UNK999 are reserved for semivolatiles analysis.

A second example for semivolatiles will demonstrate how they are reported. For this example, assume that three unknowns which elute at relative retention times of 0.51, 1.22, and 3.54 compared to the internal standard phenanthrene D-10, exceed criteria and must be reported. Because values between UNK001 and UNK500 are reserved for unknowns from volatiles analysis, 500 is added to the relative retention time. Thus, these three unknowns would be reported as UNK551, UNK622, and UNK854.

Qualitative concentrations are calculated for the unknowns based on assuming a 1:1 response factor relationship between the abundance of the NTC and the internal standard. This assumption introduces a large degree of uncertainty in the reported concentration.

3.3.4.6 Nontarget Compound Occurrence

Numerous nontarget compounds were tentatively identified and semiquantified by GC/MS analysis. The TICs were identified using the analytical procedures briefly described in Section 3.3.4.2. Table 3.3-17 lists the TICs, concentration ranges, and their frequency of detection in offpost ground water samples. All TIC data are contained in Appendix F.

About 25 TICs were identified in offpost ground-water samples, although only 2 of the TICs were identified in 3 or more samples. The TICs most commonly found include halogenated and nonhalogenated hydrocarbons, and fuel-related compounds. However, because TICs are identified for only the ten or twenty next highest nontarget peaks (depending on the analytical method), a number of other compounds may have been present in the samples, but were not identified as TICs.

Approximately 2 of the TICs are target analytes. Because of the semiquantitative methods used to quantify TIC concentrations, as previously described, the concentration of these target analytes are considered only approximate and were not evaluated further. Excluding those target analytes, at least 2 of the remaining TICs reported are on the Hazardous

Table 3.3-17. Frequency of Detection for Tentatively Identified Compounds

Time	Frequency of Detection*	Tentative Identification**	Range of Concentration (g/l)	Well Number
UNK519	3	Tetrachloroethylene	20.9-39.5	308,309,344
UNK523	4	A Nonane/chlorobenzene	2.9-10.8	353,332,344,359
UNK524	1	4-hydroxyl-4-methyl-2-pentanone	13.0	353
UNK526	1	A Nonane	20.9	353
UNK527	1	Methyloctane	32.3	353
UNK529	1	2-methylcyclopentanone	14.1	320
UNK543	2	Dichlorobenzene/DCPD isomer	2.48-11.2	309,359
UNK563	2	Cyclopentadiene derivative/Alicyclic compound	7.43-21.9	308,309
UNK565	2	Caprolactam	154-339	305,313
UNK566	2	Cyclopentadiene/Alicyclic compound	18.9-72.7	308,309
UNK573	1	Alicyclic compound	9.11	309
UNK579	1	2-(4-methyl-2-furyl)-2-cyclopenten-1-one	14.4	313
UNK585	1	Alicyclic compound	80.0	309
UNK588	1	Propanoic acid/2-Methyl-1-(1,1-dimethyl ethyl)-2-methyl-1,3-propanediel ester	38.7	313
UNK594	2	2,6,10,14-Tetramethylpentadecane/N-Heptadecane	14.3-26.4	307,343
UNK600	2	2,6,10,14-Tetramethylpentadecane/N-Octadecane	5.51-7.48	343,307
UNK605	2	N-Nonadecane	7.49-13.0	307,343
UNK610	1	N-Eicosane	7.4	307
UNK623	1	2,5,7-metheno-3H-cyclopenta-[A] pentalen-3-one	7.90	309
UNK633	2	Tetrachlorinated compound/Pentachloro compound	8.52-40.4	308,309
UNK635	2	Bis(2-ethylhexyl) phthalate	2.83-18.4	354,Boller
UNK640	1	Phthalate	5.79	Boller
UNK649	1	Phthalate	7.08	Boller
UNK654	1	Phthalate	6.42	Boller
UNK669	1	Phthalate	5.87	Boller

* Number of detections in 23 samples analyzed.

** Additional retention times for unidentified compounds are documented in Appendix F.

Substance List (HLS), including:

- o bis(2-ethylhexyl)phthalate; and
- o dichlorobenzene.

Bis(2-ethylhexyl)phthalate appears as if it may be a laboratory artifact. This analyte appeared in 2 samples.

The concentrations of the TICs reported span a wide range. The highest reported TIC concentration was for caprolactam at 339 ug/l. A total of 6 samples had concentrations of at least one analyte above 100 ug/l. The remaining samples had reported maximum analyte concentrations less than 100 ug/l. These concentrations are considered approximate because of the method of quantification.

Distribution of Nontarget Analytes

The distribution of the most commonly occurring nontarget analytes were evaluated in the forthcoming onpost Water Remedial Investigation Report (WRIR). The nontarget analyte data is presented in Appendix F. The objectives of this evaluation were to assess:

- o The distribution of each compound relative to known suspected source areas;
- o The distribution of each compound relative to other nontarget compounds; and
- o The apparent relationships between the distributions of these commonly occurring nontarget compounds and suspected migration pathways/mechanisms between the alluvial and the Denver Fm aquifer systems.

The forthcoming WRIR concluded that the distributions are similar for the nontarget analytes and appear to coincide with target analyte plumes which are migrating from known or suspected source areas. In general, the occurrence of the nontarget analytes appears to be associated with chemical sources at South Plants, Basins A and F, and to a lesser extent Basins C, D, and E, and the railroad yard located in the southwest corner of Section 3. Although the distribution of the wells analyzed by GC/MS cover a wide geographic area, both in the vicinity of and remote from source areas, the

wells with a commonly-occurring nontarget analytes do not appear to be randomly located. These data suggest that the nontarget analytes are probably not laboratory artifacts, but are representative of actual chemical distributions. In addition to their distribution relative to source areas, these compounds are generally associated with the other nontarget analytes. That is, wells with nontarget analytes commonly contain detectable levels of several analytes. This is particularly important for wells completed in the Denver Fm because it suggests areas of interconnection between the alluvial and the Denver Fm aquifers. Thus, it appears that nontarget analytes are migrating away from major source areas along the same migration routes as are the target analytes.

The number of nontarget analytes detected offpost was generally greater for samples from wells along the primary offpost plumes. For example, Wells 37308, 37309, 37313, and 37344 exhibited the greatest number of TICs. These data would substantiate onpost assessments which concluded that nontarget analytes have migrated along the same migration routes as target analytes.

3.3.4.7 Conclusions

The results of the GC/MS analyses indicate the following:

- o GC results for target analytes, including compound identification and quantification, were generally confirmed by GC/MS analyses.
- o Numerous nontarget analytes are present in ground-water samples collected from offpost wells.
- o The distribution of the most commonly occurring nontarget analytes appears to be similar to the distribution of the target analytes, suggesting similar source areas and migration pathways.

The target compounds historically identified by GC analyses were sometimes not confirmed in samples analyzed by GC/MS analytical methods. However, these situations were commonly the result of differences in method detection limits, or sometimes as a function of high dilution factors.

The concentrations reported by GC methods also were generally consistent with concentrations attained by the GC/MS methods. Concentrations were considered confirmed if GC and GC/MS results were within an order of

magnitude. However, for a few compounds, including chloroform, DIMP, CPMSO, and $CPMSO_2$, systematic deviations were noted. These deviations could result in unforeseen problems associated with remedial actions if erroneous concentrations were reported, and later found to be significantly in error.

The results of the nontarget assessment showed that numerous nontarget analytes exist in the ground-water samples from many areas of RMA. These nontarget analytes commonly consist of halogenated and nonhalogenated hydrocarbons, and fuel-related compounds. The distribution of these compounds is generally within the major plumes of the target analytes.

Although many nontarget compounds were reported, only about 9 TICs were found in 2 or more of the ground-water samples. The nontarget compound detected in the highest concentration was caprolactam at 339 ug/l in Well 37313 located along the First Creek pathway.

3.3.4.8 Recommendations

Based on the GC/MS results, the following modifications to the ground-water sampling program are recommended:

- Additional analyses should be performed to evaluate the systematic deviations in chemical concentrations reported for chloroform, DIMP, CPMSO, $CPSMO_2$. The purpose of this evaluation will be to determine, to the extent possible, the adequacy of the GC analyses for these target compounds.
- Additional GC/MS analyses should be performed to include the acid fraction of the semivolatile organics. The results of these analyses should be evaluated to determine if additional analytes need to be added to the target analyte list. Approximately 10 percent of the wells routinely sampled should be chosen for these analyses. Wells selected should cover a wide geographic area and include source area wells and those wells remote from source areas.
- Additional compounds should be considered for addition to the offpost target analyte list, including:

  Bis(2-ethylhexyl)phthalate

Caprolactam

Dichlorobenzene

Because of the uncertainties associated with the present level of identification and quantification of these three nontarget analytes, it is recommended that approximately 10 percent of the wells routinely sampled be analyzed for these compounds using specific analytical methods appropriate for their identification and quantification. These data should then be evaluated to determine if these compounds were correctly identified and quantified. Based on the result of these analyses, recommendations should be developed for additional, final modifications to the target analyte list.

3.4 EVALUATION_OF_GROUND-WATER_DATA

Contaminant distributions in the alluvial aquifer near the RMA boundaries and in the Offpost Operable Unit to a large degree reflected historical ground-water flow patterns in the area. As discussed in Section 3.3.1, contaminants north of the NBCS appeared to have followed the two distinct alluvial pathways referred to as the First Creek and Northern pathways, as shown in Figure 3.3-1. These two pathways were further characterized chemically by organic compounds that were present in samples from wells along one pathway, but not the other. For example, zones of DBCP and chloroform contamination were evident along the Northern pathway but were generally not present along the First Creek pathway. On the other hand, DCPD, 1,4-dithiane and 1,4-oxathiane were present in samples collected along the First Creek pathway but generally not along the Northern pathway.

In general, the organic contaminants observed migrating toward the NWBCS were present in significantly lower concentrations than those observed upgradient of the NBCS. For example, the highest DIMP concentrations noted upgradient of the NWBCS were less than 100 ug/l as compared to concentrations exceeding 1,000 ug/l upgradient of the NBCS. Also, the organic contaminants observed near the NWBCS were a subset of compounds noted near the NBCS. For example, only chloroform, DBCP, DIMP, dieldrin, endrin, and chlorobenzene were observed migrating toward the NWBCS, all of which were also observed near the NBCS. In the offpost area downgradient of

the NWBCS, dieldrin, chloroform, and chlorobenzene were the most frequently observed organic contaminants.

There were several factors that affected the distribution of contaminants currently observed in the Offpost Operable Unit. The primary factors that affected the distributions of contaminants were:

- o Source locations and terms;
- o Historical and present ground-water flow patterns;
- o Where contaminants intersect the NBCS;
- o The effects of the NBCS;
- o The different transport and fate characteristics of individual contaminants; and
- o Surface water interactions.

These factors will be discussed in the following sections in terms of how they affect the contaminant distribution patterns in different areas of the Offpost Operable Unit.

3.4.1 ALLUVIAL_CONTAMINATION_NORTH_OF_RMA_NORTH_BOUNDARY

Several transport hypotheses can be formulated to address alluvial contamination present in the Offpost Operable Unit. Although a range of specific contaminant migration pathways are theoretically possible, the relative likelihood of various hypotheses can be examined by evaluating two extreme mechanisms. The first mechanism would initially involve mostly vertical movement from source areas through the alluvium to relatively permeable zones of the Denver Fm. Contaminants would then migrate primarily updip through relatively permeable zones of the Denver Fm to the alluvial aquifer via subcrop areas in the Offpost Operable Unit. The second mechanism would involve contaminant migration predominantly in the lateral direction through the alluvial aquifer from source areas to the Offpost Operable Unit where alluvial contamination is currently observed.

In reality, ground-water movement at RMA can be considered a combination of these two extreme cases. Although alluvial water will flow primarily in the lateral direction, the potential for a component of vertical movement exists throughout much of RMA. The majority of cluster wells at RMA indicate that

the direction of this potential for vertical ground-water movement is mostly downward.

Contaminants that migrate according to the first mechanism would have to travel substantial vertical distances onpost to reach Denver Fm units, or their stratigraphic equivalent, which subcrop offpost. Because of the relatively low vertical hydraulic conductivity values of the confining layers of the Denver Fm, travel times via natural vertical migration would be extensive. However, travel times could be dramatically less if contaminants migrated down poorly constructed Denver Fm wells. Lateral migration of contaminants would then occur through relatively permeable zones of the Denver Fm.

Based upon aquifer tests performed in the Denver Fm onpost, average hydraulic conductivity (K) values of 1×10^{-4} cm/sec were deemed representative of K values for onpost units (WRIR, forthcoming, ESE, 1988). Using an average gradient of 0.01 ft/ft and a porosity of 33 percent, an average linear velocity of ground water of 3.0 ft/yr would result. By comparison, the highest K values noted for Denver Fm units offpost and near the NBCS were from pumping tests. The highest K value obtained from a pumping test was 5.6×10^{-4} cm/sec which results in an average linear velocity of ground water of about 17.7 ft/yr. At 17.7 ft/yr, contaminants moving at the rate of ground water would require nearly 300 years to travel one mile laterally within the Denver Fm. Even if K values were an order of magnitude greater than the K value used in the above calculation, 30 years would be required for ground water to travel one mile. This is less than the time since disposal activities began at RMA. It would appear that average linear velocities are not high enough for contaminants to migrate laterally through the Denver Fm from source areas on RMA to subcrop areas in the Offpost Operable Unit.

There are several other factors to consider when evaluating lateral contaminant migration through the Denver Fm. First, the most permeable sand zones of the Denver Fm do not comprise a continuous or homogeneous flow system. Flow through Denver Fm zones will be strongly influenced by the configuration and permeability of individual sandstone units. Thus, the

resultant component of lateral flow is not necessarily in the direction of hydraulic gradients. Assuming that contaminants flow in a straight line through the Denver Fm is therefore considered conservative when determining if travel times from source areas to the Offpost Operable Unit are sufficient to explain offpost contamination. Also, in reality, contaminants will not move at the same velocity as ground water. Migration of chemical compounds in soil-water systems is governed by convection-dispersion processes and the geochemical characteristics of the medium. One of the most important geochemical parameters affecting the rate of migration of chemical compounds is the distribution coefficient dictating the partitioning of the chemicals between the liquid phase and the solid phase. The most significant reactions contributing to the partitioning of organic compounds is the sorption to and desorption from the solid matrix. Under appropriate conditions and assumptions, the distribution coefficient, Kd, can be used to approximate the retardation factor that expresses the velocity of migration of a specific chemical relative to the advancing water front. For contaminants that have a retardation factor less than 1.0, the solute will move at a velocity less than that of ground water. Therefore, assuming that the contaminants at RMA, with retardation factors less than 1.0, will migrate at the rate of ground water is a conservative estimate.

Considering the hydrogeologic and geochemical factors presented above, it does not appear that lateral contaminant transport over large distances through the Denver Fm is responsible for the high concentrations of organic compounds observed in the alluvial aquifer downgradient of the RMA north boundary. However, this hypothesis can be further investigated by evaluating the onpost water chemistry of Denver Fm units that subcrop near the highest observed contaminant concentrations in the alluvial aquifer offpost.

Along the Northern pathway, DBCP, chloroform, DIMP, tetrachloroethylene, and CMPSO are the most prevalent organic contaminants noted. The highest offpost concentrations of these contaminants are generally found more than one half mile north of the RMA boundary. Several Denver Fm units that were identified near the NBCS are projected to subcrop along the Northern pathway. In particular, Denver Fm units NBW#1, NBW#2, and NBE#3 are

projected to subcrop along the Northern pathway near the highest contaminant concentrations in the alluvial aquifer. Evaluation of water chemistry data for these units presented in Figures 3.3-3, 3.3-4, F-66, and F-70 indicates that DIMP, DBCP, tetrachloroethylene, and CPMSO are generally not present in these Denver Fm units upgradient near the NBCS. Although chloroform is present in these units, the concentrations are generally an order of magnitude less than the highest levels observed in the alluvial aquifer offpost. Thus, the available water chemistry data suggests that the most prevalent organic contaminants noted in the alluvial aquifer along the Northern pathway are not the result of significant lateral migration within the Denver Fm.

Along the First Creek pathway, DIMP, DCPD, CPMSO2, 1,4-dithiane and 1,2-dichloroethane are the most prevalent organic contaminants noted. The highest offpost concentrations of these contaminants are generally observed more than one quarter mile downgradient of the RMA boundary. Several Denver Fm units were identified near the NBCS which are projected to subcrop along the First Creek pathway. In particular, Denver Fm units NBW#1A, NBW#1, and NBW#2 are projected to subcrop along the First Creek pathway. Several organic contaminants, most notably DIMP, DCPD, and CPMSO2 were detected in samples from wells completed within unit NBW#1A, as shown in Figure 3.3-2. Because unit NBW#1A is projected to subcrop just beyond the RMA north boundary, it appears that this unit could be presently acting as a contaminant pathway to the Offpost Operable Unit. However, the highest organic concentrations in unit NBW#1A are generally an order of magnitude less than the highest offpost alluvial concentrations. Also, Denver Fm units NBW#1 and NBW#2 generally did not exhibit detections of these organic alluvial contaminants upgradient near the NBCS. Because units NBW#1 and NBW#2 are projected to subcrop further downgradient than unit NBW#1A and closer to the highest alluvial contaminant concentrations, it would appear that these units are not the pathway for the majority of alluvial contamination presently observed along the First Creek pathway. Although measurable contaminant transport is believed to be occurring through unit NBW#1A, it does not appear to be responsible for the majority of alluvial contamination observed offpost.

A second hypothesis to explain offpost alluvial contamination is lateral contaminant transport through the alluvial aquifer as the primary mechanism. An evaluation of presystem alluvial flow paths as shown in Figure 3.3-1 indicates that contaminants migrating toward the RMA north boundary would be expected to follow the two distinct offpost paleochannel features, the Northern pathway and First Creek pathways, along which contaminants are presently observed. An evaluation of hydrogeologic data and existing contaminant distributions in the alluvial aquifer north of RMA indicate that the much of the organic contamination observed offpost may have migrated to the offpost area before the installation of the NBCS.

An evaluation of travel times in the alluvial aquifer from the nearest source area at RMA to the Offpost Operable Unit helps substantiate the above conclusion. Travel times in the alluvial aquifer were discussed in Section 3.2. Generally, the average linear velocity of ground water in the alluvium varied considerably because of the heterogeneity of the aquifer. The most rapid velocities generally occurred through the thick sequences of coarse-grained sediments that fill bedrock channels. From pumping tests performed along paleochannels onpost near the NBCS and in the offpost area, the average linear velocities through sediments filling paleochannel features were estimated at about 4 to 7 ft/day. Thus, ground water would be expected to require approximately 2.1 to 3.6 years to travel 1 mile along paleochannels near the NBCS and in the offpost area. For mobile constituents that move at a rate similar to that of ground water, 5 to 8 years would be necessary for transport from the source areas closest to the RMA North Boundary to locations about 1 mile downgradient of the RMA boundary where contaminants have been observed. As mentioned previously, a common method used to evaluate sorption (theoretical) calculates the distribution coefficient based upon the quantity of total organic carbon in the soil. Some typical Kd values estimated by Ebasco are presented in Table 3.4-1 for several organic contaminants observed offpost. Along with the Kd values are estimates of the retardation factors, R, or the ratio of the average linear velocity of ground water to the average velocity of the retarded constituent. These values are considered approximate but do provide some indication of the relative velocity of these contaminants with respect to water. Given the retardation factors in Table 3.4-1 and the

Table 3.4-1. Estimated Range of K_d and R Values for the Offpost Operable Unit

Highly Mobile	Moderately Mobile	Low Mobility	Koc	Foc = 0.0038 (high K_d*)	Foc=0.00001 (low K_d*)	R Values (Dimensionless) (high)	(Low)
DIMP			14	0.051	0.00014	1.25	1.000
Chloroform			76	0.29	0.00076	2.43	1.003
	DCPD		1,100	4.3	0.011	22.131	1.054
	DBCP		130	0.49	0.0013	3.408	1.006
		Dieldrin	24,000	93	0.24	458.03	2.179

* Estimated K_d (ml/g) equals K_{oc} x f_{oc} (Values for K_{oc} and f_{oc} from EBASCO, 1987).
** Retardation factor (R) estiamted from bulk density of 1.72 gm/cm^3 and a porosity of 35%.

Source: ESE, 1988.

travel times for ground water, presented in the previous paragraph, it appears that the highly and moderately mobile compounds were traveling rapidly enough along the paleochannels to have migrated to the offpost area before the installation of the NBCS.

Travel times and the rate of contaminant transport are affected by the hydraulic conductivity and sorptive properties in the aquifer. Therefore, the rate of migration of contaminants in the alluvial aquifer away from paleochannel features would be expected to be slower than the rates through paleochannel sediments. This is primarily because of lower overall hydraulic conductivity and greater sorptive proprties in the aquifer on the periphery of the paleochannels. Decreased hydraulic conductivity is primarily attributed to a relative thinning of coarse basal sands and gravels away from the axes of bedrock channels. Increased sorption through sediments can generally be associated with the quantity of carbonaceous aquifer materials. In naturally occurring sediments, organic carbon is generally associated with the fine sand and silt size fractions. The coarse nature of bedrock valley fill sediments also leads to decreased organic carbon content and a concurrent decrease in sediment sorptive capacity for organic contaminants as shown in Figure 3.4-1. As a result, contaminant flux is enhanced through both increased transmissivity and decreased sorptive capacity in the coarse alluvial sediments filling erosional paleochannels in the bedrock surface. Zones of elevated contaminant concentrations offpost corresponded well with the locations of erosional paleochannel features.

A second factor that substantiated that the majority of offpost contamination was primarily a result of historical migration was observed from a comparison of contaminant distribution maps prepared for DIMP and DCPD for September 1977 (presystem conditions) (Thompson et al., 1985, RIC#86078R01) and for the spring and summer 1987 as shown in Appendix F. This comparison indicated that distribution patterns for these compounds upgradient of the NBCS have not been significantly altered by the presence and operation of the NBCS. For DBCP, the pattern of distribution appeared relatively unaffected as seen by a comparison of 1979 data and the distributions observed in 1987 as shown in Appendix F (Thompson et al.,

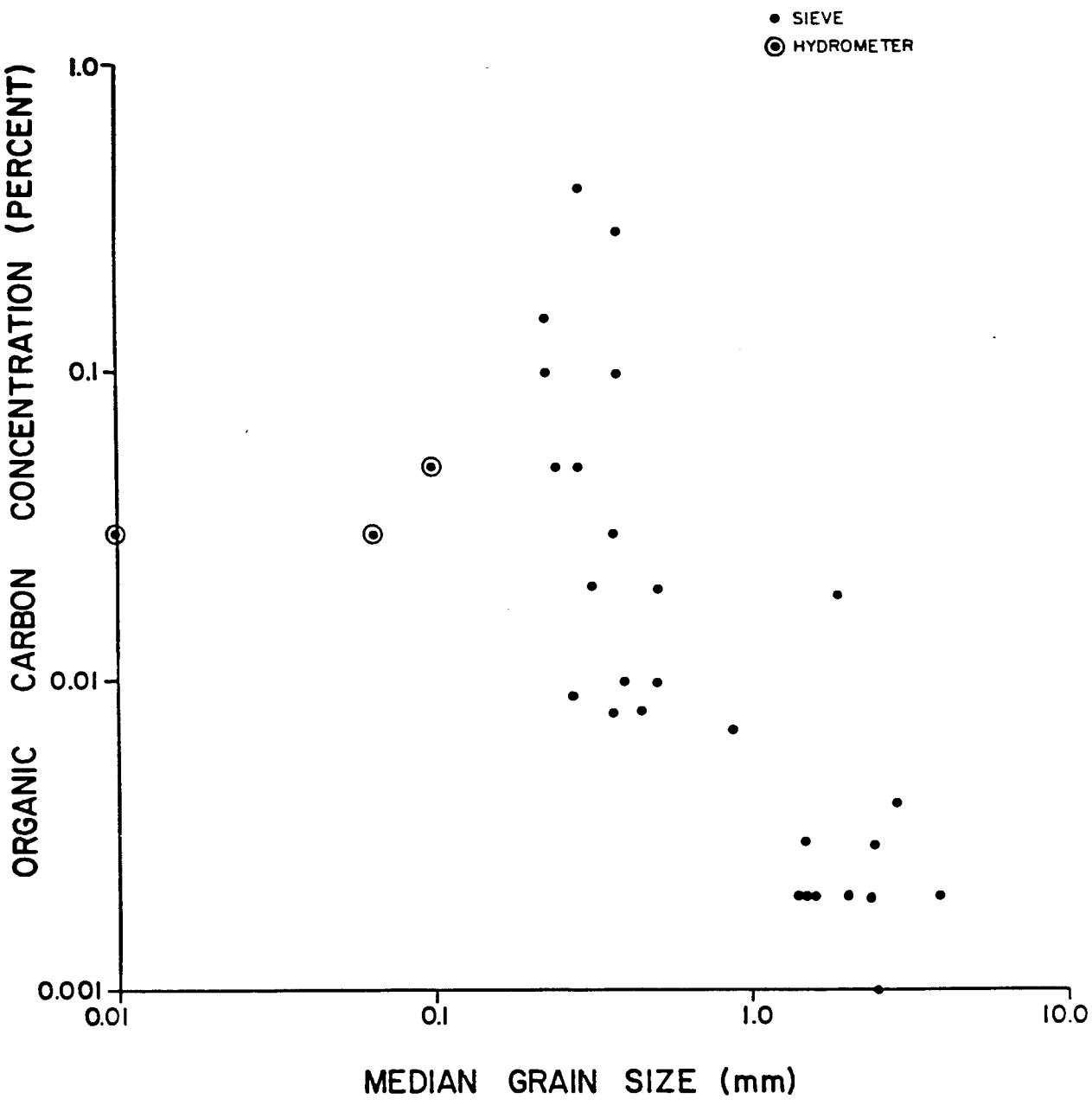


Figure 3.4-1
SCATTER DIAGRAM COMPARING
ORGANIC CARBON CONCENTRATIONS
VS MEDIAN GRAIN SIZE
SOURCE: ESE, 1988

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

1985, RIC#86078R01). Although upgradient concentrations of DBCP and DCPD have declined over the last decade, DIMP concentrations appear to have remained relatively unchanged.

Using DIMP, DBCP, and DCPD as indicators, it appeared that the upgradient pattern of distribution of contaminants was not dramatically altered by the presence of the NBCS. Thus, the present onpost patterns of distribution provide an indicator of onpost contaminant patterns that existed before the installation of the NBCS. Therefore, contaminants presently observed upgradient of the NBCS and east of D Street were generally expected to have followed historical flow directions and migrated historically along the Northern pathway. Contaminants observed upgradient of the NBCS and west of D Street would generally have migrated historically along the First Creek pathway. Where the distribution of a contaminant upgradient of the NBCS extended to the east and west of D Street, contaminants would have migrated historically along both offpost alluvial pathways. The latter situation is well illustrated by the offpost distribution of DIMP. An evaluation of onpost and offpost contaminant distributions provided in Appendix F suggested that the organic contaminants near the NBCS generally migrated in this manner.

3.4.1.1 Effects_of_the_NBCS

Offpost alluvial contamination can also be evaluated by examining the spatial distribution of relatively mobile contaminants near the RMA north boundary. An examination of contaminant distribution onpost near the NBCS and in the offpost area indicated that the plumes of relatively mobile compounds are discontinuous in the north-south direction across the area of the NBCS. For example, DIMP concentrations exceeding 1,000 ug/l were observed immediately upgradient of soil-bentonite barrier of the NBCS. However, concentrations exceeding 1,000 ug/l were generally not observed within a half-mile downgradient of the system. Instead, DIMP concentrations exceeding 1,000 ug/l were observed more than a half mile downgradient of the NBCS. A similar distribution pattern was observed for DBCP. DBCP concentrations exceeding 5.0 ug/l were noted just upgradient of the soil-

bentonite barrier, but downgradient DBCP concentrations exceeding 5.0 ug/l were noted only in samples collected more than one mile downgradient of the NBCS.

It is expected that the effects of the NBCS in reducing offpost concentrations of individual contaminants will differ depending upon the transport characteristics of different compounds. To evaluate the relative effects of the NBCS on contaminants of varying mobility in ground water, several contaminants of different transport characteristics were examined. DIMP and chloroform were chosen as "highly" mobile contaminants because they migrate at rates similar to that of ground water. DBCP and DCPD were chosen as being representative of "moderately" mobile constituents, and dieldrin was chosen as a "low" mobility compound. ESE has performed field investigations to verify the reported chemical characteristics of these contaminants in soil/water systems. The approximate range of the distribution coefficient (Kd) for each of these compounds is listed in Table 3.4-1. The values of K_d were determined using measured organic carbon contents and literature derived organic carbon partition coefficients provided by the Task 35 Toxicity Assessment (EBASCO, 1987). The rationale for examining these contaminants with a range of mobilities was to qualitatively assess the relative effects of the NBCS on reducing downgradient concentrations of contaminants with varying transport characteristics.

The chemical distribution of DIMP, DBCP, and DCPD identified from samples collected in the study area during the spring and summer of 1987 is shown in Figures F-1 through F-6 in Appendix F. The distributions of dieldrin are shown in Figures F-17 and F-18. The distributions of chloroform are presented in Figures F-23 and F-24. A summary of the concentrations and distribution of these contaminants is discussed in Section 3.3-1.

DIMP concentrations observed from wells sampled directly upgradient of the system were generally an order of magnitude higher than those obtained from wells sampled along 96th Avenue. Samples obtained from wells within 1,000 ft downgradient of 96th Avenue generally showed concentrations less than upgradient well samples but greater than from samples obtained along

96th Avenue. The declines in concentrations noted in well samples collected along 96th Avenue were generally greater east of D Street. DIMP concentrations observed from samples collected from wells over a half-mile from the RMA north boundary were generally similar in magnitude to upgradient concentrations. These higher offpost concentrations were observed in samples from Wells 37373 and 37391, which are located along the First Creek paleochannel and the Northern pathway, respectively.

The highest chloroform concentrations observed in samples from upgradient wells were generally two orders of magnitude higher than concentrations observed from well samples collected downgradient, along 96th Avenue. Chloroform was not detected at concentrations exceeding CRLs in well samples collected along the First Creek pathway. Samples from offpost Well 37389, which is located approximately 600 ft downgradient of 96th Avenue and approximately 800 ft east of Peoria Street, exhibited higher chloroform concentrations than those observed from wells sampled along 96th Avenue. However, these concentrations were less than concentrations observed in upgradient well samples. Samples from offpost Wells 37391 and 37392, which are located more than a half-mile downgradient of the NBCS and along the Northern pathway, exhibited chloroform concentrations near 100 ug/l. These concentrations were less than the highest concentrations observed from upgradient well samples but higher than downgradient concentrations observed in samples from wells closer to the NBCS.

DCPD concentrations in wells sampled directly upgradient of the NBCS were generally an order of magnitude higher than concentrations from wells sampled downgradient and along 96th Avenue. In fact, only one concentration of DCPD exceeding CRLs was observed in samples collected from wells along 96th Avenue. It was noted, however, that the areal well coverage directly downgradient of the highest upgradient DCPD concentrations was not considered adequate to fully assess DCPD concentrations in the downgradient area along 96th Avenue.

DCPD concentrations exceeding CRLs were observed in samples from offpost wells along the First Creek pathway but not along the Northern pathway. Concentrations of DCPD in samples from wells within 1,000 ft of the NBCS

were generally lower than those beyond 1,000 ft from the NBCS. DCPD concentrations observed in samples from offpost Wells 37381, 37309, and 37373 were of similar magnitude as the highest concentrations observed in upgradient wells. These three offpost wells are located more than 1,000 ft downgradient of the NBCS.

The distribution of DBCP in the study area is shown in Figures F-3 and F-4. The highest DBCP concentrations observed in samples from wells upgradient of the NBCS were generally an order of magnitude greater than the highest concentrations observed in downgradient samples from wells along 96th Avenue. Only two wells sampled along 96th Avenue during the summer of 1987 exhibited concentrations of DBCP exceeding CRLs. These downgradient detections corresponded to samples from Wells 24161 and 23043, and the concentrations observed were less than 1.00 ug/l.

DBCP was generally not observed at concentrations exceeding CRLs in offpost well samples collected along the First Creek pathway. Concentrations of DBCP were observed in samples from wells along the Northern pathway. Samples from offpost Wells 37309 and 37389, which are within 1,500 ft of the NBCS, exhibited concentrations of DBCP below 1.00 ug/l. The highest offpost concentration of DBCP was detected in a sample from Well 37391 which is located beyond a half-mile from the NBCS along the Northern pathway. The concentration observed in samples from this well were greater than 4.00 ug/l, which is similar in magnitude to the highest concentrations observed in samples from wells upgradient of the NBCS.

Dieldrin concentrations observed from well samples collected upgradient of the NBCS were generally of similar magnitude to those observed in well samples collected downgradient and along 96th Avenue. Dieldrin was detected in offpost Wells 37369, 37391, 37377, and 37313 above CRLs. Wells 37313, 37377, and 37391 are located approximately a half-mile downgradient of the NBCS. Data from these wells indicate that dieldrin has migrated along both primary offpost alluvial pathways. Downgradient dieldrin concentrations tended to decrease with increasing distance from the NBCS. This trend differed from the downgradient trends observed for the other four more mobile contaminants considered.

The patterns of contamination distribution downgradient of the NBCS were similar for compounds with similar mobility in ground water. Downgradient DIMP and chloroform concentrations, the most mobile contaminants of the five analytes examined, exhibited a pattern of increasing concentrations with increasing distance from the RMA north boundary. Concentrations of chloroform and DIMP observed in samples collected over a half-mile downgradient from the NBCS were of similar magnitude to the highest concentrations observed in samples obtained upgradient of the system. Offpost concentrations of DIMP and chloroform in samples collected immediately downgradient of the NBCS were generally an order of magnitude less than upgradient concentrations. This indicated that the NBCS has had a significant impact on reducing offpost concentrations of DIMP and chloroform.

Downgradient DBCP concentrations also exhibited a pattern of increasing concentrations with increasing distance from the NBCS. The concentration of DBCP observed in a sample collected over a half-mile downgradient of the NBCS along the Northern pathway was of similar magnitude to the highest concentrations observed in well samples collected upgradient of the system. Offpost DBCP concentrations observed in well samples obtained close to the RMA north boundary were generally an order of magnitude lower than upgradient concentrations. Downgradient DBCP concentrations tended to exhibit a pattern of increasing levels with increasing distance from the NBCS. DIMP and chloroform, which are considered only slightly more mobile than DBCP in ground water, exhibited a similar pattern offpost.

Downgradient DCPD concentrations also exhibited a pattern of increasing concentrations with increasing distance from the NBCS. However, the highest downgradient concentrations were observed closer to the NBCS than those for chloroform, DIMP, and DBCP. This is probably due to higher sorptive properties as indicated by higher estimated Kd values for DCPD as compared to DBCP, chloroform, and DIMP.

Dieldrin concentrations exhibited a completely different distribution pattern than the other four analytes examined. Concentrations immediately upgradient and downgradient of the NBCS generally did not differ greatly

from one another, although concentrations exceeding CRLs were not noted downgradient near the North Bog. Downgradient dieldrin concentrations generally decreased with increasing distances from the RMA boundary. This was an indication that, historically, dieldrin has migrated more slowly in the downgradient area than the other analytes examined. The dieldrin distribution patterns also suggested that the NBCS has not had as pronounced an effect on reducing downgradient dieldrin concentrations as for the other more mobile constituents.

Temporal Contaminant Concentration Trends in Historically Monitored Wells

An examination of contaminant distribution patterns in the Offpost Operable Unit indicated that the NBCS has had a noticeable effect on the distribution patterns of organic compounds in the Offpost Operable Unit. The effects of the NBCS in reducing offpost contaminant levels was also assessed by evaluating temporal trends in contaminant concentrations in samples from historically monitored offpost wells.

The evaluation of contaminant concentrations in offpost alluvial aquifer wells focused on five offpost wells that have been monitored by the Army since 1978. These are Wells 37307, 37308, 37309, 37312, and 37313. The contaminants evaluated for each well depended upon the location of the well with respect to offpost contaminant distributions and the availability of historical data. Generally, DIMP, DCPD, DBCP, and dieldrin were monitored historically and will be discussed for wells that exhibited detections of these compounds.

Well 37307 is located just north of 96th Avenue and about 500 ft west of D Street. Because of the limited historical data on other compounds, discussion of temporal trends for 37307 will be confined to DIMP and DCPD as illustrated in the plots of Figures 3.4-2 and 3.4-3. DIMP levels in samples from Well 37307 have declined significantly since 1978. The highest concentration of 1,450 ug/l was observed in a sample collected in July 1978.

Since that time, DIMP concentrations have declined and a concentration of 40.5 ug/l was noted in the last sample collected in June 1986.

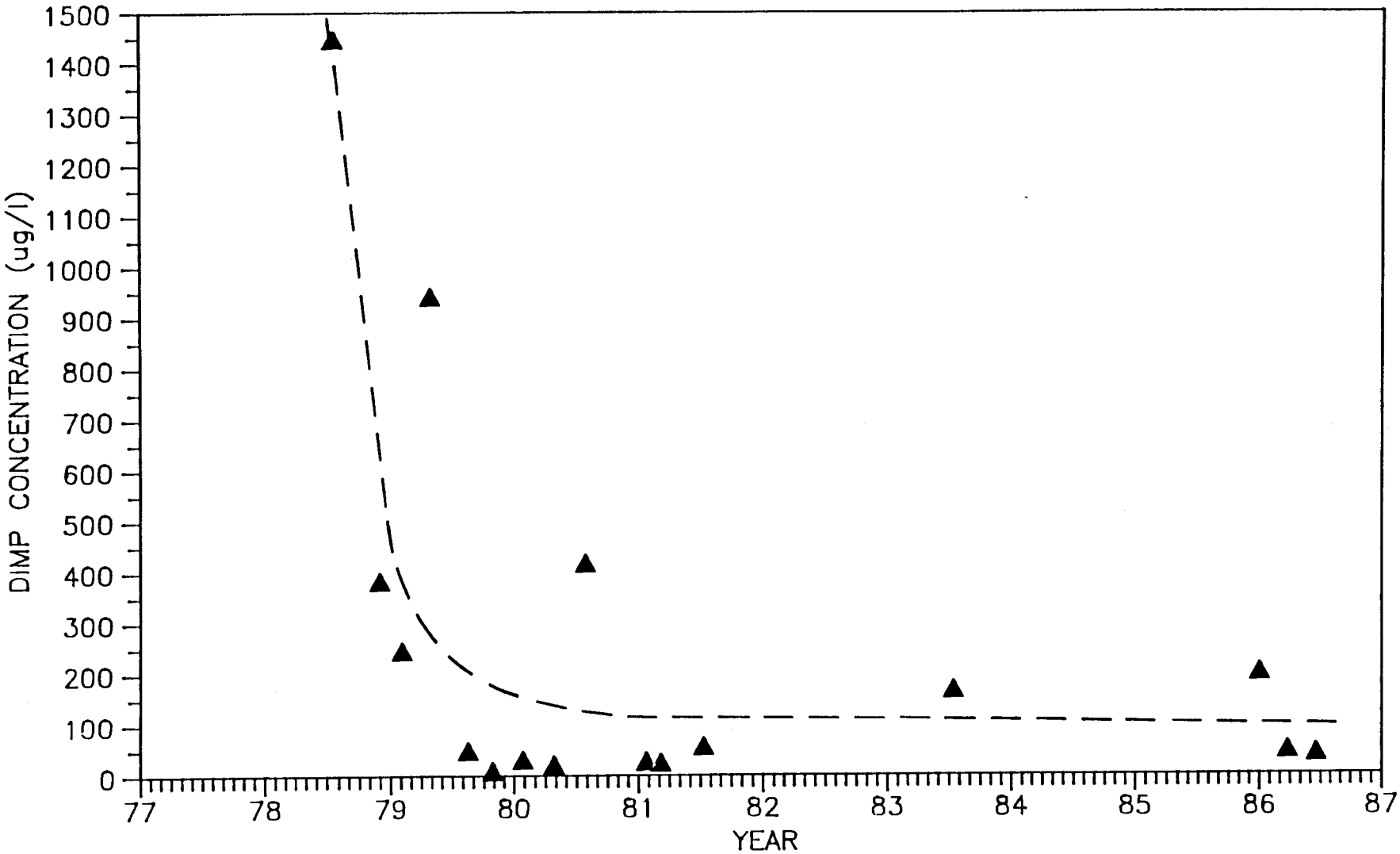


Figure 3.4–2
HISTORICAL DIMP CONCENTRATIONS
FOR WELL# 37307

SOURCE: ESE, 1988

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland

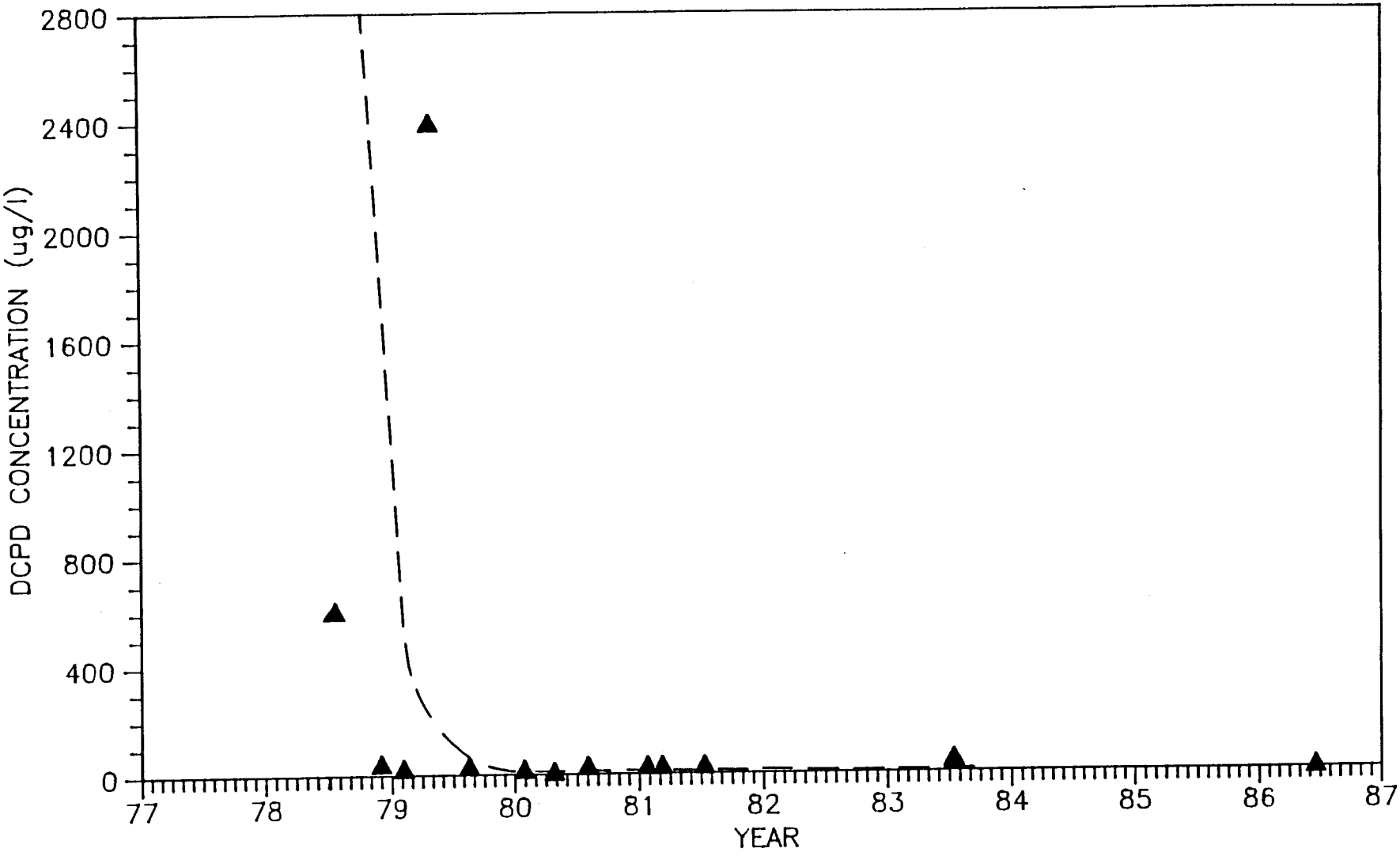


Figure 3.4–3
HISTORICAL DCPD CONCENTRATIONS
FOR WELL# 37307

SOURCE: ESE, 1988

Prepared for:
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For Rocky Mountain Arsenal

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DCPD concentrations appear to have declined in samples collected from Well 37307. The highest concentration, 2,400 ug/l, was observed in an April 1979 sample. DCPD levels declined to less than the CRL of 30 ug/l in samples collected during 1980 and 1981, and less than the CRL of 9.31 ug/l in the most recent sample collected during June 1986. Despite an apparent downward trend in DCPD concentrations in samples from this well, an evaluation of the data is limited because only two samples exhibited significant detections.

However, Well 37307 is downgradient of the DCPD plume observed upgradient of the NBCS and it therefore seems likely that concentrations have declined at this location.

Well 37308 is located offpost and approximately 500 ft north of the RMA north boundary along Peoria Street. Concentrations of DIMP observed in samples obtained since July 1978 have shown a consistent decline, as shown in Figure 3.4-4. The highest levels of DIMP were noted in a sample obtained during August 1978, which exhibited a concentration of 1,190 ug/l. The lowest DIMP concentration of 43.7 ug/l was observed in the last sample obtained during the summer of 1987.

DCPD levels also declined consistently in samples from Well 37308 as shown in Figure 3.4-5. The highest concentration from Well 37308 was from a December 1978 sample at a concentration of 2,250 ug/l. Since that time, DCPD levels have declined and the lowest historically observed concentration of 30.5 ug/l was noted in the most recent samples collected during September 1987.

Dieldrin concentrations appear to have declined slightly in samples from Well 37308 as shown in Figure 3.4-6. However, considerable scatter in the data plotted in Figure 3.4-6 limit the conclusions that can be drawn from this plot. The highest dieldrin concentration of 2.30 ug/l was noted in a sample obtained during March 1979. Two samples, collected during March and September 1987, exhibited dieldrin concentrations less than the CRL of 0.06 ug/l. However, a concentration of 0.291 ug/l was noted in the June 1987 sample. Despite these significant fluctuations in the data, the overall trend in dieldrin concentrations appears to be downward over the last

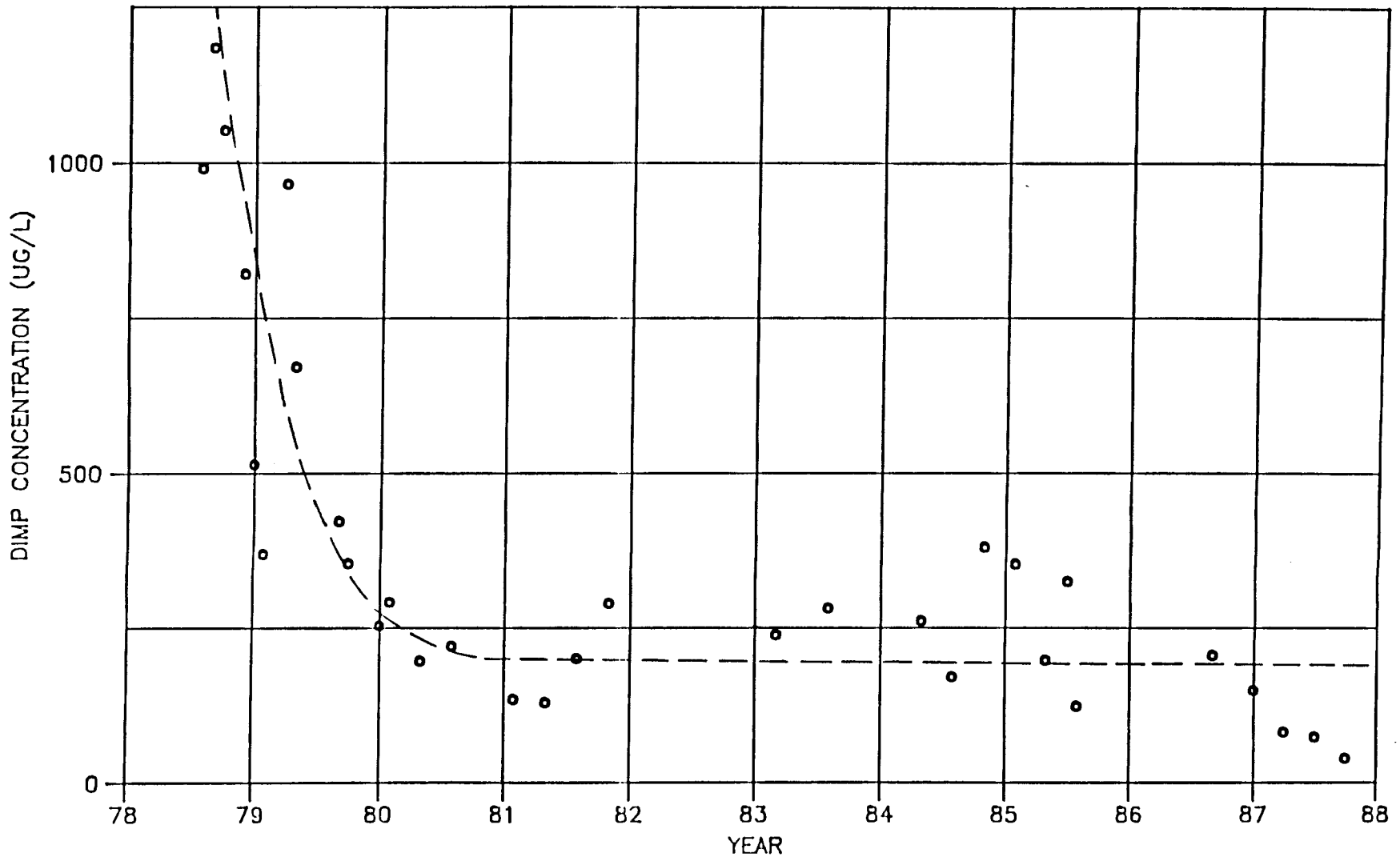


Figure 3.4–4
HISTORICAL DIMP CONCENTRATIONS
FOR WELL #37308

SOURCE: ESE, 1988

Prepared for:
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For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland

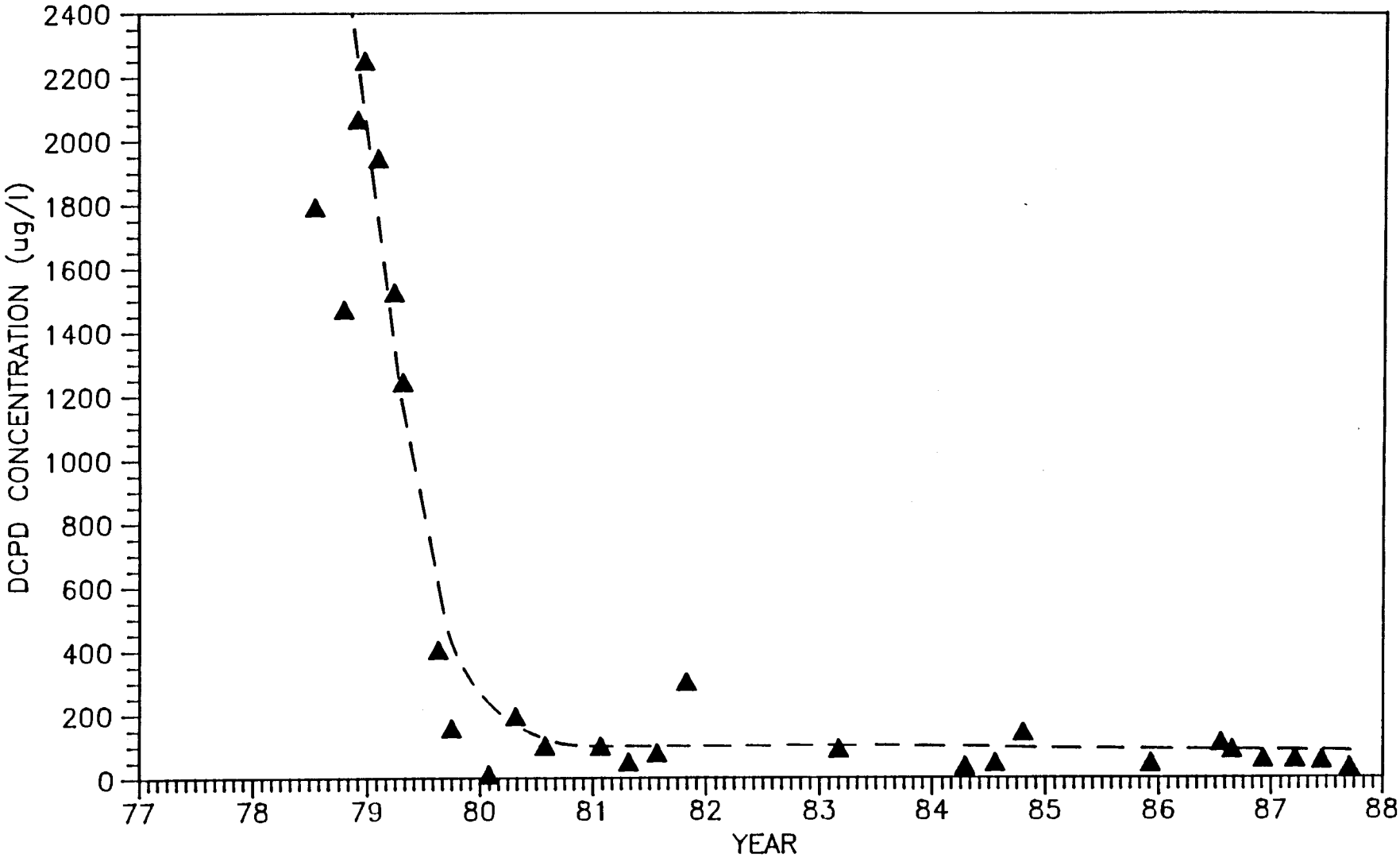


Figure 3.4–5
HISTORICAL DCPD CONCENTRATIONS
FOR WELL# 37308

SOURCE: ESE, 1988

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland

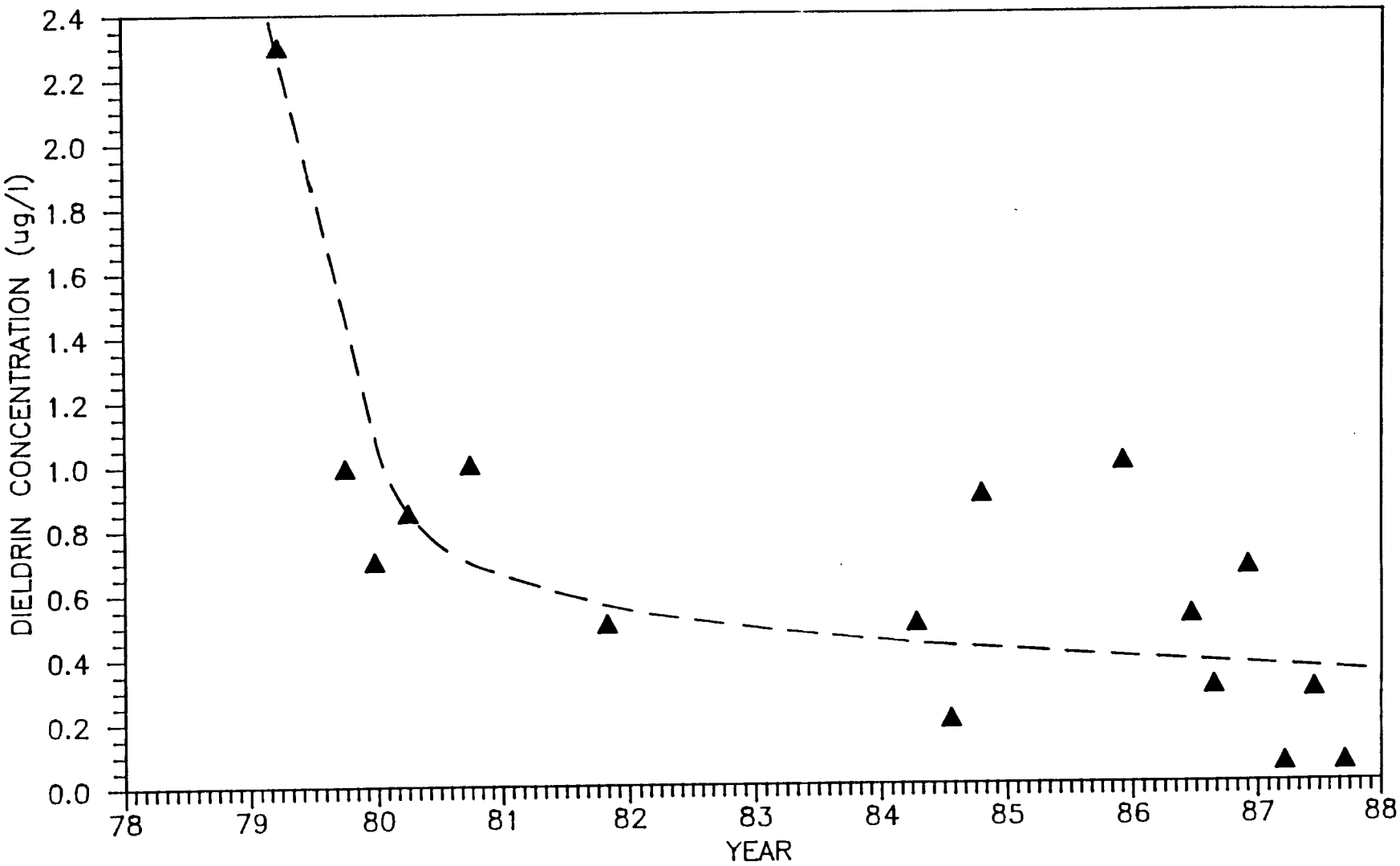


Figure 3.4–6
HISTORICAL DIELDRIN CONCENTRATIONS
FOR WELL# 37308

SOURCE: ESE, 1988

Prepared for:
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For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland

decade. Data on DBCP were not sufficient to evaluate the temporal trend for this compound.

Well 37309 is located offpost and approximately 1,300 ft north of the RMA north boundary and along Peoria Street. DIMP concentrations generally declined consistently in this well since a concentration of 3,990 ug/l was observed from a sample collected during August 1978, as shown in Figure 3.4-7. Concentrations in samples taken since January 1985 have consistently been less than 1,000 ug/l.

DCPD concentrations also declined in samples collected from Well 37309 since 1978 as shown in Figure 3.4-8. The highest concentration in a sample from Well 37309 was 2,930 ug/l which corresponds to a sample collected in January 1981. Since 1981, DCPD concentrations have declined and the lowest concentration of 475 ug/l was observed in a June 1987 sample. Although the decline in DCPD concentrations was generally consistent since 1981, the percent decline in concentrations was not nearly as great as for Wells 37307 and 37308. This may be due to the fact that Well 37309 is further downgradient of the NBCS than Wells 37307 and 37308, and the effects of the NBCS have not been realized as quickly. It is not apparent why DCPD levels increased in 1981 relative to concentrations observed in 1978 through 1980. It would appear, however, that the presence and operation of the pilot system may have affected the spatial distribution of DCPD offpost and caused a short-term increase in observed concentrations.

DBCP concentrations in samples from Well 37309 generally declined consistently since 1978 as shown in Figure 3.4-9. The highest concentration of 2.08 ug/l was observed in a July 1978 sample. Since then, DBCP concentrations declined steadily and were consistently less than 0.200 ug/l in samples collected during 1986 and 1987. Data on dieldrin were not sufficient to evaluate the temporal trends for this compound.

Well 37312 is located along 96th Avenue and about 700 ft east of Peoria Street. DIMP concentrations consistently declined in samples from this well since 1978 as shown in Figure 3.4-10. The highest concentration of 610 ug/l was observed in a July 1978 sample. The latest samples collected from this

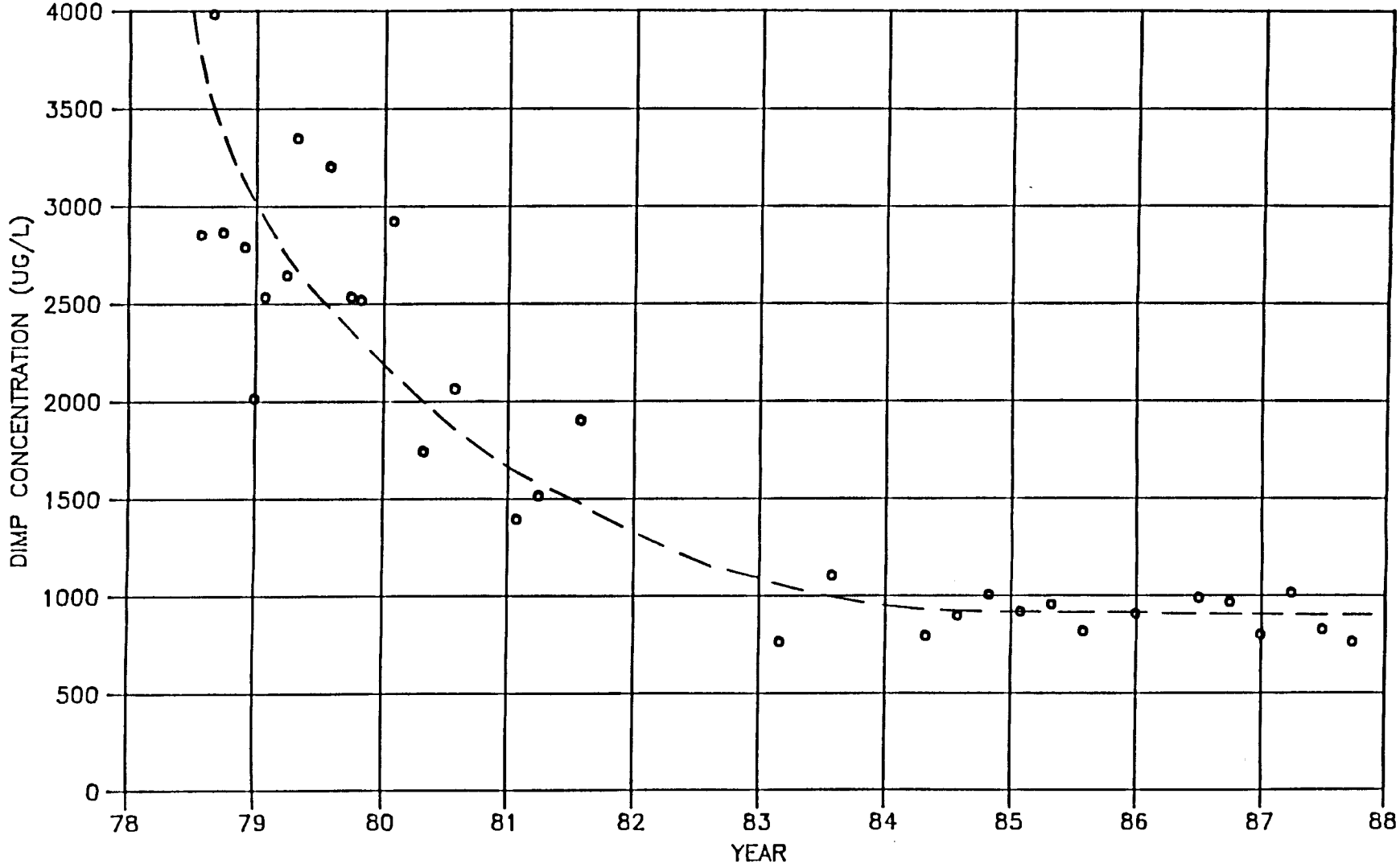


Figure 3.4–7
HISTORICAL DIMP CONCENTRATIONS
FOR WELL #37309

SOURCE: ESE, 1988

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For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland

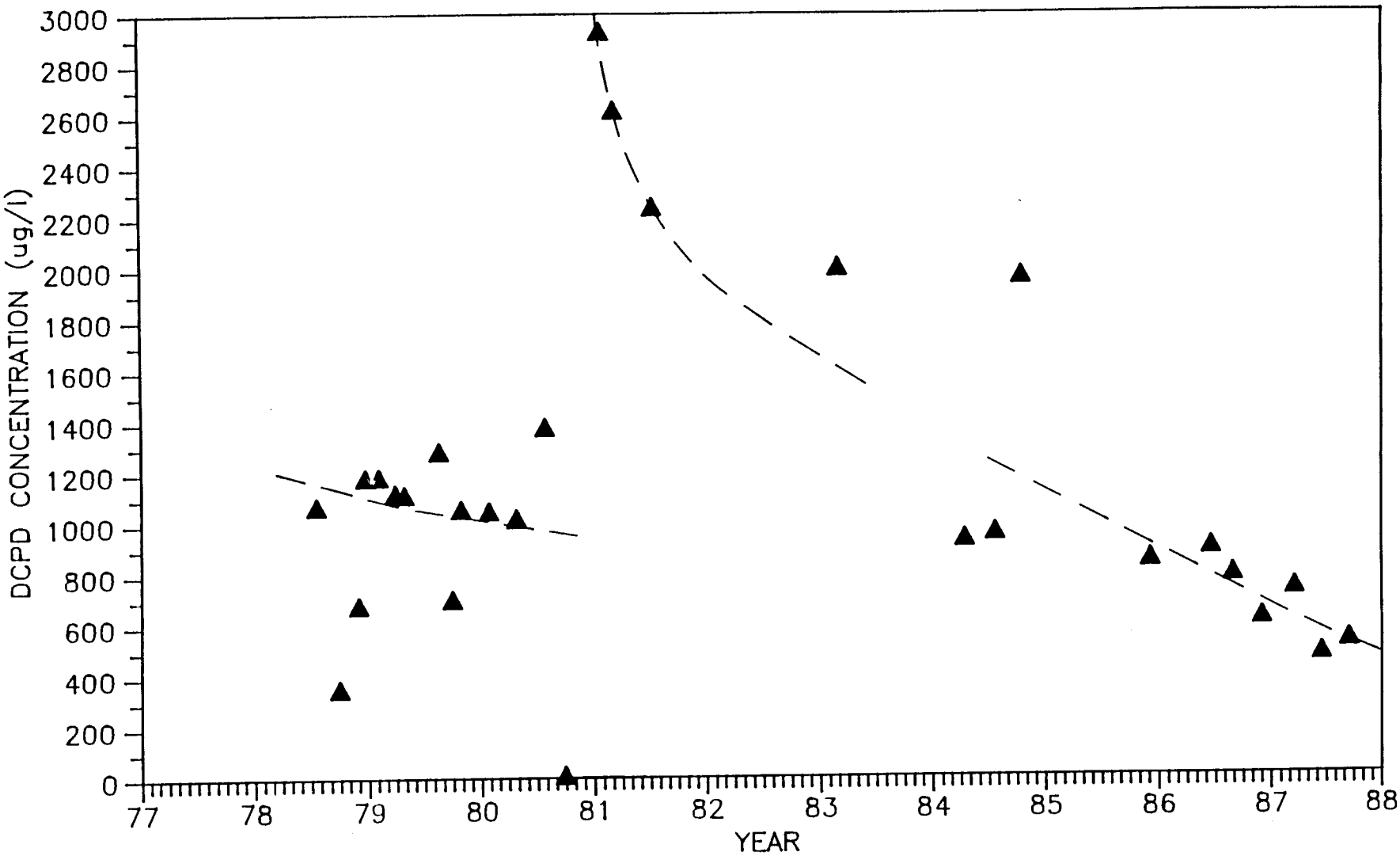


Figure 3.4–8
HISTORICAL DCPD CONCENTRATIONS
FOR WELL# 37309

SOURCE: ESE, 1988

Prepared for:
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For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland

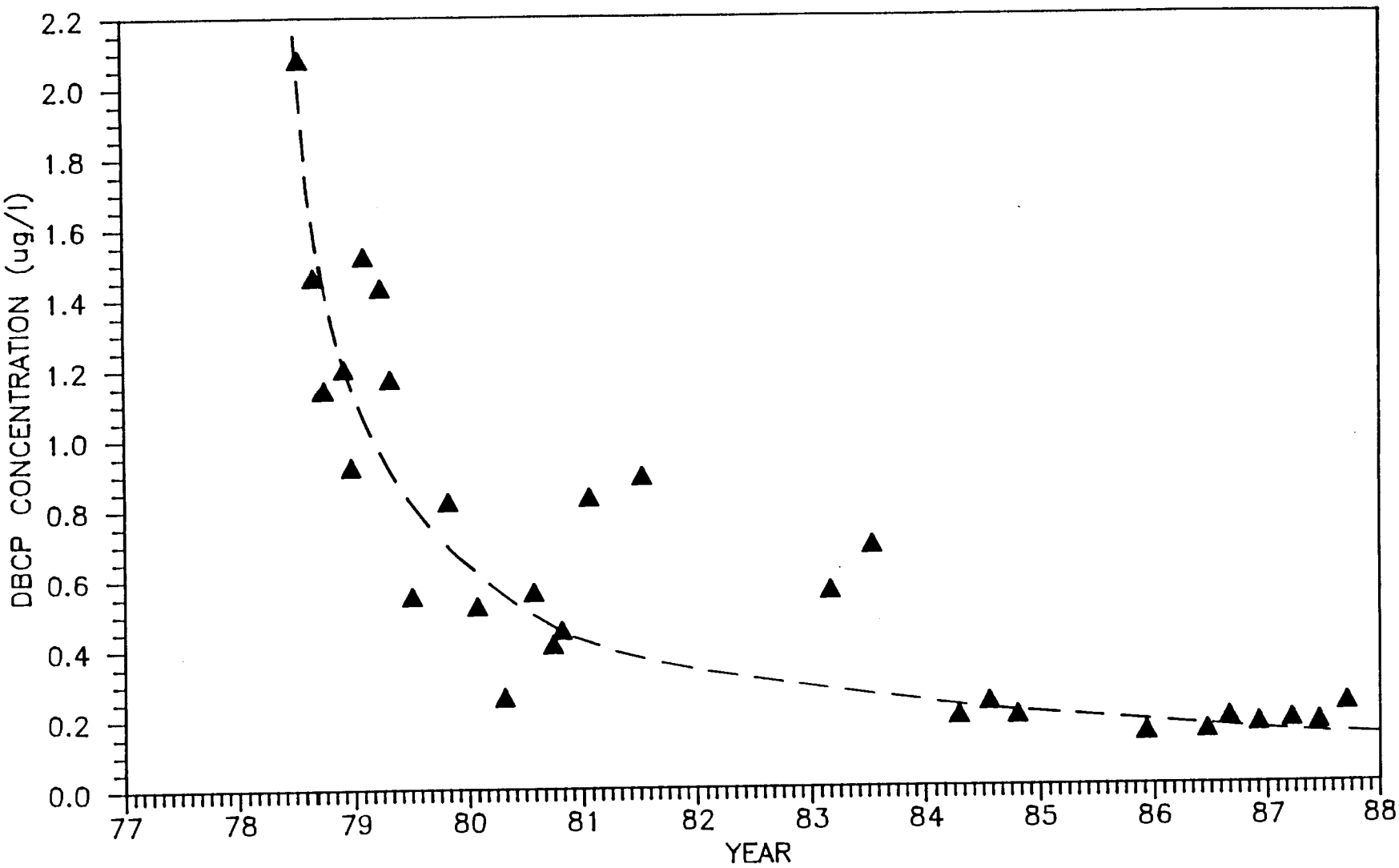


Figure 3.4–9
HISTORICAL DBCP CONCENTRATIONS
FOR WELL# 37309

SOURCE: ESE, 1988

Prepared for:
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For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland

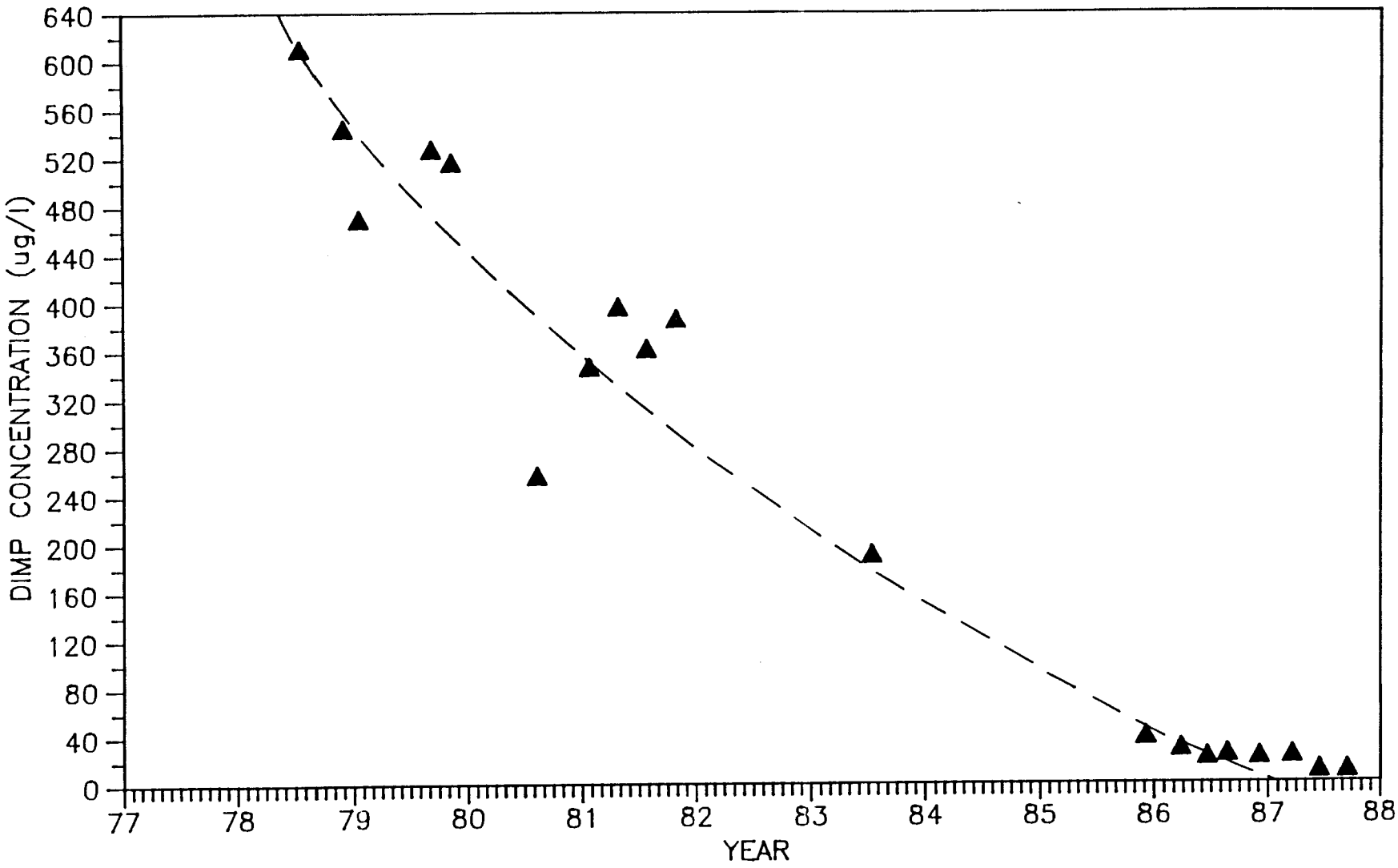


Figure 3.4–10
HISTORICAL DIMP CONCENTRATIONS
FOR WELL# 37312

SOURCE: ESE, 1988

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland

well, during June and September 1987, exhibited DIMP concentrations less than the CRL of 10.5 ug/l.

DCPD concentrations also declined consistently in samples collected from Well 37312 since 1978 as shown in Figures 3.4-11. The highest concentration of 447 ug/l was observed in an August 1978 sample. Since then, DCPD concentrations have declined, although no data is available from 1982 through 1984. DCPD concentrations in samples collected during 1985 through 1987 were consistently less than the CRL of 9.31 ug/l.

Dieldrin concentrations in samples from Well 37312 have not changed significantly since 1979 as shown in Figure 3.4-12. The highest concentration of 2.15 ug/l was observed in a sample collected during September 1979. The lowest concentration of 0.135 ug/l was observed in a September 1987 sample, but dieldrin concentrations exceeding 1.0 ug/l were consistently observed in other samples collected during 1986 and 1987. Thus, although a slight downward trend in dieldrin concentrations in indicated based upon the available data, the percentage decrease appeared to be relatively low compared to other more mobile compounds.

Well 37313 is located offpost and approximately 400 ft southwest of First Creek along Highway 2. Samples from this well have historically shown concentrations of DIMP in excess of 10,000 ug/l, as shown in Figure 3.4-13. The highest concentration of DIMP was observed in a sample obtained during January 1979 at 11,900 ug/l. DIMP concentrations averaged about 4,000 ug/l in samples collected during 1986 and 1987, which reflects an overall downward trend in this well despite significant variations in concentrations from one sampling period to the next. Data on DCPD, DBCP, and dieldrin were not sufficient to evaluate temporal trends.

Chemical analyses of samples taken from all five of these offpost wells showed a declining trend in the concentrations of DIMP, DBCP, and DCPD. Over the last decade, the DIMP, DBCP, and DCPD concentrations observed in samples from these wells generally exhibited an exponential decline with time. The decline in DIMP and DCPD levels were most pronounced in samples from Wells 37307 and 37312 which are located immediately downgradient of the NBCS along

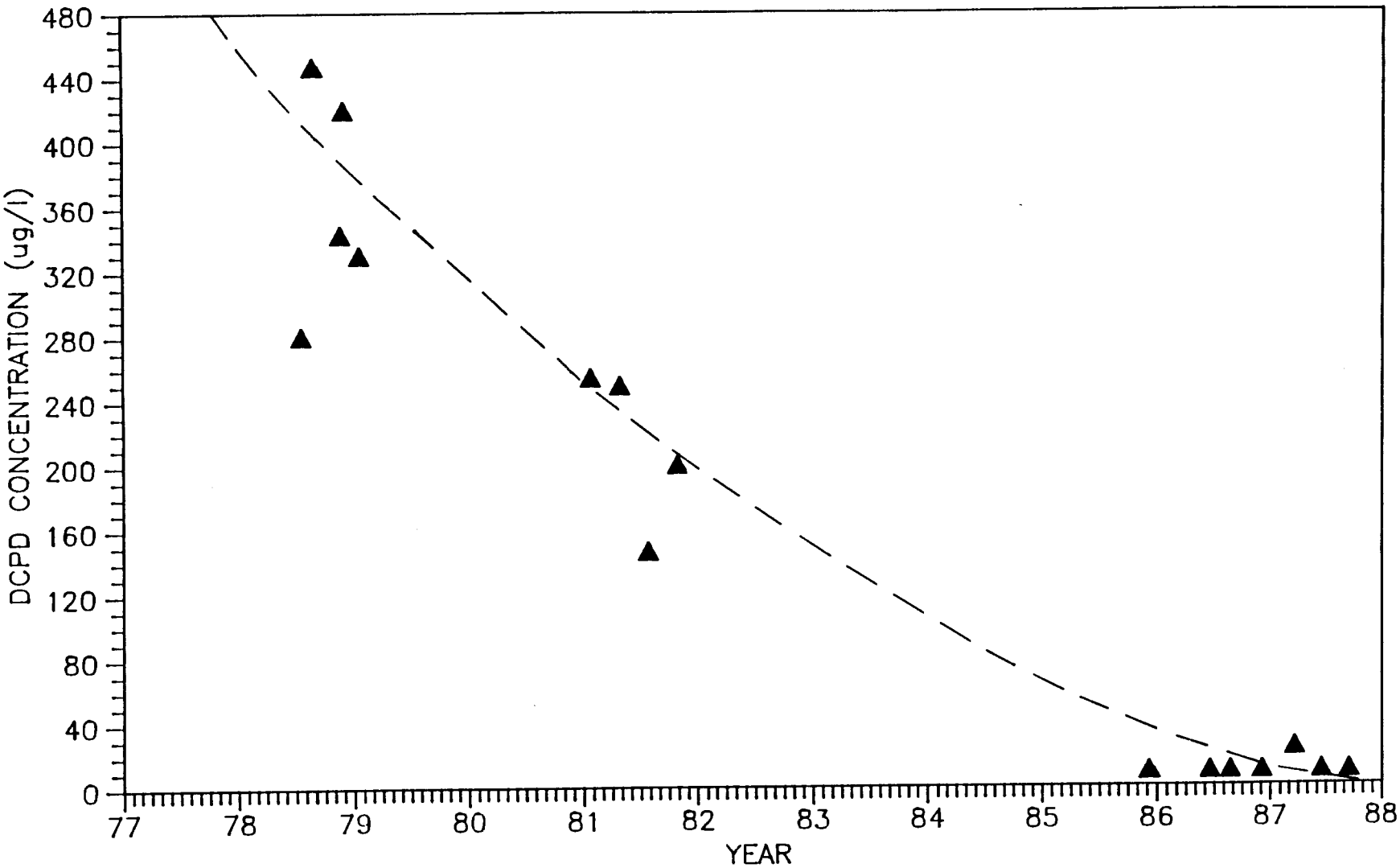


Figure 3.4–11
HISTORICAL DCPD CONCENTRATIONS
FOR WELL# 37312

SOURCE: ESE, 1988

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland

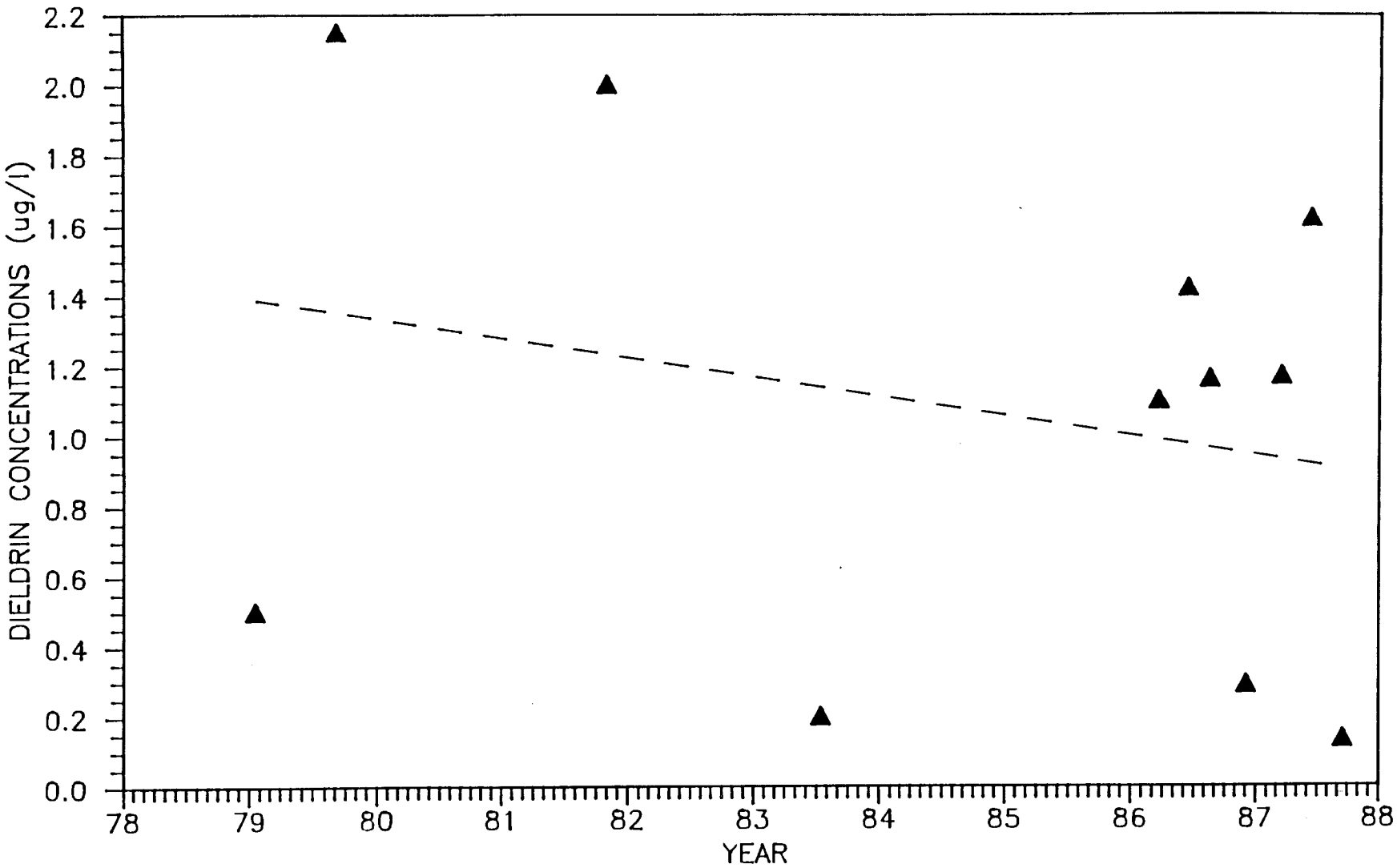


Figure 3.4–12
HISTORICAL DIELDRIN CONCENTRATIONS
FOR WELL# 37312

SOURCE: ESE, 1988

Prepared for:
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For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland

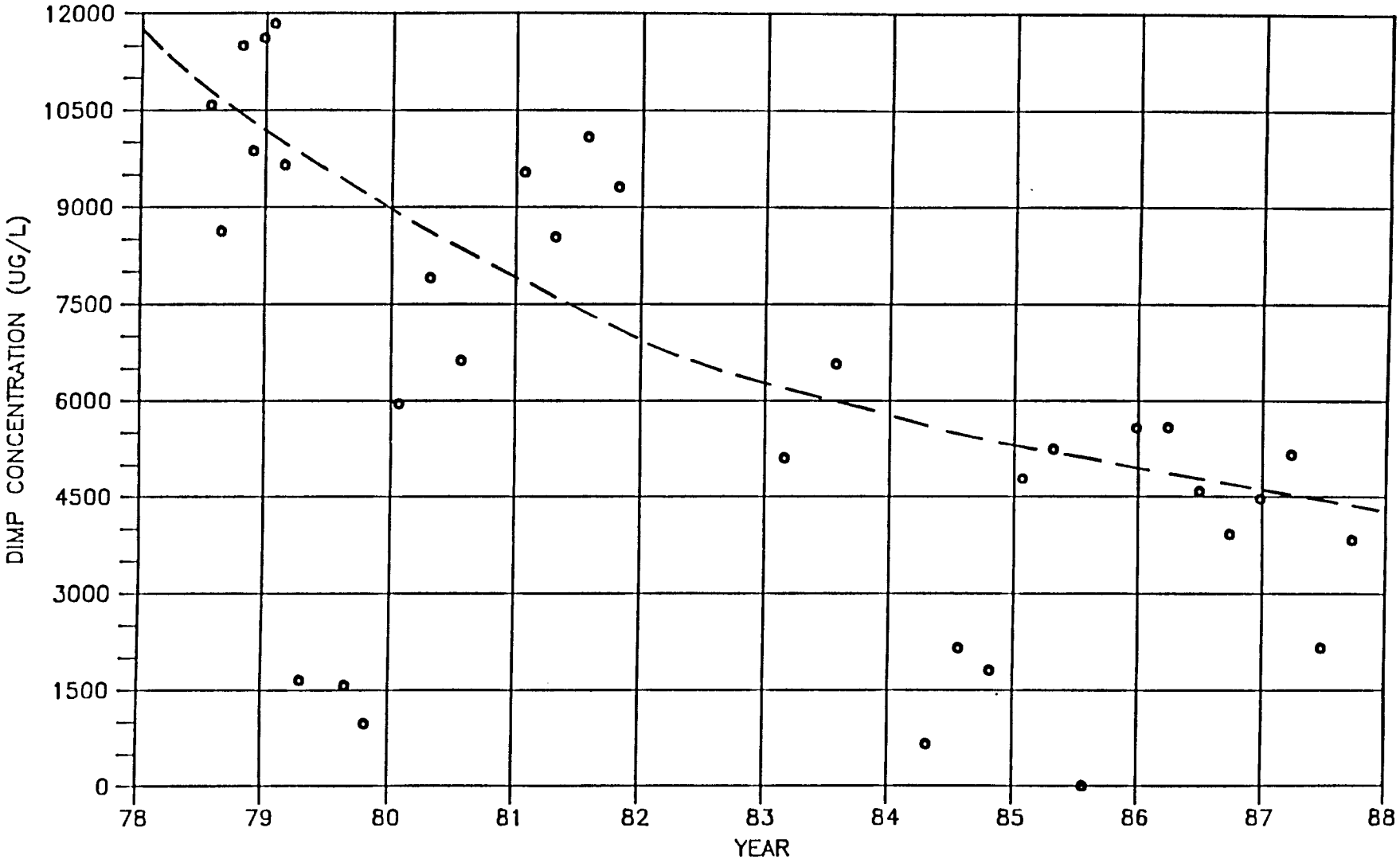


Figure 3.4–13
HISTORICAL DIMP CONCENTRATIONS FOR WELL #37313

SOURCE: ESE, 1988

Prepared for:
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For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland

96th Avenue. Downward trends were also evident for DIMP, DCPD, and DBCP in Wells 37308 and 37309 which are located 500 ft north and 1,300 ft north 96th Avenue, respectively. DIMP and DCPD concentrations declined by more than an order of magnitude in samples from Well 37308 over the last decade. Order of magnitude declines were also observed for DIMP and DBCP in samples from Well 37309. Although DCPD concentrations declined in samples from Well 37309, the percentage reduction in DCPD concentrations was not as great as for DIMP and DBCP. Slower reduction rates might be attributed to estimated lower mobilities of DCPD in ground water relative to DIMP and DBCP. DIMP concentrations in samples from Well 37313 also declined over the last decade. However, the percent reduction was not as great as with wells closer to the RMA north boundary.

Dieldrin concentrations in Wells 37308 and 37312 exhibited only a slight decrease over the last decade. This smaller percentage reduction is primarily attributed to lower mobility of dieldrin in ground water as compared to DIMP, DBCP, and DCPD.

Fate processes would also be expected to influence the concentrations of contaminants observed offpost. In particular, volatization could influence the concentrations of volatile compounds such as chloroform where shallow water table conditions exist north of the NBCS. A discussion of the significance of fate processes will be discussed in the EA report.

3.4.1.2 Effects_of_Surface_Water_Recharge

Recharge from First Creek is also expected to influence contaminant distribution patterns north of RMA. Gaging data, presented in Section 4.0 of this report, indicates that, overall, the offpost reach of First Creek loses water to the alluvial aquifer during periods of base flow. The majority of flow in First Creek occurs during the spring and summer months. As infiltration from First Creek reached the aquifer, assuming surface water contaminant concentrations are less than ground water concentrations, contaminant concentrations would be expected to decline as ground-water contaminant concentrations are diluted. The effect on contaminant concentrations in samples from a particular well is dependent upon the location of the well with respect to the recharge source. The most likely

effects of recharge from First Creek are expected to be seasonal fluctuations in contaminant concentrations downgradient of the recharge areas.

Recharge from O'Brian Canal and Burlington Ditch appear to have a considerable effect upon contaminant concentrations in the alluvial aquifer. Recharge from the canals occurred in the form of both seepage directly from the bottom of canals and irrigation in areas northwest of the canals. Konikow (1977, RIC#84192R02) estimated that the average leakage directly from both canals was about 180 gpm per mile of canal. This was subsequently substantiated by an independent study performed by Morrison Knudsen Engineers, Inc. (MKE, 1987). Considering that approximately 3 miles of the canals lie downgradient of the two primary alluvial flow paths emanating from the RMA north boundary, about 540 gpm could be recharged to the aquifer based on Konikow's estimate. This is more than twice the average flow of 220 gpm that has been recharged to the aquifer from the NBCS over the last couple of years.

The North Bog is another surface water feature that influences contaminant distribution patterns north of RMA. Large quantities of treated effluent from the NBCS, approximately 100 gpm on average, are continuously discharged to the North Bog. Organic contaminant levels in samples from wells located downgradient of the North Bog have generally been below CRLs. Because several organic contaminant plumes, such as chloroform and CPMSO, appear to have migrated through the North Bog area, it would appear that the North Bog in conjunction with the operation of the NBCS has had an influence in reducing downgradient organic contaminant levels in this area.

Recharge from irrigation northwest of the canals is also significant. Konikow estimated that irrigation rates averaged 4.2 ft/year in the area downgradient of the RMA north boundary between the canals and the South Platte River. Recharge from irrigation between the RMA north boundary and the canals was considered negligible because dry land wheat is the primary crop in this area. Konikow also estimated that 40 to 45 percent of

irrigation water recharged the alluvial aquifer. This resulted in an order of magnitude increase flow in the area downgradient of the canals and was reflected in significantly reduced contaminant concentrations in this area.

The effects of recharge from the irrigation canals can be assessed by comparing chloride concentrations upgradient and downgradient of the canals. A comparison of upgradient and downgradient chloride concentrations along both the First Creek and Northern pathways is shown in Table 3.4-2.

Chloride concentrations generally varied from a factor of three to over an order of magnitude between upgradient and downgradient wells along the First Creek pathway. The highest upgradient chloride concentrations along First Creek were more than three times greater than the highest chloride concentrations downgradient of the canals.

Significant declines in chloride concentrations were also noted in downgradient wells along the Northern pathway. The highest chloride concentrations upgradient of the canals were about five times greater than the downgradient chloride concentrations. The results of numerical modeling presented in Section 3.5 discuss these phenomena in more detail.

3.4.2 DENVER CONTAMINATION NORTH OF RMA NORTH BOUNDARY

Contamination in the Denver Fm north of the RMA north boundary was assessed by examining water quality data from 13 offpost monitoring wells in Sections 13 and 14 and a number of onpost wells near the RNA north boundary.

The vertical distribution of contaminants in the Offpost Operable Unit can be evaluated by examining water chemistry data from cluster well sites. Concentrations of some of the most prevalent organic and inorganic contaminants in the Offpost Operable Unit are shown in Tables 3.4-3, 3.4-4, and 3.4-5. A separate table, Table 3.4-4, has been prepared for benzene and chlorobenzene because these two organic compounds generally exhibited a different vertical distribution pattern than the other organic contaminants.

Table 3.4-2. Comparison of Chloride Concentrations Upgradient and Downgradient of Irrigation Canals (mg/l)

First Creek Pathway				Northern Pathway			
Up-Gradient Well No.	Conc.	Down-Gradient Well No.	Conc.	Up-Gradient Well No.	Conc.	Down-Gradient Well No.	Conc.
37313	730-1130	37346	40.9-73.9	37344	402-427	37350	85.0-86.1
37343	223-333	37347	54.9-55.5	37367	175-201	37353	103-119
37373	271-744	37348	189-325	37368	564-690	37354	65.7-87.3
37381	283-1060	37351	123-128	37383	112-131	37356	95-105
37370	518-568	37352	78.4-82.2				

Note: Concentration ranges for spring and summer 1987 samplings.
< Denotes values less than CRLs specified in Table 2.1-4.

Source: ESE, 1988.

Table 3.4-3. Selected Organic Contaminant Concentrations in Task 39 Cluster Wells (ug/l)

Well Number	Screen Interval (ft)	Denver Fm Zone	Equivalent Task 36 Denver Fm Unit	DIMP	DBCP	DCPD	Chloroform
37313		All	All	2170-3850	<	<	<
37317	51.0 - 60.5	4	*	<	<	<	<
37316	88.0 - 96.0	5	*	<10.5-27.0	<	<	<
37318	42.0 - 50.5	3	NBW#2	<	<	<	<1.88-5.51
37319	145.5 - 154.5	6	*	<	<	<	<1.88-3.10
37320	22.5 - 32.5	All	All	18.9-21.5	<	<	<
37321	64.0 - 74.0	4	*	<	<	<	<
37322	88.0 - 87.0	5	*	<	<	<	<
37338	22.5 - 29.0	All	All	<	<	<	<1.88-2.03
37376	40.5 - 51.0	3	NBE#2	<	<	<	<
37343	3.5 - 35.0	All	All	<	<	<	<
37365	49.0 - 59.5	4	*	<10.5-11.5	<	<	<
37370	4.5 - 26.0	All	All	278-1130	<	<	<
37371	28.5 - 39.0	3	NBW#2	1,100-1,480	<	<9.71-16.6	
37372	61.5 - 88.5	4	NBW#3	<	<.13-.207	<	<
37374	8.5 - 25.0	All	All	445-472	<	<	2.93-3.02
37379	39.5 - 55.5	3	NBW#2	47.1-53.7	<	<	<
37380	64.5 - 75.0	4	NBW#3	<	<	<	<
37387	37.0 - 42.5	2	*	<	<.13-0.779	<	<1.88-8.62
37388	70.0 - 86.0	4	NBW#3	<	<	<	
37389	8.5 - 35.0	All	All	343-912	.400-0.560	<	23.7-56.5
37390	40.0 - 46.0	3	NBW#2	<	<	<	

< Denotes values less than CRLs specified in Table 2.1-4.
All - Alluvial Well
* Unable to correlate to Task 36 Denver Fm unit.

Source: ESE, 1988.

Table 3.4-4. Benzene and Chlorobenzene Concentrations in Task 39 Cluster Wells (ug/l)

Well Number	Screen Interval (ft)	Denver Fm Zone	Equivalent Task 36 Denver Fm Unit	Benzene	Chlorobenzene
37313		All	All	<	<
37317	51.0 - 60.5	4	*	<	<
37316	88.0 - 96.0	5	<	<1.92-2.78	<
37318	42.0 - 50.5	3	NBW#2	<1.92-2.47	<1.36-12.0
37319	145.5 - 154.5	6	*	<	<
37320	22.5 - 32.5	All	All	<1.36-1.75	<.58-10.0
37321	64.0 - 74.0	4	*	<	<
37322	88.0 - 97.0	5	*	<	<1.36-7.74
37338	22.5 - 29.0	All	All	<1.34-1.49	2.64-8.37
37376	40.5 - 51.0	3	NBE#2	<1.92-3.64	<1.36-33.0
37343	3.5 - 35.0	All	All	<	<
37365	49.0 - 59.5	4	*	<	<
37370	4.5 - 26.0	All	All	<1.92-8.43	<1.36-27.3
37371	28.5 - 39.0	3	NBW#2	<	<
37372	61.5 - 88.5	4	NBW#3	<1.92-10.3	5.43-42.4
37374	8.5 - 25.0	All	All	2.68-3.32	13.3-21.9
37379	39.5 - 55.5	3	NBW#2	<	<1.36-17.8
37380	64.5 - 75.0	4	NBW#3	<1.92-3.65	<1.36-15.4
37387	37.0 - 42.5		*	<1.92-73.8	<1.36-74.7
37388	70.0 - 86.0	4	NBW#3	<1.92-10.1	2.07-32.8
37389	8.5 - 35.0	All	All	<	1.72-2.74
37390	40.0 - 46.0	3	NBW#2	<1.92-8.50	3.50-23.7

< Denotes values less than CRLs specified in Table 2.1-4.
All - Alluvial Well
* Unable to correlate to Task 36 Denver Fm unit.

Source: ESE, 1988.

Table 3.4-5. Fluoride, Chloride, and Sulfate Concentrations in Task 39 Cluster Wells (Concentration ug/l).

Well Number	Screen Interval (ft)	Denver Fm Zone	Equivalent Task 36 Denver Fm Unit	Fluoride	Chloride	Sulfate
37313		All	All	2030-2780	730,000-1,130,000	1,030,000-1,170,000
37317	51.0 - 60.5	4	*	1170-1290	56,000-61,800	627,000-659,000
37316	88.0 - 96.0	5	*	2060-2090	74,500-85,500	505,000-508,000
37318	42.0 - 50.5	3	NBW=2	<	39,000-44,300	313,000-314,000
37319	145.5 - 154.5	6	*	1600-1670	5,290-6,100	18,600-20,200
37320	22.5 - 2.5	All	All	<	150,000-155,000	375,000-413,000
37321	64.0 - 74.0	4	*	<	16,700-16,800	216,000-219,000
37322	88.0 - 97.0	5	*	<	16,600-17,100	207,000-209,000
37338	22.5 - 32.5	All	All	1,400-1,880	148,000-260,000	449,000-392,000
37376	40.5 - 51.0	3	NBE=2	<	14,800-15,200	192,000-210,000
37343	3.5 - 35.0	All	All	1600-1750	223,000-333,000	428,000
37365	49.0 - 59.5	4	*	<	45,100	256,000-355,000
37370	4.5 - 26.0	All	All	2550-2810	518,000-568,000	899,000-932,000
37371	28.5 - 39.0	3	NBW=2	2590-2740	429,000-467,000	678,000-700,000
37372	61.5 - 88.5	4	NBW=3	2350-2540	57,800-59,800	345,000-370,000
37374	8.5 - 25.0	All	All	<10,000-4170	386,000-716,000	202,000-214,000
37379	39.5 - 55.5	3	NBW=2	2760-3000	418,000-427,000	1,450,000-1,600,000
37380	64.5 - 75.0	4	NBW=3	2100-2680	384,000-412,000	1,100,000-1,120,000
37387	37.0 - 42.5		*	3220-4820	287,000-303,000	2,260,000-2,350,000
37388	70.0 - 86.0	4	NBW=3	2650-3700	383,000-403,000	1,480,000-1,580,000
37389	8.5 - 35.0	All	All	2190-2810	204,000-217,000	405,000-412,000
37390	40.0 - 46.0	3	NBW=2	<	55,700-72,500	242,000-251,000

All - Alluvial Well
* Unable to correlate to Task 36 Denver Fm unit.

Source: ESE, 1988.

Concentrations of the organic contaminants DIMP, DBCP, DCPD and chloroform in offpost cluster wells are provided in Table 3.4-3. DCPD was detected in subcropping sandstone with the top of the sandpack just 1.5 ft below the top of bedrock. DBCP was observed in two offpost Denver Fm wells. One detection was in a sample from Well 37387 which is completed in an upper sandstone unit that lies about 9 ft below the bedrock surface. The other well, Well 37323, is completed in a subcropping sandstone and is located along the primary alluvial DBCP plume.

DIMP was sporadically detected in offpost Denver Fm samples. The highest DIMP concentrations were noted in samples from Well 37371 which is completed in a subcropping sandstone. The DIMP concentrations in this well were comparable to those observed in the alluvial well at the site, Well 37370. DIMP was also detected in samples from Well 37379 which is completed in an upper sandstone unit. Samples from Well 37380, which is completed in the sandstone unit below 37379 did not exhibit DIMP detections. The DIMP concentrations detected in samples from Well 37379 were approximately an order of magnitude less than those observed in the overlying alluvium.

DIMP was also observed in two deeper Denver Fm wells at concentrations near the CRL. The deepest well, 37316, exhibited a DIMP concentration of 27.0 ug/l in the Spring 1987 sample. Although significant DIMP concentrations were detected in the overlying alluvial well at the site, DIMP was not detected in an intermediate Denver Fm well, Well 37317. DIMP was also detected in a sample from Well 37365 at a concentration of 11.5 ug/l which is just above the CRL of 10.5 ug/l.

Chloroform was also sporadically detected in Denver Fm wells in the Offpost Operable Unit. The highest chloroform concentrations were noted in samples from Well 37323 which is completed in a subcropping sandstone. Chloroform was also detected at relatively low concentrations, less than 9.00 ug/l in deeper Denver Fm wells. The presence of of chloroform in the deeper wells was generally noted in older wells for which construction details are not well documented.

Evaluation of Table 3.4-3 indicates that detections of DIMP, DBCP, and DCPD in the Denver Fm were most prevalent in upper sand units at the cluster sites. In deeper Denver units, chloroform and DIMP were observed in samples from older wells for which limited documentation on well construction exists. Because DIMP was not detected in stratigraphically equivalent units near the NBCS as shown in Figures 3.3-4 and Figures F-67 through F-70, it would appear that DIMP is not migrating laterally large distances through the Denver Fm. This was also substantiated by previous discussions which demonstrated relatively low average linear velocities of ground water through the Denver Fm. Hence, it is likely that vertical migration in the immediate vicinity of the Denver Fm wells may be responsible for the presence of DIMP at depth.

Although chloroform detections in deeper Denver Fm units were also noted in older Denver Fm wells, lateral migration through the Denver Fm can not be ruled out in the case of this contaminant. Chloroform was routinely detected in stratigraphically equivalent units near the NBCS at relatively low concentrations. Thus, even though the highest levels of chloroform in the Denver Fm are observed where shallow units are likely to be in hydraulic contact with the alluvial aquifer, the pathway for deeper detections of chloroform is uncertain.

Benzene and chlorobenzene generally exhibited a different vertical distribution pattern in the Denver Fm than other organic contaminants such as DIMP and DBCP. The concentrations of benzene and chlorobenzene in cluster wells in the Offpost Operable Unit are shown in Table 3.4-4. At two Denver Fm wells, 37316 and 37390, benzene was detected but was not observed in the alluvial well at the cluster site. However, at several cluster sites, benzene was observed in the alluvial aquifer and not observed in the Denver Fm. The majority of benzene detections were noted at concentrations less than 5.00 ug/l.

Chlorobenzene was observed routinely in the Denver Fm in the Offpost Operable Unit. Generally, detections of chlorobenzene in the Denver Fm corresponded to detections in the overlying alluvial aquifer. However,

higher chlorobenzene concentrations were noted in some Denver Fm wells when compared to alluvial concentrations at cluster sites. In most instances, chlorobenzene detections in the deeper Denver Fm wells also corresponded to detections in overlying Denver Fm units.

Chemistry data from Denver units upgradient near the NBCS, as shown in Figures F-67 through F-70 (i.e., NBW#2, NBW#3, NBE#2, NBE#3, and NBE#4) exhibit routine presence of benzene and chlorobenzene. Thus, it is possible that offpost detections of these two compounds is the result of lateral migration. Although average linear velocities of ground water in the Denver Fm do not support this hypothesis, chemistry data does not allow it to be ruled out.

Chemical data for benzene and chlorobenzene do not demonstrate clear-cut spatial relationships vertically or laterally. It is likely that vertical migration in the immediate vicinity of a Denver Fm well is sometimes responsible for observed detections of benzene or chlorobenzene. In other instances, it is possible that benzene or chlorobenzene migrated vertically to the Denver Fm slightly upgradient and then migrated laterally within the Denver Fm.

The vertical distribution of the inorganic constituents chloride, fluoride, and sulfate are shown in Table 3.4-5. Generally, concentrations of these analytes decreased significantly with depth into the Denver Fm. A notable exception to this observation was at the cluster site comprised of Wells 37374, 37379, and 37380. The sulfate concentrations in the Denver Fm wells at this site were more than five times that noted in the alluvial well. Also, chloride concentrations at this cluster site were fairly uniform with depth.

Inorganic concentrations in stratigraphically equivalent units near the NBCS were generally lower (Figures F-67, F-68, F-69, and F-70) than offpost where the units are shallower and closer to the alluvial aquifer. These data indicate that elevated levels of these inorganic constitutents offpost is the result of localized downward movement from the alluvial aquifer offpost and not the result of considerable lateral migration through the Denver Fm.

The depth of contamination in the Offpost Operable Unit is dependent upon the analyte being considered. Detections of the majority of organic constituents such as DIMP, DBCP, DCPD, and trichloroethylene were generally confined to the upper units of the Denver Fm where they were detected in the overlying alluvial aquifer. The absence of the contaminants in upgradient Denver Fm units suggests that these detections are the result of mostly vertical migration with only limited lateral movement through the Denver Fm. This transport hypothesis is also supported by lateral and vertical distributions of inorganic constituents.

Although significant concentrations of chloroform, greater than 5 ug/l, were also restricted to the uppermost units of the Denver Fm, relatively low concentrations, generally less than 5 ug/l, were noted sporadically in deep Denver Fm wells. The transport pathways for these detections of chloroform are not clear based upon the data available.

Benzene and chlorobenzene were also noted at depth within the Denver Fm at fairly low concentrations (benzene generally less than 10.0 ug/l and chlorobenzene generally less than 35.0 ug/l). The transport pathways for these contaminants is not evident. Because benzene and chlorobenzene were frequently detected in upgradient units, lateral migration of the contaminants through the Denver Fm can not be ruled out as a transport mechanism.

It is ESE's judgement that the depth of contamination can be reasonably assessed for some organic constituents but not for others (i.e., chloroform, benzene, and chlorobenzene). Whether or not further investigation is warranted to determine the vertical extent of these contaminants is dependent upon remedial action objectives set for these contaminants.

3.4.3 ALLUVIAL CONTAMINATION DOWNGRADIENT OF RMA NORTHWEST BOUNDARY

Dieldrin and chloroform were the primary organic contaminants observed in the offpost areas downgradient of the NWBCS. Dieldrin concentrations were highest immediately downgradient of the NWBCS and decreased further downgradient of the system. The distribution pattern of dieldrin in this

area resembled the distribution pattern downgradient of the NBCS. Because of dieldrin's relatively low mobility in ground water, it is likely that the NWBCS has not been in operation long enough to significantly reduce downgradient concentrations.

The distribution pattern of chloroform downgradient of the NWBCS was similar to that of dieldrin. The highest concentrations, generally 10 to 20 ug/l, were observed immediately downgradient of this system. However, chloroform is considerably more mobile in ground water than dieldrin. As shown near the NBCS, compounds with similar mobility would be expected to exhibit comparable distribution patterns downgradient of the system. For example, operation of the NWBCS appeared to decrease downgradient concentrations of DIMP and DBCP which were not detected in offpost samples collected downgradient of the RMA northwest boundary.

Chemistry data obtained by ESE during 1987 from effluent samples of the NWBCS indicated that chloroform was not being effectively removed from the influent stream. In fact, effluent concentrations were generally observed in the 10 to 20 ug/l range. This range of concentrations was similar to those observed in downgradient monitoring well samples. If chloroform has been consistently breaking through the carbon system, this may explain downgradient chloroform concentrations while other more mobile constituents such as DIMP and DBCP are generally not observed in this area. Efforts are currently underway to modify the operational procedures at the NWBCS to alleviate chloroform break-through.

Contaminant distributions downgradient of the NWBCS could be altered by the addition of a proposed SACWD alluvial extraction well field in the southwest quadrant of Section 21. The effects of the proposed pumping will be addressed in Section 3.5 of this report.

3.5 CONTAMINANT TRANSPORT MODELING

Based on current conditions, contaminant transport modeling was performed to simulate future contaminant concentrations in the alluvial aquifer in the Offpost Operable Unit if no remedial actions were implemented. Four scenarios were performed using DIMP, dieldrin, chloroform, and DBCP in the

model simulations. The following sections of the report describe the computer program used, the model input data, model calibration, and simulations.

3.5.1 COMPUTER PROGRAM

The computer program CSU/GWTRAN, a Galerkin finite element contaminant transport model written and developed by Dr. James Warner at Colorado State University was used in the model simulations. The mathematical development and verification of the model is given in Warner (1981) and Warner, et al. (1987). The area of the model is shown in Appendix G, Figure G-1. The model area extends from the NBCS and NWBCS to the South Platte River. The finite element mesh is shown in Figure G-2. A nonuniform element mesh was used so that the irregular geology and model boundaries could be accurately represented and so as to permit a more detailed definition of hydrogeologic conditions in the vicinity of the NBCS. The mesh consists of 2138 nodes and 4014 elements. The model was used to calculate the water table elevation and contaminant concentration at each of these nodes.

3.5.2 MODEL INPUT DATA

The sources of input data to the model included the following:

- Data collected by ESE personnel;
- Northwest Boundary Barrier Operation Model Study (Warner et al., 1986, RIC#87085R01);
- The CSU North Boundary Barrier Operation Model Study (Warner et al., 1988, RIC#84324M01);
- Konikow's (1975) Regional Hydrogeologic Study; and
- Written communication with Morrison and Knudsen Engineers (1988).

The input data sets are similar to but predate those presented in the Water Remedial Investigation Report. The data from all of the above mentioned sources for aquifer thickness, transmissivity and water table elevation were combined into a single data base. Kriging was then used to make a first estimate of aquifer properties and water table elevation at each of the nodes in the finite element mesh. Model calibration involved adjusing aquifer properties to achieve a best fit between the model calculated water

table elevation and the observed water table elevation. This kriging procedure aided in the calibration of the current model since fewer calibration simulations were needed than would have otherwise been required. The extensive calibration efforts in previous models (Warner et al., 1986, RIC#87085R01 and 1988) were thus utilized in the current model calibration.

3.5.2.1 Boundary Conditions

In the model, a no-flow boundary was used for the contact with the alluvial aquifer and the Denver Fm. A specified flux boundary condition was used for the North and Northwest barrier systems. Flux rates for the barrier systems were obtained from Warner et al., (1986, RIC#87085R01 and 1988). A constant head boundary was used in the model for the contact of the alluvial aquifer and the South Platte River.

3.5.2.2 Irrigation Recharge, Canal Leakage and Other Recharge/Discharge

Data for irrigation recharge and canal leakage was obtained from recent recharge studies conducted by Morrison Knudsen Engineers (1987). Canal leakage from Burlington and O'Brian Canals was specified as 2,400 gallons per minute (gpm) and recharge from irrigation was specified as 2,335 gpm. A water balance for the model area is shown on Figure G-3. Canal leakage and recharge from irrigation were the two largest recharge sources in the model. These two sources accounted for approximately two-thirds of the recharge to the ground water in the model area. Other recharge sources were the Northwest boundary barrier system (183 gpm), North Boundary Barrier System (221 gpm), First Creek Impoundment (114 gpm), and underflow from adjacent alluvial aquifer (1,775 gpm). The average annual leakage from First Creek was determined from flow data obtained at the gages at the North Boundary of RMA and at Highway 2. This recharge to the aquifer was assumed to be constant. Because the bottom of the impoundment along First Creek is always above the water table, while other reaches of First Creek may gain or lose water, the total recharge was assumed to be from the impoundment. The NWBCS and NBCS accounted for only about 6 percent of the recharge in the model. The major discharge was ground-water discharge to the South Platte River (6,868 gpm). Some discharge occurs as underflow to the adjacent aquifer (160 gpm).

3.5.2.3 Aquifer Thickness

Saturated thickness of the alluvial aquifer varied from 60 ft near the South Platte River to zero where outcrops of the Denver Fm interrupt the alluvial aquifer (Figure G-4). Abandoned stream channels, terraces and meander scars caused considerable variations in the thickness and composition of the alluvium.

3.5.2.4 Porosity And Storage Coefficient

The storage coefficient used in the model varied from 0.05 to 0.25. Previous model studies performed by the U.S. Geological Survey (Robson, 1976 and 1977; Warner 1979) used specific yield values of 0.25 which would be representative of water yield due to gravity drainage for the course grained alluvial aquifer material present in the vicinity of RMA. This value was originally obtained from a regional water resource investigation along the South Platte River (Smith et al., 1964). Where this value may be more representative of the alluvial aquifer regionally, more recent aquifer tests and geologic mapping indicate that the alluvium in the vicinity of the NBCS is confined, or partially confined by overlying aeolian deposits.

The apparent specific yield for all pumping tests that are in the nearby vicinity of the model area are shown in Table 3.2-1. From these pumping tests, the specific yield of the alluvium where confined by overlying aeolian deposits are less than 0.05 (based on 10 aquifer tests). VEry few of these aquifer tests are in the Offpost Operable Unit between the North Boundary Barrier System and the O'Brian and Burlington canals. However, HLA (1988) did perform a recent test in this area and obtained an apparent specific yield of .0019. This storage coefficient of 0.05 was used in the RI model in the area between the NBCS and the O'Brian and Burlington Canals.

The specific yield of 0.25 used in earlier model studies is more appropriate for the terrace gravels and course sands comprising the terraces of the South Platte River. In the Water Remedial Investigation Report, these terrace deposits are mapped and occur in the model area to the northwest of the O'Brian and Burlington Canals. In the RI model a specific yield of 0.25 was used in the model area between the canals and the South Platte River.

A porosity value of 0.35 was used in the model. This agreed with previous model studies by Warner et al., (1986, RIC#87085R01 and 1988).

3.5.2.5 Transmissivity

During model calibration, the transmissivity of the aquifer was adjusted so that the model calculated water table would better match the measured water table. The resulting transmissivity ranged from about 750 to 225,000 gpd/ft (Figures G-5a,b).

3.5.2.6 Dispersivity

For the transport model, dispersivity of the aquifer was needed. Dispersivity controls the longitudinal and transverse spreading of the contaminant plumes during migration. Dispersivity has been shown to be a scale dependent process. In the model a variable dispersivity was used depending on the distance from the contaminant plumes. The longitudinal dispersivity in the model varied from 190 ft to 1,100 ft. The smallest values of dispersivity were used in the region of the model adjacent to the NBCS. The largest value of longitudinal dispersivity was used near the South Platte River. A ratio of transverse to longitudinal dispersivity of .3 was used in the model.

3.5.2.7 Sorption Characteristics Of Contaminants

Four chemical contaminants were modeled. These were: DIMP, dieldrin, chloroform, and DCPD. ESE performed field investigations to verify the reported sorption characteristics of these contaminants in soil/water systems. All of the contaminants are considered somewhat reactive with the solid aquifer material. This is expressed by the distribution coefficient K_d. The values of K_d were determined using measured organic carbon contents and literature derived organic carbon partition coefficients provided by the Task 35 Toxicity Assessment (EBASCO, 1987). The resulting values of K_d for DIMP ranged from 0.00014 to 0.051 with mean value of 0.0042. The value of K_d for dieldrin ranged from 0.24 to 93 with a mean of 7.2, the K_d value for chloroform ranged from 0.00076 to 0.29 with a mean of 0.0228 and for DCPD, K_d ranged from 0.011 to 4.3 with a mean of 0.33. The mean value of K_d for each contaminant was used in all of the model simulations. It is realized

that the Kd values used for the no action simulations are very approximate and the actual Kd values in the ground water environment at RMA could vary from these values appreciably. Because of the lack of historical contaminant distribution data offpost however, even a rudimentary calibration of solute transport parameters was not considered helpful. Thus, the no action simulations presented should only be considered a rough indicator of how these contaminants will migrate in the future. Sensitivity analyses, for critical contaminants of concern, will be performed in the FS to evaluate the effects of differing Kd values on the no action simulation results.

3.5.2.8 Mass Balance

Mass balance errors for flow and contaminant mass were calculated by the model. This is an internal check in the model. Mass balance errors were less than one percent for flow and less than 2.5 percent for contaminant mass in the model simulations.

3.5.3 MODEL CALIBRATION

Model calibration involved adjusting aquifer properties to achieve the best fit between model calculated water table elevation and the observed water table elevation. The aquifer properties were initially estimated by kriging from field data and other model studies and then adjusted during the calibration process to increase or decrease heads where necessary. Transmissivity was mainly adjusted in the model calibration process. The calibration process was an iterative process and was repeated until a satisfactory fit was achieved. Shown on Figure G-6 is the measured spring 1987 water table map. The assumption was made that the ground-water in the model area was in a state of dynamic equilibrium. Shown on Figure G-7 is the model calculated water table map. Comparison of Figures G-6 and G-7 indicate very good agreement. No calibration check was performed on contaminant concentrations since very little data was available for past years of off-arsenal contaminant concentrations. This was not considered a significant problem and the over-all model calibration was considered to be excellent.

3.5.4 MODEL SIMULATIONS

The purpose of the model was to determine the future contaminant concentrations in the aquifer if no changes to the current ground-water system (e.g., remedial actions) were implemented. Four basic scenarios were simulated for each chemical contaminant. These four scenarios were:

Scenario 1: NBCS operated with current recharge rates and distribution extended into the future.

Scenario 2: NBCS operated with recharge rates and distribution for natural flow conditions.

Scenario 3: New South Adams County Well field is operated at approved conditions as described below.

Scenario 4: New South Adams County Well field is expanded (as proposed).

The SACWSD has approval to operate two alluvial wells within the model area by May 1989 (Ford, 1988). These wells are located offpost in the southwest quarter of Section 21, and the southeast quarter of Section 20, T25, R67W. Each of these wells will pump about 400 ac-ft per year. So far in 1988 South Adams county has recharged about 800 ac-ft in the alluvial recharge facility No. 2 located just north of the two alluvial wells and between O'Brian Canal and Little Burlington Ditch. The current recharge rate will be increased to 1,000 ac-ft per year at the times the alluvial wells will be in operation. In Scenario 3, this condition was extended indefinitely into the future. Under Scenario 4, South Adams County proposes to increase the number of wells in the model area from 2 wells to 11 wells although the addition of only 2 new production wells is scheduled for the near future. Most of these proposed wells will be located downgradient of Burlington Ditch (Section 16 and 21, T25, R67W) and west of the NWBCS. Each well will pump about 400 ac-ft per year. They additionally plan to increase recharge to about 4,000 ac-ft per year.

Following is a brief description of the model simulations for these four scenarios. The total distribution and concentrations for a contaminant is composed by the different figures (i.e., a, b, etc.) shown in Appendix G. The results are presented in concentration interval figures to best represent the contamination distribution.

3.5.4.1 DIMP

The 1987 DIMP concentrations are shown on Figure G-8. DIMP concentrations for the next 5, 10, 20, and 30 years for Scenario 1 (NBCS operated at existing conditions) are shown on Figures G-9 to G-12. DIMP is very mobile in ground water relative to the other chemical contaminants that were modeled. Several important observations should be noted. The plume of high concentration of DIMP located approximately 2,500 ft downgradient of the NBCS is diluted by canal leakage and by recharge from irrigation as the plume moves northwest across the O'Brian and Burlington canals. As a result, the high concentrations of DIMP observed downgradient of the NBCS were never observed in the area between these canals and the South Platte River. In 1987, the DIMP concentration in this area was about 200 ug/l. The model predicted that this will decline to about 100 ug/l within about 5 years due to continued dilution by irrigation recharge and natural dispersion within the aquifer. In about 10 years, the maximum concentration of DIMP in the area between the canals and the South Platte River will be about 50 ug/l and in about 20 years the maximum concentration in this area will be less than 20 ug/l.

The second observation was that DIMP concentrations on the order of 20-180 ug/l remained in the aquifer downgradient of the west side of the NBCS over the next 20- to 30-year time period. The highest concentrations of DIMP gradually moved away from the barrier (evidenced by the decreasing DIMP concentrations in this region of the model) but the flushing of the aquifer by clean recharge water from the NBCS did not displace all of the DIMP contamination.

DIMP concentrations at 5, 10, 20, and 30 years for operation of the NBCS for natural flow conditions (Scenario 2) are shown on Figures G-13 to G-16. Currently, most of the recharge water is being recharged through the north bog and the recharge wells located in the vicinity of First Creek.. With this simulation, it is assumed that recharge trenches are constructed so that more of the water is recharged towards the west end of the barrier. Comparison of Scenario 1 with Scenario 2 indicated very little change in offpost DIMP concentrations between the two scenarios. The amount of water

flowing in the aquifer toward the west end of the barrier was small, even for natural flow conditions. Thus, flushing of the aquifer of DIMP in this region will be slow. Additionally, a small paleochannel in this region funnels much of the recharge water away and the flushing of contaminants in this region of very low permeability will be very difficult.

DIMP concentrations for Scenario 3 (approved and existing new South Adams County well field operation) are shown on Figures G-17 to G-20. DIMP concentrations for Scenario 4 (proposed South Adams County well field) are shown on Figures G-21 to G-24. Comparison of these results for Scenario 3 and 4 with Scenarios 1 and 2 indicated that there was little effect of approved and existing or the proposed new South Adams County well field operations on contaminant concentrations in the vicinity of NBCS. It should be noted that, in both Scenarios 3 and 4, South Adams County is recharging about the same amount of water as they are pumping. Under these conditions, where recharge operations approximately balance the amount of water pumped, their operations should have minimal impact on contaminant concentration in the vicinity of the NBCS.

3.5.4.2 DIELDRIN

The 1987 dieldrin concentrations are shown in Figure G-25. The dieldrin simulations are shown on Figures G-26 to G-41. Dieldrin is the only one of the four mode

3.5.4.3 CHLOROFORM AND DCPD

The 1987 chloroform concentrations are shown on Figure G-42. Chloroform was found as an isolated plume north of the NBCS system. The results for Scenario 3 (approved and existing South Adams County well field operation) are shown in Figures G-43 to G-46. The other scenarios gave results very similar to Scenario 3 and thus are not shown. Chloroform is fairly mobile in ground water and will migrate towards the South Platte River. Leakage from O'Brian and Burlington canals rapidly diluted the chloroform plume and resulted in significantly decreasing chloroform concentrations with time. Within 10 years, the chloroform plume was shown to have a maximum concentration of about 20 ug/l and in about 30 years chloroform concentrations were everywhere less than 20 ug/l.

The 1987 DCPD concentrations are shown on G-47. DCPD was found only in the immediate vicinity of the NBCS. The results of simulations for Scenario 3 (approved and existing new South Adams County well field operation) are G-48 to G-51. The other scenarios gave very similar results to Scenario 3 and are thus not shown. DCPD is somewhat mobile in ground water and the current plume is located in a fairly high permeability zone near the NBCS. The DCPD plume did migrate to the northwest due to flushing of the aquifer from recharge water from North Boundary barrier operations. Within 10 years, DCPD concentrations in the plume declined to a maximum of about 50 ug/l, and within 20 years to maximum of about 10 ug/l. Within 30 years, concentrations declined everywhere to less than 10 ug/l.

3.5.5 CONCLUSIONS

The model simulations indicated the following:

- Canal leakage and recharge from irrigation significantly diluted any contaminants that migrated to the northwest of the O'Brian and Burlington canals;
- Recharging more water to the west end of the NBCS did not have a significant impact on the high concentration of DIMP in this region. Transmissivities are very low in this area and flushing of the aquifer will be slow;
- The impact on contaminant plumes of the approved and proposed new South Adams County well field operations were minimal, because net pumpage in that area was insufficient to cause reversal of hydraulic gradients;
- Effects of pumpage from the proposed well field areas north of the area where recharge is being performed is also minimal due to high hydraulic conductivities, large saturated thicknesses, and continued leakage from the canals; and
- Contaminant concentrations still exist in the Offpost Operable Unit at levels above CRLs even after 20 years.

4.0 SURFACE WATER CONDITIONS

The purpose of this section is to describe the surface water chemistry of the Offpost Operable Unit and to identify the potential pathways of contaminants associated with RMA to offpost surface water. Since ground water is the primary pathway by which contamination has migrated from source areas on RMA, emphasis in this report has been placed on depicting the interactions between ground water and surface water.

4.1 DESCRIPTION OF SURFACE DRAINAGES

The principal drainage in the Offpost Operable Unit is the South Platte River. At one time, First and Second Creeks were tributaries to the South Platte, but irrigation canals were subsequently constructed and presently intercept these channels. The average monthly flows for the South Platte River recorded at the gage just downstream of the Burlington Ditch Headgate are listed in Table 4.1-1 for the period of October 1985 through October 1987.

Figure 4.1-1 illustrates that First Creek flows to the north and northwest through the eastern portion of RMA and is the only defined channel which crosses RMA. The locations of offpost surface water sampling stations are also shown in Figure 4.1-1. Second Creek runs roughly parallel to First Creek and through the northeast corner of RMA. Both First Creek and Second Creek are tributaries to O'Brian Canal and flow intermittently during the year. First Creek generally flows from early winter through early summer, but flow periods may vary from year to year as shown in the average monthly flows listed in Table 4.1-1.

The irrigation canals between RMA and the South Platte River are O'Brian Canal, Burlington Ditch, Fulton Ditch, and Bull Ditch. The headgate for Burlington Ditch is located on the South Platte River just downstream of the Sand Creek confluence. From the headgate, Burlington Ditch flows northeast. Just upstream of 88th Avenue a diversion structure directs a majority of this flow to O'Brian Canal. O'Brian Canal and Burlington Ditch flow

Table 4.1-1. Comparison of Average Monthly Flows for South Platte River, Burlington Ditch, O'Brian Canal, and First Creek in the RMA Offpost Operable Unit (All Values in Acre-Feet)

Month	South Platte River*	Burlington Ditch Headgate**	First Creek @ RMA North Boundary***	O'Brian Canal Downstream**
Nov. 85	1,394	2,713	193	2,992
Dec. 85	12,210	0	128	0
Jan. 86	10,810	0	195	0
Feb. 86	2,320	9,652	87	8,149
Mar. 86	906	11,780	62	12,872
Apr. 86	25,020	9,797	263	7,339
May 86	4,620	19,589	70	13,265
Jun. 86	12,040	23,286	5	16,203
Jul. 86	20,690	18,207	0	10,258
Aug. 86	19,590	2,519	0	0
Sep. 86	5,900	10,064	0	5,185
Oct. 86	2,550	10,382	0	6,733
Nov. 86	1,280	16,312	0	14,098
Dec. 86	1,190	8,793	0	7,843
Jan. 87	1,250	8,309	20	8,834
Feb. 87	3,820	6,871	56	5,866
Mar. 87	12,770	6,335	99	5,268
Apr. 87	26,920	15,850	64	12,535
May 87	164,500	18,300	236	12,612
Jun. 87	63,350	33,803	258	23,955
Jul. 87	19,050	9,380	0	7,087
Aug. 87	18,520	5,861	0	3,629
Sep. 87	1,350	11,794	0	13,565
Oct. 87	2,520	14,228	0	11,382
Annual Average	216,865	136,912	900	104,834

Sources: * CSU - Division of Water Resources.
** Burlington Ditch Reservoir and Land Co., 1988.
*** ESE, 1988.

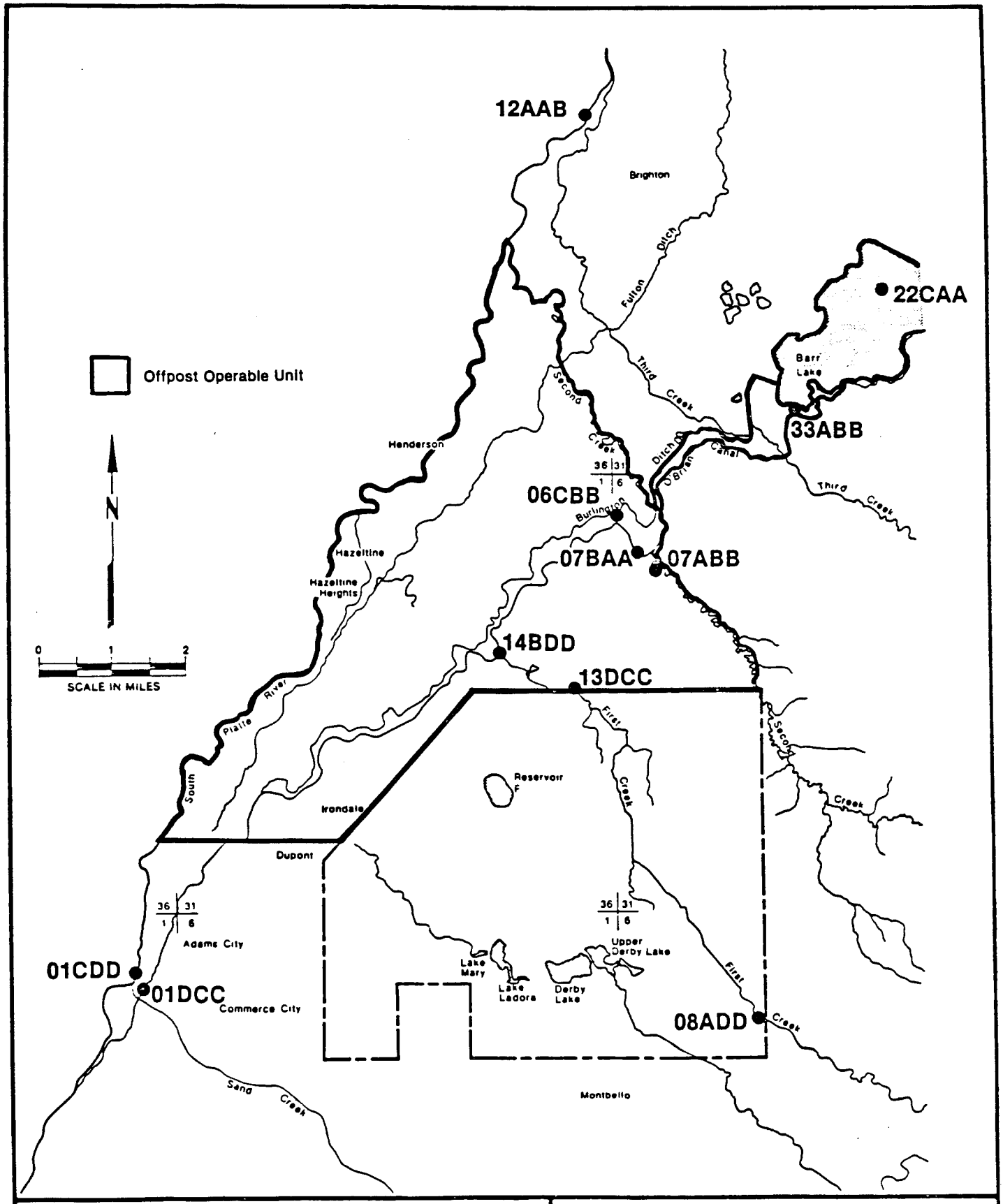


Figure 4.1-1

LOCATIONS OF OFFPOST SURFACE WATER SAMPLING STATIONS

SOURCE: ESE, 1988

Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

side-by-side to the northeast to irrigate areas to the north of RMA. Water from the O'Brian Canal may also be diverted to Barr Lake for storage. The average monthly flows for Burlington Ditch just downgradient of the headgate and O'Brian Canal just upgradient of Barr Lake are listed in Table 4.1-1.

Fulton Ditch originates as a separate drainage within the South Platte River floodplain. Farther downstream, water is diverted from the South Platte River into Fulton Ditch for irrigation of land between Burlington Ditch and the South Platte River. Bull Ditch is a small drainage channel in the South Platte floodplain between Fulton Ditch and the South Platte River.

4.2 NATURE AND EXTENT OF CONTAMINATION

ESE water-quality sampling began on a quarterly basis during the winter of 1985. The frequency of detection and range of organic and inorganic contaminant concentrations observed in samples collected from First Creek, O'Brian Canal, Burlington Ditch, South Platte River, and Barr Lake offpost surface water sampling stations during ESE sampling are presented in Tables 4.2-1 and 4.2-2. All surface water chemistry data is provided in Appendix F, and a summary of these data is provided below.

4.2.1 ORGANICS

The organic contaminants observed at concentrations exceeding CRLs in multiple samples at each offpost sampling station are illustrated in Figure 4.2-1. Generally, concentrations of organic contaminants exceeding CRLs were only sporadically observed in offpost surface water samples. Out of the eleven offpost sites sampled, nine had organic contaminant concentrations exceeding CRLs. Of these nine sites, only two had multiple detections out of an average of seven samples for each site.

Several RMA organic compounds were observed in samples from the First Creek Highway 2 station. DIMP and aldrin were the only organic contaminant observed in First Creek samples obtained upstream of RMA (08ADD). The DIMP concentration in this sample was 11.0 ug/l, and the result was not reproduced in any other sample analyses. DIMP, dieldrin, and aldrin were

Table 4.2-1. Summary of Organic Contaminant Concentrations in Offpost Surface Water (Page 1 of 2)

Station and Organic Analytes Observed	Contaminant Concentration (ug/l)	Total Number of Samples*	Number of Concentrations Exceeding CRL
First Creek			
08ADD First Creek Upstream of RMA		9	
Aldrin	0.20		1
DIMP	11		1
13DCC First Creek at North Boundary		6	
Aldrin	0.20		1
Dieldrin	0.080		1
DIMP	17		1
14BDD First Creek at O'Brian Canal		7	
CPMSO2	5.20		1
Dieldrin	0.062		1
DIMP	69.8-550		7
1,4-Dithiane	2.21-2.76		2
12DCLE	0.754		1
DCPD	24.2-31.5		2
O'Brian Canal			
07BAA Just Above 2nd Cr. Confluence		8	
Chloroform	7.96		1
DIMP	22		1
12 DCLE	1.17		1
Burlington Ditch			
01DCC upstream before headgate		7	
No Detections			0
06CBB downstream from RMA		3	
DIMP	16.9		1
Second Creek			
07ABB Just Above O'Brian Confluence		7	
No Detections			0

Table 4.2-1. Summary of Organic Contaminant Concentrations in Offpost Surface Water (Page 2 of 2)

Station and Organic Analytes Observed	Contaminant Concentration (ug/l)	Total Number of Samples*	Number of Concentrations Exceeding CRL
South Platte River			
01CDD Upstream of RMA		8	
Benzene	14.6		1
Chloroform	1.20		1
DIMP	13		1
TCLEE	2.77-7.34		3
12DCE	1.82		1
12AAB Downstream of RMA		8	
Aldrin	0.10		1
Barr Lake			
22CAA Middle Pool		6	
DIMP	11.7		1
33ABB Upstream			
Endrin	0.4	8	1
Aldrin	0.1		1

* Samples collected from December 1985 through November 1988.

Source: ESE, 1988.

Table 4.2-2. Inorganic Concentration Ranges at Offpost Surface Water Sampling Stations (ug/l)

Station	Number of Samples	Chloride (Cl)	Fluoride (F)	Sulfate (SO_4)	Calcium (Ca)	Magnesium (Mg)	Potassium (K)	Arsenic (As)	Zinc (Zn)	Sodium (Na)	Cadmium (Cd)	Chromium (Cr)	Copper (Cu)	Lead (Pb)	Mercury (Hg)
08ADD First Creek Entering RMA	8	44,800-63,330	<1,200	11,800-141,000	24,400-117,000	18,500-26,900	2,460-5,640	<3.07-6.55	<20.1-25.2	59,800-92,600	<5.16-13.7	<6.0-12.5	<7.9-21.1	<18.5-21.9	<.24
13DCC First Creek Exiting RMA	4	78,100-111,000	1,200	254,000-281,000	10,300-113,000	3,300-44,600	4,530-6,670	3.5	<20.1-41.4	12,200-174,000	<5.16	<5.96	<7.94	<18.6	<.24
14BDD First Creek at Highway 2	7	131,000-295,000	1,280-1,9100	288,000-410,000	85,300-135,000	38,400-55,600	2,610-7,070	<3.90-9.04	<20.1-29.5	157,000-302,000	<5.15	<5.96-11.5	<7.94	<18.6	<.24
07ABB Second Creek at the O'Brian Canal	6	24,900-336,000	<1,200-1,590	129,000-2,080,000	51,000-347,000	14,400-118,000	2,550-5,080	<3.9-14.4	<20.1-173	47,900-813,000	<5.16-18.5	<5.96-16.2	<7.94-22.0	<18.5	<.24-1.17
01DCC Burlington Ditch at Headgate	8	22,600-93,300	<1,200	39,300-181,000	27,300-82,700	7,220-16,600	1,870-12,500	<3.07-2.98	23.0-68.3	20,900-94,700	<5.16-	<5.96-16.3	<7.94	<18.6	<.24
06CBB Burlington Ditch at Second Creek	5	26,300-83,500	<1,200	43,700-191,000	32,300-95,500	7,850-21,200	2,160-7,750	<3.07-9.04	<20.1-114	889-112,000	<5.16	<6.0-11.5	<7.90	<18.5	<.24
07BAA O'Brian Canal at Second Creek	8	23,900-250,000	<1,200-1,730	43,000-1,730,000	27,400-306,000	7,190-92,900	1,770-5,080	<3.07-6.26	<20.1-67.2	22,600-615,000	<5.16	<6.0-16.3	<7.94	<18.6	<.24
33ABB O'Brian Canal at Barr Lake	8	24,200-97,000	<1,200	41,800-176,000	31,300-131,000	7,290-16,100	2,160-4,430	<3.90	<20.1-39.8	25,000-123,000	<5.16	<6.0-7.68	<7.90	<18.6	<.24
22CAA Barr Lake	6	51,400-61,100	<1,200	98,600-136,000	57,100-87,400	11,800-15,000	4,410-5,710	<3.90-2.96	<20.1-23.2	58,800-89,000	<5.20	<6.0	<7.94-12.1	<18.5-31.2	<.24
01CDD South Platte River at Sand Creek	6	53,000-109,000	<1,200-1,300	136,000-316,000	55,300-139,000	12,000-22,300	2,890-13,000	<2.5-33.4	<20.1-65.2	67,100-159,000	<5.16	<5.96-16.3	<7.9-10.2	<18.6	<.24
12AAB South Platte River at Brighton	7	31,300-112,000	<1,200	84,700-199,000	40,200-101,000	8,160-17,400	3,930-11,300	<3.90-4.72	<20.1-81.1	40,900-134,000	25.16-28.6	<5.96-31.3	<7.94-32.1	<18.6-28.6	<.24

Source: ESE, 1988.

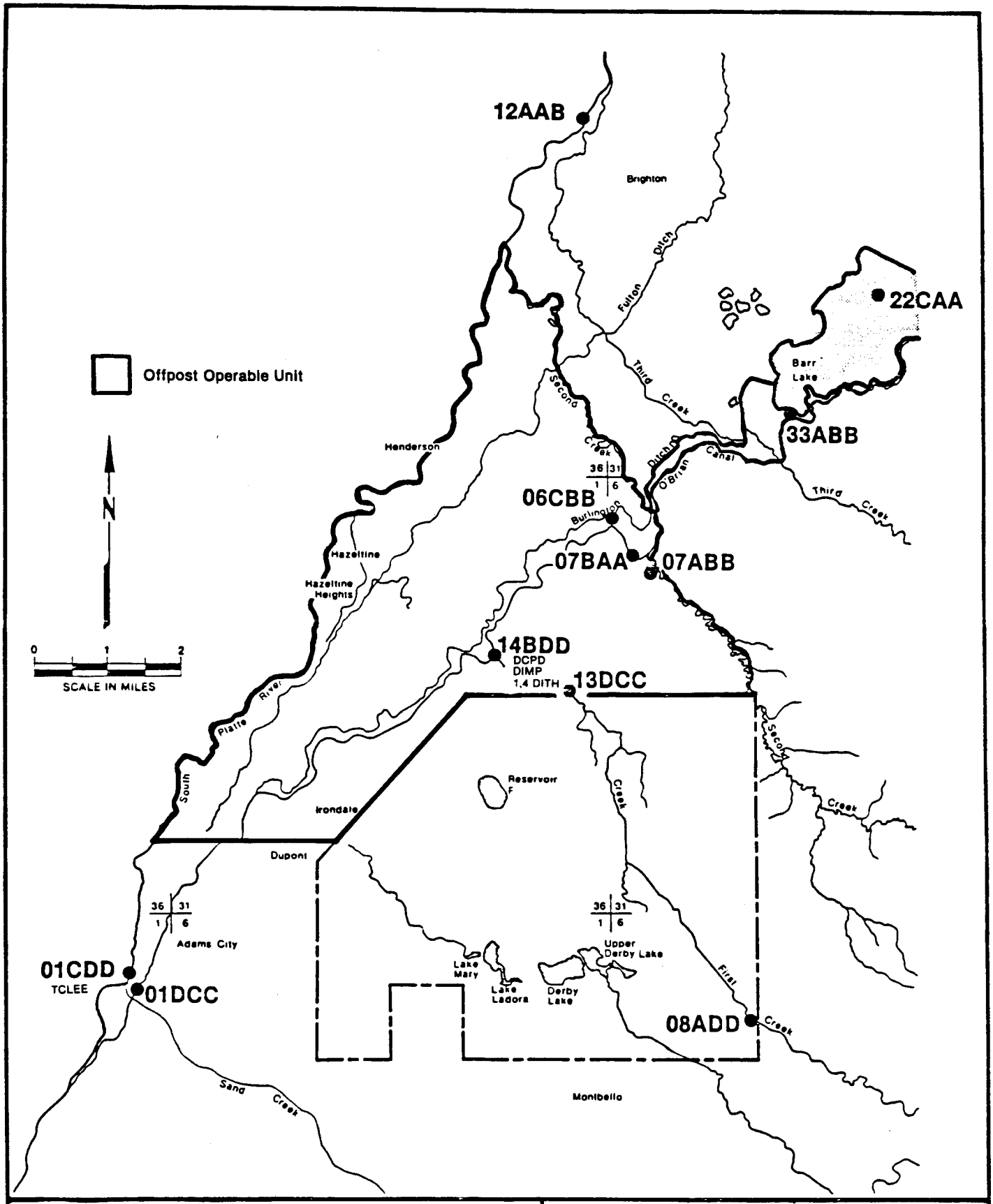


Figure 4.2-1
ORGANIC CONTAMINANTS OBSERVED IN MULTIPLE SAMPLES AT OFFPOST SURFACE WATER STATIONS
SOURCE: ESE, 1988

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observed once in samples from First Creek where it exits RMA at 96th Avenue (13DCC). The concentrations of all these contaminants were just above their respective CRLs. DCPD, DIMP, 1,4-dithiane, CPMSO2, 1,2-dichloroethane, and dieldrin were observed at concentrations exceeding CRLs in samples from First Creek at Highway 2 (14BDD).

The highest organic contaminant concentrations were observed in First Creek at the Highway 2 station during low-flow periods. This is illustrated in Figure 4.2-2 which shows DIMP concentrations versus First Creek discharge at the Highway 2 station. The highest DIMP concentrations (values exceeding 500 ug/l) were noted during flows of about 0.1 cfs and during periods when no flow was noted at the upstream North Boundary gage. These data suggests that the observed organic contaminants at Highway 2 are attributable to ground water discharges to First Creek offpost. No organic contaminants were observed in samples from Second Creek (07ABB).

Organic contaminants did not exceed CRLs in samples collected from the Burlington Ditch station upstream of RMA and the O'Brian Canal and Burlington Ditch diversion structure (01DCC). DIMP was observed in one sample collected in Burlington Ditch downstream of RMA (06CBB). The concentration of DIMP in this sample was 16.9 ug/l, and was the only organic contaminant observed in samples from Burlington Ditch. Chloroform was the only organic contaminant not observed in First Creek samples that was observed in samples from O'Brian Canal downgradient of RMA. DIMP and 1,2-dichloroethane were also observed once in a sample from O'Brian Canal at this station. Aldrin and endrin were observed in samples from O'Brian Canal as it enters Barr Lake (33ABB). DIMP was observed in samples from Barr Lake (22CAA).

Chloroform, DIMP, benzene, trans-1,2-dichloroethylene, and tetrachloroethylene were observed upstream of RMA in the South Platte River (01CDD). The DIMP concentration observed in this sample was 13.0 ug/l, which just exceeds the CRL. This station is directly downstream of the Sand Creek confluence and some observed contamination may be attributable to

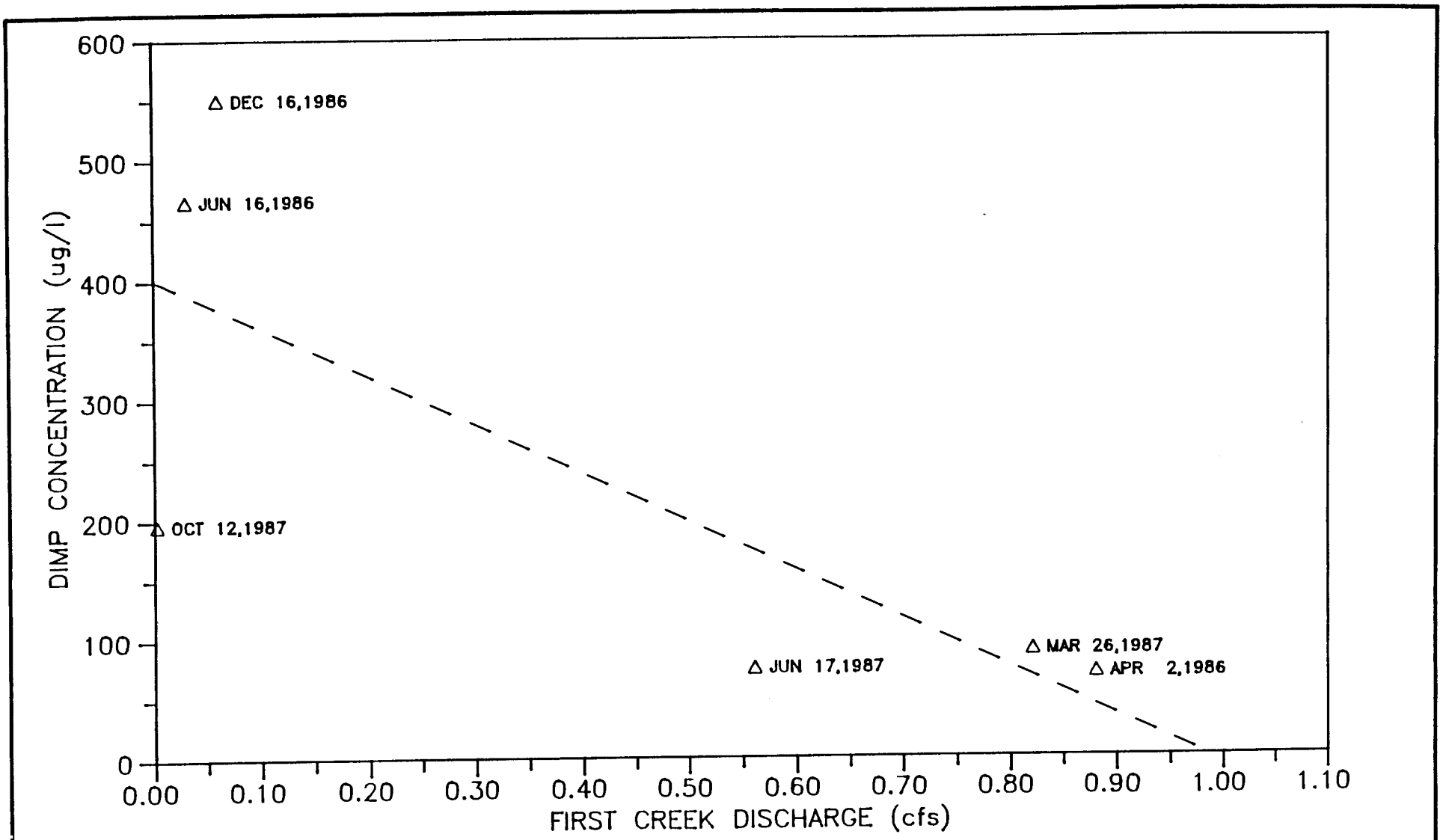


Figure 4.2–2
RELATIONSHIP BETWEEN FIRST CREEK DISCHARGES AND DIMP CONCENTRATIONS

SOURCE: ESE, 1988

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other sources along Sand Creek. Aldrin was the only organic contaminant observed at concentrations exceeding CRLs in samples collected from the South Platte River downstream of RMA near Brighton (12ABB).

4.2.2 INORGANICS

The inorganic chemistry of samples collected at each of the offpost surface water stations is summarized in Table 4.2-2. Chloride concentrations generally ranged from about 20,000 ug/l to 100,000 ug/l for offpost surface water samples. However, higher than average chloride concentrations were observed in samples from the First Creek Highway 2 station and ranged from 131,000 ug/l to 295,000 ug/l. The lowest chloride concentrations were generally observed in samples from the stations upstream of RMA on First Creek (08ADD) and Burlington Ditch (01DCC) and samples from the station on Second Creek (07ABB). Chloride concentrations from these stations were generally less than 50,000 ug/l.

Fluoride concentrations in samples from the offpost surface water stations were generally less than the CRL of 1,200 ug/l. However, higher concentrations were observed in samples collected from First Creek at the Highway 2 station. All seven samples from this station exhibited fluoride concentrations exceeding the CRL. The highest concentration in a sample from this station was 1,910 ug/l. Concentrations of fluoride in samples collected at the First Creek station upstream at 96th Avenue were all less than the CRL.

Sulfate concentrations in samples from the offpost surface water network generally ranged from about 50,000 ug/l to 200,000 ug/l. The highest concentrations were observed in samples from the South Platte River at the station upstream of RMA (01CDD) and the First Creek station at Highway 2 (14BDD). The sulfate concentrations in samples from stations 01CDD and 14BDD ranged from 136,000 to 316,000 ug/l and 288,000 to 410,000 ug/l, respectively.

Calcium concentrations in offpost surface water samples generally ranged from about 25,000 ug/l to 150,000 ug/l. The highest concentrations of 306,000 ug/l and 347,000 ug/l were observed in samples from O'Brian Canal (07BAA) and Second Creek (07ABB), respectively. Magnesium concentrations in offpost surface water samples generally ranged from about 5,000 ug/l to 25,000 ug/l. The highest concentrations, 92,900 ug/l and 118,000 ug/l, were observed in samples from Second Creek (07ABB) and O'Brian Canal (07BAA), respectively. Magnesium concentrations in samples from First Creek at Highway 2 were generally higher than in upstream samples from First creek and ranged from 38,400 ug/l to 55,600 ug/l. Potassium concentrations in offpost surface water samples generally ranged from about 2,000 ug/l to 12,000 ug/l. The highest observed concentration of 13,000 ug/l was observed in a sample from the South Platte River at the station upstream of RMA (01CDD). Potassium concentrations in samples from First Creek were generally within the ranges observed at other offpost stations.

Arsenic was observed at concentrations exceeding CRLs sporadically in offpost surface water samples. The highest concentration, 33.4 ug/l, was observed in a South Platte River sample collected just downstream of the Sand Creek confluence (01CDD). Zinc concentrations in offpost surface water samples ranged from less than the CRL of 20.1 ug/l to 173 ug/l. The highest concentration, 173 ug/l, was observed in a sample from Second Creek.

Sodium concentrations varied greatly in surface water samples collected in the Offpost Operable Unit. The concentrations generally ranged from about 10,000 ug/l to 150,000 ug/l. The highest concentration, 813,000 ug/l, was observed in a sample from Second Creek (07ABB). On the average, sodium concentrations were highest in samples from First Creek at the Highway 2 Station (14BDD). The lowest sodium concentration in a sample from the Highway 2 station was 157,000 ug/l.

Cadmium, chromium, copper, lead, and mercury were only observed sporadically at concentrations exceeding their respective CRLs. The highest cadmium, chromium, and copper concentrations were observed in samples from the

downstream South Platte River station (12AAB) at 28.6 ug/l, 31.3 ug/l, and 32.1 ug/l, respectively. The highest lead concentration, 31.2 ug/l, was noted in a sample from Barr Lake (22CAA). Mercury was observed in only one offpost sample at a concentration exceeding CRLs. This sample was collected from Second Creek, and the mercury concentration was 1.17 ug/l.

Generally, chloride, fluoride, and sulfate concentrations were elevated in samples from the First Creek Highway 2 station relative to upstream sample concentrations. These higher concentrations may be a result of ground water discharges to First Creek along the offpost reach. Concentrations of metals, such as arsenic, cadmium, chromium, copper, and lead did not exhibit a pattern of increased levels downstream of RMA. Instead, concentrations of these metals were infrequently observed at levels exceeding CRLs and no pattern of elevated concentrations was evident.

4.3 CONTAMINANT PATHWAYS TO OFFPOST SURFACE WATER

This section evaluates the potential pathways of contaminants to surface water in the Offpost Operable Unit. The two most probable pathways are direct surface water runoff and erosion from source areas onpost and contaminated ground water discharges to surface channels. These two pathways will be examined in the following discussion.

4.3.1 FIRST CREEK

Since First Creek essentially provides the sole conduit for surface water exiting RMA, it was a primary target for surface quality monitoring efforts. Upon detection of RMA contaminants in First Creek offpost, attempts were made to determine the pathway of these contaminants from onpost source areas. Two primary contaminant pathways to First Creek offpost were considered. The first is contaminated surface water flows from First Creek onpost. The second is contaminated ground water discharging to First Creek offpost.

4.3.1.1 First Creek Flows From Onpost

Onpost surface water stations along First Creek from where samples have been collected for chemical analysis are shown in Figure 4.3-1. The frequency of detection and ranges of organic contaminants observed in samples taken from December 1985 through June 1987 are summarized in Table 4.3-1.

Table 4.3-1 shows that organic contaminants have only been observed in three of the five onpost stations. Of these three stations, only Station 24-001 has had repeated hits. Aldrin and chlorobenzene were observed at concentrations exceeding CRLs in samples from Station 31-001. Samples from Station 31-002 exhibited concentrations of chloroform exceeding CRLs in one out of five samples. Contaminants observed at this latter station may be attributable to the Toxic Gas Yard in Section 6.

Station 24-001 exhibited concentrations of aldrin, dieldrin, DBCP, and chloroform exceeding CRLs. This station samples Sewage Treatment Plant effluent as it enters a ditch which is tributary to First Creek. Stream flows in this ditch average about 50 gpm and generally do not reach First Creek. However, during storm events, flows from this ditch were considered the most probable source of contaminants detected at the north boundary site (08ADD) since aldrin and DIMP were the only organic contaminants detected at that site.

As First Creek traverses RMA, it can gain water from and lose water to the alluvial aquifer. Whether this exchange is positive or negative varies as a function of the reach location as well as the time of year. In order to determine if ground water was contributing to the surface water flows onpost, the First Creek stream bed elevations were surveyed at road crossings. These elevations were compared with ground-water elevations taken from a summer 1986 water table map to determine areas where ground water discharge may be occurring. The resulting elevation comparisons are shown in Figure 4.3-2. In this figure, the cross-hatched areas indicate that the interpolated ground-water elevation exceeded the stream bottom elevation. The ground water was contributing to the stream flow.

Table 4.3-1. Summary of Organic Contaminant Concentrations Onpost in First Creek and its Potential Tributariaries

Station and Organic Contaminants Observed	Range of Observed Concentrations (ug/l)	Number of Samples	Number of Detections
5-001 First Creek At 6th Avenue		4	
No Detections Above CRLs			0
31-002 First Creek Downstream of Gas Storage Yard		5	
Chloroform	3.54		1
30-002 First Creek Downstream of Toxic Storage Yard		5	
No Detections Above CRLs			0
31-001 Toxic Storage Yard Drainage Ditch		4	
Chlorobenzene	1.75		1
Aldrin	0.08		1
24-001 Sewage Treatment Plant Effluent		5	
Aldrin	0.080-2.98		5
DBCP	0.15		1
Dieldrin	0.009-0.936		4
Chloroform	4.85-11.4		2

Source: ESE, 1988.

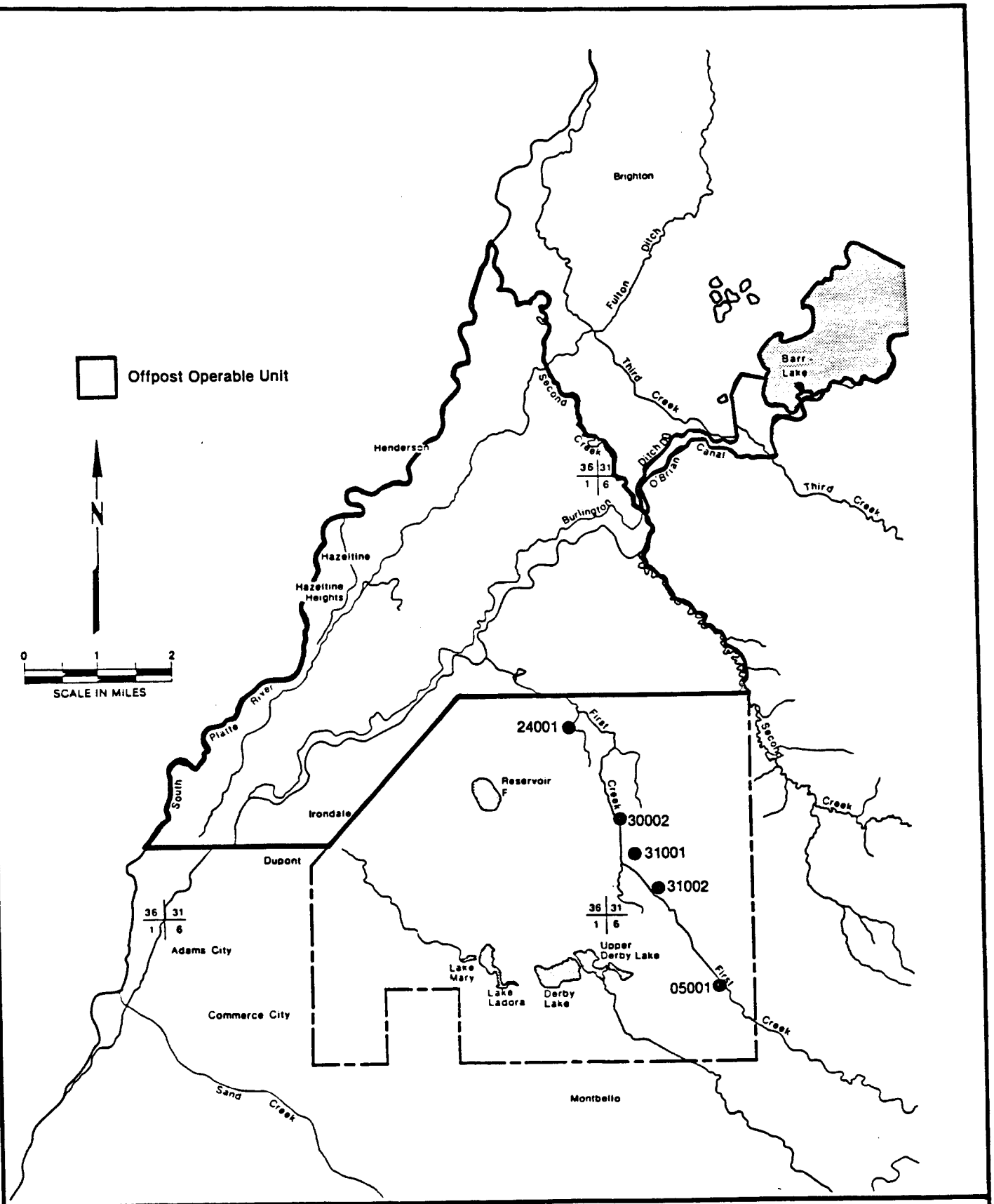


Figure 4.3-1

FIRST CREEK WATER QUALITY STATIONS ONPOST

SOURCE: ESE, 1988

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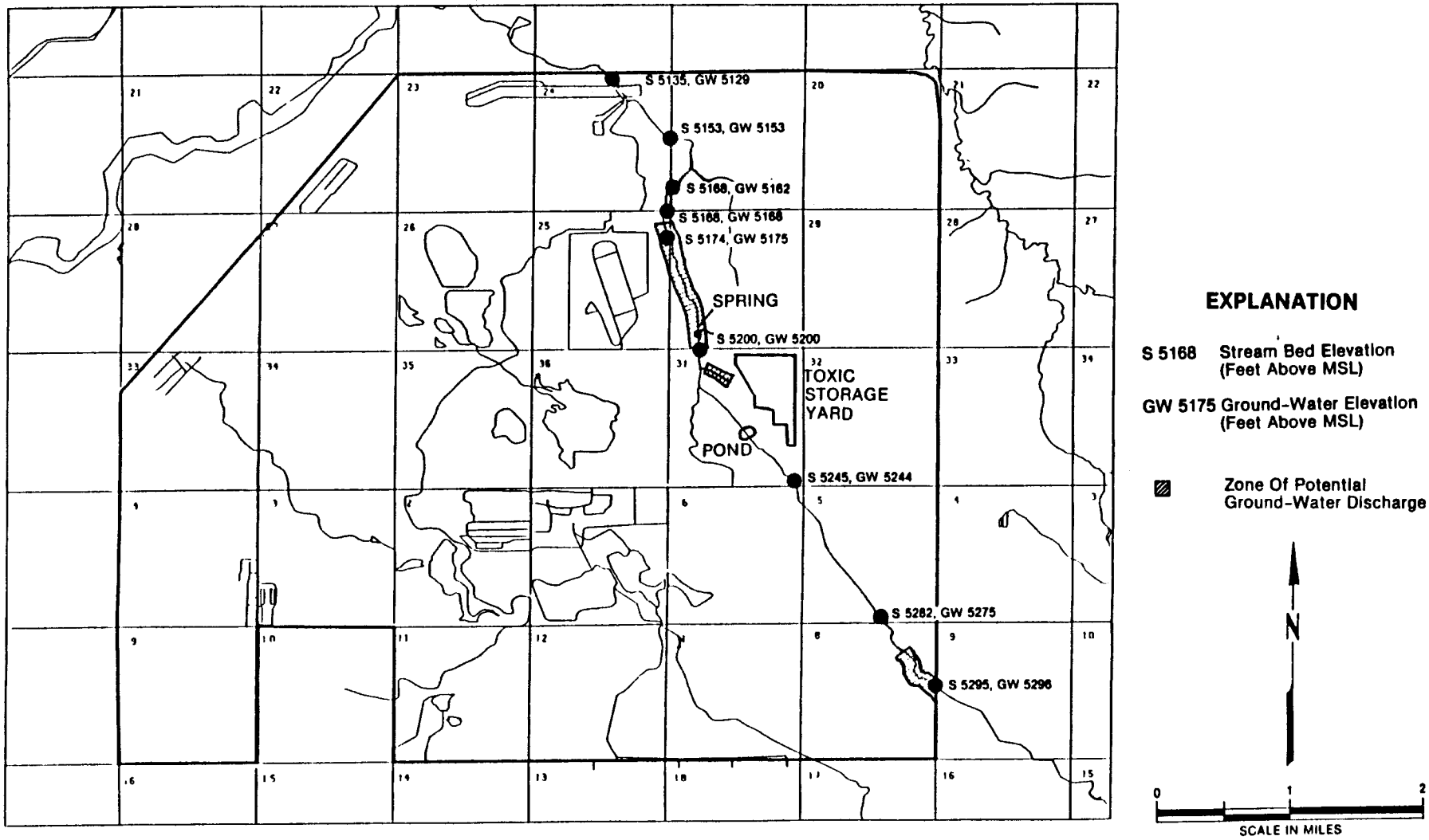


Figure 4.3-2

ZONES OF POTENTIAL GROUND-WATER DISCHARGE TO FIRST CREEK ONPOST

SOURCE: ESE, 1988

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The comparison of stream bottom elevations and ground water elevations illustrate the potential for ground-water discharge to First Creek onpost. However, the ground water along the onpost reach of First Creek is generally not downgradient of the primary source areas at RMA, and thus, contaminant concentrations in the ground water were generally not as high as levels observed along the offpost reach of First Creek. Therefore, the potential for contamination of First Creek due to ground water discharge was considered more likely offpost than onpost. The infrequent detection and relatively low concentrations of organic contaminants in samples from First Creek at the North Boundary station (13DCC) also suggested limited potential for contaminants migrating from First Creek onpost.

4.3.1.2 Ground-Water Discharge to First Creek Offpost

All available data indicate that contaminated ground-water discharge offpost was the primary avenue for offpost First Creek contamination. This scenario may also delineate the primary mechanism by which RMA contaminants have migrated to O'Brian Canal and Barr Lake (i.e., contaminated flows from First Creek).

As stated previously, contaminants historically observed in samples from First Creek onpost may be the result of surface runoff from onpost source areas or ground water infiltration. However, organic contaminants were not frequently observed in the surface water exiting RMA. Also, the inorganic constituents chloride and fluoride were not observed at significantly higher concentrations at the north boundary gage when compared to the upstream gage on First Creek. However, in samples from First Creek at its confluence with the O'Brian Canal (14BDD), organic contaminants were routinely observed. Since there are no direct surface pathways from onpost surface sources to this offpost reach of First Creek, ground-water contamination was suspected as the source of contaminants. DIMP concentrations in the alluvial aquifer near the RMA north boundary are depicted in Figure 4.3-3. This figure illustrates how DIMP and other contaminants exhibiting a similar spatial distribution were present in ground water along the offpost reach but not onpost reaches near the north boundary.

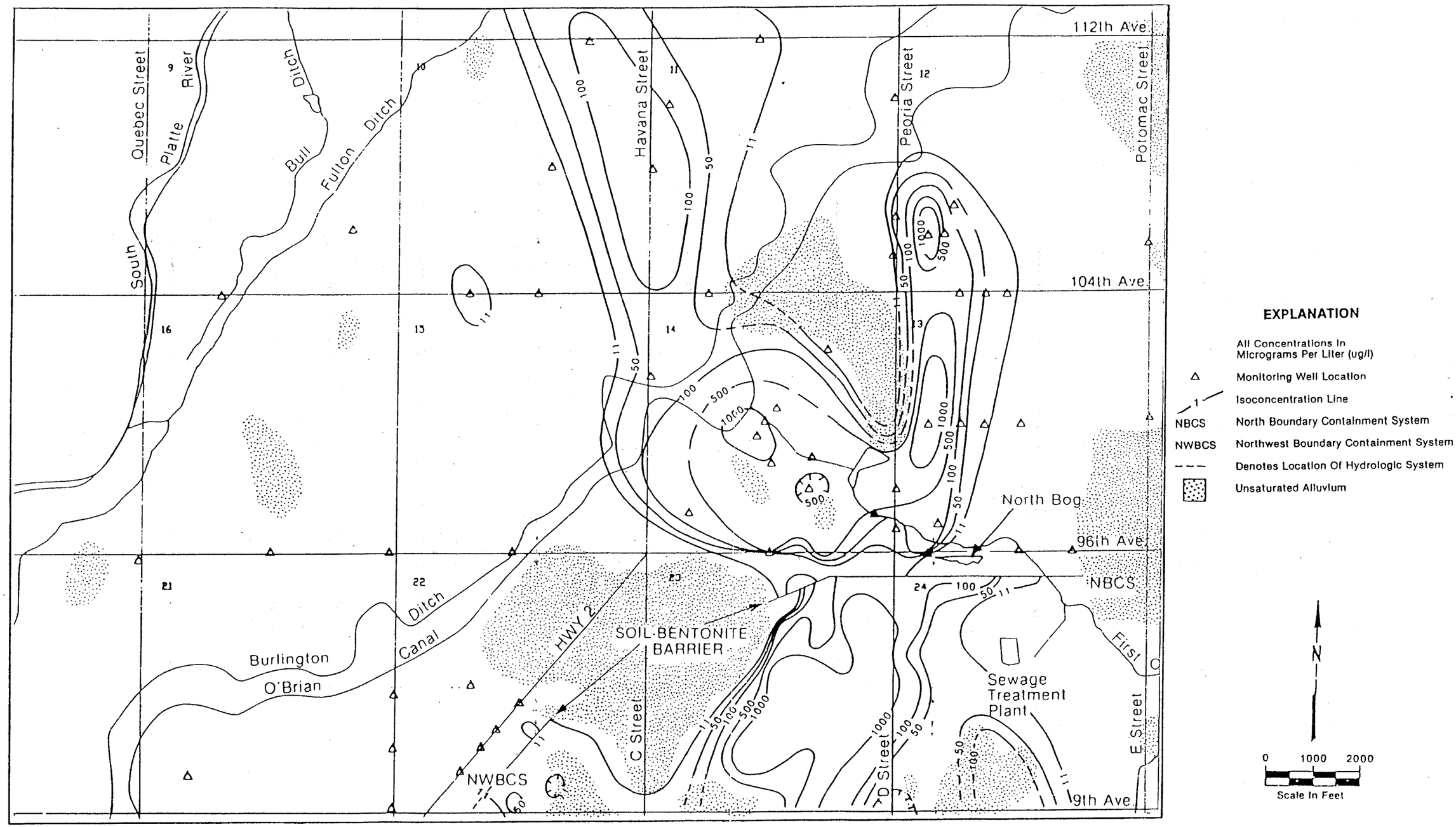


Figure 4.3-3

DIMP CONCENTRATION DISTRIBUTION, ug/l, 3RD QUARTER, FY87, ALLUVIAL AQUIFER

SOURCE: ESE, 1988

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All of the contaminants found in samples from First Creek at the Highway 2 station were observed in samples of the ground water collected from wells just north of the RMA north boundary. This is illustrated in the chemical distribution maps shown in Appendix F. Furthermore, the concentrations of organic (DIMP, 1,2-dichloroethane, DCPD, CPMSO2, and 1,4-dithiane) and inorganic parameters (chloride, fluoride, and sulfate) were higher in samples collected at the Highway 2 station than at the north boundary station. These parameters were all present in the ground water along the offpost reach of First Creek at higher average concentrations than in the offpost surface water samples collected along First Creek. Thus, higher concentrations in samples from the Highway 2 station help substantiate that ground water is infiltrating to First Creek offpost.

Having determined the presence of contaminated ground water in the vicinity of the offpost First Creek reach, it was necessary to examine the potential for ground water discharges to the surface water. One accepted method of determining if a channel reach is gaining or losing water is the mass balance approach. This type of analysis utilizes the following relationship:

$$SO = SI + GW - L - S - E$$

where:
- SO = Surface water outflows at the end of the reach;
- SI = Surface water inflows at the beginning of the reach:
- GW = Ground water discharges to the surface water channel along the reach:
- L = Losses along the channel from surface water to ground water;
- E = Losses from evaporation: and
- S = Change in channel storage.

Solving for ground-water contributions to the surface water and assuming storage to remain constant, the equation becomes:

$$GW = SO - SI + L + E$$

The change in storage of the impoundment along First Creek was estimated to be at a maximum 10 ac-ft and would not alter the conclusions of the analysis.

Evaporation losses were estimated by assuming an average loss over the gaging period and multiplying by the approximate surface area of First Creek and the impoundment along the creek in Section 14. The resulting evaporation rates for First Creek offpost and the impoundment were estimated at about 20 ac-ft/year. The surface water inflows (SI) were determined by flow measurements collected at the North Boundary gage. This site is located just inside the RMA north boundary on First Creek. Data for this site date back to April 29, 1982, but the most recent continuous record begins on October 1, 1985.

The surface water outflows (SO) were determined by flow measurements collected just before the First Creek confluence with the O'Brian Canal. This gage was installed at the end of June, 1986. First Creek flows at the North Boundary gage, the Highway 2 gage, and the gage at the southeast corner of RMA are shown in Figure 4.3-4.

For the mass balance equation, three of the five terms have been determined. Unfortunately, the amount of water entering the system and lost before exiting is unknown, so a determination of GW can not be made. However, upon close inspection of Figure 4.3-4, it is observed that before and after the primary flow season, the downstream gage recorded flows while the upstream gage remained dry. Since there are no surface water tributaries between the two gages, ground water appears to be entering First Creek between the two gages. Furthermore, from the mass balance equation, it is evident that ground water inflows exceeded channel losses or flow would not be observed at the Highway 2. During low flow periods, the impoundment along First Creek generally did not contribute to First Creek flows, therefore, its presence has no effect on this conclusion.

When comparing the total flow volumes for the fourteen months of common data for the North Boundary and Highway 2 gages, the onpost gage recorded larger

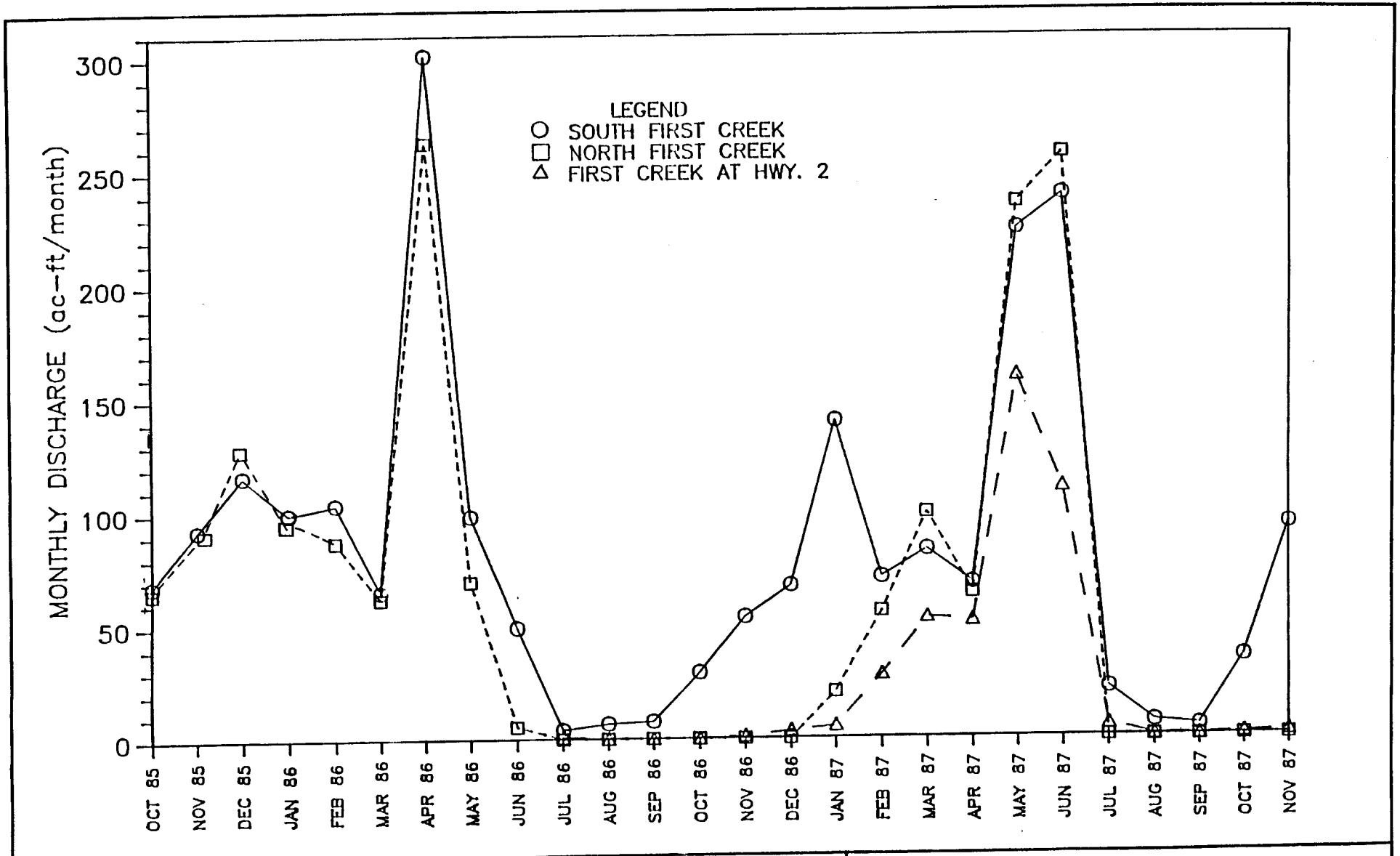


Figure 4.3–4
MONTHLY DISCHARGE VALUES AT
FIRST CREEK GAGING STATIONS

SOURCE: ESE, 1988

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flow volumes. Even though the upstream gage started flowing later and stopped flowing sooner, it still recorded a larger total discharge. This indicates that for larger flows, channel losses exceeded ground-water inflows. The capacity of the impoundment only account for approximately 10 acre-ft of storage and therefore did not alter the conclusions of this analysis.

The periods of gaining and losing flow are illustrated for First Creek in Figure 4.3-5. This figure shows flows recorded at the Highway 2 gage along the X-axis and the net gain or loss along the Y-axis. For a particular flow at the Highway 2 gage, if there was a net gain in the flow from the upstream to the downstream gage, the observation is plotted above the zero line. If water was lost from First Creek, a negative value is plotted. For lower stream flows, ground-water inflows exceeded stream losses. For higher flows, stream losses exceeded ground-water inflows resulting in a net loss for the reach. It is not known if an increase in head during higher flows prevented ground-water inflow. Alternatively, ground-water inflows could occur in some reaches and stream losses occur in others. Losses would increase with higher flows to the extent of overcoming ground-water inflows. This scenario allows for both inflows and outflows to occur simultaneously. Both cases may occur to some extent.

As shown in Figure 4.3-5, it appears net losses equal net inflows corresponding to a discharge of 3 acre-ft/day or less at the Highway 2 gage. Analysis of Figure 4.3-4 indicates that during periods of low First Creek flows, ground-water discharges into First Creek were approximately 0.06 cfs.

If large flows in First Creek can inhibit the inflow of contaminated ground water into the channel, it is important to note how often flows are great enough for this to occur. The number of days flows of different magnitudes occurred from July 1986 to August 1987 are shown in Figure 4.3-6. If it is assumed a flow of 3 acre-ft/day is the flow at which ground-water inflows equal stream losses, based on Figure 4.2-3, ground-water inflows exceeded channel losses 346 days out of 427 days. Even though the total flow volume

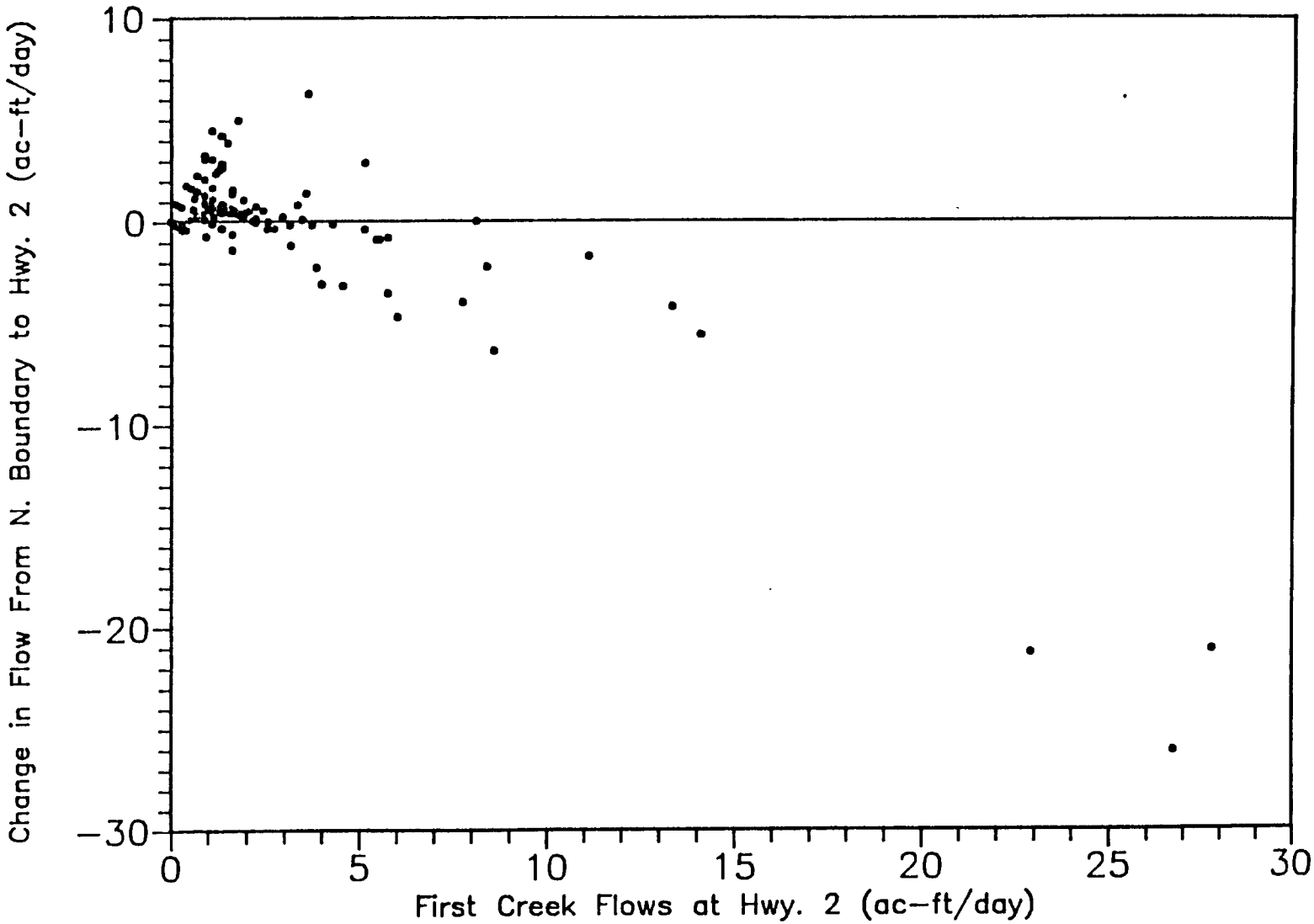


Figure 4.3-5

CHANGE IN FIRST CREEK FLOWS OFFPOST VS. DISCHARGE AT HIGHWAY 2 STATION

SOURCE: ESE, 1988

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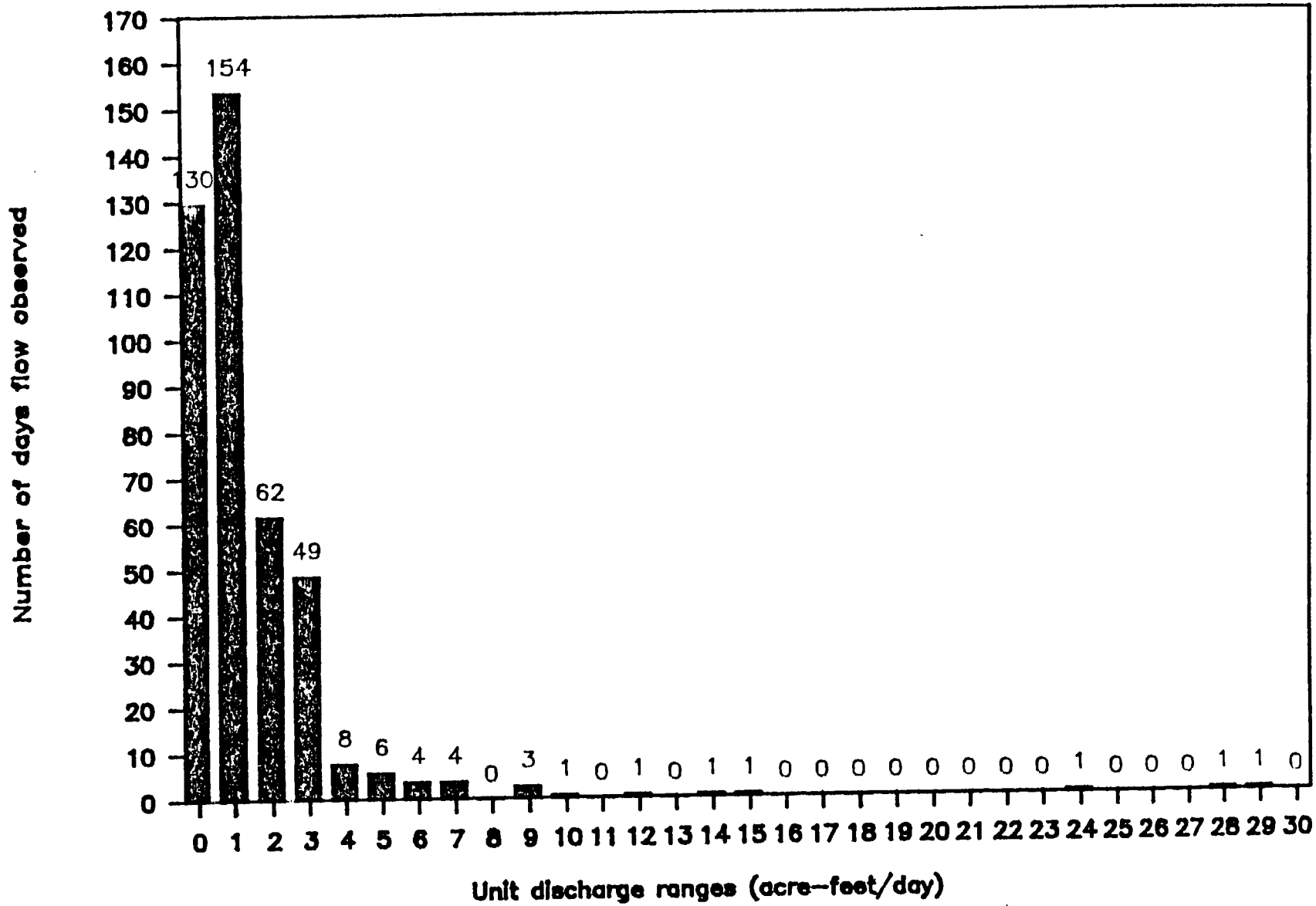


Figure 4.3-6

FLOW FREQUENCY HISTOGRAM FOR FIRST CREEK AT HIGHWAY 2 STATION (JULY 1986 THROUGH AUGUST 1987)

SOURCE: ESE, 1988

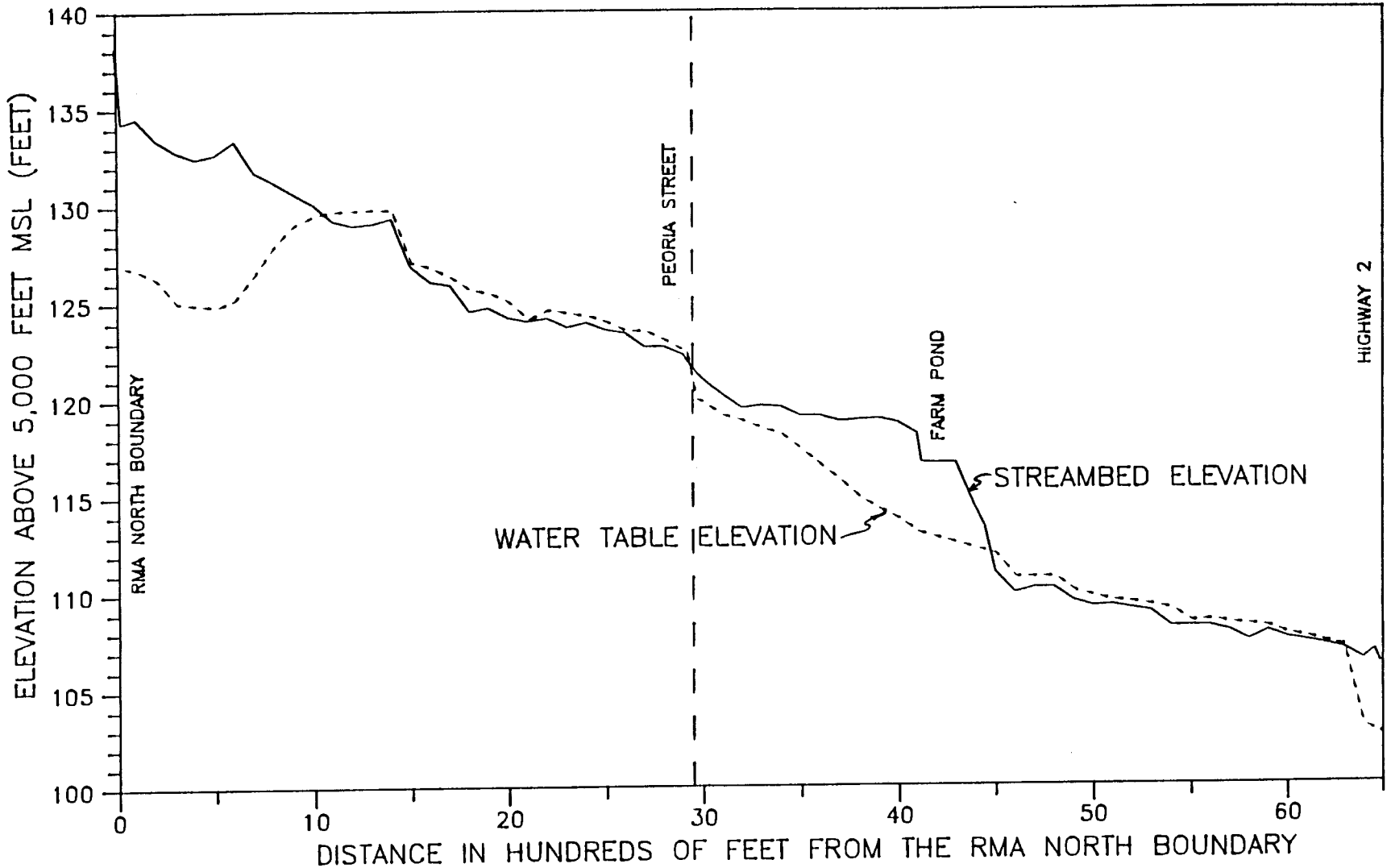
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at the North Boundary gage exceeded that at the downstream gage, large flows did not occur frequently enough nor were they long enough in duration to provide an effective means of inhibiting ground-water inflow to First Creek.

The occurrence of ground water discharging into First Creek was also documented by comparing stream bed elevations to water levels from wells located near First Creek. Although the number of wells was limited, these data indicate that ground water levels exceeded stream bed elevations by several feet in some areas. These data also show that areas of potential ground water discharge were present in both Sections 13 and 14 north of RMA. Elevations of the First Creek stream bottom and ground water along First Creek from the RMA north boundary to Highway 2 are shown in Figure 4.3-7. The First Creek stream bottom and water surface elevations were measured in a survey of the First Creek channel conducted August 10 through 14, 1987. During the time of the survey, no flow was observed at the North Boundary gage, in the overflow pipe leading from the impoundment in Section 14 or at the Highway 2 gage. Since flow was not detected at the Highway 2 gage for a week prior to the survey and for over a month prior to the survey at the North Boundary gage, it was assumed that standing water levels in First Creek represented ground-water levels. Ground-water elevations below the surface were interpolated from the summer 1987 ground-water elevation map.

Although Figure 4.3-7 may not provide the most accurate representation of ground-water gradients, it does provide a good illustration of the relative position of the ground water in relation to the streambed elevation.

Examination of Figure 4.3-7 suggests that ground-water elevations exceeded the First Creek Channel bottom elevation from downgradient of the RMA north boundary to Peoria Street, and again from just downstream of the impoundment to Highway 2. Since there were no base flows during this period, this substantiated that ground water was discharging into First Creek along this reach. The bottom of First Creek was above the ground-water table as it exited RMA to the offpost area near the North Bog and again from Peoria Street to just downstream of the impoundment.



Note : Watertable elevations were taken from summer 1987 map and observed water levels in First Creek.

Figure 4.3-7
ESTIMATED GROUND-WATER ELEVATIONS ALONG FIRST CREEK FROM THE ROCKY MOUNTAIN ARSENAL NORTH BOUNDARY TO HIGHWAY 2

SOURCE: ESE, 1988

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The bottom of the offpost impoundment appears to be about 4 ft above the water table, and it was, therefore, a potential source of ground-water recharge. From observed water level declines in the impoundment during July and August 1987 and gaging data, the approximate losses from the impoundment to the alluvial aquifer was estimated to be over 100 gpm.

4.3.2 O'BRIAN CANAL AND BURLINGTON DITCH

Samples from Burlington Ditch upstream of RMA did not exhibit organic contamination. Downstream of the O'Brian Canal diversion and RMA, samples from Burlington Ditch exhibited only concentrations of DIMP. However, the water diverted into the O'Brian Canal, sampled at a site the First Creek confluence, exhibited concentrations of organic constituents 1,2-dichloroethane, chloroform, and DIMP. Of these contaminants, all but chloroform were observed in samples from the First Creek Highway 2 station. This suggests that contaminants observed in First Creek discharges may be migrating several miles downstream into O'Brian Canal.

DIMP was the only organic contaminant observed at a concentration exceeding CRLs in a sample from Burlington Ditch, which is not connected to First Creek by surface drainages. However, it is in the vicinity of ground-water contaminants that might act as a source of contamination for both the O'Brian and Burlington canals. This information raises the question of whether ground water ever discharges into these canals. If it does, ground-water contaminants would probably be observed in downstream samples from Burlington Ditch. A previous ground-water modeling study conducted in the area estimated that substantial leakage (0.4 cfs/mi) was occurring from these unlined canals (Konikow, 1977, RIC#84192R02; and Warner, 1986, RIC#87085R01). This suggested that the water levels in these canals were generally above the water table.

To determine whether ground water might be contributing to O'Brian Canal and Burlington Ditch flows, the bottom of the canals were surveyed. The stream-bottom elevations were then compared with the spring 1987 ground-water elevation map. Spring water levels were used for comparison because they generally represent the highest water levels during the year.

For O'Brian Canal, the ground-water table was from 15 to 23 ft below the canal bottom. For Burlington Ditch, the water table was from 12 to 23 ft lower than the stream bottom. This comparison suggests that ground water is not discharging to the canals. Figure 4.3-8 shows the stream-bottom and ground-water elevations used for comparison.

Chloroform concentrations observed in samples from O'Brian Canal, but not First Creek, may be attributable to chloroform concentrations in First Creek not observed at the Highway 2 station. This is certainly possible with a quarterly sampling program which can provide only an indication of the nature of surface water contaminants. The DIMP concentration observed in a sample from Burlington Ditch did not appear to be attributable to surface water runoff or ground water discharges. Since the concentration observed was quite low, the detection may have been due to irrigation activities and subsequent runoff into the ditch.

Having determined that ground water was not likely to discharge to the irrigation canals, the importance of the irrigation canals in transport of contaminated flows from First Creek was evaluated. Monthly flow volumes for Burlington Ditch at the upstream headgate and for the O'Brian Canal just upstream of Barr Lake are presented in Table 4.1-1. The location of the gages did not allow the determination of the flow diverted from Burlington Ditch to O'Brian Canal, but the values in Table 4.1-1 for the downstream gage for O'Brian Canal indicate that a majority of the flows were diverted into O'Brian Canal. Flows at the two stations peaked in June and were lowest or nonexistent in the fall and winter months. This was primarily because irrigation demands for crops are greatest in the summer. First Creek discharges into the O'Brian Canal were also included in Table 4.1-1 for comparison. From this table, it is evident that O'Brian Canal discharges greatly exceeded those of First Creek for most months. These data indicate that during most of the year, the flows from O'Brian Canal would have a significant diluting effect on contaminant concentrations entering from First Creek.

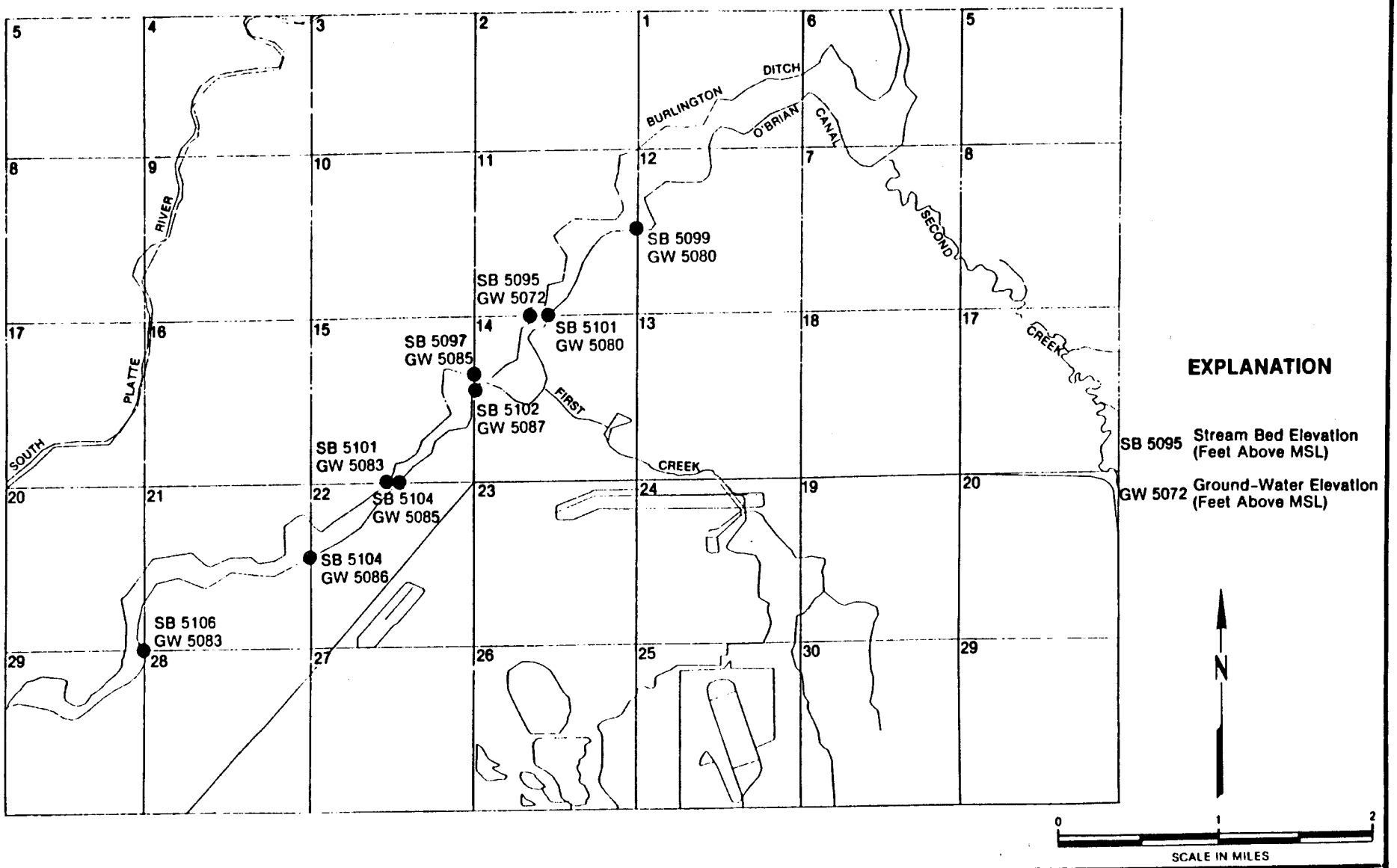


Figure 4.3-8

ESTIMATED GROUND WATER ELEVATIONS VERSUS STREAM BED ELEVATIONS FOR O'BRIAN CANAL AND BURLINGTON DITCH

SOURCE: ESE, 1988

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4.3.3 OVERLAND FLOODING

Previous studies conducted by Resource Consultants, Inc. (RCI, 1982, RIC#84234R01) and the COE (1983a, RIC#84066R01) concluded that there were significant limitations to overland water flow at the RMA north and northwest boundaries. Highway 2 and the Burlington Northern Railroad tracks restricted overland flow at the northwest boundary. Also, the absence of well-defined channels crossing the northwest boundary indicated a lack of historic runoff. However, the COE study (1983a, RIC#84066R01) concluded that during a 100-year storm event, water would flow beyond the northwest boundary. Any flow from RMA that would pass beyond the boundary would ultimately be intercepted by O'Brian Canal and potentially Burlington Ditch.

The COE report (1983, RIC#84066R01) concluded that there was adequate storage capacity in the Basin F and Basin A drainage basins to prevent discharges during a 100-year storm. Thus, even if overland flow did pass the northwest boundary during a severe storm event, it is not likely that runoff from the contaminated basins in Section 26 would contribute to this flow.

During most storm events, the majority of water approaching the north boundary would flow to First Creek and exit through culverts which pass beneath 96th Avenue. In the event this culvert would be unable to handle these flows, backwater would accumulate until it overtops 96th Avenue. Contaminated areas along First Creek, such as the Toxic Storage Yard, or flows from ditches leading from the North Plants or the Sewage Treatment Plant could contribute contaminants to First Creek during storm events. As stated previously, surface runoff flows from Basin A and drainage Basin F would not occur even during a 100-year storm. Thus, even though the potential for overland flow contributing to offpost surface water contamination exists, it would only occur during storm events that are sufficient to cause significant overland flow near First Creek.

4.4 CONCLUSION

Analysis of surface water contamination using quarterly analytical data provided an indication of problem areas and potential pathways. However, contaminants may have passed surface water stations unobserved due to the infrequency of monitoring. Despite this, the data presented in this report clearly indicate that ground-water discharge to First Creek after it exits RMA was a primary source of offpost surface water contamination. This was substantiated by First Creek gaging, a comparison of ground-water and stream-bed elevations, field surveys, and water chemistry data.

The majority of contamination observed in samples from O'Brian Canal downstream of RMA can be explained by the First Creek pathway since the contaminants observed in O'Brian Canal were also present in First Creek or the ground water discharging to First Creek. It is expected that contaminants from RMA would have the highest probability of being observed in O'Brian Canal samples during low flow periods. Isolated concentrations of organic contaminants, not specific to RMA, in the canals farther downstream and in Barr Lake could be attributable to ground-water discharges into First Creek, but more intensive investigation would be required to verify this.

Contaminated flows from First Creek onpost is another potential pathway for offpost surface water contamination. Although surface water monitoring onpost detected organic contaminants in First Creek, some of these organic constituents were not observed in samples from First Creek at the RMA north boundary and others (aldrin, dieldrin, and DIMP) were only observed once at concentrations just exceeding CRLs. These data indicate that this pathway was not as significant as offpost ground-water discharges.

Finally, contaminant transport resulting from overland flow appears to be a concern only during major storms. This is because the pervious surface soils at RMA do not produce a great deal of runoff except during major floods. Overland flow from source areas in drainage Basins A and F would not occur even during a 100-year storm. Thus, overland flow from potential sources along First Creek would be the primary concern when considering this pathway.

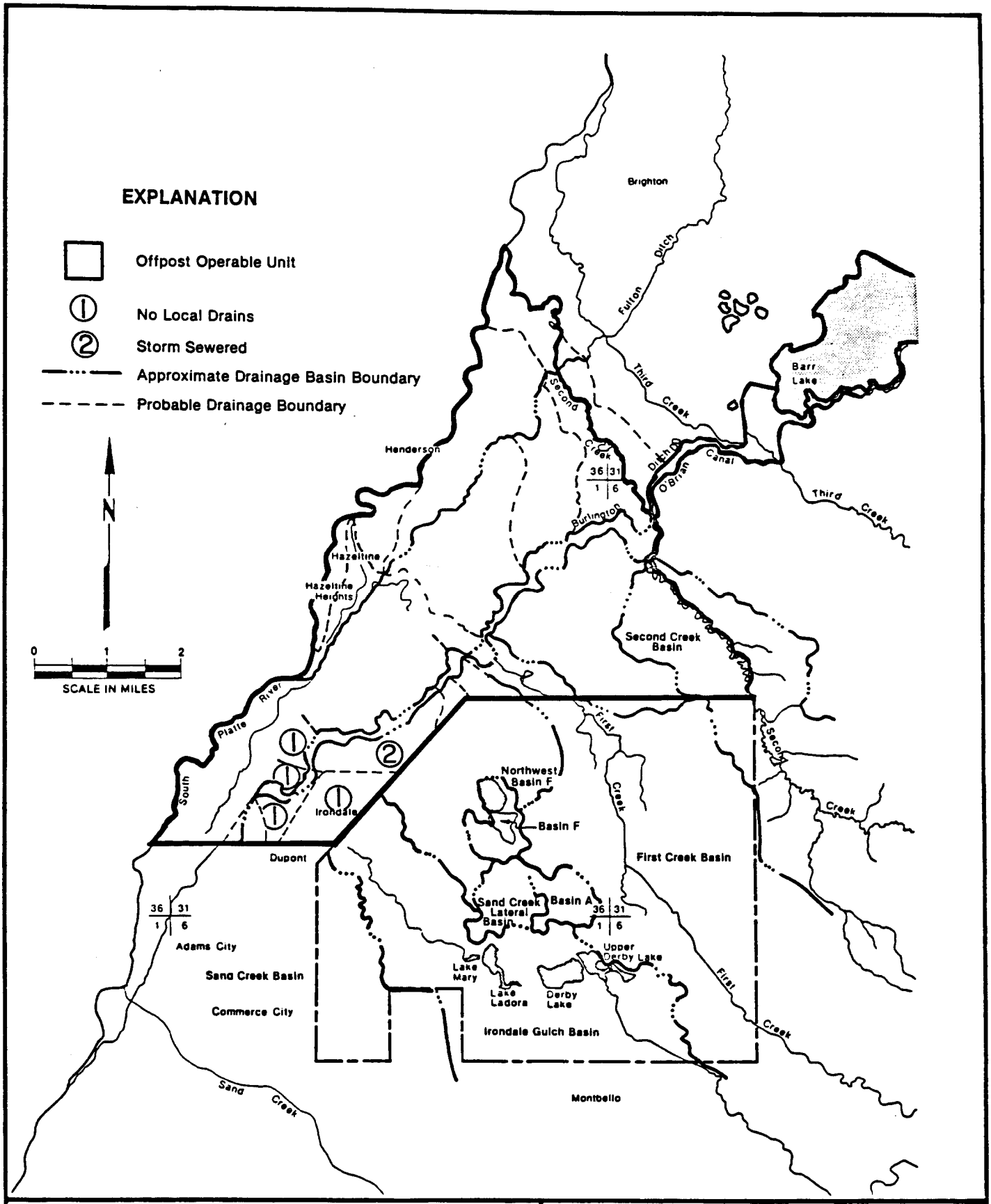


Figure 4.3-9

SURFACE WATER DRAINAGE BASINS AT THE ROCKY MOUNTAIN ARSENAL AND IN THE OFFPOST OPERABLE UNIT

SOURCE: ESE, 1988

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5.0 OFFPOST SEDIMENT CONDITIONS

The previous section provided an evaluation of the quality of surface water in the Offpost Operable Unit and the potential pathways for RMA contamination sources to offpost surface water. It was concluded that offpost discharge of contaminated ground water to First Creek was the primary pathway for contamination to offpost surface water. Organic target contaminants were also observed sporadically in samples collected onpost from First Creek at the North Boundary station, and, thus, the potential for contaminated First Creek water flowing offpost exists. Heavy metals such as arsenic, cadmium, chromium, copper, and lead were also observed in samples from First Creek.

Sorption of contaminants by sediments and subsequent desorption are particularly important processes in surface water systems such as those found at RMA. Organic matter associated with lake or stream sediment strongly sorbs organic solutes such as dieldrin, while clay and fine-grained silt particles tend to sorb trace metals such as lead. As a result, contaminants are often found in sediments when concentrations of the same contaminant can not be detected in the overlying water column. Sorption is ordinarily a reversible process, however, and can represent a continuous and persistent source of contaminants to the overlying water.

Once sorbed onto sediments, contaminants can move downstream in one of two ways. The first mechanism is a consequence of the reversible nature of the sorption-desorption process. Contaminants are removed from the water column by sorption, later desorbed back into the water, and moved some distance downstream by the flow of the stream. The contaminant is then sorbed again, and the process is continued downstream. The amount of time required to move a contaminant downstream is a function of the strength of sorption, hydraulic characteristics of the stream, and the chemical characteristic of the stream bed.

The second mechanism for movement of sorbed contaminants downstream is through mass movement of the sediment particles themselves, a function in

part, of the size of the particles and the velocity of the stream. Dissolved constituents with either high volatility or high solubility tend not to be sorbed onto sediments. Volatile contaminants tend to be lost rapidly from warm, well-aerated surface waters unless they are strongly sorbed to colloidal or particulate matter in the water. Chemicals with low volatilities and high water solubilities, such as chloride, are easily transported downstream with minimal sorption.

The physical environment also influences the occurrence of contaminants in sediments. Turbulence in streams generally keeps the finest, most contaminated particles in suspension, allowing transport. When stream waters enter the relatively quiescent environment of a lake, these particles can settle to the bottom and create an area of high contaminant concentration relative to those found upstream in the main stream channel or in the coarser deltaic deposits of the lake.

For many contaminants in a surface water environment, sediment burial is their ultimate fate. Environmentally, this is significant because benthic dwelling organisms may mobilize these contaminants into the food chain.

Several of the contaminants identified in samples from First Creek and other offpost surface waters can be expected to be sorbed by organic and particulate matter in the underlying sediments.

5.1 NATURE AND EXTENT OF CONTAMINATION

5.1.1 ANALYTICAL SCHEDULE

Realizing that some RMA contaminants were not readily sorbed onto surface water sediments, the list of analytes evaluated in this study did not include all RMA target analytes. To aid in selecting an appropriate analytical suite, a plot of the logarithm of Henry's Law Constant versus the logarithm of the partition coefficient (Kd) for RMA target analytes, as shown in Figure 5.1-1, was used. The vertical axis of the plot represents the chemicals' volatility and the horizontal axis indicates how strongly the contaminants sorb to soils and sediments. By examining the plot, different behavioral groups were distinguished. Chemicals such as trichloroethylene

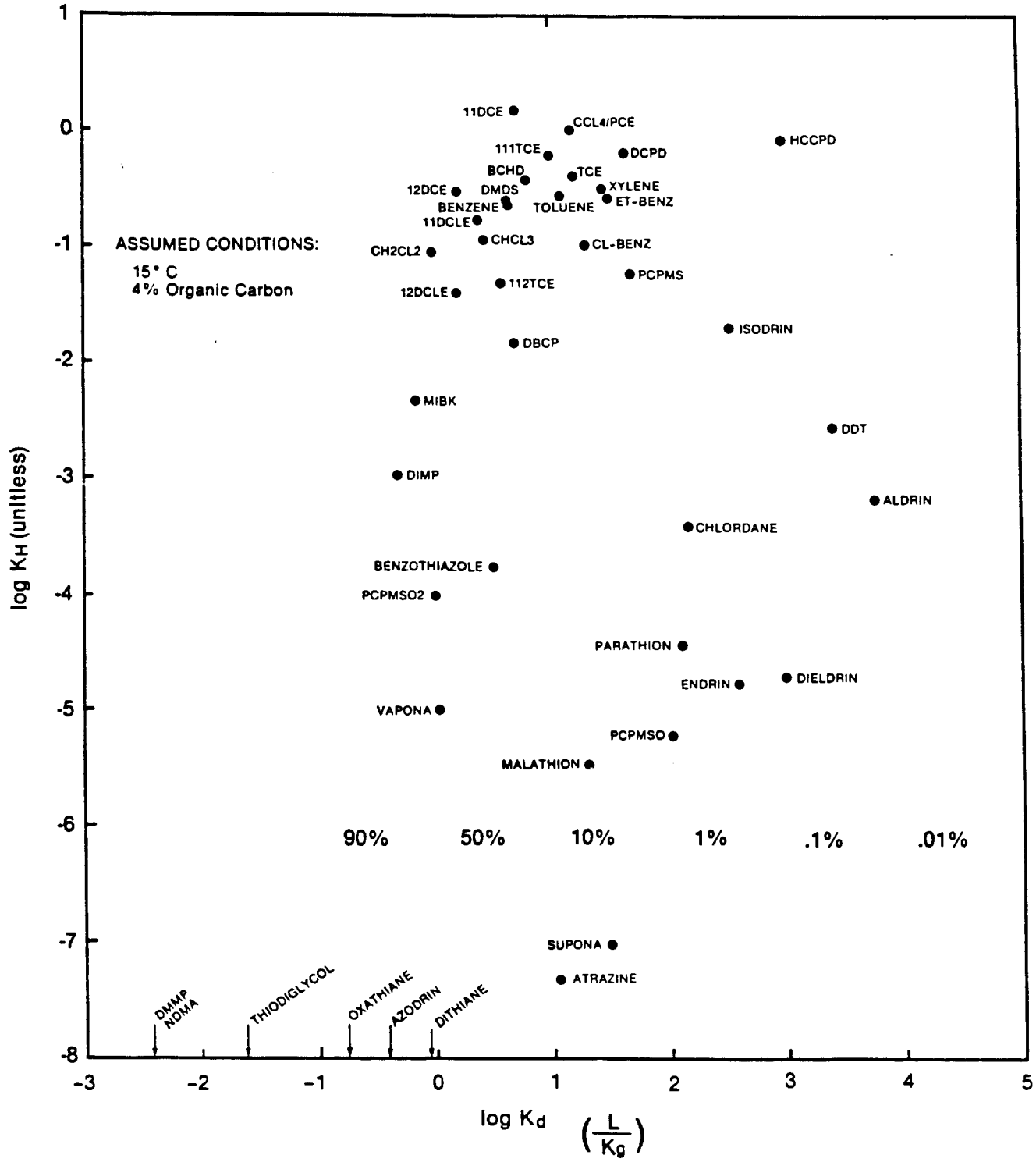


Figure 5.1-1

CONTAMINANT VOLATILITY VS. SORPTION

SOURCE: ESE, 1988

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and benzene, which plot toward the top of the chart, are the most volatile and will not be strongly sorbed onto sediments. Those to the left of the chart are more soluble, poorly sorbed, and are easily transported by water. The chemicals to the lower right of the chart, such as dieldrin and heavy metals, are strongly sorbed to sediments and exhibit negligible volatility.

The analytes selected for study in the Offpost Operable Unit were those that are non-volatile and strongly sorbed or are attributable to RMA and were noted in ground water and/or surface water offpost. The analytical suite chosen included: organochlorine pesticides, DBCP, DIMP, organosulfur compounds, ICAP metals, arsenic, and mercury. ICAP metals, mercury, arsenic, and organochlorine pesticides are strongly sorbed. The organosulfur compounds (oxathiane, dithiane, CPMS, CPMSO, CPMSO2), DIMP, and DBCP are attributable to RMA and were noted in offpost ground water and/or surface water. In addition to the above parameters, organic carbon content was included because it is the major accumulative phase for organic chemicals.

5.1.2 RESULTS OF PREVIOUS SEDIMENT STUDY

Offpost sediment sampling was performed at the sites shown in Figure 5.1-2 during April 1986. Analyses were performed for a suite of target organic and inorganic analytes. The constituents analyzed and their corresponding CRLs are listed in Table 5.1-1. Results of the analytical program were reported in the Offpost CAR (ESE, 1987a, RIC#87202R01).

None of the samples collected exhibited organic contaminant concentrations exceeding the CRLs. However, several of the samples exhibited metal concentrations exceeding CRLs. The metals concentrations observed at the different sampling locations are summarized in Table 5.1-2. The highest metal concentrations were generally observed in the sediment samples from Barr Lake. The results of the analysis of metals in offpost sediment samples are presented briefly below.

The highest cadmium concentration, 6.47 ug/g, was observed in the sample from Barr Lake (22CAA). Cadmium was also observed at a concentration of

Table 5.1-1. Analyte Schedule and Certified Reporting Limits for Sediment Analyses Performed For Offpost Contamination Assessment Report. (Page 1 of 2)

Analytes/Methods	Certified Reporting Limit (ug/g)
Volatile Organic Compounds/GCMS	
1,1-Dichloroethane (11DCLE)	0.300
1,2-Dichloroethane (12DCLE)	0.300
1,1,1-Trichloroethane (111TCE)	0.300
1,1,2-Trichloroethane (112TCE)	0.300
Benzene	0.300
Bicycloheptadiene	0.300
Carbon tetrachloride	0.300
Chlorobenzene	0.300
Chloroform	0.300
Dibromochloropropane (DBCP)	0.300
Dicyclopentadiene (DCPD)	0.300
Dimethyldisulfide	0.300
Ethylbenzene	0.300
m-Xylene	0.300
Methylene chloride	0.300
Methylisobutyl ketone (MIBK)	0.300
o,p-Xylene	0.500
Tetrachloroethylene (TCLEE)	0.300
Toluene	0.300
Trans 1,2-dichloroethene (12DCE)	0.300
Trichloroethylene (TRCLE)	0.300
Semivolatile Organic Compounds/GCMS	
1,4-Oxathiane	0.300
2,2-Bis (para-chlorophenyl)-1,1-dichloroethane	0.400
2,2-Bis (para-chlorophenyl)-1,1,1-trichloroethane	0.300
Aldrin	0.900
Atrazine	0.700
Chlordane	1.00
Chlorophenylmethyl sulfide (CPMS)	0.300
Chlorophenylmethyl sulfoxide (CPMSO)	0.400
Chlorophenylmethyl sulfone (CPMSO2)	0.300
Dibromochloropropane (DBCP)	0.300
Dicyclopentadiene (DCPD)	0.300
Dieldrin	0.300
Diisopropylmethyl phosphonate (DIMP)	0.500
Dimethylmethyl phosphonate (DMMP)	2.00
1,4-Dithiane	0.300
Endrin	0.700

Table 5.1-1. Analyte Schedule and Certified Reporting Limits for Sediment Analyses Performed For Offpost Contamination Assessment Report. (Page 2 of 2)

Analytes/Methods	Certified Reporting Limit (ug/g)
Semivolatile Organic Compounds/GCMS	
Hexachlorocyclopentadiene	1.00
Isodrin	0.300
Malathion	0.600
Parathion	0.700
Supona	0.500
Vapona	0.300
Metals/ICAP	
Cadmium	0.900
Chromium	7.20
Copper	4.80
Lead	17.0
Zinc	16.0
Metals/AA	
Arsenic	4.70
Mercury	0.05

Source: ESE, 1988.

Table 5.1-2. Metal Concentrations in Offpost Sediment Samples From Offpost Contamination Assessment Report (ug/g)

	SAMPLING LOCATIONS										
	01CDD	01DCC	12AAB	07BAA	07ABB	06CBB	22CAA	33ABB	14BDD	13DCC	08ADD
Analyte											
Cadmium	<0.900	<0.900	1.42	2.15	<0.900	<0.900	<6.42	<0.900	<0.900	<0.900	<0.900
Chromium	<7.20	<7.20	20.3	23.9	27.1	24.5	106	20.5	10.2	11.2	9.7
Copper	<4.80	<4.80	50.9	23.5	24.2	6.27	75.8	14.4	6.48	9.65	<4.80
Lead	28.9	<17.0	84.1	54.4	60.9	23.3	146	<17.0	25.1	24.0	<17.0
Zinc	29.6	32.6	206	166	98.7	71.7	492	77.2	39.6	43.1	43.9
Arsenic	<4.70	<4.70	<4.70	<4.70	8.92	<4.70	<4.70	<4.70	<4.70	<4.70	<4.70
Mercury	<0.05	<0.05	0.123	0.116	<0.05	0.05	<0.386	<0.05	<0.05	<0.05	<0.05

Source: ESE, 1987.

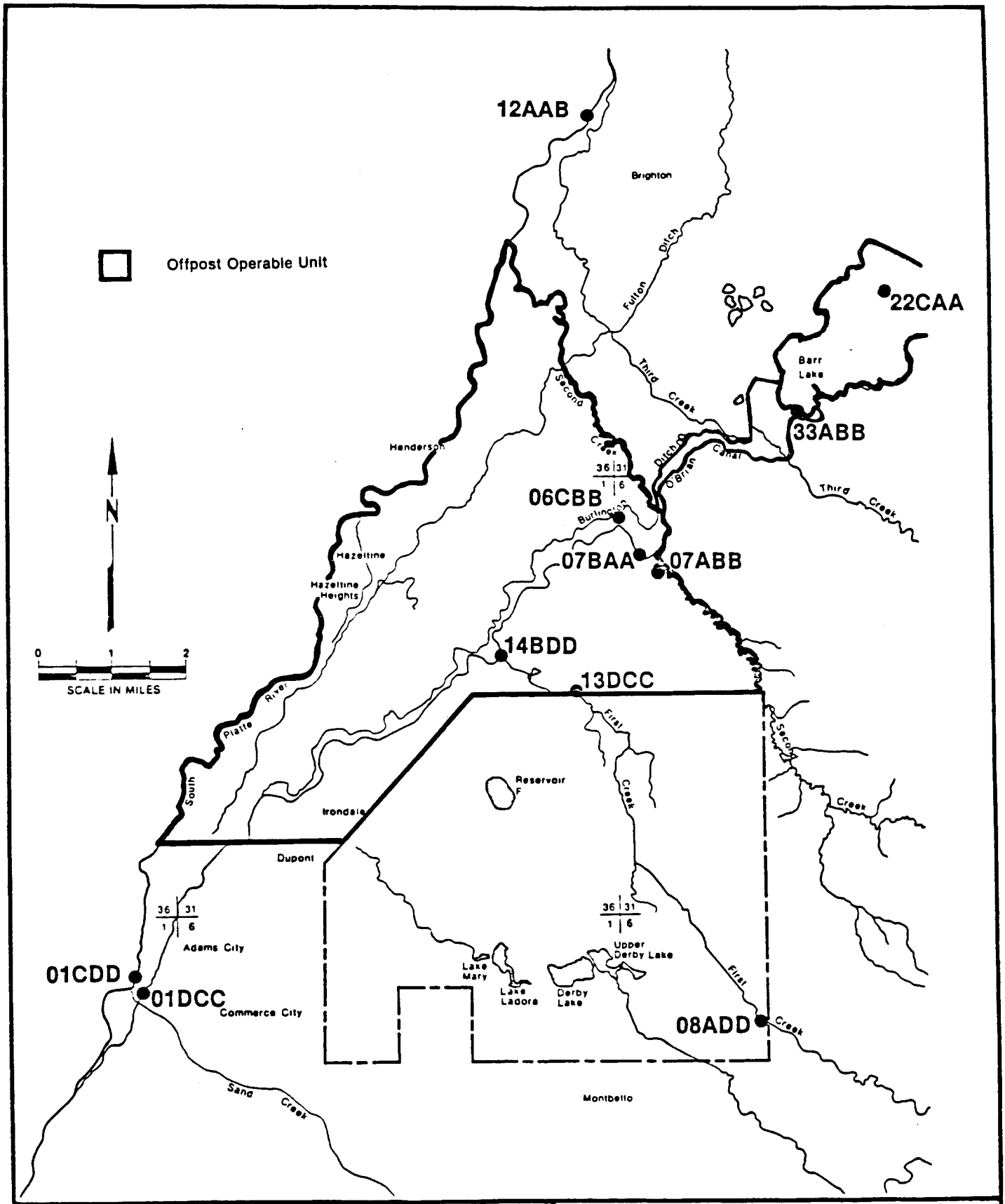


Figure 5.1-2

OFFPOST SEDIMENT SAMPLING LOCATIONS (APRIL, 1986)

SOURCE: ESE, 1988

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2.15 ug/g in the sample from O'Brian Canal about 0.3 mile downstream of the First Creek confluence (07BAA). Concentrations of cadmium in samples collected upstream of RMA and from First Creek were less than the CRL of 0.900 ug/g.

The highest chromium concentration, 106 ug/g, was also observed in the sample from Barr Lake (22CAA). Concentrations exceeding 20 ug/g were noted in the samples from Second Creek (07ABB), Burlington Ditch (06CBB), O'Brian Canal (07BAA), and the South Platte River (12AAB) downstream of RMA. Chromium concentrations in sediment samples collected upstream of RMA were less than 10.0 ug/g. The highest chromium concentration in sediment samples from First Creek was 11.2 ug/g.

The highest copper concentration, 75.8 ug/g, was observed in a sample from Barr Lake (22CAA). A relatively high concentration of 50.9 ug/g was observed in the downstream sample from the South Platte River (12AAB). Sediment samples collected upstream of RMA exhibited copper concentrations less than the CRL of 4.80 ug/g. Copper concentrations in samples from First Creek were less than 10.0 ug/g.

The highest lead concentration, 146 ug/g, was observed in the sample from Barr Lake (22CAA). Lead concentrations in sediments from Second Creek (07ABB), Burlington Ditch (06CBB), and the South Platte River (12ABB) downstream of RMA exceeded 50 ug/g. Lead concentrations in sediment samples from First Creek were generally about 25 ug/g or less.

The highest zinc concentrations were observed in samples from Barr Lake (22CAA) and downstream in the South Platte River (12ABB) at 492 ug/g and 206 ug/g, respectively. Zinc concentrations in samples collected upstream of RMA were less than 50 ug/g. Concentrations in sediment samples from First Creek were generally about 40 ug/g.

Arsenic was observed at a concentration exceeding the CRL only in the offpost sediment sample from Second Creek (07ABB), where the concentration was 8.92 ug/g.

The highest mercury concentration, 0.386 ug/g, was observed in the sample from Barr Lake (22CAA). Mercury was found in the downstream samples from the South Platte River (12ABB) and O'Brian Canal (07BAA) at concentrations of 0.123 ug/g and 0.116 ug/g, respectively. Mercury concentrations in all the offpost sediment samples were less than 0.05 ug/g.

5.1.3 RESULTS OF PRESENT SEDIMENT STUDY

Results of the offpost sediment contamination study are tabulated in Table 5.1-3. All concentrations are given in terms of weight of dry sediment. Five detectable concentrations of organic contaminants and 40 detectable concentrations of metals were observed in samples from nine sites. The only organic analytes detected were the strongly sorbed pesticides p,p'-DDT, p,p'-DDE, and dieldrin. Of the five detectable concentrations, four were in O'Brian Canal and one was in First Creek. The concentrations of p,p'-DDT, p,p'-DDE, and dieldrin upstream of the First Creek confluence (OBC1S), were all less than 0.010 ug/l. The concentration of dieldrin in the sample from OBC3S was 0.003 ug/g. The detection of dieldrin in sediments from First Creek immediately north of 96th Avenue was 0.006 ug/g (FC1S). No detections of organic contaminants specific only to RMA in the Offpost Operable Unit were observed in any offpost sediment sites.

Unlike organics, the detection of metals in sediments does not necessarily signify contamination because metals are naturally occurring in the environment. To attribute significance to metal concentrations requires establishing natural or background values. A comparison of stream sediments showed that in all cases, metal concentrations in First Creek sediments were lower than concentrations in O'Brian Canal sediments by an average factor of about three. Arsenic was not detected in sediments from any site.

A deep stratum (20-24 inches) of Barr Lake sediment collected at BLSC was also analyzed for metals to determine if there were significant vertical differences in metal content. This sample had the highest metal concentrations for five of the six metals analyzed. Sediment accumulation rates in Barr Lake are unknown, and a precise age can not be assigned to this deeper stratum.

Table 5.1-3. Sediment Analyses (April 14, 1988 Sampling) (ug/g)

Site Number	HCPD	Aldrin	Isodrin	p,p'DDE	Dieldrin	p,p'DDT	CLDANE	DMDS	OXATH	DITH	CPMS
OBC1S	<.003	<.018	<.001	.004	.003	.008	<.111	<.692	<.856	<.571	<1.08
FC1S	<.003	<.002	<.001	<.001	.006	<.002	<.111	<.692	<.856	<.571	<1.08
FC2S	<.003	<.002	<.001	<.001	<.012	<.002	<.111	<.692	<.856	<.571	<1.08
OBC2S	<.003	<.002	<.001	<.001	<.001	<.002	<.111	<.692	<.856	<.571	<1.08
OBC3S	<.003	<.002	<.001	<.001	.003	<.002	<.111	<.692	<.856	<.571	<1.08
BLSE	<.003	<.002	<.001	<.001	<.001	<.002	<.111	<.692	<.856	<.571	<1.08
BLSC1	<.003	<.002	<.001	<.001	<.001	<.002	<.111	<.692	<.856	<.571	<1.08
BLSC2	NRQ	NRQ	NRQ	NRQ	NRQ	NRQ	NRQ	NRQ	NRQ	NRQ	NRQ
BLSW	<.003	<.002	<.001	<.001	<.001	<.002	<.111	<.692	<.856	<.571	<1.08
FCL	<.003	<.002	<.001	<.001	<.001	<.002	<.111	<.692	<.856	<.571	<1.08
FCL*	<.003	<.002	<.001	<.001	<.001	<.002	<.111	<.692	<.856	<.571	<1.08

Site Number	BTZ	CPMSO	CPMSO2	Cd	Cr	Cu	Pb	Zn	As	Hg	DBCP	DIMP	DMMP
OBC1S	<1.08	<2.25	<2.87	1.91	43.2	34.3	131	200	<4.7	.564	<.005	<.114	<.133
FC1S	<1.08	<2.25	<2.87	<.921	15.4	17.3	<16.8	66.1	<4.7	<.05	<.005	<.114	<.133
FC2S	<1.08	<2.25	<2.87	<.921	<7.16	8.86	<16.8	43.1	<4.7	<.05	<.005	<.114	<.133
OBC2S	<1.08	<2.25	<2.87	<.921	26.5	22.9	40.8	144	<4.7	<.05	<.005	<.114	<.133
OBC3S	<1.08	<2.25	<2.87	1.27	28.1	21.7	46.1	162	<4.7	<.05	<.005	<.114	<.133
BLSE	<1.08	<2.25	<2.87	5.41	96.8	84.3	161	509	<4.7	<.05	<.005	<.114	<.133
BLSC1	<1.08	<2.25	<2.87	2.85	51.2	44.5	87.4	258	<4.7	.136	<.005	<.114	<.133
BLSC2	NRQ	NRQ	NRQ	9.24	202	125	158	704	<4.7	1.84	NRQ	NRQ	NRQ
BLSW	<1.08	<2.25	<2.87	5.64	114	89.6	169	490	<4.7	.252	<.005	<.571	<.108
FCL	<1.08	<2.25	<2.87	<.921	40.6	35	<16.8	145	<4.7	<.05	<.005	<.571	<.108
FCL*	<1.08	<2.25	<2.87	<.921	25	26.3	<16.8	101	<4.7	<.05	<.005	<.571	<.108

NRQ - Not Requested.
* Duplicate sample.

Source: ESE, 1988.

5.2 SEDIMENT CONTAMINATION PATHWAYS

There are several potential sources and pathways for sediment contamination in the Offpost Operable Unit. Surface waters can introduce contaminants to sediments either by transport of contaminated particles or by transport of dissolved contaminants that may sorb to a stronger sorbent than exists upstream. Contaminated particles may be introduced to stream water during storms that erode contaminated soil particles or resuspend already contaminated sediments, which may then be deposited in stream channels or lake bottoms. An evaluation of source areas within the onpost portion of the First Creek drainage indicated that potential for erosion of contaminated soil particles exists with subsequent movement directly to First Creek. Contaminants may enter First Creek by this mechanism primarily from three potential source areas. These are:

- the Toxic Storage Yard;
- the Sewage Treatment Plant; and
- the North Plants.

Contaminated soils from the Toxic Storage Yard may enter First Creek by overland erosion. Potential contamination from North Plants and the Sewage Treatment Plant may enter First Creek subsequent to storm events which resuspend contaminated sediments in drainage ditches leading to First Creek. However, it is not known if any of these possibilities has contributed to sediment contamination along First Creek onpost.

Dissolved contaminants can enter the surface water environment by essentially two mechanisms. First, contaminants can be leached from contaminated soils during storm events. Secondly, contaminants can be discharged to surface water from ground water. In the latter case, contaminant transport primarily involves dissolved chemicals that are weakly sorbed. However, because stream sediments usually have higher organic carbon contents than aquifers, the sediments may retain some of the contaminants. For this to be a significant mechanism, the ground-water surface elevation must be higher than the water level in the stream. This condition exists along the reach of First Creek in the offpost area north of the RMA north boundary as discussed in Section 4.0. The potential for contaminated ground water discharging to First Creek onpost is not well

documented, but is a potential pathway as discussed in Section 4.0. Because there are no surface water flow paths leading directly to the northwest from RMA, and the bottom of O'Brian Canal and Burlington Ditch are above ground water elevations in this area, no sample sites were included along either canal in this area.

The high metal concentrations encountered in the deeper Barr Lake stratum may be due to the past disposal of Denver wastewater sludge in the lake, rather than by the mechanisms discussed above. Wastewater sludge is known to contain high concentrations of metals. Representative average and range of metal concentrations in sludge is provided in Table 5.2-1. No values were available for arsenic or mercury.

5.3 CONCLUSIONS

Natural concentrations of metals in fresh water sediments varied with sediment characteristics as well as watershed geology. The average and range of values for metals concentrations in uncontaminated fresh water sediments is provided in Table 5.3-1. The detection limit for cadmium (0.92 mg/kg) is above the natural concentration range, so little can be said about those samples with values below the CRL.

With the exception of arsenic, the metals concentration in Barr Lake sediments exceeded the average and upper range of values found in typical uncontaminated sediments as characterized by Table 5.3-1. Concentrations in First Creek sediments were below the average of naturally occurring metals except for zinc. Zinc concentrations were slightly above average but within the range of natural concentrations. O'Brian Canal sediments exceeded average natural values for cadmium, lead, zinc, and, for one sample, mercury. The O'Brian Canal site with the highest metal concentrations was upstream of the First Creek confluence.

Although sediment samples were collected and analyzed from offpost sites in the Offpost CAR and no target organic analytes were detected at any of the

Table 5.2-1. Representative Metals Concentrations in Wastewater Sludge (ug/g).

Metal	Average	Range
Cadmium	NA	<1,500
Chromium	250	40 - 8,800
Copper	800	200 - 8,000
Lead	700	120 - 3,000
Zinc	3,000	700 - 49,000

N/A - Not Applicable.

Source: Leeper, 1978

Table 5.3-1. Metal Concentrations Commonly Found in Uncontaminated Fresh Water Sediments (ug metal/gm dry sediment).

Metal	Average	Range
Cadmium	0.17	0.1-0.3
Chromium	72	10-90
Copper	33	5-40
Lead	19	2-50
Zinc	95	20-165
Arsenic	7.7	1-15
Mercury	0.19	0.1-0.5

Sources: Bowen (1979), Kabata-Pendias and Pendias (1984), and Moore (1984).

sites, improved analytical methods have lowered the CRLs, resulting in the detection of previously undetectable organic contaminants.

With respect to the metals, however, the results of the current study and those of the previous study were very similar for the sites that were common to both studies. The average metal concentrations at the three Barr Lake sites in the current study are lower by an average of 20 percent. This does not include the data for the deep stratum and may be due, in part, to difference in sampling technique (i.e., corer versus dredge). Metal concentrations in First Creek were generally slightly higher than in the previous study except for lead, where lower concentrations were observed. The higher values are due in part to the collection of smaller particle sizes, and the decrease in lead may be due to reduced leaded gasoline use.

The site on O'Brian Canal that remained the same was 07BAA (OBC2S). Except for cadmium and mercury, which were not detected in the current study, the other metal concentrations were very similar, differing by a maximum of 24 percent.

For organic contaminants, the results are much the same for both studies except for the five detections of p,p'-DDT, p,p'-DDE, and dieldrin in O'Brian Canal and First Creek. The detection of dieldrin in First Creek at 0.006 ug/g suggests that First Creek may be a source of contamination to O'Brian Canal. However, the lack of detectable concentrations in First Creek downstream of this site suggests that First Creek is not a significant source. Three of the four pesticides detected in O'Brian Canal were present upstream of its confluence with First Creek. This suggests there is another source contributing contaminants from upstream. Because there are no known flow paths from RMA to O'Brian Canal upstream of OBC1S except during extreme storm events, it is likely that some other source exists.

6.0 AIR QUALITY CONDITIONS

Characterization of air quality in the area north of RMA was based upon an evaluation of data collected on or near the Offpost Operable Unit, and by simulation of contaminant migration from potential sources on RMA. Offpost air quality has been monitored by EPA and CDH, and onpost air quality has been monitored by the Army. This section presents air quality data and discusses conditions in the Offpost Operable Unit, as well as evaluates the significance of airborne contaminants relative to Federal and State standards and guidelines.

6.1 CRITERIA AIRBORNE POLLUTANTS

Criteria airborne pollutants include particulates (TSP and PM-10), CO, NO_x, SO_x, O_3, and Pb. All of these contaminants have either been monitored onpost and/or offpost of RMA. In general, the urban environmental setting in the Denver metropolitan area has experienced deterioration of air quality over recent years. Regional air quality in the vicinity of RMA is summarized in Table 6.1-1. This table shows that the region is not in compliance with EPA NAAQS for three of the six criteria pollutants: TSP; CO; and O_3.

Onsite sampling for TSP and PM-10 during 1986 and 1987 indicated that air quality for these contaminants was well within Federal guidelines. For TSP, the average annual concentration at the north and northwest boundary was approximately 40 micrograms per cubic meter (ug/m^3) as compared to the secondary TSP standard of 60 ug/m^3. For PM-10, the average annual concentration northwest of RMA was approximately 30 ug/m^3 compared to an annual secondary standard of 50 ug/m^3. There was no site-specific TSP or PM-10 data in the Offpost Operable Unit. However, based upon the low onpost concentrations, RMA does not appear to be a source of particulates in the Offpost Operable Unit.

Recent data indicate that CO and O_3 may exceed the NAAQS in the Offpost Operable Unit. Although there is no RMA site specific data, RMA is not suspected of being a source of CO and O_3 in the Offpost Operable Unit.

Table 6.1-1. Summary of Air Quality Parameters in the Vicinity of the Rocky Mountain Arsenal.

Site	Criteria Pollutant					
	Particulate as Total Suspended Particulate ($\mu g/m^3$)	Carbon Monoxide (ppm)	Ozone (ppm)	Nitrogen Oxides (ppm)	Sulfur Dioxide (ppm)	Lead ($\mu g/m^3$)
National Ambient Air Quality Standards	(Annual Geometric Mean)	(8-Hour)	(1-Hour)	(Annual Arithmetic Mean)	(Annual Arithmetic Mean)	(Calendar Quarter)
(Primary)	75	9	0.12	0.053	0.03	1.5
(Secondary)	60	N/A	N/A	N/A	0.5 (3-hour)	N/A
Northeast Denver*	83	12.8	0.162	0.027	0.006	0.2 (maximum)
Urban Denver*	89	21.6	0.132	0.047	0.009	0.375 (maximum)
Historical Data Near RMA**	24-72	>9	N/A	0.075	0.10 (maximum)	0.13-0.26

N/A = Not Analyzed.

* CDH, 1986.

** Miscellaneous air monitoring investigations at RMA.

6.2 TOXIC AIRBORNE POLLUTANTS

Toxic airborne contaminants have been monitored at RMA since the 1960's, with special interest in the Basin F area for volatile and semi-volatile organic compounds (VOCs and SVOCs) and the Basin A area for metals. Historical data at RMA have identified the organics and metals listed in Tables 6.2-1 and 6.2-2, respectively.

Recently, Task 18 at RMA sampled for organic contaminants at RMA near Basins A and F. The Final Air Remedial Investigation Report (ESE, 1988) contains a detailed discussion of the results of the monitoring program. In general, very little airborne organic contamination was noted near Basin A. SVOCs were identified at low concentrations near the boundary of Basin F at the following levels:

- Aldrin - 0.064 - 0.20 ug/m^3;
- Dieldrin - 0.041 - 1.6 ug/m^3;
- Endrin - 0.031 - 0.13 ug/m^3;
- Isodrin - 0.038 ug/m^3;
- CPMSO - 0.026 - 0.065 ug/m^3; and
- CPMSO2 - 0.34 - 1.7 ug/m^3.

Airborne contaminant levels are estimated at the north and northwest RMA boundaries using Gaussian Plume diffusion formulas (U.S. Atomic Energy Commission, 1968). The formulas consider the source strength, source height, and distance to receptors, as well as atmospheric conditions such as vertical, horizontal, and lateral diffusion, atmospheric stability and wind speed according to the following relationship:

where:
- X = the time weighted concentrations at the boundary (grams/$meter^3$)
- Q' = source strength (grams/second)
- σ_y = horizontal dispersion coefficient, meters (m)
- σ_z = vertical dispersion coefficient (m)
- U = mean wind speed
- y = the distance from the center of the plume at the boundary
- h = the height of the source

Table 6.2-1. Airborne Organic Compounds at Rocky Mountain Arsenal (Page 1 of 5)

Contaminant	Amount or Range*	Dates Sampled	References
Acetaldehyde	0.08-0.66 µg/m^3	10/78-11/78	RMA 094 0605-0610
Acetone	Detected 0.16-3.51 µg/m^3	12/76 10/78-11/78	RMA 120 2864 FL RMA 094 0605-0610
Aldrin	17.2 µg/g 6.7x10^{-6}-0.021 µg/m^3 ND-1.03 µg/m^3	9/77 9/80-12/80 6/82-8/82	RMA 019 1760F RIC#81293R04 RIC#83192R02
Azomethane	0.09 µg/m^3	11/78	RMA 094 0605-0610
Benzaldehyde	1.31-3.58 µg/m^3 Detected	10/78-11/78 11/80	RMA 094 0605-0610 RIC#85213R03
Benzene	0.55-2.52 µg/m^3 Detected	10/78-11/78 1/81	RMA 094 0605-0610 RAA 012 0055-0057
Benzonitrile	0.02-0.10 µg/m^3	6/82-8/82	RIC#83192R02
n-Butane	0.17-0.95 µg/m^3	10/78-11/78	RMA 094 0605-0610
Chloroform	8.07 µg/m^3 Detected	10/78 1/81	RMA 094 0605-0610 RAA 012 0055-0057
Chloromethyl sulfonyl benzene	0.003-27 µg/m^3	6/82-8/82	RIC#83192R02
Chlorophenyl methyl sulfate	0.9-29 µg/g	9/77	RMA 019 1760F
Dichlorobenzonitrile	ND-0.2 µg/m^3	6/82-8/82	RIC#83192R02
Dichlorodiphenyldichloroethylene (DDE)	<0.002 µg/g	9/77	RMA 019 1760F
Dichlorodiphenytrichloroethane (DDT)	<0.002 µg/g	9/77	RMA 019 1760F
1,1-Dichloroethane	3.45 µg/m^3	10/78	RMA 094 0605-0610
1,2-Dichloroethane	0.49-3.03 µg/m^3	10/78	RMA 094 0605-0610
Dichloromethane	5.18 µg/m^3	10/78	RMA 094 0605-0610
Dicyclopentadiene (DCPD)	Identified Detected	12/76 1/81	RMA 120 2864FL RAA 012 0055-0057

Table 6.2-1. Airborne Organic Compounds at Rocky Mountain Arsenal
(Continued, Page 2 of 5)

Contaminant	Amount or Range*	Dates Sampled	References
Dieldrin	88.4 µg/g	9/77	RMA 019 1760F
	$1x10^{-5}$-0.1023 µg/m^3	9/80-12/80	RIC# 81293R04
	ND-0.82 µg/m^3	6/82-8/82	RIC#83192R02
Diethyl ether	Detected	1/81	RAA 012 0055-0057
Diisopropylmethyl phosphonate (DIMP)	<0.1 µg/g	9/77	RMA 019 1760F
N,N-Dimethyl acetamide (NNDMA)	Detected	11/80	RIC#85213R03
	Detected	1/81	RAA 012 0055-0057
	0.002-27 µg/m^3	6/82-8/82	RIC#83192R02
2,3-Dimethyloctane	0.03	11/78	RMA 094 0605-0610
Dimethyl disulfide (DMDS)	ND-0.1 µg/m^3	6/82-8/82	RIC#83192R02
2,2-Dimethyl-3-ethylhexane	1.06 µg/m^3	10/78	RMA 094 0605-0610
2,2-Dimethyl-4-ethylhexane	0.65 µg/m^3	11/78	RMA 094 0605-0610
N,N-Dimethyl formamide	2.90 µg/m^3	10/78	RMA 094 0605-0610
2,4-Dimethyl heptane	2.85 µg/m^3	11/78	RMA 094 0605-0610
3,4-Dimethyl heptane	1.85 µg/m^3	11/78	RMA 094 0605-0610
3,4-Dimethyl hexane	2.39-4.04 µg/m^3	11/78	RMA 094 0605-0610
3,3-Dimethyl hexane	1.11 µg/m^3	11/78	RMA 094 0605-0610
1,1-Dimethyl hydrazine	ND-92 ppm	6/80	RIC#85247R07
Dimethylmethyl phosphonate (DMMP)	Detected	11/80	RIC#85213R03
	Detected	1/81	RAA 012 0055-0057
	ND-260 µg/m^3	6/82-8/82	RIC#83192R02
Dimethyl pentane	3.75 µg/m^3	11/78	RMA 094 0605-0610
Dipropyl amine	ND	6/82-8/82	RIC#83192R02
Dithiane	0.09 µg/g	9/77	RMA 019 1760F

Table 6.2-1. Airborne Organic Compounds at Rocky Mountain Arsenal
(Continued, Page 3 of 5)

Contaminant	Amount or Range*	Dates Sampled	References
Endrin	2.3 µg/g	9/77	RMA 019 1760F
	1.7×10^{-5}-0.0286 µg/m^3	9/80-12/80	RIC#81293R04
	ND-0.39 µg/m^3	6/82-8/82	RIC#83192R02
2,3-Epoxybutane	0.27-0.36 µg/m^3	11/78	RMA 094 0605-0610
Ethanol	0.01-0.09 µg/m^3	10/78	RMA 094 0605-0610
Ethylbenzene	1.83 µg/m^3	10/78	RMA 094 0605-0610
	Detected	1/81	RAA 012 0055-0057
1-Fluoroheptane	3.90 µg/m^3	11/78	RMA 094 0605-0610
Formaldehyde dimethyl hydrazone	41.48 µg/m^3	10/78	RMA 094 0605-0610
n-Heptane	1.36-2.73 µg/m^3	10/78-11/78	RMA 094 0605-0610
Hexachlorobicycloheptadiene (HCBCH)	ND-2 µg/m^3	6/82-8/82	RIC#83192R02
Hexachlorobutadiene (HCB)	ND-0.3 µg/m^3	6/82-8/82	RIC#83192R02
Hexane	0.57-4.85 µg/m^3	10/78-11/78	RMA 094 0605-0610
	Detected	1/81	RAA 012 0055-0057
Hexanol	Detected	1/81	RAA 012 0055-0057
3-Hexanone	2.06 µg/m^3	10/78	RMA 094 0605-0610
Hydrazine	ND-0.92 ppm	6/80	RIC#83192R02
Isocyanomethane (ICM)	ND-2 µg/m^3	6/82-8/82	RIC#83192R02
Isodrin	5.9 µg/g	9/77	RMA 019 1760F
Isopropyl benzene	3.47 µg/m^3	11/78	RMA 094 0605-0610
Methanol	0.34 µg/m^3	10/78	RMA 094 0605-0610
2-Methylbutane	0.28-0.47 µg/m^3	10/78-11/78	RMA 094 0605-0610
Methyl cyanide	0.09 µg/m^3	10/78	RMA 094 0605-0610
Methylene chloride	Detected	12/76	RMA 120 2864FL

Table 6.2-1. Airborne Organic Compounds at Rocky Mountain Arsenal
(Continued, Page 4 of 5)

Contaminant	Amount or Range*	Dates Sampled	References
2-Methyl-4-ethyl benzene	1.56 µg/m^3	10/78	RMA 094 0605-0610
1-Methyl-4-ethyl benzene	0.71 µg/m^3	11/78	RMA 094 0605-0610
2-Methylheptane	2.94 µg/m^3	10/78	RMA 094 0605-0610
3-Methylhexane	1.31-4.22 µg/m^3	10/78-11/78	RMA 094 0605-0610
2-Methylpentane	0.26-1.75 µg/m^3	10/78-11/78	RMA 094 0605-0610
3-Methylpentane	1.11 µg/m^3	10/78	RMA 094 0605-0610
2-Methyl-1-pentanol	0.29 µg/m^3	11/78	RMA 094 0605-0610
2-Methyl-1-pentene	0.20 µg/m^3	11/78	RMA 094 0605-0610
2-Methylpropane	0.08-0.17 µg/m^3	10/78-11/78	RMA 094 0605-0610
2-Methylpropene	No Data Available	10/78-11/78	RMA 094 0605-0610
N-Nitrosodimethylamine (NDMA)	0.87-34.71 µg/m^3 <0.17-24.2 µg/m^3	10/78-11/78 6/80	RMA 094 0605-0610 RIC#85247R07
n-Nonane	0.65 µg/m^3	11/78	RMA 094 0605-0610
n-Octane	1.49-4.11 µg/m^3	10/78-11/78	RMA 094 0605-0610
Oxathiane	<0.05 µg/g	9/77	RMA 091 1760F
n-Pentane	0.12-3.95 µg/m^3	10/78-11/78	RMA 094 0605-0610
2-Pentanone	0.41 µg/m^3	11/78	RMA 094 0605-0610
2-Propylheptanol	2.15 µg/m^3	11/78	RMA 094 0605-0610
Toluene	1.73-14.64 µg/m^3 Detected Detected	10/78-11/78 11/80 1/81	RMA 094 0605-0610 RIC#85213R03 RAA 012 0055-0057
Trichlorobenzene	0.82-1.19 µg/m^3	10/78-11/78	RMA 094 0605-0610
Trichloroethylene (TRCLE)	0.64-1.75 µg/m^3	10/78-11/78	RMA 094 0605-0610

Table 6.2-1. Airborne Organic Compounds at Rocky Mountain Arsenal
(Continued, Page 5 of 5)

Contaminant	Amount or Range*	Dates Sampled	References
Trimethylbenzene	Detected	1/81	RAA 012 0055-0057
Xylene	1.64-9.08 $\mu g/m^3$	10/78-11/78	RM A094 0605-0610
m-Xylene	Detected	1/81	RAA 012 0055-0057
o-Xylene	Detected	1/81	RAA 012 0055-0057
p-Xylene	Detected	1/81	RAA 012 0055-0057

* $\mu g/m^3$= micrograms per cubic meter
$\mu g/g$ = microgram per gram
ND = Non-Detectable
ppm = parts per million

Source: ESE, 1988.

Table 6.2-2. Airborne Metals at the Rocky Mountain Arsenal

Contaminant	Arithmetic Mean*	Amount or Range	Dates Sampled	References
Arsenic	0.004-0.005 $\mu g/m^3$	0.004-0.018 $\mu g/m^3$	4/80-9/80	RIC#81293R04
Cadmium	0.005-0.007 $\mu g/m^3$	0.004-0.036 $\mu g/m^3$	4/80-9/80	RIC#81293R04
Copper	0.030-0.16 $\mu g/m^3$	0.01-1.241 $\mu g/m^3$	4/80-9/80	RIC#81293R04
Lead	0.131-0.260 $\mu g/m^3$	0.080-0.624 $\mu g/m^3$	4/80-9/80	RIC#81293R04
Mercury	0.0002-0.0008 $\mu g/m^3$	0.00007-0.0425 $\mu g/m^3$	4/80-9/80	RIC#81293R04

* $\mu g/m^3$ = micrograms per cubic meter.

Source: ESE, 1988.

The shortest distance to the RMA boundary from Basin F is approximately 1 mile or 1,600 m. Slightly stable conditions were assumed, which correspond to a wind speed (U) of about 3 meters/second (m/s). For this condition, the value of $_y$ and $_z$ from pages 102 and 103 of the U.S. Atomic Energy Commission (1968) are approximately 90 and 20, respectively. The height of the source was assumed to be 2 m and the distance from the center of the plume assumed to be zero. This provides the most conservative estimate of downwind concentrations.

The source strength was determined by taking a cross-section 2 m high and 250 m long above Basin F (corresponding to the portion of Basin F filled with liquid during monitoring), multiplying by the wind speed U (3 m/s) and the maximum dieldrin concentration (1.6×10^{-6} g/m^3). The resulting source strength is 2.4×10^{-3} gm/sec. The concentration X at the boundary was then determined by substituting into equation 6-1. The resultant concentration was estimated to be 1.4×10^{-7} or about 11.5 times less than the maximum concentration at the Basin F boundary.

Also during Task 18, metals were sampled near Basin A as well as at the perimeter of the RMA. Of special concern were metals results at the north and northwest boundaries. The ranges of concentrations in individual samples collected at the boundary were as follows:

- As - No detections;
- Cd - 0.003 - 0.017 ug/m^3;
- Cr - 0.004 - 0.006 ug/m^3;
- Cu - 0.064 - 0.204 ug/m^3;
- Hg - No detections;
- Pb - 0.009-0.056 ug/m^3; and
- Zn - 1.99 - 4.11 ug/m^3.

6.3 CONCLUSIONS

Criteria pollutants in the Offpost Operable Unit exceed Federal and State guidelines for TSP, CO, and O_3. However, RMA does not appear to be a source of these airborne contaminants. While there are not specific Federal and State toxic air quality guidelines, onpost toxic air contaminants were found

at very low concentrations and, therefore, offpost levels of these RMA contaminants would have to be as low or lower than the onpost concentrations. Even at these very low concentrations, odors may be noticed in the Offpost Operable Unit should emissions increase onpost.

7.0 BIOTA CONDITIONS

This section discusses the results of field studies conducted to determine the home range of species identified at RMA that may be migrating to the Offpost Operable Unit and that represent potential pathways for offpost contaminant migration. Rationale for species selection are discussed in Section 7.3. An evaluation of tissue sampling and analyses conducted onpost over the past 2 years has also been conducted under the RMA Biota RI task to allow for an assessment of the potential for contamination in onpost biota that might move to the Offpost Operable Unit. Definition of the nature and extent of contamination for biota will come from application of criteria developed in the draft Biota RI, and is addressed in the Offpost Endangerment Assessment.

7.1 RESULTS OF HOME RANGE STUDIES

7.1.1 RING-NECKED PHEASANTS

Fourteen ring-necked pheasants were equipped with transmitters, and home range areas were determined for 11 of the birds (10 male, 1 female) during the study (Table 7.1-1). Ten of the 11 transmitters utilized in home range determinations were found located on the ground surface without any pheasant parts. In some instances it was determined that the animals had lost the transmitters, but in other cases the animals may have been killed and the transmitters subsequently detached. Three transmitters were found in association with pheasant remains, indicating probable death from natural causes. No signal was detected from the remaining transmitter, suggesting that either the transmitter failed to function or the pheasant had flown beyond the one mile detection radius of the transmitter. The return of a reward band from a pheasant shot several miles north of RMA supports the latter possibility.

The three captured pheasants not utilized for home range determinations were radio-collared, but the transmitters immediately came off of two birds and radio contact was never established with the third. The number of locations per bird appeared to influence home range estimates. Four pheasants with

Table 7.1-1. Pheasant Home Range Estimates

Animal Number	Sex	Dates Monitored	No. of Locations	Home Range Area(acres)	Maximum Distance Covered (mi)	Comments
1	Male	May 23, 1985-June 6, 1985	12	11	0.29	
2	Male	May 30, 1985-Oct. 18, 1985	24	125	0.75	Transmitter found Oct. 18, 1985.
3	Male	Aug. 7, 1985-Nov. 1, 1985	25	81	0.54	Transmitter found Nov. 1, 1985.
4	Male	Aug. 7, 1985-Nov. 13, 1985	29	242	1.00	Transmitter found Nov. 13, 1985.
5	Male	Aug. 10, 1985-Nov. 20, 1985	31	150	0.75	
6	Male	Aug. 14, 1985-Nov. 20, 1985	34	275	1.37	
7	Male	Aug. 10, 1985-Oct. 16, 1985	19	41	0.40	Transmitter found Oct. 16, 1985.
8	Male	Aug. 12, 1985-Nov. 13, 1985	31	278	0.95	Transmitter found Nov. 13, 1985.
9	Female	Aug. 7, 1985-Oct. 18, 1985	18	84	0.56	Transmitter found Oct. 18, 1985.
10	Male	Aug. 10, 1985-Oct. 18, 1985	15	45	0.44	Transmitter found Oct. 19, 1985.
17	Male	Aug. 15, 1985-Jan. 13, 1986	56	101	0.63	Transmitter found Jan. 13, 1986.

Source: ESE, 1988.

less than 20 locations each had an average home range of 45.3 ac (range 11-84 ac), whereas seven birds with a minimum of 20 locations each had an average home range of 179 ac (Range 81-278 ac) (Figure 7.1-1).

One pheasant had over 50 percent of its locations on private land north of RMA. Its transmitter was subsequently found in a wheat stubble field about 0.5 mi north of RMA. Several times in the fall consecutive locations for this pheasant were on either side of the RMA boundary. A local hunter who returned a leg band claimed he had killed a pheasant in an agricultural area east of Brighton, Colorado (Section 13, T66W, R1S), about 7.5 mi northeast of the RMA boundary. In addition, four undamaged collars were found on the ground at RMA, suggesting that some birds could have flown offpost and not been detected.

Pheasants were occasionally observed flying to and from RMA along the northern perimeter, and hunters were observed near the northern boundary in November. These sightings were reported by drillers and technicians working in the Offpost Operable Unit, but were not documeted in field logs. Pheasant monitoring ceased when the last functional transmitter and pheasant remains were located approximately 0.5 mi northeast of the bird's home range. Although the number of pheasants equipped with transmitters decreased from fall to winter, the data obtained provided relevant information on their seasonal movements consistent with published information and casual observations.

No seasonal movement pattern was apparent upon examination of fall and winter areas of use for the one pheasant for which data were available. The greatest distance traversed for all pheasants monitored averaged 0.70 mi (range 0.29-1.4 mi). For pheasants with greater than 20 observations, the average was 0.86 mi (range 0.54-1.4 mi). Maximum distance traversed could not be compared between seasons because only one pheasant was monitored in winter.

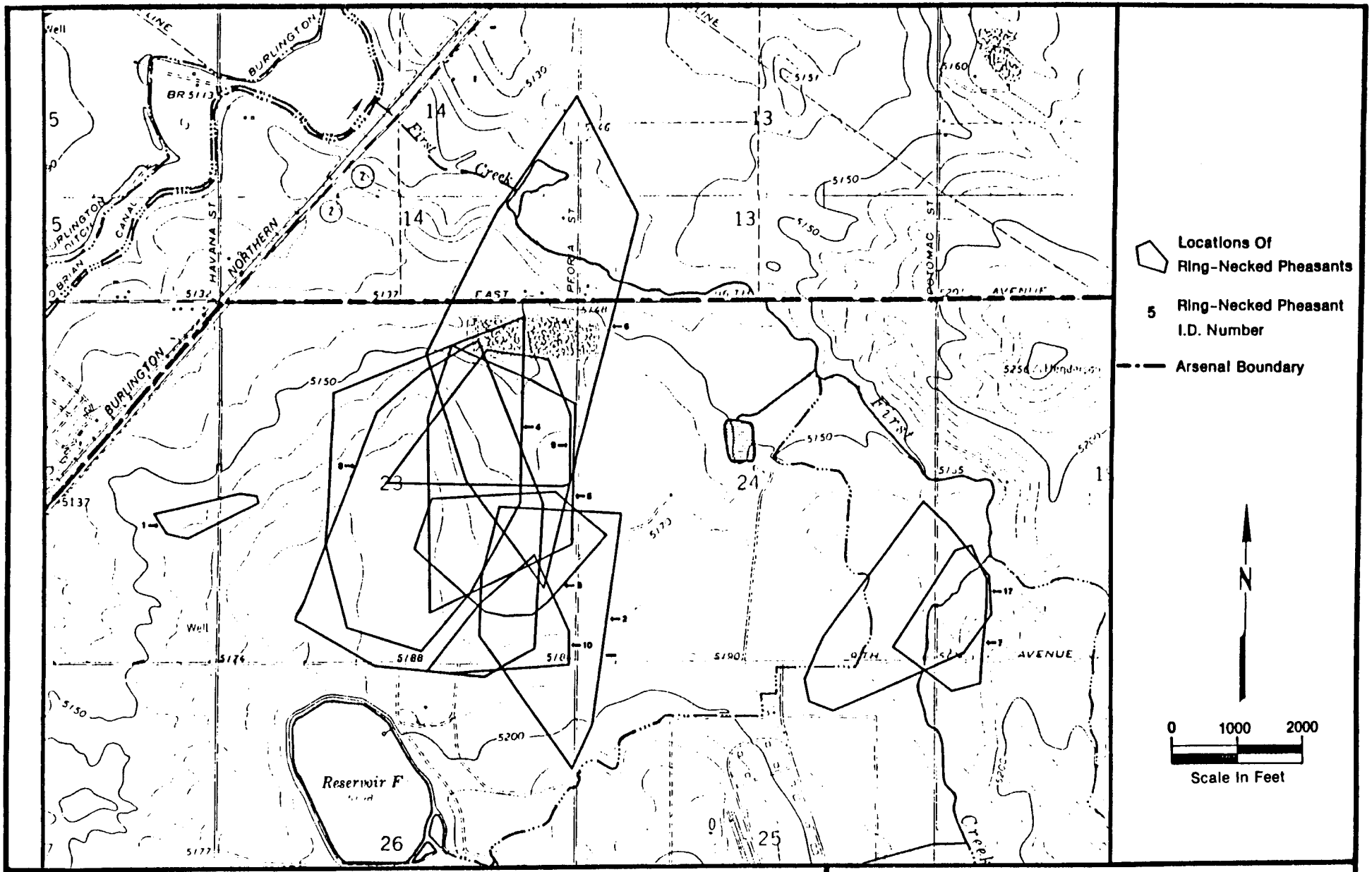


Figure 7.1-1

HOME RANGES OF RING-NECKED PHEASANTS

SOURCE: ESE, 1988

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

7.1.2 DESERT COTTONTAIL RABBITS

Twenty-six desert cottontail rabbits were captured during all seasons and marked with ear tags. Sixteen of them received collar-mounted transmitters. During the course of field monitoring, contact was completely lost with four transmitters. Three transmitters were traced to below-ground locations where the collars had either been lost or the animals had died. Four functioning collars were found associated with rabbit remains, indicating that the animals had died with the collars on. Two transmitters were near the pistol range in Section 19, and two were in recently plowed areas of Section 23, suggesting death due to human causes. Three additional transmitters were found in grassy areas, one in association with a rabbit carcass. The two remaining transmitters were functioning on live rabbits at the termination of field studies in January 1986. Of the 16 rabbits fitted with transmitters, seven were monitored for home range determination.

Transmitters and animals were lost throughout the investigation. Some transmitters lost early in the study were re-located and placed on new animals in an attempt to maintain a sample size of ten or more. This was not possible in all cases because of lost signals and buried transmitters. The fate of all animals equipped with transmitters throughout the study is presented in Table 7.1-2.

Home range size averaged 6.5 ac (range 2.3-12.6 ac). Night activity patterns accounted for much of the area used. Although all rabbits monitored were located onpost within 0.75 mi of the northern boundary, none were detected offpost (Figure 7.1-2). However, other rabbits were observed along the boundary fenceline and in the roadside ditch just outside RMA. Potential home range estimates are presented in Table 7.1-3.

7.2 DISCUSSION OF HOME RANGE STUDY

Results of this study indicated that some resident wildlife, ring-necked pheasants, from RMA moved offpost into adjacent areas where they could be hunted and subsequently consumed by humans. Although portions of the study area were disturbed during this investigation and several study animals were lost, the data obtained provide an objective and quantitative basis for evaluating potential pathways of offpost contaminant movement.

Table 7.1-2. Final Status of Animal and Transmitter (Page 1 of 3)

Animal	Date	Time	Location T	R	Sec	Comments
Pheasant 1			67W	2S	22	Transmitter found in plowed area, antenna bent.
Pheasant 2	Oct. 18, 1985	1205	67W	2S	23	Transmitter found on ground.
Pheasant 3	Nov. 1, 1985	0933	67W	2S	23	Transmitter found on ground amid feathers, bones. Teeth marks present on harness and antenna.
Pheasant 4	Nov. 13, 1985	1430	67W	2S	23	Bird and collar found beneath snow. Carcass not chewed upon or decomposed.
Pheasant 5	Dec. 17, 1985	0952	67W	2S	23	Transmitter found beneath snow. Acrylic cracked; small teeth marks present on harness, antenna.
Pheasant 6	Dec. 27, 1985	1320	67W	2S	13	Transmitter found in wheat stubble field on private land north of RMA.
Pheasant 7	Oct. 16, 1985	1430	66W	2S	30	Transmitter found in plowed field.
Pheasant 8	Nov. 13, 1985	1025	67W	2S	23	Transmitter found on ground.
	Jan. 22, 1986	1205				Leg band obtained from hunter in Brighton, Colorado.
	Jan. 22, 1986		66W	1S	13	Location where bird was reportedly shot.
Pheasant 9	Oct. 18, 1985	1230	67W	2S	23	Transmitter found on ground.
Pheasant 10	Oct. 18, 1985	1245	67W	2S	23	Transmitter found on ground.
Pheasant 11	Oct. 25, 1985					Status unknown, no signal detected.
Pheasant 17	Jan. 13, 1986	1617	66W	2S	19	Transmitter found on ground amid feathers, bones.

Table 7.1-2. Final Status of Animal and Transmitter (Continued, Page 2 of 3)

Animal	Date	Time	Location T	R	Sec	Comments
Pheasant 18	Nov. 13, 1985	1420	67W	2S	23	Transmitter immediately came off, found on ground. Collar torn and enlarged.
Pheasant 19	Nov. 20, 1985	1731	67W	2S	23	Transmitter immediately came off, found on ground.
Rabbit 2	Aug. 8, 1985		66W	2S	20	No signal heard after this date, animal status unknown.
Rabbit 6	Aug. 22, 1985					Transmitter recovered.
Rabbit 7	Aug. 30, 1985		67W	2S	23	Transmitter found in plowed field.
Rabbit 8	Oct. 7, 1985		67W	2S	23	Transmitter not recovered, known home range plowed in September.
Rabbit 9	Oct. 24, 1985	1435	67W	2S	23	Transmitter, partial carcass found in plowed field.
Rabbit 10	Jan. 17, 1986	1250	66W	2S	20	Animal alive, transmitter functional.
Rabbit 11	Jan. 17, 1986	1310	66W	2S	20	Animal alive, transmitter functional.
Rabbit 12	Jan. 8, 1986	1113	67W	2S	23	Transmitter located underground, animal status unknown.
Rabbit 14	Oct. 15, 1985	1750	66W	2S	19	Transmitter, partial carcass found on shooting range.
Rabbit 15	Dec. 17, 1985	1245	66W	2S	20	No signal heard after this date, animal status unknown.
Rabbit 16	Oct. 7, 1985	0820	66W	2S	20	No signal heard after this date, animal status unknown.
Rabbit 23	Oct. 16, 1985	0630	66W	2S	19	Transmitter, partial carcass found on shooting range.

Table 7.1-2. Final Status of Animal and Transmitter (Continued, Page 3 of 3)

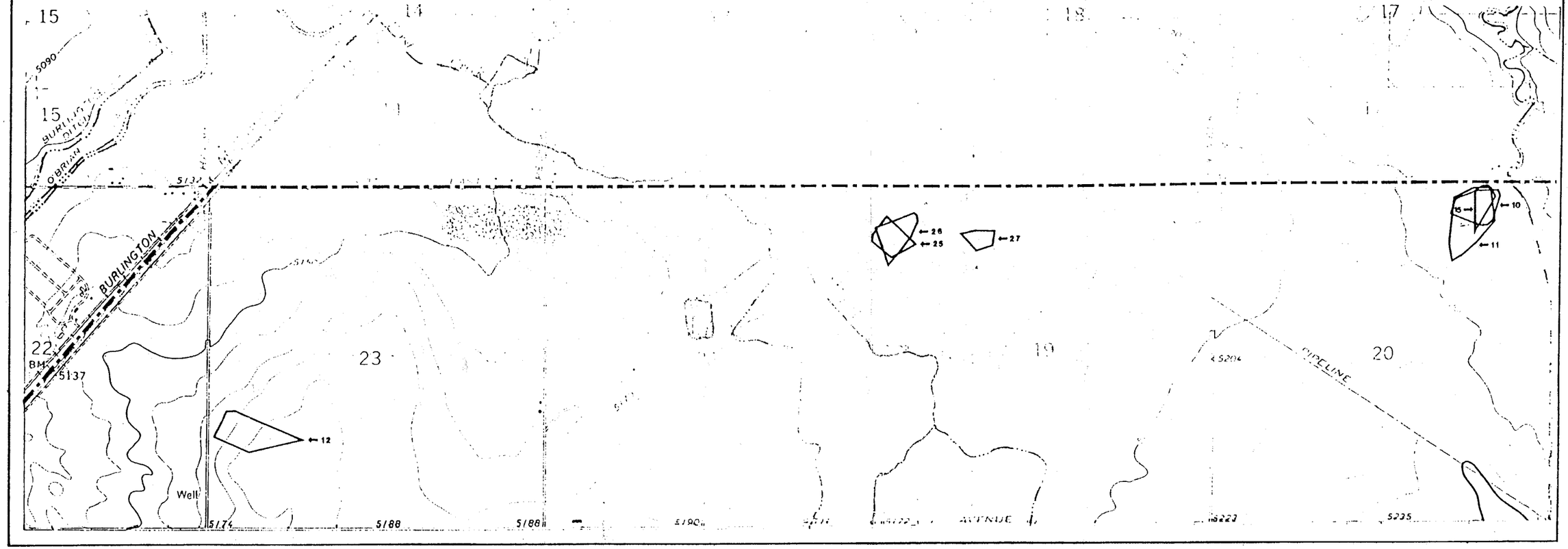
Animal	Date	Time	Location T	R	Sec	Comments
Rabbit 25	Dec. 17, 1985	1049	66W	2S	19	Transmitter located underground, animal status unknown.
Rabbit 26	Nov. 20, 1985	1839	66W	2S	19	Transmitter, partial carcass found beneath snow. Collar partially removed, 1 part wedged in mouth behind incisors.
Rabbit 27	Dec. 27, 1985	1117	66W	2S	19	Transmitter found beneath snow, antenna partially stripped.
Rabbit 28	Nov. 11, 1985	1157	66W	2S	19	Transmitter located underground, animal status unknown.

Source: ESE, 1988.

Table 7.1-3. Cottontail Home Range Estimates

Animal Number	Dates Monitored	No. of Locations	Home Range Area(acres)	Maximum Distance Covered (mi)	Comments
10	Aug. 9, 1985-Jan. 17, 1986	57	7.0	0.16	
11	Aug. 20, 1985-Jan. 17, 1986	62	12.6	0.24	
12	Aug. 26, 1985-Nov. 20, 1985	22	9.9	0.26	
15	Oct. 7, 1985-Nov. 13, 1985	23	2.8	0.13	
25	Oct. 31, 1985-Nov. 20, 1985	11	4.8	0.12	
26	Nov. 1, 1985-Nov. 20, 1985	11	6.0	0.17	Transmitter found Nov. 20, 1985
27	Nov. 4, 1985-Nov. 20, 1985	9	2.3	0.10	

Source: ESE, 1988.



EXPLANATION

Locations Of Cottontail Rabbits

Arsenal Boundary

12 Cottontail Rabit I.D. Number

N

0 1/2 1

SCALE IN MILES

Figure 7.1-2

HOME RANGE OF COTTONTAIL RABBITS

SOURCE: ESE, 1988

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

While only minimum home range and greatest distance moved estimates were obtained, radiotelemetry data indicated that ring-necked pheasants moved up to 1.4 mi and at least two of the 14 total individuals equipped with radiotransmitters left RMA during the course of this study. The reward band from one pheasant tagged on RMA during the summer was returned after the pheasant was shot in an agricultural area 7.5 mi northeast of RMA. This distance is within the range reported from locations in the Midwest (MacMullan, 1954) and is probably valid. The loss of contact with some pheasants may have been because they moved beyond the 1 to 2 mi range of the transmitters used.

Both home range size and greatest distance traversed estimates continued to increase with the number of observations (Table 7.1-1). This indicated that either the number of observations was insufficient to provide an adequate estimate of home range or, more likely, some seasonal shifts in home range occurred, resulting in an expanded total home range for individual pheasants. Shifts in seasonal home range could not be determined in a short-term study such as this, particularly since there was a substantial loss of monitored individuals. Habitat disturbance, loss of radiotransmitters from some pheasants, predation, and hunting all contributed to a reduction of pheasant numbers to levels that did not permit an evaluation of seasonal home range movement. Only one pheasant retained a radiotransmitter by the time of the winter survey, and this pheasant succumbed by the end of the study in late January, 1986. Actual home ranges/distance traversed was probably higher than the estimates obtained in this study because pheasants were not monitored throughout their life (or even a full year) and continuous readings on their movements were not taken.

Loss of some monitored individuals and transmitters early in the study probably resulted in low estimates of the number of individuals that moved offpost from RMA. In spite of such losses, these results remained within the range of pheasant movements reported from other studies. Hanson and Progulske (1973) obtained home range estimates of 89 ac for ring-necked pheasants in South Dakota. This study, however, was conducted in an agricultural area without the large unhunted and ungrazed habitats that characterize the northern portion of RMA. Home range data indicate that

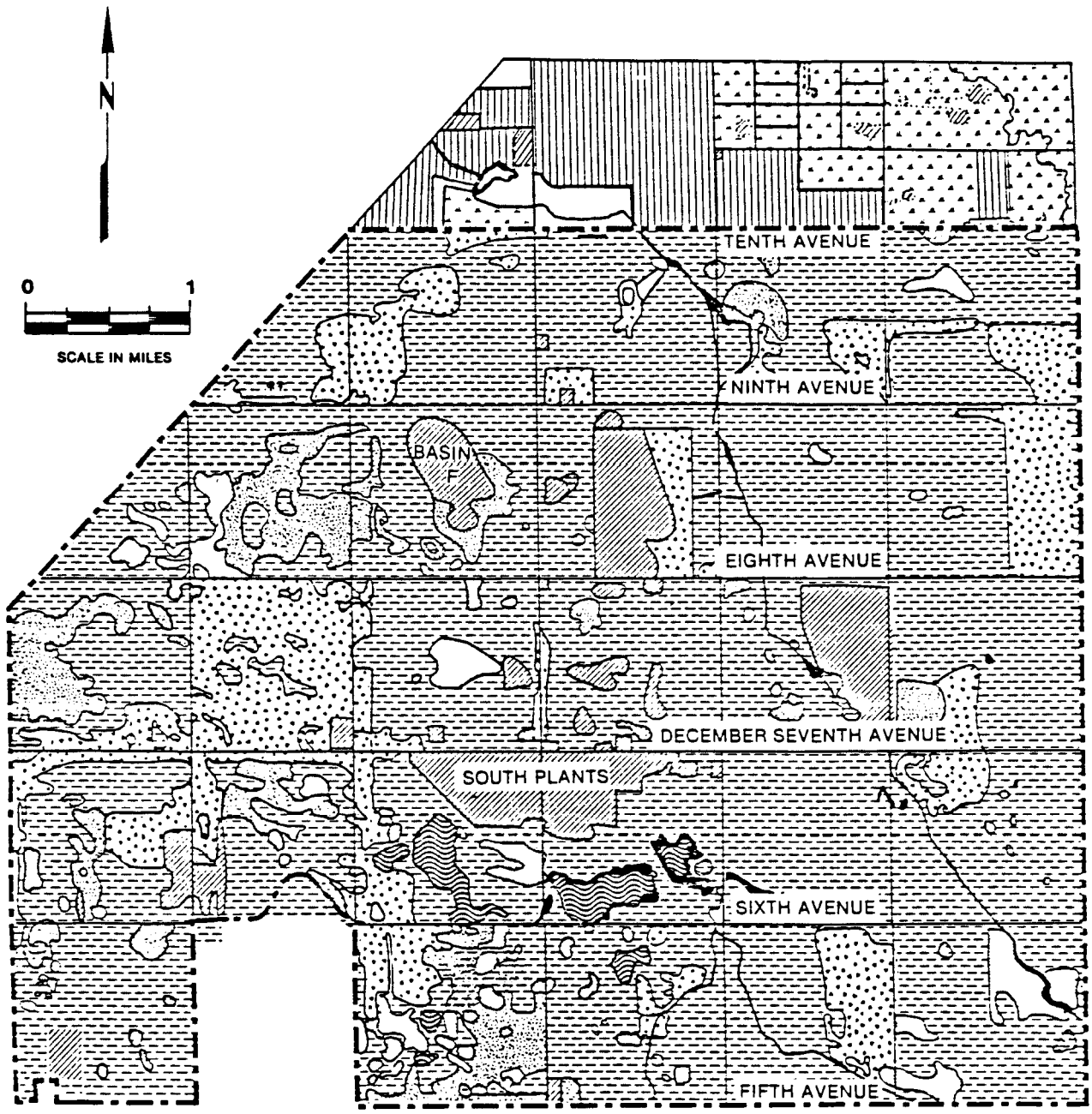
ranges of these individuals could encompass offpost areas. During the fall, many pheasants were observed flying from RMA during the morning and returning to RMA at night.

Home ranges and distances traversed data were determined to be large enough to permit individuals exposed to onpost sites of known contamination to move into offpost areas where they could be hunted. Several hunters were observed in the offpost study area adjacent to RMA during fall surveys. The home range size and movement of pheasants can be influenced by factors such as habitat type (Figure 7.2-1), cover, food availability, weather, and population density. The extent to which these factors affected pheasant movements during the course of this investigation was not determined.

None of the 16 cottontails that were equipped with radiotransmitters during this study were observed in the offpost areas. The small home range size (mean 6.5 ac, range 2.3-12.6 ac) and short distance traversed (mean 0.17 mi, range 0.10-0.26 mi) suggest that only individuals inhabiting the border of RMA might move into the offpost environment. Although the sample size was small, there was no evidence of seasonal movement from this study. Although no comparable data exist for the desert cottontail in this region, the home range size is within the range found for cottontails throughout the United States (1.2-22.5 ac; Schwartz, 1941; Haugen, 1942). Results therefore indicate that cottontails found adjacent to RMA in the offpost areas were not likely to be exposed to sites of contamination that would make them a threat to human hunters in the vicinity offpost of RMA.

7.3 EVALUATION OF BIOTA CONTAMINANT PATHWAYS

Ring-necked pheasant carcasses were obtained for analyses onpost and offpost for control. Detectable levels of mercury, aldrin, endrin, and p,p'-DDE were not observed in pheasant carcasses onpost, however, arsenic and dieldrin were observed in onpost specimens. Dieldrin was less frequently detected in offpost carcasses but the highest concentration of dieldrin at 18.6 was observed in an offpost control sample. This sample was apparently



EXPLANATION

- RMA Boundary
- Non-Native Herbaceous
- Native Herbaceous
- Crested Wheatgrass
- Woody Schrubs
- Structures Or Bare Ground
- Wetland/Riparian Areas
- Water
- Wheat Fields
- Pasture

Figure 7.2-1

PRELIMINARY VEGETATION MAP OF ROCKY MOUNTAIN ARSENAL

SOURCE: ESE, 1988

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

not associated with RMA as it was collected in Weld County. Arsenic concentrations were similar in onpost and offpost samples. P,p'-DDE was detected in one offpost sample at a concentration of 1.34 ug/g.

In addition to ring-necked pheasants and cottontail rabbits, several other resident species were identified which could become contaminated at RMA and migrate to the Offpost Operable Unit. Waterfowl such as mallards and red-headed ducks may stay at RMA year-round or migrate short distances to the South Platte River or Barr Lake during the year. Although these waterfowl represent a potential for contaminant transport to offpost areas, the populations of these species at RMA are relatively small compared to the total population in the area. Because potentially contaminated individuals would become interspersed with animals from uncontaminated offpost locations, the potential for multiple exposures to ducks contaminated at RMA and hunted in the area is small.

Mallard duck carcasses were obtained for analyses onpost and offpost for control. Offpost and onpost samples exhibited detectable levels of mercury and p,p'-DDE. Muscle and liver tissues were sampled because of the potential for these tissues to be consumed by humans and because these tissue levels could be related to adverse biological effects. Mercury levels were similar for onpost and offpost samples and generally close to the detection limit of 0.05 ug/g. The highest concentration of p,p'-DDE was noted in an offpost sample at 1.02 ug/g. Dieldrin was below detectable levels in offpost control samples but was observed in onpost specimens.

Samples of muscle and liver were collected from red-headed ducks onpost. Contaminants were generally detected more frequently and at higher levels in liver samples. Mercury, aldrin, dieldrin, endrin, and p,p'-DDE were detected in liver samples. Dieldrin was the most frequently detected organochlorine pesticide and the highest concentration was 0.747 ug/g. Muscle samples exhibited detectable levels of mercury and dieldrin. The highest dieldrin concentration in a muscle sample was 0.203 ug/g.

Although a detailed study has not been performed to determine the home range of mule deer at RMA, mule deer have been observed by ESE personnel crossing the RMA boundaries. Thus, deer that are contaminated on RMA and hunted in the offpost area represent a potential pathway for contamination to the offpost area. Only 1 of the 14 deer sampled on RMA showed detectable levels of dieldrin (0.281 ug/g in liver). This individual was collected between Basin A and the South Plants near the center of RMA.

Contaminant levels were found in resident mobile species (e.g., pheasant, ducks, and deer). The ring-necked pheasant is the only species of concern in this regard, because some individuals collected from areas of contamination contain substantial levels of organochlorine pesticides and this species has home range sizes in the region that permit them to move offpost. However, data on seasonal movements and contaminant distribution in RMA pheasants indicate only limited potential for offpost movement of contaminated individuals. Although cottontails near sites of contamination onpost were found to contain some RMA contaminants, home range data collected as part of the Offpost Operable Unit RI indicate that cottontail home ranges are too small to permit offpost movement of contaminated individuals.

The potential hazards are discussed and quantified in the Offpost Endangerment Assessment currently being prepared. Additional information on tissue levels of RMA contaminants in onpost biota are presented in the Draft Final Biota RI which will be available in early 1989.

8.0 POTENTIAL CHEMICAL SPECIFIC ARARs

To support the EA and FS, potential chemical specific ARARs have been identified for the Offpost Operable Unit and are listed in Appendix H. Potential ARARs were identified for all target analytes that were detected offpost in the most recent sampling events or were detected historically in the Offpost Operable Unit. Also, in media for which onpost contamination data are relevant to the offpost area (i.e., air and biota), chemical specific ARARs have been identified for analytes that were detected in these media onpost. For each analyte, the media in which the contaminant was detected in is listed, and for each media of concern, all potential ARARs are listed.

9.0 CONCLUSIONS

Field investigations conducted over the last several years in the Offpost Operable Unit have examined various media to evaluate the nature and extent of contamination that has resulted from contaminant migration from RMA. Consumptive Use Assessments (ESE, 1985; RIC#87016R02, ESE, 1986b; RIC#87016R03, ESE, 1987f) and Contamination Assessments conducted since 1984 have indicated that ground water was the primary pathway for contaminant migration to the offpost area. Thus, much of the most recent investigative efforts focused on evaluating ground-water pathways and the nature and extent of ground-water contamination. However, surface water, sediments, air, and biota were assessed in this report to evaluate potential contamination in these media and the extent to which these media may be contaminant pathways from RMA to the Offpost Operable Unit. The ground water and surface water data are considered sufficient to conduct an EA/FS on these media. Additonal data collection for these media, particularly for ground water downgradient of the NWBCS, will be outlined in a plan for a STI and presented in preliminary design documents. However, additional information regarding the evaluation of biota, sediments, soils, and windblown dust will be provided in addenda to the RI report.

9.1 GROUND WATER

The ground-water investigations performed as part of the RI concentrated on the area north of the RMA north boundary but did include the area northwest of RMA. This was done because the area north of the RMA north boundary is downgradient of the primary ground-water contaminant plumes onpost. Data collected under the RI identified two general zones of alluvial contamination in this offpost area. These zones generally correspond to two paleochannel features in the bedrock surface. These two paleochannel features in the bedrock surface are referred to as the First Creek and Northern pathways. Enhanced migration of contaminants along the paleochannel features was attributed to the high hydraulic conductivity and low sorptive capacity of relatively thick coarse basal sands and gravels within these features.

The available data indicate that much of the observed contamination north of RMA migrated to the offpost area prior to installation of the NBCS. These data also

indicate the NBCS has had a noticeable effect in lowering downgradient organic contaminant concentrations. This was evidenced not only by lower contaminant concentrations downgradient of the NBCS relative to upgradient contaminant concentrations but also by general order of magnitude declines in contaminant concentrations in historically monitored wells near the RMA North Boundary.

Recharge to the alluvial aquifer from irrigation canals both directly from seepage and indirectly from irrigation appears to have had a marked influence on ground-water contaminant concentrations in the area downgradient of O'Brian Canal. Approximate estimates of recharge indicated that an order of magnitude more flow is present in the alluvial aquifer near O'Brian Canal than in areas upgradient of the canals and just north of the RMA north boundary. This recharge is thought to be responsible for reduced contaminant concentrations downgradient of the canals as compared to concentrations observed upgradient of the canals and just north of the RMA north boundary.

Contaminant migration off the northwest boundary has been restricted primarily to dieldrin and chloroform. Currently, steps are being taken to improve the operations of the NWBCS to provide for more efficient treatment of chloroform. Additional data collection to support remedial design downgradient of the northwest boundary will be outlined in a plan for a STI and the results provided in preliminary design documents.

Because of the relatively slow average linear velocities in Denver Fm sandstone units and the potential for downward vertical migration from the alluvial aquifer, Denver Fm wells in the Offpost Operable Unit were located in the area of known or suspected alluvial contamination. Contamination in the Denver Fm generally exhibited a trend of decreasing contaminant concentrations with depth. The highest contaminant concentrations in the Denver Fm were generally observed in samples from wells completed within sandy zones of the upper Denver Fm. These zones are in direct contact with the base of the alluvium. Most of the organic contaminants observed in the Denver Fm were generally present in the overlying alluvium nearby. Downward gradients from the alluvium to the Denver Fm and relatively low lateral velocities in the Denver Fm suggested that a component of vertical migration

in the offpost area was present. Lateral migration of mobile contaminants within the Denver Fm that move at a rate similar to that of ground water is expected to be relatively slow as compared to the alluvial aquifer.

Benzene, chlorobenzene, and chloroform were detected routinely in samples from Denver Fm wells offpost. Because these contaminants were also frequently observed in upgradient Denver Fm wells, lateral migration of these contaminants through the Denver Fm cannot be ruled out as a transport mechanism.

Consumptive use studies performed by ESE during 1984 and 1985 (ESE, 1985, RIC#87016R02: ESE, 1986b, RIC#87016R03) located only three Denver Fm domestic use wells in the area north of the RMA boundary and upgradient of O'Brian Canal. None of these wells exhibited organic contamination at concentrations exceeding CRLs.

Organic contamination in the alluvial aquifer downgradient of the NWBCS was generally characterized primarily by dieldrin and chloroform. Dieldrin contamination appeared relatively unaffected by the presence and operation of the NWBCS. This was attributed to dieldrin's low mobility in ground water and the fact that the NWBCS has been in operation for only about 5 years. More mobile contaminants such as DBCP and DIMP, which have also migrated toward the NWBCS, were generally not observed in offpost samples collected downgradient of the NWBCS.

Chloroform contamination in the alluvial aquifer downgradient of the NWBCS appeared to be due, at least in part, to chloroform breaking through the carbon adsorption system at the NWBCS due to the present operation practices being used. Samples collected from the influent and effluent of the NWBCS during the fall of 1987 by ESE suggested that influent chloroform concentrations were passing through the system relatively unchanged. Efforts are currently underway to modify the operational procedures of the NWBCS to alleviate chloroform break-through through the carbon system.

Contamination in the offpost area north of 80th Avenue was generally restricted to sporadic detections of volatile organohalogens such as

trichloroethylene. Several studies are currently underway to identify the sources of these compounds to the south of the Offpost Operable Unit and to evaluate trichloroethylene sources on the Western Tier of RMA. The presence of DBCP, which historically extended into the offpost area north of 80th Avenue, was not observed in the most recent sampling efforts indicating the effectiveness of the ICS in preventing the offpost migration of this contaminant.

9.2 SURFACE WATER AND SEDIMENTS

Surface water was examined in the Offpost Operable Unit by evaluating the chemistry of quarterly samples collected from a network of sampling locations upgradient of and in the Offpost Operable Unit. An evaluation of surface runoff patterns and chemistry data collected since 1985 indicated that First Creek was the primary pathway for surface water contaminant migration to the Offpost Operable Unit. Further evaluation of chemistry and ground-water level data along First Creek indicated that contamination was primarily entering First Creek via infiltration of contaminated ground water offpost. This was evidenced by zones along the offpost reach of First Creek where the ground-water elevation was near or exceeded the base elevation of the stream bottom. In addition, organic contamination was observed at the sampling station at the confluence of First Creek and O'Brian Canal but not at the upstream station at the RMA north boundary. Increased inorganic contaminant concentrations were observed in First Creek samples collected from to the O'Brian Canal Station versus the North Boundary Station. Also, all of the contaminants observed in samples from First Creek offpost were present in the ground water offpost in areas where infiltration to First Creek was suspected.

Organic contaminants were only observed sporadically in samples collected downstream of First Creek and at levels near the CRLs. However, no organic contaminants were observed in more than one sample from Burlington Ditch, O'Brian Canal, and Barr Lake. Lower and more sporadic detections of organic contaminants downgradient of First Creek were primarily attributed to fate processes, such as volatilization, and dilution from larger upstream flows from O'Brian Canal. Observed organic contamination in samples from the

upstream station on the South Platte River may be attributed to contaminated flow from Sand Creek, which enters the South Platte River upstream.

Evaluation of surface water sediments contamination was conducted by assessing analytical data from two sampling events. The first sampling and analysis effort was conducted during April 1986. No organic compounds were detected exceeding certified limits, although significantly lower CRLs were used in the second sampling and analyses event. The highest levels of metals were noted in samples from Barr Lake and with the exception of arsenic, were considered to be above the levels typically found in fresh water sediments. These relatively high metals concentrations may be attributable to the past disposal of wastewater sludge in the lake.

The second round of sampling and analysis performed during April 1988 used significantly lower CRLs in the chemical analyses. The results from nine sampling locations showed five detections of organic contaminants. The only organic analytes detected were the strongly sorbed pesticides p,p'-DDT, p,p'-DDE, and dieldrin. Of the five detections, four were in O'Brian Canal sediments and one in First Creek sediments. The only organic analyte detected in First Creek sediments was dieldrin at a concentration of 0.006 ug/g from Site FC1S, immediately north of 96th Avenue.

Metal concentrations in the second round of samples were comparable to the levels observed in the April 1986 sampling. The highest levels of metals were noted in Barr Lake from deep stratum sample (20 to 24 inches). Higher levels in the deeper stratum sample may be attributable to past wastewater sludge disposal in the lake.

Metal concentrations in First Creek sediment samples were considered to be within the range of metals concentrations for fresh water sediments. The single detection of dieldrin in First Creek sediments may be the result of RMA contaminant migration, or may have originated from some other offpost source. However, the samples from the impoundment along First Creek offpost did not exhibit organic contamination. Because of the fine-grained sediments in the offpost impoundment, it was initially surmised that

contaminants from First Creek accumulated there. The fact that organic contaminants were not observed in the impoundment suggested that the extent of organically contaminated sediments along First Creek was not great.

9.3 AIR

The evaluation of air conditions in the Offpost Operable Unit were evaluated by assessing onpost data for criteria pollutants and toxic airborne contaminants. Because the criteria pollutants measured onpost were well within Federal and State standards and guidelines for ambient air quality, the offpost air quality does not appear to have been significantly affected by RMA originating airborne contaminants. The onpost toxic air contaminants were found to be at very low concentrations and, therefore, offpost levels would be as low or lower than onpost concentrations.

9.4 BIOTA

Biota was examined as a potential pathway from RMA to the Offpost Operable Unit by identifying species that could transport onpost contaminants by migrating offpost. Several resident species, such as mallards and red-headed ducks, have the potential for migrating offpost. However, because of their relatively small populations at RMA, the chances for multiple exposure to individuals hunted offpost were considered quite small. Although a detailed study of the home range size for mule deer was not performed for this study, mule deer have been observed crossing the RMA boundaries.

However, of fourteen deer collected for analysis onpost, only one of these individuals showed contamination. This detection was of dieldrin (0.281 ug/g in liver). This individual was collected between Basin A and the South Plants near the center of RMA.

Studies were performed during the RI to determine the home range size of desert cottontail rabbits and ring-necked pheasants. These species were chosen for investigation because their home range sizes and populations were thought to be such that they could present the potential for multiple exposures from individuals hunted in the Offpost Operable Unit. Although cottontails near sites of onpost contamination were found to contain some

RMA contaminants, home range data collected as part of the RI indicated that cottontail home ranges were too small to permit offpost movement of contaminated individuals. The species of greatest concern was the ring-necked pheasant. This species was of concern because some individuals collected from areas of onpost contamination contained substantial levels of organochlorine pesticides. In addition, this species has home range sizes in the region that permitted them to move offpost. However, data on seasonal movements and contaminant distribution in RMA pheasants indicate only limited potential for offpost movement of contaminated individuals.

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11.0 ACRONYMS AND ABBREVIATIONS

Army	Department of the Army
As	A sand zone - channel
Au	A sand zone - upper
Am	A sand zone - middle
Al	A sand zone - lower
ac-ft	acre-feet
ac-ft/mo	acre-feet per month
ac-ft/yr	acre-feet per year
ASTM	American Society for Testing and Materials
CDH	Colorado Department of Health
CF&I	Colorado Fuel and Iron
cfs	cubic feet per second
cm/sec	centimeters per second
CO	carbon monoxide
COE	U.S. Army Corps of Engineers
COR	Contracting Officer's Representative
COS	combined organosulfur compounds
CPMS	chlorophenylmethyl sulfide
CPMSO	chlorophenylmethyl sulfoxide
$CPMSO_2$	chlorophenylmethyl sulfone
CRL	certified reporting limits
CSU	Colorado State University
CSU-GWFlow	Colorado State University Ground-Water Flow Model
CWP	Composite Well Program
DATS	Denver Air Toxics Study
DBCP	Dibromochloropropane
11DCE	1,1-dichloroethylene
11DCLE	1,1-dichloroethane
12DCE	trans-1,2-dichloroethylene
DCPD	Dicyclopentadiene
DDT	Dichlorodiphenyltrichloroethane
DIMP	Diisopropylmethyl phosphonate
DMDS	dimethyldisulfide
DMMP	dimethylmethyl phosphonate

EA	Endangerment Assessment
EA	Environmental Assessment
EPA	U.S. Environmental Protection Agency
ESE	Environmental Science and Engineering, Inc.
^{o}F	degrees Farenheit
FCP	First Creek Paleochannel
Fm	Formation
FRICO	Farmer's Reservoir and Irrigation Company
FS	Feasibility Study
ft	feet
ft/day	feet per day
ft/yr	feet per year
ft^3	cubic feet
FY87	Fiscal Year 1987
gal/ft^2	gallons per square foot
GB	Sarin (nerve agent)
GC/MS	gas chromatography/mass spectrometry
gpd/ft	gallons per day per foot
gpd/ft^2	gallons per day per square foot
gpm	gallons per minute
H	Levinstein mustard
HCCPD	hexachlorocyclopentadiene
HGU	Hydrogeologic unit
ICAP	inductively-coupled argon plasma
ICS	Irondale Containment System
ID	inside diameter
in/mo	inches per month
iph	inches per hour
K	hydraulic conductivity
K_d	partition coefficient
LA	Lignite A
LB	Lignite B
LC	Lignite C
LD	Lignite D
lbs/ft^3	pounds per cubic foot
MCL	maximum contaminant level

mg/l	milligrams per liter
mi	miles
MIBK	methylisobutyl ketone
MKE	Morrison-Knudsen Engineers, Inc.
mm	millimeter
mph	miles per hour
msl	mean sea level
NAAQS	National Ambient Air Quality Standards
NBCS	North Boundary Containment System
NBE	north boundary east
NBTP	North Boundary Treatment Plant
NBW	north boundary west
NO_x	Nitrogen Oxides
NWBCS	Northwest Boundary Containment System
NWBP	Northwest Boundary Paleochannel
O_3	ozone
OAS	Organizations and the State
OD	outside diameter
PCE	tetrachloroethene
PI	plasticity index
PID	photoionization detector
PM-10	particulate matter less than 10 microns in diameter
PMO-RMA	U.S. Army Program Manager's Office-Rocky Mountain Arsenal Contamination Cleanup
PMSO	Program Manager Staff Office
p,p'-DDE	p,p'-1,1-dichloro-2,2-bis(4-chlorophenyl)-ethylene
p,p'-DDT	p,p'-dichlorodiphenyltrichloroethane
ppm	parts per million
psi	pounds per square inch
PVC	polyvinyl chloride
RCI	Resource Consultants, Inc.
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
RIC	RMA Information Center
RMA	Rocky Mountain Arsenal

RMA-ED	Rocky Mountain Arsenal Environmental Division
SACWSD	South Adams County Water and Sanitation District
SCC	Shell Chemical Company
SCS	Soil Conservation Service
Shell	Shell Chemical Company
SIA	Stapleton International Airport
SO_x	sulfur oxides
sq mi	square mile(s)
SW/GW	Surface Water/Ground Water
STP	Sewage Treatment Plant
SVOC	semivolatile organic compounds
SYA	apparent specific yield
T	transmissivity
TCE	trichloroethlene
111TCE	1,1,1-trichloroethane
112TCE	1,1,2-trichloroethane
TCLEE	tetrachloroethane
TRCLE	trichloroethene
TSP	total suspended particulates
lu	number 1 upper sand
ug/g	micrograms per gram
ug/l	micrograms per liter
ug/m^3	micrograms per cubic meter
USAEHA	U.S. Environmental Hygiene Agency
USATHAMA	U.S. Army Toxic and Hazardous Materials Agency
USCS	Unified Soil Classification System
UTM	Universal Transverse Mercator
VC	volcaniclastic interval
VCE	clay-rich stratigraphically equivalent zone to VC
VOC	volatile organic compounds
WES	U.S. Army Corps of Engineers Waterways Experiment Station
WRI	Water Remedial Investigation
WWII	World War Two

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VOLUME II
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LITIGATION TECHNICAL SUPPORT AND SERVICES

Rocky Mountain Arsenal

Rocky Mountain Arsenal Information Center Commerce City, Colorado

Offpost Operable Unit
Remedial Investigation and Chemical
Specific Applicable or Relevant and
Appropriate Requirements
Final Report
(Version 3.1)
Volume II

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U.S. ARMY PROGRAM MANAGER'S OFFICE FOR
ROCKY MOUNTAIN ARSENAL

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TABLE OF CONTENTS

Section			Page
VOLUME I			
	EXECUTIVE SUMMARY		
1.0	**INTRODUCTION**		1-1
1.1	CONDITIONS IN THE OFFPOST OPERABLE UNIT		1-5
1.2	ONGOING RESPONSE ACTIONS		1-7
	1.2.1	NORTH BOUNDARY: CONTAINMENT/TREATMENT	1-7
	1.2.2	NORTHWEST BOUNDARY: CONTAINMENT/TREATMENT	1-8
	1.2.3	IRONDALE: CONTAINMENT/TREATMENT	1-8
1.3	SUMMARY OF TECHNICAL APPROACH		1-9
2.0	**DATA COLLECTION AND ANALYSES**		2-1
2.1	GROUND-WATER MONITORING PROGRAM		2-2
	2.1.1	MONITORING NETWORK AND RATIONALE	2-3
		2.1.1.1 Alluvial Aquifer Monitoring Network	2-5
		2.1.1.2 Denver Fm Monitoring Network	2-11
	2.1.2	GROUND-WATER MONITORING	2-15
		2.1.2.1 Water Level Monitoring	2-15
		2.1.2.2 Water Quality Monitoring	2-19
	2.1.3	ANALYTICAL PROGRAM	2-19
	2.1.4	AQUIFER TESTS	2-23
		2.1.4.1 Pumping Tests	2-23
		2.1.4.2 Slug Tests	2-25
2.2	SURFACE WATER MONITORING		2-26
	2.2.1	ACCURACY OF RESULTS	2-31
2.3	SEDIMENT SAMPLING AND ANALYSIS		2-32
	2.3.1	SITE LOCATIONS	2-32
	2.3.2	FIELD SAMPLING METHODOLOGY	2-34
	2.3.3	ANALYTICAL METHODS	2-35
2.4	AIR MONITORING		2-35
	2.4.1	OFFPOST AIR MONITORING	2-36
	2.4.2	ONPOST AIR MONITORING	2-36
2.5	BIOTA		2-39
	2.5.1	METHODS OF INVESTIGATION	2-41
3.0	**GROUND-WATER CONDITIONS**		3-1
3.1	GEOLOGY		3-1
	3.1.1	CHARACTERIZATION OF ALLUVIUM	3-1
		3.1.1.1 Characterization of the Alluvium in the Offpost Operable Unit	3-2
	3.1.2	BEDROCK SURFACE	3-8
	3.1.3	CHARACTERIZATION OF THE DENVER FM	3-13
		3.1.3.1 Depositional Environment	3-13
		3.1.3.2 Stratigraphic Correlation within the Denver Fm	3-16
		3.1.3.3 Characterization and Definition of the Denver Fm	3-17

TABLE OF CONTENTS

Section		Page
3.1.4	CHARACTERIZATION OF ARAPAHOE FM	3-31
3.2	HYDROGEOLOGY	3-32
3.2.1	ALLUVIAL AQUIFER	3-33
3.2.1.1	Water Table	3-34
3.2.1.2	Saturated Alluvial Thickness	3-43
3.2.1.3	Aquifer Parameters	3-45
3.2.1.4	Ground-Water Flow Directions and Qualities	3-50
3.2.1.5	Stresses to the Alluvial Aquifer System	3-53
3.2.2	DENVER FM	3-56
3.2.2.1	Aquifer Recharge	3-58
3.2.2.2	Denver Fm Zones	3-58
3.2.2.3	Potentiometric Surface	3-59
3.2.2.4	Hydraulic Conductivity and Transmissivity	3-64
3.2.2.5	Discharge	3-69
3.2.2.6	Aquifer Interactions	3-69
3.2.3	ARAPAHOE FM	3-72
3.3	GROUND-WATER CONTAMINATION	3-74
3.3.1	NATURE AND EXTENT OF ALLUVIAL AQUIFER CONTAMINATION	3-75
3.3.1.1	Data Presentation	3-79
3.3.1.2	DIMP	3-87
3.3.1.3	DBCP	3-88
3.3.1.4	DCPD	3-89
3.3.1.5	Organosulfur Compounds	3-89
3.3.1.6	1,4-Oxathiane and 1,4-Dithiane	3-91
3.3.1.7	Organochlorine Pesticides	3-91
3.3.1.8	Volatile Organohalogens	3-93
3.3.1.9	Volatile Aromatics	3-97
3.3.1.10	Inorganics	3-97
3.3.2	NATURE AND EXTENT OF DENVER AQUIFER CONTAMINATION	3-104
3.3.2.1	Data Presentation	3-105
3.3.2.2	Contamination in Units Identified at NBCS	3-111
3.3.2.3	Contamination Units Not Correlated to NBCS	3-120
3.3.3	QA/QC DATA	3-124
3.3.3.1	DIMP, DBCP, DCPD	3-125
3.3.3.2	1,4-Oxathiane, 1,4-Dithiane, CPMS, CPMSO, CPMSO2	3-134
3.3.3.3	Organochlorine Pesticides	3-134
3.3.3.4	Volatile Organohalogens	3-134
3.3.3.5	Volatile Aromatics	3-135
3.3.3.6	Inorganics	3-135
3.3.3.7	Additional Inorganics	3-135
3.3.4	GAS CHROMATOGRAPHY/MASS SPECTOMETRY RESULTS	3-135
3.3.4.1	Well Selection	3-136
3.3.4.2	GC/MS Analytical Methods	3-139
3.3.4.3	Quality Assurance/Quality Control	3-139
3.3.4.4	Confirmation of Target Analytes and Concentrations	3-142
3.3.4.5	Nontarget Compound Analytical Results	3-143
3.3.4.6	Nontarget Compound Occurrence	3-145
3.3.4.7	Conclusions	3-148
3.3.4.8	Recommendations	3-149

TABLE OF CONTENTS

Section		Page
3.4	EVALUATION OF GROUND-WATER DATA	3-150
3.4.1	ALLUVIAL CONTAMINATION NORTH OF RMA NORTH BOUNDARY	3-151
3.4.1.1	Effects of the NBCS	3-159
3.4.1.2	Effects of Surface Water Recharge	3-180
3.4.2	DENVER CONTAMINATION NORTH OF RMA NORTH BOUNDARY	3-182
3.4.3	ALLUVIAL CONTAMINATION DOWNGRADIENT OF RMA NORTHWEST BOUNDARY	3-190
3.5	CONTAMINANT TRANSPORT MODELING	3-191
3.5.1	COMPUTER PROGRAM	3-192
3.5.2	MODEL INPUT DATA	3-192
3.5.2.1	Boundary Conditions	3-193
3.5.2.2	Irrigation Recharge, Canal Leakage and Other Recharge/Discharge	3-193
3.5.2.3	Aquifer Thickness	3-194
3.5.2.4	Porosity and Storage Coefficient	3-194
3.5.2.5	Transmissivity	3-195
3.5.2.6	Dispersivity	3-195
3.5.2.7	Chemical Character	3-195
3.5.2.8	Mass Balance	3-196
3.5.3	MODEL CALIBRATION	3-196
3.5.4	MODEL SIMULATIONS	3-197
3.5.4.1	DIMP	3-198
3.5.4.2	Dieldrin	3-199
3.5.4.3	Chloroform and DCPD	3-199
3.5.5	CONCLUSIONS	3-200
4.0	**SURFACE WATER CONDITIONS**	4-1
4.1	DESCRIPTION OF SURFACE DRAINAGES	4-1
4.2	NATURE AND EXTENT OF CONTAMINATION	4-4
4.2.1	ORGANICS	4-4
4.2.2	INORGANICS	4-11
4.3	CONTAMINANT PATHWAYS TO OFFPOST SURFACE WATER	4-13
4.3.1	FIRST CREEK	4-13
4.3.1.1	First Creek Flows From Onpost	4-14
4.3.1.2	Ground Water Discharge to First Creek Offpost	4-18
4.3.2	O'BRIAN CANAL AND BURLINGTON DITCH	4-28
4.3.3	OVERLAND FLOODING	4-31
4.4	CONCLUSION	4-32
5.0	**OFFPOST SEDIMENT CONDITIONS**	5-1
5.1	NATURE AND EXTENT OF CONTAMINATION	5-2
5.1.1	ANALYTICAL SCHEDULE	5-2
5.1.2	RESULTS OF PREVIOUS SEDIMENT STUDY	5-4
5.1.3	RESULTS OF PRESENT SEDIMENT STUDY	5-10
5.2	SEDIMENT CONTAMINATION PATHWAYS	5-12
5.3	CONCLUSIONS	5-13

TABLE OF CONTENTS

Section		Page
6.0	**AIR QUALITY CONDITIONS**	6-1
6.1	CRITERIA AIRBORNE POLLUTANTS	6-1
6.2	TOXIC AIRBORNE POLLUTANTS	6-3
6.3	CONCLUSIONS	6-10
7.0	**BIOTA CONDITIONS**	7-1
7.1	RESULTS OF HOME RANGE STUDIES	7-1
7.1.1	RING-NECKED PHEASANTS	7-1
7.1.2	DESERT COTTON TAIL RABBITS	7-5
7.2	DISCUSSION OF HOME RANGE STUDY	7-5
7.3	EVALUATION OF BIOTA CONTAMINANT PATHWAYS	7-12
8.0	**POTENTIAL CHEMICAL-SPECIFIC ARARS**	8-1
9.0	**CONCLUSIONS**	9-1
9.1	GROUND WATER	9-1
9.2	SURFACE WATER AND SEDIMENTS	9-4
9.3	AIR	9-6
9.4	BIOTA	9-6
10.0	**REFERENCES**	10-1
11.0	**ACRONYMS AND ABBREVIATIONS**	11-1

VOLUME II

APPENDICES

APPENDIX A -- WELL DESIGNATION CRITERIA

APPENDIX B -- WELL COMPLETION SUMMARIES, LITHOLOGIC LOGS, AND GEOPHYSICAL LOGS

APPENDIX C -- WELL LOCATIONS, COMPLETION DATA AND SITE CONDITIONS, AND SITING RATIONAL

C.1 ALLUVIAL WELLS
C.2 DENVER WELLS

APPENDIX D -- SLUG TESTS: COOPER TYPE CURVES AND DATA CURVES, AND AQUIFER TEST ANALYSES

D.1 SLUG TESTS: COOPER TYPE CURVES AND DATA CURVES
D.2 WELL 37367 AQUIFER TEST ANALYSES

TABLE OF CONTENTS

Section — Page

VOLUME III

APPENDIX E -- GEOLOGIC AND HYDROLOGIC PRODUCTS

APPENDIX F -- CONTAMINANT DISTRIBUTION MAPS, CONTAMINANT POINT PLOTS, AND WATER QUALITY DATA

F.1 CONTAMINANT DISTRIBUTION AND POINT PLOT MAPS
F.2 WATER QUALITY DATA
F.3 GC/MS ANALYTICAL RESULTS

APPENDIX G -- CONTAMINANT TRANSPORT MODEL RESULTS

APPENDIX H -- POTENTIAL CHEMICAL-SPECIFIC ARARS FOR OFFPOST OPERABLE UNIT ROCKY MOUNTAIN ARSENAL

APPENDIX I -- CONTAMINANT DISTRIBUTION PLOTS FROM OFFPOST CONTAMINATION ASSESSMENT REPORT

APPENDIX J -- COMMENTS AND RESPONSES TO THE OFFPOST OPERABLE UNIT REMEDIAL INVESTIGATION AND CHEMICAL SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS, DRAFT FINAL REPORT (VERSION 2.1), AUGUST 1988

LIST OF FIGURES

Figure		Page
1.0-1	Location Map of Rocky Mountain Arsenal	1-2
1.0-2	Offpost Operable Unit	1-3
2.1-1	Location Map of Alluvial Wells in the Offpost Operable Unit	2-6
2.1-2	New Alluvial Sites	2-7
2.1-3	Generalized Alluvial Aquifer Monitor Well Construction	2-8
2.1-4	Location Map of Denver Wells in the Offpost Operable Unit	2-12
2.1-5	New Denver Sites	2-13
2.1-6	Generalized Bedrock Aquifer Monitor Well Construction (First Sandstone)	2-16
2.1-7	Generalized Bedrock Aquifer Monitor Well Construction (Second Sandstone)	2-17
2.1-8	Idealized Diagram of Slug-in Aquifer	2-27
2.2-1	Locations for Surface Water Sampling in the Offpost Operable Unit	2-29
2.2-2	Offpost Operable Unit Surface Water Gaging Station Locations	2-30
2.3-1	Locations for Sediment Sampling in Offpost Operable Unit	2-33
3.1-1	Geologic Map of Rocky Mountain Arsenal Area	3-3
3.1-2	Quarternary Columnar Section	3-4
3.1-3	Unified Soil Classification (ASTM D-2487)	3-5
3.1-4	Generalized East-West Alluvial Cross-Section from the South Platte River to the Northeast Corner of Rocky Mountain Arsenal	3-6
3.1-5	East-West Geologic Cross-Section NB Downgradient 30.6	3-9
3.1-6	Southwest-Northeast Geologic Cross-Section NWB Downgradient 3.5	3-10
3.1-7	Bedrock Surface Elevation Map in the Offpost Operable Unit Near the Rocky Mountain Arsenal Boundaries	3-12
3.1-8	Schematic Diagrams Depicting Denver Fm Depositional Environments	3-15

LIST OF FIGURES

Figure		Page
3.1-9	Location of Geologic Cross Sections in the Vicinity of the Offpost Operable Unit	3-18
3.1-10	Southwest-Northeast Geologic Cross Section NWB Upgradient 7.8	3-20
3.1-11	Southeast-Northwest Geologic Cross Section NWB 0.0	3-21
3.1-12	Subcrop Map of Denver Fm Zones	3-23
3.1-13	East-West Geologic Cross Section NB Slurry Wall	3-26
3.1-14	North-South Geologic Cross Section NB 0.0	3-27
3.1-15	Subcrop Map of Denver Fm Sandstone Units in the Offpost Area Downgradient of the NBCS	3-30
3.2-1	Water Table Elevation Map in the Offpost Operable Unit Near the RMA Boundaries (Spring, 1987)	3-35
3.2-2	Historical Hydrograph for Well 37309	3-38
3.2-3	Historical Hydrograph for Well 37335	3-39
3.2-4	Seasonal Hydrograph for Wells 37308 and 37309	3-41
3.2-5	1986 Seasonal Hydrograph for Well 37335	3-42
3.2-6	Saturated Thickness Map for the Alluvial Aquifer in the Offpost Operable Unit Near the Rocky Mountain Arsenal Boundaries (Summer, 1987)	3-44
3.2-7	Location of Alluvial Aquifer Tests	3-46
3.2-8	Potentiometric Surface Map of Denver Fm Zone 2 (Spring 1987)	3-61
3.2-9	Potentiometric Surface Map of Denver Fm Zone 3 (Spring 1987)	3-62
3.2-10	Potentiometric Surface Map of Denver Fm Zone 4 (Spring 1987)	3-63
3.2-11	Location of Denver Fm Aquifer Tests	3-65
3.3-1	DIMP Assessment in Alluvial Wells for Consumptive Use--Phase I and II and Revision III-360° Programs	3-76

LIST OF FIGURES

Figure		Page
3.3-2	Generalized Pre-system Alluvial Flow Pathways (February-March, 1978 water table)	3-86a
3.3-3	Water Chemistry Data for Denver Fm Unit NBW#1A, Summer Quarter, 1987	3-107
3.3-4	Water Chemistry Data for Denver Fm Unit NBW#1, Spring and Summer Quarters, 1987	3-108
3.3-5	Water Chemistry Data for Denver Fm Unit NBW#2, Summer Quarter, 1987	3-109
3.3-6	Water Chemistry Data for Offpost Denver Fm Wells Not Correlated to Sandstone Units Identified at NBCS	3-110
3.3-7	Location of Offpost Wells Sampled for GC/MS Analyses	3-138
3.4-1	Scatter Diagram Comparing Organic Carbon Concentrations Versus Medium Grain Size	3-158
3.4-2	Historical DIMP Concentrations for Well 37307	3-165
3.4-3	Historical DCPD Concentrations for Well 37307	3-166
3.4-4	Historical DIMP Concentrations for Well 37308	3-168
3.4-5	Historical DCPD Concentrations for Well 37308	3-169
3.4-6	Historical Dieldrin Concentrations for Well 37308	3-170
3.4-7	Historical DIMP Concentrations for Well 37309	3-172
3.4-8	Historical DCPD Concentrations for Well 37309	3-173
3.4-9	Historical DBCP Concentrations for Well 37309	3-174
3.4-10	Historical DIMP Concentrations for Well 37312	3-175
3.4-11	Historical DCPD Concentrations for Well 37312	3-177
3.4-12	Historical Dieldrin Concentrations for Well 37312	3-178
3.4-13	Historical DIMP Concentrations for Well 37313	3-179
4.1-1	Locations of Offpost Surface Water Sampling Locations	4-2
4.2-1	Organic Contaminants Observed in Multiple Samples at Offpost Surface Water Stations	4-8
4.2-2	Relationship Between First Creek Discharges and DIMP Concentrations	4-10

LIST OF FIGURES

Figure		Page
4.3-1	First Creek Water Quality Stations Onpost	4-16
4.3-2	Zones of Potential Ground-Water Discharge to First Creek Onpost	4-17
4.3-3	DIMP Concentration Distribution, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	4-19
4.3-4	Monthly Discharge Values at First Creek Gaging Stations	4-22
4.3-5	Change In First Creek Flows Offpost Versus Discharge at Highway 2 Station	4-24
4.3-6	Flow Frequency Histogram For First Creek at Highway 2 Station (July 1986 through August 1987)	4-25
4.3-7	Estimated Ground-Water Elevations Along First Creek from the RMA North Boundary to Highway 2	4-27
4.3-8	Estimated Ground-Water Elevations Versus Stream Bed Elevations for O'Brian Canal and Burlington Ditch	4-30
4.3-9	Surface Water Drainage Basins at RMA and in Offpost Operable Unit	4-33
5.1-1	Contaminant Volatility Versus Sorption	5-3
5.1-2	Offpost Sediment Sampling Locations (April 1986)	5-8
7.1-1	Home Ranges of Ring-necked Pheasants	7-4
7.1-2	Home Ranges of Cottontail Rabbits	7-10
7.2-1	Preliminary Vegetation Map of Rocky Mountain Arsenal	7-13
E-1	East-West Geologic Cross-Section NB Downgradient 59.0 (104th Avenue)	
E-2	Bedrock Elevation Map	
E-3	Net Sand Isopach Contour Map of Regional Denver Formation Zone 2	
E-4	Net Sand Isopach Contour Map of Regional Denver Formation Zone 3	
E-5	Net Sand Isopach Contour Map of Regional Denver Formation Zone 4	
E-6	Isopach Map of the NBW#1A and NBE#1 Sandstone Units	

LIST OF FIGURES

Figure		Page
E-7	Isopach Map of the NBW#1 Sandstone Unit	
E-8	Isopach Map of the NBW#2 Sandstone Unit	
E-9	Isopach Map of the NBW#3 Sandstone Unit	
E-10	Water Table Elevation Map, Spring 1987	
E-11	Water Table Elevation Map, Summer 1987	
E-12	Historical Hydrograph for Well 37308	
E-13	Historical Hydrograph for Well 37334	
E-14	Saturated Thickness Map for Alluvial Aquifer	
E-15	Potentiometric Surface Map of Denver Fm Unit NBW#1A, February 1988	
E-16	Potentiometric Surface Map of Denver Fm Unit NBW#1, February 1988	
E-17	Potentiometric Surface Map of Denver Fm Unit NBW#2, February 1988	
E-18	Potentiometric Surface Map of Denver Fm Unit NBW#3, February 1988	
F-1	DIMP Concentration Distribution, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-2	DIMP Concentration Distribution, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-3	DBCP Concentration Distribution, ug/l 3rd Quarter, FY87, Alluvial Aquifer	
F-4	DBCP Concentration Distribution, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-5	DCPD Concentration Distribution, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-6	DCPD Concentration Distribution, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-7	CPMSO2 Concentration Distribution, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-8	CPMSO2 Concentration Distribution, ug/l, 4th Quarter, FY87,	

LIST OF FIGURES

Figure		Page
	Alluvial Aquifer	
F-9	CPMSO Concentration Distribution, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-10	CPMSO Concentration Distribution, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-11	CPMS Concentration Distribution, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-12	CPMS Concentration Distribution, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-13	1,4-Dithiane Concentration Distribution, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-14	1,4-Dithiane Concentration Distribution, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-15	1,4-Oxathiane Concentration Distribution, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-16	1,4-Oxathiane Concentration Distribution, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-17	Dieldrin Concentration Distribution, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-18	Dieldrin Concentration Distribution, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-19	Endrin Concentration Distribution, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-20	Endrin Concentration Distribution, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-21	Organochlorine Pesticides Concentrations Exceeding Certified Reporting Limits, ug/l, p,p-DDE, p,p-DDT, Aldrin, Isodrin, 3rd Quarter, FY87, Alluvial Aquifer	
F-22	Organochlorine Pesticides Concentrations Exceeding Certified Reporting Limits, ug/l, p,p-DDE, p,p-DDT, Aldrin, Isodrin, 4th Quarter, FY87, Alluvial Aquifer	
F-23	Chloroform Concentration Distribution, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-24	Chloroform Concentration Distribution, ug/l, 4th Quarter, FY87, Alluvial Aquifer	

LIST OF FIGURES

Figure		Page
F-25	Tetrachloroethene Concentration Distribution, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-26	Tetrachloroethene Concentration Distribution, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-27	Trichloroethene Concentration Distribution, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-28	Trichloroethene Concentration Distribution, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-29	1,2-Dichloroethene Concentration Distribution, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-30	1,2-Dichloroethene Concentration Distribution, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-31	Chlorobenzene Concentrations Exceeding Certified Reporting Limits, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-32	Chlorobenzene Concentrations Exceeding Certified Reporting Limits, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-33	Volatile Organohalogens (CCL4, 12DCE, 11DCLE, 111TCE, 12TCE, CH2CL2) Exceeding Certified Reporting Limits, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-34	Volatile Organohalogens (CCL4, 12DCE, 11DCLE, 111TCE, 12TCE, CH2CL2) Exceeding Certified Reporting Limits, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-35	Benzene Concentrations Exceeding Certified Reporting Limits, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-36	Benzene Concentrations Exceeding Certified Reporting Limits, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-37	Volatile Aromatics (Ethylbenzene, m-Xylene, o,p-Xylene) Exceeding Certified Reporting Limits, ug/l, 3rd Quarter, Alluvial Aquifer	
F-38	Chloride Concentration Distribution, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-39	Chloride Concentration Distribution, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-40	Fluoride Concentration Distribution, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	

LIST OF FIGURES

Figure		Page
F-41	Fluoride Concentration Distribution, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-42	Arsenic and Mercury Concentrations Exceeding Certified Reporting Limits, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-43	Arsenic and Mercury Concentrations Exceeding Certified Reporting Limits, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-44	Sulfate Concentration Distribution, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-45	Sulfate Concentration Distribution, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-46	Calcium Concentration Distribution, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-47	Calcium Concentration Distribution, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-48	Potassium Concentration Distribution, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-49	Potassium Concentration Distribution, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-50	Sodium Concentration Distribution, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-51	Sodium Concentration Distribution, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-52	Magnesium Concentration Distribution, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-53	Magnesium Concentration Distribution, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-54	Nitrate Concentration Distribution, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-55	Nitrate Concentration Distribution, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-56	Zinc Concentration Distribution, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-57	Zinc Concentration Distribution, ug/l, 4th Quarter, FY87, Alluvial Aquifer	

LIST OF FIGURES

Figure		Page
F-58	Cadmium Concentrations Exceeding Certified Reporting Limits, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-59	Cadmium Concentrations Exceeding Certified Reporting Limits, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-60	Lead Concentrations Exceeding Certified Reporting Limits, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-61	Lead Concentrations Exceeding Certified Reporting Limits, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-62	Chromium Concentrations Exceeding Certified Reporting Limits, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-63	Chromium Concentrations Exceeding Certified Reporting Limits, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-64	Copper Concentrations Exceeding Certified Reporting Limits, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-65	Copper Concentrations Exceeding Certified Reporting Limits, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-66	Water Chemistry Data for Denver Fm Unit NBW#1A, Spring Quarter, 1987	
F-67	Water Chemistry Data for Denver Fm Unit NBW#2, Spring Quarter, 1987	
F-68	Water Chemistry Data for Denver Fm Unit NBW#3, Spring and Summer Quarters, 1987	
F-69	Water Chemistry Data for Denver Fm Unit NBE#2, Spring and Summer Quarters, 1987	
F-70	Water Chemistry Data for Denver Fm Units NBE#3 and NBE#4, Spring and Summer Quarters, 1987	
F-71	Nontarget Compounds (Bis (2-ethylhexyl) pthalate, Caprolactum) Identified by GC/MS Analysis, ug/l, Task 4 and Task 44, Alluvial Aquifer	
F-72	Nontarget Compound (Dichlorobenzene) Identified by GC/MS Analysis, ug/l, Task 4 and Task 44, Alluvial Aquifer	
G-1	Index Map of Model Area	
G-2	Finite Element Mesh	

LIST OF FIGURES

Figure		Page
G-3	Water Balance of Model Area	
G-4	Auqifer Thickness Map	
G-5a	Transmissivity Map: Contour Interval 1,000-5,000 ft^2/day	
G-5b	Transmissivity Map: Contour Interval 5,000-25,000 ft^2/day	
G-6	Measured Spring 1987 Water Table Map	
G-7	Model Calculated Steady State Water Table Map	
G-8a	DIMP 1987 Concentrations: Contour Interval 20-100 ug/l	
G-8b	DIMP 1987 Concentrations: Contour Interval 100-200 ug/l	
G-8c	DIMP 1987 Concentrations: Contour Interval 200-1,000 ug/l	
G-9a	DIMP Concentrations in 1992 (5 years) with Existing North Boundary Recharge Operations: Contour Interval (20-100 ug/l)	
G-9b	DIMP Concentrations in 1992 (5 years) with Existing North Boundary Recharge Operations: Contour Interval (100-200 ug/l)	
G-9c	DIMP Concentrations in 1992 (5 years) with Existing North Boundary Recharge Operations: Contour Interval (200-800 ug/l)	
G-10a	DIMP Concentrations in 1997 (10 years) with Existing North Boundary Recharge Operations: Contour Interval (20-100 ug/l)	
G-10b	DIMP Concentrations in 1997 (10 years) with Existing North Boundary Recharge Operations: Contour Interval (100-700 ug/l)	
G-11a	DIMP Concentrations in 2007 (20 years) with Existing North Boundary Recharge Operations: Contour Interval (20-100 ug/l)	
G-11b	DIMP Concentrations in 2007 (20 years) with Existing North Boundary Recharge Operations: Contour Interval (100-300 ug/l)	
G-12	DIMP Concentrations in 2017 (30 years) with Existing North Boundary Recharge Operations: Contour Interval (20-180 ug/l)	

LIST OF FIGURES

Figure		Page
G-13a	DIMP Concentrations in 1992 (5 years) with North Boundary Recharge Operation for Natural Flow Conditions: Contour Interval (20-100 ug/l)	
G-13b	DIMP Concentrations in 1992 (5 years) with North Boundary Recharge Operation for Natural Flow Conditions: Contour Interval (100-200 ug/l)	
G-13c	DIMP Concentrations in 1992 (5 years) with North Boundary Recharge Operation for Natural Flow Conditions: Contour Interval (200-800 ug/l)	
G-14a	DIMP Concentrations in 1997 (10 years) with North Boundary Recharge Operation for Natural Flow Conditions: Contour Interval (20-100 ug/l)	
G-14b	DIMP Concentrations in 1997 (10 years) with North Boundary Recharge Operation for Natural Flow Conditions: Contour Interval (100-700 ug/l)	
G-15a	DIMP Concentrations in 2007 (20 years) with North Boundary Recharge Operation for Natural Flow Conditions: Contour Interval (20-100 ug/l)	
G-15b	DIMP Concentrations in 2007 (20 years) with North Boundary Recharge Operation for Natural Flow Conditions: Contour Interval (100-300 ug/l)	
G-16	DIMP Concentrations in 2017 (30 years) with North Boundary Recharge Operation for Natural Flow Conditions: Contour Interval (20-180 ug/l)	
G-17a	DIMP Concentrations in 1992 (5 years) with Existing South Adams County Well Field: Contour Interval (20-100 ug/l)	
G-17b	DIMP Concentrations in 1992 (5 years) with Existing South Adams County Well Field: Contour Interval (100-200 ug/l)	
G-17c	DIMP Concentrations in 1992 (5 years) with Existing South Adams County Well Field: Contour Interval (200-800 ug/l)	
G-18a	DIMP Concentrations in 1997 (10 years) with Existing South Adams County Well Field: Contour Interval (20-100 ug/l)	
G-18b	DIMP Concentrations in 1997 (10 years) with Existing South Adams County Well Field: Contour Interval (100-700 ug/l)	
G-19a	DIMP Concentrations in 2007 (20 years) with Existing South Adams County Well Field: Contour Interval (20-100 ug/l)	

LIST OF FIGURES

Figure		Page
G-19b	DIMP Concentrations in 2007 (20 years) with Existing South Adams County Well Field: Contour Interval (100-300 ug/l)	
G-20	DIMP Concentrations in 2017 (30 years) with Existing South Adams County Well Field: Contour Interval (20-180 ug/l)	
G-21a	DIMP Concentrations in 1992 (5 years) for Proposed South Adams County Well Field: Contour Interval (20-100 ug/l)	
G-21b	DIMP Concentrations in 1992 (5 years) for Proposed South Adams County Well Field: Contour Interval (100-200 ug/l)	
G-21c	DIMP Concentrations in 1992 (5 years) for Proposed South Adams County Well Field: Contour Interval (200-800 ug/l)	
G-22a	DIMP Concentrations in 1997 (10 years) for Proposed South Adams County Well Field: Contour Interval (20-100 ug/l)	
G-22b	DIMP Concentrations in 1997 (10 years) for Proposed South Adams County Well Field: Contour Interval (100-700 ug/l)	
G-23a	DIMP Concentrations in 2007 (20 years) for Proposed South Adams County Well Field: Contour Interval (20-100 ug/l)	
G-23b	DIMP Concentrations in 2007 (20 years) for Proposed South Adams County Well Field: Contour Interval (100-300 ug/l)	
G-24	DIMP Concentrations in 2017 (30 years) for Proposed South Adams County Well Field: Contour Interval (20-180 ug/l)	
G-25	Dieldrin 1987 Concentrations	
G-26	Dieldrin Concentrations in 1992 (5 years) with Existing North Boundary Recharge Operations	
G-27	Dieldrin Concentrations in 1997 (10 years) with Existing North Boundary Recharge Operations	
G-28	Dieldrin Concentrations in 2007 (20 years) with Existing North Boundary Recharge Operations	
G-29	Dieldrin Concentrations in 2017 (30 years) with Existing North Boundary Recharge Operations	
G-30	Dieldrin Concentrations in 1992 (5 years) with North Boundary Recharge Operation for Natural Flow Conditions	
G-31	Dieldrin Concentrations in 1997 (10 years) with North Boundary Recharge Operation for Natural Flow Conditions	

LIST OF FIGURES

Figure		Page
G-32	Dieldrin Concentrations in 2007 (20 years) with North Boundary Recharge Operation for Natural Flow Conditions	
G-33	Dieldrin Concentrations in 2017 (30 years) with North Boundary Recharge Operation for Natural Flow Conditions	
G-34	Dieldrin Concentrations in 1992 (5 years) with Existing South Adams County Well Field	
G-35	Dieldrin Concentrations in 1997 (10 years) with Existing South Adams County Well Field	
G-36	Dieldrin Concentrations in 2007 (20 years) with Existing South Adams County Well Field	
G-37	Dieldrin Concentrations in 2017 (30 years) with Existing South Adams County Well Field	
G-38	Dieldrin Concentrations in 1992 (5 years) for Proposed South Adams County Well Field	
G-39	Dieldrin Concentrations in 1997 (10 years) for Proposed South Adams County Well Field	
G-40	Dieldrin Concentrations in 2007 (20 years) for Proposed South Adams County Well Field	
G-41	Dieldrin Concentrations in 2017 (30 years) for Proposed South Adams County Well Field	
G-42	Chloroform Concentrations for 1987	
G-43	Chloroform Concentrations in 1992 (5 years) with Existing South Adams County Well Field	
G-44	Chloroform Concentrations in 1997 (10 years) with Existing South Adams County Well Field	
G-45	Chloroform Concentrations in 2007 (20 years) with Existing South Adams County Well Field	
G-46	Chloroform Concentrations in 2017 (30 years) with Existing South Adams County Well Field	
G-47	DCPD Concentrations in 1987	
G-48	DCPD Concentrations in 1992 (5 years) with Existing South Adams County Well Field	
G-49	DCPD Concentrations in 1997 (10 years) with Existing South Adams County Well Field	

LIST OF FIGURES

Figure		Page
G-50	DCPD Concentrations in 2007 (20 years) with Existing South Adams County Well Field	
G-51	DCPD Concentrations in 2017 (30 years) with Existing South Adams County Well Field	
I-1	Aromatic and Halogenated Aliphatic Solvent Assessment RMA Offpost First Quarter Sampling of Wells	
I-2	Aromatic and Halogenated Aliphatic Solvent Assessment RMA Offpost Second Quarter Sampling of Wells	
I-3	Chlorinated Pesticide Assessment RMA Offpost First Quarter Sampling of Wells	
I-4	Chlorinated Pesticide Assessment RMA Offpost Second Quarter Sampling of Wells	
I-5	Organosulfur Compounds Assessment RMA Offpost First Quarter Sampling of Wells	
I-6	Organosulfur Compounds Assessment RMA Offpost Second Quarter Sampling of Wells	
I-7	DBCP Assessment RMA Offpost First Quarter Sampling of Wells	
I-8	DBCP Assessment RMA Offpost Second Quarter Sampling of Wells	
I-9	DCPD Assessment RMA Offpost First Quarter Sampling of Wells	

LIST OF TABLES

Table		Page
2.1-1	Aquifer Designations for Wells in Offpost Operable Unit	2-9
2.1-2	Completion Data for New Alluvial Wells	2-14
2.1-3	Completion Data for New Denver Wells	2-18
2.1-4	Chemical Analyses-Offpost Operable Unit Analytical Program	2-21
2.4-1	Summary of Previous Air Quality Monitoring Programs at RMA	2-38
3.2-1	Transmissivity (T), Hydraulic Conductivity (K), and Apparent Specific Yield (SYA) from Pumping Tests	3-48
3.2-2	Hydraulic Conductivity of Combined Soil Groups in the Alluvial Aquifer	3-51
3.2-3	Slug Test Results for Denver Fm Units Near the North Boundary of RMA	3-66
3.2-4	Water Elevations for Well Cluster Sites in the Offpost Operable Unit	3-71
3.3-1	Frequency of Detection and Range of Concentrations for Target Analytes--Spring 1987	3-80
3.3-2	Frequency of Detection and Range of Concentrations for Target Analytes--Summer 1987	3-82
3.3-3	Representative Concentrations for Naturally Occurring Constituents in Upgradient Alluvial Wells	3-98
3.3-4	Typical Background Water Chemistry From the Denver Fm	3-118
3.3-5	Additional Inorganic Parameters for Wells 37379 and 37380, Spring and Summer 1987	3-121
3.3-6	Field QA/QC Procedures	3-126
3.3-7	Duplicate Data: DIMP, DBCP, DCPD, (ug/l)	3-127
3.3-8	Duplicate Data: 1,4-Oxathiane, 1,4-Dithiane, CPMS, CPMSO, CPMSO2 (ug/l)	3-128
3.3-9	Duplicate Data: Organochlorine Pesticides (ug/l)	3-129
3.3-10	Duplicate Data: Volatile Organohalogens (ug/l)	3-130
3.3-11	Duplicate Data: Volatile Aromatics (ug/l)	3-131

LIST OF TABLES

Table		Page
3.3-12	Duplicate Data: Inorganics (ug/l)	3-132
3.3-13	Duplicate Data: Additional Inorganics (ug/l)	3-133
3.3-14	Offpost Wells from which Water Samples were Collected and Submitted for GC/MS Analysis	3-137
3.3-15	GC/MS Target Analytes	3-140
3.3-16	Certified Reporting Limit for GC Analyses and Apparent Method Detection Limit for GC/MS Analyses	3-141a
3.3-17	Frequency of Detection for Tentatively Identified Compounds	3-146
3.4-1	Estimated Range of K_d Values	3-156
3.4-2	Comparison of Chloride Concentrations Upgradient and Downgradient of Irrigation Canals (mg/l)	3-183
3.4-3	Selected Organic Contaminant Concentrations in Task 39 Cluster Wells (ug/l)	3-184
3.4-4	Benzene and Chlorobenzene Concentrations in Task 39 Cluster Wells (ug/l)	3-185
3.4-5	Fluoride, Chloride, and Sulfate Concentrations in Task 39 Cluster Wells (ug/l)	3-186
4.1-1	Comparison of Average Monthly Flows for South Platte River, Burlington Ditch, O'Brian Canal, and First Creek in the RMA Offpost Operable Unit (All Values in Acre-Feet)	4-3
4.2-1	Summary of Organic Contaminant Concentrations in Offpost Surface Water	4-5
4.2-2	Inorganic Concentration Ranges at Offpost Surface Water Sampling Stations (ug/l)	4-7
4.3-1	Summary of Organic Contaminant Concentrations Onpost in First Creek and Its Potential Tributaries	4-15
5.1-1	Analyte Schedule and Certified Reporting Limits for Sediment Analyses Performed for Offpost Contamination Assessment Report	5-5
5.1-2	Metal Concentrations in Offpost Sediment Samples from Offpost Contamination Assessment Report	5-7
5.1-3	Sediment Analyses (April 14, 1988 Sampling)	5-11

LIST OF TABLES

Table		Page
5.2-1	Representative Metals Concentrations in Wastewater Sludge (ug/g)	5-14
5.3-1	Metal Concentrations Commonly Found in Uncontaminated Freshwater Sediments (ug metal/gm dry sediment)	5-15
6.1-1	Summary of Air Quality Parameters in the Vicinity of the Rocky Mountain Arsenal	6-2
6.2-1	Airborne Organic Compounds at Rocky Mountain Arsenal	6-4
6.2-2	Airborne Metals at the Rocky Mountain Arsenal	6-9
7.1-1	Pheasant Home Range Estimates	7-2
7.1-2	Final Status of Animal and Transmitter	7-6
7.1-3	Cottontail Home Range Estimates	7-9

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
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WELL CONSTRUCTION SUMMARY

Borehole E34D Well JR 34 37376

Project Name and Location T36 Well Installation, 9646 Ave Project Number 17053 07410

Drilling Company Boyles Driller B Roach Rig Number Failing 25

Drilling Method(s) continuous core

Borehole Diameter 7 7/8 in. ____ cm. COD 33 ft. ____ cm. to 55 ft. ____ cm.
12 1/4 in. ____ cm. 0 ft. ____ cm. to 33 ft. ____ cm.

Size(s) and types of Bit(s) 12 1/4" blade bit
7 7/8"

Size and Type PVC 4" schedule 40

Total Borehole Depth 51 ft. ____ cm.

Depth to Bedrock 31 ft ____ cm.

Depth to Water NA ft. ____ cm.

Water Level Determined By NA

Length Plain PVC (total) 42 ft. ____ cm.

Length of Screen 10.7 ft. ____ cm.

Total Length of Well Casing 52.7 ft. ____ cm.

PVC Stick Up 1.7 ft. ____ cm.

Depth to Bottom of Screen 51 ft. ____ cm.

Depth to Top of Screen 40.3 ft. ____ cm.

Depth to Top of Sand 39 ft. ____ cm.

Depth to Top of Bentonite 34.5 ft. ____ cm.

Sampling Method(s) Core

Date/Time Start Drilling 2·18·87 1145

Date/Time Finish Drilling 2·19·87 1106

Date/Time Start Completion 2·19·87 1152

Date/Time Cement Protective Casing 2·19·87 1410

Materials Used

Plain PVC 45.17' total (4x10' & 1x5')

Slotted PVC 10.7' total (1x10')

Bentonite Pellets 1 1/4 buckets

Bentonite Granular

Cement ~~85~~ 85 bags

Sand 3 bags

Water added during completion —

Water added during drilling —

Total Gallons of water added —

Drill Site Geologist C Beuseu

Date 2·20·87

Date/Time/Personnel Internal Mortar, Cement Pad, and Weep Hole Installed [mortar & Cement Pad] 4-7-87/1500/K Pacheco, M. Westcott

Date/Time/Personnel Casing Painted 4/14/87/1300/Ken Pacheco & Mark Westcott

Date/Time/Personnel Numbers Painted 4/15/87 J.vf BAG 0847

Materials Used 13 bags quickcrete cement, 1/2 bag portland cement & 1/2 silica for internal m

Top of Protective Casing to Top of PVC 0.2 ft. ____ cm.

Top of Protective Casing to Weep Hole 1.22 ft. ____ cm.

Top of Protective Casing to Internal Mortar 1.23 ft. ____ cm.

Top of Protective Casing to Top of Cement Pad 1.52 ft. ____ cm.

Top of Protective Casing to Ground Level ~~1.52~~ OR 1.90 ft. ____ cm.

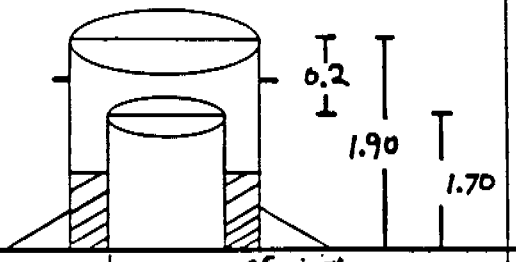
COMMENT/NOTES

Reviewed By Joseph L. Reed Date 6/10/87

Drill Site Geologist ____ Date ____

ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
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ENGLEWOOD, COLORADO 80112 • 303/741-0839

Borehole: E34D Well: 37376

Depth-Feet	Soil/Rock Type	Well Completion	Description
			

Drill Site Geologist: C Fenlon Date: 2.20.87

Reviewed By: Joseph L. Reed Date: 6/10/87

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
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BOREHOLE SUMMARY LOG

Borehole E-34 Well 37376

Project Name and Location MW Installation Project Number 17053 07410

Drilling Company Boyles Driller Roach Rig Number Failing 25

Drilling Method(s) Rotary - water used

Size(s) and type(s) of bit(s) 12¼" rock, 7⅞" tricone

Borehole Diameter 12¼ in. ____ cm. 0 ft. ____ cm. to 32 ft. ____ cm.

7⅞ in. ____ cm. 32 ft. ____ cm. to 55 ft. ____ cm.

Sampling Methods Continuous core

Total Number Soil Sampling Tubes NA

Total Number Core Boxes 6

Number of Gallons Lost Drilling Fluid 0

Date/Time Started Drilling 2·17·87 0948

Date/Time Completed Drilling 2·17·87 1230

Total Borehold Depth 55 ft. ____ cm.

Depth to Bedrock 28 ft. ____ cm.

Depth to Water — ft. ____ cm.

Water Level Determined By? not determined - drilling with water

Borehole Completed as Monitoring Well? NO

Date/Time Grouting Completed 2·18·87 0856

Depth of Tremmie Pipe 55'

Gallons of Grout 30

Materials Used 3 bags cement, 30 gal. water

Comments hole grouted to surface, casing ~~breaking~~ COs broken off 66 below surface

Wellsite Geologist C Benson Date 3·23·87

Checked for Grout Settlement on 4/28/87 by JhR

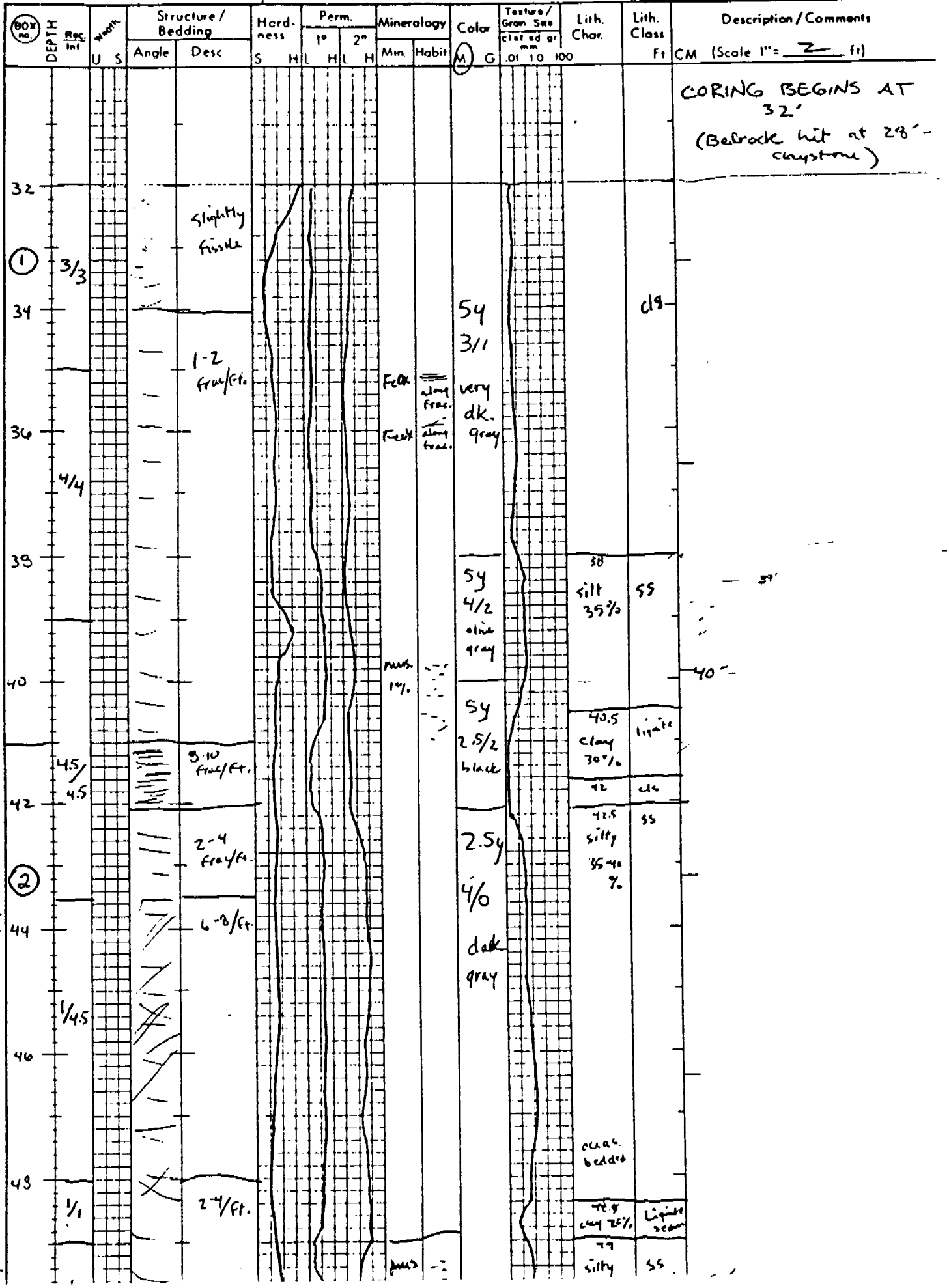
Amount of Grout Added —

All Measurements from Ground Level

Reviewed by Joseph L. Reed Date 4/28/87

Drill Site Geologist ____ Date ____

, Inc. CORE LOG By CEB Date 2-25-87 BORE E-340 Well(s) _____ Page 1 of 2



BORE E-340 WELL(S)

E, Inc.

FSF, Inc. CORE LOG By CDB Date 2 25 87 BORE E-34B Well(s) _____ Page 2 of 7

BOX no.	DEPTH	Rec. Int.	Weath. U	Weath. S	Structure/Bedding Angle	Structure/Bedding Desc.	Hardness S	Hardness H	Perm. 1° L	Perm. 1° H	Perm. 2° L	Perm. 2° H	Mineralogy Min	Mineralogy Habit	Color M	Color G	Texture/Grain Size clst ed gr mm .01 1.0 100	Lith. Char	Lith. Class Ft	Description/Comments CM (Scale 1" = _____ ft)
	52	3/4				very Friable									2.5Y 4/0	dark gray	clc	52 Shaly	Cls	
	54	2/2				1-2/Ft. competent									2.5Y 2/0	black		53 Lignitic 5%		
③	55																			END OF BORING AT 55'

FSF, Inc. BORE E-34B WELL(S)

Frontier Logging
Lakewood, Colorado

Date FEB. 18, 1987

Company ESE
Bore Hole E-34
Area/Project RMA
County ADAMS COUNTY
State COLORADO
Section
Township
Range
Elevation
Log Measured From Ground Level
Driller Depth 55½ Ft
Bit Size 3⅞"
Casing Driller 32 Ft
Fluid in Hole Water
Density/Viscosity
pH
Drilling Measured From
Miles Round Trip
Standby
Time In 0725
Time Out 0740
Unit No. 110
Operator Wm. Linton
Location Lakewood

EQUIPMENT DATA

T.D. Logged 55½ Ft
Natural Gamma 200 Scale = 20 CPS per Inch
Time Constant 2 Sec
Logging Speed 10 Ft/Min
Calibr Source No/Value = CPS
Probe No 103-1241
Probe Diameter 1⅝"
Doctor Type Size xtal ¾×1"
K Factor 2.35 ×10⁻⁵
Dead Time 7 Microsec
Water Factor 1.10 for hole size 3⅞"
Casing Factor for wall thk
Resistance 40 ohms/5" Ohms per 5 Inches
S.P. 20 MV/Inch MV per Inch

NATURAL GAMMA RERUNS (ANALOG)
(Initial log on scale)

Scale = CPS/in	Scale = CPS/in	Scale = CPS/in	Scale = CPS/in
T.C. Sec / Logging Speed Ft/Min	T.C. Sec / Logging Speed Ft/Min	T.C. Sec / Logging Speed Ft/Min	T.C. Sec / Logging Speed Ft/Min
From Ft To Ft	From Ft To Ft	From Ft To Ft	From Ft To Ft
Total Ft	Total Ft	Total Ft	Total Ft

Gamma (Analog) Ft
Gamma (Digital) Ft
Caliper Ft
Temperature Ft

DIRECTIONAL DATA

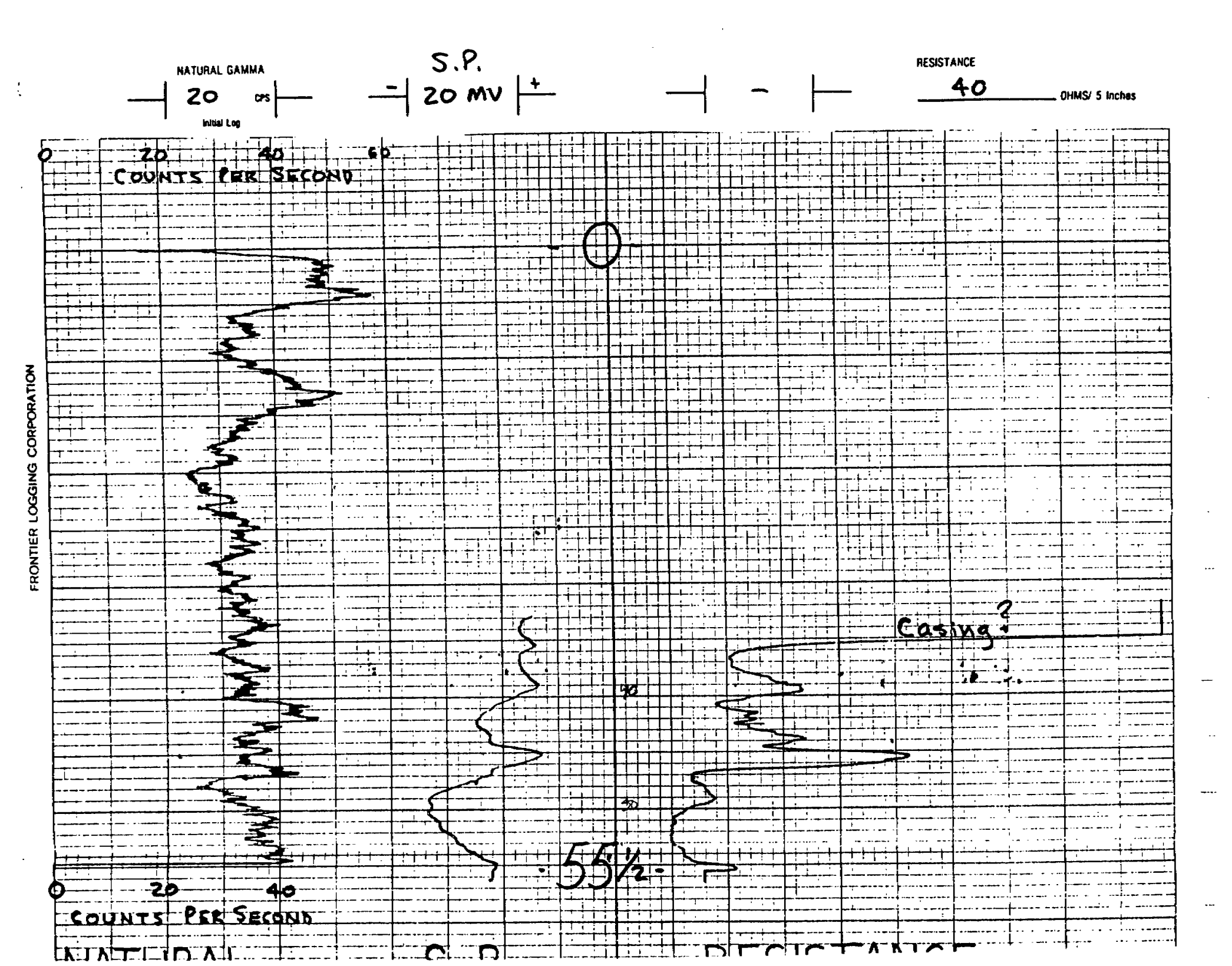
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Azimuth
True Vertical Ft
Survey Depth Ft

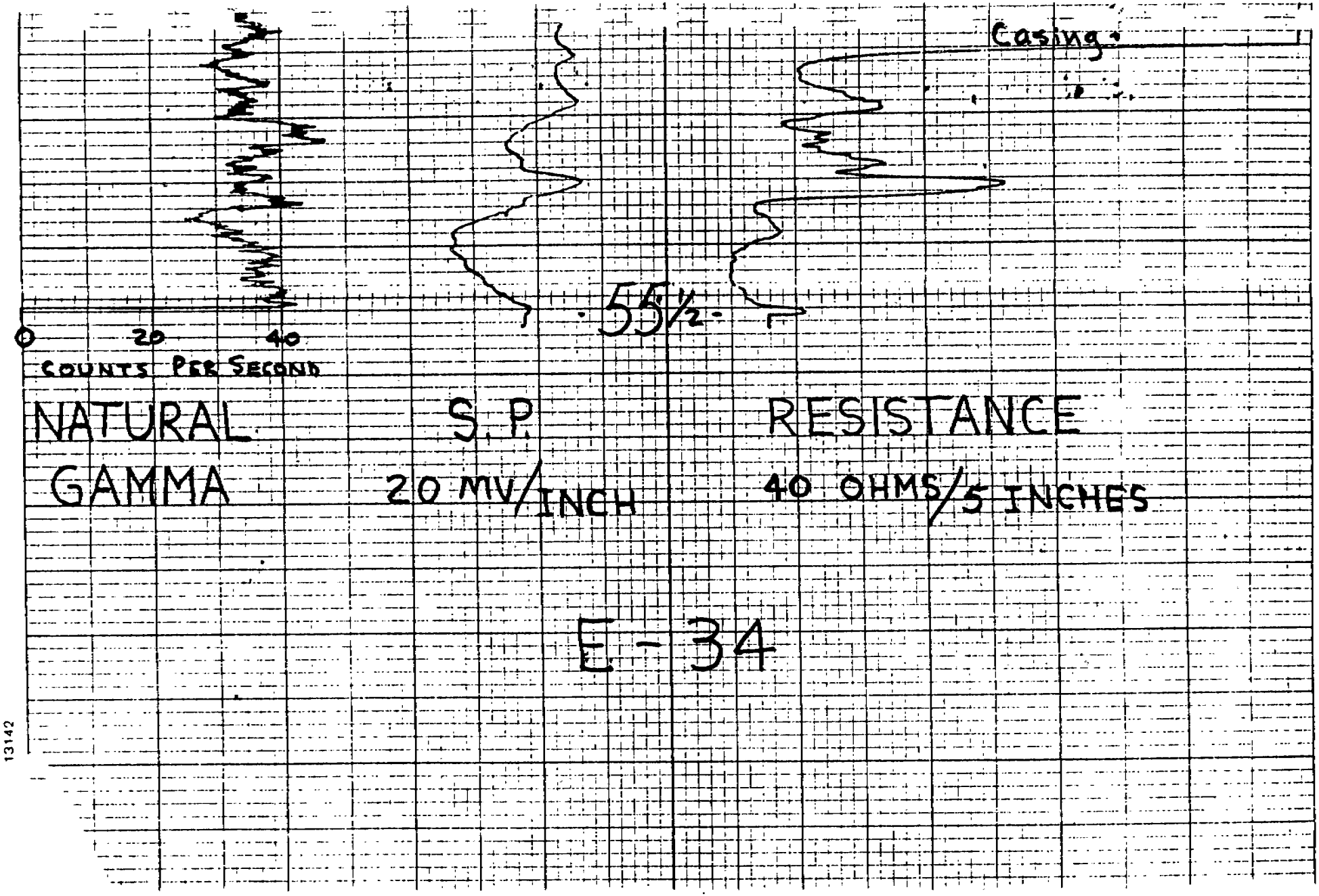
Density Source No
Type Strength
CPS/inch
Neutron Source No
Type Strength
CPS/inch

NATURAL GAMMA — 20 CPS — Initial Log

S.P. — − 20 MV +

RESISTANCE — 40 OHMS/ 5 Inches


NATURAL GAMMA
20 cps
Initial Log
S.P.
20 MV
RESISTANCE
40 OHMS/ 5 Inches
0 20 40 60
COUNTS PER SECOND
FRONTIER LOGGING CORPORATION
Casing?
55½
0 20 40
COUNTS PER SECOND


Casing
55½
0
20
40
COUNTS PER SECOND
NATURAL GAMMA
S.P.
20 MV/INCH
RESISTANCE
40 OHMS/5 INCHES
E-34
13142

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Borehole: E-38A

Well: JR E-38A 3737A

Depth-Feet	Soil/Rock Type	Well Completion	Description
0		3 ⊥ 3.0' 2.7 Gound Level	
4			4.8 Top of Bentonite
8			7.7 Top of Sand 8.7 Top of Screen
10			10' Water level
24			24.9 Bottom of screen
26			25.8 Bottom of Hole

Drill Site Geologist: Greg Litus Date: 3/2/87

Reviewed By: Joseph L. Reed Date: 4/20/87

ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
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WELL CONSTRUCTION SUMMARY

Borehole E-38A Well E-38A 37374

Project Name and Location Oxbow- Drilling ¼ mile NE of 95th ST on Hwy 2 Project Number 120113-038/0

Drilling Company Boyles Bros Driller Jarvis Rig Number

Drilling Method(s) Augers

Borehole Diameter 12¼ in. cm. 0 ft. cm. to 5 GL 26.5 ft. cm.

in. cm. ft. cm. to ft. cm.

Size(s) and types of Bit(s)

Size and Type PVC 4"

Total Borehole Depth 26.5' ft. cm.

Depth to Bedrock 26' ft. cm.

Depth to Water 10' ft. cm.

Water Level Determined By Samples

Length Plain PVC (total) GL 11.4 11.37 ft. cm.

Length of Screen 16.23 ft. cm.

Total Length of Well Casing 27.6 ft. cm.

PVC Stick Up 2.7' ft. cm.

Depth to Bottom of Screen 24.4 ft. cm.

Depth to Top of Screen 8.7 ft. cm.

Depth to Top of Sand 7.8 ft. cm.

Depth to Top of Bentonite 4.8 ft. cm.

Sampling Method(s) Split Spoon Continuous

Date/Time Start Drilling 1045

Date/Time Finish Drilling 1320

Date/Time Start Completion 1445

Date/Time Cement Protective Casing 1620

Materials Used 7-4' TUBES 3 BOXES

Plain PVC 1-10' 1-5' FOR 11.37

Slotted PVC 1-10' 1-5' FOR 16.23

Bentonite Pellets 3½ Buckets

Bentonite Granular 0

Cement 3 BAGS

Sand 11½ BAGS

Water added during completion 0 (5 GALS TO SWAB BOREHOLE)

Water added during drilling 0

Total Gallons of water added 0 5 JR

Drill Site Geologist Bob Grippe, Greg Lewis Date 3/2/87

Date/Time/Personnel Internal Mortar, Cement Pad, and Weep Hole Installed 04/08/87 1320 PJ B

Date/Time/Personnel Casing Painted JWF BAL 4/15/87 0915

Date/Time/Personnel Numbers Painted JWF BAL 4/15/87 0915

Materials Used 14 Bgs Quick-Crete ½ Bg Cement ½ Bg Sand 1 Roll Lawn Edging

Top of Protective Casing to Top of PVC 3 ft. cm.

Top of Protective Casing to Weep Hole 2.5 ft. cm.

Top of Protective Casing to Internal Mortar 2.3 ft. cm.

Top of Protective Casing to Top of Cement Pad 2.9 ft. cm.

Top of Protective Casing to Ground Level 3.0 ft. cm.

COMMENT/NOTES

Reviewed By Joseph L. Reed Date 4/20/87

Drill Site Geologist Greg Lewis Date 3/2/87

7222 SOUTH ALTON WAY • SUITE H
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SHEET 1 OF 2

Borehole: E-38A Well Number: 37374

Depth-Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description MUNSELL COLORS
0.0	1, 1-0	1'	NA	1, 1-0	ML	ML Sandy-silt, 10% v.f.gr. sand, 10YR, 3/2-3 v. dk. grysh. brn., non-plas., loose, moist, alluvium
1.0	1-2'	1'		1-2'		
1.6						At 1.6', color changes to 10YR, 5/2-3, grysh brn., moisture decreases to slightly moist.
2.0	2-3'	1'		2-3'		At 2.0' color changes to 10YR, 5/4-6, grysh brn., percentage of v.f.gr sand increases to ~25%.
3.0	3-4'	1'		3-4'		
4.0	4-5'	2'		4-6'		
5.0						At 5.0', percent of v.f.gr. sand increases to ≈ 40-45%, color changes to 10YR, 5/3, brn, moisture increases to moist.
6.0	6-8	1.25'		6-8		
7.0					SM	SM silty-sand, 25% silt, 10YR, 5/3, brn., non-plas., loose, wet, alluvium.
8.0	8-10'	1.5'		8-10'		
10.0						▽ Moisture change to saturated, W.T. @ 10.0'
10.2	10-12'	1'		10-12'		
11.0						

Drill Site Geologist: A.E. Odell Date: 3/3/87

Reviewed By: Joseph L. Reed Date: 4/16/87

ENVIRONMENTAL SERVICES AND SYSTEMS
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SHEET ___ OF ___

Borehole: E-38A Well Number: 37574

Depth-Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description — Munsell Colors
1						
11.0	10-12'	1'	NA	10-12'	SM	
12.0	12-14'	2'		12-14'		At 12.0, percent silt increases to ~40%.
14.0	14-16'	2'		14-16'	ML	ML sandy-silt, 10-15% v. f. gr. sand, 10YR, 6/3-4, pale brn., non-plas, mod. dense, wet, alluvium
16.5	16-18'	1.75'		16-18'	SM	SM ~~Sandy~~ silty f-c sand, 15-20% c. gr. sand to 20% silt, 10YR, 5/4-6, yeld brn, non-plas, loose, wet, alluvium
18.0	18-20'	2'		18-20'		
20.0	20-21.5'	2'		20-21.5'		
21.5	21.5-23	1.75'		21.5-23		

Drill Site Geologist: A.E Dutton Date: 3/3/87

Reviewed By: Joseph L. Reed Date: 4/16/87

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Borehole: E-38A Well Number: 37374

Depth - Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
22.0	21.5 - 23'	1.75'	N1	21.5 - 23'	SM	
23.0	23 - 25'	2'		23 - 25'		
24.0						
25.0	25 - 26.5'	1.5'		25 - 26.5'	CL	CL = silty-clay, 30% silt, 10 YR 6/6-8 ben-yellow, slightly plas, soft, moist, blank
26.5						END OF BORING LOG

Drill Site Geologist: A.R. Smith Date: 3/3/87

Reviewed By: Joseph L. Reed Date: 3/3R 4/16/87

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WELL CONSTRUCTION SUMMARY

Borehole E-38 D1 Well ~~E-30DT~~ JR 37379

Project Name and Location MW Installation Project Number 17053.07410

Drilling Company Boyles Driller Brack Rig Number

Drilling Method(s) continuous rotary drilling

Borehole Diameter ~~8~~ 12¼ in. ____ cm. ~~30~~ 100 ft. ____ cm. to 30 ft. ____ cm.
~~4 7/8~~ in. ____ cm. 30 ft. ____ cm. to 56.5 ft. ____ cm.

Size(s) and types of Bit(s) 12¼" blade bit

Size and Type PVC 4", schedule 40

Total Borehole Depth	56.5 ft. ____ cm.	Sampling Method(s)	no sampling
Depth to Bedrock	97 ft. ____ cm.	Date/Time Start Drilling	3-13-87 0837
Depth to Water	unknown ft. ____ cm.	Date/Time Finish Drilling	3-13-87 1056
Water Level Determined By		Date/Time Start Completion	3-13-87 1100
Length Plain PVC (total)	~~15~~ ft. 41.96 cm.	Date/Time Cement Protective Casing	3-13-87 1401
Length of Screen	16.24 ft. ____ cm.	Materials Used	
Total Length of Well Casing	58.2 ft. ____ cm.	Plain PVC	1x5' 4x10'
PVC Stick Up	2.7 ft. ____ cm.	Slotted PVC	1x10' 1x5'
Depth to Bottom of Screen	55.5 ft. ____ cm.	Bentonite Pellets	1½ buckets
Depth to Top of Screen	39.26 ft. ____ cm.	Bentonite Granular	1 bag
Depth to Top of Sand	37.8 ft. ____ cm.	Cement	7 bags
Depth to Top of Bentonite	33.4 ft. ____ cm.	Sand	2½ bags
		Water added during completion	500 gal. pumped th
		Water added during drilling	400 gal
		Total Gallons of water added	900 gal.

This water was all pumped back out of the hole

Drill Site Geologist C Ronan Date 3-16-87

Date/Time/Personnel Internal Mortar, Cement Pad, and Weep Hole Installed 04/08/87 11:00 PDB

Date/Time/Personnel Casing Painted ~~JDF~~ BAG 4/15/87 0907

Date/Time/Personnel Numbers Painted JDF BAG 4/15/87 0907

Materials Used 14 Bgs Quick-crete 1 Bg Cement 1 Bg Sand, Roll Down Edging

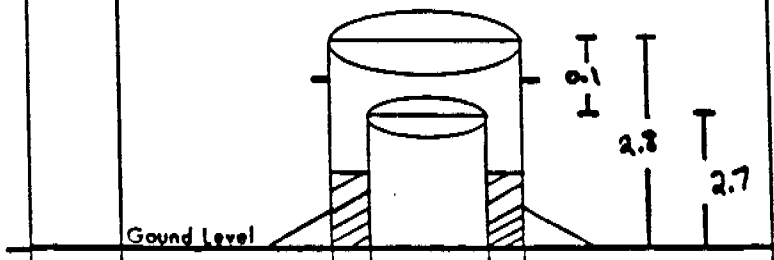
Top of Protective Casing to Top of PVC	.1 ft. ____ cm.	COMMENT/NOTES	
Top of Protective Casing to Weep Hole	1.48 ft. ____ cm.		
Top of Protective Casing to Internal Mortar	1.43 ft. ____ cm.		
Top of Protective Casing to Top of Cement Pad	1.94 ft. ____ cm.		
Top of Protective Casing to Ground Level	2.8 ft. ____ cm.		

Reviewed By Joseph L. Reed Date 4/20/87

Drill Site Geologist ____ Date ____

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Borehole: E-39D1 Well: ~~E-39D1~~ 37379

Depth-Feet	Soil/Rock Type	Well Completion	Description
			
5			
10		9.07 joint	GROUT
15			
20		19.15 joint	
25			
30		29.19 joint	TOP OF BENTONITE SEAL 33.4'
35			TOP OF SANDPACK 37.8'
40			TOP OF SCREEN 39.26'
45			
50			Bottom of Screen 55.5'
55			Total depth 56.5'
60			

Drill Site Geologist: C Beyson Date: 3·16·87

Reviewed By: ~~Joseph Lilard~~ Date: 4/20/87

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WELL CONSTRUCTION SUMMARY

Borehole E30D2 Well 37380

Project Name and Location Hwy. 2 MW Installation Project Number 17053074.10

Drilling Company Boyles Driller B Roach Rig Number Failing 25

Drilling Method(s) Rotary - drilled with water

Borehole Diameter 17 1/2 in. ____ cm. 0 ft. ____ cm. to 30 ft. ____ cm.
11 3/4 in. ____ cm. 30 ft. ____ cm. to 55 ft. ____ cm.
7 7/8 " 55 ft. to 75 ft.

Size(s) and types of Bit(s) 17 1/2" tricone, 11 3/4" blade bit, 7 5/8" blade

Size and Type PVC 4" schedule 40

Total Borehole Depth 75 ft. ____ cm.

Depth to Bedrock 27 ft. ____ cm.

Depth to Water NA ft. ____ cm.

Water Level Determined By NA

Length Plain PVC (total) 66.29 ft. ____ cm.

Length of Screen 10.71 ft. ____ cm.

Total Length of Well Casing 76.71 ft. ____ cm.

PVC Stick Up 1.7 ft. ____ cm.

Depth to Bottom of Screen 75 ft. ____ cm.

Depth to Top of Screen 64.29 ft. ____ cm.

Depth to Top of Sand 59 ft. ____ cm.

Depth to Top of Bentonite 54 ft. ____ cm.

Drill Site Geologist C Benson

Sampling Method(s) NA

Date/Time Start Drilling 3.23.87 1006

Date/Time Finish Drilling 3.23.87 1115

Date/Time Start Completion 3.23.87 1130

Date/Time Cement Protective Casing 3.23.87 1540

Materials Used

Plain PVC 7 x 10'

Slotted PVC 1 x 10'

Bentonite Pellets 1 bucket

Bentonite Granular 2 3 bag

Cement 8 bags

Sand 4 bags

Water added during completion 0 COB

Water added during drilling 1200

Total Gallons of water added 1200

Water pumped back out into ≈ 28 barrels

Date 3.23.87

Cement Pad = mortar

Date/Time/Personnel Internal Mortar, Cement Pad, and Weep Hole Installed 4/7/87/1100/K. Pacheco, M. Westcott

Date/Time/Personnel Casing Painted 4/8/87/1900/K. Pacheco, M. Westcott

Date/Time/Personnel Numbers Painted 4/15/87 0928 Final BAG

Materials Used 8 bags quickcrete, 1/2 bag portland cement, 1 1/2 bag silica sand

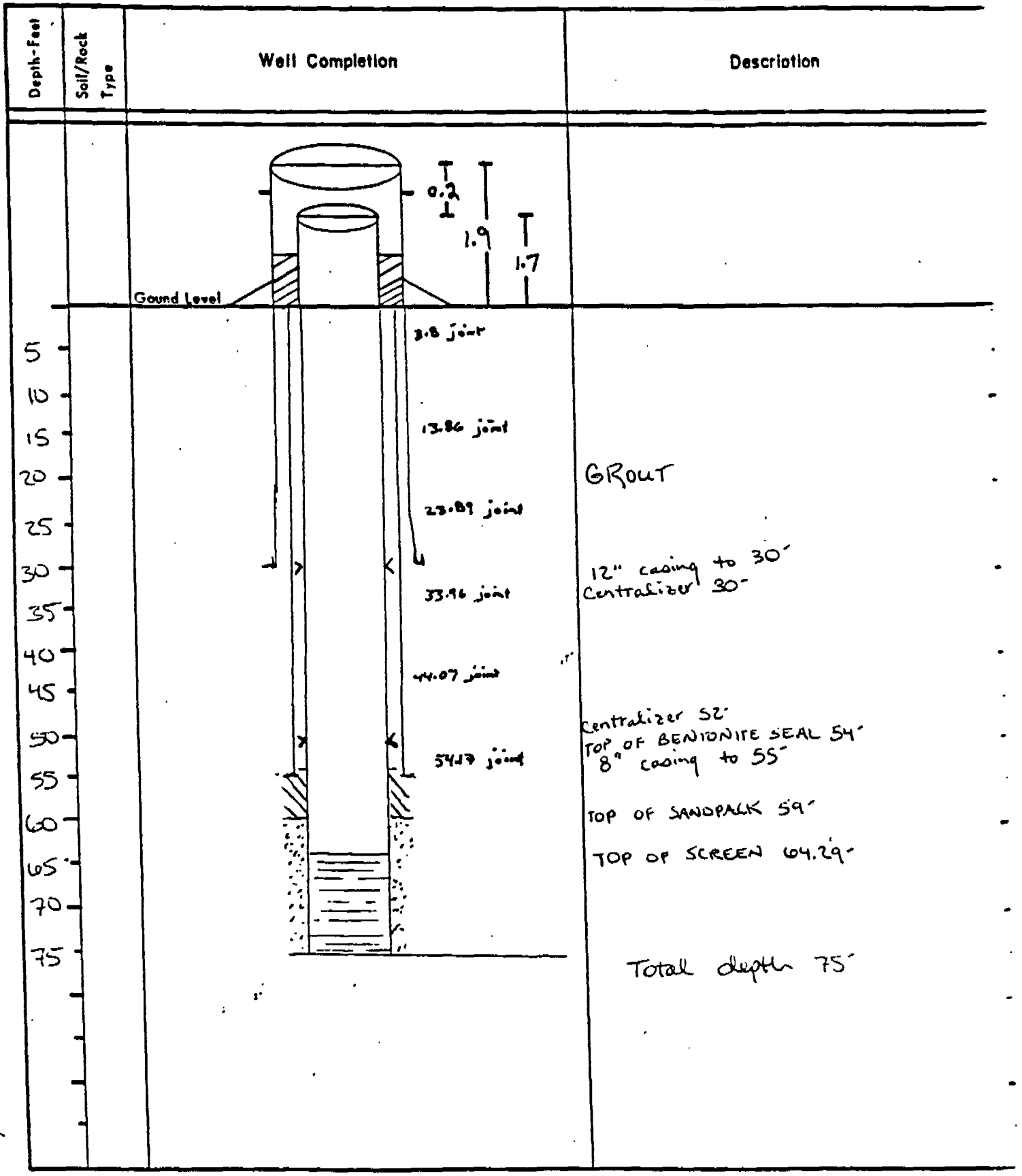
Top of Protective Casing to Top of PVC	.2 ft.	____ cm.	COMMENT/NOTES
Top of Protective Casing to Weep Hole	1.1 ft.	____ cm.	
Top of Protective Casing to Internal Mortar	1.69 ft.	____ cm.	
Top of Protective Casing to Top of Cement Pad	1.4 ft.	____ cm.	
Top of Protective Casing to Ground Level	1.9 ft.	____ cm.	

Reviewed By Joseph L. Reed Date 4/20/87

Drill Site Geologist ____ Date ____

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Borehole: E38D2 Well: 37380



Drill Site Geologist: [signature] Date: 3.27.87

Reviewed By: [signature] Date: 4/20/87

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BOREHOLE SUMMARY LOG

Borehole E-38 Well NA

Project Name and Location MW Installation Project Number 17053 074 40

Drilling Company Boyles Driller Jarvie Rig Number ~~Failing 25~~ Au Failing 25

Drilling Method(s) auger to 30', rotary to 130

Size(s) and type(s) of bit(s) 12 1/4, 7 7/8 rock bit

Borehole Diameter 12 1/4 in. ____ cm. 0 ft. ____ cm. to 30 ft. ____ cm.

7 7/8 in. ____ cm. 30 ft. ____ cm. to ~130 ft. ____ cm.

Sampling Methods Continuous core

Total Number Soil Sampling Tubes —

Total Number Core Boxes 14

Number of Gallons Lost Drilling Fluid 0

Date/Time Started Drilling 3·6·87 0758

Date/Time Completed Drilling 3·10·87 1418

Total Borehold Depth 130 ft. ____ cm.

Depth to Bedrock 25.8 ft. ____ cm.

Depth to Water ~ 10 ft. ____ cm.

Water Level Determined By? DR760A water level indicator

Borehole Completed as Monitoring Well? NO

Date/Time Grouting Completed 3·10·87 1700

Depth of Tremmie Pipe 130'

Gallons of Grout 90

Materials Used 9 bags cement, 1 bag bentonite, 90 gals. water

Comments grouted to surface

Wellsite Geologist C Benson Date 3·23 87

Checked for Grout Settlement on ____ by ____

Amount of Grout Added ____

All Measurements from Ground Level

Reviewed by Joseph L. Reed Date 4/13/87

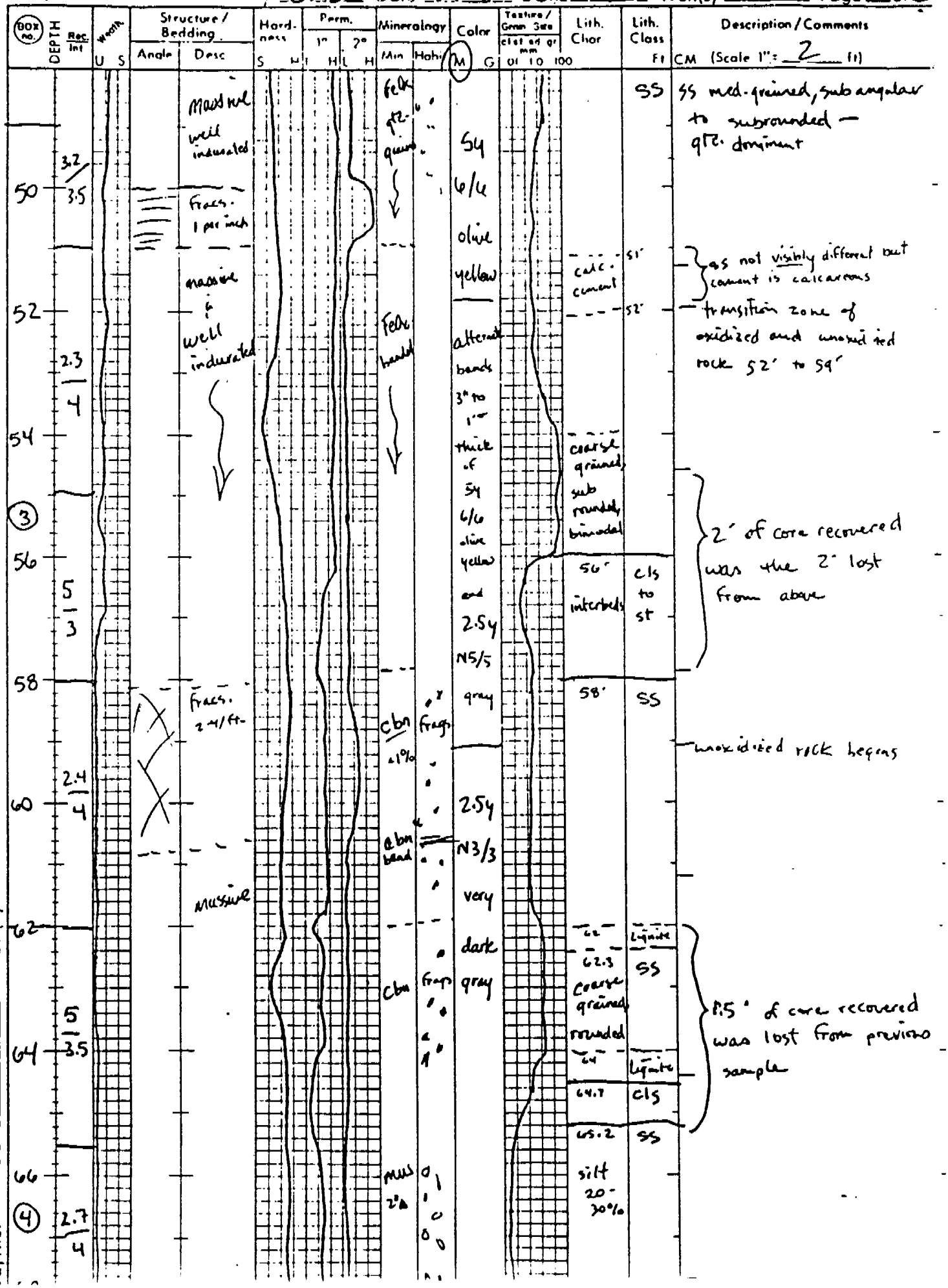
Drill Site Geologist ____ Date ____

ESE, Inc. CORE LOG By COB Date 3-11-87 BORE E-38 Well(s) 37379,380 Page 1 of 6

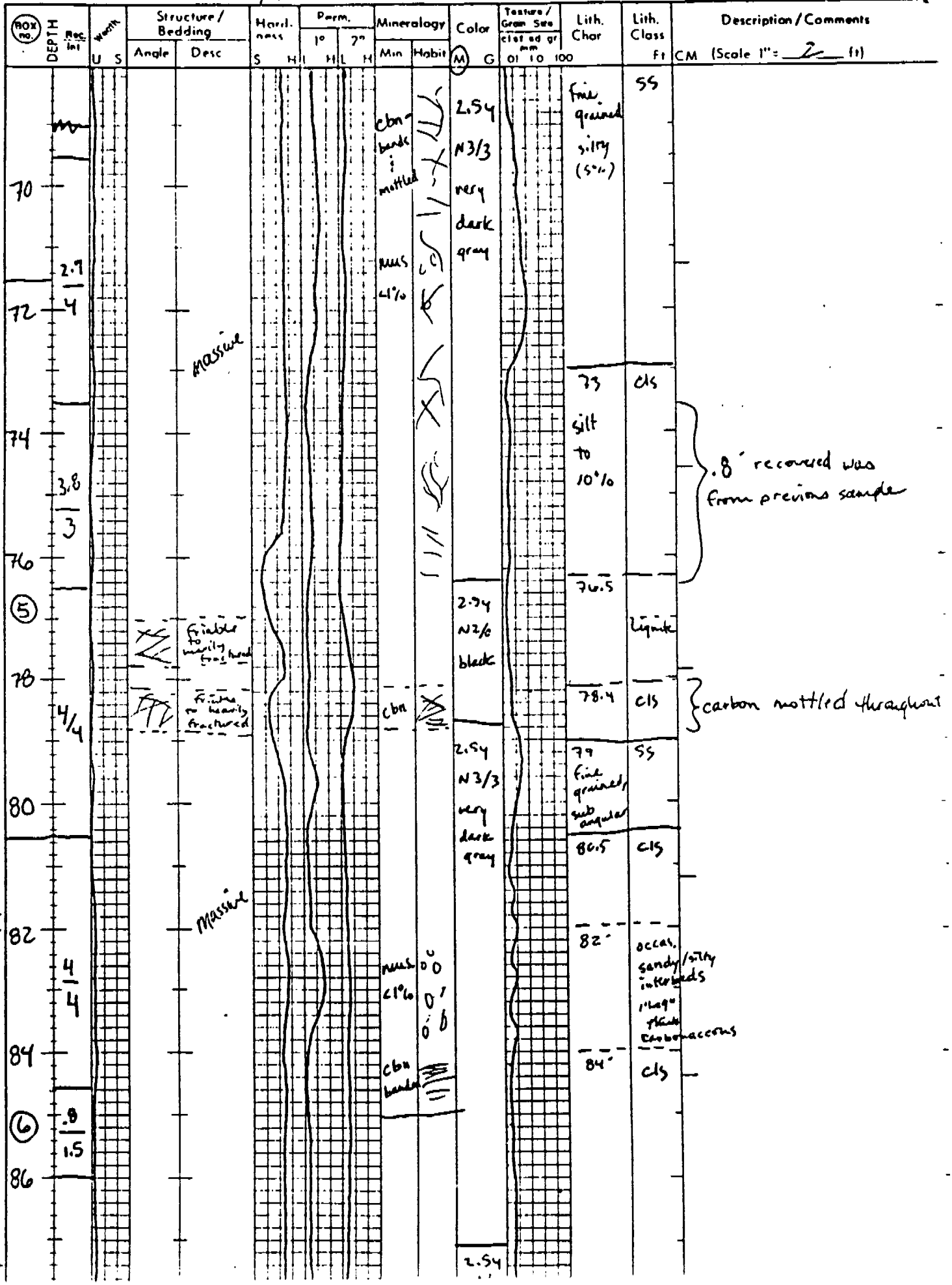
Box no.	Depth	Rec. Int	Weath. U S	Structure/Bedding Angle	Structure/Bedding Desc	Hardness S H	Perm. 1° L H	Perm. 2° L H	Mineralogy Min	Mineralogy Hab	Color (M) G	Texture/Grain Size clst sd gr mm .01 1.0 100	Lith. Char.	Lith. Class Ft	Description/Comments CM (Scale 1" = 2 ft)
	30	Cement			CEMENT										Cement - alluvium logged on soils log
	32	2.3/4			massive fracs. 2-4/ft.				lim & hem	frac. coat	5Y 5/6 olive			cls	claystone lim & hem concentrated as fracture coatings
1	34														
	36	4/4													
	38								nuss. <1%	1			occas. carbonaceous (<1%) mottled		silt to 15%
	40	4/4								6	5Y 4/2 dusky gray		40.5	cls/st	
	42									0			25-40% silt and fine sand		43" 1/2" rounded pebble of calcite/dolomite visible in core
	44									D	5Y 6/6 olive yellow				
2	46	4.7/5													rock type change is transitional

ESE, Inc. BORE E-38 WELL(S)

E3E, Inc. COPE LOG By CDB Date 3.11.87 BORE E-38 Well(s) _____ Page 2 of 6



ESE, Inc. CORE LOG By CDB Date 3/1/87 BORE E-38 Well(s) _____ Page 3 of 6



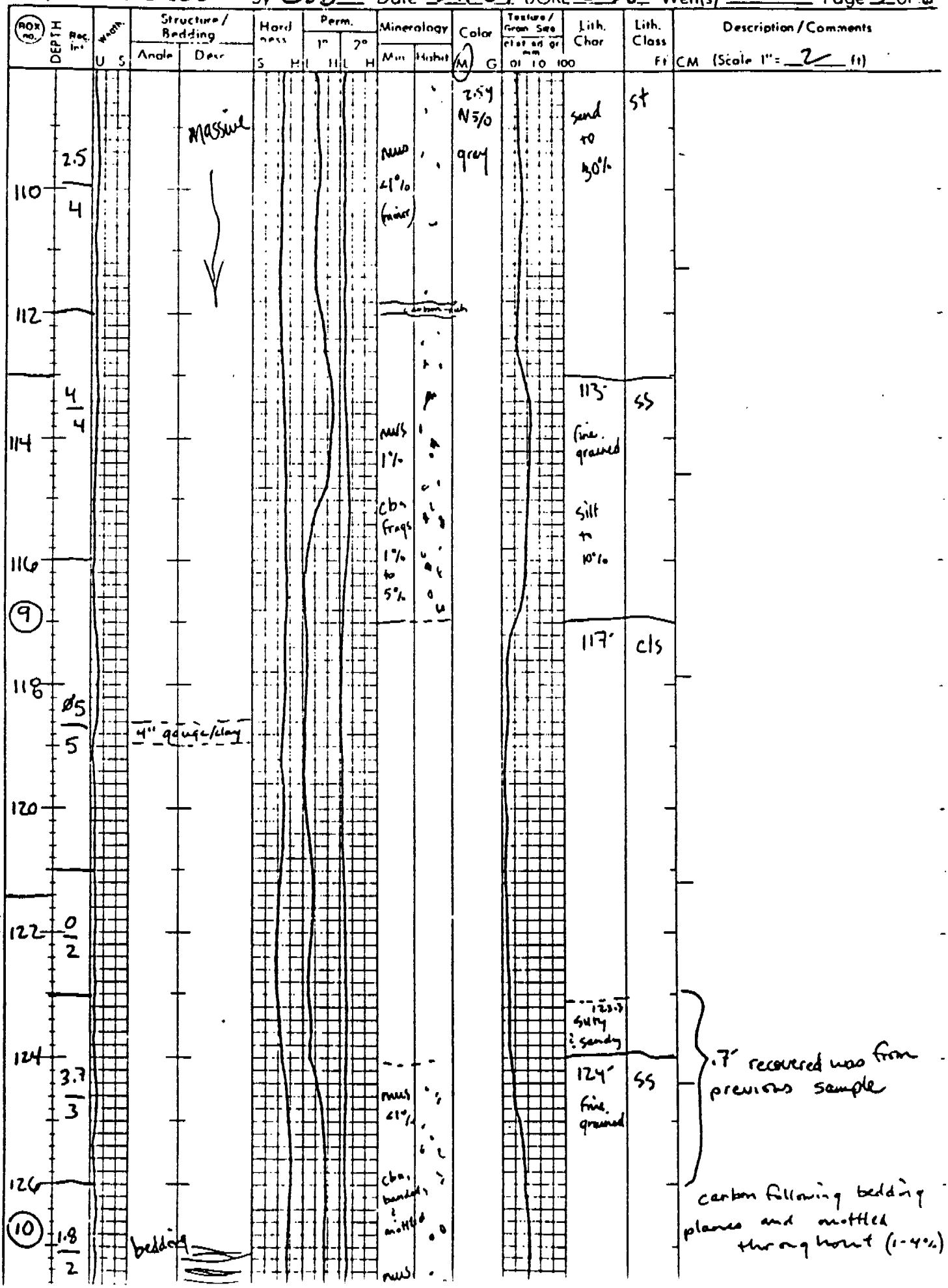
ESE, Inc. CORE LOG By CDB Date 3-11-87 BORE E-38 Well(s) _____ Page 4 of 6

Box No.	Depth	Rec. Int.	Weath. U	Weath. S	Structure/Bedding Angle	Structure/Bedding Desc	Hardness S	Hardness H-L	Perm. 1° H-L	Perm. 2° H-L	Mineralogy Min	Mineralogy Habit	Color (M) G	Texture/Grain Size clst sd gr mm .01 1.0 100	Lith. Char	Lith. Class Ft	Description/Comments CM (Scale 1" = 2 ft)
	90	0 / 4				massive							2.5y N2/0 black			cls	
		2 / 1				friable in small fractured											1' recovered was from previous sample
	92	0 / 4				massive							2.5y N3/3 very dark gray				
	94	4 / 1															3' recovered was from previous sample
(7)	96																
	98	5 / 5															
	100																
	102	5 / 5				massive but less indurated (only slightly less)					Clay	pervasive	2.5y N2/0 black				
	104												2.5y N5/0 gray				
	106																
(8)		2 / 2															

BORE E-38 WELL(S)

ESE, Inc.

ESE, Inc. CORE LOG By CDB Date 3.11.87 BORE E-38 Well(s) _____ Page 5 of 6



ESE, Inc. CORE LOG By CDB Date 3.11.87 BORE E-39 Well(s) _____ Page 6 of 6.

Box no.	Depth	Rec. Int	Weath. U	Weath. S	Structure/Bedding Angle	Structure/Bedding Desc.	Hardness S	Hardness H	Perm. 1° L	Perm. 1° H	Perm. 2° L	Perm. 2° H	Mineralogy Min	Mineralogy Habit	Color	Texture/Grain Size clst sd gr mm .01 .10 1.00	Lith. Char	Lith. Class Ft	Description/Comments CM (Scale 1" = 2 ft)
(10)		1.8 / 2				massive							cbn to 20%		2.5y N5/0 gray		silt 2%, fine sand	SS	very carbon-rich
	130																		130' END OF HOLE

ESE, Inc. BORE E-38 WELL(S)

Frontier Logging
Lakewood, Colorado

Company: ESE
Bore Hole: E-38
Area/Project: RMA
County: Adams County
State: Colorado
Section:
Township:
Range:
Elevation:
Log Measured From: Ground Level

Date: Mar. 10, 1987
Driller Depth: 130 Ft
Bit Size: 3 7/8"
Casing Driller: 30 feet
Fluid in Hole: water
Density/Viscosity:
pH: 0
Drilling Measured From:
Miles Round Trip:
Standby:
Time In: 1445
Time Out: 1525
Unit No.: 110
Operator: W. Linton
Location: Lakewood

EQUIPMENT DATA

T.D. Logged: 129 Feet
Natural Gamma: 200 Scale = 20 CPS per inch
Time Constant: 2 Sec
Logging Speed: 15 Ft/Min
Calib. Source No/Value: CPS
Probe No: 103-1041
Probe Diameter: 1 5/8"
Detector Type Size: xtal 3/4 x 1 3/4"
K Factor: 1.60 x 10⁻⁵
Dead Time: 7 Microsec
Water Factor:
Casing Factor: 1.10 for hole size 3 7/8"
for wall thk
Resistance: 50 ohms/5" Ohms per 5 inches
S.P.: 15 MV/Inch MV per inch

NATURAL GAMMA RERUNS (ANALOG)
(Initial log off scale)

Scale = CPS/in	T.C. Sec	Logging Speed Ft/Min	From Ft	To Ft	Total Ft

DIRECTIONAL DATA

Gamma (Analog) Ft
Gamma (Digital) Ft
Caliper Ft
Temperature Ft
Closure Ft
Azimuth
True Vertical
Survey Depth

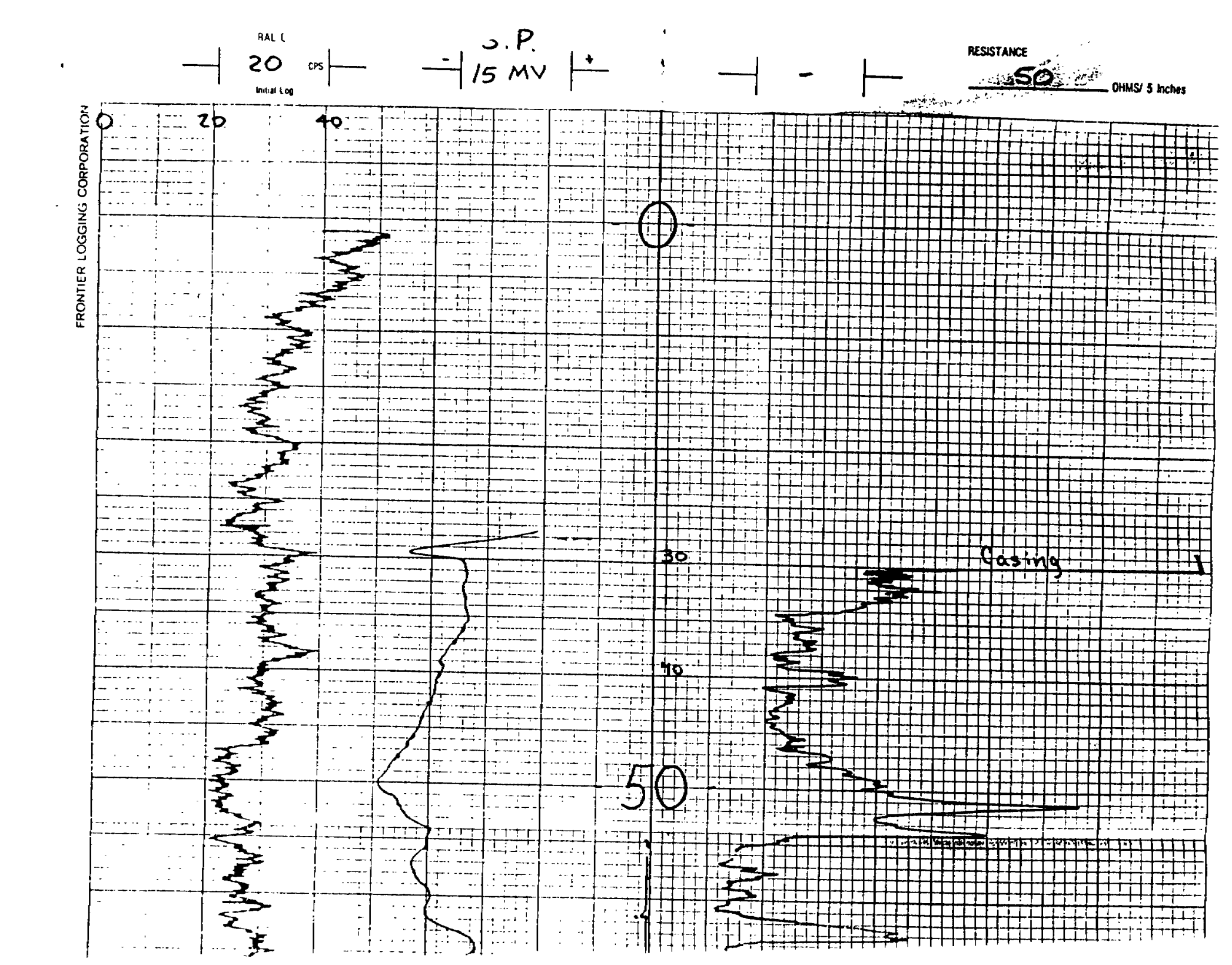
Density Source No
Type
CPS/inch
Neutron Source No
Type
Strength
CPS/inch

NATURAL GAMMA
20 CPS
Initial Log

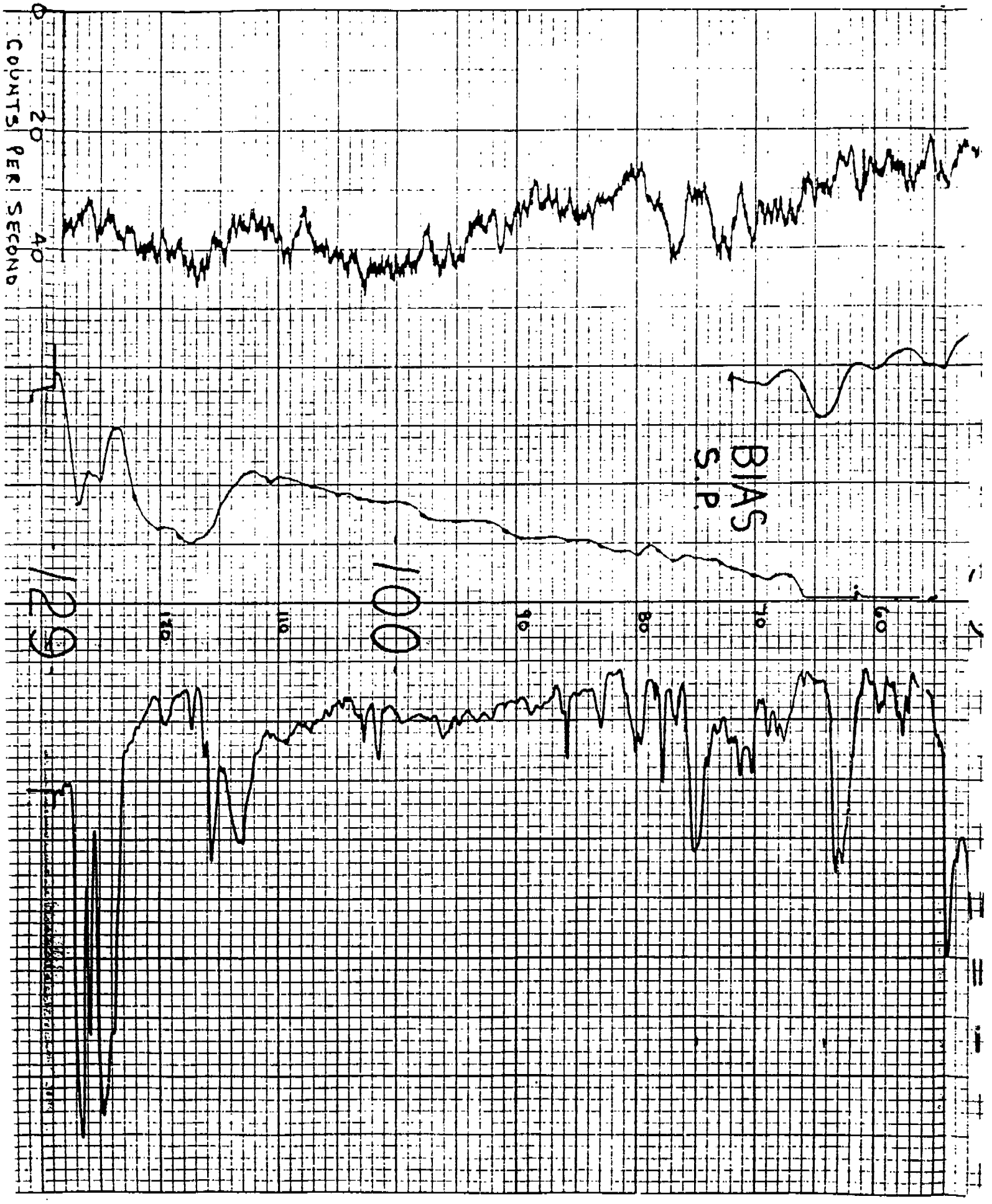
S.P.
15 MV

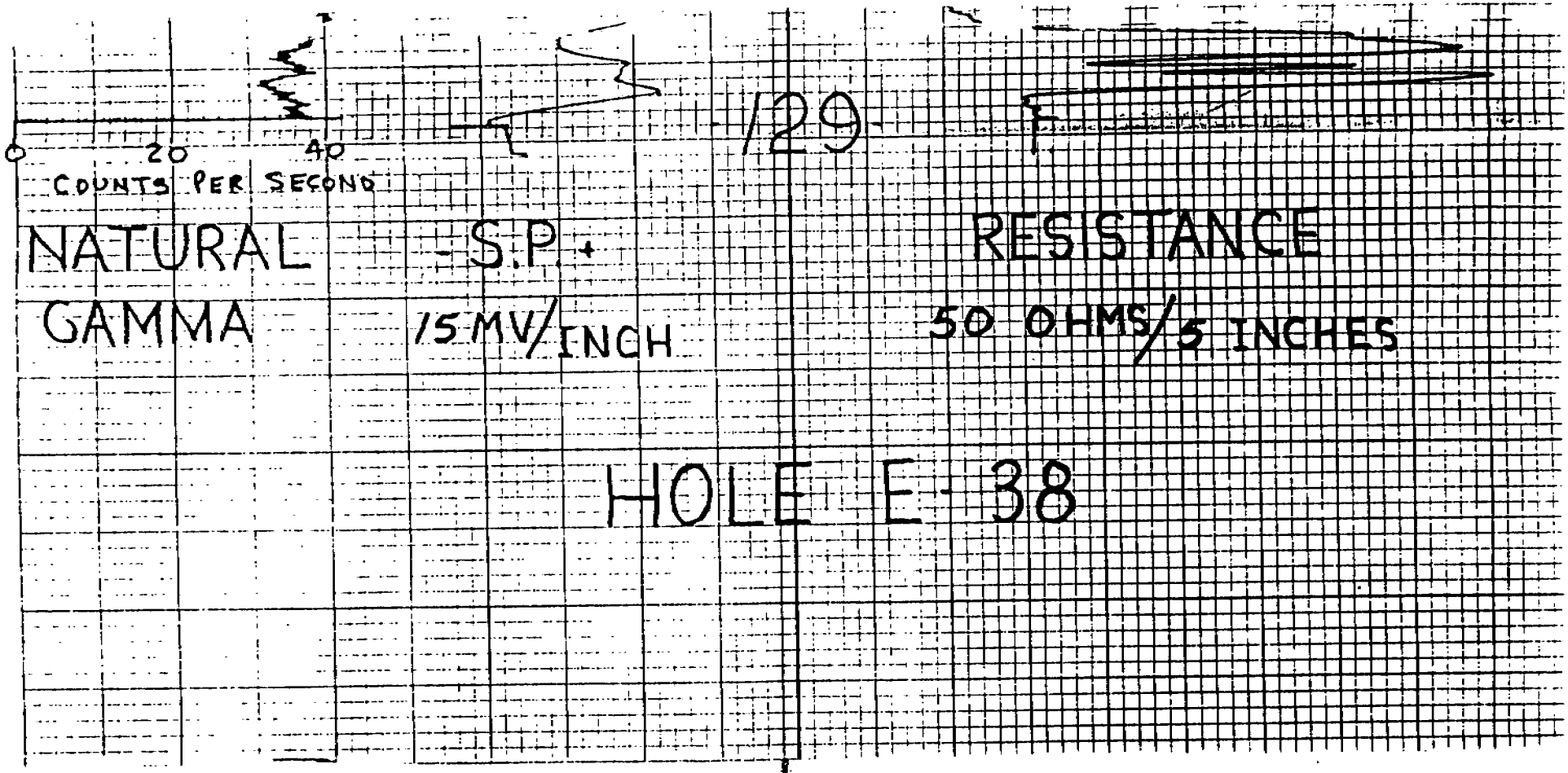
RESISTANCE
50 OHMS/ 5 Inches

40


RAL C
20
CPS
Initial Log
S.P.
15 MV
-
+
RESISTANCE
50
OHMS/ 5 Inches
FRONTIER LOGGING CORPORATION
0
20
40
0
30
40
50
Casing

No. GC13142




20
40
COUNTS PER SECOND
NATURAL GAMMA
-S.P.+
15 MV/INCH
129'
RESISTANCE
50 OHMS/5 INCHES
HOLE E-38

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BOREHOLE SUMMARY LOG

Borehole E-39 Well —

Project Name and Location MW Installation Project Number 17052 07410

Drilling Company Boyles Driller B Roach Rig Number Failing 25

Drilling Method(s) Rotary - drill mud used

Size(s) and type(s) of bit(s) 3 7/8" tricone bit

Borehole Diameter 3 7/8 in. ____ cm. ____ 0 ft. ____ cm. to 130 ft. ____ cm.

____ in. ____ cm. ____ ft. ____ cm. to ____ ft. ____ cm.

Sampling Methods continuous core

Total Number Soil Sampling Tubes —

Total Number Core Boxes 14

Number of Gallons Lost Drilling Fluid ≈ 1400 gals. - water lost 50'

Date/Time Started Drilling 4·2·87 1109

Date/Time Completed Drilling 4·3·87 1640

Total Borehold Depth 130 ft. ____ cm.

Depth to Bedrock 17 ft. ____ cm.

Depth to Water unknown ft. ____ cm.

Water Level Determined By? A.A.

Borehole Completed as Monitoring Well? NO

Date/Time Grouting Completed 4·6·87 1330

Depth of Tremmie Pipe 125'

Gallons of Grout 95

Materials Used 9 1/2 bags cement, 9/10 bag bentonite, 95 gals water

Comments Hole grouted to surface

Wellsite Geologist C Benson Date 4·6·87

Checked for Grout Settlement on 6/11/87 by JRL

Amount of Grout Added 0

All Measurements from Ground Level

Reviewed by Joseph L. Reed Date 6/11/87

Drill Site Geologist ____ Date ____

FSE, Inc. CORE LOG by CDB Date 4-7-87 BORE E-39 Well(s) _____ Page 1 of 6

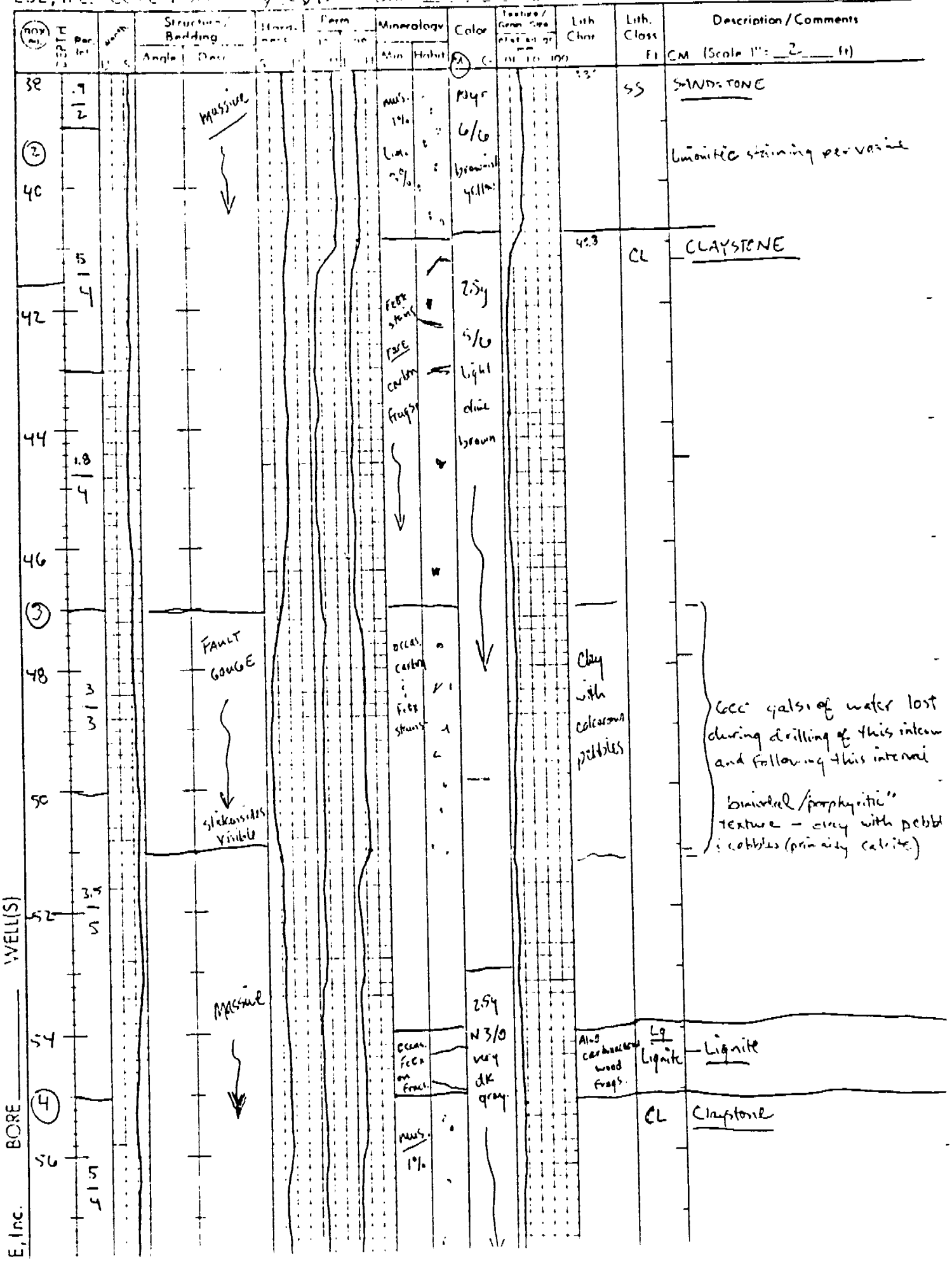
Index (m)	Depth (ft)	Rec Int	Structure / Bedding Angle	Structure / Bedding Dirn	Hardness	Perm	Mineralogy Min	Mineralogy Habit	Color (M)	Texture / Grain Size	Lith Char	Lith. Class Ft	Description / Comments CM (Scale 1" = 2 ft)
													C-20' Logged on soil Log Form
	20											CL	Claystone
	22	4.7 / 4							2.5Y 6/4 Light yellowish brown				
	24												
	26	2.0 / 4									20'		sl sandy- silt 10%
1	28												
	30	2 / 2									28'		
	32	4.7 / 2											
	34												
2	36	0											No Recovery
												CL	Claystone

Carbonaceous frags

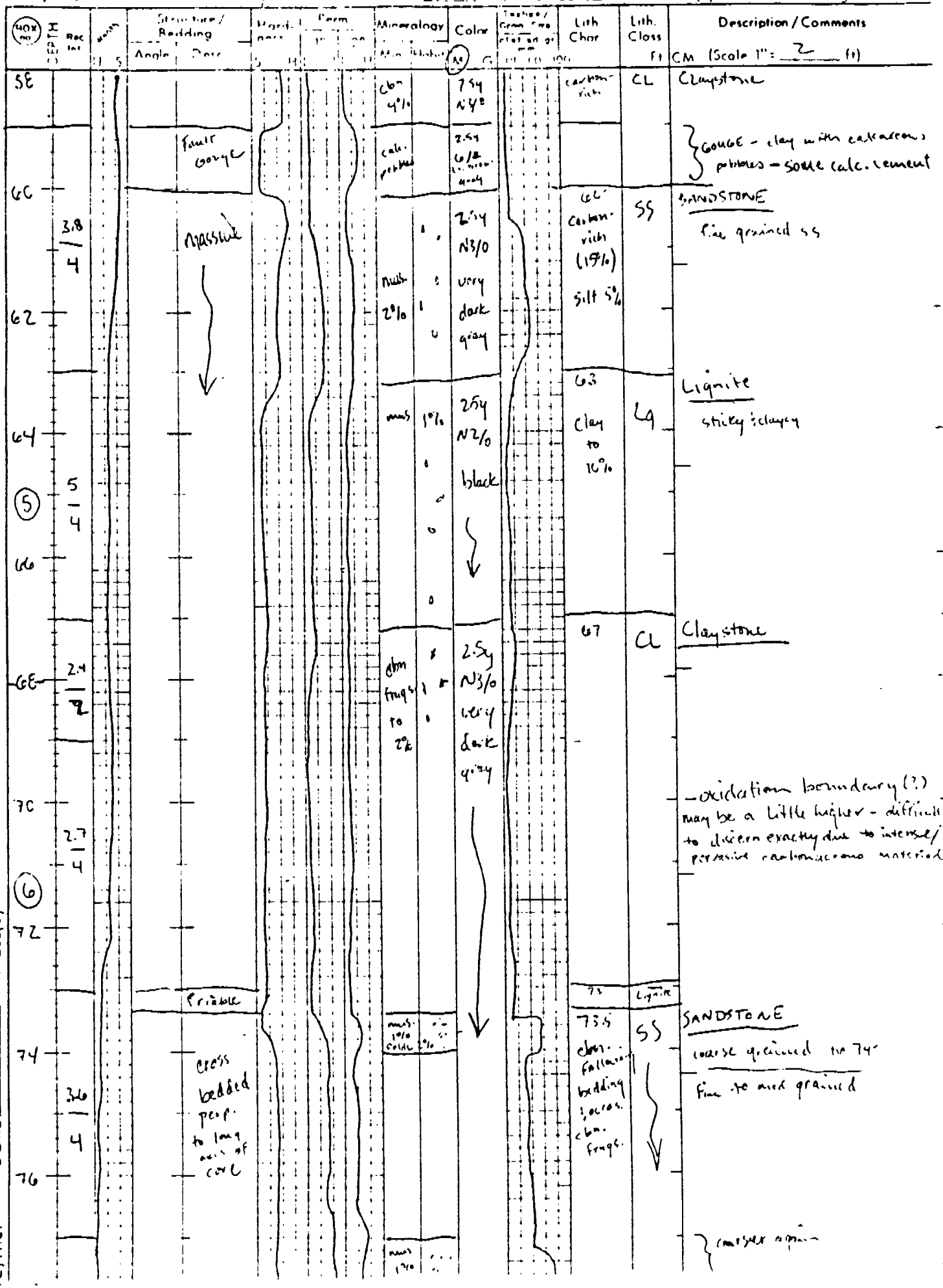
BORE E-39 WELL(S)

FSE, Inc.

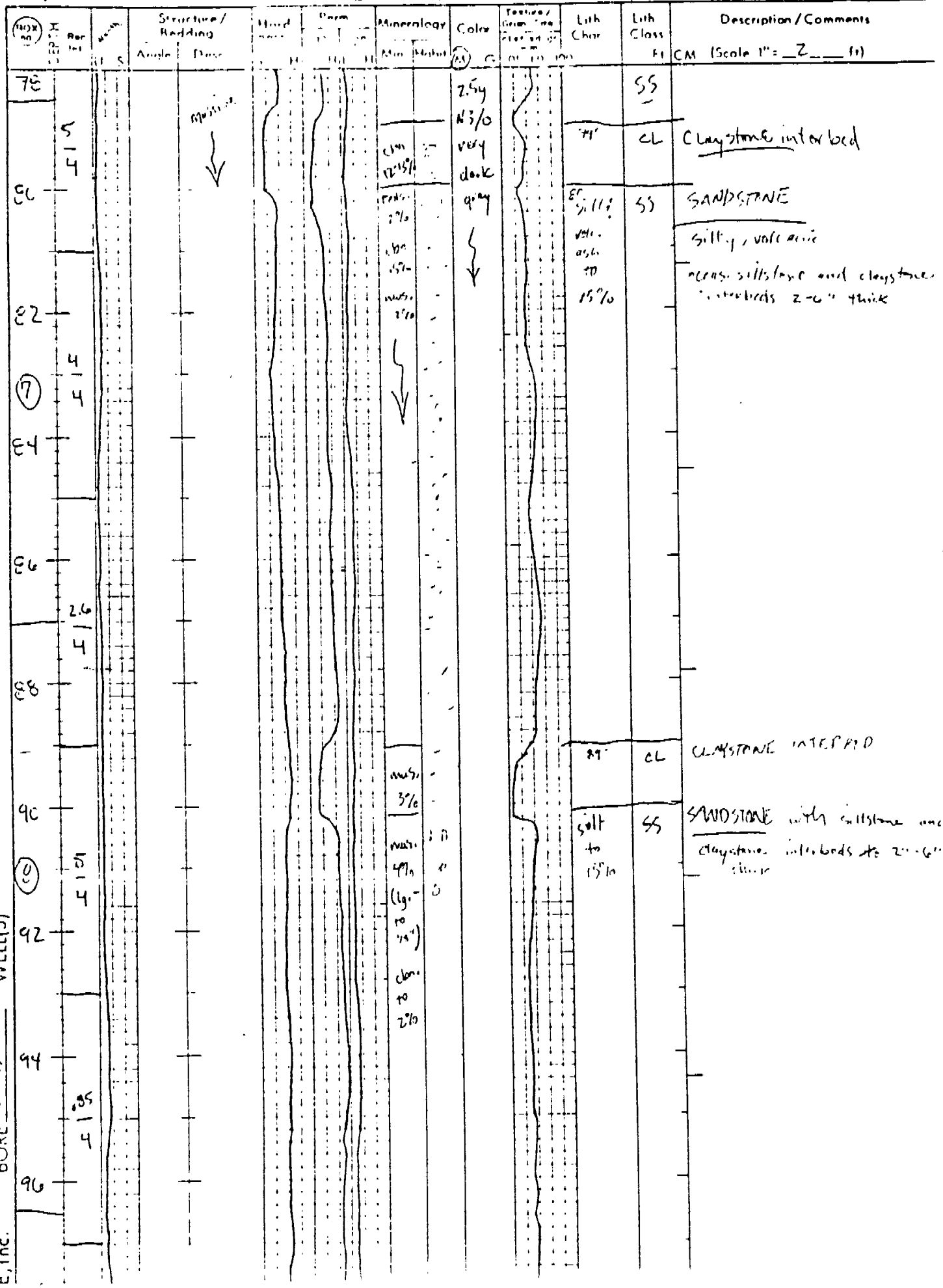
ESE, Inc. CORE LOG By CDB Date 4/8/87 ROCK 639 Well(s) _____ Page 2 of 6



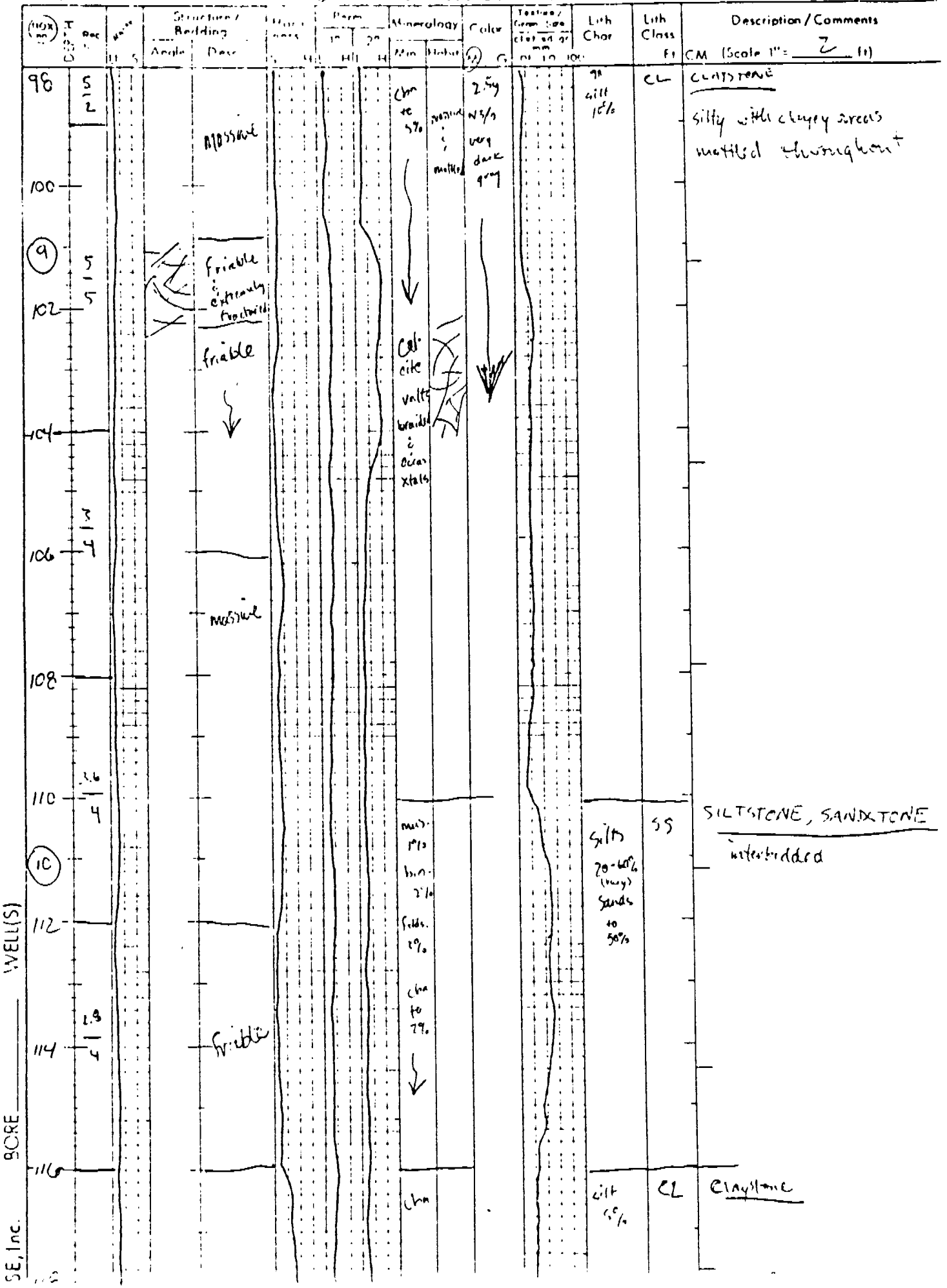
ESE, Inc. CORE LOG By CDS Date 4.7.87 BORE E-39 Well(s) _____ Page 3 of 6



ESE, Inc. CORE LOG by CDG Date 4.7.87 BORE E-39 Well(s) _____ Page 5 of 6



ESE, Inc. CORE LOG By CDB Date 4.7.87 BORE C-39 Well(s) _____ Page 5 of



ESE, Inc. LOG OF BORE / WELL(S) By CMS Date 4/7/87 BORE 1 of 29 Well(s) _____ Page 6 of 6

Run (min)	Rec (ft)	Structure / Bedding Angle	Structure / Bedding Dir.	Mineralogy	Color	Lith Char	Lith Class	Description / Comments
118	4.5 / 4			clay 2%	2.5Y N3/0 very dark gray	silty to 7%	CL	CLAYSTONE
120						120' silt 10 to 40%	SS	SANDSTONE with siltstone & occas claystone interbeds
(11)		cross bedding and fine bedding perpendicular to core long axis		mica to 3% clay to 4%				carbon mottled through core and following bedding planes
122	5 / 5							
124								
126								
(12)	4.6 / 5							
128								
130								END OF BORING AT 130'

BORE _____ WELL(S) _____

ESE, Inc.

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ENGLEWOOD, COLORADO 80112 • 303/741-0639

BOREHOLE SUMMARY LOG

Borehole E 39A Well

Project Name and Location T-36 ¼ mile N of 96th St along K FRACTIONAL SECTION Project Number

Drilling Company Boyles Bros Driller Dave Jarvis Rig Number 5451

Drilling Method(s) Auger

Size(s) and type(s) of bit(s)

Borehole Diameter 8 in. cm. ft. cm. to ft. cm.

in. cm. ft. cm. to ft. cm.

Sampling Methods Continuous Split Spoon

Total Number Soil Sampling Tubes 10 - 2 FT

Total Number Core Boxes 2

Number of Gallons Lost Drilling Fluid 0

Date/Time Started Drilling 3/25/87 — 0815

Date/Time Completed Drilling 3/25/87 — 0915

Total Borehold Depth 20' ft. cm.

Depth to Bedrock 17' ft. cm.

Depth to Water 19' ft. cm.

Water Level Determined By? Samples

Borehole Completed as Monitoring Well? No

Date/Time Grouting Completed 3/25/87 1035

Depth of Tremmie Pipe ~~Gravity~~

Gallons of Grout 50

Materials Used 3 BAGS OF CEMENT / 15 lbs BENTONITE

Comments 20' of 4" PVC grouted in place to be used as Sucker casing for Exploratory boring E-39

Wellsite Geologist Greg Citus Date 3/25/87

Checked for Grout Settlement on 4/28/87 by JLR

Amount of Grout Added

All Measurements from Ground Level

Reviewed by Joseph L. Reed Date 4/28/87

Drill Site Geologist Date

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SHEET 1 OF 2

Borehole: E 39 A Well Number: Dry Hole

SOILS LOG
Description

Munsell Colors

Depth - Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	Description
0	2 - 0	2'	NA	0 - 2'	ML	ML sandy-silt, ~20-30% v.f.-f.gr. sand, 10YR, 4/3-4, dk. yerk. brn., non-plas., loose, moist, alluvium
1.5	4 - 2	1.2'		4 - 2'		At 1.5' color changes to 10YR, 6/3-4, pale brn., natural density increases to mod. dense, moisture decreases to dry.
1	9 - 4	2'		9 - 4'	SM	SM silty-sand, ~30±% silt, 10YR 5/4-6, yerk. brn., non-plas, loose, moist alluvium.
6.5	7 - 9	0.9'		7 - 9'		At 6.5' percent silt decreases to ~20%, color changes to 10YR, 6/6-8, brnish. yellow.
7.0	6 - 7	1.25'		6 - 7'		
9.0	11 - 6	1.25'		11 - 6'		

Lab & Drill Site Geologist: A. Patella Date: 3/27/87

Reviewed By: Joseph L. Reed Date: 4/16/87

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Borehole: E39A Well Number: Dry Hole

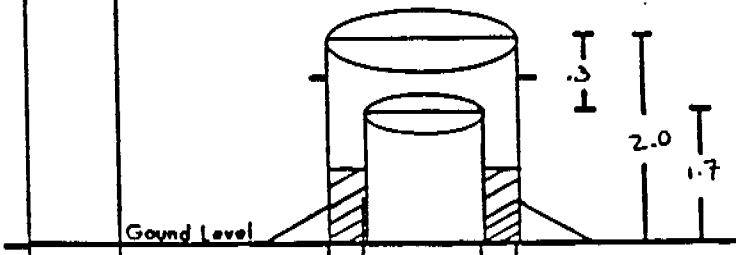
Depth-feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description (Munsell Colors)
11.0	S1-11' / 13'	1.7'	NA	11'-13'	ML	ML sandy-silt, ~30% v.f. gr. sand, 10YR 5/6-8, yeast. brn.; non-plas., loose, moist alluvium
12.0					SC	SC clayey-sand, ~20-30% clay, 10YR 5/3-4, brown, slight plas., v. soft, moist, alluvium.
13.0	S1-13' / 15'	1.2'		13'-15'		At 14.0', percent clay increases to ~40%, color changes to 10YR 6/3-4, pale brn.
15.0	S1-15' / 17'	2'		15'-17'		At 16.0' color changes to 10YR 5/2-3, grayish brn.
17.0	S1-17' / 19'	2'		17'-19'	CL	CL sandy-clay, ~5-10% v.f. gr. calc. sand, 10YR 5/1-2 grayish brn., low plas., soft, moist Lisbon
19.0	S1-19' / 19.2'	1'		19'-23'	WT ▽	At 19.0 moisture increases to saturated.
20.0						END OF BORING LOG
1.0						AKO
2.0						

Drill Site Geologist: [signature] Date: 3/17/87

Reviewed By: Joseph L. Reed Date: 4/16/87

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Borehole: E-39D1 Well: 37387

Depth-Feet	Soil/Rock Type	Well Completion	Description
			
5		6.55 joint	
10			
15		16.61 joint	
20		21'	8" casing
25		26.66 joint 28'	TOP of BENTONITE SEAL
30		32.4	TOP of SAND PACK
35		joint 36.78'	TOP of SCREEN
40		42.66'	BOTTOM OF HOLE, SCREEN
45			

Drill Site Geologist: C Dunker Date: 4.9.87

Reviewed By: Joseph L. Reed Date: 5/20/87

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
7332 SOUTH ALTON WAY • SUITE H-1
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WELL CONSTRUCTION SUMMARY

Borehole E-39D1 Well 37387

Project Name and Location MW Installation Project Number 170530741C

Drilling Company Boyles Driller B. Roach Rig Number Failing 25

Drilling Method(s) Rotary with mud (bentonite and water)

Borehole Diameter 12¼ in. ____ cm. 0 ft. ____ cm. to 21 ft. ____ cm.
7¾ in. ____ cm. 21 ft. ____ cm. to 42.66 ft. ____ cm.

Size(s) and types of Bit(s) 12¼" blade bit, 7¾" blade bit

Size and Type PVC Schedule 40, 4"

Total Borehole Depth	42.66 ft.	____ cm.	
Depth to Bedrock	17 ft.	____ cm.	
Depth to Water	N.A. ft.	____ cm.	
Water Level Determined By	not determined		
Length Plain PVC (total)	~~30.78~~ 30.48 COD 38.48 ft.	____ cm.	
Length of Screen	5.88 ft.	____ cm.	
Total Length of Well Casing	44.36 ft.	____ cm.	
PVC Stick Up	1.7 ft.	____ cm.	
Depth to Bottom of Screen	42.66 ft.	____ cm.	
Depth to Top of Screen	36.78 ft.	____ cm.	
Depth to Top of Sand	32.4 ft.	____ cm.	
Depth to Top of Bentonite	28 ft.	____ cm.	

Sampling Method(s) not sampled

Date/Time Start Drilling 4.8.87 0942

Date/Time Finish Drilling 4.8.87 0936

Date/Time Start Completion 4.8.87 0936

Date/Time Cement Protective Casing 4.8.87 1151

Materials Used

Plain PVC 4x10'

Slotted PVC 1x5'

Bentonite Pellets 1.5 buckets

Bentonite Granular ~~none~~ 5 1/2 bags

Cement 5 bags cement

Sand 2 bags

Water added during completion —

Water added during drilling —

Total Gallons of water added —

Drill Site Geologist C. Benson Date 4.9.87

Date/Time/Personnel Internal Mortar, Cement Pad, and Weep Hole Installed 05/08/87 1250 SMH PJB

Date/Time/Personnel Casing Painted 05-12-87 0800 SMH PJB

Date/Time/Personnel Numbers Painted 05-12-87 1255 SMH PJB

Materials Used 10 Bgs Quick Crete 1 Roll Lawn Edging

Top of Protective Casing to Top of PVC	0.25 ft.	____ cm.	COMMENT/NOTES
Top of Protective Casing to Weep Hole	0.51 ft.	____ cm.	
Top of Protective Casing to Internal Mortar	0.52 ft.	____ cm.	
Top of Protective Casing to Top of Cement Pad	1.95 ft.	____ cm.	
Top of Protective Casing to Ground Level	1.95 ft.	____ cm.	

Reviewed By Joseph L. Reed Date 6/19/87

Drill Site Geologist ____ Date ____

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Borehole: E39D2 Well: 37388

Depth-Feet	Soil/Rock Type	Well Completion	Description
0		Ground Level	
5		joint 4.74	
10		joint 9.51	
15			
20		joint 19.55	20' 12" steel casing
25			
30		joint 29.59	
35		centralizer 36'	
40		joint 39.64	
45			45' 8" steel casing
50		joint 49.68	
55			
60		joint 59.73	TOP OF BENTONITE SEAL 59.6
65			TOP OF SAND PACK 64.2
70			TOP OF SCREEN 69.78'
75			
80			
85			Total Depth 86'
90			

Drill Site Geologist: C. Beusen Date: 4.10.87

Reviewed By: Joseph K. Reed Date: 5/20/87

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WELL CONSTRUCTION SUMMARY

Borehole E39D2 Well 37388

Project Name and Location MW Installation Project Number 1705207410

Drilling Company Boyles Driller B. Roach Rig Number Failing 25

Drilling Method(s) Rotary sampling with bentonitic mud

Borehole Diameter 16 1/2 in. ____ cm. 0 ft. ____ cm. to 20 ft. ____ cm.
11 1/2 in. ____ cm. 20 ft. ____ cm. to 45 ft. ____ cm.
7 7/8" 45 to 86'

Size(s) and types of Bit(s) 16 1/2" blade, 11 1/2" blade and 7 7/8" blade bit

Size and Type PVC 4" schedule 40

Total Borehole Depth	86 ft.	____ cm.	
Depth to Bedrock	17 ft.	____ cm.	
Depth to Water	____ ft.	____ cm.	
Water Level Determined By			
Length Plain PVC (total)	71.48 ft.	____ cm.	
Length of Screen	16.22 ft.	____ cm.	
Total Length of Well Casing	87.7 ft.	____ cm.	
PVC Stick Up	1.7 ft.	____ cm.	
Depth to Bottom of Screen	86 ft.	____ cm.	
Depth to Top of Screen	69.78 ft.	____ cm.	
Depth to Top of Sand	64.2 ft.	____ cm.	
Depth to Top of Bentonite	57.8 ft.	____ cm.	

Sampling Method(s) not sampled

Date/Time Start Drilling 4.10.87 0737

Date/Time Finish Drilling 4.10.87 0910

Date/Time Start Completion 4.10.87 0910

Date/Time Cement Protective Casing 4.10.87 1212

Materials Used

Plain PVC 7 x 10' 5' x 1

Slotted PVC 1 x 10' 1 x 5'

Bentonite Pellets 7 buckets

Bentonite ~~Granular~~ powder 1 bag

Cement 13 bags

Sand 2 1/2 bags

Water added during completion —

Water added during drilling —

Total Gallons of water added —

Drill Site Geologist C Benson Date 4.10.87

Date/Time/Personnel Internal Mortar, Cement Pad, and Weep Hole Installed 05/08/87 1330 PJB SMH

Date/Time/Personnel Casing Painted 05-12-87 0800 PJB/SMH

Date/Time/Personnel Numbers Painted 05-12-87 14:00 PJB/SMH

Materials Used

Top of Protective Casing to Top of PVC	2.26 ft.	____ cm.	COMMENT/NOTES
Top of Protective Casing to Weep Hole	1.46 ft.	____ cm.	
Top of Protective Casing to Internal Mortar	1.46 ft.	____ cm.	
Top of Protective Casing to Top of Cement Pad	1.85 ft.	____ cm.	
Top of Protective Casing to Ground Level	1.96 ft.	____ cm.	

Reviewed By Joseph L. Reed Date 6/9/87

Drill Site Geologist ____ Date ____

Frontier Logging
Lakewood, Colorado

Date APRIL 6, 1987

Company ESE

Bore Hole E-39

Project RMA

County ADAMS COUNTY | State COLORADO

Section | Township | Range | Elevation

Log Measured From Ground Level

Driller Depth 130 FT. | Miles Round Trip

Bit Size 3 7/8" | Standby

Casing Driller | Time In 0910 | Time Out 1155

Fluid in Hole water + native mud | Unit No 110

Density/Viscosity | pH | Operator W. Linton

Drilling Measured From Ground Level | Location Lakewood

EQUIPMENT DATA

128 FT

Natural Gamma 200 Scale = 20 CPS per inch

Time Constant 2 Sec | Logging Speed 15 Ft/Min

Probe No 103-1041 | Probe Diameter 1 5/8"

Detector Type Size xtal 3/4 x 1 3/4"

K Factor 1.60 x 10⁻⁵ | Dead Time 7 Microsec

Water Factor | Hole Size

Casing Factor | Casing Size

Resistance 40 + 50 ohms Ohms per 5 inches

SP 20 MV/INCH MV per inch

NATURAL GAMMA RERUNS (ANALOG) (Initial log off scale)

	CPS/in		CPS/in		CPS/in		CPS/in
TC	Logging Speed	TC	Logging Speed	TC	Logging Speed	TC	Logging Speed
Sec	Ft/Min	Sec	Ft/Min	Sec	Ft/Min	Sec	Ft/Min
From	To	From	To	From	To	From	To
Total		Total		Total		Total	

Gamma (Analog)	Density Source No
Gamma (Digital)	Type Strength
Caliper	CPS/inch
Temperature	
DIRECTIONAL DATA	Neutron Source No
Closure	Type Strength
Azimuth	CPS/inch
True Vertical / Survey Depth	

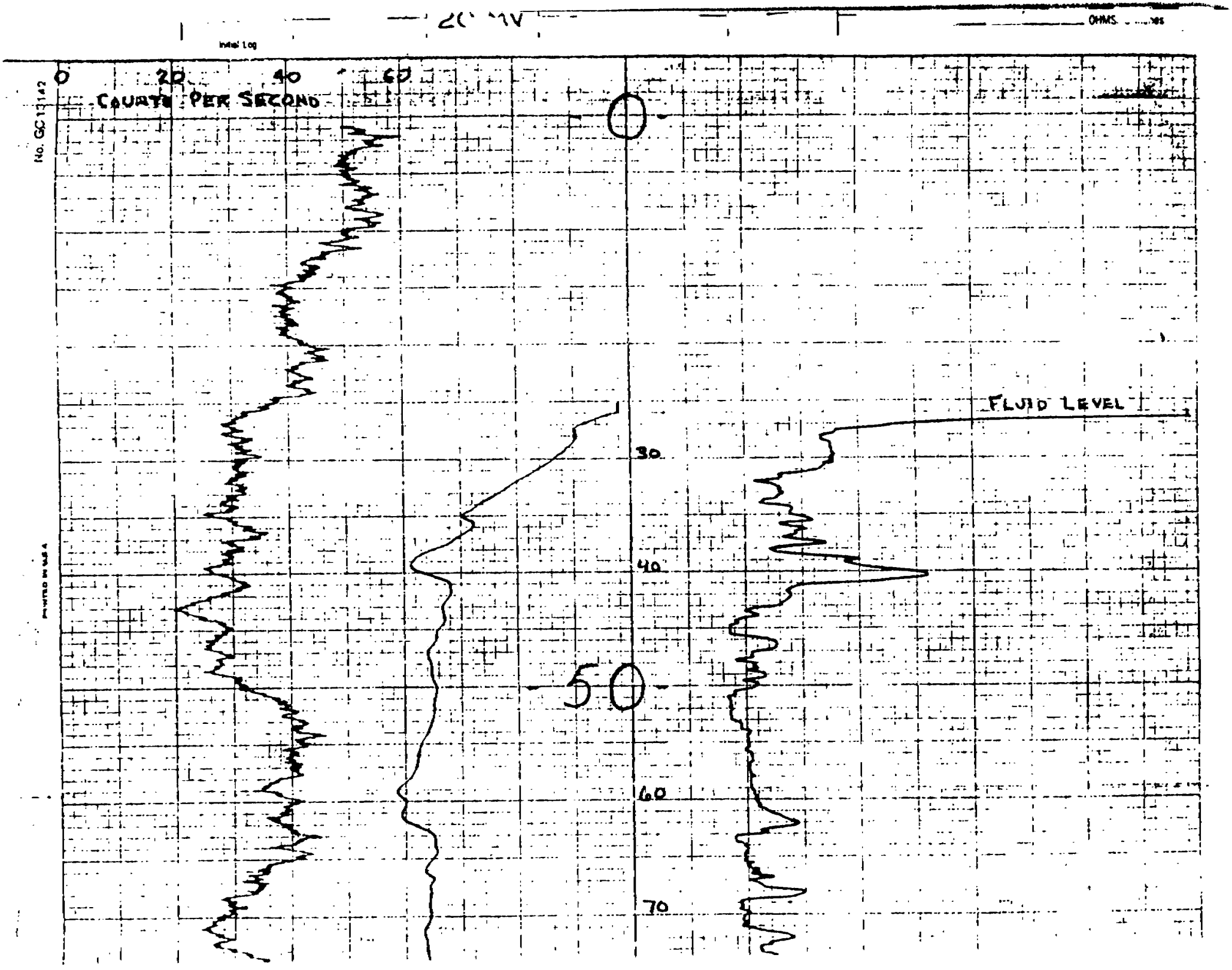
6 trips into hole

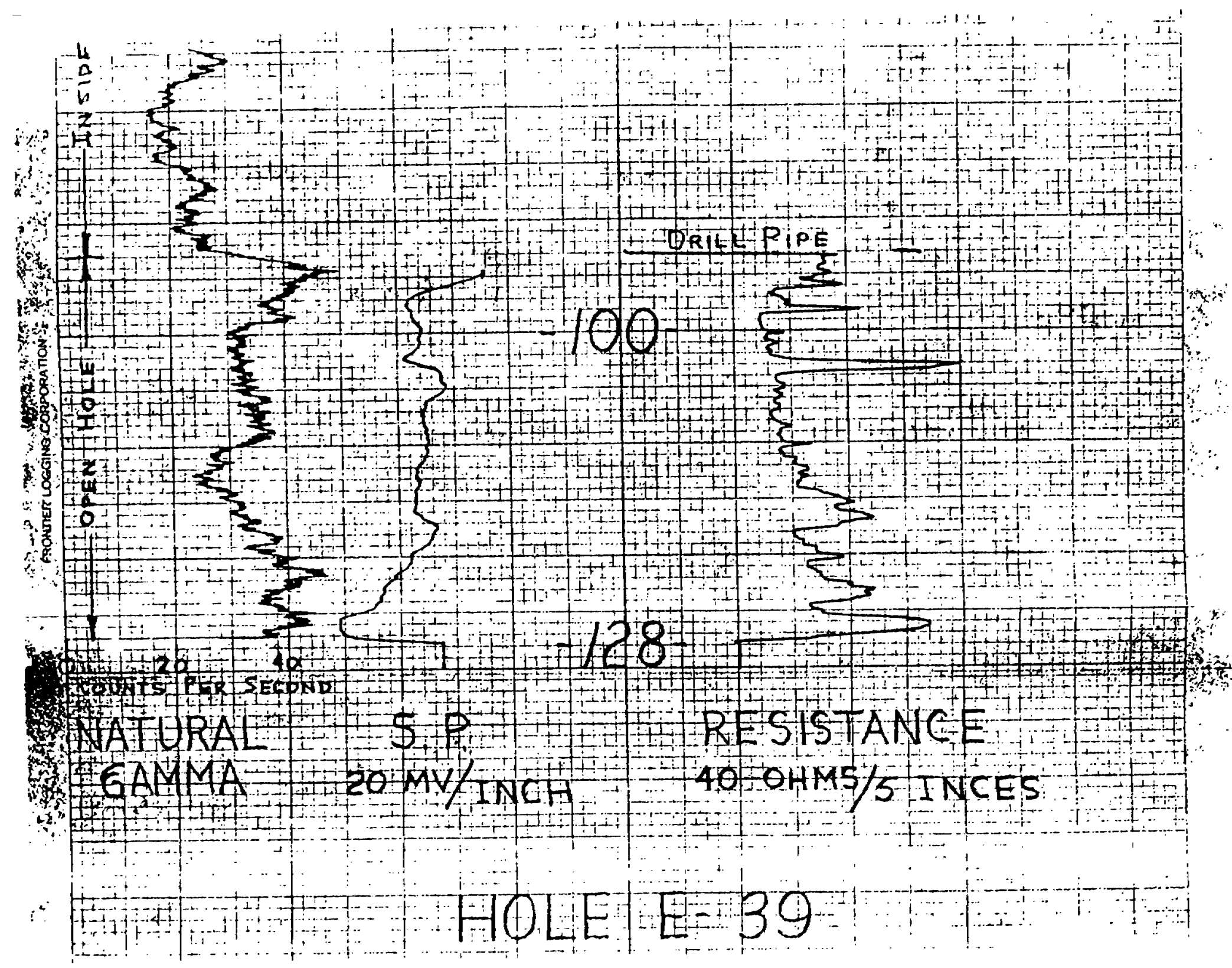
clay/shaly boots in hole

S.P.

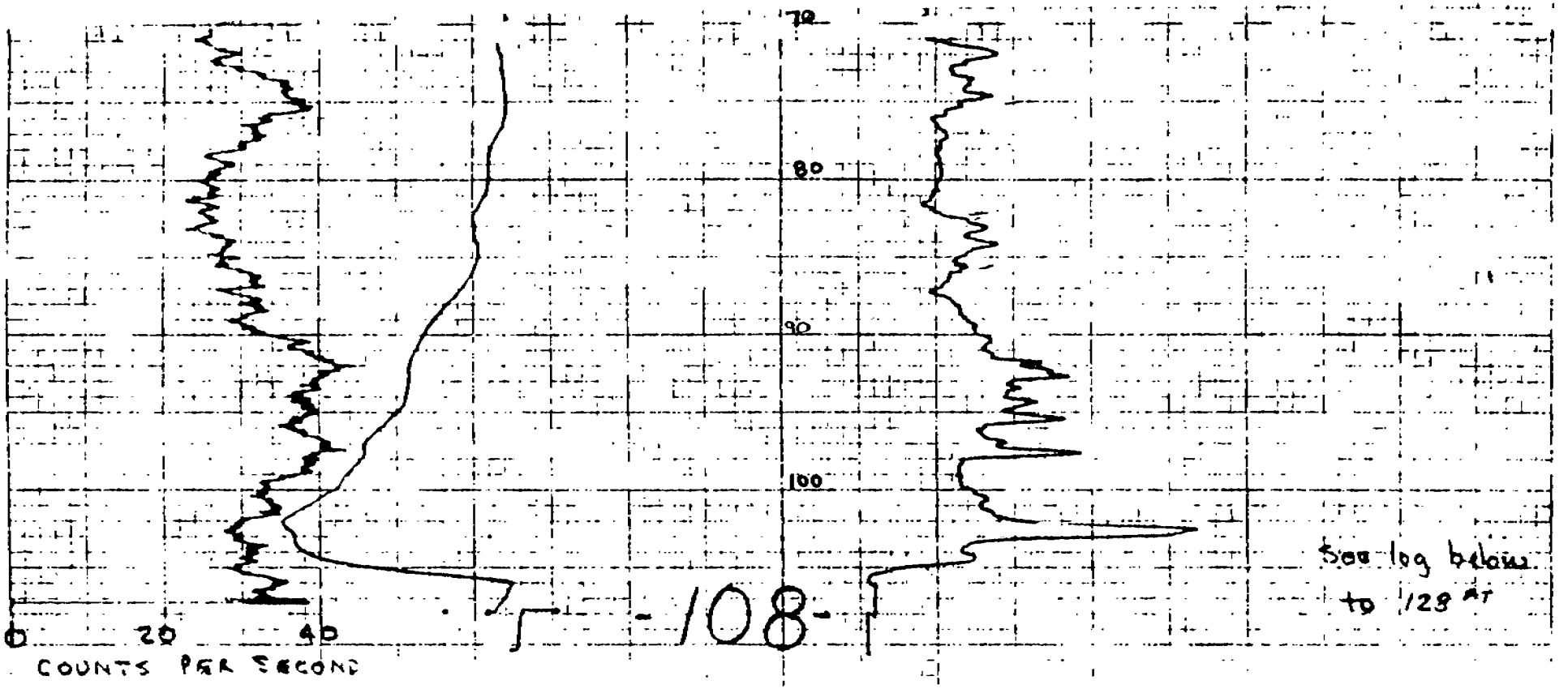
NATURAL GAMMA

RESISTANCE


OHMS
0
20
40
60
COUNTS PER SECOND
FLUID LEVEL
30
40
50
60
70


INSIDE
OPEN HOLE
DRILL PIPE
-100-
-128-
2α
1α
COUNTS PER SECOND
NATURAL
GAMMA
S.P.
20 MV/INCH
RESISTANCE
40 OHMS/5 INCES
FRONTIER LOGGING CORPORATION

HOLE E-39



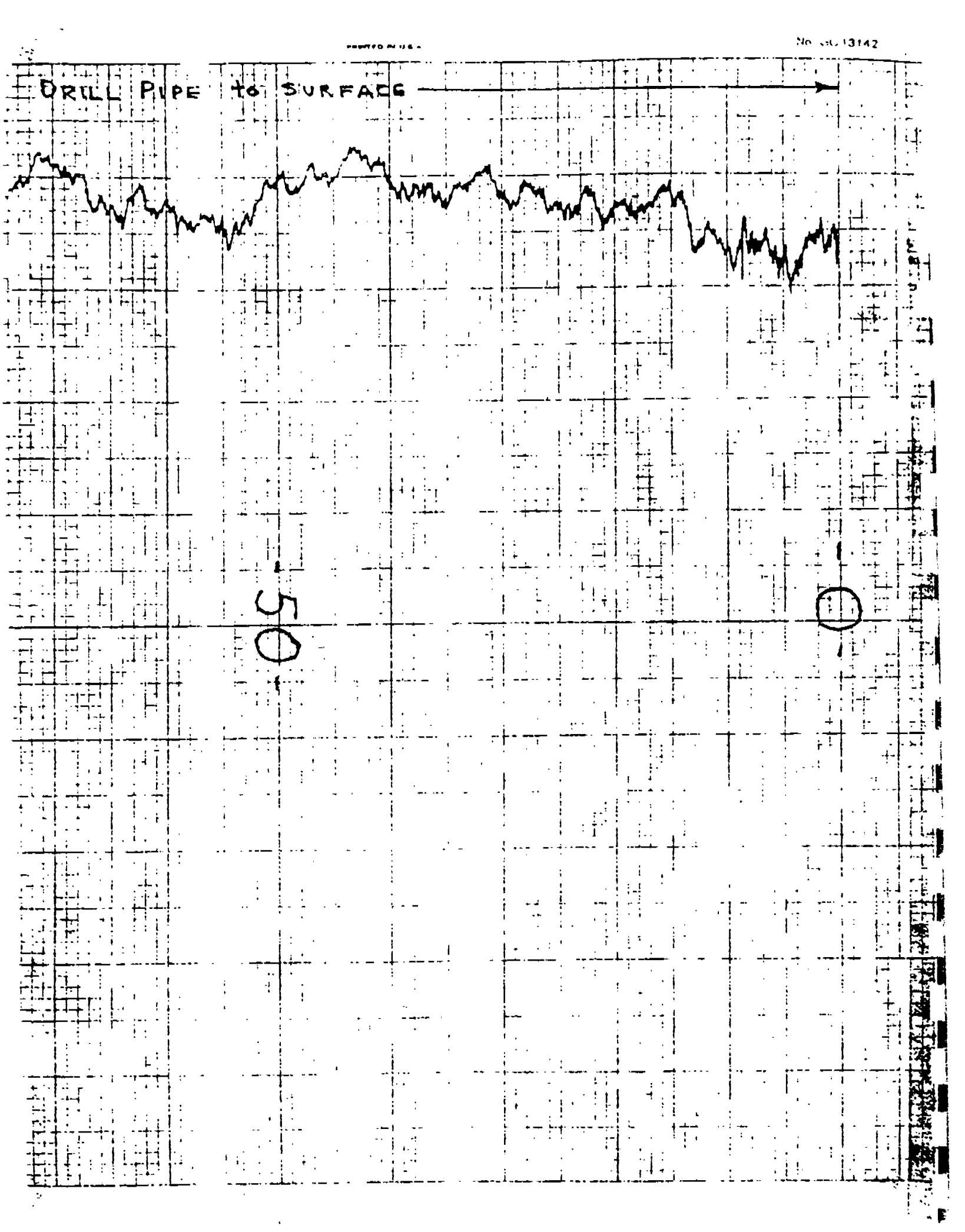
-108-

NATURAL GAMMA

S. P. 20 MV/INCH

RESISTANCE 50 OHMS/5 INCHES

E-39


DRILL PIPE to SURFACE
50
0

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WELL CONSTRUCTION SUMMARY

Borehole E40A Well 37370

Project Name and Location RMA offsite Project Number

Drilling Company Boyles Bros. Driller D. Jarvie Rig Number B57

Drilling Method(s) continuous core

Borehole Diameter 12¼ OD in. cm. 0 ft. cm. to 25.8 ft. cm.
~~10~~ in. cm. ft. cm. to ft. cm.

Size(s) and types of Bit(s) 3¼" hollow stem auger

Size and Type PVC 4" schedule 80

Total Borehole Depth 27 ft. cm.

Depth to Bedrock 25.8 ~~25.0~~ COP ft. cm.

Depth to Water 9 ft. cm.

Water Level Determined By field observation

Length Plain PVC (total) 7.1 ft. cm.

Length of Screen 21.41 ft. cm.

Total Length of Well Casing 28.5 ft. cm.

PVC Stick Up 2.7 ft. cm.

Depth to Bottom of Screen 25.8 ft. cm.

Depth to Top of Screen 4.4 ft. cm.

Depth to Top of Sand 3 ft. cm.

Depth to Top of Bentonite 2 ft. cm.

Sampling Method(s) continuous core

Date/Time Start Drilling 1·21·87 0919

Date/Time Finish Drilling 1·21·87 1101

Date/Time Start Completion 1·21·87 1152

Date/Time Cement Protective Casing 1·21·87 1435

Materials Used ~~1 10' piece CDB~~ 7-4' TUBES

Plain PVC 2 CDB 10' piece

Slotted PVC 2 10' piece

Bentonite Pellets 50 gal.

Bentonite Granular 10 lb.

Cement 1 bag

Sand 13½ bags

Water added during completion 30 gal.

Water added during drilling 0

Total Gallons of water added 30 gal.

Drill Site Geologist C. D. Benson Date 1·21·87

Date/Time/Personnel Internal Mortar, Cement Pad, and Weep Hole Installed 2/10/87 1030 JWF KWP

Date/Time/Personnel Casing Painted 2/10/87 1315 KWP

Date/Time/Personnel Numbers Painted 4/15/87 1115 JWF BAL

Materials Used 10 bags Quickcrete

Top of Protective Casing to Top of PVC 0.6 ft. cm.

Top of Protective Casing to Weep Hole 2.34 ft. cm.

Top of Protective Casing to Internal Mortar 2.4 ft. cm.

Top of Protective Casing to Top of Cement Pad 3.05 ft. cm.

Top of Protective Casing to Ground Level ~~3.05~~ JF 3.30 ft. cm.

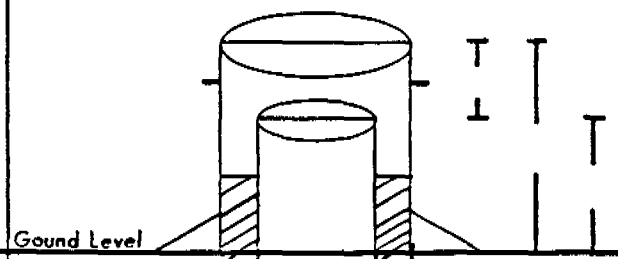
COMMENT/NOTES

Reviewed By Joseph L. Reed Date 6/9/87

Drill Site Geologist Date

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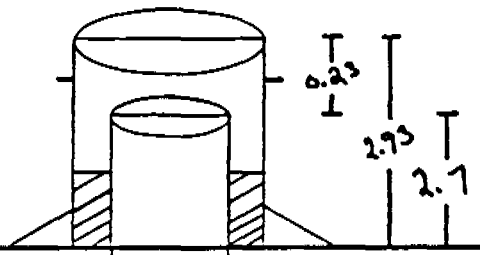
Borehole: E40A Well: 37370

Depth-Feet	Soil/Rock Type	Well Completion	Description
			
2			TOP OF BENTONITE 2'
4			TOP OF SAND 3'
6			TOP OF SCREEN 4.4' / Joint
8			
10			Water Level 9'
12			
14			
16			Joint at 14.91'
18			
20			
22			
24			
26			Bottom of Screen 25.8'
28			

Drill Site Geologist: C. D. Benson Date: 1.21.87
Reviewed By: Joseph L. Read Date: 6/11/87

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Borehole: E40 Piezometer Well: 37371

Depth-Feet	Soil/Rock Type	Well Completion	Description
			
5			
10			
15			
20			
25		23' 27.3' 28.3	TOP OF BENTONITE SEAL SAND TOP OF ~~BENTONITE~~ SOB TOP OF SCREEN
30			
35		39'	Total Depth

Drill Site Geologist: C. D Ferguson Date: 12.6.87
Reviewed By: Joseph L. Reed Date: 7/9/87

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WELL CONSTRUCTION SUMMARY

Borehole E40 Piezometer Well 37371

Project Name and Location Offpost Monitor well Project Number

Drilling Company Boyles Driller B. Roach Rig Number T60

Drilling Method(s) Continuous core

Borehole Diameter 7 7/8 in. cm. 0 ft. cm. to 39 ft. cm.

in. cm. ft. cm. to ft. cm.

Size(s) and types of Bit(s) 7 7/8

Size and Type PVC 2" Schedule 40

Total Borehole Depth	39 ft.	cm.	
Depth to Bedrock	27 ft.	cm.	
Depth to Water	7 ft.	cm.	
Water Level Determined By	visual		
Length Plain PVC (total)	34.36 ft.	cm.	
Length of Screen	10.63 ft.	cm.	
Total Length of Well Casing	~~45.03~~ 44.99 ft.	cm.	
PVC Stick Up	2.7 ft.	cm.	
Depth to Bottom of Screen	39 ft.	cm.	
Depth to Top of Screen	28.3 ft.	cm.	
Depth to Top of Sand	27.3 ft.	cm.	
Depth to Top of Bentonite	23 ft.	cm.	

Sampling Method(s) NA

Date/Time Start Drilling 2-5-87 1023

Date/Time Finish Drilling 2-5-87 1512

Date/Time Start Completion 2-5-87 1536

Date/Time Cement Protective Casing 2-6-87 1105

Materials Used

Plain PVC 3 x 10' 1 x 5'

Slotted PVC 1 x 10'

Bentonite Pellets 1 bucket

Bentonite Granular 1 bag

Cement 4 bags

Sand 3 bags

Water added during completion none

Water added during drilling none

Total Gallons of water added none

Drill Site Geologist C. D. Benson Date 2-6-87

Date/Time/Personnel Internal Mortar, Cement Pad, and Weep Hole Installed 2/10/87 JR & JWF

Date/Time/Personnel Casing Painted JWF BAG 4/15/87 1049

Date/Time/Personnel Numbers Painted JWF BAG 4/15/87 1049

Materials Used 13 Bags Quikrete

Top of Protective Casing to Top of PVC	0.23 ft.	cm.	COMMENT/NOTES
Top of Protective Casing to Weep Hole	2.13 ft.	cm.	
Top of Protective Casing to Internal Mortar	2.19 ft.	cm.	
Top of Protective Casing to Top of Cement Pad	2.57 ft.	cm.	
Top of Protective Casing to Ground Level	2.93 ft.	cm.	

Reviewed By Joseph L. Reid Date 7/9/87

Drill Site Geologist Date

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
7332 SOUTH ALTON WAY • SUITE H-I
ENGLEWOOD, COLORADO 80112 • 303/741-0839

Borehole: E40A Well Number: E40A 37370

Depth - feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
0	0-2'	2'	NA	0-2'	SM	SM - silty sand, sl. clay, 10yr 3/3, dk. brown, med. dense, nonplast, sl. moist alluvium
2.0	2-4'	1.8'		2-6'	SC	SC clayey sand, 25% clay, 10 yr 3/1, very dk. gray, med stiff, med plast, sl. moist alluvium
4.0	4-6'	2'				
6.0	6-8	1.2'			SM	SM silty sand, ≈ 20% coarse sand, 10yr 3/1, med dense, nonplast., moist
8.0	8-10	2'				—moisture change to saturated at 9' (W.T.)
10.0	10-12	2'		10-12	SW	coarse sand increase to 25% SW coarse sand, 10yr 4/3, brown, med dense nonplast. saturated
11.0						

Drill Site Geologist: C. D. Benson Date: 1-22-87
N.D. 4/11/07

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SHEET 2 OF 3

Borehole: E40.1 Well Number: 37370

Depth-Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
11.0	10 12	2'	NA	10 12	SW	SW - well-graded sands, gravelly sands — 5% gravel, 10yr 4/3, brown/dk. brown, med dense, non plast, saturated
12.0	12 14	2'		12 14		
14.0	14 16	1.8'		14 16		
16.0	16 18	1.6		16 18		
18.0	18 20	1.8'		18 20		
20.0	20 22	.7'		20 22		20' increase in % gravel to 30% Gravelly Sands
22.0						

Drill Site Geologist: C. D. Bleyer Date: 1.22.87

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SHEET 3 OF 3

Borehole: E40.4 Well Number: 37370

Depth-Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
22.0						
	22-24	1' (lake stuff)	NA		SW	SW gravelly sands 30-40% gravel, 10yr 4/2 dk. grayish brown, med dense non plast, saturated
23.0						
24.0	24-26	1' (lake stuff)				
25.0						
26.0	26-27	1'				BEDROCK - weathered claystone 10yr 4/3 dk. brown
27.0						END OF BORING - REAMED TO 26' 27'

Drill Site Geologist: L.D. Benyon Date: 1-27-87
Geologist Rev'd 1/11/87

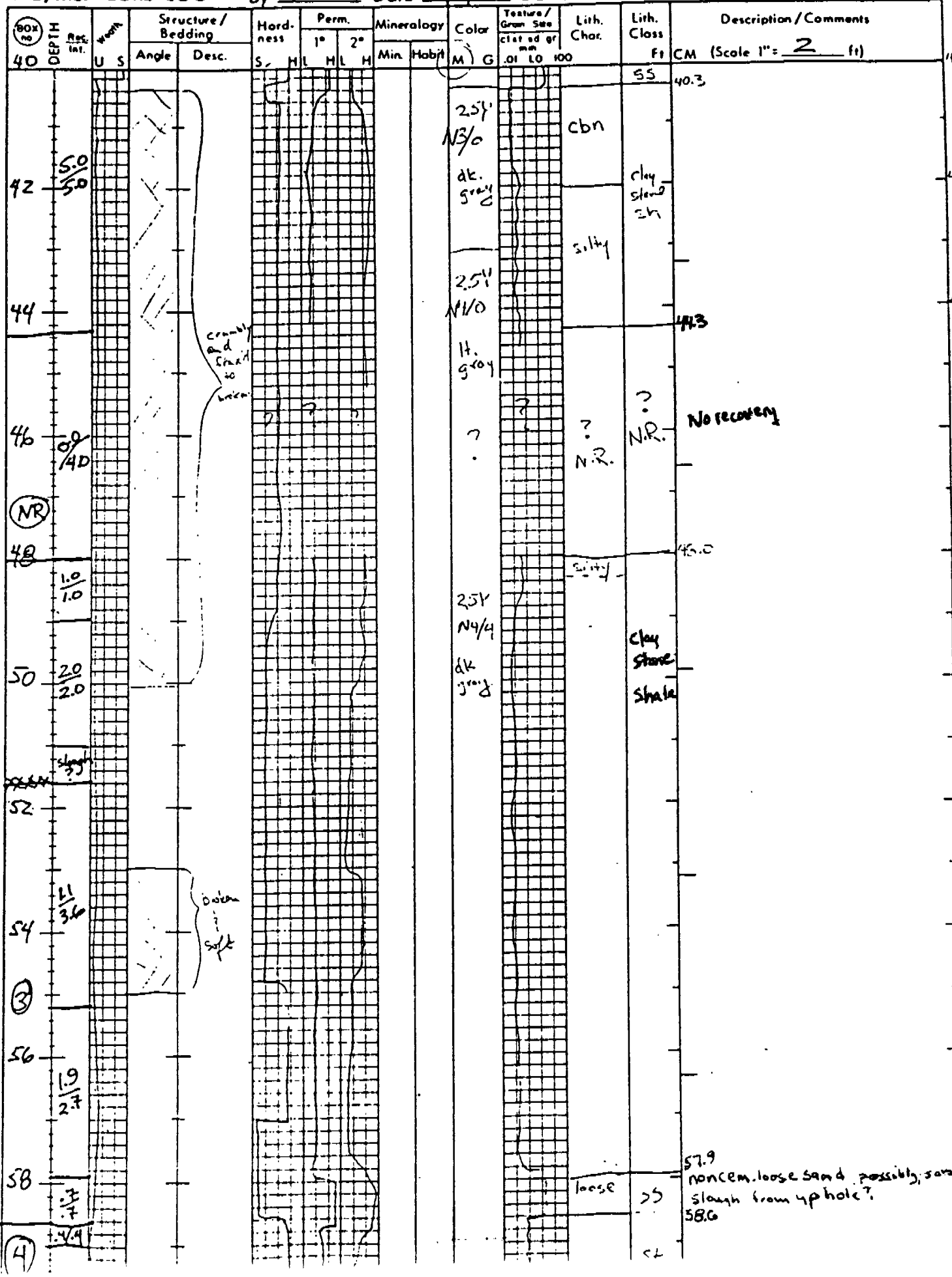
ESE, Inc. CORE LOG By MLG Date 2/6/87 BORE E40D Well(s) _____ Page 1 of 4

Box no.	Depth	Rec. / Int.	Weath U	Weath S	Structure/Bedding Angle	Structure/Bedding Desc.	Hardness S	Hardness H	Perm. 1° L	Perm. 1° H	Perm. 2° L	Perm. 2° H	Mineralogy Min.	Mineralogy Habit	Color M	Color G	Texture/Grain Size clay sd gr mm .01 LO 100	Lith. Char.	Lith. Class Ft	Description/Comments CM (Scale 1" = 2 ft)
20	22																			
	24																			
	26																			Start Coring. Alluvium logged on another sheet (All. Log)
	28	1.0/2.0				Strongly fract broken												sandy-clay rich	Silt stone	interbed of clay rich sandstone and fine sandy to
	30	1.0/1.3				10-20/ft														30.3'
①	32	4.0/4.0			0°										yel. brn. 25Y 4/4				SS	Sandstone becomes coarse-grained with depth to 40.
	34				8°	x bdg												clay balls		
	36	5.0/5.0			0°								clay frags		gray 25Y N4/0					
	38	MG				10-20/ft									yel brn 25Y 4/4					
②															gray 25Y N4/0					

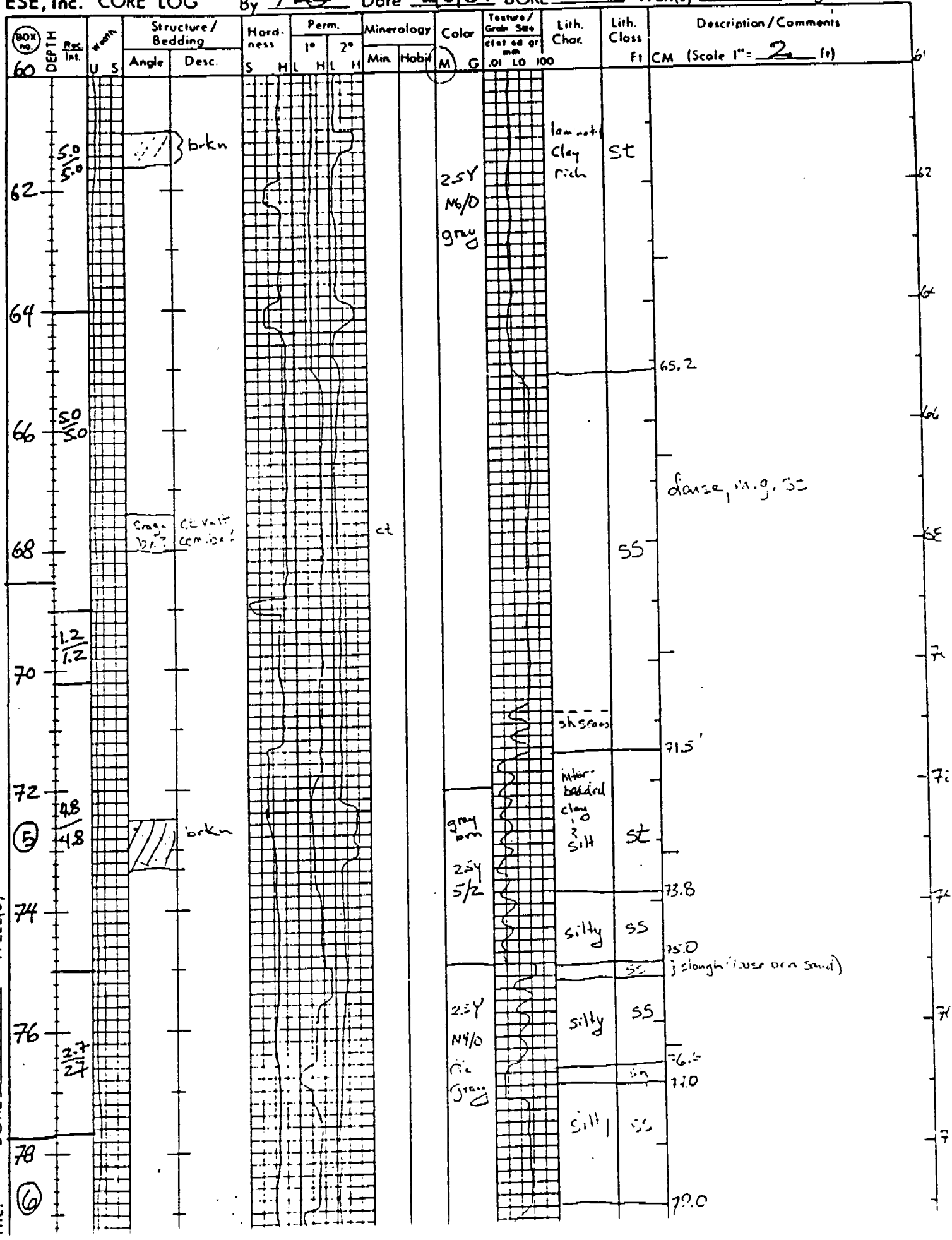
BORE E40D WELL(S)

Inc.

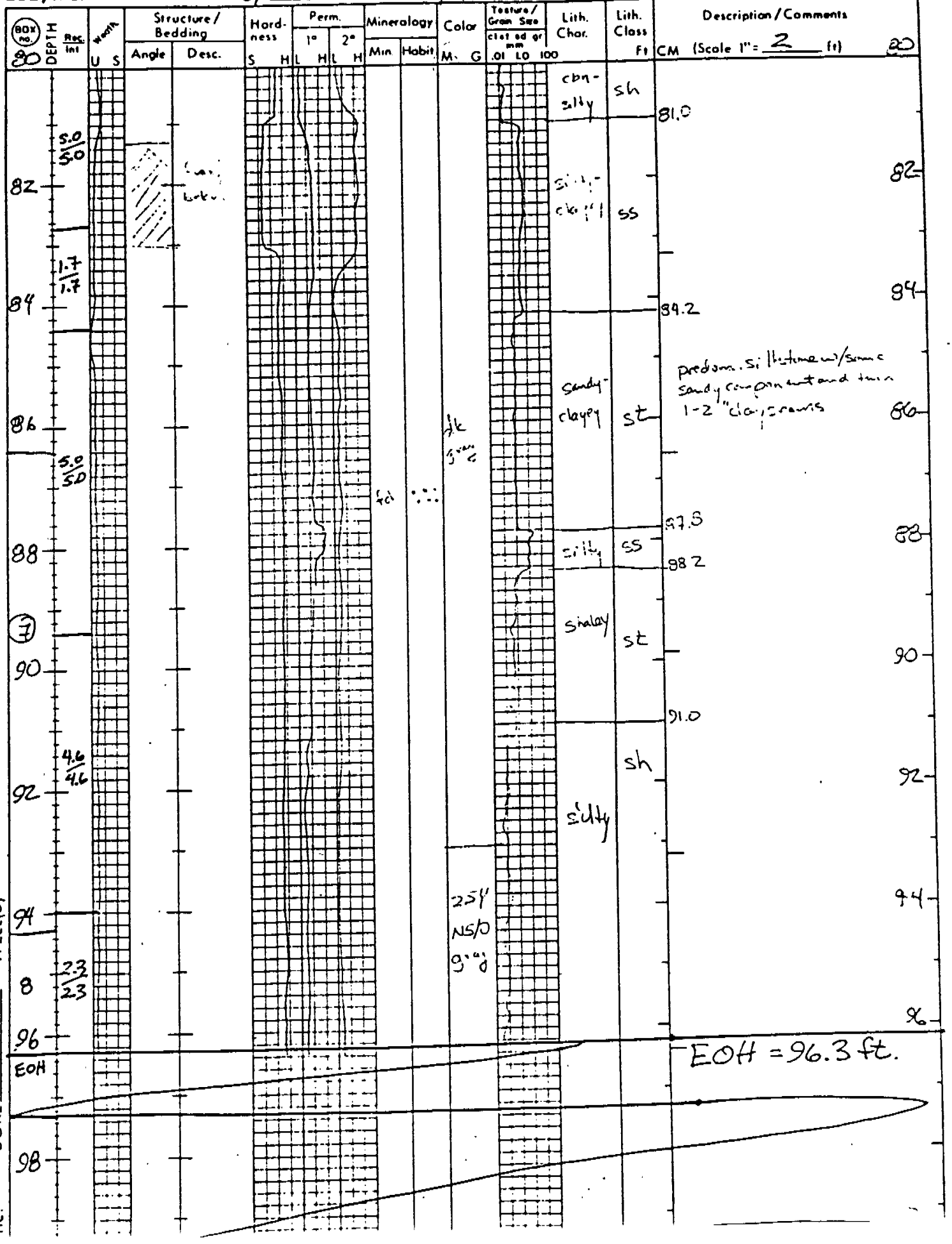
ESE, Inc. CORE LOG By MG Date 2/6/87 BORE E40D Well(s) _____ Page 2 of 4



ESE, Inc. CORE LOG By MG Date 2/6/87 BORE E40D Well(s) _____ Page 3 of 4



ESE, Inc. CORE LOG By MG Date 2/6/87 BORE E40D Well(s) _____ Page 4 of 4



Frontier Logging
Lakewood, Colorado

Company: ESE

Bore Hole: E 40 DENVER

Area/Project:

County: ADAMS COUNTY | State: COLORADO

Section | Township | Range | Elevation

Log Measured From: Ground Level

Date: JAN. 28. 1987

Driller Depth: 55 Ft

Bit Size: 3 Inch

Casing Depth: 28 Feet

Fluid in Hole: Water

Density/Viscosity | pH: •

Drilling Measured From: Ground Level

Miles Round Trip: 40

Standby

Time In: 1220 | Time Out: 1250

Unit No.: 110

Operator: Wm. Linton

Location: Lakewood, CO

EQUIPMENT DATA

T D Logged: 52 Feet

Natural Gamma: 200 Scale = 20 CPS per Inch

Time Constant: 2 Sec | Logging Speed: 15 Ft/Min

Calib Source No/Value: CPS

Probe No: 103- | Probe Diameter: 1 5/8"

Detector Type Size: xtal 3/4 x 1"

K Factor: 2.35 x 10^{-5} | Dead Time: 7 Microsec

Water Factor: 1.07 for hole size 3 Inch

Casing Factor: for wall thk

Resistance: 75 ohms/5" Ohms per 5 Inches

S.P.: 20 MV / Inch MV per Inch

NATURAL GAMMA RERUNS (ANALOG)
(Actual log off scale)

Scale = CPS/In	Scale = CPS/In	Scale = CPS/In	Scale = CPS/In
T C Sec / Logging Speed Ft/Min	T C Sec / Logging Speed Ft/Min	T C Sec / Logging Speed Ft/Min	T C Sec / Logging Speed Ft/Min
From Ft To Ft	From Ft To Ft	From Ft To Ft	From Ft To Ft
Total Ft	Total Ft	Total Ft	Total Ft

Gamma (Analog) Ft | Density Source No

Gamma (Digital) Ft | Type

Caliper Ft | CPS/Inch

Temperature Ft

DIRECTIONAL DATA

Closure Ft

Azimuth

True Vertical Ft | Survey Depth Ft

Neutron Source No

Type | Strength

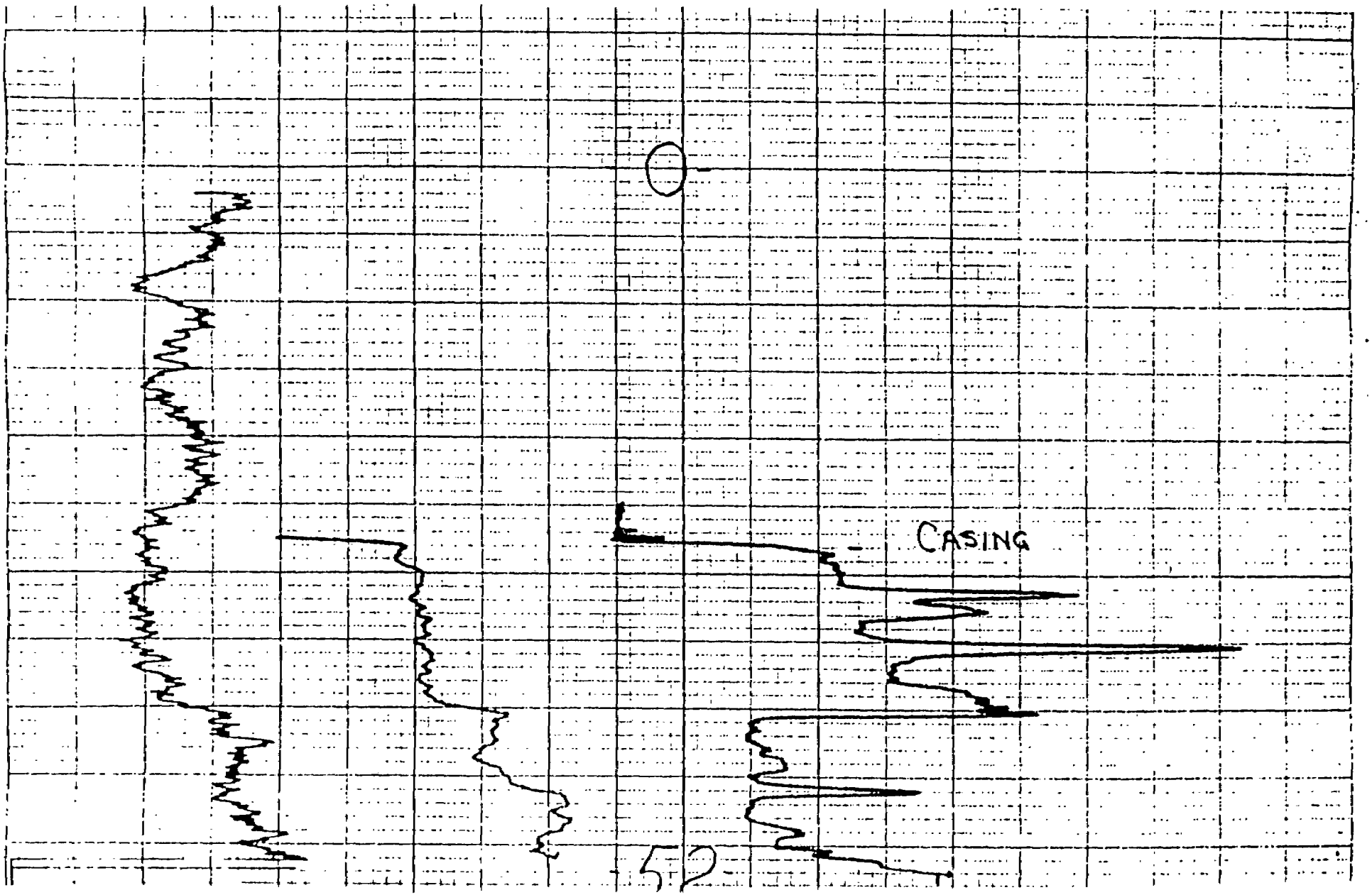
CPS/Inch

		True Vertical ft	Survey Depth ft	

NATURAL GAMMA
20 CPS
Initial Log

S.P.
20 MV

RESISTANCE
75 OHMS/ 5 Inches



LOGGING CORPORATION

FRONTIER LOGGING CORPORA.

NATURAL GAMMA

S.P. 20 MV/INCH

RESISTANCE 75 OHMS/5 INCHES

E 40 DENVER

GC 13142

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
7332 SOUTH ALTON WAY • SUITE H-1
ENGLEWOOD, COLORADO 80112 • 303/741-0839

WELL CONSTRUCTION SUMMARY

Borehole E40 DE, Well ~~37.8~~ JR 37372

Project Name and Location MW Installation - off post 96th Ave. Project Number

Drilling Company Boyles Driller B. Roach Rig Number TH-60

Drilling Method(s) Continuous core

Borehole Diameter 7 7/8 in. cm. 0 ft. cm. to 96.3 ft. cm.

in. cm. ft. cm. to ft. cm.

Size(s) and types of Bit(s) 7 7/8" OD

Size and Type PVC 4" schedule 40

Total Borehole Depth ~~315 ft.~~ 963 cm.

Depth to Bedrock 26 ft. cm.

Depth to Water 9 ft. cm.

Water Level Determined By visual

Length Plain PVC (total) ~~232 ft.~~ 73.04 cm.

Length of Screen 26.96 ft. cm.

Total Length of Well Casing ~~327.0 ft.~~ ~~99 ft.~~ cm. COG

PVC Stick Up 2.7 ft. cm.

Depth to Bottom of Screen 88.5 ft. cm.

Depth to Top of Screen 61.5 ft. cm.

Depth to Top of Sand 60.5 ft. cm.

Depth to Top of Bentonite 56 ft. cm.

Sampling Method(s) continuous core

Date/Time Start Drilling 1-23-87 1051

Date/Time Finish Drilling 1-29-87 1404

Date/Time Start Completion 2-3-87 0736

Date/Time Cement Protective Casing 2-4-87 1300

Materials Used 10 core boxes

Plain PVC 70.32 (7 : 10')

Slotted PVC 26.96 (2 : 10', 1 : 5')

Bentonite Pellets 4 buckets

Bentonite Granular 4 buckets

Cement ~~20~~ 26 bags

Sand 7 bags

Water added during completion —

Water added during drilling —

Total Gallons of water added —

Drill Site Geologist C. D. Benson Date 2-5-87

Date/Time/Personnel Internal Mortar, Cement Pad, and Weep Hole Installed 2/10/87 0930 JWF KWP

Date/Time/Personnel Casing Painted 2/10/87 1400 KWP

Date/Time/Personnel Numbers Painted 4/5/87 1100 JWF BAB

Materials Used 10 BAGS QUICKCRETE

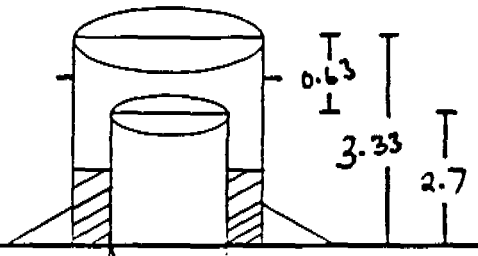
Top of Protective Casing to Top of PVC	0.63 ft.	cm.	COMMENT/NOTES
Top of Protective Casing to Weep Hole	1.91 ft.	cm.	
Top of Protective Casing to Internal Mortar	3.15 ft.	cm.	
Top of Protective Casing to Top of Cement Pad	2.35 ft.	cm.	
Top of Protective Casing to Ground Level	3.35 ft.	cm.	

Reviewed By Joseph L. Reed Date 6/11/87

Drill Site Geologist Date

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
7332 SOUTH ALTON WAY • SUITE H-1
ENGLEWOOD, COLORADO 80112 • 303/741-0839

Borehole: 40D Well: 37372

Depth-Feet	Soil/Rock Type	Well Completion	Description
			
5			
10			
15			
20			
25			
30			
35			
40			
45			
50			
55		56'	TOP OF BENTONITE
60		60.5'	TOP OF SAND
		61.5'	TOP OF SCREEN
65			
70			
75			
80			
85			
90		88.5' 90'	TOP OF SAND TOP OF BENTONITE PLUG
95		96.3'	Bottom of Hole

Drill Site Geologist: C D Benson Date: 2-5-87

Reviewed By: Joseph L. Reed Date: 7/9/87

ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
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ENGLEWOOD, COLORADO 80112 • 303/741-0639

WELL CONSTRUCTION SUMMARY

Borehole E42A Well 37369

Project Name and Location RMA Offsite Well Installation Project Number 1705804510

Drilling Company Boyles Bros Driller D. Jarvis Rig Number B57

Drilling Method(s) Continuous core

Borehole Diameter 12¼ in. ____ cm. 0.0 ft. ____ cm. to 25.26 ft. ____ cm.

____ in. ____ cm. ____ ft. ____ cm. to ____ ft. ____ cm.

Size(s) and types of Bit(s) 3¼" hollow stem auger Sampling Method(s) Continuous core

Size and Type PVC 4" Schedule 40

Total Borehole Depth 25.26 ft. ____ cm.

Depth to Bedrock 25.0 ft. ____ cm.

Depth to Water 5.0 ft. ____ cm.

Water Level Determined By Field Observed

Length Plain PVC (total) 6.68 ft. ____ cm.

Length of Screen 21.21 ft. ____ cm.

Total Length of Well Casing 27.89 ft. ____ cm.

PVC Stick Up 2.7 ft. ____ cm.

Depth to Bottom of Screen 25.26 ft. ____ cm.

Depth to Top of Screen 4.05 ft. ____ cm.

Depth to Top of Sand 3.0 ft. ____ cm.

Depth to Top of Bentonite 2.0 ft. ____ cm.

Date/Time Start Drilling 1/19/87 1115

Date/Time Finish Drilling 1/19/87 1289

Date/Time Start Completion 1/19/87 1402

Date/Time Cement Protective Casing 1/19/87 1545

Materials Used

Plain PVC 1-10'

Slotted PVC 2-10'

Bentonite Pellets 1 bucket

Bentonite Granular 5#

Cement 1 bag

Sand 13½ bags

Water added during completion 0

Water added during drilling 0

Total Gallons of water added 0

Drill Site Geologist D.A. Mannan Date 1/19/87

Date/Time/Personnel Internal Mortar, Cement Pad, and Weep Hole Installed ____

Date/Time/Personnel Casing Painted ____

Date/Time/Personnel Numbers Painted ____

Materials Used ____

Top of Protective Casing to Top of PVC ____ ft. ____ cm.

Top of Protective Casing to Weep Hole ____ ft. ____ cm.

Top of Protective Casing to Internal Mortar ____ ft. ____ cm.

Top of Protective Casing to Top of Cement Pad ____ ft. ____ cm.

Top of Protective Casing to Ground Level ____ ft. ____ cm.

COMMENT/NOTES

Reviewed By ____ Date ____

Drill Site Geologist ____ Date ____

ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
7332 SOUTH ALTON WAY • SUITE H-I
ENGLEWOOD, COLORADO 80112 • 303/741-0639

Borehole: E42A Well: 37369

Depth-Feet	Soil/Rock Type	Well Completion	Description
0		Gound Level	
2			Top of Bentonite (2.0)
3			Top of Sand (3.0)
4			Top of Screen (4.05) / Joint Water Level (5.0)
6			
8			
10			
12			
14			
16			
18			
20			
22			
24			
25.26			Bottom of Screen (25.26)

Drill Site Geologist: D.A. Meehan Date: 1/19/87

Reviewed By: _____ Date: _____

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SHEET 1 OF 3

Borehole: E42A Well Number: E42A 37369

Depth-Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
0.0	1, 0-2	2'	NA	0-2,	SC.	SC, clayey sand, 20% clay, 10yR 3/1 v. dark gray; med-stiff, med plast, moist Alluvium (Roots present 0-.4') -
2.0	1, 4-6	2'			SM	SM, silty sand, 30% silt, 10yR 3/4, dark yellowish b. med-dense, non-plast moist Alluvium
4.0	1, 6-8	2'				moisture increase to wet
5.0	1, 8-10	2'			SM	moisture change to sat at 5.0' (W.T.)
7.0	1, 12-14	2'				
9.0	1, 14-16	1.0'				
11.0	1, 16-18	.5'				

Drill Site Geologist: D.A. MEEHAN Date: 1/19/87

Reviewed By: W. Woodward Date: 1/20/87

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Borehole: E42A Well Number: E42A 37369

Depth-Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
11.0						
	E1-11	1.0'		11-12	SM	Silty SAND, 40% SILT, vfg SAND, 10YR 5/4 yellowish brn, med. dense, non-plast, SATURATED Alluvium
12.0						
	H1-G1	2.0'				
14						m-c.g SAND LENSE
	J1-H1	2.0'				
16						
	L1-J1	1.5'				
18						
	N2-L1	1.5' 1.5 SHF				
20						
	P2-N2	1' REC 1' SHF				
22						

Drill Site Geologist: D.H. MEEHAN Date: 11/19/87

Reviewed By: D Annicelli Date: 1/20/87

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SHEET 3 OF 3

Borehole: E45A Well Number: E45A 37369

Depth-Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
22					SM	SM, silty sand, 40% silt 10yR 3/4, dk yeash brn, loose, non-plast; saturated Alluvium
23	55-45 22-23	2.0'				
24		1.0'				
25					clayshale (?)	BEDROCK AT 25' END OF BORING
		1.0' SMUFF				1' sluff
26						~~HOLE~~ NDA SEEMED to 25' FOR WELL DEPTH w/ 10" I.D. H.S. Auger 8¼ ID Auger JLR

NDA

Drill Site Geologist: _____ Date: _____

Reviewed By: Donald L. Reid Date: 4/16/87

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
7332 SOUTH ALTON WAY • SUITE H-1
ENGLEWOOD, COLORADO 80112 • 303/741-0639

WELL CONSTRUCTION SUMMARY

Borehole E44A Well 37373

Project Name and Location KMA Offsite - CO 2 Project Number 1705304510

Drilling Company Boyles Bros Driller V. Jarvis Rig Number B57

Drilling Method(s) Continuous Core

Borehole Diameter 12 1/4 in. ____ cm. 0 ft. ____ cm. to 26 ft. ____ cm.
____ in. ____ cm. ____ ft. ____ cm. to ____ ft. ____ cm.

Size(s) and types of Bit(s) 3 1/4" + 12" DAM hollow stem auger

Size and Type PVC 4" schedule 80

Total Borehole Depth	25.7 ft. ____ cm.	Sampling Method(s)	Continuous Core
Depth to Bedrock	25 ft. ____ cm.	Date/Time Start Drilling	1/20/87 1038
Depth to Water	3 ft. ____ cm.	Date/Time Finish Drilling	1/20/87 1228
Water Level Determined By	Field observation	Date/Time Start Completion	1/20/87 1348
Length Plain PVC (total)	16.96 ft. ____ cm.	Date/Time Cement Protective Casing	1/20/87 1521
Length of Screen	21.40 ft. ____ cm.	Materials Used	7-4' TUBES 3 BOXES
Total Length of Well Casing	18.36 ft. ____ cm.	Plain PVC	1 - 10'
PVC Stick Up	2.7 ft. ____ cm.	Slotted PVC	2 - 10'
Depth to Bottom of Screen	25.7 ft. ____ cm.	Bentonite Pellets	1 1/2 buckets
Depth to Top of Screen	4.3 ft. ____ cm.	Bentonite Granular	10#
Depth to Top of Sand	3.3 ft. ____ cm.	Cement	1 bag
Depth to Top of Bentonite	2.0 ft. ____ cm.	Sand	13 1/2 bags
		Water added during completion	3 gal
		Water added during drilling	0
		Total Gallons of water added	3 gal

Drill Site Geologist D.A. Magnan Date 1/20/87 DAM

Date/Time/Personnel Internal Mortar, Cement Pad, and Weep Hole Installed 4/14/87 JWF

Date/Time/Personnel Casing Painted JWF BAG 4/15/87 1009

Date/Time/Personnel Numbers Painted JWF BAL 4/15/87 1009

Materials Used ____

Top of Protective Casing to Top of PVC	.76 ft. ____ cm.	COMMENT/NOTES	
Top of Protective Casing to Weep Hole	2.4 ft. ____ cm.		
Top of Protective Casing to Internal Mortar	2.4 ft. ____ cm.		
Top of Protective Casing to Top of Cement Pad	2.8 ft. ____ cm.		
Top of Protective Casing to Ground Level	3.5 ft. ____ cm.		

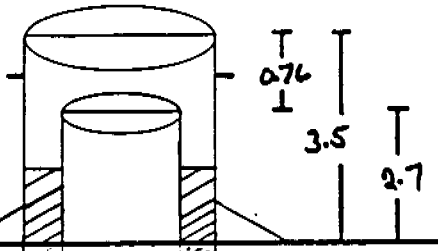
Reviewed By Joseph L. Reed Date 4/20/87

Drill Site Geologist ____ Date ____

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Borehole: 11A Well: 37373

Depth-Feet	Soil/Rock Type	Well Completion	Description
0		Gound Level	
2			Top of bentonite (2.0)
4			Top of sand (3.3) Water level (3.5) Top of screen (4.3) / Joint
6			
8			
10			
12			
14			
16			
18			
20			
22			
24			
25.7			Bottom of screen (25.7)
26			



Drill Site Geologist: D. Linda Mann Date: 4/20/87

Reviewed By: Joseph L. Reed Date: 4/20/87

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SHEET 1 OF 3

Borehole: SAA Well Number: SAA 3737B

Depth-Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
1	0-2	2'	NA	0-2	SC	SC, clayey sand, 20% clay, 10YR 3/1-2, V. dk gry to V. dk gry-brn, mod stiff, sl plas, moist, alluvium, roots present in top 0.3'
2	2-4	1'	NA	2-4	SM	SM, silty sand, 40% silt, 10YR 4/4-6, dk yosh brn, med dense, non plas, moist, alluvium
3						At 3.0' sample is wet
4	4-6	2'		4-6		At 4.0' sample is sat, water level approximated @ 3.5'
5						
6	6-8	2'		6-8		
7			NA		SC	SC, clayey sand, 30% clay, 10YR 4/4-6, dk yosh brn, mod stiff, plas, sat, alluvium
8	8-10	2'	NA	8-10	SM	SM, silty sand, 30% silt, 10YR 4/4-6, dk yosh brn, med dense, non plas, sat, alluvium
9						
10	10-12	1/2'	NA	10-12	SW	At 10' water changes to DAM SW, coarse sand, few fines, 10YR 5/4-6, yosh brn, loose, non plas, sat, alluvium
11						

Drill Site Geologist: D.A. Meeuwsen Date: 1/21/87 Drill

Reviewed By: D. A. Meeuwsen Arnold K. Reed Date: 1/22/87 Mtlg 4/16/87

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
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Borehole: 744A Well Number: 744A 37373

Depth-feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
11			NA		SW	SW as above
12	12-14	1'		12-14		
13						
14	14-16	1'		14-16		
15						
16	16-18	1/2'		16-18		At 16' sand is coarse w/ occ gravel
17						
18	18-20	0		18-20		
19						
20	20-22	1'		20-22		
21						
22						

Drill Site Geologist: D. A. Illegnan Date: 1/21/87

Reviewed By: D. A. Illegnan Joseph L. Reed Date: 1/22/87 4/14/87

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
7532 SOUTH ALTON WAY • SUITE H-I
ENGLEWOOD, COLORADO 80112 • 303/741-0839

SHEET 3 OF 3

Borehole: L 44A Well Number: 2144A 37373

Depth - feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
22	22-24	1'	NA	22-24	SW	SW as above
23						
24	24-26	2	NA	24-26	CS	CS, bedrock, claystone, weathered, 10YR 5/6-8, yellowish brn
25						
26						End of boring log

Drill Site Geologist: D.H. Heaman Date: 1/21/87

Reviewed By: D.H. Heaman Joseph Reed Date: 1/22/87 4/16/87

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
7332 SOUTH ALTON WAY • SUITE H-I
ENGLEWOOD, COLORADO 80112 • 303/741-0639

WELL CONSTRUCTION SUMMARY

Borehole E-44-081 Well 37398

Project Name and Location RMA Monitor Well Install. Project Number T39

Drilling Company Boyle Bros Driller Tom High Rig Number Mobile B-61

Drilling Method(s) 3¼" ID 6½" OD Hollow stem auger with Moss sampler, then reamed with 12¼" OD Hollow stem Auger with center bit

Borehole Diameter 6½ in. ____ cm. 0 ft. ____ cm. to 24.0 ft. ____ cm.

Reamed 12¼ in. ____ cm. 0 ft. ____ cm. to 25.0 ft. ____ cm.

Size(s) and types of Bit(s) 6½" OD + 12¼" OD Auger bits

Size and Type PVC 2" sch 40 .020 slot

Total Borehole Depth	25.0 ft.	____ cm.	
Depth to Bedrock	23.7 ft.	____ cm.	
Depth to Water	2.2 ft.	____ cm.	
Water Level Determined By	measuring to surface		
Length Plain PVC (total)	6.11 ft.	____ cm.	
Length of Screen	20.29 ft.	____ cm.	
Total Length of Well Casing	26.40 ft.	____ cm.	
PVC Stick Up	2.70 ft.	____ cm.	
Depth to Bottom of Screen	23.70 ft.	____ cm.	
Depth to Top of Screen	3.41 ft.	____ cm.	
Depth to Top of Sand	2.50 ft.	____ cm.	
Depth to Top of Bentonite	1.50 ft.	____ cm.	

Sampling Method(s) Continuous - Moss System

Date/Time Start Drilling 3/22/88 1042

Date/Time Finish Drilling 3/23/88 1048

Date/Time Start Completion 3/23/88 1123

Date/Time Cement Protective Casing 3/23/88 1440

Materials Used ~~3/23/88 1048~~ SP

Plain PVC 1 - 10' sect. (wt)

Slotted PVC 2 - 10' sections, 1 end cap, 1 typical

Bentonite Pellets 1 bucket

Bentonite Granular ½ bag

Cement 2 bags

Sand 14 bags

Water added during completion 0

Water added during drilling 50 gal

Total Gallons of water added 50 gal

Drill Site Geologist [signature] Date 4/1/88

Date/Time/Personnel Internal Mortar, Cement Pad, and Weep Hole Installed 3/25/88 1330 BW&RR

Date/Time/Personnel Casing Painted 3/25/88 1400 BW&RR

Date/Time/Personnel Numbers Painted 3/25/88 1530 BW&RR

Materials Used 12 bags of Sakrete

Top of Protective Casing to Top of PVC	0.38 ft.	____ cm.	COMMENT/NOTES
Top of Protective Casing to Weep Hole	2.38 ft.	____ cm.	
Top of Protective Casing to Internal Mortar	2.40 ft.	____ cm.	
Top of Protective Casing to Top of Cement Pad	2.5 ft.	____ cm.	
Top of Protective Casing to Ground Level	2.7 ft.	____ cm.	

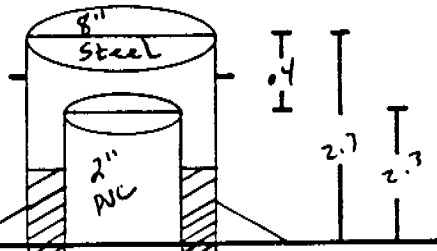
Reviewed By [signature] Date 4.8.88

Drill Site Geologist [signature] Date 4-8-88

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
7332 SOUTH ALTON WAY • SUITE H-I
ENGLEWOOD, COLORADO 80112 • 303/741-0639

Borehole: EPA E-44-081 Well: 37398

Depth-Feet	Soil/Rock Type	Well Completion	Description



Grout from 0-1.5'
1.5' TOP of bentonite
2.51' TOP of SAND
3.41' TOP OF Screen
23.7' Bottom of Screen Top of Bedrock
25.0' TOTAL DEPTH

Drill Site Geologist: S. Low Date: 4.1.88
Reviewed By: [signature] Date: 4-8-88

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
7332 SOUTH ALTON WAY • SUITE H-1
ENGLEWOOD, COLORADO 80112 • 303/741-0839

Borehole: E-44 OB-1 Well Number: OB-1 37398

Depth - Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
0	0 [2	.4/2		0 ↓ 2	SC	Clayey Sand, 35% clay 10YR 3/2 very dark grayish brn, fine to medium sand moist, low plastic, med stiff
2	2 1 4	1.9/2.0		SS 2 ↓ 4	SM	SM/silty sand fine to medium, 20% silt 10YR 3/3 dark brown, low plastic, soft, very moist b-
4	4 ↓ 6	1.7/2		4 ↓ 6		Saturated at 4' Same as above
6	6 SC 8	2/2		6 ↓ 8	SC	SS ~~Sandy~~ clayey Sand, fine to coarse, 30% clay 2.5Y/5/2-4 light olive-grayish brn, med plastic soft
8	8 ↓ 10	2/2		8 ↓ 10		From 9.5 to 10' interbedded with thin lenses of fine to medium sands

Drill Site Geologist: [signature] Date: 4-15-88

Reviewed By: [signature] Date: 4/20/88

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
7332 SOUTH ALTON WAY • SUITE H-1
ENGLEWOOD, COLORADO 80112 • 303/741-0839

SHEET 1 OF 3

Borehole: F-114 OB-1 Well Number: OB-1 37398

Depth-Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
10						
10	10		10	10	SP	Sand fine to medium, 10% silt, 10YR 6/8 brownish yellow, saturated, loose non plast.
11		1.5/2				
			12	12		
12	12					
	12			12		
13		1/2				
	14			14		
14						NO Recovery 14 feet to 19.4 feet flowing sands
	14			14		
15		0/2		6		
				16		
16	16					
	16			16		
17		0/2		18		
18	18					
		1/2		18		
19						19
					SP	Sand-fine to medium 2.5Y 5/4 light olive brown, saturated, loose
20	20			20		

Drill Site Geologist: [signature] Date: 4-15-88

Reviewed By: [signature] Date: 4/20/88

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
7332 SOUTH ALTON WAY • SUITE H-I
ENGLEWOOD, COLORADO 80112 • 303/741-0839

Borehole: E-44 OB-1 Well Number: 37398

Depth-Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
20	20	2/4		20	SP	Same as above
21						
22	22 / 24					
23						
23.7	24			24		23.6 Bedrock = Claystone weathered 2.5Y 6/6 olive yellow

Drill Site Geologist: [signature] Date: 4.15.88

Reviewed By: [signature] Date: 4/20/88

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
7332 SOUTH ALTON WAY • SUITE H-I
ENGLEWOOD, COLORADO 80112 • 303/741-0839

WELL CONSTRUCTION SUMMARY

Borehole E-44 OB-2 Well 37399

Project Name and Location RMA OFFPOST SECT. 14 Project Number TASK 59

Drilling Company Boyles Bros. Driller Tom Night Rig Number B-61 Auger rig

Drilling Method(s) Auger w/ Moss System in 6¼" OD. Hollow Stem Augers, then ream hole w/ 12" O.D. auger.

Borehole Diameter 12 in. ____ cm. 0 ft. ____ cm. to 24 ft. ____ cm.

____ in. ____ cm. ____ ft. ____ cm. to ____ ft. ____ cm.

Size(s) and types of Bit(s) 6¼" OD. hollow stem auger, 12" O.D. auger.

Size and Type PVC 2" Sch. 40

Total Borehole Depth 24 ft. ____ cm.

Depth to Bedrock 22.8 ft. ____ cm.

Depth to Water 2.4 ft. ____ cm.

Water Level Determined By Solinst water level meter.

Length Plain PVC (total) 6.42 ft. ____ cm.

Length of Screen 20.28 ft. ____ cm.

Total Length of Well Casing 26.70 ft. ____ cm.

PVC Stick Up 2.65 ft. ____ cm.

Depth to Bottom of Screen 24.05 ft. ____ cm.

Depth to Top of Screen 3.77 ft. ____ cm.

Depth to Top of Sand 2.1 ft. ____ cm.

Depth to Top of Bentonite 0.5 ft. ____ cm.

Sampling Method(s) Moss System w/ hollow stem Au

Date/Time Start Drilling 3-24-88 / 0940

Date/Time Finish Drilling 3-24-88 / 1324

Date/Time Start Completion 3-24-88 / 1403

Date/Time Cement Protective Casing 3-24-88 / 1500

Materials Used 8" Surface casing.

Plain PVC (1) 10 ft. section

Slotted PVC (2) 10 ft. sections

Bentonite Pellets ½ bucket

Bentonite Granular N/A

Cement 2 bags.

Sand 12 bags

Water added during completion 0

Water added during drilling 50 gal

Total Gallons of water added 50 gal

Drill Site Geologist [signature] Date 3/25/88

Date/Time/Personnel Internal Mortar, Cement Pad, and Weep Hole Installed 3/25/88 1430 BW & RR

Date/Time/Personnel Casing Painted 3/25/88 1500 BW & RR

Date/Time/Personnel Numbers Painted 3/25/88 1530 BW & RR

Materials Used 12 bags sacrete

Top of Protective Casing to Top of PVC 0.53 ft. ____ cm.

Top of Protective Casing to Weep Hole 2.29 ft. ____ cm.

Top of Protective Casing to Internal Mortar 2.38 ft. ____ cm.

Top of Protective Casing to Top of Cement Pad 2.67 ft. ____ cm.

Top of Protective Casing to Ground Level 3.18 ft. ____ cm.

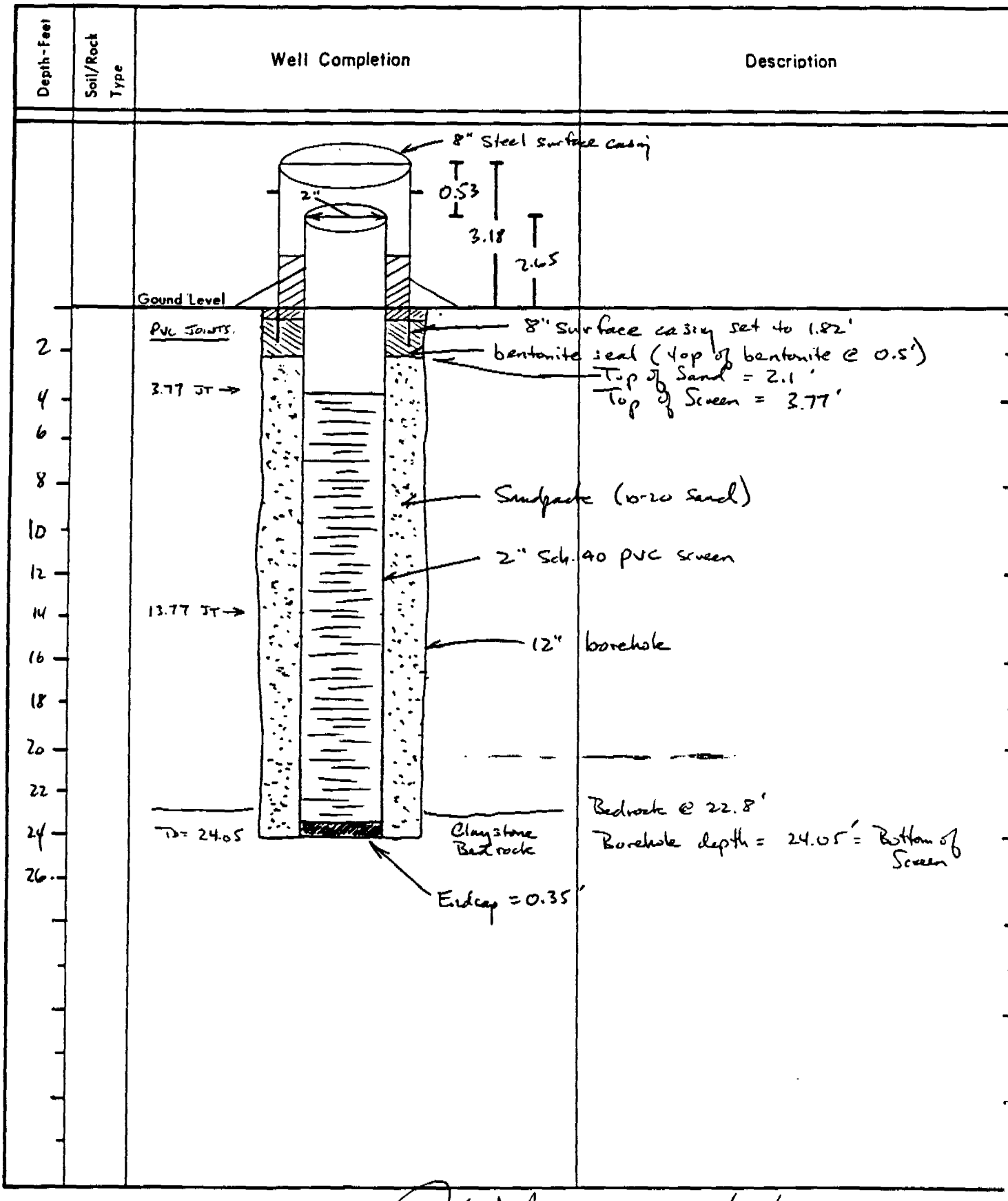
COMMENT/NOTES

Reviewed By [signature] Date 3/27/88

Drill Site Geologist [signature] Date 3/25/88

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
7332 SOUTH ALTON WAY • SUITE H-1
ENGLEWOOD, COLORADO 80112 • 303/741-0839

Borehole: E-44 08-2 Well: 37397



Drill Site Geologist: [signature] Date: 3/25/88

Reviewed By: [signature] Date: 3/27/88

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
7392 SOUTH ALTON WAY • SUITE H-1
ENGLEWOOD, COLORADO 80112 • 303/741-0639

Borehole: E-44082 Well Number: 37399

Depth-Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
		1.5/2.0			SC	clay SAND, 30% clay, fine to medium grained sand, 10YR 3/3, dark brown, moist, low plastic, medstiff
2		1.6/2.0			SM	Silty SAND, 30% silt, fine to medium grained SAND 10YR 3/3 dark brown, saturated, non plastic
					SC	Clayey SAND, 25% clay, fine to medium grained sand 10YR 3/3 dark brown, saturated, low plastic
4		1.0/2.0				
6		2.0/2.0			SC	Clayey SAND, 35% clay, fine to coarse grained sand, 10YR 4/3 brown, moist, stiff, medium plastic
8						No recovery 8' to ~~18~~ SP 20'
10						

Drill Site Geologist: [signature] Date: 3/25/88

Reviewed By: [signature] Date: 3/27/88

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
7332 SOUTH ALTON WAY • SUITE H-I
ENGLEWOOD, COLORADO 80112 • 303/741-0839

Borehole: E44082 Well Number: 37399

Depth-Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
10						No Recovery 8 to 20'
12						
14						
16						
18						
20						

Drill Site Geologist: [signature] Date: 3/25/88

Reviewed By: [signature] Date: 3/27/88

& Lozaad

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
7332 SOUTH ALTON WAY • SUITE H-I
ENGLEWOOD, COLORADO 80112 • 303/741-0839

Borehole: E-44 DB2 Well Number: 37399

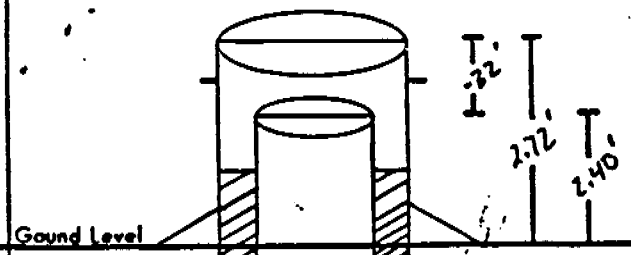
Depth - Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
20					SP	SAND, 3% silt, medium to very coarse grained 10YR 6/4 brownish yellow, saturated, loose
22						22.
					22.8'	sandstone bedrock, fine grained, silty, 2.5Y 5/4, light olive brown, weathered.
24						TOTAL DEPTH 24.0'

Drill Site Geologist: [signature] Date: 3/25/88

Reviewed By: [signature] Date: 3/27/88

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
7332 SOUTH ALTON WAY • SUITE H-1
ENGLEWOOD, COLORADO 80112 • 303/741-0626

Borehole: E-96A Well: E-46A-1 37377

Depth-Feet	Soil/Rock Type	Well Completion	Description
			

17.8 Top of Bentonite

21.7 Top of SAND

22.68 Top of Screen

27.5 H_2O level

38.90 Bottom of Screen
39.50 Bottom of Hole

Drill Site Geologist: Guy LA Date: 3/9/87

Reviewed By: Joseph L. Reed Date: 9/23/87

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
7332 SOUTH ALTON WAY • SUITE H-I
ENGLEWOOD, COLORADO 80112 • 303/741-0630

WELL CONSTRUCTION SUMMARY

Borehole E-46A Well E-46A-1 37377

Project Name and Location Task 26 ¼ mile N ¼ mile E of Former 903 Project Number 17055.074.10

Drilling Company Boyles Bros Driller Dave Jarvey Rig Number

Drilling Method(s) Auger

Borehole Diameter 12¼ in. cm. 0 ft. cm. to 39.5 ft. cm.
in. cm. ft. cm. to ft. cm.

Size(s) and types of Bit(s)

Size and Type PVC 4" Screen .020

Total Borehole Depth	39.5 ft. cm.	Sampling Method(s)	no sampling
Depth to Bedrock	39.5 ft. cm.	Date/Time Start Drilling	3/6/87 11:30
Depth to Water	27.5 ft. cm.	Date/Time Finish Drilling	3/6/87 1400
Water Level Determined By	Previous Boring	Date/Time Start Completion	3/6/87 1400
Length Plain PVC (total)	25.4 ft. cm.	Date/Time Cement Protective Casing	3/10/87 10:00
Length of Screen	16.25 ft. cm.	Materials Used	
Total Length of Well Casing	41.65 ft. cm.	Plain PVC	3 - 10' sections
PVC Stick Up	≈2.7 ft. cm.	Slotted PVC	1-10' 1-5'
Depth to Bottom of Screen	38.90 ft. cm.	Bentonite Pellets	4 Buckets
Depth to Top of Screen	22.68 ft. cm.	Bentonite Granular	0
Depth to Top of Sand	21.7 ft. cm.	Cement	10 Bags ABANDONED HOLE 30 BAGS
Depth to Top of Bentonite	17.8 ft. cm.	Sand	8 BAGS
		Water added during completion	0 Back to Surface Treatment
		Water added during drilling	0
		Total Gallons of water added	0 5.0

Drill Site Geologist Greg Lukas Date 3/4/87

Date/Time/Personnel	Internal Mortar, Cement Pad, and Weep Hole Installed	[Internal mortar & Cement Pad] 4/8/87/0930/K. Pacheco, M. Westcott
Date/Time/Personnel	Casing Painted	4/9/87/1100 K. Pacheco, M. Westcott
Date/Time/Personnel	Numbers Painted	4/15/87 1031 JWF BAG
Materials Used	12 bags quickrete cement, [¼ portland cement, ½ bag silica sand mortar]	

			COMMENT/NOTES
Top of Protective Casing to Top of PVC	0.32 ft.	cm.	
Top of Protective Casing to Weep Hole	1.5 ft.	cm.	
Top of Protective Casing to Internal Mortar	1.19 ft.	cm.	
Top of Protective Casing to Top of Cement Pad	2.72 ft.	cm.	
Top of Protective Casing to Ground Level	2.72 ft.	cm.	

Reviewed By Joseph L. Reed Date 4/23/87

Drill Site Geologist Date

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
7332 SOUTH ALTON WAY • SUITE H-I
ENGLEWOOD, COLORADO 80112 • 303/741-0839

Borehole: E-46A Well Number: 37377

Depth-Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
						MUNSELL COLORS
0.0	0-2'	1'	NA	0-2'	ML	ML Sandy-silt, 30-35% f. gr. sand, 10YR 5/2-3, grysh brn., non-plas. loose, dry, alluvium.
1.0						
2.0						
2.6	2-4'	1.6'		2-4'		At 2.6' color changes to 10YR 5/3-4, brn.,
3.0						moisture increases to slightly moist.
4.0						
5.0	4-5.5'	1.5'		4-5.5'		At 5.0' color changes to 10YR 5/4-6, grysh brn.,
5.5						natural density increases to med. dense.
6.0	5.5-6.5'	1'		~~5.5-6.5'~~		
6.5						At 6.5' percent f.g. calc. sand increases to ~15%,
7.0	6.5-8.5'	2'		6.5-8.5'		color changes to 10YR, 6/4-6, light grysh. brn.
8.0						
8.5						
9.0	8.5-12.5	4'		8.5-13.5		
10.0						
11.0						

Drill Site Geologist: A.R. Ortiz Date: 3/12/87

Reviewed By: Joseph L. Reed Date: 4/16/87

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
7332 SOUTH ALTON WAY • SUITE H-I
ENGLEWOOD, COLORADO 80112 • 303/741-0839

Borehole: E-46A Well Number: 37377

SOILS LOG

Depth-Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	Description
						Munsell Colors
11.0	8.5-12.5'	4'	NA	8.5-13.5'	ML	At 11.0', percent f.gr. calc. sand decreases to ~5%.
12.0						
12.5	12.5-13.5'	1'		SW		
13.0						
13.5	13.5-17.5'	3'		13.5-18'		
14.0						
15.0						
16.0					SM	SM silty-sand, ~30% silt, 10YR 4/4-6, dk. yush brn., non-plas, loose, moist alluvium.
17.0	17-18'	1'		SP		
18.0	18-21'	2.2'		18-22'		
19.0					ML	ML sandy-silt, ~15-20% v.f.gr. sand, 10YR, 5/3-4, brn., non-plas, loose, moist, alluvium
20.0						
21.0	21-22'	1'		SP		
22.0						

Drill Site Geologist: [signature] Date: 3/12/87

Reviewed By: Joseph L. Reed Date: 4/16/87

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
7332 SOUTH ALTON WAY • SUITE H-I
ENGLEWOOD, COLORADO 80112 • 303/741-0839

Borehole: E-46A Well Number: 37377

Depth-Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
22.0	22 - 23.5'	1.5'	NA	22 - 23.5'	ML	Munsell Colors
23.0						
23.5	23.5 - 27.5'	2.3'		23.5 - 28.5'		
24.0						
25.0						
26.0						
27.0						
27.3					SM	SM silty-sand, ~15-20% silt, 10 YR 6/3-4, light yrsh brn, non-plas, loose, wet, alluvium. WT @ 27.8
27.5	27.5-28.5	1'				At 27.8, percent silt decreases to 2-3%, 95% coarse gr. sand, moisture increases to saturated. SP or SW?
28.0 27.8						
28.5						
29.0	28.5 - 32.5'	1'		28.5 - 32.5		
30.0						
31.0						
32.0						~~At 32.0 abr change to 10 YR 6/2, light brownish yellow~~ ~~SW~~
32.5	32.5 - 34	0.5'		32.5 - 34		
33.0						

Drill Site Geologist: [signature] Date: 3/12/87

Reviewed By: Joseph L. Reed Date: 4/16/87

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
7332 SOUTH ALTON WAY • SUITE H-I
ENGLEWOOD, COLORADO 80112 • 303/741-0839

Borehole: E461 Well Number:

Depth – Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
						Munsell Colors
33.0	32.5-34	0.5'	NA	32.5-34	SM	
34.0						At 34.0', color changes to 10YR, 6/2, light brnish. gy.
35.0	34-37	1'		34-39		
36.0						
37.0						At 37.0', color changes to 10YR, 5/3-4, brn.
38.0	37-39	0.6'				
39.0						NO RECOVERY
40.0	39-42	0'		39-42		AUGER LOSS
41.0						
42.0						At 42.5' natural density changes to v. dense, fine to
42.5	42-42.8	0.8'		42-42.8		med. gr. sandstone / bedrock
42.8						END OF BORING LOG
43.0						ASD
44.0						

Drill Site Geologist: Date: 3/12/87

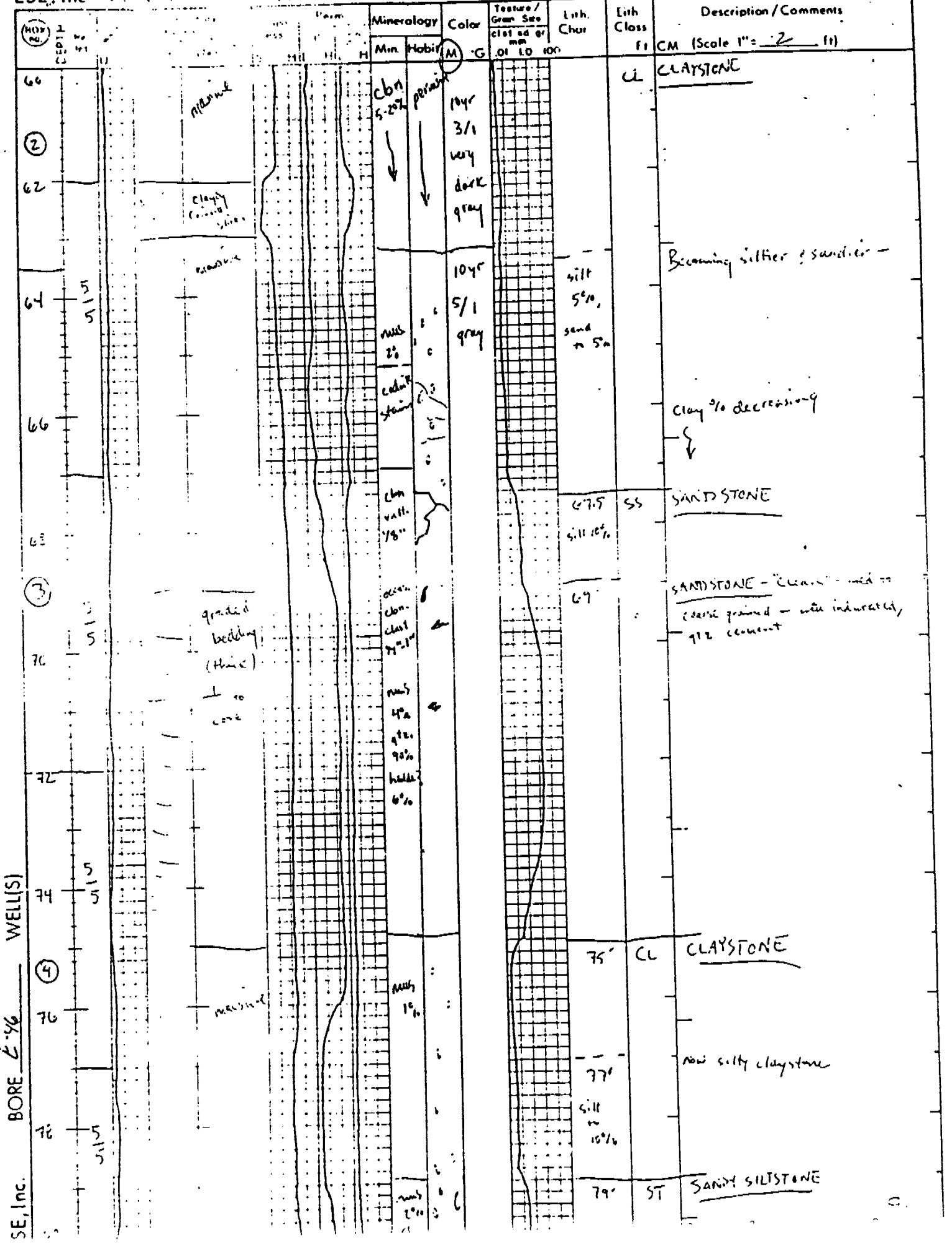
Reviewed By: Joseph L. Reed Date: 4/16/87

ESE, Inc. CORE LOG By CDB Date 4-21-87 BORE E-46 Well(s) _____ Page 1 of 4

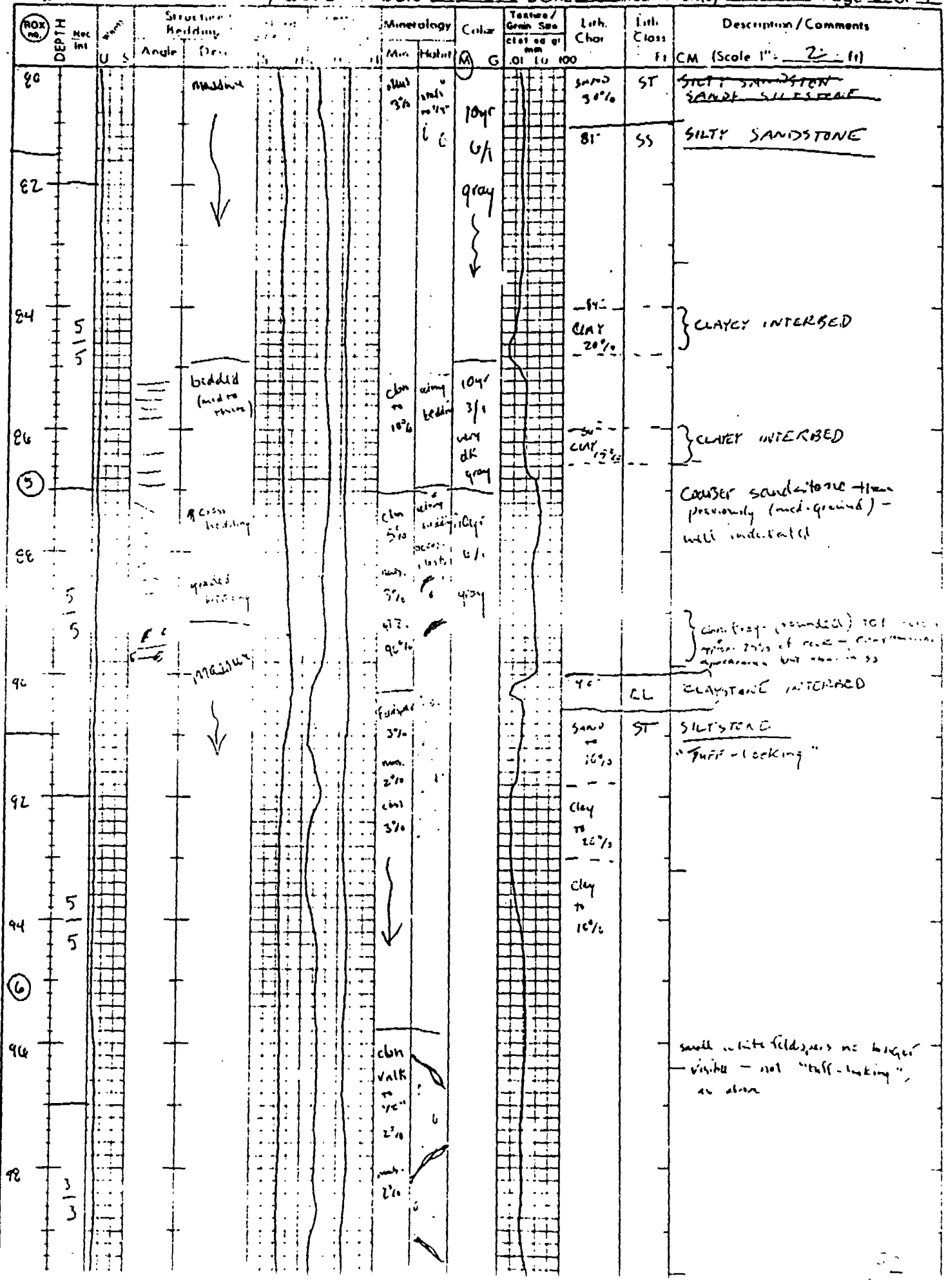
BOX no.	DEPTH	Rec. Int	Recovery U	Recovery S	Structure/Bedding Angle	Structure/Bedding Desc.	Hardness S	Hardness H	Perm. 1° L	Perm. 1° H	Perm. 2° L	Perm. 2° H	Mineralogy Min.	Mineralogy Habit	Color M	Color G	Texture/Grain Size clst sd gr mtx .01 1.0 100	Lith. Chor.	Lith. Class Ft	Description/Comments CM (Scale 1"= 2 ft)
	40																			BEGIN SAMPLING AT 41' — SEE SOILS LOG FOR 0-41' Geology
																			CL	CLAYSTONE
	42																			
		4				Rigid brit							Lim + hem	SM fracs	10yr	7/1				
	44	5														gray				
																				45' Approx. oxidation boundary
	46																			
						Fracs. abundant									10yr	5/1				
	48	(1)														gray				
		1.6																		
		5																		
	50																			
						Silt ~1"														
		2.3																		
	52	3				Rigid brit														
													Cl		o	o				
													mnrls 42%		o	o				
															o	o				
																				53' sand/silt to 5%
	54																			SILTSTONE
		5																	54	2' of recovery from upholes
		3																	ST	Clay up to 18%, sand up to 10%
		1.5																		
	56												clay 2%							
		(2)																		
													Foss (lim)							
	58																			
		4.2																		
		5																	59	CL CLAYSTONE

BORE E-46 WELL(S)

ESE, Inc.


Mineralogy
Min.
Habit
Color
M
G
Texture / Grain Size
clay sd gr
mm
.01 1.0 100
Lith. Char
Lith Class
Description / Comments
CM (Scale 1" = 2 ft)
CLAYSTONE
Becoming siltier & sandier
Clay % decreasing
SANDSTONE
SANDSTONE - "clean" med to coarse grained - with interbedded, grn cement
CLAYSTONE
now silty claystone
SANDY SILTSTONE
BORE E-46
WELL(S)
ESE, Inc.

ESE, Inc. CORE LOG by CDB Date 4-20-81 BORE E-16 Well(s) _____ Page 3 of 4



Lakewood, Colorado

Date APRIL 17, 1987

Company: ESE	Driller Depth: 116 Ft	Miles Round Trip:	
Bore Hole: E-46	Bit Size: 3 7/8"	Standby:	
Area/Project: RMA	Casing Depth: PVC to 41 Ft	Time In: 0750	Time Out: 0815
County: ADAMS COUNTY	Fluid in Hole: Native mud	Unit No.: 110	
State: COLORADO	Density/Viscosity:	Rm:	Operator: Wm. Linton
Section:	Township:	Range:	Elevation:
	Log Measured From: Ground Level	Drilling Measured From: Ground Level	Location: Lakewood

BOREHOLE DATA

T.D. Logged: 114 Ft

Natural Gamma: 200 Scale = 20 CPS per Inch

Time Constant: 2 Sec | Logging Speed: 15 Ft/Min

Cable Source No/Value: CPS

Probe No: 103-1041 | Probe Diameter: 1 5/8"

Detector Type - Size: xtal 3/4 x 1 1/4"

K Factor: 1.60 X 10^{-8} | Dead Time: 7 Microsec

Water Factor: 1.10 for hole size 3 7/8"

Casing Factor: for well bo

Resistance: 20 ohms/5" Ohms per 5 Inches

S.P.: 15 MV/Inch MV per Inch

NATURAL GAMMA (ANALOG) (dotted log off scale)

Scale = CPS/in	Scale = CPS/in	Scale = CPS/in	Scale =
T.C. Sec / Logging Speed Ft/Min	T.C. Sec / Logging Speed Ft/Min	T.C. Sec / Logging Speed Ft/Min	T.C. Sec / Logging Speed
From Ft To Ft	From Ft To Ft	From Ft To Ft	From Ft To Ft
Total Ft	Total Ft	Total Ft	Total

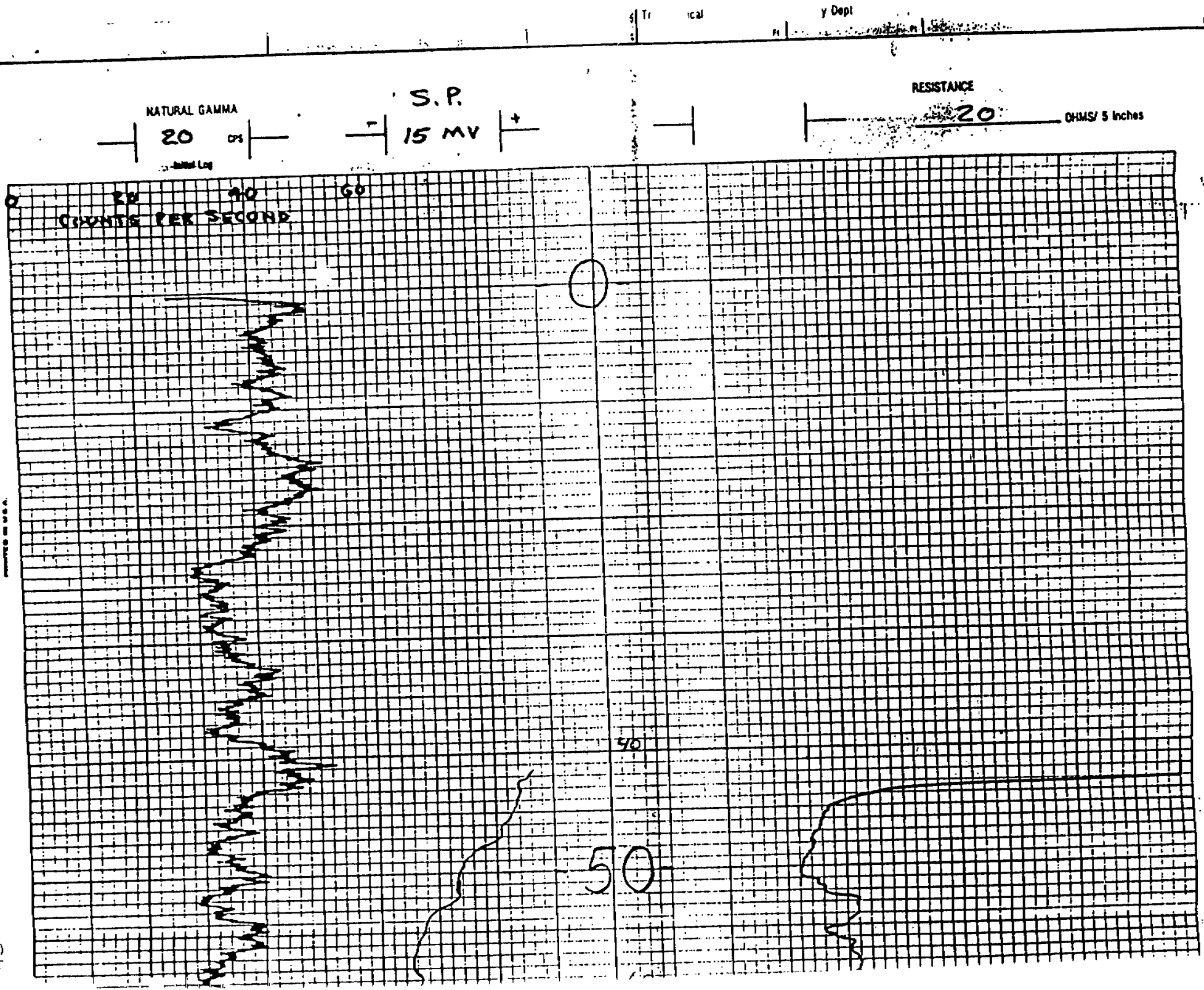
Gamma (Analog) Ft	Density Source No
Gamma (Digital) Ft	Type / Strength
Caliper Ft	CPS/Inch
Temperature Ft	
DIRECTIONAL DATA	Neutron Source No
Closure Ft	Type / Strength
Azimuth	CPS/Inch
True Vertical / Survey Depth	

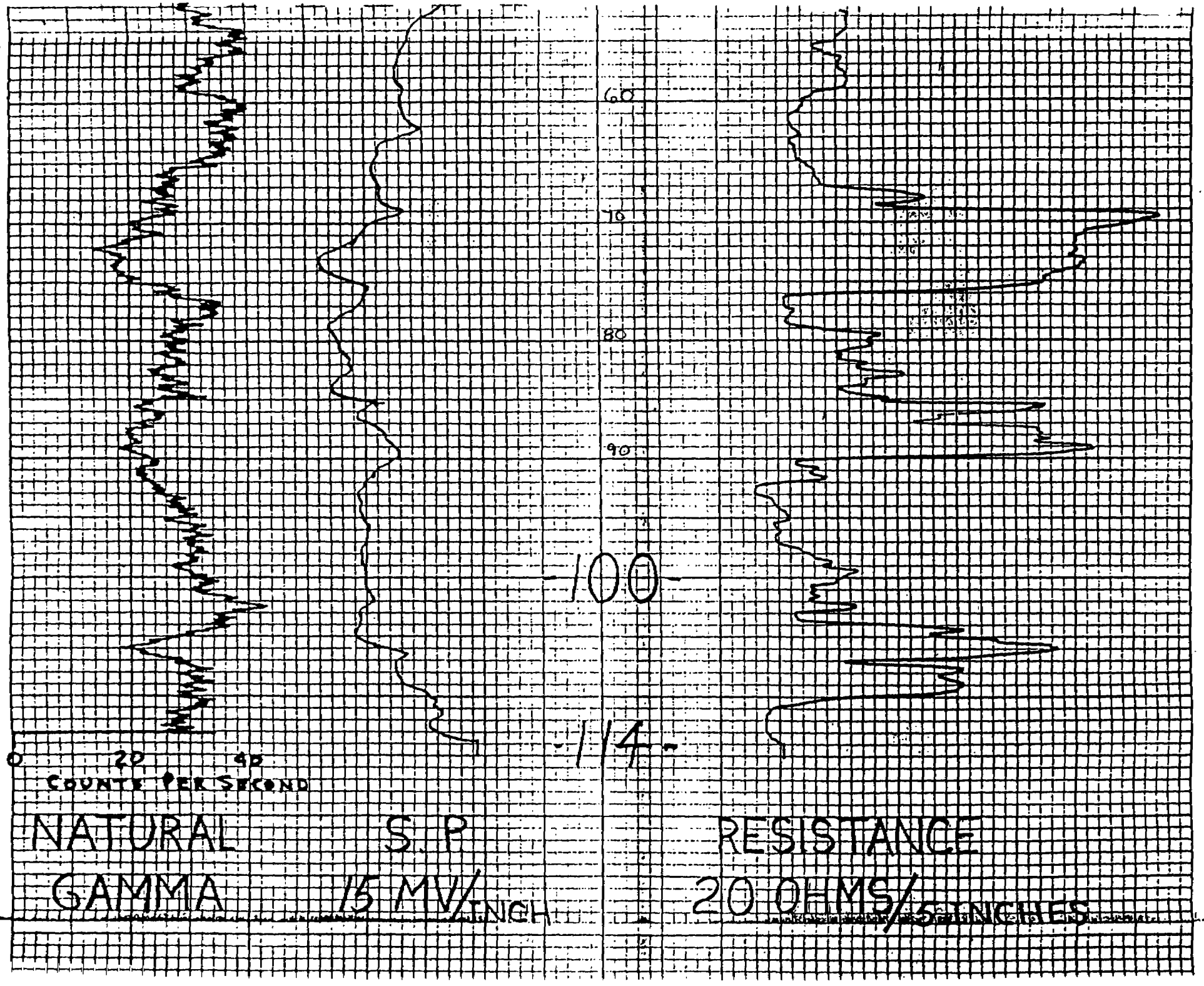
NATURAL GAMMA — 20 CPS — (Dotted Log)

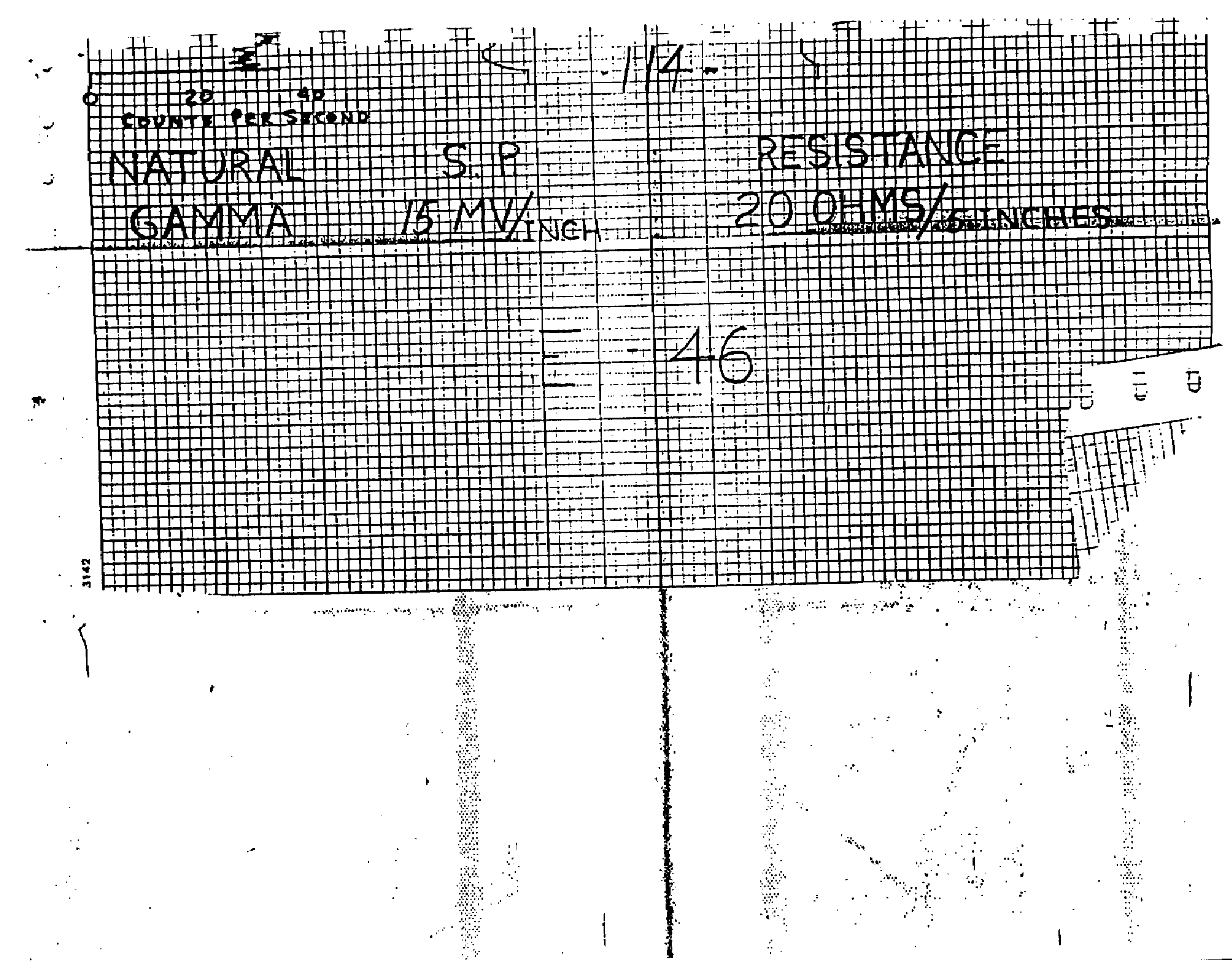
S.P. — − 15 MV +

RESISTANCE — 20 OHMS/ 5 Inches

0 20 40 60
COUNTS PER SECOND


NATURAL GAMMA
20 CPS
S.P.
15 MV
RESISTANCE
20
OHMS/ 5 Inches
0
20
40
60
COUNTS PER SECOND
0
40
50


FRONTIER LOGGING CORPORATION
60
70
80
90
100
110
0
20
40
COUNTS PER SECOND
NATURAL GAMMA
S. P
15 MV/INCH
RESISTANCE
20 OHMS/5 INCHES

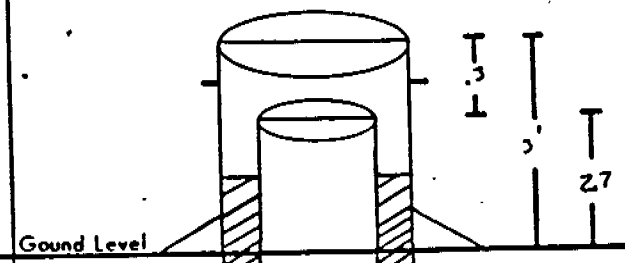

20
40
COUNTS PER SECOND
NATURAL GAMMA
S.P.
15 MV/INCH
114
RESISTANCE
20 OHMS/INCHES
46
3142

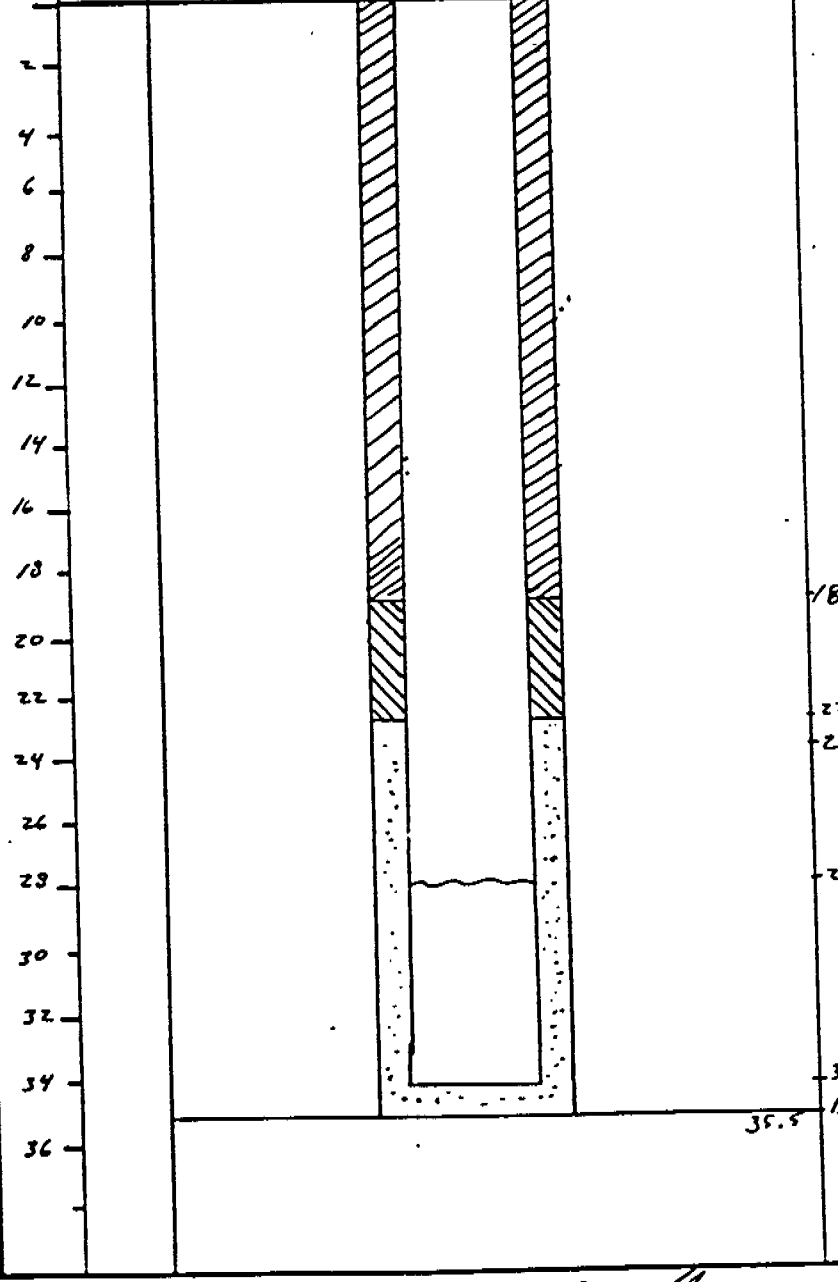
ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
7332 SOUTH ALTON WAY • SUITE H-I
ENGLEWOOD, COLORADO 80112 • 303/741-0839

Borehole: E-47A

Well: E-47A 37378 JR

Depth-Feet	Soil/Rock Type	Well Completion	Description





Drill Site Geologist: Gary Hall Date: 3/5/87

Reviewed By: Joseph L. Reed Date: 4/20/87

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7332 SOUTH ALTON WAY • SUITE H-I
ENGLEWOOD, COLORADO 80112 • 303/741-0839

WELL CONSTRUCTION SUMMARY

Borehole E-47A Well E-47A 37378

Project Name and Location ½ mile N, ½ mile E of Prospect & 96th St Project Number 17053.074.10

Drilling Company Boyles Bros Driller Dave Travis Rig Number

Drilling Method(s) Auger

Borehole Diameter 12¼ in. cm. 0 ft. cm. to 35.5 ft. cm.
in. cm. ft. cm. to ft. cm.

Size(s) and types of Bit(s)

Size and Type PVC 4" Screen .020

Total Borehole Depth	35.5 ft. cm.	Sampling Method(s)	Continuous Split Spoon
Depth to Bedrock	35.0 ft. cm.	Date/Time Start Drilling	3/5/87 0830
Depth to Water	28.0 (was 23.0) ft. cm.	Date/Time Finish Drilling	3/5/87 1400
Water Level Determined By	Samples	Date/Time Start Completion	3/5/87 1400
Length Plain PVC (total)	26.5 ft. cm.	Date/Time Cement Protective Casing	3/5/87 1600
Length of Screen	10.9 ft. cm.	Materials Used	9 - 4' tubes 4 boxes
Total Length of Well Casing	37.4 ft. cm.	Plain PVC	3-10' sections
PVC Stick Up	2.7 ft. cm.	Slotted PVC	1-10' section
Depth to Bottom of Screen	34.7 ft. cm.	Bentonite Pellets	4 buckets
Depth to Top of Screen	23.8 ft. cm.	Bentonite Granular	0
Depth to Top of Sand	22.8 ft. cm.	Cement	10 bags
Depth to Top of Bentonite	18.8 ft. cm.	Sand	8.5 bags
		Water added during completion	0 5 gals to swell bentonite
		Water added during drilling	0
		Total Gallons of water added	0 5

Drill Site Geologist Greg Litus Date 3/5/87

Date/Time/Personnel Internal Mortar, Cement Pad, and Weep Hole Installed [mortar & Cement Pad 4/6/87/1000/K Pacheco, M. Westcott] weep hole 04/19/89 11:35 pg 2

Date/Time/Personnel Casing Painted 4/9/87 / 1100 / K. Pacheco, M. Westcott

Date/Time/Personnel Numbers Painted ~~4/9/87~~ 4/15/87 0945 JJF BAG

Materials Used 9 bags quickcrete, [1/4 bag portland, 1/2 bag silica sand, mortar]

Top of Protective Casing to Top of PVC	0.35 ft. cm.	COMMENT/NOTES	
Top of Protective Casing to Weep Hole	2.1 ft. cm.		
Top of Protective Casing to Internal Mortar	2.15 ~~2.35~~ ft. cm.		
Top of Protective Casing to Top of Cement Pad	2.6 ft. cm.		
Top of Protective Casing to Ground Level	3.0 ft. cm.		

Reviewed By Joseph L. Reed Date 4/20/87

Drill Site Geologist Date

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
7332 SOUTH ALTON WAY • SUITE H-1
ENGLEWOOD, COLORADO 80112 • 303/741-0439

SHEET 1 OF 4

Borehole: E-47A Well Number: 37378

Depth-Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description (Munsell Colors)
0.0			NA		ML	ML sandy-silt, 15-20% v.f.gr. sand, 10YR, 4/1-6, dk. gywsh. brn., non-plas., loose, slightly moist alluvium.
1.0	0-2	2'		0-2		
2.0						At 2.0' color changes to 10YR, 6/2-3, pale brn., moisture decreases to dry.
3.0	2-4	1.6'		2-4		
4.0						At 4.0' color changes to 10YR, 5/6-6, gywsh brn., moisture increases to moist, percent sand increase to ~40% v.f.gr. sand.
5.0	4-5.5	1.2'		4-5.5		
5.5						
6.0	5.5-7.5	1.6'		5.5-7.5		
7.0						
7.5						
8.0	7.5-9.5	2'		7.5-9.5		At 8.0' color is mottled w/ 10YR, 7/2-3, v. pale brn, ~30% calc. sand.
9.0						
9.5						At 10.0', percent of calc sand decreases to 5%.
10.0	9.5-11.5	2'		9.5-11.5		
11.0						

Drill Site Geologist: A.E. Dutt Date: 3/13/87

Reviewed By: David L. Reed Date: 4/16/87

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
7332 SOUTH ALTON WAY • SUITE H-1
ENGLEWOOD, COLORADO 80112 • 303/741-0839

SHEET 2 OF 4

Borehole: E-47A Well Number: 37378

Depth-Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
						Munsell Colors
11.0	S11-S5	2'	NA	S11-S5	ML	
11.5	S11 11.5 - 13.5	1.6'		S11 11.5 - 13.5	SM	SM silty-sand, ~30% silt, 10YR, 5/6-8, yvsh. brn., non-plas., loose, moist, alluvium.
12.0						
13.0						
13.5	S11 13.5 - 15.5	1'		S11 13.5 - 15.5		At 14.0', percent of silt decreases to ~15%...
14.0						
15.0						
15.5	S11 15.5 - 17.5	1.35		S11 15.5 - 17.5		
16.0						
17.0						At 17.0', percent of silt decreases to ~5-10%.
17.5	S11 17.5 - 19.5	1.2'		S11 17.5 - 19.5		
18.0						
19.0					SP	SP Gravelly-sand, 20% quartzite gravel, 60% coarse gr. sa 20% silt, 10YR, 5/3-4, brn, non-plas, loose, moist, all
19.5	S11 19.5 - 21.5	1.5'		S11 19.5 - 21.5	SM	SM silty-sand, ~5% silt, 10YR, 6/3-4, ~~brown~~ to ~~yellow~~ pale brown, non-plas, loose, moist, alluvium.
20.0						
21.0						
21.5	S11 21.5 - 22.5	1'		S11 21.5 - 22.5		
22.0						

Drill Site Geologist: Date: 3/13/87

Reviewed By: Date: 4/16/87

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
7332 SOUTH ALTON WAY • SUITE H-I
ENGLEWOOD, COLORADO 80112 • 303/741-0830

Borehole: E-41A Well Number: 37378

SOILS LOG
Description

MUNSELL COLORS

Depth-feet	Tube Number / Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	Description
22.0	21.5 - 23.5	1'	NA	21.5 - 23.5	SM	
23.0						At 23.5' color changes to 10 YR, 6/6-8 brownish yellow.
23.5	23.5-24	0.5'		23.5-24	½	
24.0	24 - 25.5	1.1'		24 - 25.5		
25.0						
25.5						
26.0	25.5 - 27.5	2'		25.5 - 27.5	SC	SC Clayey-sand, ~30-40% clay, 10YR, 7/2-3, v. pale brn., slightly plas., soft, moist, alluvium
26.5						
27.0						
27.5						WT @ 28'
28.0	27.5 - 29.5	1.2'		27.5 - 29.5	SM	SM silty-sand, ~20% silt, 10 YR, 5/4-6, yish. brn., non-plas., loose, saturated alluvium
29.0						
29.5	29.5-30.5	1'		29.5-30.5		
30.0						
30.5	30.5 - 32.5	1.3'		30.5 - 32.5		At 31.0', percent silt decreases to 5-10%.
31.0						
32.0						
32.5	32.5-34	0'		32.5-34		NO RECOVERY - AUGER LOSS
33.0						

Drill Site Geologist: [signature] Date: 3/13/87

Reviewed By: Joseph L. Reed Date: 4/16/87

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
7332 SOUTH ALTON WAY • SUITE H-I
ENGLEWOOD, COLORADO 80112 • 303/741-0936

Borehole: E-47A Well Number: 37378

Depth - feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
						MUNSELL COLORS
33.0	32.5-34	0'		32.5-34		NO RECOVERY - AUGER LOSS
34.0					SM	
34.5	34-36	2'		34-36	CL	CL silty-clay, 20-30% silt, ~~10YR~~ 5YR, 5-6/1, gray w/ 5YR, 5/6 yw/ red weathering, slightly plas., med. stiff, wet, bedrock.
35.0						
36.0						END OF BORING LOG
37.0						
38.0						
39.0						
40.0						
41.0						
42.0						
43.0						
44.0						

Drill Site Geologist: _____ Date: 3/13/87

Reviewed By: Joseph L. Reed Date: 9/16/87

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
7332 SOUTH ALTON WAY • SUITE H-I
ENGLEWOOD, COLORADO 80112 • 303/741-0839

WELL CONSTRUCTION SUMMARY

Borehole E-50 A Well 37396

Project Name and Location RMA T39, ~½ mi S. Hwy 2 of 104th on Hwy 2. Project Number 17053.075.10

Drilling Company Boyles Brothers Driller D. Ervin Rig Number E.R. TH-60

Drilling Method(s) Sample w/ 3¼" I.D. H.S. auger, 2' split sample barrel, 0.18' sample shoe, & "Moss" system. Ream w/ 8" I.D. H.S. auger w/ center bit.

Borehole Diameter 12½ in. ____ cm. 0 ft. ____ cm. to 28.5 ft. ____ cm.

____ in. ____ cm. ____ ft. ____ cm. to ____ ft. ____ cm.

Size(s) and types of Bit(s) H.S. center bit, continuous flight auger.

Size and Type PVC 1" I.D. Sch. 40

Total Borehole Depth	28.50 ft. ____ cm.	Sampling Method(s)	3½" I.D. H.S. auger a/a
Depth to Bedrock	28.50 ft. ____ cm.	Date/Time Start Drilling	12/18/87 0952
Depth to Water	PRG 8.30 ~~8.50~~ ft. ____ cm.	Date/Time Finish Drilling	12/22/87 0935
Water Level Determined By	measurement steel tape.	Date/Time Start Completion	12/22/87 0940
Length Plain PVC (total)	9.09 ft. ____ cm.	Date/Time Cement Protective Casing	12/22/87 1140
Length of Screen	21.11 ft. ____ cm.	Materials Used	~~9.09~~ 9.1P locking cap & [illegible]
Total Length of Well Casing	30.20 ft. ____ cm.	Plain PVC	9.09' sch. 40
PVC Stick Up	1.70 ft. ____ cm.	Slotted PVC	21.11' 20 Johnson Enviro. Scre.
Depth to Bottom of Screen	28.50 ft. ____ cm.	Bentonite Pellets	2 buckets (5gal/bucket) 3/8" Slop.
Depth to Top of Screen	7.39 ft. ____ cm.	Bentonite Granular	none
Depth to Top of Sand	3.40 ft. ____ cm.	Cement	1 bag (94#/bag) Type II Mountain
Depth to Top of Bentonite	1.50 ft. ____ cm.	Sand	15½ bags CSSI 10-20
		Water added during completion	25 gal
		Water added during drilling	0
		Total Gallons of water added	25 gal

Drill Site Geologist James F. Pearce Date 1/6/88

Weep hole : 3-14-88/1335/DWW & BW

Date/Time/Personnel Internal Mortar, Cement Pad, and Weep Hole Installed 3/10/88 1420 JG/RP

Date/Time/Personnel Casing Painted 3-10-88 RP/JG

Date/Time/Personnel Numbers Painted 3-14-88 / 1335 / DWW & BW

Materials Used 10 bag Quikrete

			COMMENT/NOTES
Top of Protective Casing to Top of PVC	0.30 ft. ____ cm.		
Top of Protective Casing to Weep Hole	0.62 ~~1.08~~ DW ft. ____ cm.		
Top of Protective Casing to Internal Mortar	0.70 ft. ____ cm.		
Top of Protective Casing to Top of Cement Pad	1.68 ft. ____ cm.		
Top of Protective Casing to Ground Level	1.70 ft. ____ cm.		

Reviewed By [signature] Date 3/15/88

Drill Site Geologist ____ Date ____

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
7332 SOUTH ALTON WAY • SUITE H-1
ENGLEWOOD, COLORADO 80112 • 303/741-0636

Borehole: E-50 Well: 37396

Depth-Feet	Soil/Rock Type	Well Completion	Description
		8" I.D. steel csg 4" I.D. Sch 40 PVC .30 1.20 1.40 locking cap Gound Level	Set 8" I.D. protective csg. to 1.5' 4" I.D. scd. 40 plain PVC from ~1.7' above ground to 7.39' below ground. 4" I.D. 20 Johnson Environ. Scrn. from 7.39' below ground to TD @ 28.5'
5	silty sand		Top of bentonite: 1.40' Bottom 8" I.D Steel csg: 1.50'
	silty-clay		Top of sand: 3.40'
		Jt. 7.39	Top of screen: 7.39'
10	clay sand		
	silty clay		
	silty/clayey sand		
15			
	silty sand	Jt. 17.87	
20	sand		
25	c. sand		
	mottled sandy clay B.R.		Bottom of screen: 28.5' T.D. @ 28.5' Bedrock: 28.5'
30			

Materials

Plain PVC: 2.09' Scd 40
Slotted PVC: 21.11', 20 Johnson Environ Scrn.
Bent. Pellets: 2 buckets, 3/8" slope Indicator
Cement: 1 bag Type II Mtn.
Sand: 15 1/2 bags CSSI #-20
Protect csg: 5' x 8" I.D red [illegible] w/ locking cap

Drill Site Geologist: J.F. Sousa Date: 11/6/88
Reviewed By: [signature] Date: 11/7/88

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
7332 SOUTH ALTON WAY • SUITE H-1
ENGLEWOOD, COLORADO 80112 • 303/741-0636

Borehole: E-50 Well Number: 37396

Depth-Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
						Munsell Colors
0					SM	Silty sand, 10-30% silt, predom., f-vf grained sand, trace clay, 10YR 3/2 v dk grayish brn, rounded-subrounded, pred qtz, abundant root fragments & organic debris, loose, non-plas, moist alluvium
1	2-0	2'		2-0		
2						
3	2-4	2'		2-4		At 3.0'; root frags absent.
4					CL	At 3.8'; ~~clay~~, silty clay, 10-30% silt, 10YR 4/2 dk grayish brn, slightly plas, soft, moist alluvium.
5	4-6	2'		4-6		
6						

Drill Site Geologist: J. F. Trace Date: 1/6/88

Reviewed By: [signature] Date: 1/7/88

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
7332 SOUTH ALTON WAY • SUITE H-1
ENGLEWOOD, COLORADO 80112 • 303/741-0839

Borehole: E-50 Well Number: 3739b

Depth-Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
						Munsell Colors
0		X				No Recovery
	8-9	1.5		8-9		At 6.5'; saturated.
7						
8		X				No Recovery
	01-8	2		01-8	SC	At 8.7'; clayey sand, 20-40% clay, pred f. vf grained sand, occ med grnd, 10YR 4/2 dk grayish brn v. sl. plas, soft, saturated. alluvium,
9		1.25'				
					CL	At 9.5'; silty clay, 10-30% silt, 10YR 4/1 dk gray, sl plas, soft-med stiff, moist alluvium.
10						
	11-01	2		11-12		
11						
12						

Drill Site Geologist: G.F. Pearce Date: 1/6/88

Reviewed By: [signature] Date: 1/18/88

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
7332 SOUTH ALTON WAY • SUITE H-I
ENGLEWOOD, COLORADO 80112 • 303/741-0839

Borehole: E-50 Well Number: 3739b

Depth-Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
12						Munsell Colors.
13	12-14			12-14		No Recovery
		0.5'			SC	At 13.5'; clayey sand, 20-30% clay, pred f-vf grained sand, 10YR 4/1 dk gray, sl plas, saturate alluvium.
14	14-16	2'		14-16		At 14.0'; color changes to 10YR 5/3 ~~vf~~ brn some Fe stain 10YR 6/8 brn yell.,
15					SM	At 15.0'; silty sand, 10-30% silt, pred. f grined sand. 10-20% clay, 10YR 5/3 brn, w/ mottled and occ layered Fe stain 10YR 5/8 yell brn, pred qtz, sme ferromags, sl. plas, saturated, alluvium.
16	16-18	2'		16-18	SC	At 15.8'; clayey sand, 25-30% clay, pred f-vf w/ occ med grained sand, 10-20% silt, 10YR 5/4 yell brn, w/ mottled Fe stain as above, sl plas, soft, saturated, alluvi
17					CL	At 17.2', silty clay, 20-30% silt, some vf-f sand, 10YR 5/3 brn, Fe stain absent, sl-low plas, soft-med stiff, saturated, alluvium.
18						

Drill Site Geologist: C.F. Lewis Date: 1/6/88

Reviewed By: [signature] Date: 1/8/88

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
7332 SOUTH ALTON WAY • SUITE H-I
ENGLEWOOD, COLORADO 80112 • 303/741-0839

Borehole: E-50 Well Number: 37396

Depth-Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
						Munsell Colors
19						No Recovery
19	18-20	1'		18-20	SM	At 19.0'; silty sand 30-40% silt, pred f grained sand, 10YR5/4 yell brn, loose, non-plas, saturated alluvium
20	20-22	2'		20-22	SP	At 19.9'; poorly graded sand, 20% med, 60% fine, remainder vf w/ tr coarse, 10YR 4/4 dk yell brn, pred qtz w/ 10-20% feldspar & minor ferromags, loose, non-plas saturated alluvium.
21						At 20.6'; 20% vf, 20% f, 20% coarse 40% med grained, color changes to 10YR 4/2 dk grayish brn.
						At 21.7'; coarse increases to 30%
22						
	22-24	1'		22-24		No Recovery
23						At 23.0'; pred f grained w/ 20% med, 10% coarse occ. pebble
24						At 23.8'; pred coarse w/ abund. v.coarse

Drill Site Geologist: Q.F. Pearce Date: 1/6/88

Reviewed By: [signature] Date: 1/8/88

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
7392 SOUTH ALTON WAY • SUITE H-I
ENGLEWOOD, COLORADO 80112 • 303/741-0639

Borehole: E-50 Well Number: 37396

Depth-Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
						Munsell Colors.
24						
25	24-26	N		24-26		
26						
27	26-28	2		26-28		At 27.0'; pred v. coarse
28						At 28.3'; gravel - pebble
						At 28.5'; weathered clay, sandy.
29	28-30	2		28-30	CL	At 29.0'; clay, 10YR 4/1 dk gray, stiff, mod plas, moist, bedrock.
30						

END OF BORING LOG

Drill Site Geologist: D.T. Pearce Date: 1/6/88

Reviewed By: [signature] Date: 1/18/88

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
7333 SOUTH ALTON WAY • SUITE H-I
ENGLEWOOD, COLORADO 80112 • 303/741-0830

WELL CONSTRUCTION SUMMARY

Borehole E-92 Well 37397

Project Name and Location RMA T32, 1/8 mi N. of 104th on Peoria Project Number 17053.075-10

Drilling Company Boyles Brothers Driller D. Ervin Rig Number E.R. TH-60

Drilling Method(s) Sample w/ 3¼" I.D. H.S. auger, 2' split sample barrel, w/ 0.18" sample shoe, and "Moss" system. Ream w/ 8" I.D. H.S. auger w/ cutting bit

Borehole Diameter 12¼ in. ____ cm. 0 ft. ____ cm. to 34.80 ft. ____ cm.

____ in. ____ cm. ____ ft. ____ cm. to ____ ft. ____ cm.

Size(s) and types of Bit(s) H.S. auger center bit, continuous flight auger.

Size and Type PVC 4" I.D. sch. 40

Total Borehole Depth 34.80 ft. ____ cm.

Depth to Bedrock 31.90 ft. ____ cm.

Depth to Water 25.00 ft. ____ cm.

Water Level Determined By meas. w/ steel tape

Length Plain PVC (total) 20.29 ft. ____ cm.

Length of Screen 16.17 ft. ____ cm.

Total Length of Well Casing ~~36.46~~ 97 ft. 36.46 ft. cm.

PVC Stick Up 1.70 ft. ____ cm.

Depth to Bottom of Screen 34.80 ft. ____ cm.

Depth to Top of Screen 18.63 ft. ____ cm.

Depth to Top of Sand 14.20 ft. ____ cm.

Depth to Top of Bentonite 9.00 ft. ____ cm.

Sampling Method(s) 3¼" I.D. H.S. as above.

Date/Time Start Drilling 1/4/88 1420

Date/Time Finish Drilling 1/5/88 1230

Date/Time Start Completion 1/5/88 1230

Date/Time Cement Protective Casing 1/5/88 1410

Materials ~~Used~~ Protective Csg w/ locking cap.

Plain PVC 20.29' 4" ID sch 40

Slotted PVC 16.17' 4" I.D. 20 - Johnson Envir.

Bentonite Pellets 5 buckets (35#/buck) 3/8" slope indicator

Bentonite Granular Done

Cement 5 bags Type II Mountain

Sand 12 bags CSSI 10-20

Water added during completion 5 gal

Water added during drilling 0

Total Gallons of water added 5 gal.

Drill Site Geologist James F. Pearce Date 1/6/88

Weep hole: 3-14-88 / 1400 / DLW & BW

Date/Time/Personnel Internal Mortar, Cement Pad, and Weep Hole Installed 3-10-88 / 1100 / RP & FG

Date/Time/Personnel Casing Painted 3-10-88 / 1030 / RP & FG

Date/Time/Personnel Numbers Painted 3-14-88 / 1400 / DLW & BW

Materials Used 12 bags concrete

Top of Protective Casing to Top of PVC	0.27 ft.	____ cm.	COMMENT/NOTES
Top of Protective Casing to Weep Hole	1.57 ft.	____ cm.	
Top of Protective Casing to Internal Mortar	1.60 ft.	____ cm.	
Top of Protective Casing to Top of Cement Pad	1.87 ft.	____ cm.	
Top of Protective Casing to Ground Level	1.87 ft.	____ cm.	

Reviewed By [signature] Date 3/15/88

Drill Site Geologist ____ Date ____

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Borehole: E-52 Well: 37397

Depth-Feet	Soil/Rock Type	Well Completion	Description
		8" I.D. steel csg.	Set 8" I.D. protect. csg to 3.00'.
		.27	4" I.D. sch. 40 PVC from ~1.7' above ground to 18.63 below ground
		1.57	4" I.D. 20-Johnson Envirotech screen from 18.63 to TD at 34.80'.
		1.60	
		locking cap	
		Ground Level	
		4" I.D. sch 40 PVC	
	Silty-sand		Bottom of 8" I.D. steel csg: 3.00'
5			
	Sand. f-gr		
		Jt. 8.59	Top of Bentonite: 9.00'
10			
	Sandy-silt		
			Top of sand: 14.20
15			
	Silty sand		
		Jt. 18.63	Top of screen: 18.63
20	Sand f-m gr.		
	Clay &		
	Clayey sand	Jt. 24.13	
25			
	Silty sand		
30			Bedrock: 31.90'
	Sand f-m		
		34.80' T.D.	Bottom of screen: 34.80'
35			**Materials**
			Plain PVC: 20.29, 4" I.D. std 40
			Slot PVC: 16.17 " " 20-Johnson
			Bent. Pellets: 5 buckets
			3/8" Slope Indicator
			Cement: 5 bags Type II Portn.
			Sand. 12 bags CSSI 10-20.
			Protect csg: 5' x 8" I.D. red iron w/ locking cap.

Drill Site Geologist: James F. Pierce Date: 1/6/88

Reviewed By: [signature] Date: 3/15/88

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Borehole: E-52 Well Number: 37397

Depth – Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description — Munsell Colors
0					SM	Silty sand, 10-20% silt, pred f grain w/ 20-30% v.f. grnd sand, subrnded to rounded qtz., 10YR 3/2 v. dk grayish brn, loose, non plas., moist alluvium.
1	0-2	2'	0-2	2-0		
2						At 1.8'; color changes to 10YR 5/4 yell. brn.
	2-4	2'	2-4	2-4		At 2.0'; silt increases to 20-30%, sand grain sizes change to pred vf w/ 10-20% f, occ. med-coarse grnd sand; 10YR 4/4 dk. yell brn
3						At 2.6'; mottled 10YR 6/4 lt. yell. brn.
						At 3.2'; mottled 10YR 6/4, absent.
4						
	4-6	2'	4-6	4-6		
5						
6					SP	At 5.8'; poorly graded sand, 20% v.f., 20% med

Drill Site Geologist: Gary F. Pearce Date: 1/6/88

Reviewed By: [signature] Date: 1/7/88

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Borehole: E-52 Well Number: 37397

Depth - Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description Munsell Colors
7	8-9	2'	8-9	8-9		60% f grained sand, 10YE 6/6 brnish yell. subrnded to rnded, qtz., loose, non-plas; moist alluvium. At 6.5; pred med grained sand.
8	8-10	2'	10-8	11-8	SM	At 7.3; Silty sand, 10-30% silt, 20% med, 20% v.f, 20% f grned sand, 10YR 4/6 dk yell brn, subrnd-rnd, qtz, loose, non-plas, moist alluvium. At 8.5; mottled $CaCO_3$, 10YR 6/3, pale brn At 9.2; 0.1' thick layer w/ 40-50% silt and moderate clay.
9						At 9.5; silt decreases to 20-30%, clay absnt. 20% vf grned, 90% fine grned sand.
10	21-11	2'	21-11	21-11	ML	At 10.6'; Sandy silt, 20-30% sand, pred vf-f grained, occ coarse & pebble grains, 10YR 5/4, yell brn, loose, non plas, moist alluvium. At 11.5; sand decreases to 10-20%
11						
12						

Drill Site Geologist: C.F. Pearce Date: 1/6/88

Reviewed By: [signature] Date: 1/7/88

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Borehole: E-52 Well Number: 37397

Depth-Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description (Munsell Colors)
12						At 12.0'; sand pred. coarse grained, occ granite pebbles.
13	12-14	2	12-14	12-14		At 13.0'; color changes to 10YR 6/4, lt yell brn.
14						At 14.0'; mottled CaCO3 10YR 7/2 lt gray sand pred f-vf grained w/ occ coarse
15	14-16	2	14-16	14-16		
16					SM	At 15.8'; silty sand, 20-30% silt, 20% vf, 20% f grained, 30% med grained,
17	16-18	2	16-18	16-18		At 16.6'; silt decreases to 10-20%, sand pred med grad. At 17.0'; silt increases to 20-30%. At 17.7'; silt decreases to 10-20%, sand pred med grained w/ 10-20% coarse grained.
18						

Drill Site Geologist: K. A. Grace Date: 1/6/88

Reviewed By: [signature] Date: 1/7/88

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Borehole: E-52 Well Number: 37397

Depth-feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
18						No Recovery
19	18-20	1.5'	18-20	18-20	SP	At 18.5'; poorly graded sand, 10-20% vf-f, 30% f, 30% med grained, 10YR5/4 yell brn, subrnd-rnd. qtz w/ minor feldspar, loose, non plas, moist alluvium. At 19.5'; pred coarse grained.
20					CL	At 19.7'; silty clay, 10-30% silt, 10YR5/6, yell brn, sl plas, med stiff, moist. alluvium.
21	20-22	2'	20-22	20-22	SP	At 20.2'; poorly graded sand, pred coarse-med grained, 20-30% vf-f grained, ~~tan~~ 10YR 6/4 lt yell brn, pred. rnded. qtz, loose, non-plas. moist. alluvium.
22					CL	At 21.8'; clay, trace silt, 10YR 5/2 grayish brn, low plas, stiff, moist, alluvium.
23	22-24	1'	22-24	22-24		No Recovery
24					SC	At 23.3'; clayey sand, 10-40% clay, pred med-f grained sand, 10YR 5/3, brn, w/ abundant Fe staining 5YR 4/4 red brn, subrnd-rnded, qtz-feldspar, loose, non-plas moist alluvium.

Drill Site Geologist: C.F. Reece Date: 1/6/88

Reviewed By: [signature] Date: 1/7/88

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Borehole: E-52 Well Number: 37397

Depth-Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
						Munsell Colors
24						
25	24.26	2'	24.26	24.26		At 24.8'; occ mottled CaCO3 10YR 7/2 lt gray
						At 25.7'; 0.15" thick clay lens.
26						At 26.0'; pred vf. f grained, 20% med grned. saturated at 26.0'.
						At 26.4'; Fe stain & CaCO3 absent
					SM	At 26.5'; silty sand, 10-30% silt, pred, f-vf grained sand, 10YR 5/4 yell. brn., loose, non-plas, saturated alluvium.
27	26.28	2'	26.28	26.28		
28						
29	28-30		28-30 No Sample	28-30		No Recovery
30						

Drill Site Geologist: C.F. Pearce Date: 1/6/88

Reviewed By: [signature] Date: 1/7/88

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Borehole: E-52 Well Number: 37397

Depth - Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
						Munsell colors
30						No Recovery
31	30-32	1'	30-32	30-32	SM	~~Silt~~ At 31.2'; silty sand as above.
32	32-34	2'	32-31	32-34	SP	At 31.9'; poorly graded sand, 20% vf, 50-50% f-med, trace coarse, some silt, 10YR 4/6, dk yell. brn, ~~med qtz~~, w/ abundant, Fe staining. 10YR 6/8 brn yell, med qtz, thinly bedded & compacted & indurated, hard, moist bedrock.
33						
34						End of Boring Log.

9711

Drill Site Geologist: D. Pearce Date: 1/6/88

Reviewed By: [signature] Date: 1/7/88

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WELL CONSTRUCTION SUMMARY

Borehole E-53A Well 37367

Project Name and Location RMA Off Post task 39 Project Number 86-942-0210

Drilling Company Boyles Bros. Driller Dave Jarvie Rig Number 5451

Drilling Method(s) Hollow stem auger 3¼" ID 7¼" O.D. Continuous Sampling
Reamed with 8¼ ID 12¼ OD Hollow Stem Auger

Borehole Diameter 12¼ in. ____ cm. 0 ft. ____ cm. to 39.5 ft. ____ cm.
____ in. ____ cm. ____ ft. ____ cm. to ____ ft. ____ cm.

Size(s) and types of Bit(s) Hollow stem Auger 12¼

Size and Type PVC 4" Sch 40 .020" slot

Total Borehole Depth	39.5 ft. ____ cm.	Sampling Method(s)	Continuous Hollow Stem Auger
Depth to Bedrock	39.5 ft. ____ cm.	Date/Time Start Drilling	12/17/86 1400
Depth to Water	8.7 ft. ____ cm.	Date/Time Finish Drilling	12/18/86 1500
Water Level Determined By	Measurement 6¼" Augers after 24 hrs	Date/Time Start Completion	12/19/86 0800
Length Plain PVC (total)	13.16 ft. ____ cm.	Date/Time Cement Protective Casing	1000
Length of Screen	26.91 ft. ____ cm.	Materials Used	
Total Length of Well Casing	40.07 ft. ____ cm.	Plain PVC	2-10'
PVC Stick Up	1.70 ft. ____ cm.	Slotted PVC	2-10' 1-5'
Depth to Bottom of Screen	38.37 ft. ____ cm.	Bentonite Pellets	5 Buckets (50 lbs)
Depth to Top of Screen	11.46 ft. ____ cm.	Bentonite Granular	10 lbs
Depth to Top of Sand	7.70 ft. ____ cm.	Cement	2 Bags
Depth to Top of Bentonite	3.70 ft. ____ cm.	Sand	17 Bags
		Water added during completion	10gal
		Water added during drilling	0
		Total Gallons of water added	10 gal

Drill Site Geologist Joe Reed Date 12/19/86

Date/Time/Personnel Internal Mortar, Cement Pad, and Weep Hole Installed ____

Date/Time/Personnel Casing Painted ____

Date/Time/Personnel Numbers Painted ____

Materials Used ____

Top of Protective Casing to Top of PVC	.35 ft. ____ cm.	COMMENT/NOTES	
Top of Protective Casing to Weep Hole	1.0 ft. ____ cm.		
Top of Protective Casing to Internal Mortar	1.33 ft. ____ cm.		
Top of Protective Casing to Top of Cement Pad	1.95 ft. ____ cm.		
Top of Protective Casing to Ground Level	2.05 ft. ____ cm.		

Reviewed By ____ Date ____

Drill Site Geologist Joseph L. Reed Date 12/19/86

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Borehole: E-53A Well: 37367

Depth-Feet	Soil/Rock Type	Well Completion	Description
		Gound Level	1.91 Joint
			3.7 Top of Bentonite
5			7.70 Top of sand
10			11.46 Top of Screen
			18.7 water level
20			21.98 Joint
			32.5 joint
30			38.37 Bottom of screen
40			39.5 Borehole T.D. Bedrock

Drill Site Geologist: Joseph K. Dixon Date: 12/9/86

Reviewed By: _____ Date: _____

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Borehole: E-53A Well Number: 37367

Depth - Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
0						NO RECOVERY
20.0		32%	FS3-A	20-22'	ML	~~Fill~~ sandy silt, 30% fine-grained sand, 10YR 4/4-6 dark yellowish brown non-plastic, med-stiff, saturated Alluvium
22.0		96%	E53-A	22-24.0'		
24.0			E 53A	24-25.0'		
25.0						

Drill Site Geologist: D. Chamberlain Date: 12/22/86

Reviewed By: Date:

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Borehole: ES3A Well Number: 37367

Depth – Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
25.0		100%	ES3A	25 – 26.5	SM	SM, silty sand, 20% silt, fine-c. grain sand, 10YR 5/4 yellowish brn, non-plast, Loose, Saturated Alluvium.
26.0						
26.5		80%	ES3A	26.5 – 28.0		DECREASE sand size, f-gr.
27.0						
28.0		100%	ES3A	28.0 – 29.5		
29.0						
29.5		100%	ES3A	29.5 – 31.5		
30.0						
31.0						

Drill Site Geologist: W. Gumstead Date: 10/22/86

Reviewed By: Date:

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Borehole: E53A Well Number: 37367

Depth-Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
31.0		100%	E53A	31 – 32.5	SM	INCREASE grain size to COARSE Increase grain size to coarse
31.5		WDA				
32.0						
32.5		100%	E53A	32.5 – 33.5		DECREASE grain size to fine-med grain, color change to 10YR 4/4-6 dark yosh Brn.
33.0						
33.5		50% 1.5'	E53A	33.5 → 35.0		
34.0						
35.0		1.5	E53A	35.0 → 36.5		INCREASE grain size to coarse grain
36.0						
36.5		1.5	E53A	36.5 → 38.0		COARSE sand w/ 10% gravel SP PRG 8/28
37.0						

Drill Site Geologist: W. Armistead Date: 12/22/86

Reviewed By: Date:

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Borehole: ESSA Well Number: 37367

Depth - Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
37.0					SM	
38.0		1.5	ESSA	38 - 39.5		
39.0						
39.5						END of Boring

Drill Site Geologist: [signature] Date: 12/22/86

Reviewed By: Date:

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WELL CONSTRUCTION SUMMARY

Borehole E-5308-1 Well 37400

Project Name and Location RMA off post Sect 12 Project Number T39

Drilling Company Boyle Bros Driller Tom High Rig Number Mobile

Drilling Method(s) 3¼" ID Hollow stem auger Mono system sampling thru reamed with 12¼" OD Hollow stem auger

Borehole Diameter 12¼ in. ____ cm. 0 ft. ____ cm. to 42.0' ft. ____ cm.

— in. — cm. — ft. — cm. to . ft. ____ cm.

Size(s) and types of Bit(s) Augers

Size and Type PVC 2" sched 40 .020 slot

Total Borehole Depth	42.0	ft.	____	cm.
Depth to Bedrock	38.5	ft.	____	cm.
Depth to Water	20.0	ft.	____	cm.
Water Level Determined By	sample			
Length Plain PVC (total)	18.29	ft.	____	cm.
Length of Screen	25.41	ft.	____	cm.
Total Length of Well Casing	43.7	ft.	____	cm.
PVC Stick Up	2.0	ft.	____	cm.
Depth to Bottom of Screen	41.7	ft.	____	cm.
Depth to Top of Screen	16.29	ft.	____	cm.
Depth to Top of Sand	11.90	ft.	____	cm.
Depth to Top of Bentonite	7.50	ft.	____	cm.

Drill Site Geologist [signature]

Sampling Method(s) continuous (Mono)

Date/Time Start Drilling 3/30/88 0903

Date/Time Finish Drilling 4/4/88 0957

Date/Time Start Completion 4/4/88 1028

Date/Time Cement Protective Casing 4/4/88 1210

Materials Used 1 protective casing, 1 cap, 1 locks

Plain PVC 1-10', 1-cut section

Slotted PVC 2-10' 1-5' section

Bentonite Pellets 4 buckets (50# bulk)

Bentonite Granular 3/10 bags (50#)

Cement 3 bags

Sand 22 bags

Water added during completion 100 gal

Water added during drilling —

Total Gallons of water added 100 gal

Date 4/14/88

Date/Time/Personnel Internal Mortar, Cement Pad, and Weep Hole Installed 4/7/88 SMP & SCS 1000

Date/Time/Personnel Casing Painted 4/7/88 SMP & SCS 1200

Date/Time/Personnel Numbers Painted 4/8/88 SMP & KR 1000

Materials Used 10 bags of cement

Top of Protective Casing to Top of PVC	0.24	ft.	____	cm.
Top of Protective Casing to Weep Hole	1.44	ft.	____	cm.
Top of Protective Casing to Internal Mortar	1.44	ft.	____	cm.
Top of Protective Casing to Top of Cement Pad	1.90	ft.	____	cm.
Top of Protective Casing to Ground Level	2.24	ft.	____	cm.

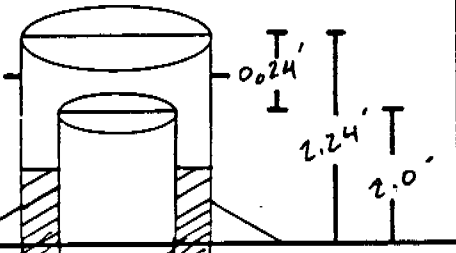
COMMENT/NOTES

Reviewed By [signature] Date 4-20-88

Drill Site Geologist [signature] Date 4-20-88

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Borehole: E-5308-#1 Well: 37400

Depth-Feet	Soil/Rock Type	Well Completion	Description
			

7.5 Top of bentonite
11.9 Top of SAND
16.29 Top of Screen
41.7' Bottom of Screen
42' Total Depth

Drill Site Geologist: A. Ross Date: 4/8/88
Reviewed By: T. L. L. Date: 4-20-88

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SHEET 1 OF 4

Borehole: E-53 Well Number: OB-1 37406

Depth - Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
0						
1	0 ↓ 2	2/2	1	0 ↓ 2	SM	Silty sand, fine grained, 45% silt, 15YR 4/4 dark yellow brown, dry, low plastic med stiff
2						
3	2 ↓ 4	2/2	2	2 ↓ 4	SC	Clayey sand fine to medium 25% clay 10YR 4/4 dark yellowish brown, med stiff moist med plas
4						
5	4 ↓ 6	2/2	3	4 ↓ 6	SM	Silty sand, fine to medium grained 30% silt 10YR 5/3 brown, non cohesive, dry
6						
7	6 ↓ 8	2/2	4	6 ↓ 8	SC	Clayey sand, fine to medium grain, 30% clay 10YR 6/8 light yellowish brown, med stiff moist med plastic
8						at 8' changes to fine to coarse
9	8 ↓ 10	2/2	5	8 ↓ 10		
10						at 10' very calcareous

Drill Site Geologist: ~~Dave Wood~~ / Installed / Logged) Date: 4-13-88

Reviewed By: Date: 4/20/88

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Borehole: E-53 Well Number: OB-1 37400

Depth-Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
10	16	.7/2	6	10	SC	Same as above
11	12			12	SM	Silty sand fine to medium, 15% silt 10YR 5/6 yellowish brown, slightly moist low plastic med stiff
12	12		7	12		
13	14	2/2		14	SC	Clayey sand, fine to medium 25% clay 10YR 5/6 yellowish brown, slightly moist med stiff, low plastic, calc nods
14	14		8	14		
15	16	2/2		16		at 16' clay content increases to 35% grain size increases to fine to coarse
16	16	2/2	9	16		
17	18			18		at 18' clay increases to 45%
18	18	2/2	10	18		
19	20			20		
20						

Dave West - Installer

Drill Site Geologist: ~~[illegible] Logger~~ Date: 4-15-88

Reviewed By: [signature] Date: 4/20/88

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Borehole: E-53 Well Number: OB-1 37400

Depth-Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
20	20 / 22	.5/2	11	20 / 22	SC	Same as above, saturated at 20'
22	22 / 24	0/2	N/A	22 / 24		no recovery from 22 to 25.5
24	24 / 26	.5/2	12	24 / 26	SM	Silty sand, fine to very coarse, 5% gravel 20% silt, 10YR6/4 light yellow brown, saturated, non plastic, med dense
26	26 / 28	1	13	26 / 28		
28	28 / 29	1/1	14	28 / 29		
29	29 / 30	1/1	15	29 / 30		
30						

Drill Site Geologist: _____ Date: 4-13-88

Reviewed By: _____ Date: 4/20/89

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Borehole: E-53 Well Number: OB-1 37400

Depth-Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
30	30 ↓ 32	.5/2	16	30 ↓ 32	SM	same as above
32	32 ↓ 34	.5/2	17	32 ↓ 34		
34	34 ↓ 36	.5/2	18	34 ↓ 36		gravel increases to 10% at 36'
36	36 ↓ 38	0/2	NR	36 ↓ 38		no recovery 36'→38'
38	38 ↓ 40				GP	Poorly graded gravel small to large (2.5") 30% sand fine to very coarse 10YR 5/4 yellowish brown saturated
						Claystone bedrock mottled, very weathered
						Soft claystone clasts in soft clay matrix
40						Olive with blue-gray clasts

Drill Site Geologist: [signature] Date: 4-15-88

Reviewed By: [signature] Date: 4/20/88

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WELL CONSTRUCTION SUMMARY

Borehole E-53032 Well 37401

Project Name and Location RMA OFF-POST SECT. 12 Project Number TASK 39

Drilling Company BOYLES BROS. Driller TOM HIGHT Rig Number B-61 Auger Rig

Drilling Method(s) AUGER W/ MOSS SYSTEM (6½" AUGERS) THEN REAM HOLE TO T.D. W/ 12" AUGERS.

Borehole Diameter 12 in. ____ cm. 0 ft. ____ cm. to 42 ft. ____ cm.
____ in. ____ cm. ____ ft. ____ cm. to ____ ft. ____ cm.

Size(s) and types of Bit(s)	6½" hollow stem auger 12"(OD) auger.	Sampling Method(s)	Moss System w/ Hollow Stem Auger
Size and Type PVC	2" sch. 40	Date/Time Start Drilling	3/25/88 1026
Total Borehole Depth	42 ft. ____ cm.	Date/Time Finish Drilling	3/29/88 0913
Depth to Bedrock	41 ft. ____ cm.	Date/Time Start Completion	3/29/88 0950
Depth to Water	18.75 ft. ____ cm.	Date/Time Cement Protective Casing	3/29/88 1500
Water Level Determined By	Solinst	Materials Used	10 ft. sect surface casing.
Length Plain PVC (total)	18.44 ft. ____ cm.	Plain PVC	(2) 10ft sections
Length of Screen + Endcap	25.24 ft. ____ cm.	Slotted PVC	(2) 10ft sections (1) 5ft. section
Total Length of Well Casing	43.68 ft. ____ cm.	Bentonite Pellets	2 buckets
PVC Stick Up	1.63 ft. ____ cm.	Bentonite Granular	N/A
Depth to Bottom of Screen	42.05 ft. ____ cm.	Cement	3 bags
Depth to Top of Screen	16.81 ft. ____ cm.	Sand	21 bags
Depth to Top of Sand	9.0 ft. ____ cm.	Water added during completion	~ 110 gal.
Depth to Top of Bentonite	3.0 ft. ____ cm.	Water added during drilling	~ 50 gal
		Total Gallons of water added	~ 160 gal

Drill Site Geologist _____ Date 4/6/88

Date/Time/Personnel Internal Mortar, Cement Pad, and Weep Hole Installed Weep hole & internal mortar: 4/6/88 DLW & BR 13
Cement pad: 4/1/88 SMP & SCS 12

Date/Time/Personnel Casing Painted 4/1/88 SMP & SCS

Date/Time/Personnel Numbers Painted 4/6/88 SMP & BW 1300

Materials Used 10 BW 8 bags Sacrete

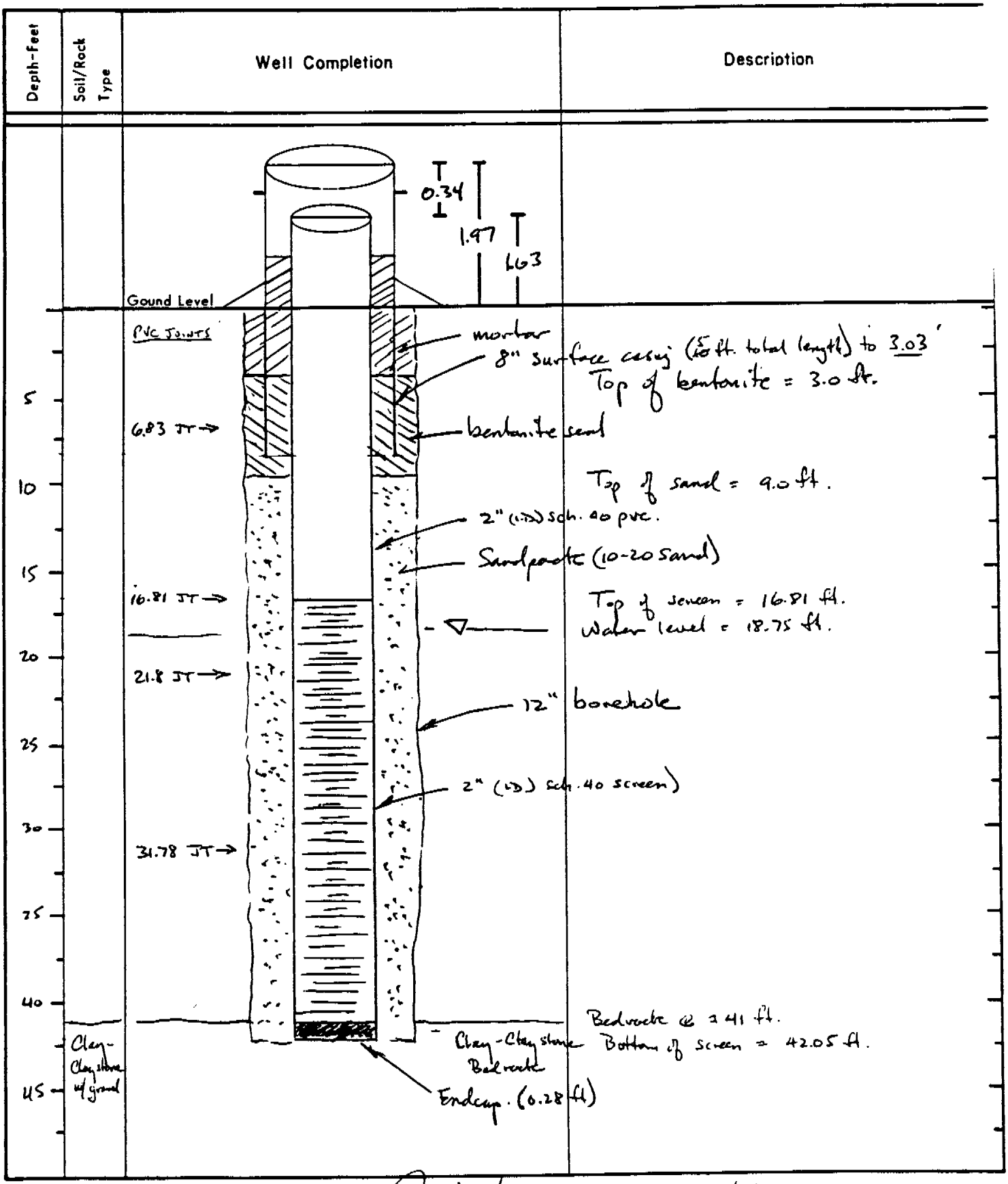
Top of Protective Casing to Top of PVC	0.34 ft. ____ cm.	COMMENT/NOTES	
Top of Protective Casing to Weep Hole	1.49 ft. ____ cm.		
Top of Protective Casing to Internal Mortar	1.51 ft. ____ cm.		
Top of Protective Casing to Top of Cement Pad	1.79 ft. ____ cm.		
Top of Protective Casing to Ground Level	1.97 ft. ____ cm.		

Reviewed By _____ Date 4/25/88

Drill Site Geologist _____ Date 4/6/88

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ENGLEWOOD, COLORADO 80112 • 303/741-0639

Borehole: E-53 08-2 Well: 37401



Drill Site Geologist: _____ Date: 4/6/88

Reviewed By: _____ Date: 4/25/88

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Borehole: E-53 ~~SB~~-2 Well Number: 37401

Depth - feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
0					SC	SAND, 40% clay, fine to medium grained sand, 10 YR 4/4, dark yellowish brown, moist, low plastic, med stiff.
1	① 0 - 2.0'	2.0/2.0	1	0-2.0'		
2						
3	② 2.0' - 4.0'	1.1/2.0	2		SM	SAND, 25% silt, fine to medium grained sand, 10 YR 6/4, light yellowish brown, med stiff, light moist, v. low plastic
4						
5		0/2.0		Same as tube interval		
6						
7	③ 4.0' - 8.0'	.5/2.0	3			
8						
9	④ 8.0' - 12.0'	2.0/2.0	4		SC	SAND, 20% clay, fine to medium grained sand 10 YR 5/4 yellowish brown, stiff, moist, medium plastic
10	SB					

Drill Site Geologist: Dave West logged by Hanford Date: 4/15/88

Reviewed By: [signature] Date: 4-20-88

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Borehole: E-5308-2 Well Number: 37401

Depth-Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
10					SC	SAND, 20% clay, fine to medium grained, 10YR 5/4 yellowish brown, stiff, moist, medium plastic
11	5 8.0' to 12.0'	1.4/2.0				
12						No Recovery 12-15'
13		0/2.0				
14						
15	6 12.0' - 16.0'	0.8/2.0			SC	SAND, 40% clay, fine to coarse grained sand, 10YR 7/3 very pale brown, stiff, moist, medium plastic, calc.
16						
17	7	2.0/2.0				at 16.5' SAND, 25% clay, fine to coarse grained sand, 10YR 5/4 yellowish brown, stiff moist, medium plastic, calc.
18						
19	8 16.0' - 20.0'	2.0/2.0				
20						20'

Drill Site Geologist: Dave West logged by Steve Pace Date: 4/15/88

Reviewed By: [signature] Date: 4-26-88

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Borehole: F-53-087 Well Number: 37401

Depth – Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
20						No Recovery 20-21
21	(9) 21.0' - 24.0'	1.1/2.0			SP	SAND, 3% silt, fine to coarse grained, 10YR 5/4 yellowish brown, loose, saturated, non plastic
22					SM	SAND, 10% silt, fine to medium grained sand 10YR 5/4 yellowish brown, loose, saturated, non-plastic
23	(10) 20.0'	2.0/2.0			SC	SAND, 20% clay, fine to v. coarse sand, occ. small gravel, 10YR 6/4 light yellowish brown, med dense, v. moist, low plastic
24						No Recovery 24-26'
25	(8)	0/2.0				
26					SP	SAND, 3% silt, fine to very coarse grained, 5% small gravels, 10YR 6/4, light yellowish brown, med dense, saturated, non plastic
27	(11) 24.0' - 28.0'	2.0/2.0				
28						No Recovery 28-33.5'
29	28.0' - 32.0'	0.0/2.0				
30						

Drill Site Geologist: Dave West logged by Alan Parr Date: 4/15/88

Reviewed By: [signature] Date: 4-20-88

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Borehole: E-53-08-2 Well Number: 37401

Depth-Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
30						No Recovery 28-33.5'
31	28.0' - 32.0'	0/2.0				
32						
33	32.0' - 34.0'	0.4/2.0				
					GC	Gravel, 5% Clay, small to medium (1") gravel, 10YR 5/3, brown dense, saturated
34					SP	SAND, 5% silt, fine to very coarse grained sand, 5% gravel, small to medium gravel (2"), 10YR 5/3, brown dense, saturated
35	34.0 - 36.0	1.2/2.0	Same as Tube #8	Same as tube SP interval		
36						
37						
38	36.0' - 40.0'	0/4.0				
39						
40						Claystone bedrock, 5YR 5/3 olive, weathered Fe stains
	40.0' - 42.0'	1.1/2.0				
42						TOTAL DEPTH 42'

Drill Site Geologist: Dave West logged by [illegible] Date: 4/15/88

Reviewed By: [signature] Date: 4-20-88

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WELL CONSTRUCTION SUMMARY

Borehole E-55A JR Well E55A #3782

Project Name and Location T-36 1/4 mile E of Yellowcake on 92nd Project Number 17053.074.10

Drilling Company Boyles Bros Driller Dave Jarvis Rig Number 5451 & 5452

Drilling Method(s) Auger

Borehole Diameter 12¼ in. ____ cm. ____ ft. ____ cm. to 49.5 ft. ____ cm.
____ in. ____ cm. ____ ft. ____ cm. to ____ ft. ____ cm.

Size(s) and types of Bit(s) ____

Size and Type PVC 4" .020 s/or

Total Borehole Depth 50.0 49.5 ft. ____ cm.

Depth to Bedrock 49 ft. ____ cm.

Depth to Water 37 ft. ____ cm.

Water Level Determined By Samples

Length Plain PVC (total) 35.25 ft. ____ cm.

Length of Screen 16.45 ft. ____ cm.

Total Length of Well Casing 51.7 ft. ____ cm.

PVC Stick Up 1.7 ft. ____ cm.

Depth to Bottom of Screen 50 ft. ____ cm.

Depth to Top of Screen 33.55 ft. ____ cm.

Depth to Top of Sand 28.5 ft. ____ cm.

Depth to Top of Bentonite 23.0 ft. ____ cm.

Sampling Method(s) Continuous Split Spoon

Date/Time Start Drilling 3/27 0905

Date/Time Finish Drilling 3/31 1000 (inclusive dates)

Date/Time Start Completion 3/31 1000

Date/Time Cement Protective Casing 3/31 1245

Materials Used 11 4' tubes 5 boxes

Plain PVC 4-10' pieces

Slotted PVC 1-10', 1-5'

Bentonite Pellets 5 Buckets

Bentonite Granular 50 lbs

Cement 11 bags

Sand 14 bags

Water added during completion 25 ~~20~~ gals

Water added during drilling 15 10 gals above ground

Total Gallons of water added 40 gals

Drill Site Geologist Greg Lett

Date 3/31/87

Date/Time/Personnel Internal Mortar, Cement Pad, and Weep Hole Installed 04/08/87 11:00 PJB

Date/Time/Personnel Casing Painted 04/08/87 14:00 PJB

Date/Time/Personnel Numbers Painted 04/17/87 0930 PJB

Materials Used 14 Bags Quick-Crete ½ Bag Cement ½ Bag Sand

Top of Protective Casing to Top of PVC 0.45 ft. ____ cm.

Top of Protective Casing to Weep Hole 1.1 ft. ____ cm.

Top of Protective Casing to Internal Mortar 1.2 ft. ____ cm.

Top of Protective Casing to Top of Cement Pad 1.9 ft. ____ cm.

Top of Protective Casing to Ground Level 2.1 ft. ____ cm.

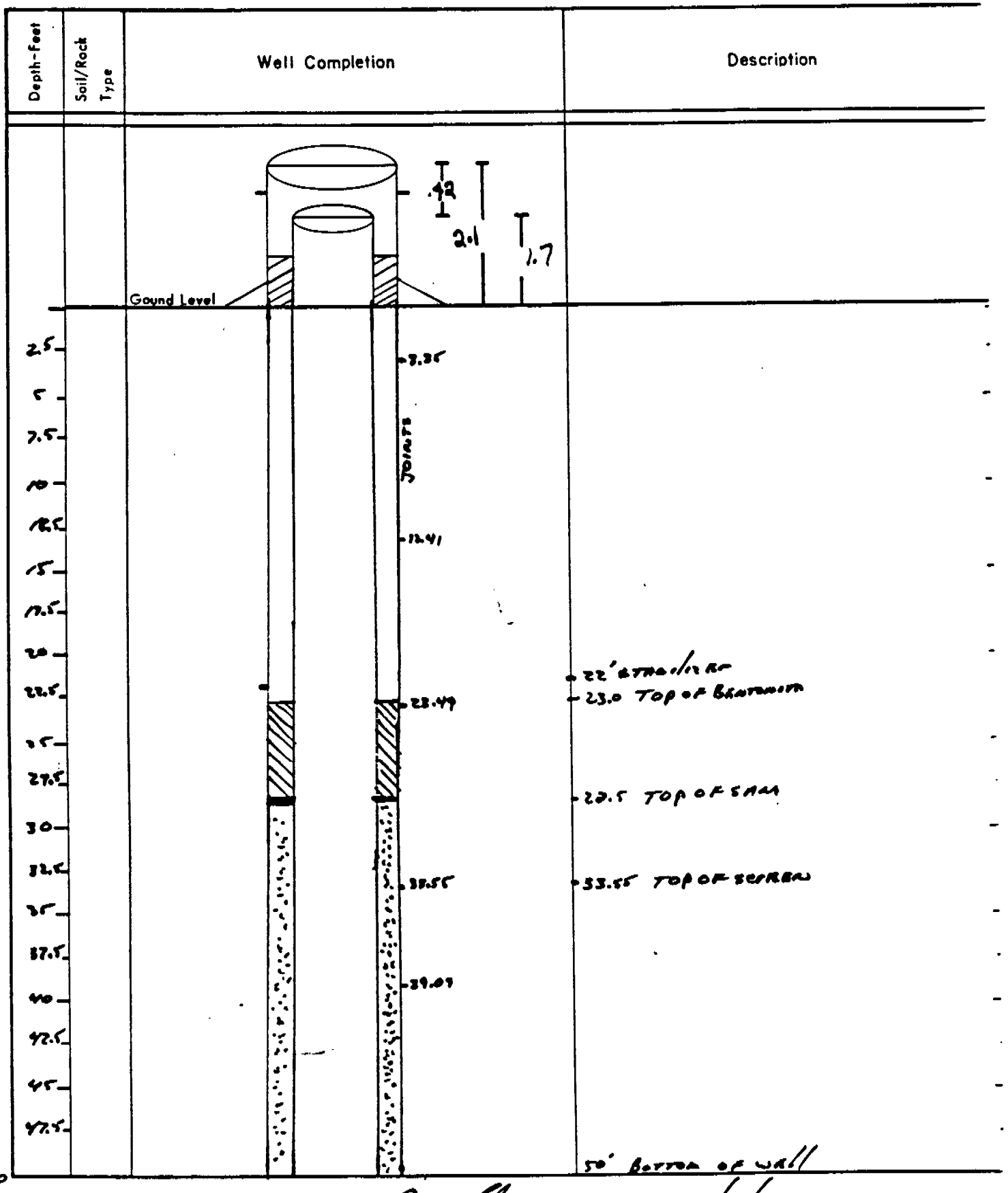
COMMENT/NOTES

Reviewed By Joseph L. Reid Date 4/20/87

Drill Site Geologist ____ Date ____

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Borehole: E-55A Well: E55A 37382



Drill Site Geologist: [signature] Date: 3/31/87

Reviewed By: Joseph L. Rud Date: 4/20/87

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SHEET 1 OF 3

Borehole: ESSA Well Number: 37382

Depth - Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
2	C. 2	100%		0. 2	ML	SILTS with 10% fine sand, 10% clay, roots occas. 2.5y 3/2 very dark grayish brown, loose ~~to dense~~ soft, nonplastic moist → sl. cheesie (soft)
4	2- 4	100%		2- 4	SM	Silty sands - 10% silt, 3-5% clay, 2.5y 4/4 olive brown, loose to medium dense, nonplastic, dry
6	4- 6	80%		4- 6		occas. CaCO3-rich areas visible (pervasive white)
8	6- 8	100%		6- 8	SW	SANDS - 2% silt, 2.5y 5/6 light olive brown, loose, to med dense, nonplastic, sl. moist
10	8- 10	100%		8- 10		
12	10- 12	100%		10- 12	SM	Silty SANDS - 10% silt, 5% clay, 2.5y 5/6 light olive brown,
	12- 14	100%		12- 14		Medium dense, nonplastic, moist occas. CaCO3-rich areas
14	14- 16	106%		14- 16		% of ~~silts~~ decreasing gradually samples dry beginning at 14'
16	16- 18	100%		16- 15		
18	18- 20	100%		18- 20	SW	SANDS - 2.5y 5/6 light yellowish brown, loose, nonplastic moist
20	20- 22	100%		20- 22		

Drill Site Geologist: [signature] Date: 5.31.97

Reviewed By: [signature] 6/11/97

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
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Borehole: E-55A Well Number: 37382

Depth-feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
22	22 24	100%		22 24	SW	SANDS - 5% small gravel (basalt), 2.5y 6/4 light yellowish brown, loose, nonplastic, moist
24	24 26	80%		24 26		25.5'
26	26 28	100%		26 28	ML	SILT - 10% fine sand, 5% clay, 2.5y 4/4 olive brown, dry (cohesive), nonplastic, moist
28	28 30	100%		28 30		
30	30 32	100%		30 32		CaCO3 - rich area - bleached calcite - ± 30.6 to 31'
32	32 34	100%		32 34	SP	31.4 - 31.6 sandy; gravelly seam coal/lignite smear on sample 32.5 Gravelly, sands - small to ½" gravel ≈ 20%, 10yr 4/6 dark yellowish brown, loose, nonplastic, moist
34	34 36	50%		34 36		moisture increases at 34' most gravel well-rounded, milky quartz
36	36 38	50%		36 38		gravel larger than previously (avg. ½" to 1") and 20 - 40% of sample
38	38 40	0%		38 40		NO SAMPLE - no recovery
40	40 41.5	50%		40 41.5		one cobble in sample = 2" across well rounded
42	41.5 43.5	25%		41.5 43.5		cobbles 1" to 2" about 15% of sample - most subrounded
44					SS	BEDROCK / TOP OF WATER TABLE

Drill Site Geologist: C Bell Date: 3-21-87

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
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Borehole: _____ Well Number: 37382

Depth-Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
44	43.5 to 45.5	100%		43.5 to 45.5	SS	SANDSTONE BEDROCK 10yr 4/6 dark yellowish brown, moderately indurated (friable), massive, saturated
46	45.5 to 47.5	100%		45.5 to 47.5		} sandstone very Friable Rock not well indurated course sandstone (small lenses are conglom FeOx staining common on some pebble-size clasts & cement
48	47.5 to 49.5	50%		47.5 to 49.5	CS	49' — CLAYSTONE 10yr 3/3 Dark brown, soft
50						END OF BORING AT 49.5'

Drill Site Geologist: C Reed Date: 3.31.87

Reviewed By: Jack T. Reed Date: 4/16/87

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
7332 SOUTH ALTON WAY • SUITE H-1
ENGLEWOOD, COLORADO 80112 • 303/741-0639

WELL CONSTRUCTION SUMMARY

Borehole E-58 Well 37368

Project Name and Location TASK 39: OFFPOST / PEORIA 1/4 MI. W. OF 2 Project Number 86 9460210

Drilling Company BOYLES BROS. Driller DOUG JARVIS Rig Number B-57 5451

Drilling Method(s) HOLLOW STEM AUGER

Borehole Diameter 12 1/4 in. ____ cm. 0.0 ft. ____ cm. to 33.7 ft. ____ cm.
____ in. ____ cm. ____ ft. ____ cm. to ____ ft. ____ cm.

Size(s) and types of Bit(s) 8 1/4 I.D., 12" OD HOLLOW STEM AUGER

Size and Type PVC 4" SCHEDULE 40

Total Borehole Depth 34.8 ~~33.7~~ ft. ____ cm.

Depth to Bedrock 34.0 ft. ____ cm.

Depth to Water 25.0 ft. ____ cm.

Water Level Determined By SAMPLE INSPECTION

Length Plain PVC (total) 19.78 ft. ____ cm.

Length of Screen 16.19 ft. ____ cm.

Total Length of Well Casing 35.97 ft. ____ cm.

PVC Stick Up 1.7 ft. ____ cm.

Depth to Bottom of Screen 34.27 ft. ____ cm.

Depth to Top of Screen 18.08 ft. ____ cm.

Depth to Top of Sand 12.8 ft. ____ cm.

Depth to Top of Bentonite 7.8 ft. ____ cm.

Sampling Method(s) CONTINUOUS AUGERING

Date/Time Start Drilling 12-19-86 / 1300

Date/Time Finish Drilling 12-22-86 / 1000

Date/Time Start Completion 12-22-86 / 1000

Date/Time Cement Protective Casing 12-22-86 / 1145

Materials Used

Plain PVC 2 - 10' SECTIONS

Slotted PVC 1 - 10' AND 1 - 5' SECTION

Bentonite Pellets 4.25 BUCKETS

Bentonite Granular 20 lb.

Cement (4) ~~60 lb.~~ BAGS

Sand 13.25 BAGS

Water added during completion 15 GAL.

Water added during drilling 4.5 GAL

Total Gallons of water added 19.5 GAL

Drill Site Geologist M. Mynill Date 12-22-86

Date/Time/Personnel Internal Mortar, Cement Pad, and Weep Hole Installed ____

Date/Time/Personnel Casing Painted ____

Date/Time/Personnel Numbers Painted ____

Materials Used ____

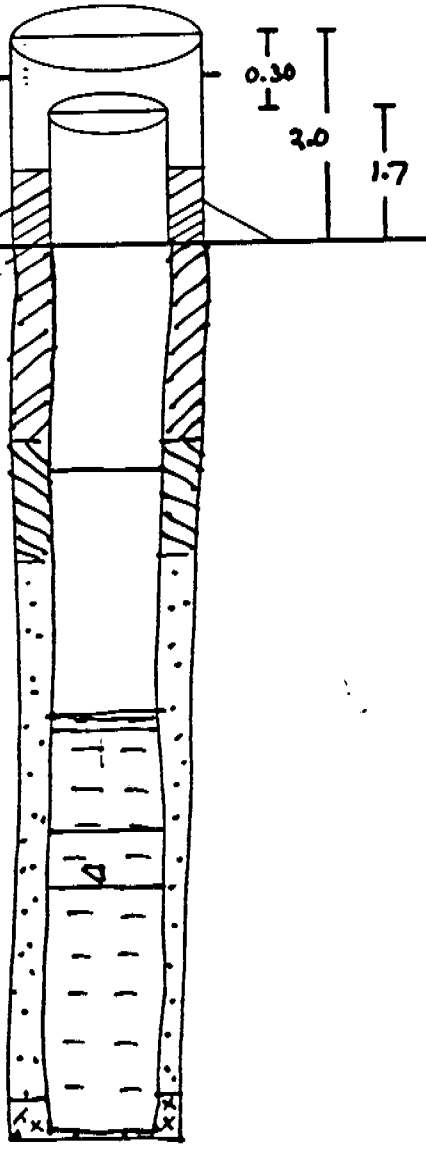
Top of Protective Casing to Top of PVC	2.30 ft.	____ cm.	COMMENT/NOTES
Top of Protective Casing to Weep Hole	1.29 ft.	____ cm.	____
Top of Protective Casing to Internal Mortar	1.25 ft.	____ cm.	____
Top of Protective Casing to Top of Cement Pad	1.85 ft.	____ cm.	____
Top of Protective Casing to Ground Level	2.00 ft.	____ cm.	____

Reviewed By Joseph R. Reed Date ____

Drill Site Geologist ____ Date ____

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Borehole: E-58 Well: _____

Depth-Feet	Soil/Rock Type	Well Completion	Description
0			GROUT FROM 7.8' TOP OF BENTONITE SEAL = 7.8' JOINT = 8.04' TOP OF SAND = 12.8' TOP OF SCREEN = 18.08' / JOINT JOINT 23.5 WATER LEVEL = 25.0' BEDROCK = 34.0' BOTTOM OF SCREEN 34.27 T.D. = 34.3'
5			
10			
20			
30			
40			

Drill Site Geologist: _____ Date: _____

Reviewed By: _____ Date: _____

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Borehole: E58 Well Number: 37368

Depth-feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
0		1.0'	E58 (All sample numbers accel-x)	0-2'	CL	CL, sandy clay, 15% vfg sand, 10YR 3/3 dark brn, med plast, med stiff, moist Alluvium
1.0						
2.0		.5'		2-4'	ML	ML, sandy silt, 10% vfg sand, ~~non-plast, med-stiff~~ WDA 10YR 3/4 dark yosh brn, non-plast, med-stiff moist Alluvium
3.0						
4.0		.2'		4-5'		
5.0		.5'		5-6'		color change 10YR 5/4 yosh brn
6.0						

Drill Site Geologist: W. Grunstead Date: 12/22/86

Reviewed By: _____ Date: _____

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Borehole: E 58 Well Number: 37368

Depth - Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
6.0		.5'		6-7.0'	CL	CL, sandy clay, 30% vfg sand, 10YR 4/4 dark yush brn, med plast, med-stiff moist Alluvium
7.0		.65'		7-9.0		color change to 10yr 5/4 yush brn silty clay
8.0						
9.0		.45'		9-10.0		Sandy clay, 20% vfg sand
10.0		.70'		10-11.0'	SC	SC, clayey sand, 40% clay, 10YR 4/4 dark yush brn, low plast., med stiff moist Alluvium
11.0		.65'		11-12.0'		
12.0						

Drill Site Geologist: W Armistead Date: 12/22/86

Reviewed By: _____ Date: _____

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Borehole: E 5 J Well Number:

Depth-Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
12.0		.6'		12-13.0	SC	SC Clayey sand, 10% clay vf-fg sand, 10YR5/6 yellowish brn, non-plast, loose, moist Alluvium
13.0		.45'		13-14.0'		
14.0		.8'			SM	SM, silty sand, 15% silt, fg 10YR5/4 yellowish brn, non plast Loose, moist Alluvium
15.0		NO REC		15-18.0		NO RECOVERY
16.0						
17.0						
18.0						

Drill Site Geologist: W. Armstead Date: 12/22/86

Reviewed By: Date:

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Borehole: E-58 Well Number: 37368

Depth-Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
18.0		.85'		18-20.1'	SP	SP, poorly graded, f-m g sand 10YR 5/4 yowsh brn, non plast, LOOSE moist Alluvium
19.0						
20.0		1.0'		20-22'	SW	SW, well graded f-c.g. 10YR 6/4 lt. yowsh brn, non-plast, Loose, moist Alluvium
21.0						
22.0		.8'		22-24'		moisture increase to WET
25.0						
24.0						

Drill Site Geologist: W. Armstead Date: 12/22/86

Reviewed By: Date:

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Borehole: E58 Well Number: 37368

Depth-Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
24.0		1.1'		24-26'	SW	SW – color change 10YR 4/4 dark yowsh brn
24.5						moisture increase to saturated water table at 24.5
25.0						
26.0		1.5'		26→ 27.5'		SP, poorly graded, m-c grained 10YR 4/4 yowsh brn non-plast loose saturated Alluvium
27.0						
28.0		1.6'		27.5- 28.5	SP	SP, poorly graded sand, m-c grained, 10YR 4/4 yowsh brn, non-plast, loose, saturated Alluvium (0.6' slough)
29.0		1.6'		28.5- 30.0		
30.0		1.5'		30.- 31.5'		
31.0						
32.0		0.0		31.5→ 32.0		NO RECOVERY
		2.0		32- 34.0	SP	SP, poorly graded sand, c-g. 10YR 4/4 yowsh brn, non-plast loose saturated Alluvium
33.0						
33.8						claystone bedrock at 33.8'
34.0						END OF BORING LOG

WJA-

Drill Site Geologist: W. Armstead Date: 12/22/86

Reviewed By: Date:

-8

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
7332 SOUTH ALTON WAY • SUITE H-I
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WELL CONSTRUCTION SUMMARY

Borehole E-39 Well 3739.5

Project Name and Location RMA T39, offpost alluvial Project Number 17053.075.10

Drilling Company Boyles Brothers Driller D. Ecrio Rig Number E.R. TH-60

Drilling Method(s) 12½" O.D. H.S. Auger with 2' x 2" split spoon sample barrel

Borehole Diameter 12½ in. ___ cm. 0 ft. ___ cm. to 44.96' ft. ___ cm.
~ in. ___ cm. ~ ft. ___ cm. to ___ ft. ___ cm.

Size(s) and types of Bit(s) 8" O.D. center bit

Size and Type PVC 4" I.D. Sch. 40

Total Borehole Depth	44.96 ft.	___ cm.	
Depth to Bedrock	44.50 ft.	___ cm.	
Depth to Water	25.80 ft.	___ cm.	
Water Level Determined By	sample saturation		
Length Plain PVC (total)	~~18.83~~ 19.89 ft.	JTP ___ cm.	
Length of Screen	26.67 ft.	___ cm.	
Total Length of Well Casing	46.56 ft.	___ cm.	
PVC Stick Up	1.60 ft.	___ cm.	
Depth to Bottom of Screen	44.96 ft.	___ cm.	
Depth to Top of Screen	18.29 ft.	___ cm.	
Depth to Top of Sand	12.85 ft.	___ cm.	
Depth to Top of Bentonite	6.00 ft.	___ cm.	

Sampling Method(s) Push sample w/ 2' barrel

Date/Time Start Drilling 12/14/87 1425

Date/Time Finish Drilling 12/15/87 1526

Date/Time Start Completion 12/16/87 0902

Date/Time Cement Protective Casing 12/17/87 0845

Materials Used 5' 8" ID steel csg. protective

Plain PVC 19.89'

Slotted PVC 26.67'

Bentonite Pellets 30 gal 3/8" slope indicator

Bentonite Granular ⅓ bag (50# bag)

Cement 3 bags (100# bag) Type II Mountain

Sand 20¼ bags (100# bag) 10-20 CSSF

Water added during completion ~75 gal

Water added during drilling ~25 gal

Total Gallons of water added 100 gal

Drill Site Geologist Craig F Pearce Date 12-17-87

Weep hole: 3-14-88/1425/DW & BW

Date/Time/Personnel Internal Mortar, Cement Pad, and Weep Hole Installed 3/11/88 1000 FJ/RP

Date/Time/Personnel Casing Painted 3/11/88 1100 FJ/RP

Date/Time/Personnel Numbers Painted ~~3/11/88 1105 FJ/RP~~ DW 3-14-88/1425/DW & DL

Materials Used 8 bags of sakrete

Top of Protective Casing to Top of PVC	0.28 ft.	___ cm.	COMMENT/NOTES
Top of Protective Casing to Weep Hole	1.48 ft.	___ cm.	
Top of Protective Casing to Internal Mortar	1.51 ft.	___ cm.	
Top of Protective Casing to Top of Cement Pad	1.72 ft.	___ cm.	
Top of Protective Casing to Ground Level	1.75 ft.	___ cm.	

Reviewed By [signature] Date 3/16/88

Drill Site Geologist ___ Date ___

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Borehole: E-59 Well: 37395

Depth-Feet	Soil/Rock Type	Well Completion	Description
		8" I.D. steel csg.	Set 5' length 8" I.D. steel csg to 3',
		4" I.D. sch. 40 PVC	4" I.D sch. 40 PVC from 1.6' above ground to 18.29' below ground.
		0.4 / 2.0 / 1.6	4" I.D. Johnson Environ. Screen from 18.29' below ground to TD @
		Gound Level	
	Silty-sands		Bottom 8" protective csg: 3.0
			Top of bentonite: 6.00'
	Sand	Jt. 8.27	
10	clayey silts		Top of sand: 12.85'
	Silty-clay		
	Sands mainly sorted	Jt. 18.29	Top of screen: 18.29'
20			
	Silty-clay	Jt. 23.76	
	Clayey silts		
	Silty-sand		
	Sand		
	Silty-sandy clay		
30	Sands		
	Silty-sands		
		Jt. 34.28	
	no recovery		
40			
44.5		Bedrock	Bedrock: 44.50'
	sandy clay w/Fe stain.		TD (4" ID PVC): 44.96'
50			

Drill Site Geologist: G.F. Evans Date: 12-17-87

Reviewed By: [signature] Date: 1/7/87

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Borehole: E-52 offpost RFI/A 739 Well Number: 37395

Depth-Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description Munsell Colors
0			NA		SM	Silty sands; 20-40% silt, vf-f grained sands, 10YR 3/3 dark brn, root frags to 1.0'; loose, non-plas, moist alluvium.
1	2-0	1.8		2-0		At 1.0'; silty sands, 10-30% silt, vf f sands, color changes to 10YR 4/4, 3 brn to dark yellowish brn, occ root frags, loose non-plas, moist alluvium.
2						
3	4-2	1.7		4-2		
4						
5	6-4	2.0'		6-4		
6						

Drill Site Geologist: JJ Equice Date: 12-17-87

Reviewed By: [signature] Date: 1/9/87

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Borehole: E-59 Offpost Well Number: 37395

Depth-Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
6			NA			
7	8-9 8	1.8		8-9		
8						
8	9-10 9	1.8		9-10	SP	At 8.6'; ~~SP~~ poorly graded sands, 10-20% med-coarse grained sand, 10YR 9/3, brn-dk brn, loose, non-plas, moist alluvium.
9					ML	At 8.8'; clayey silts, 10-20% clay, trace v.f. sand, 10YR 5/3 brn, mottled w/ $CaCO_3$ 10YR 7/3, v. pale brn, loose, v-sl. plas, moist alluvium.
10						
11	11-12 12	1.7		11-12		At 11.0'; $CaCO_3$ absent
12						

Drill Site Geologist: C. T. Pearce Date: 12-17-87

Reviewed By: [signature] Date: 1/9/88

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Borehole: E-59 DMA T39 Well Number: 37395

Depth - Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
12			NA			At 12.0'; clayey silts, clay increases to 20-30%, 10YR 5/4, yellowish brn, soft, sl plas, moist alluvium.
13	#1-21	2.0'		#1-21		
14						
15	#1-16	2.0'		#1-16	CL	At 15.2'; silty clay, 20-30% silt, fr vf-f grained sand. 10YR 5/4, yellowish brn, sl stiff, sl plas, moist alluvium.
16						
17	#1-18	2.0'		#1-18	SP	At 16.2'; poorly graded sand, 10-20% vf 10-20% med grained, 60-80% fine grained 10YR 6/4 light yellowish brn, loose non-plas, moist alluvium.
18						

Drill Site Geologist: J.F. Pearce Date: 12-17-87

Reviewed By: [signature] Date: 1/9/87

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Borehole: E-59 RMA T39 Well Number: 37395

Depth-Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
18			NA			No Recovery
19						
19.4	19.4-21	1.8		19.4-21	SP	At 20.0'; pred. med sand, 20-30% coarse grained, some vf & v. coarse grains, subrounded, 10YR 6/4, lt. yell. brn, loose, non-plas, moist alluvium.
20						
21						At 21.2', pred. coarse grained, sm v c. sands
22	21-23	2.0		21-23	CL	At 22.2'; inorganic silty clay, 10-20% silt, 10YR 5/3 brown, soft, sl-med plas, moist alluvium.
23	23-25	1.8		23-25	ML	At 23.5', clayey ~~silt~~ silts, 10-30% clay, 10YR 5/4, yell. brn, loose, sl plas moist alluvium.
24						

Drill Site Geologist: [signature] Date: 12-17-87

Reviewed By: [signature] Date: 1/9/87

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Borehole: E-59 RMA T39 Well Number: 37395

Depth - Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
24	23-25	1.8		23-25	SM	At 24.0'; silty sand, 30-40% silt, 10YR5/4 yell. brn, loose, non plas, moist alluvium.
25						No Recovery
26	25.5-27.	1.5		25.5-27	SP	At 25.5'; poorly graded sands, pred med, 10-20% coarse, 10-20% vf., some v. coarse, 10YR5/4 yell. brn. loose, wet, alluvium. saturated at 25.8. Water Table @ 25.8'
						At 26.9'; clayey silts, 20-40% clay, 10YR5/3 brn, soft. sl. plas, saturated alluvium.
27					ML	No Recovery
28	27.5-29	1.5		27.5-29	CL	At 28.0'; sandy clay, 10-20% sand (pred f-vf), 10YR5/3 brn, sl stiff, sl plas, saturated alluvium. ~~At 28.5'~~ At 28.8'; occ. mottled CaCO3, 10YR7/3 v. pale brn.
29	29-31	2.0'		29-31	SP	At 29.2'; poorly graded, subrounded, ~~f-pc~~ ~~coarse~~ sands, 10YR5/4 yell. brn, pred med grained loose, non-plas, saturated. alluvium. At 29.8'; predom. coarse sands
30						

Drill Site Geologist: AJP Date: 12-17-87

Reviewed By: [signature] Date: 1/9/88 ED

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Borehole: E-59 Well Number: 37395

Depth - Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
30			NA 1			At 30.0'; predom. v.c. sands.
					CL	At 30.2'; silty clay, 10-30% silty, 10YR 5/4 brn, sl stiff, sl plas, saturated alluvium.
31					SM	At 31.0'; silty sands, 20-40% silt, poorly graded w/ predom f-m. grained sand, some coarse to vc. sands, 10YR 5/3 brn, loose, non plas, saturated alluvium.
	31-32	1.0		31-32		
32						No Recovery 32.0 – 44.5'
						No Recovery 32.0 – 44.5'
44						
44.5					CL	At 44.5'; sandy clay, 10-20% vf-f grained sand, 10YR 5/3; 4 brn-dk brn, stiff, sl plas, abund Fe staining 10YR 6/8 brn yell. occ carbonaceous flakes,
45	44.5-45.5	1.0		44.5-45.5		
45.5						END OF BORING LOG

Drill Site Geologist: J. T. Pearce Date: 12-17-87

Reviewed By: [signature] Date: 1/9/87

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WELL CONSTRUCTION SUMMARY

Borehole E-63A Well 37389

Project Name and Location Task 39 Project Number

Drilling Company Boyles Bros Driller Dave Jarvie Rig Number 5451

Drilling Method(s) Auger

Borehole Diameter 7 1/4 OD in. ____ cm. 0 ft. ____ cm. to 36.0 ft. ____ cm.
reamed to 12 1/4 OD in. ____ cm. 0 ft. ____ cm. to 36.0 ft. ____ cm.

Size(s) and types of Bit(s) ____

Size and Type PVC 4" Sch. 40

Total Borehole Depth 36.0 ft. ____ cm.

Depth to Bedrock ~34cm 23.5 ____ cm.

Depth to Water ~9 ft. ____ cm.

Water Level Determined By Sample saturation

Length Plain PVC (total) 10.1 ft. ____ cm.

Length of Screen 26.8 ft. ____ cm.

Total Length of Well Casing 36.9 ft. ____ cm.

PVC Stick Up 1.7 ft. ____ cm.

Depth to Bottom of Screen 35.2 ft. ____ cm.

Depth to Top of Screen 8.4 ft. ____ cm.

Depth to Top of Sand 7.1 ft. ____ cm.

Depth to Top of Bentonite 3.0 ft. ____ cm.

Sampling Method(s) 2 ft wire-line runs

Date/Time Start Drilling 4/22 1212

Date/Time Finish Drilling 4/22 1402

Date/Time Start Completion 4/23 1140

Date/Time Cement Protective Casing 4/23 1405

Materials Used

Plain PVC 1X10'

Slotted PVC 1X5', 2X10'

Bentonite Pellets 1 1/2 buckets

Bentonite Granular 2 bags X50#

Cement ~~15 1/2 bags X94#~~ 2 bags X94#

Sand 15 1/2 bags X94# (7 more before redrill)

Water added during completion Ø

Water added during drilling 20 gallons *0% returned

Total Gallons of water added Ø

Drill Site Geologist K.J. Mathews

Date 4/2

Date/Time/Personnel Internal Mortar, Cement Pad, and Weep Hole Installed RAG 5/19/87

Date/Time/Personnel Casing Painted 06 03 87 1315 PJB WTV

Date/Time/Personnel Numbers Painted 06 16 87 930 PJB DLW

Materials Used 12 Bags Quikcrete 1 Bag Sand 1 Bag Cement

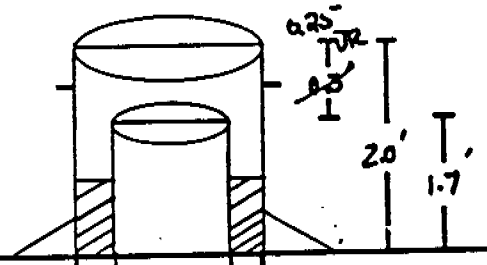
			COMMENT/NOTES
Top of Protective Casing to Top of PVC	.25 ft.	____ cm.	
Top of Protective Casing to Weep Hole	1.12 ft.	____ cm.	
Top of Protective Casing to Internal Mortar	1.15 ft.	____ cm.	
Top of Protective Casing to Top of Cement Pad	1.54 ft.	____ cm.	
Top of Protective Casing to Ground Level	1.95 ft.	____ cm.	

Reviewed By Joseph L. Reed Date 7/8/87

Drill Site Geologist K.J. Mathews Date 7/8/87

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Borehole: E-63A Well: 37389

Depth-Feet	Soil/Rock Type	Well Completion	Description
			

Bottom of grout 7.1'
Top of sand pack 7.1'
Top of ~~sand pack~~ screen 8.4'

Bottom of screen 35.2
Bottom of hole 36.0'

Drill Site Geologist: K.A. Mattson Date: 7/8/87
Reviewed By: Joseph L. Reed Date: 7/9/87

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BR. = 23.5'

Borehole: E-63A Well Number: 37389 PRG 9/15-187

Depth-Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
0	1, 2-0	2.0'	N/A	1, 2-0	ML	ML - clayey silt. ~20% clay. 10YR3/3 dk brown. Loose. Slightly plastic. Moist. Alluvium. Occasional white inclusions.
3	2, 4-2	1.5'		2, 4-2	SM	SM - silty sand. ~20% silt in f. gr. sand. 10YR4/4 dk yellowish brown. Loose. Non-plas. Wet. Alluvium.
5	3, 6-4	2.0'		3, 6-4	ML	ML - sandy clayey silt. ~10% f. gr. sand; ~20% clay. 10YR6/3 pale brown. Loose. Slightly plastic. Wet. Alluvium. Grades into sand below.
7	4, 8-6	1.3'		4, 8-6		~8' Water table noted in field.
9	5, 10-8	1.5'		5, 10-8	SM	SM - silty sand. ~15% silt in f.g. sand. 10YR6/4 light yellowish brown. Loose. Non-plas. Wet. Alluvium
11	6, 12-10	2.0'		6, 10-12		

LAB
~~Drill Site~~ Geologist: K.J. Matthews Date: 4/29/87

Reviewed By: Joseph L. Reed Date: 7/9/87

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Borehole: E-63A Well Number: 37389

Depth-Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
11						
	21-01	2.0'	N/A	21-01	SM	
12						From 12'-~~23.5~~ LKJm 23.5' sands become fine to medium grained.
	41-21	4.1'		41-21		
13						
14						
	61-41	2.0'		61-41		
15						
16						
	81-61	1.1'		81-61		
17						
18						
	101-81	2.0'		101-81		
19						
20						
	121-101	2.0'		121-101		
21						
22						

LAB
~~Drill Site~~ Geologist: K.J. Matthews Date: 4/25/87

Reviewed By: Joseph L. Reed Date: 7/9/87

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Borehole: E-63A Well Number: 37389

Depth - Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
22						
	22'-24'	1.4'	N/A	22'-24'		
23						Bedrock = 23.5' PRG
23.5					ML	ML - clayey silt. ~40% clay. Trace f.gr. sand. 10YR 4/1 dk. yellowish brown. Loose. Slightly plas. wet. Alluvium.
24	24'-26'	2.0'		24'-26'		At 25': Fine grain sand increases to ~10% qtz, mica.
25						
26	26'-28'	2.0'		26'-28'		
27						
28	28'-30'	2.0'		28'-30'		At 28': Fine grained sand increases to ~15%. Includes qtz, mica. Color has tint of orange; black deposits. Non-plastic.
29						
30	30'-32'	1.4'		30'-32'		
31						
32	32'-34'	2.0'		32-34'		
33						

(AB)
~~Drill Site~~ Geologist: K.J. Mathews Date: 4/29/87

Reviewed By: Joseph L. Reed Date: 7/9/87

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Borehole: E-63A Well Number: 37389

Depth - Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
33						
	32'-34'	2.0'	N/A	32'-34'	ML	ML - sandy silt. ~40% f.gr. sand. Trace clay. 2.5YR5/2 grayish brown. Loose. Non-plastic. Moist. Alluvium. Interbeds with clay below.
34						
	34'-36'	2.0'		34'-36'		
35					CL	CL - silty clay. ~40% silt. 10YR3/1 v.dk. gray. Med. dense. friable. Dry. Bedrock.
36						End of Boring

Drill Site Geologist: K.J. Mathews Date: 4/29/87

Reviewed By: Joseph L. Reed Date: 7/9/87

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WELL CONSTRUCTION SUMMARY

No record of MW10

Borehole EG3D1 Well 37390

Project Name and Location MW Installation Project Number T3a 17053074

Drilling Company Boyles Driller B. Roach Rig Number Failing 25

Drilling Method(s) rotary - bentonite mud

Borehole Diameter 7 7/8 in. ____ cm. 0 ft. ____ cm. to 26 ft. ____ cm.
3 7/8 in. ____ cm. 26 ft. ____ cm. to 46 ft. ____ cm.

Size(s) and types of Bit(s) 7 7/8" Blade

Size and Type PVC 4" Sched. 40

Total Borehole Depth 346 ft. ____ cm.

Depth to Bedrock 25 ft. ____ cm.

Depth to Water 3 ft. ____ cm.

Water Level Determinad By tape measure

Length Plain PVC (total) 41.32 ft. ____ cm.

Length of Screen 5.88 ft. ____ cm.

Total Length of Well Casing 47.7 ft. ____ cm.

PVC Stick Up 1.7 ft. ____ cm.

Depth to Bottom of Screen ~~45~~ 46 ft. ____ cm.

Depth to Top of Screen 40.12 ft. ____ cm.

Depth to Top of Sand 39 ft.* ____ cm.

Depth to Top of Bentonite 34 ft. ____ cm.

Sampling Method(s) not Sampled

Date/Time Start Drilling 4-23-87 0815

Date/Time Finish Drilling 4-23-87 0901

Date/Time Start Completion 4-23-87 0926

Date/Time Cement Protective Casing 4-23-87

Materials Used

Plain PVC 4 x 10' 1 x 3.5' (cut off and piece

Slotted PVC 1 x 5'

Bentonite Pellets 1 1/2 buckets

Bentonite ~~Granular~~ Powder 3/4 bags

Cement 7 1/2 bags

Sand 1 1/2 bags

Water added during completion 0

Water added during drilling 0

Total Gallons of water added 0

Drill Site Geologist C Benson Date 4-23-87

* sand pack usually 3-5 ft. but this smaller sand pack was done specifically at the request of ESE staff.

Date/Time/Personnel Internal Mortar, Cement Pad, and Weep Hole Installed 5/19/87 RAG

Date/Time/Personnel Casing Painted 06-03-87 WTV PJB 1315

Date/Time/Personnel Numbers Painted 06-22-87 DLW PJB 13:50

Materials Used

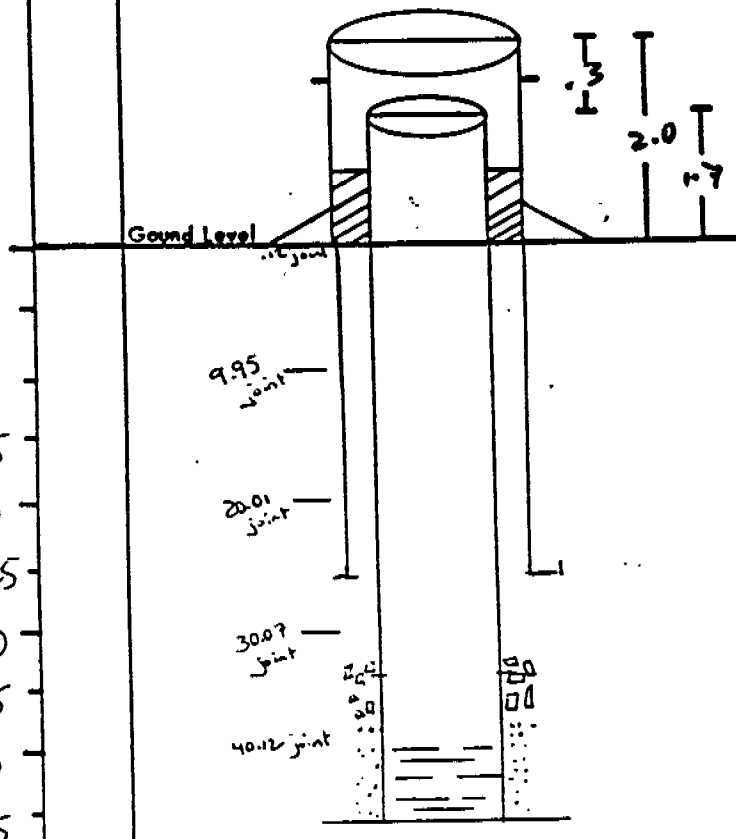
Top of Protective Casing to Top of PVC	0.36 ft.	____ cm.	COMMENT/NOTES
Top of Protective Casing to Weep Hole	1.0 ft.	____ cm.	
Top of Protective Casing to Internal Mortar	1.27 ft.	____ cm.	
Top of Protective Casing to Top of Cement Pad	1.86 ft.	____ cm.	
Top of Protective Casing to Ground Level	2.08 ft.	____ cm.	

Reviewed By Joseph L. Reed Date 6/23/87

Drill Site Geologist ____ Date ____

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Borehole: E-63D1 Well: 37390

Depth-Feet	Soil/Rock Type	Well Completion	Description
5			26' - Bottom of 8" steel casing
10			34' - Top of BENTONITE SEAL
15			39' - Top of SANDPACK
20			40.12' - TOP OF SCREEN
25			Total Depth 46'
30			
35			
40			
45			

Drill Site Geologist: C Benson Date: 4-23-97

Reviewed By: Joseph L. Reid Date: 7/8/97

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BOREHOLE SUMMARY LOG

Borehole E-63 Well

Project Name and Location MW Installation - Tank 36 Project Number 1705 20 410

Drilling Company Boyles Driller B. Roach Rig Number Failing 25

Drilling Method(s) continuous core - rotary with bentonitic drill mud

Size(s) and type(s) of bit(s) 7 7/8"

Borehole Diameter 7 7/8 in. ____ cm. 0 ft. ____ cm. to 76 ft. ____ cm.

3 7/8 in. ____ cm. 76 ft. ____ cm. to 63 ft. ____ cm.

Sampling Methods core

Total Number Soil Sampling Tubes —

Total Number Core Boxes 3

Number of Gallons Lost Drilling Fluid 0

Date/Time Started Drilling 4.17.87 1200

Date/Time Completed Drilling 4.17.87 1408

Total Borehold Depth 63 ft. ____ cm.

Depth to Bedrock 21 ft. ____ cm.

Depth to Water 60 ft. ____ cm.

Water Level Determined By? tape

Borehole Completed as Monitoring Well? NO

Date/Time Grouting Completed 4.17.87 1600

Depth of Tremmie Pipe 60 feet

Gallons of Grout 50

Materials Used 50 gals. water, 5 bags cement, ½ bag bentonite

Comments

Wellsite Geologist C Burson Date 4.17.87

Checked for Grout Settlement on 12/1/87 by Steve Pace

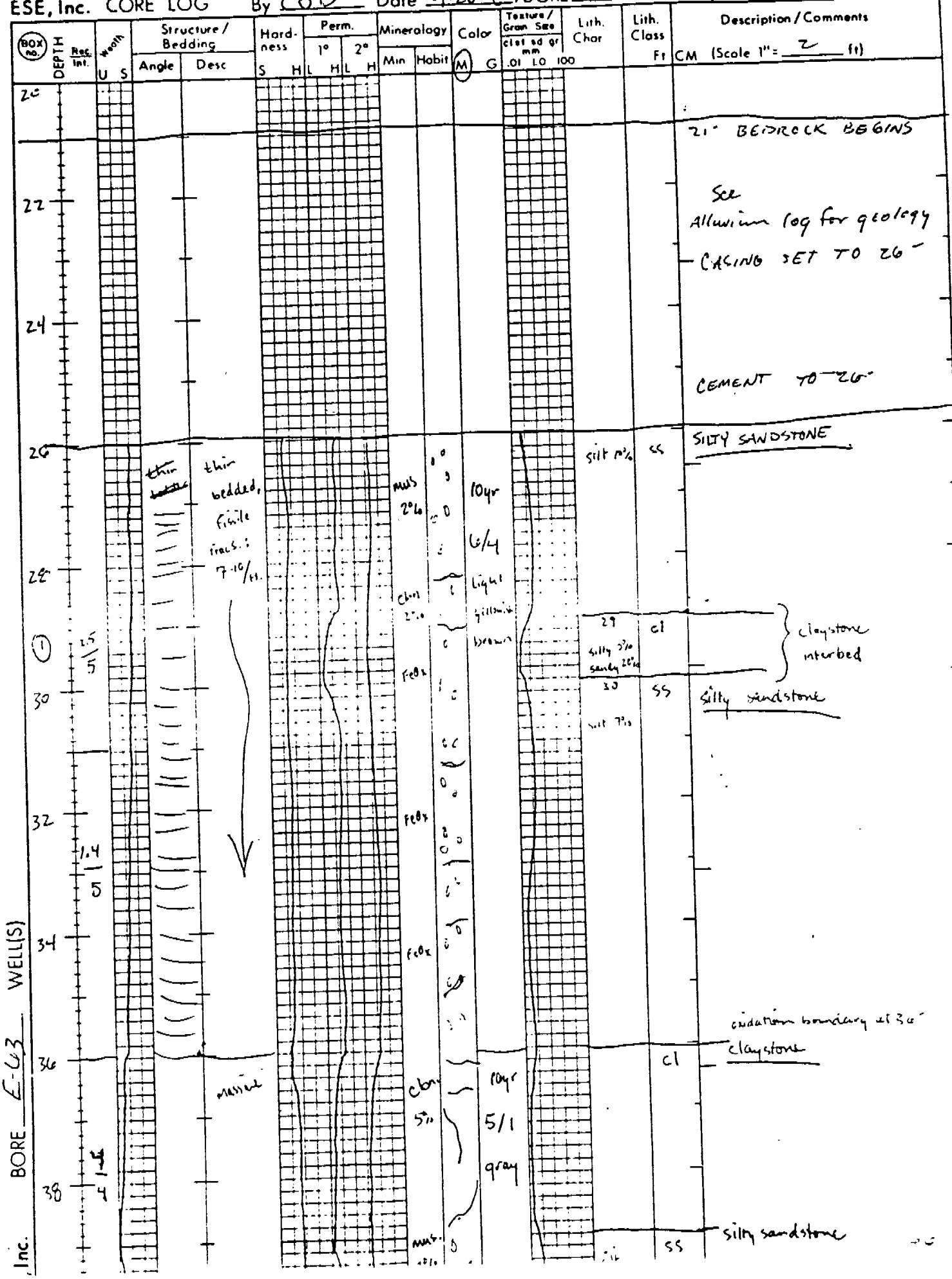
Amount of Grout Added none needed

All Measurements from Ground Level

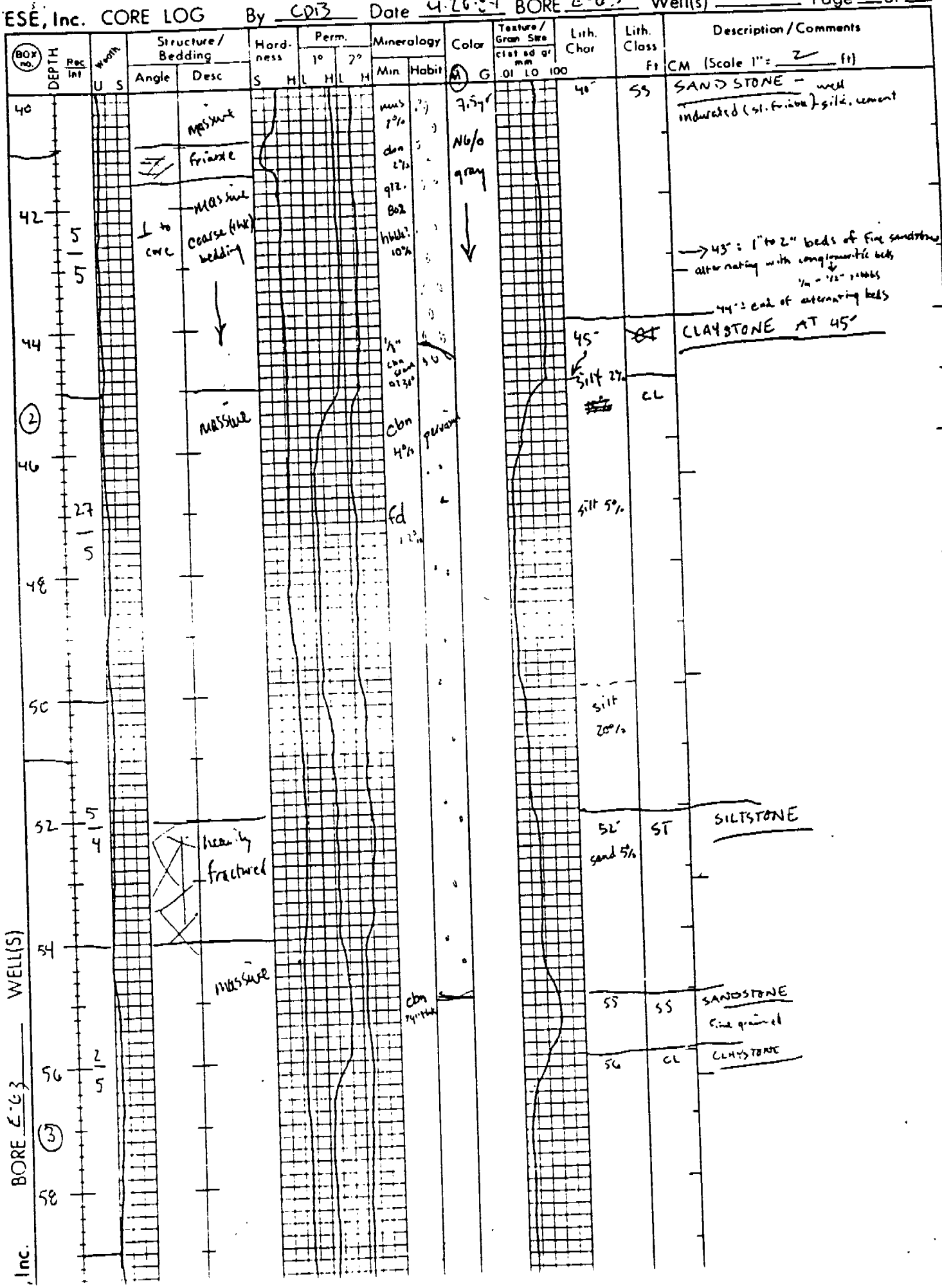
Reviewed by Steve Pace Date 12/1/87

Drill Site Geologist ____ Date ____

ESE, Inc. CORE LOG By COB Date 4.26.87 BORE E-63 Well(s) _____ Page 1 of 3



ESE, Inc. CORE LOG By CDB Date 4.26.89 BORE E-63 Well(s) _____ Page 2 of 3



ESE, Inc. CORE LOG By CDB Date 4.26.87 BORE E-63 Well(s) _____

(BOX no.) DEPTH	Rec. Int.	Weath U S	Structure/Bedding Angle	Structure/Bedding Desc.	Hardness S H	Perm. 1° L H	Perm. 2° L H	Mineralogy Min	Mineralogy Habit	Color M	Color G	Texture/Grain Size clst sd gr mm .01 LO 100	Lith. Char.	Lith. Class Ft	Description/Comments CM (Scale 1" = 2 ft)
62				Massive						7.5yr N6/0	gray			CL	CLAYSTONE
63	1.8 / 5														63' Total Depth

BORE E-63 WELL(S) _____ Inc.

Frontier Logging

Lakewood, Colorado

Date APRIL 17, 1987

Company ESE

Bore Hole E 63

Area/Project RMA

County ADAMS COUNTY | State COLORADO

Section | Township | Range | Elevation

Log Measured From Ground Level

Driller Depth 63 Ft. Ft

Bit Size 3 7/8"

Casing Driller 26 Feet Ft

Fluid in Hole water + native mud

Density/Viscosity | pH 0

Drilling Measured From Ground Level

Miles Round Trip

Standby

Time In 1435 | Time Out 1455

Unit No. 110

Operator Wm. Linton

Location Lakewood

EQUIPMENT DATA

TD Logged 61 1/2 Ft

Natural Gamma 200 Scale = 20 CPS per inch

Time Constant 2 Sec | Logging Speed 15 Ft/Min

Calib. Source No/Value = CPS

Probe No 103-1041 | Probe Diameter 1 5/8"

Detector Type - Size xtal 3/4 x 1 1/4"

K Factor 1.60 x 10^{-5} | Dead Time 7 Microsec

Water Factor 1.10 for hole size 3 7/8"

Casing Factor for wall thk

Resistance 20 Ohms per 8 inches

S.P. 20 MV per inch

NATURAL GAMMA RETURNS (ANALOG)

(plotted log off scale)

Scale = CPS/in	T.C. Sec	Logging Speed Ft/Min	From Ft To Ft	Total Ft

Gamma (Analog) Ft

Gamma (Digital) Ft

Caliper Ft

Temperature Ft

DIRECTIONAL DATA

Closure Ft

Azimuth

True Vertical | Survey Depth

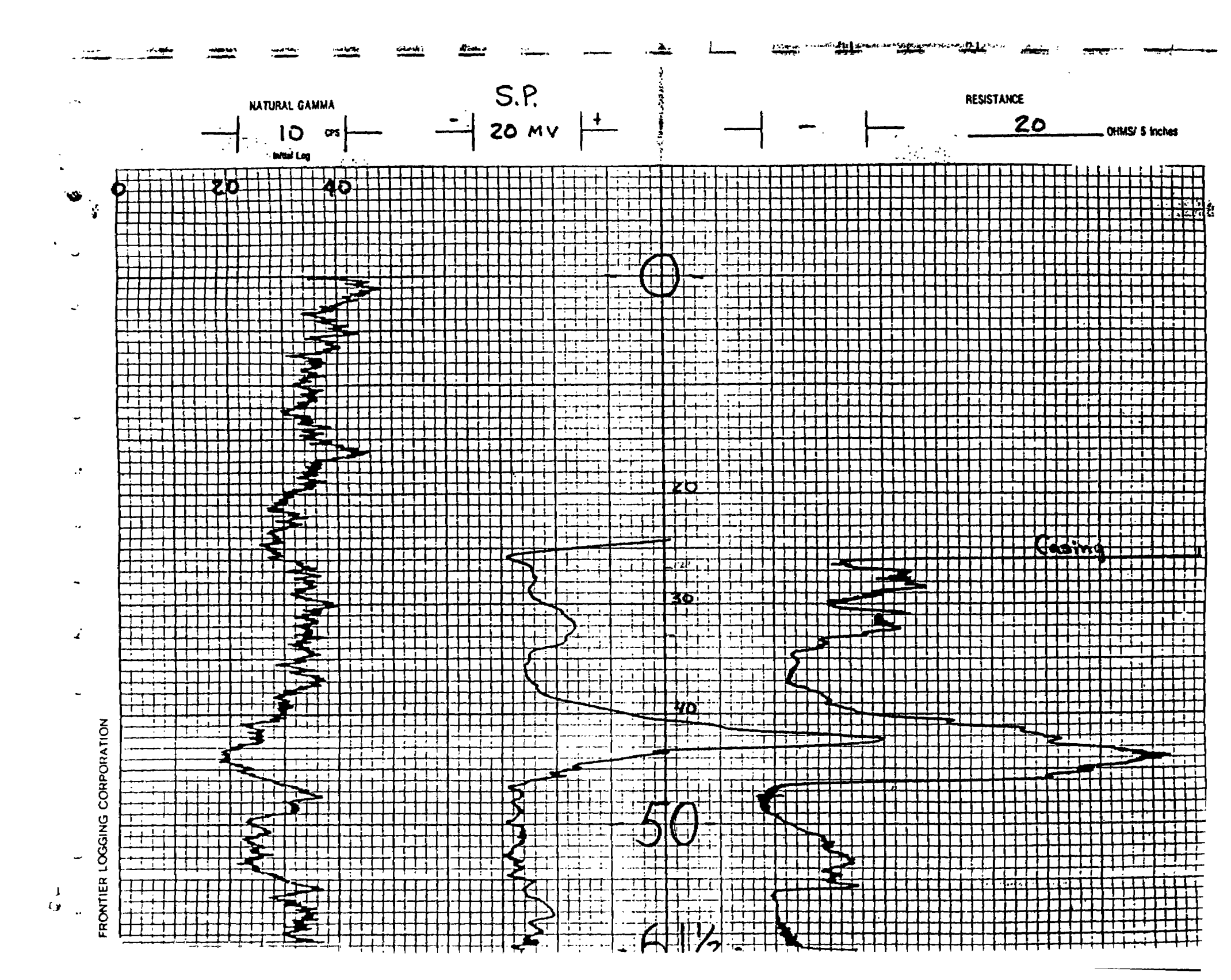
Density Source No | Type | Strength | CPS/inch

Neutron Source No | Type | Strength | CPS/inch

NATURAL GAMMA 10 CPS (Natural Log)

S.P. - 20 MV +

RESISTANCE 20 OHMS/ 5 inches


NATURAL GAMMA
10 cps
Initial Log
S.P.
20 MV
RESISTANCE
20
OHMS/ 5 inches
0
20
40
0
20
30
40
50
Casing
FRONTIER LOGGING CORPORATION

FRONTIER LOGGING COR

0 20 40
COUNTS PER SECOND

NATURAL GAMMA

-SP+
20 MV/INCH

50

-6 1/2-

RESISTANCE
20 OHMS/5 INCHES

E - 63

No. GC13142

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BOREHOLE SUMMARY LOG

Borehole E-64 Well Dry

Project Name and Location T-36 ½ mile N of 96th on Pecos Project Number 17053-074.10

Drilling Company Boyles Bros Driller Dave Jarvis Rig Number 5451

Drilling Method(s) Auger

Size(s) and type(s) of bit(s)

Borehole Diameter 8 in. cm. ft. cm. to 20.5 ft. cm.

in. cm. ft. cm. to ft. cm.

Sampling Methods Continuous Split Spoon

Total Number Soil Sampling Tubes 3.25 - 4' tubes

Total Number Core Boxes 2

Number of Gallons Lost Drilling Fluid 0

Date/Time Started Drilling 0850 3/4/87

Date/Time Completed Drilling 3/4/87 1001

Total Borehold Depth 20.5 ft. cm.

Depth to Bedrock 20.5 ft. cm.

Depth to Water 0 Dry ft. cm.

Water Level Determined By? Samples

Borehole Completed as Monitoring Well? No

Date/Time Grouting Completed 3.4.87 1025

Depth of Tremmie Pipe In Auger

Gallons of Grout 60

Materials Used 4 bags of Cement 20 lbs of Bentonite

Comments In review we may have hit a boulder today at Auger Refusal

Wellsite Geologist Greg Lett Date 3/4/87 JLR 6.8.87

Checked for Grout Settlement on 6/11/87 by JLR

Amount of Grout Added 0

All Measurements from Ground Level

Reviewed by Joseph L. Reed Date 6/11/87

Drill Site Geologist Date

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PRG

Borehole: E-64A Well Number: ~~3755~~ (Dry)

SOILS LOG
Description

Munsell Colors

Depth-Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	Description
0.0	2-0	1.2'	NA	0-2	SM	SM silty-sand, ~ 30-40% silt, 10YR, 5/4-6, yowsh. brn., non-plas., loose, slightly moist alluvium.
1.0						
2.0	4-2	0'		4-2		No Recovery - Auger Loss
3.0						
4.0	6-4	1.4'		6-4	SM	At 4.0', percent silt decreases to ~ 10-20%, color changes to 10YR, 4/4-6, dk. yowsh. brn.,
5.0						
6.0	8-6	1.5'		8-6		At 7.0' color changes to 10YR, 6/6-8, brnsh. yellow,
7.0						
8.0	10-8	1.4'		10-8	ML	ML sandy-silt, 30-40% f. gr sand, 10YR, 5/6-8, yowsh brn., non-plas. loose, moist, alluvium
9.0						
10.0	12-10	1.4'		12-10		
11.0						

Drill Site Geologist: A.E. Smith Date: 3/13/87

Reviewed By: Joseph L. Reed Date: 4/14/87

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SHEET 1 OF 1

Borehole: E-64A Well Number: PRG 3 Dry

SOILS LOG

Depth-Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	Description
						Munsell Colors
11.0	10-12	1.4	NA	10-12	SC	SC Clayey-sand, ~30-40% clay, 10YR, 7/3-4, v. pale brn., slightly plas., med. stiff, moist, alluvium.
12.0						
	12-14	1.5'		12-14		
13.0						
14.0					SM	SM silty-sand, ~5-10% silt, 90-95% coarse g sand, 10YR, 5/2-3 grysh. brn., non-plas, loose slightly moist alluvium
	14-16	1.5		14-16		
15.0						
16.0						
17.0	~~16-18~~ 16-20	0'		16-18		No Recovery
18.0						Auger Loss
19.0				18-20		
20.0		0.3'			ML	ML sandy silt, 10-15% v.f.g sand, 10YR, 7/3-4, v. pale brn, non-plas, med dense, dry alluvium
20.5						END OF BORING LOG
21.0						
						ABD
22.0						

Drill Site Geologist: [signature] Date: 3/13/87

Reviewed By: Joseph L. Reed Date: 4/16/87

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Borehole: E-65A

Well: JR 3738 / 65-A

Depth-Feet	Soil/Rock Type	Well Completion	Description
		.36	
		2.06	
		1.7	
		Gound Level	
2		Joints	
4			3 – Top of BENTONITE
			4 – Top of SAND
6			5 – H_2O
		7.25	7.75 – Top of SCREEN
8			
10			
12			
14			
16			
18		17.78	
20			
22			
24			
26			
28		28.32	28.5 Bottom of Boring
30			

Drill Site Geologist: Greg Citus Date: 3/26/87

Reviewed By: Joseph L. Reed Date: 6/11/87

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WELL CONSTRUCTION SUMMARY

Borehole E-65A Well JR 37381 ~~E65-A~~

Project Name and Location T-36 ½ mile North 96th & ½ mile West of Pecos Project Number 17053 074.10

Drilling Company Boyles Bros Driller Dave Jarvis Rig Number 5451

Drilling Method(s) Auger

Borehole Diameter 12 in. ____ cm. 28.5 ft. ____ cm. to ____ ft. ____ cm.
____ in. ____ cm. ____ ft. ____ cm. to ____ ft. ____ cm.

Size(s) and types of Bit(s) ____

Size and Type PVC 4" .020

Total Borehole Depth	28.5 ft.	____ cm.	
Depth to Bedrock	28 ft.	____ cm.	
Depth to Water	5 ft.	____ cm.	
Water Level Determined By	SAMPLES		
Length Plain PVC (total)	8.95 ft.	____ cm.	
Length of Screen	21.25 ft.	____ cm.	
Total Length of Well Casing	30.2 ft.	____ cm.	
PVC Stick Up	1.7 ft.	____ cm.	
Depth to Bottom of Screen	28.5 ft.	____ cm.	
Depth to Top of Screen	7.25 ft.	____ cm.	
Depth to Top of Sand	4 ft.	____ cm.	
Depth to Top of Bentonite	3 ft.	____ cm.	

Sampling Method(s) Continuous Split spoon

Date/Time Start Drilling 3/26/87 0845

Date/Time Finish Drilling 3/26/87 ~~1010~~ SWL 1120

Date/Time Start Completion 3/26/87 1120

Date/Time Cement Protective Casing 3/26/87 1415

Materials Used

Plain PVC 1-10' LENGTH

Slotted PVC 2-10' LENGTHS

Bentonite Pellets 1 BUCKET

Bentonite Granular 10 lbs

Cement 12 BAGS

Sand 18 BAGS

Water added during completion 90

Water added during drilling 0

Total Gallons of water added 90

Drill Site Geologist Greg Citus Date 3/26/87

Date/Time/Personnel Internal Mortar, Cement Pad, and Weep Hole Installed RAG 5/19/87

Date/Time/Personnel Casing Painted 06-03-87 0800 PJB/WTV

Date/Time/Personnel Numbers Painted 06-03-87 1500 PJB/WTV

Materials Used 13 bags Quikcrete 1 Bag sand 1 Bag cement

Top of Protective Casing to Top of PVC	0.36 ft.	____ cm.	COMMENT/NOTES
Top of Protective Casing to Weep Hole	1.42 ft.	____ cm.	
Top of Protective Casing to Internal Mortar	1.43 ft.	____ cm.	
Top of Protective Casing to Top of Cement Pad	1.62 ft.	____ cm.	
Top of Protective Casing to Ground Level	2.06 ft.	____ cm.	

Reviewed By Joseph L. Reed Date 6/11/87

Drill Site Geologist ____ Date ____

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Borehole: E-65A Well Number:

Depth-Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
	C-2	100%		0-2	ML	Silts with ≈ 30% clays – roots and twigs to 10% of sample 5Y 3/2, dark olive gray, loose, nonplastic, moist
2	2-4	100%		2-4	ML	Silts with 20% clays, now 5 10% sands (med. to coarse), 2.5Y 3/2, very dark grayish brown, loose, nonplastic, moist
4	4-6	100%		4-6	SM	saturated — SANDS with 25% silt – Fine – 2.5Y 5/4, light olive brown, loose, nonplastic, saturated also < 5% clay
6	6-8	100%		6-8		
8	8-10	100%		8-10		
10	10-12	100%		10-12		
12	12-14	100%		12-14	SM	H2O increases in hole/sample — SANDS - 15% silts, 1% clay, 2.5Y 5/6 light olive brown, loose, nonplastic, saturated
14	14-16	100%		14-16		
16	16-18	25% 100%		16-18	SM	SANDS – 15% silts, 1% clay – sand coarser than previously – 10yr 6/8, brownish yellow, loose, nonplas, sat.
18	18-20	100% 25%		18-20	SM	SANDS - 15% silts, 1% clay – 2.5Y 5/6 light olive brown, loose, nonplastic, saturated
20	20-22	100%		20-22	SP	SANDS – 5% silt – med to medium grained – 10yr 6/6, brownish yellow, loose, nonplas, saturated
22						

Drill Site Geologist: C. Fraser Date: 3.31.87

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Borehole: E-165A Well Number:

Depth-Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
22	22-23.5	100%		22-23.5	SP	SANDS - 5% silt - sand fine to medium grainsize - 10yr 6/6, brownish yellow, loose, nonplastic, saturated
24	23.5-25	100%		23.5-25		
	25-26	100%		25-26		NOTE: 1' sample intervals contain 2' of sample due to influx of sands in the augers
26	26-27	100%		26-27		
	27-29	100%		27-29	SS	28' BEDROCK - sandstone - slightly more indurated - occas. carbon fragments in bedrock.
30						END OF BORING AT 29'

Drill Site Geologist: C Benson Date: 3.31.87

Reviewed By: Date:

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WELL CONSTRUCTION SUMMARY

Borehole E-66A Well ~~E66~~ JR 37386

Project Name and Location MW Installation Project Number 7-25

Drilling Company Boyles Bros Driller Dave Jarvie Rig Number 545 1

Drilling Method(s) Auger

Borehole Diameter 12¼ in. ____ cm. 0.0 ft. ____ cm. to 50.6 ft. ____ cm.
____ in. ____ cm. ____ ft. ____ cm. to ____ ft. ____ cm.

Size(s) and types of Bit(s) ____

Size and Type PVC 4" ID

Total Borehole Depth	50.6 ft.	____ cm.	
Depth to Bedrock	50.0 ft.	____ cm.	
Depth to Water	46.5 ft.	____ cm.	
Water Level Determined By	Sample		
Length Plain PVC (total)	41.23 ft.	____ cm.	
Length of Screen	10.89 ft.	____ cm.	
Total Length of Well Casing	52.12 ft.	____ cm.	
PVC Stick Up	1.7 ft.	____ cm.	
Depth to Bottom of Screen	50.4 ft.	____ cm.	
Depth to Top of Screen	39.51 ft.	____ cm.	
Depth to Top of Sand	34.7 ft.	____ cm.	
Depth to Top of Bentonite	29.7 ft.	____ cm.	

Sampling Method(s) Auger

Date/Time Start Drilling ____

Date/Time Finish Drilling 4/10/87 0902

Date/Time Start Completion 4/10/87 0823

Date/Time Cement Protective Casing 4/10/87 1130

Materials Used 25 ft risers

Plain PVC ____

Slotted PVC ____

Bentonite Pellets 4½ buckets

Bentonite Granular ½ bucket + ¼ bucket

Cement 18 bags

Sand 9 bags

Water added during completion 5 gallons

Water added during drilling 20 g. x ~50% = 10 gallons

Total Gallons of water added 10 gallons + 5 gal

Drill Site Geologist K. J. Mathews Date 4-10-87

Date/Time/Personnel Internal Mortar, Cement Pad, and Weep Hole Installed 5/19/87 / 0900 / RAG + WW

Date/Time/Personnel Casing Painted 06-03-87 1430 PJB WTV

Date/Time/Personnel Numbers Painted 06-16-87 0800 PJB DLW

Materials Used 15 Bags Quickcrete 1 Bag Sand, 1 Bag Cement

Top of Protective Casing to Top of PVC	0.32 ft.	____ cm.	COMMENT/NOTES
Top of Protective Casing to Weep Hole	1.32 ft.	____ cm.	
Top of Protective Casing to Internal Mortar	1.55 ft.	____ cm.	
Top of Protective Casing to Top of Cement Pad	1.72 ft.	____ cm.	
Top of Protective Casing to Ground Level	2.02 ft.	____ cm.	

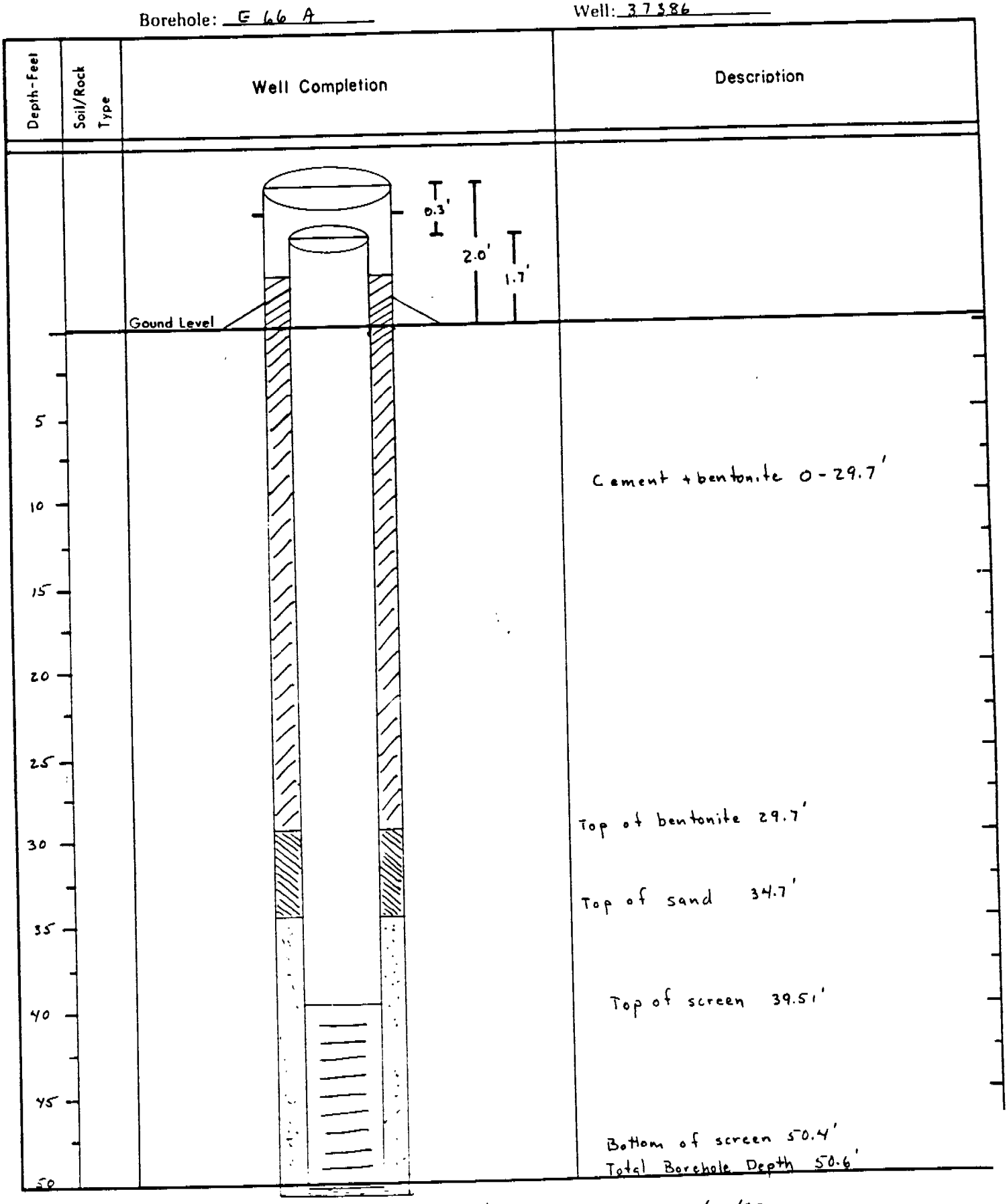
Reviewed By Joseph L. Reed Date 6/19/87

Drill Site Geologist ____ Date ____

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Borehole: E 66 A

Well: 37386



Drill Site Geologist: K. J. Matthews

Date: 8/26/87

Reviewed By:

Date: 12/1/87

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SHEET 1 OF 5

Borehole: E-66A E-66A Well Number: ~~37389~~ JR 37386

Depth-Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
						Munsell Colors
0.0			NA		ML	ML sandy-silt, 10-20% v.f. gr. sand, 10 YR, 4/3-4, dk. brn., non-plas., loose, moist, alluvium.
	0-2'	2'		0-2'		
1.0						
1.8						At 1.8', sandy-silt, 10-20% v.f. gr. sand, 10 YR, 7/2-3, v. pale brn., non-plas., loose, dry, alluvium.
2.0						
	2-4'	2'		2-4'		
3.0						
4.0						
	4-6'	2'		4-6'		
5.0						At 5.0', sandy-silt, 40-45% v.f. gr. sand, 10 YR, 5/6-8, ywsh. brn., non-plas, loose, slightly moist alluvium.
6.0						
	6-8'	2'		6-8'		
7.0						
8.0						
	8-10'	2'		8-10'		
9.0						
10.0						At 10.0', sandy-silt, 10-20% v.f. gr. sand, 10 YR, 5/6-8, ywsh. brn., non-plas., loose, slightly moist alluvium.
	10-12'	2'		10-12'		
11.0						

~~Drill Site~~ Lab Geologist: A.E. Estell Date: 4/9/87

Reviewed By: Joseph L. Reed Date: 4/16/87

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Borehole: E-66A Well Number: ~~37389~~ JR 37386

Depth – Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
11.0	10-12'	2'	NA	10-12'	ML	Munsell Colors
12.0	12-14'	2'		12-14'		At 13.0, sdy-slty, ~ 10-20% v.f.gr. sand, 10 YR, 5/6-8, mottled w/ 5-10% calc. sand 1% v.f.gr sand, 10 YR, 8/1, white, non-plas, med. dense, slightly moist, alluvium.
14.0	14-16'	2'		14-16'		
15.0	16-18'	2'		16-18'		
17.0	18-20'	2'		18-20'		At 20.0', sand-silt, ~ 40% v.f.gr. sand, 10 YR, 5/6-8, mxed. brn., non-plas., loose, slightly moist, alluvium.
19.0	20-22'	2'		20-22'		
21.0						
22.0						

Drill Site Geologist: S.K. Ostlund Date: 4/9/87

Reviewed By: Lab Joseph L. Reed Date: 4/16/87

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SHEET 3 OF 5

Borehole: E-66A Well Number: ~~37389~~ JR 37386

Depth-Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
						Munsell Colors
22.0	22-24'	2'	NA	22-24'	ML	ML clayey-silt, ~10-20% clay, 10 YR, 6/6-8, brownish yellow, slightly plas., soft, moist, alluvium.
23.0						
24.0	24-26'	0'		24-26'		— No Recovery —
25.0						
26.0	26-28'	2'		26-28'	ML	At 27.0', clayey-silt, ~20-30% clay, 10 YR, 5/4-6, gmsh. brn., ~~low plas.~~ to mottled w/ 1" f. gr calc. sand, 10 YR, 8/1, white, low-med. plas., soft., moist, alluvium.
27.0						
28.0	28-30'	2'		28-30'		
29.0						
30.0	30-32'	2'		30-32'		
31.0						
32.0	32-32.7'	2'		32-32.7'		At 32.0', clayey-silt, ~5-10% clay, 10 YR 5/4-6 gmsh. brn., slightly plas., soft., moist, alluvium.
33.0						

Drill Site Geologist: A.R. Dittli Date: 4/9/87

Reviewed By: Joseph L. Reed Date: 4/16/87

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SHEET 4 OF 5

Borehole: E-66A Well Number: 37389 3e 37386

SOILS LOG
Description

Monsanto Celcar

Depth-Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	Description
33.0	32-34	2'	NA	32-34	ML	
34.0	34-36	2'		34-36		
35.0	34-36	2'		34-36		At 35.0'; clayey-silt, 30-40% clay, 10 YR, 4/4-6, dk yowsh. brn., low-med. plas., med. stiff, moist, alluvium.
36.0	36-38	2'		36-38		
37.0	36-38	2'		36-38		
38.0	38-40	2'		38-40		
39.0	38-40	2'		38-40		
40.0	40-42	1.6'		40-42	CL	CL silty-clay, ~30% silt, 10 YR, 4/3-4, dk. yowsh. brn., med. plas., med. stiff, moist, alluvium.
41.0	40-42	1.6'		40-42		
42.0	42-43	1.0'		42-43		At 42.0'; silty-clay, ~10% silt, 10 YR, 4/3-4, dk yowsh. brn., med. plas., med. stiff, moist, alluvium.
43.0	42-43	1.0'		42-43		
44.0						

Lab
~~Drill Site~~ Geologist: A.K. Ostella Date: 4/9/87

Reviewed By: Joseph L. Reed Date: 4/16/87

134

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SHEET 5 OF 5

Borehole: E-661 Well Number: 37389 JR 37386

Depth-Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
						Munsell Colors
44.0	53-44	1'	NA	53-44	SP	SP = gravelly-sand, 20-30% gtz. gravel, 10 YR, 5/6-8, yush. brn., non-plas., loose, moist, alluvium.
45.0	44-54	1'		44-54		
46.0	54-47	0.5'		54-47		▽ = At. 46.5 gravelly-sand, 20-30% gtz. gravel, 10YR, 5/6-8, yush brn, non plas, loose, saturated, alluvium.
47.0	54-47	0'		54-47		No Recovery - Auger Loss
49.0	52-49	0'		52-49		No Recovery - Auger Loss
51.0	52-50	0'		52-50		No Recovery - Auger Loss
53.0	55-52	0'		55-52		No Recovery - Auger Loss
55.0	57-55	0'		57-55		No Recovery - Auger Loss
55.0						END OF BORING LOG

Drill Site Geologist: S.E. Dutton Date: 4/9/87

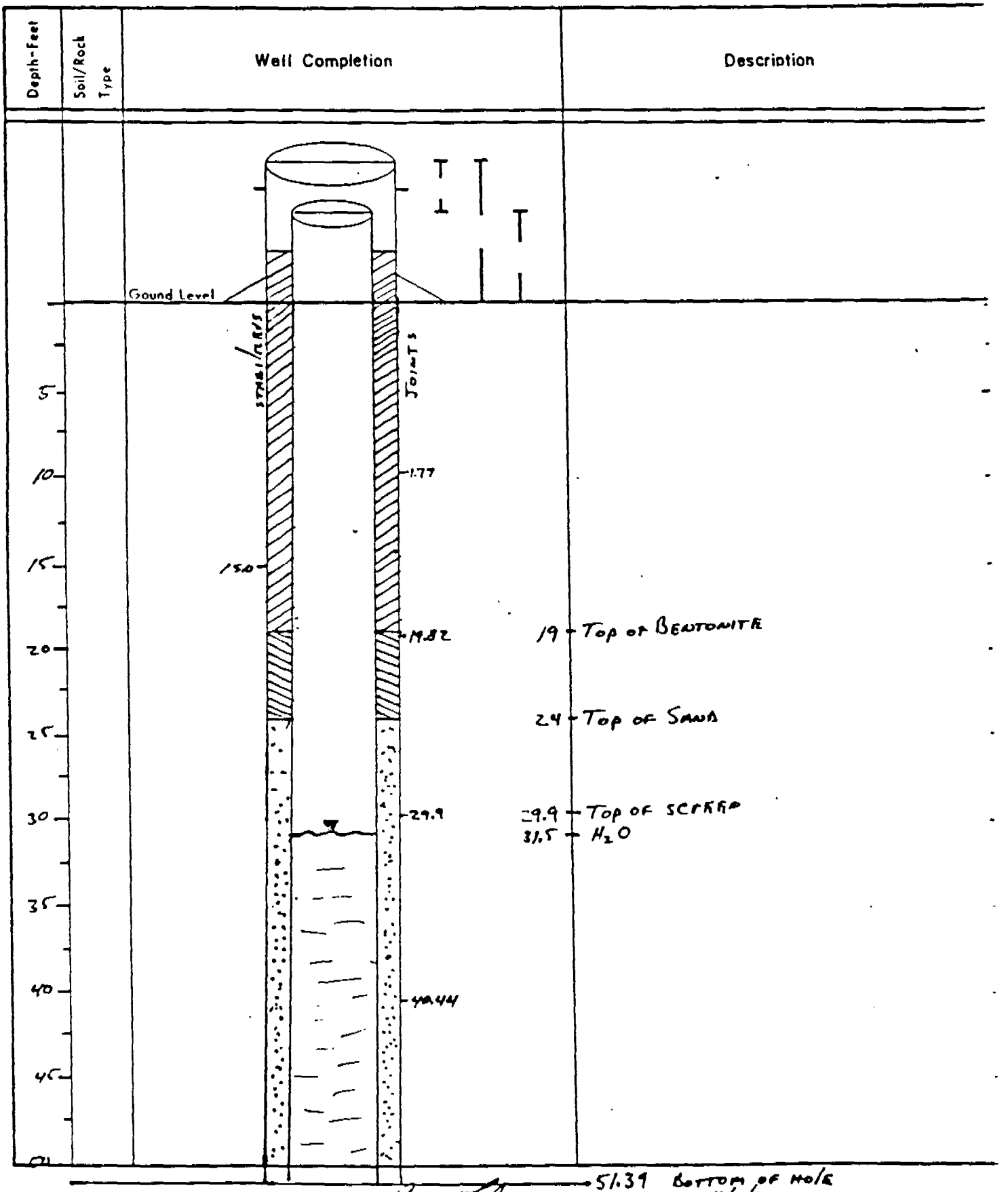
Reviewed By: Joseph L. Reid Date: 4/16/87

185

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
7332 SOUTH ALTON WAY • SUITE H-1
ENGLEWOOD, COLORADO 80112 • 303/741-0639

JR 37385

Borehole: E-67A Well: ~~E67A~~



Drill Site Geologist: Greg Lee Date: 4/2/87

Reviewed By: _____ Date: _____

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
7337 SOUTH ALTON WAY • SUITE H-1
ENGLEWOOD, COLORADO 80112 • 303/741-0839

WELL CONSTRUCTION SUMMARY

Borehole GWE E-67A Well E-67A JR 37385

Project Name and Location T-25 YOSEMITE & 92ND Project Number

Drilling Company Boyles Bros Driller Dave Jarvis Rig Number 5451

Drilling Method(s) Auger

Borehole Diameter 12¼ in. cm. 0 ft. cm. to 51.39 ft. cm.

in. cm. ft. cm. to ft. cm.

Size(s) and types of Bit(s)

Size and Type PVC 4" .020 slot

Total Borehole Depth	51.39 ft.	cm.	
Depth to Bedrock	51 ft.	cm.	
Depth to Water	31.5 ft.	cm.	
Water Level Determined By	Samples		
Length Plain PVC (total)	31.6 ft.	cm.	
Length of Screen	21.49 ft.	cm.	
Total Length of Well Casing	53.09 ft.	cm.	
PVC Stick Up	1.7 ft.	cm.	
Depth to Bottom of Screen	51.39 ft.	cm.	
Depth to Top of Screen	29.90 ft.	cm.	
Depth to Top of Sand	24.0 ft.	cm.	
Depth to Top of Bentonite	19.0 ft.	cm.	

Sampling Method(s) Continuous Split Spoon

Date/Time Start Drilling 4/3/87 1330

Date/Time Finish Drilling 4/3/87 1626 DOES NOT INCLUDE REAM

Date/Time Start Completion 4/7/87 0830

Date/Time Cement Protective Casing 4/7/87 1120

Materials Used 22-2' TUBES 46 CAPS

Plain PVC 3-10' SECTIONS + 1 CUT PIECE

Slotted PVC 2-10' SECTIONS

Bentonite Pellets 4.5 BUCKETS

Bentonite Granular 40 lbs

Cement 8 Bags

Sand 16 BAGS

Water added during completion 35

Water added during drilling 15-all WATER WAS BROUGHT UP WITH CUTTIN

Total Gallons of water added 50

Drill Site Geologist Greg Lee Date 4/9/87

Date/Time/Personnel Internal Mortar, Cement Pad, and Weep Hole Installed 5/19/87 RAG

Date/Time/Personnel Casing Painted 06-03-87 13:00 PJB-WTV

Date/Time/Personnel Numbers Painted

Materials Used 12 Bags Quickcrete 1 Bag Sand 1 cement

Top of Protective Casing to Top of PVC	0.25 ft.	cm.	COMMENT/NOTES
Top of Protective Casing to Weep Hole	1.54 ft.	cm.	
Top of Protective Casing to Internal Mortar	1.54 ft.	cm.	
Top of Protective Casing to Top of Cement Pad	1.77 ft.	cm.	
Top of Protective Casing to Ground Level	1.95 ft.	cm.	

Reviewed By Joseph L. Reed Date 6/11/87

Drill Site Geologist Date

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ENGLEWOOD, COLORADO 80112 • 303/741-0639

Borehole: E-67-1 Well Number: 37385

Depth-Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
						Munsell Colors
0.0	0-2'	2'	NA	0-2'	ML	ML clayey-silt, ~30-40% clay, 10 YR, 5/2-3, grysh brn., non-plas slightly plas, v. soft, moist alluvium.
1.0						
1.7						At 1.7', sandy-silt, ~20-30% v.f.gr. sand, 10 YR, 4/3-4, dk. grysh. brn., non-plas., loose, moist alluvium.
2.0	2-4'	2'		2-4'		
3.0						
3.6						At 3.6', sandy-silt, ~30% v.f.gr. sand, 10 YR 6/4-6, lght. grysh. brn., non-plas., loose, slightly moist alluvium.
4.0						
5.0	4-6'	2'		4-6'		
5.5						At 5.5', sand-silt, ~40-45% v.f.gr. sand, 10 YR, 6/6, brnsh. yellow, non-plas, loose, dry, alluvium
6.0						
7.0	6-8'	2'		6-8'	SM	SM silty-sand, ~30% silt, 10 YR, 6/6-8, brnsh. yello non-plas, loose, moist, alluvium.
8.0						
8.5						
9.0	8-10'	2'		8-10'	ML	ML clayey-silt, ~20% clay, 10 YR, 5/4-6, grysh. brn., non slightly plas., med. stiff, slightly moist, alluv.
10.0						
10.0	10-12'	2'		10-12'		
11.9						

Drill Site Geologist: A.E. Ostella Date: 4/9/87

Reviewed By: Date:

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
7332 SOUTH ALTON WAY • SUITE H-I
ENGLEWOOD, COLORADO 80112 • 303/741-0839

Borehole: E-67A Well Number: 37385

Depth-Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
						Munsell Colors
11.0	10-12'	2'	NA	10-12'	ML	At 11.0', clayey-silt, ~ 30-40% clay, 10 YR, 5/6-8, yvsh. brn., low plas., soft, moist, alluvium.
12.0	12-14'	2'		12-14'		
13.0						At 13.0', clay-silt ~ 30-40% clay, 10 YR, 5/6-8, mottled w/ 5-10% calc. sand 10 YR, 8/1-2, white, low plas., soft, moist, alluvium.
14.0	14-16'	2'		14-16'		
15.0						
16.0	16-18'	2'		16-18'		
17.0						
17.7					SM	SM silty-sand, ~ 20% silt, 10 YR, 7/4-6, v. pale brn. non-plas., loose, slightly moist, alluvium.
18.0	18-20'	2'		18-20'	ML	ML clayey-silt, ~ 10-20% clay, 20% v. f. gr. sand., 10 YR, 5/6-8, yvsh. brn., slightly plas., soft, moist, alluvium.
19.0						
20.0	20-22'	2'		20-22'		At 21.0', clayey-silt ~ 30-40% clay, 10 YR, 5/6-8, yvsh brn., low med. plas, soft, moist, alluvium
21.0						
22.0						

~~Drill Site~~ LAB Geologist: A.E. Dutt Date: 4/9/87

Reviewed By: Jack L. Reed Date: 4/16/87

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ENGLEWOOD, COLORADO 80112 • 303/741-0839

Borehole: E-671 Well Number: 37385

Depth-Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
						Munsell Colors
23.0	22-24'	2'	NA	22-24'	ML	
24.0	24-26'	2'		24-26'	CL	CL silty-clay, ~30% silt, 10 YR, 7/2-3, v. pale brn., low plas., soft, moist, alluvium.
25.0	26-28'	2'		26-28'		At 27.5', silty-clay, ~5-10% silt, 10 YR, 7/1-2, light gray, low plas., soft, moist, alluvium.
27.5						
28.0	28-30'	2'		28-30'		
29.0	30-32'	2'		30-32'	SM	▽ SM silty-sand, 10% silt, 10 YR, 5/4-6, yowel-brn., non-plas., loose, saturated, alluvium.
31.0	32-34'	2'		32-34'		
31.5						
32.0						
33.0						

Drill Site Geologist: S.E. Smith Date: 4/9/87

Reviewed By: Joseph L. Reid Date: 4/16/87

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ENGLEWOOD, COLORADO 80112 • 303/741-0839

Borehole: E-67A Well Number: 37385

SOILS LOG
Description

Munsell Colors

Depth-Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	Description
33.0	32-34'	2'	NA	32-34'	SP	SP = gravelly-sand, 20-30% qtz. gravel, 10 YR, 5/4-6, yrsh. brn., non-plas., loose, saturated, alluvium
34.0	34-35'	1'		34-35'		
35.0	35-37'	0'		35-37'		No Recovery — Auger Loss
37.0	37-39'	0.3'		37-39'	SM	SM = silty-sand, 10-15% silt, 10 YR, 5/4-6, yrsh-brn., non-plas., loose, saturated, alluvium
39.0	39-41'	0'		39-41'		No Recovery — Auger Loss
41.0	41-43'	0.3'		41-43'	SM	
43.0	43-45'	0'		43-45'		No Recovery + Auger Loss
45.0						

Drill Site Geologist: A.E Estelle Date: 4/9/87

Reviewed By: Joseph L. Reed Date: 4/16/87

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
7332 SOUTH ALTON WAY • SUITE H-I
ENGLEWOOD, COLORADO 80112 • 303/741-0639

Borehole: E-67A Well Number: 37385

Depth - Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
44.0		0'	NA			MUNSELL COLORS NO RECOVERY - AUGER LOSS
45.0					SM	
46.0						
47.0						
48.0						
49.0						
50.0					CL	CL sandy-clay, 20% med-coarse gr. sand, 10 YR 4/2 dk gray-brn., low plas., soft, wet, bedrock. At 51.0 silty-clay st., 30% silt 10 YR, 3/1, v. dk gray, slightly plas., hard, wet, bedrock.
51.0						
52.0						END OF BORING LOG
53.0						
54.0						
55.0						

AEO

Drill Site Geologist: L.S. Smith Date: 4/9/87

Reviewed By: Joseph L. Reed Date: 4/16/87

192

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ENGLEWOOD, COLORADO 80112 • 303/741-0639

BOREHOLE SUMMARY LOG

Borehole E-69 Well

Project Name and Location MW Installation Project Number 17053 074.10

Drilling Company Boyles Driller Roach Rig Number Failing 75

Drilling Method(s) Rotary - with water

Size(s) and type(s) of bit(s) 12¼ rock, 7⅞ tricone

Borehole Diameter 12¼ in. ____ cm. 0 ft. ____ cm. to 30 ft. ____ cm.

7⅞ in. ____ cm. 30 ft. ____ cm. to 121 ft. ____ cm.

Sampling Methods Continuous core

Total Number Soil Sampling Tubes —

Total Number Core Boxes 13

Number of Gallons Lost Drilling Fluid 0

Date/Time Started Drilling 2-11-87 1027

Date/Time Completed Drilling 2-12-87 1305

Total Borehold Depth 121 ft. ____ cm.

Depth to Bedrock 27 ft. ____ cm.

Depth to Water — ft. ____ cm.

Water Level Determined By? NOT Determined - drilled with water

Borehole Completed as Monitoring Well? No

Date/Time Grouting Completed 2-12-87 1506

Depth of Tremmie Pipe 120'

Gallons of Grout 80

Materials Used 9 bags cement, 80 gals water

Comments hole grouted to 10' of surface as requested by landowner, Casing removed

Wellsite Geologist C Benson Date 3-23-87

Checked for Grout Settlement on 5-19-87 by CDB

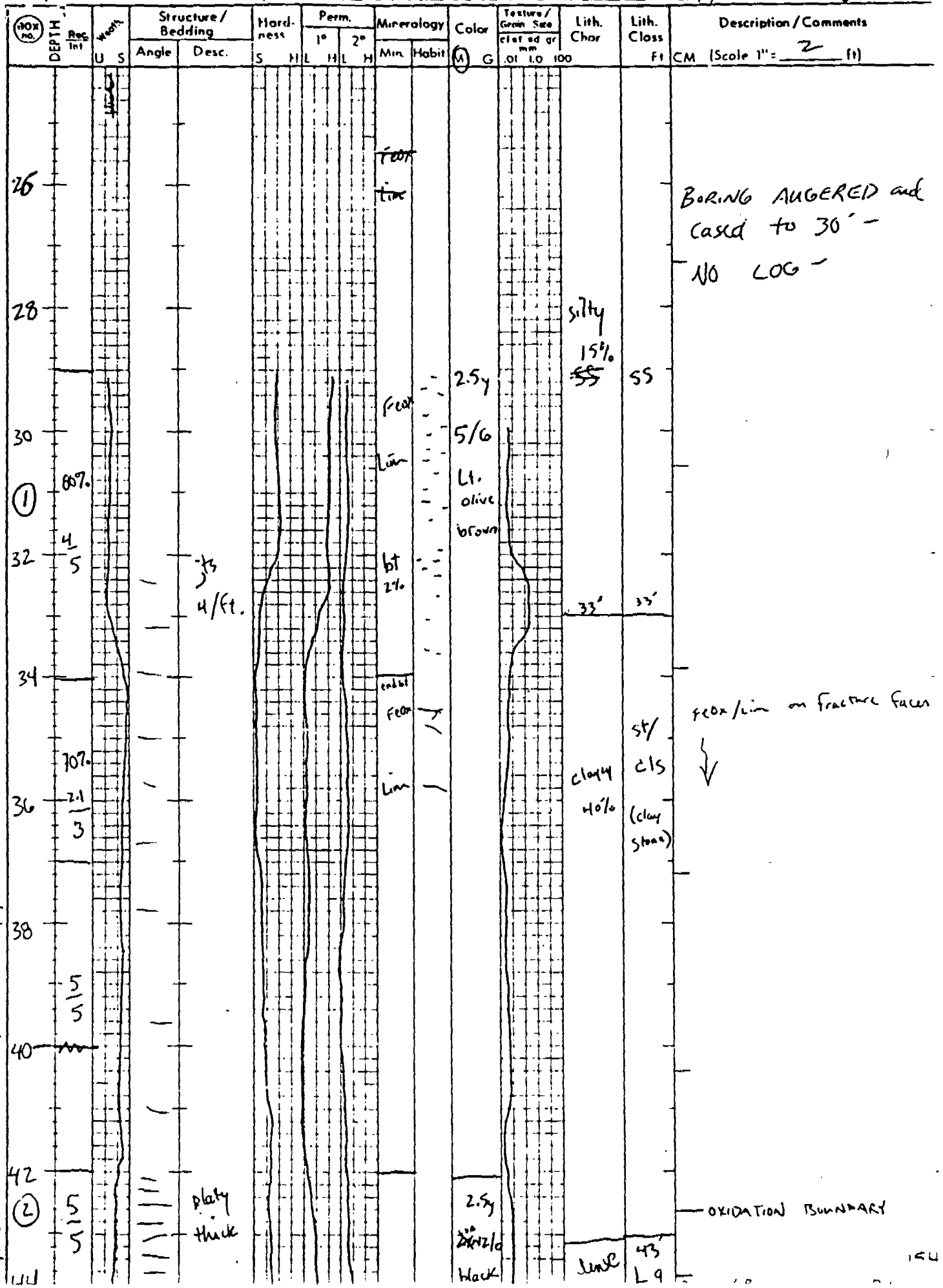
Amount of Grout Added none

All Measurements from Ground Level

Reviewed by Joseph L. Reed Date 6/11/87

Drill Site Geologist ____ Date ____

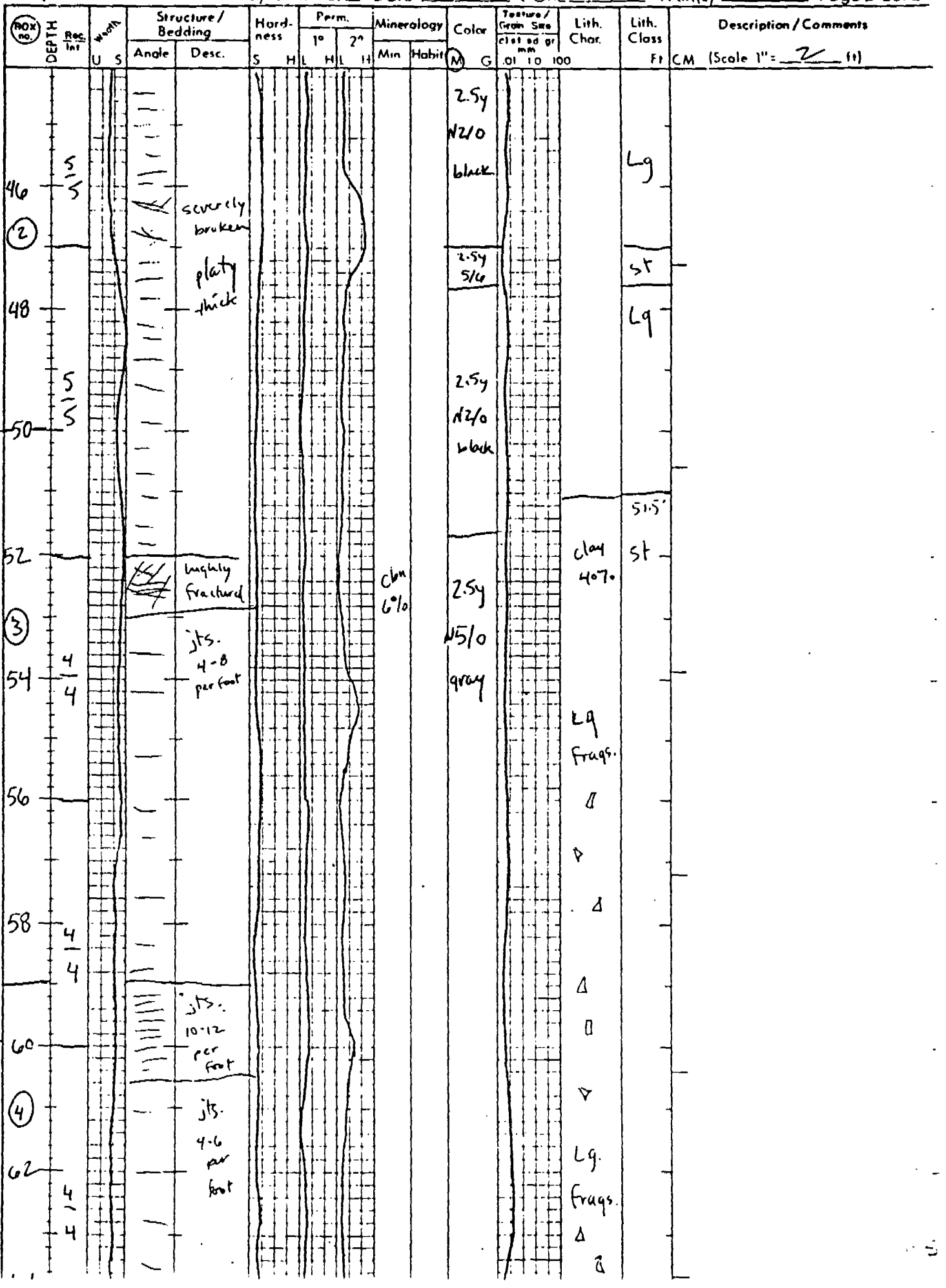
ESE, Inc. CORE LOG By Benson Date 2-13-87 BORE E-69 Well(s) _____ Page 1 of 5



BORE E-69 WELL(S)

SE, Inc.

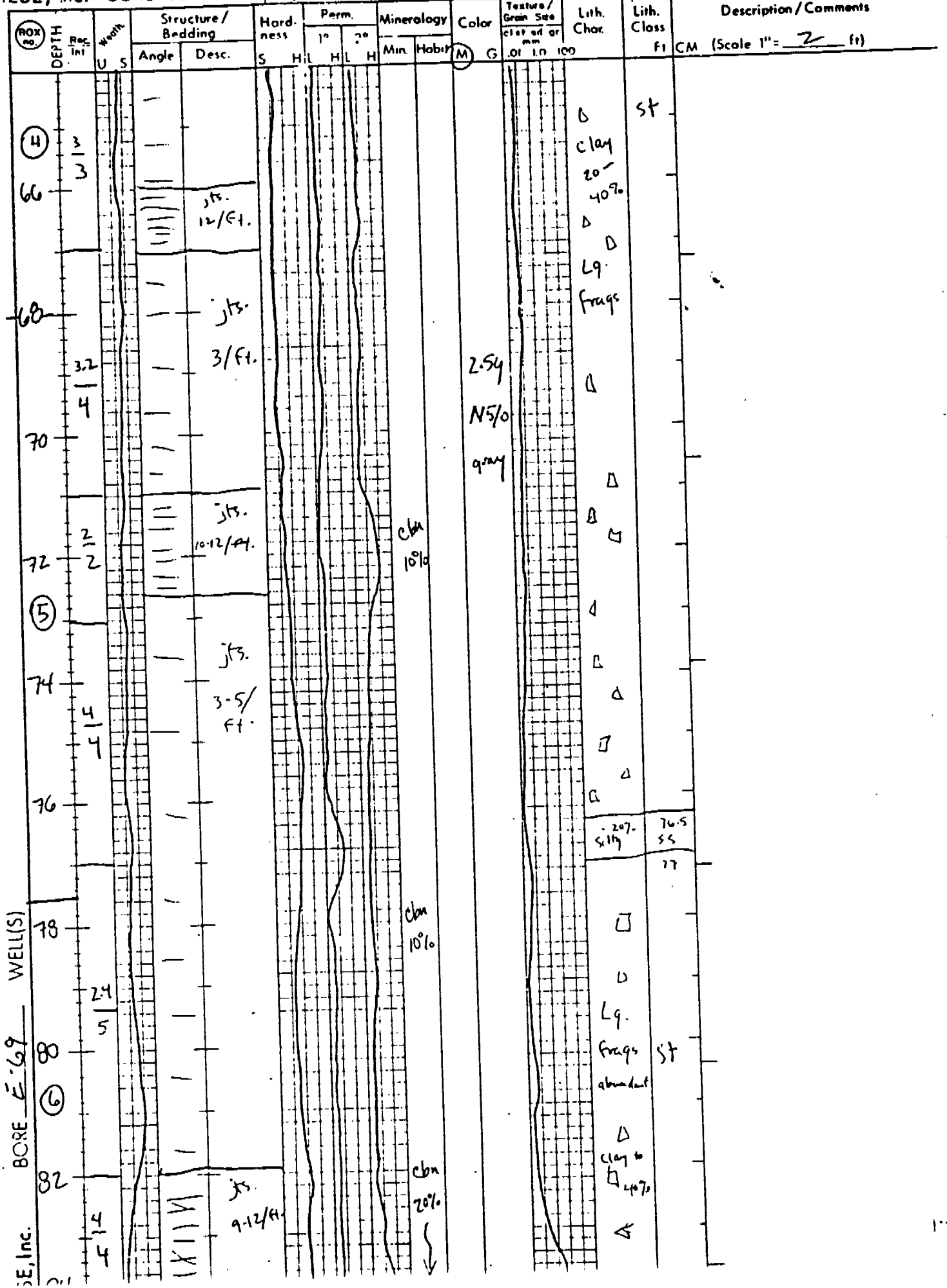
ESE, Inc. CORE LOG By Benson Date 2-13-87 BORE E-69 Well(s) _____ Page 2 of 5

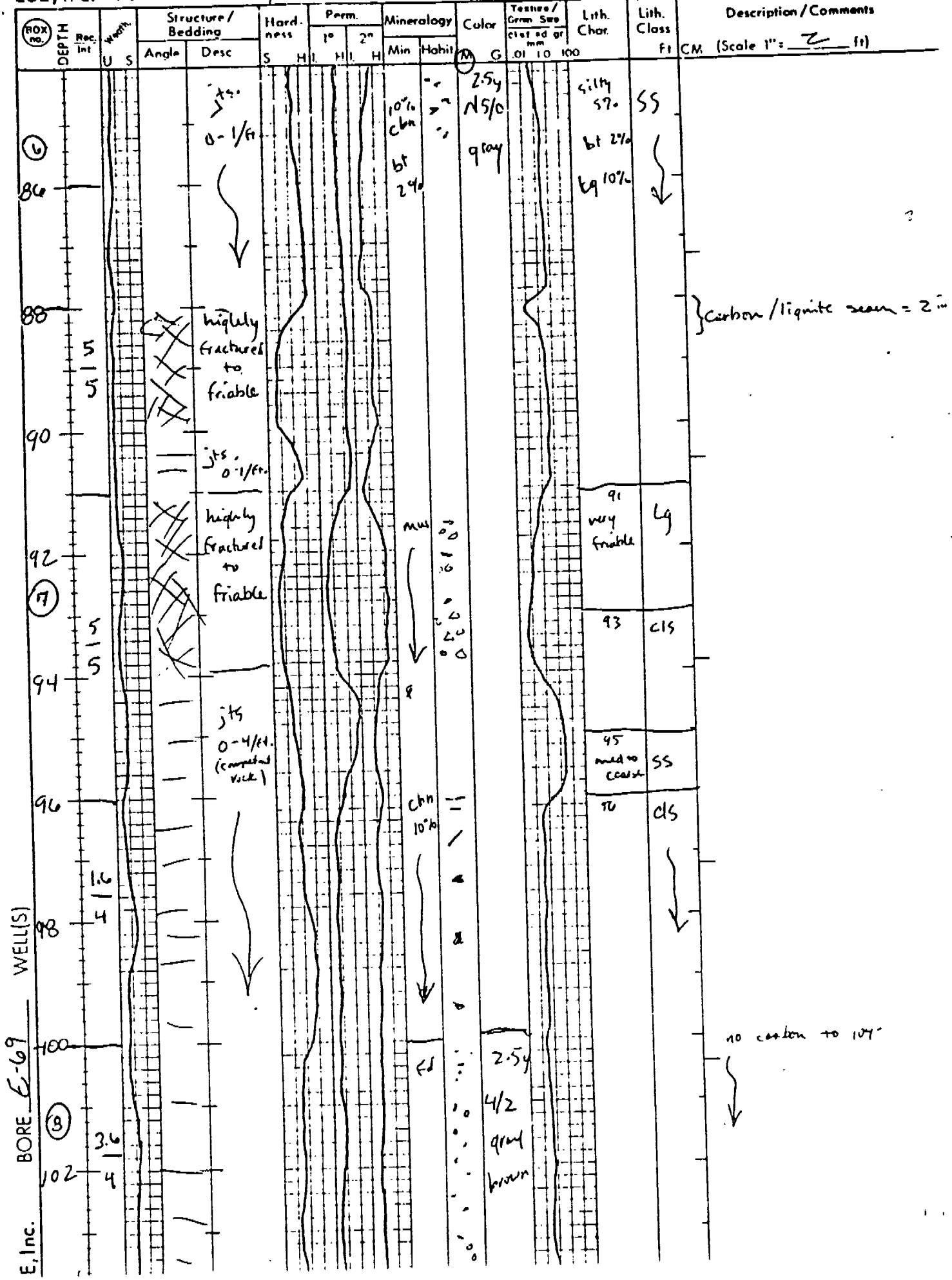


BORE E-69 WELL(S)

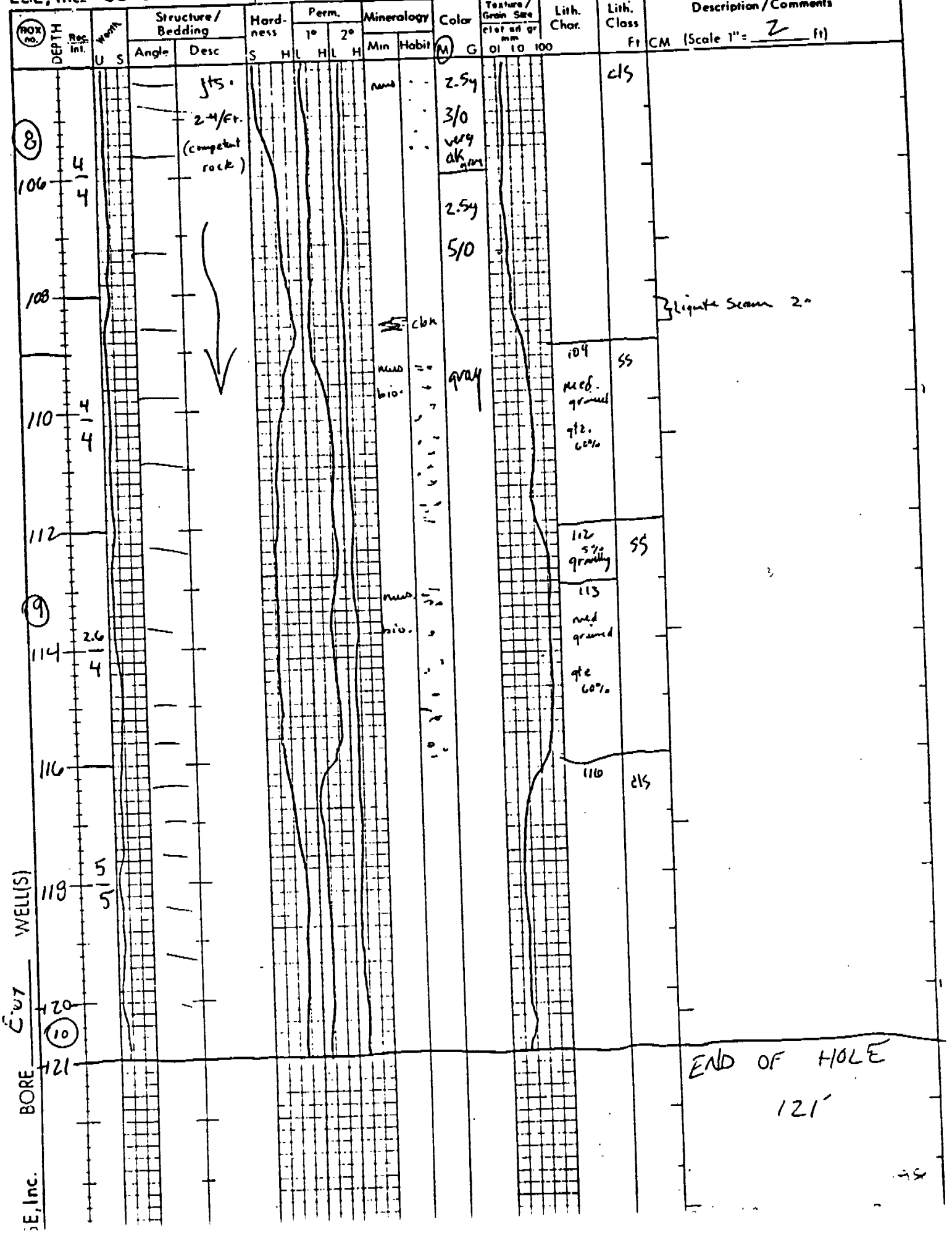
ESE, Inc.

ESE, Inc. CORE LOG By C. Benson Date 2-13-87 BORE E-69 Well(s) _____




ROX no.
DEPTH
Rec. Int
Weath. U S
Structure / Bedding
Angle
Desc
Hardness S H
Perm. 1° H 2° H
Mineralogy
Min
Habit
Color M G
Texture / Grain Size clay sd gr mm .01 1.0 100
Lith. Char.
Lith. Class Ft
Description / Comments CM (Scale 1" = 2 ft)
jts. 0-1/ft
highly fractured to friable
jts. 0-1/ft.
highly fractured to friable
jts 0-4/ft. (computed value)
10% chn
bt 2%
2.5y N5/0 gray
silty 5%
bt 2%
lg 10%
SS
Carbon/lignite seam = 2 in
91 very friable
lg
93
cls
95 med to coarse
SS
70
cls
chn 10%
fd
2.5y 4/2 gray brown
no carbon to 104'
5 / 5
5 / 5
1.6 / 4
3.6 / 4
86
88
90
92
94
96
98
100
102
BORE E-69 WELL(S)
E, Inc.

ESE, Inc. CORE LOG By Benson Date 2-13-87 BORE E-69 Well(s) _____



Company: ESE

Bore Hole: E-69

Area/Project: RMA

County: ADAMS COUNTY | State: COLORADO

Section | Township | Range | Elevation

Log Measured From: Ground Level

D Depth: 120 Ft | Log

Bit Size: 3 3/4"

Casing Driller: 28 Ft

Fluid in Hole: Water/Native Mud

Density/Viscosity | Rm @

Drilling Measured From: Ground Level

Standby Hrs

Time In: 1320 | Time Out: 1345

Unit No.: 110

Operator: Wm. Linton

Location: Lakewood

EQUIPMENT DATA

TD Logged: 118 Feet

Natural Gamma: 200 Scale = 20 CPS per Inch

Time Constant: 2 Sec | Logging Speed: 15 Ft/Min

Cable Source No Value CPS

Probe No: 103-124H | Probe Diameter: 1 5/8"

Detector Type Size: xtal 3/4 x 1"

K Factor: 2.35 x 10⁻⁵ | Dead Time: 7 Microsec

Water Factor | Mud Hole Size

Casing Factor | Mud Wt lbs

Resistance: 75 ohms/5" Ohms per 5 Inches

SP: 10 MV/Inch MV per Inch

NATURAL GAMMA RERUNS (ANALOG)
(Initial log off scale)

Scale = CPS/In	TC Sec	Logging Speed Ft/Min	From Ft	To Ft	Total Ft

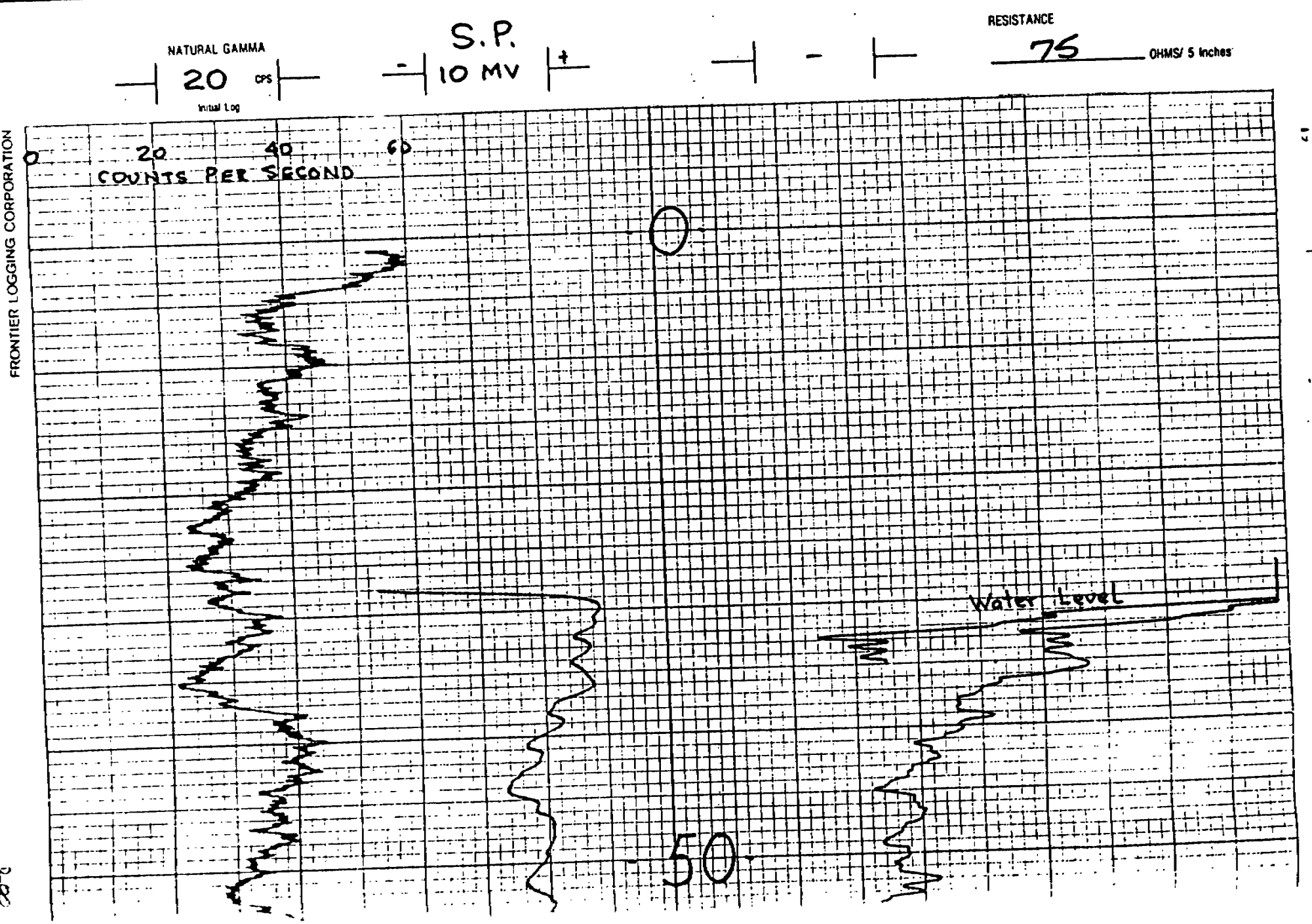
Gamma (Analog) Ft	Density Source No Strength
Gamma (Digital) Ft	Type
Caliper Ft	CPS/Inch
Temperature Ft	Ft
DIRECTIONAL DATA	Neutron Source No
Closure Ft	Type Strength
Azimuth	CPS/Inch
True Vertical Ft / Survey Depth Ft	

NATURAL GAMMA 20 CPS — Initial Log

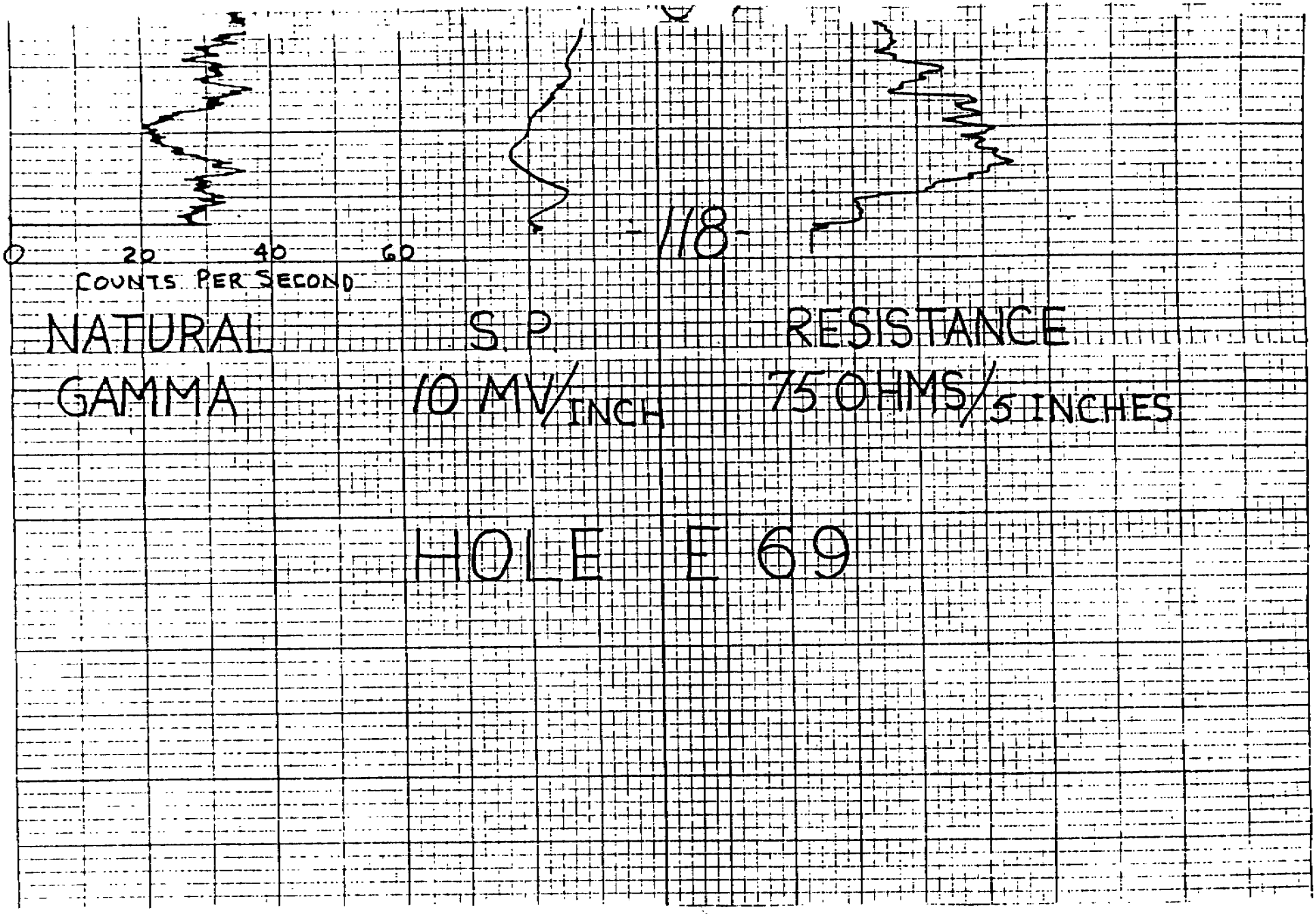
S.P. - 10 MV +

RESISTANCE 75 OHMS/ 5 Inches

0 20 40 60 COUNTS PER SECOND

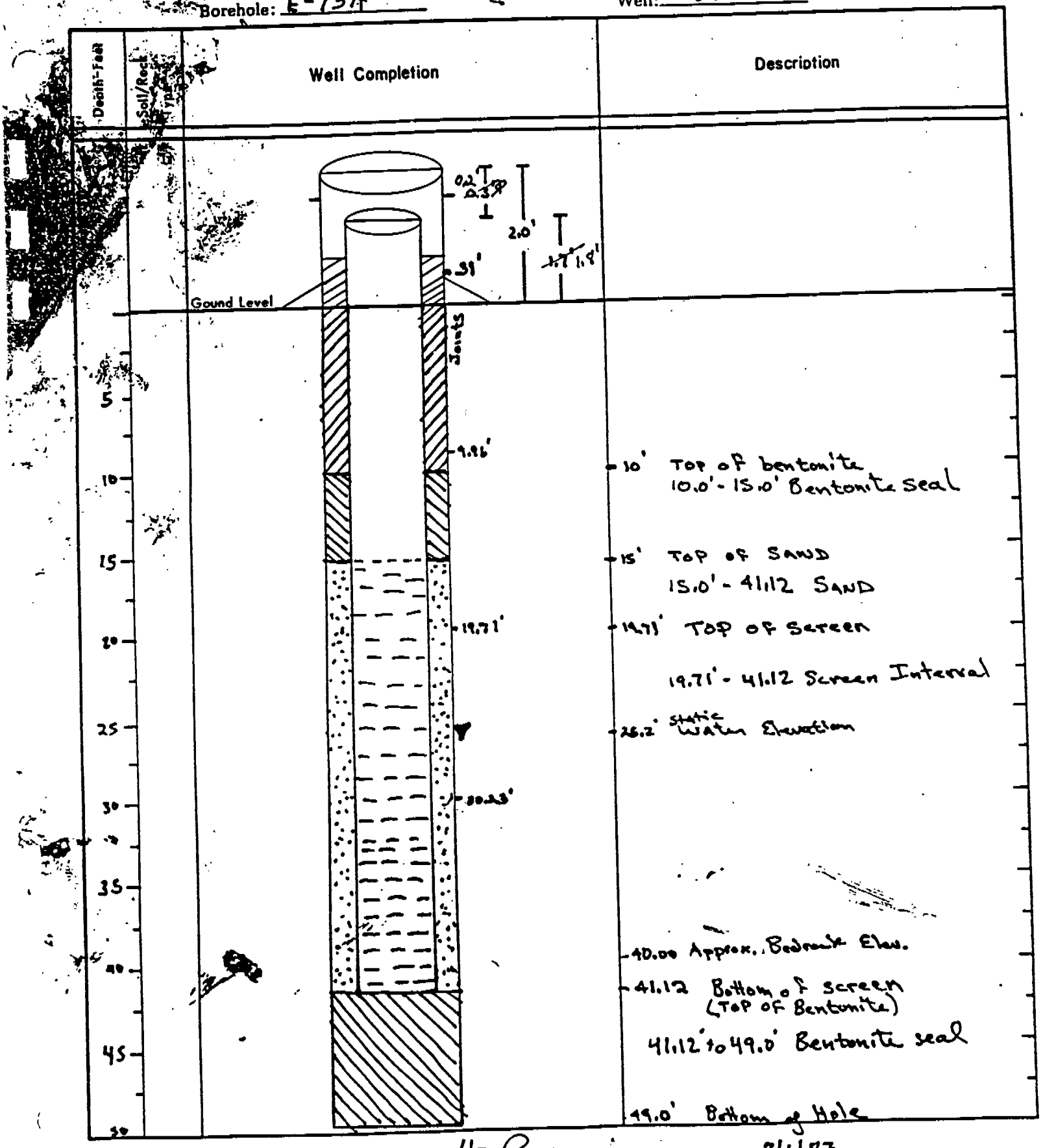

NATURAL GAMMA
20 cps
Initial Log
S.P.
10 MV
RESISTANCE
75 OHMS/ 5 Inches
FRONTIER LOGGING CORPORATION
0 20 40 60
COUNTS PER SECOND
0
Water Level
-50-

No GC13142
60
70
80
90
100
118
0
20
40
60
COUNTS PER SECOND
NATURAL GAMMA
S.P.
10 MV/INCH
RESISTANCE
75 OHMS/5 INCHES


0
20
40
60
COUNTS PER SECOND
NATURAL GAMMA
-118-
S.P.
10 MV/INCH
RESISTANCE
75 OHMS/5 INCHES
HOLE E 69

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7332 SOUTH ALTON WAY • SUITE H-I
ENGLEWOOD, COLORADO 80112 • 303/741-0839

Borehole: E-73A Well: 37391



Drill Site Geologist: Steven Rapp Date: 7/6/87

Reviewed By: Joseph L. Reed Date: 11/18/87

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
7332 SOUTH ALTON WAY • SUITE H-I
ENGLEWOOD, COLORADO 80112 • 303/741-0636

WELL CONSTRUCTION SUMMARY

Borehole E-73A Well 37391

Project Name and Location Task 39 off post Project Number

Drilling Company Boyles Bros. Driller Dan Irvine Rig Number IR

Drilling Method(s) Auger

Borehole Diameter 12¼ in. cm. 0.0' ft. cm. to 49.0' ft. cm.

in. cm. ft. cm. to ft. cm.

Size(s) and types of Bit(s) Hollow Stem Augers

Size and Type PVC 4" .020 slot

Total Borehole Depth	99.00 ft.	cm.
Depth to Bedrock	40.00 ft.	cm.
Depth to Water	25.20 ft.	cm.
Water Level Determined By	Sounding + sample	
Length Plain PVC (total)	21.41 ft.	cm.
Length of Screen	21.41 ft.	cm.
Total Length of Well Casing	42.82 ft.	cm.
PVC Stick Up	1.70 ft.	cm.
Depth to Bottom of Screen	41.12 ft.	cm.
Depth to Top of Screen	19.71 ft.	cm.
Depth to Top of Sand	15.0 ft.	cm.
Depth to Top of Bentonite	10.0 ft.	cm.

Sampling Method(s) Continous Split Spoon

Date/Time Start Drilling 6/29/87 1341

Date/Time Finish Drilling 6/29/87 1031

Date/Time Start Completion 6/29/87 1047

Date/Time Cement Protective Casing 6/30/87 0930

Materials Used 15-2' Tubes 30 caps

Plain PVC 2-10' section + 1 cut piece

Slotted PVC 2-10' section

Bentonite Pellets 13.5 buckets

Bentonite Granular ~~5 lb~~ 5/8 bag

Cement 5 Bags

Sand 18 bags

Water added during completion 30 gal.

Water added during drilling NA

Total Gallons of water added 30 gal

Drill Site Geologist STEVE PARIS Date 7/2/87

Date/Time/Personnel Internal Mortar, Cement Pad and Weep Hole Installed 07/13/87 / 0900 / am

Date/Time/Personnel Casing Painted (White) 07/13/87 / 0930 / am

Date/Time/Personnel Numbers Painted 7/13/87 JLR

Materials Used 10 bags Sakrete

Top of Protective Casing to Top of PVC	.20 ft.	cm.
Top of Protective Casing to Weep Hole	1.95 ft.	cm.
Top of Protective Casing to Internal Mortar	1.95 ft.	cm.
Top of Protective Casing to Top ofCement Pad	1.84 ft.	cm.
Top of Protective Casing to Ground Level	2.0 ft.	cm.

COMMENT/NOTES

Reviewed By Date

Drill Site Geologist Date

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
7332 SOUTH ALTON WAY • SUITE H-I
ENGLEWOOD, COLORADO 80112 • 303/741-0639

Borehole: E-73A Well Number: 37391

Depth-feet	Tube Number / Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
1'	1 — 0.0'-2.0'	.35'/2.0'			SM	Silty Sand, 30% silt, 2.5Y 6/2, light brownish grey, very loose, non plastic, moist
2'						
3'	2 — 2.0'-4.0'	.23/2.0'				
4'						
5'	3 — 4.0'-6.0'	1.08'/2.0'			CL	CLAY, 35% sand, fine to coarse grained, 2.5Y 7/4, pale yellow, very stiff, moist, calcareous low plastic
6'						
7'	4 — 6.0'-8.0'	1.44'/2.0'				gradual change to sc
8'					SC	Clayey Sand, 25% clay, fine to coarse grained, med. dense 2.5Y 6/6 olive yellow, moist, calcareous
9'	5 — 8.0'-10.0'	1.47/2.0'			CL	Clay, 30% Sand, fine to coarse grained, 2.5Y 4/4 olive brown, very stiff, moist, calcareous low plastic
10'						

Drill Site Geologist: Steve Pace Date: 6/29/87

Reviewed By: Joseph L. Reed Date: 9/29/87

206

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
7332 SOUTH ALTON WAY • SUITE H-1
ENGLEWOOD, COLORADO 80112 • 303/741-0839

Borehole: E-73A Well Number: 37391

Depth-feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
11	6 10.0'-12.0'	1.35'/2.0'			CL	Clay, 30% Sand, fine to coarse grained, 2.5Y 4/4 olive brown, very stiff, moist, very calcareous, low plastic
12						gradual change to SC
13	7 12.0'-14.0'	0.73/2.0'			SC	Clayey Sand, 20% clay, fine to coarse grained 2.5Y 4/4, olive brown, med dense, moist
14						color change from 14.5' to 15.0' 10YR 3/3 dark brown
15	8 14.0'-16.0'	1.4'/2.0'			Sm	Silty Sand, 15% silt, fine to medium grained 2.5Y 5/4, light olive brown, med dense moist
16						
17	9 16.0-18.0	1.28'/2.0'			SP	Poorly graded Sands, 3% silt, fine to coarse grained, 2.5Y 6/4, light yellowish brown med dense, moist
18						
19	10 18.0'-20.0'	1.65'/2.0'				
20						

Drill Site Geologist: Steve Pavey Date: 6/29/87

Reviewed By: Joseph L. Reed Date: 9/29/87

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
7332 SOUTH ALTON WAY • SUITE H-I
ENGLEWOOD, COLORADO 80112 • 303/741-0639

Borehole: E-73A Well Number: 37391

Depth-Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
21	11 20.0'-22.0'	1.42'/2.0'			SP	SANDS^SP Poorly graded SANDS, 3% silt, fine to coarse grained, 2.5Y 5/4, light olive brown, med dense, moist
22						
23	12 22.0'-24.0'	1.10'/2.0'				Sand grain size increase to: fine to very coarse grained including some small gravels (15%)
24						SANDS saturated 24'-25'
25	13 24.0'-26.0'	1.82'/2.0'			SC	Clayey SANDS, 15% clay, fine to very coarse grained, 10YR 5/4, yellowish brown, med. dense, moist
26						Sharp contact with gravels below
					GM GP GS	~~Poorly graded gravel~~ Silty gravel, 15% silt, 30% sand, fine to v. coarse grained sand, small to med gravels, 10YR 5/4, yellowish brown, med. dense, saturated
27	14 26.0'-28.0'	1.44'/2.0'			SP	Poorly graded sands, 10% silt, fine to very coarse grained 10YR 6/4, light yellowish brown, med dense, saturated
28						
29	15 28.0'-30.0'	No Recovery				No recovery after 28.0'. Predict poorly graded sands and silty gravels flowing out of sampler while samples were being removed from hole.
30						

Drill Site Geologist: Steve Parks Date: 6/29/87

Reviewed By: Joseph L. Reed Date: 9/29/87

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7332 SOUTH ALTON WAY • SUITE H-I
ENGLEWOOD, COLORADO 80112 • 303/741-0639

Borehole: E-73A Well Number: 37391

Depth-Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
						Continous sampling method utilized to 99'. No recovery after 28.0', Suspect unconsolidated sands and gravels flowing out of sampler or plugged auger resulted in no recovery from 28.0'-49.0' Estimate 4.0' of weathered bedrock from 36.0'-40.0'. Determined by increase torque on drill rig to auger through this depth Estimate bedrock at 40.0' by increase in torque from 40.0'-49.0'.

Drill Site Geologist: Steve Pagnac Date: 7/6/87

Reviewed By: Joseph L. Reed Date: 9/29/87

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
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ENGLEWOOD, COLORADO 80112 • 303/741-0839

BOREHOLE SUMMARY LOG

Borehole E-73 Well 37391

Project Name and Location MW Installation - Offpost Project Number Task 39

Drilling Company Boyles Driller B. Roach Rig Number Failing 1500

Drilling Method(s) Rotary

Size(s) and type(s) of bit(s) 11" in " auger, 3 7/8" tricone bit

Borehole Diameter 11 1/2 in. ____ cm. 0 ft. ____ cm. to 39 ft. ____ cm.

3 7/8 in. ____ cm. 39 ft. ____ cm. to 111 ft. ____ cm.

Sampling Methods Continuous core

Total Number Soil Sampling Tubes —

Total Number Core Boxes 7

Number of Gallons Lost Drilling Fluid —

Date/Time Started Drilling 7-9-87 0918

Date/Time Completed Drilling 7-9-87 0837

Total Borehold Depth 111 ft. ____ cm.

Depth to Bedrock 36' ft. ____ cm.

Depth to Water — ft. ____ cm.

Water Level Determined By? —

Borehole Completed as Monitoring Well? NO

Date/Time Grouting Completed 7-9-87 1030

Depth of Tremmie Pipe 108'

Gallons of Grout 80 gals.

Materials Used 80 gals. water, 8 bags cement, 1 bag bentonite

Comments hole grouted to surface —

Wellsite Geologist C. D. Benson Date 7-9-87

Checked for Grout Settlement on Nov 18 by 11/18/87

Amount of Grout Added 0

All Measurements from Ground Level

Reviewed by Joseph L. Reed Date 11/18/87

Drill Site Geologist ____ Date ____

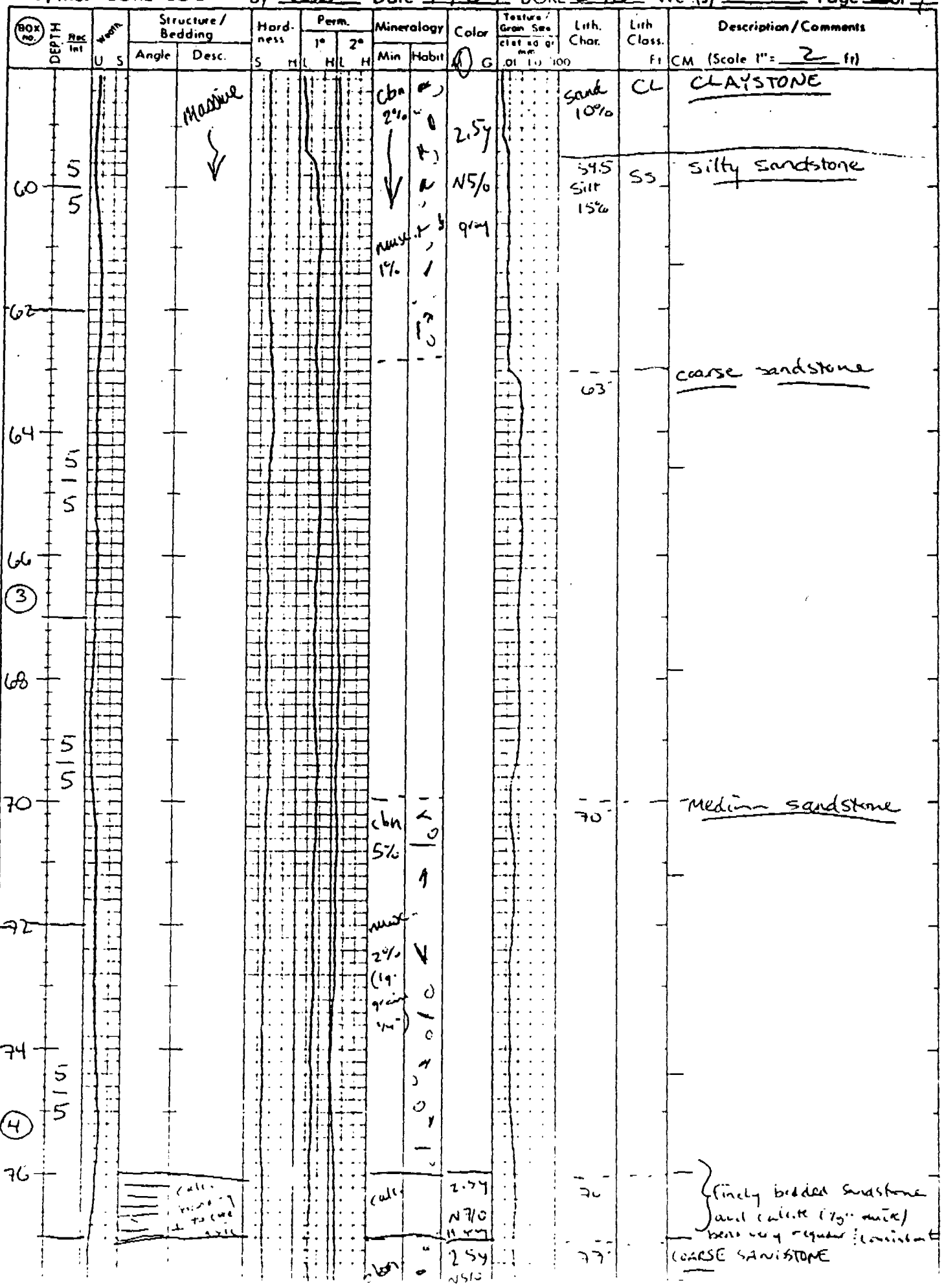
ESE, Inc. CORE LOG By CDB Date 7.9.87 BORE E73 Well(s) _____ Page 1 of 4

Box no.	Depth	Rec. Int	Weath. U S	Structure/Bedding: Angle	Structure/Bedding: Desc	Hardness S H	Perm 1° L H	Perm 2° L H	Mineralogy: Min	Mineralogy: Habit	Color M G	Texture/Gram Size: clay sd gr mm 01 1.0 100	Lith. Char	Lith. Class Ft	Description/Comments CM (Scale 1" = 2 ft)
															Casing set to 39', bedrock at 36', core begins at 39'
														CL	CLAYSTONE
	40				fractures 2-3/ft. ⊥ to core				FeOx stain fractures		2.5y N6/2 lt. brownish gray				
		3.4/4													
	42								calc. vnlt. ¼" wide 5°						
	44														
(1)		3.2/4													
	46												46'		Oxidation boundary
											2.5y N4/0 dk. gray		47' sand 15%		
	48								clon fragt 10%				48.5' sand 35%		sandy, carbonaceous claystone
		4.1/5													
	50								musc 2% pyrite 1%				50'	SS	sandstone
	52								clon 2%				52' sand 10%	CL	Sandy, carbonaceous claystone
									clon 5%						
	54														Sandy claystone
		4.7/5							musc 1%				sand 5%		
(2)															
	56														

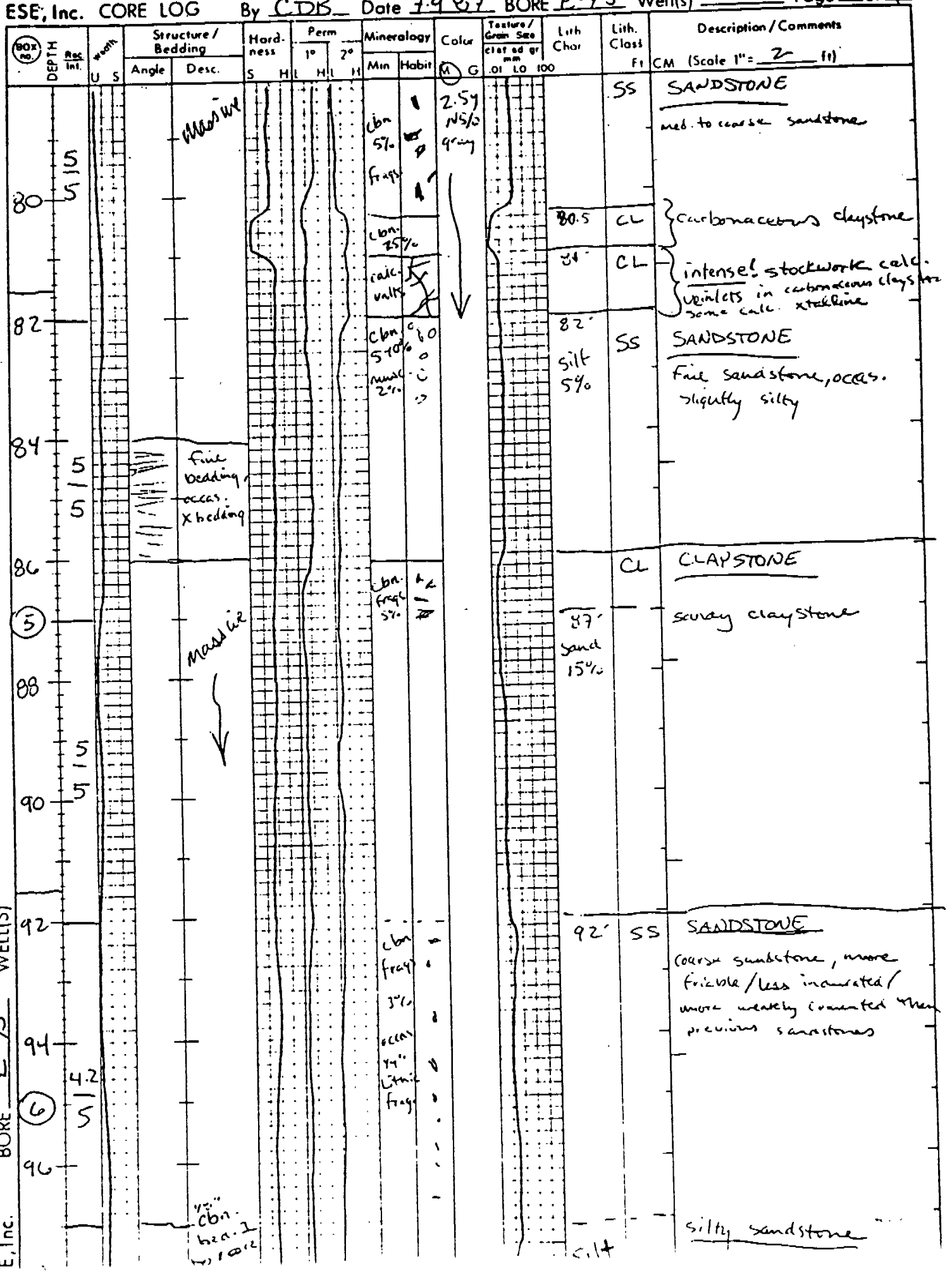
BORE E73 WELL(S)

E, Inc.

ESE, Inc. CORE LOG By CDB Date 7.9.87 BORE E73 We (s) _____ Page 2 of 4



ESE, Inc. CORE LOG By CDB Date 7-9-87 BORE E-73 Well(s) _____ Page 3 of 4



ESE, Inc. CORE LOG . By CDB Date 7-9-87 BORE E-73 Well(s) _____

Box no.	Depth	Rec. Int.	Weath. U	Weath. S	Structure/Bedding Angle	Structure/Bedding Desc	Hardness S	Hardness H	Perm. 1° L	Perm. 1° H	Perm. 2° I	Perm. 2° H	Mineralogy Min	Mineralogy Habit	Color M	Color G	Texture/Grain Size clst ed gr mm .01 LO 100	Lith Char	Lith. Class Ft	Description/Comments CM (Scale 1" = 2 ft)
	98																	98'	ST	SILTSTONE carbonaceous
	99																	99'		
	100	4.2/4											mult. 2% fine grains			2.5Y N5/0 gray				
	102																	102'	CL	CLAYSTONE
	104	5/5											carb. 30%			dk. gray		104'	SS	SANDSTONE
	106												carb. frags 20%					106.5	CL	CLAYSTONE
(7)													carb. 10%			2.5Y N4/0 dk. gray				
	108	4.2/5																		
	110																			
	111																			Total Depth 111'

BORE E-73 WELL(S)

ESE, Inc.

Frontier Logging

Lakewood, Colorado

Company: ESE

Bore Hole: E-73

Area/Project: RMA

County: ADAMS COUNTY — State: COLORADO

Section — Township — Range — Elevation

Log Measured From: Ground Level

Date: JULY 9, 1987

Driller Depth: 111 FT — Miles Round Trip

Bit Size: 3 7/8" — Standby

Casing Driller: 39 FT — Time In: 0900 — Time Out: 0945

Fluid in Hole: water — Unit No.: 110

Density/Viscosity — pH — Operator: Wm. Linton

Drilling Measured From: Ground Level — Location: Lakewood

EQUIPMENT DATA

T Logged: 110 FT

Natural Gamma: 200 Scale = 20 CPS per inch

Time Constant: 2 Sec — Logging Speed: 15 Ft/Min

Calib Source No/Value: = CPS

Probe No: 103-1041 — Probe Diameter: 1 5/8"

Doctor Type Size: xtal 3/4 x 1"

K Factor: 1.60 x 10^{-5} — Dead Time: 7 Microsec

Water Factor: 1.10 for hole size 3 7/8"

Casing Factor: for wall thk

Resistance: 40 ohms/5" Ohms per 5 Inches

S.P.: 20 MV/Inch MV per Inch

NATURAL GAMMA RERUNS (ANALOG)

(Initial log off scale)

Scale = CPS/In	T C Sec	Logging Speed Ft/Min	From Ft	To Ft	Total Ft

DIRECTIONAL DATA

Gamma (Analog) Ft

Gamma (Digital) Ft

Caliper Ft

Temperature Ft

Closure Ft

Azimuth

True Vertical Ft — Survey Depth Ft

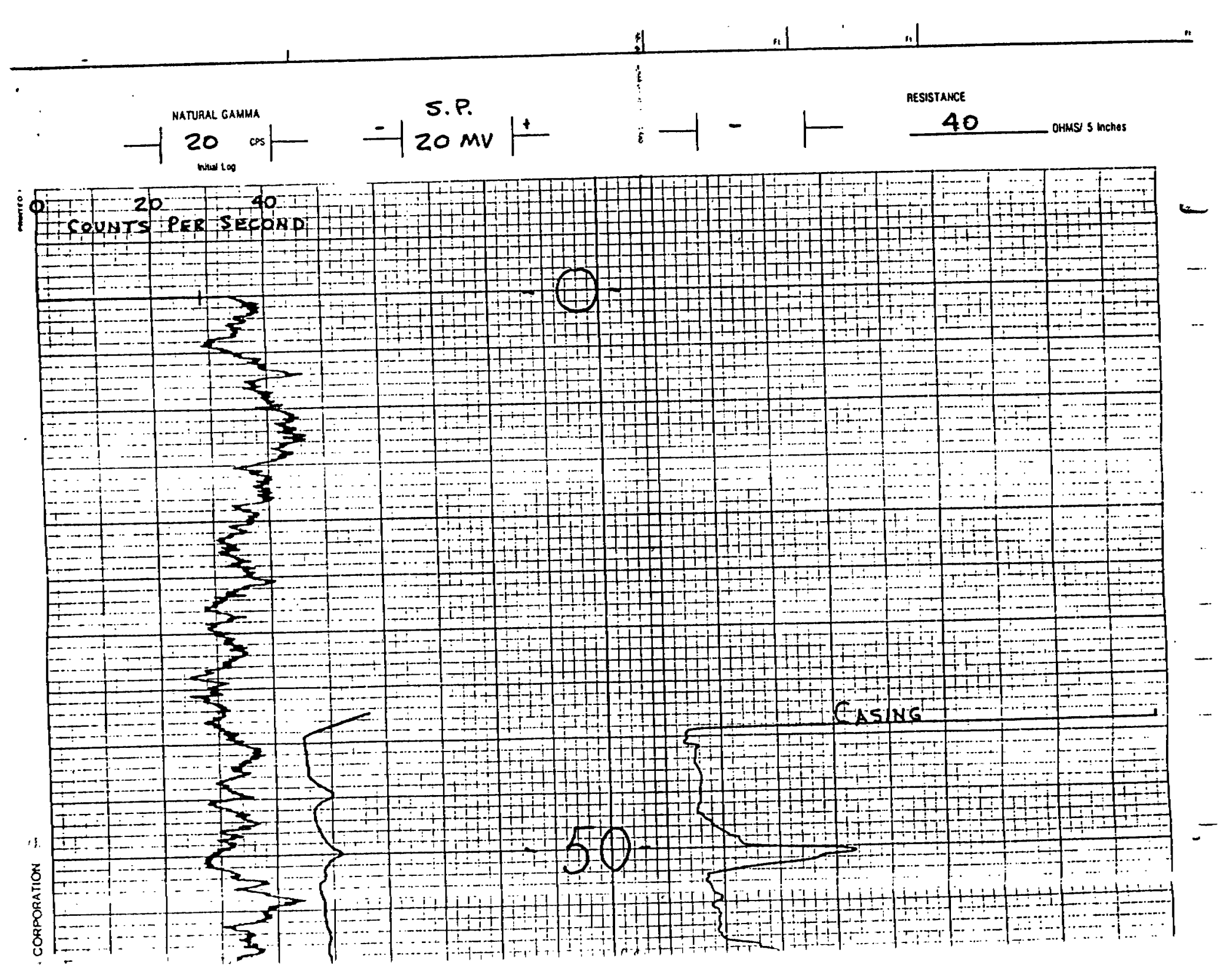
Density Source No — Type — Strength — CPS/inch — Ft

Neutron Source No — Type — Strength — CPS/inch — Ft

NATURAL GAMMA: 20 CPS (Initial Log)

S.P.: - 20 MV +

RESISTANCE: 40 OHMS/ 5 Inches


NATURAL GAMMA
20 CPS
Initial Log
S.P.
20 MV
RESISTANCE
40 OHMS/ 5 Inches
0 20 40
COUNTS PER SECOND
0
50
CASING

FRONTIER LOGGING

No. GC13142

10

80

90

100

110

0 20 40

COUNTS PER SECOND

NATURAL GAMMA

-S.P.-

20 MV/INCH

RESISTANCE

40 OHMS/5 INCHES

E-13

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
7332 SOUTH ALTON WAY • SUITE H-I
ENGLEWOOD, COLORADO 80112 • 303/741-0839

WELL CONSTRUCTION SUMMARY

Borehole E-74A Well 37392

Project Name and Location _____ Project Number Task 39

Drilling Company Boyles Bros Driller Don Irvine Rig Number IR

Drilling Method(s) Auger SP Hollow stem auger 3¼" ID 7¼" OD, continous samples, reamed with 8½" ID 12¼" OD Hollow Stem Auger

Borehole Diameter 12¼ in. _____ cm. 0.0' ft. _____ cm. to 30.2' ft. _____ cm.

_____ in. _____ cm. _____ ft. _____ cm. to _____ ft. _____ cm.

Size(s) and types of Bit(s) Hollow stem Auger 12¼

Sampling Method(s) continous, Split spoon

Date/Time Start Drilling 7/2/87 1048

Size and Type PVC 4" sch. 40 0.20' slot

Date/Time Finish Drilling 7/6/87 1556

Total Borehole Depth	30.2' ft.	_____ cm.	Date/Time Start Completion 7/7/87 0810
Depth to Bedrock	28.1' ft.	_____ cm.	Date/Time Cement Protective Casing 7/7/87 0927
Depth to Water	18.5' ft.	_____ cm.	Materials Used –
Water Level Determined By	Sample		Plain PVC 1-10' section, 1-5' section
Length Plain PVC (total)	14.91 15.05 SP ft.	_____ cm.	Slotted PVC 1-10' section, 1-5' section
Length of Screen	16.22 ft.	_____ cm.	Bentonite Pellets 4½ buckets
Total Length of Well Casing	31.13 ft.	_____ cm.	Bentonite Granular ⅜ bag
PVC Stick Up	1.70' ft.	_____ cm.	Cement 3 bags
Depth to Bottom of Screen	29.43 ft.	_____ cm.	Sand 11½ bags
Depth to Top of Screen	13.21 ft SP	_____ cm.	Water added during completion none
Depth to Top of Sand QS	8.60 SP ft.	_____ cm.	Water added during drilling none
Depth to Top of Bentonite	3.50 ft.	_____ cm.	Total Gallons of water added –

Drill Site Geologist Steve Pauls Date 7/9/87

Date/Time/Personnel Internal Mortar, (Cement Pad), and Weep Hole Installed 07/13/87 / 1000 / am

Date/Time/Personnel Casing Painted (White) 07/13/87 / 1030 / am

Date/Time/Personnel Numbers Painted 7/13/87 JR/TZR

Materials Used 9 bags Sakrete

Top of Protective Casing to Top of PVC	.46 ft.	_____ cm.	COMMENT/NOTES
Top of Protective Casing to Weep Hole	1.2 ft.	_____ cm.	
Top of Protective Casing to Internal Mortar	1.2 ft.	_____ cm.	
Top of Protective Casing to Top of Cement Pad	1.65 ft.	_____ cm.	
Top of Protective Casing to Ground Level	1.80 ft.	_____ cm.	

Reviewed By _____ Date _____

Drill Site Geologist _____ Date _____

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
7332 SOUTH ALTON WAY • SUITE H-1
ENGLEWOOD, COLORADO 80112 • 303/741-0839

Borehole: E-74A Well: 37392

Depth-Feet	Soil/Rock Type	Well Completion	Description
		.46, 1.8, 1.34	
		Gound Level	
		Bentonite 3.11'	3.5' Top of bentonite Bentonite seal 3.5' to 8.5'
10			8.5' Top of SAND SAND pack from 8.5' - 30.20'
		13.21'	13.21 Top of Screen Screen from 13.21' - 29.43'
		18.72 18.5	18.5' STATIC WATER ELEV
20			
			28.1' Top of bedrock
30			29.43 Bottom of screen
			30.20' Total depth

Drill Site Geologist: Steven Pace Date: 7/13/87
Reviewed By: Joseph E. Lloyd Date: 11/18/87

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
7332 SOUTH ALTON WAY • SUITE H-I
ENGLEWOOD, COLORADO 80112 • 303/741-0639

Borehole: E-74A Well Number: 37392

Depth - Feet	Tube Number / Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
1	1 0.0'-2.0'	100% 2.0'/2.0'			SM	Silty SAND, 35% silt, fine to coarse grained sand, 10YR 4/4, Dark yellowish brown, medium dense, moist, non plastic
2					CL	Clay, 20% SAND, fine to coarse sand, 10YR 5/4, yellowish brown, stiff, moist, medium plastic, calcareous.
3	2 2.0'-4.0'	1.6'/2.0'				
4						Sand increases to 35%, fine to coarse grained
5	3 4.0'-6.0'	1.4'/2.0'				
6						
7	4 6.0'-8.0'	1.2'/2.0'			SM	Silty SAND, 15% Silt, fine to coarse grained sand, 10YR 6/4, light yellowish brown, med. dense, moist, non-plastic
8					SC	Clayey SAND, 20% clay, fine to very coarse grained SAND, 10YR 5/6, Yellowish brown medium dense, moist, L. plastic.
9	5 8.0'-10.0'	1.4'/2.0'				
10						
	6 10.0'-12.0'	1.8'/2.0'			SM	Silty Sand, 15% silt, fine to coarse grained sand (from 10.5' to 10.8')

Drill Site Geologist: Steve Pace Date: 7/9/87

Reviewed By: Joseph L. Reed Date: 9/29/87

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
7332 SOUTH ALTON WAY • SUITE H-I
ENGLEWOOD, COLORADO 80112 • 303/741-0839

Borehole: E-74A Well Number: 37392

Depth - Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
					SM	2.5Y 6/6, Olive yellow, medium dense, moist, non plastic
11 — 12	6 10.0'-12.0'	1.8'/2.0'			CL	CLAY, 30% SAND, fine to coarse grained sand, 2.5Y 5/4 light olive brown, oily, moist, medium plastic
13 — 14	7 12.0'-14.0'	1.8'/2.0'			SC	SANDY Clay, 30% CLAY, 10YR 5/3, brown, medium dense, moist, brown, low plastic (fine to coarse grained sand)
15 — 16	8 14.0'-16.0'	100% 2.0'/2.0'			SP	Poorly graded SANDS, fine to coarse grained sands, 5% small gravels, 2.5Y 6/4, light yellowish brown, loose, moist, non plastic
17 — 18	9 16.0'-18.0'	2.0'/2.0'			GP	Poorly graded gravels, fine to medium, 10YR 6/4, light yellowish brown, loose, moist, non plastic
19 — 20	10 18.0'-20.0'	2.0'/2.0'			SP	Poorly graded Sands, fine to very coarse grained, 10YR 7/2 light grey, loose, moist, non plastic SANDS saturated at 19.0'
	R 200'-220'					

Drill Site Geologist: Steve Page Date: 7/9/87

Reviewed By: Joseph L. Reed Date: 7/29/87

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
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ENGLEWOOD, COLORADO 80112 • 303/741-0839

Borehole: E-74A Well Number: 37392

Depth-Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
21	11 20.0'-22.0'	0.0'/2.0'			SP	Poorly graded sands, fine to very coarse grains 10YR 7/2, light grey, loose, saturated, non plastic SP No recovery from 20.0' - 22.0' cuttings ind. native poorly graded sands (SP)
22						
23	12 22.0'-24.0'	3'/2.0'			SP	No Recovery from 22.0' - 27.0' 24.0' Auger cuttings indicate poorly graded sands (SP) with possible silty sand lenses (SM) Poorly graded sands (SP) from 22.0'-29.0', fine to medium grained 10YR 7/2, light grey, loose, saturated, non plastic.
24						
25						
26						
27						
28	14 22.0'-29.0' 100% 2.0'/2.0'			28.1'	SP	Poorly graded SANDS, fine to very coarse grained, 10% gravel, 10YR 7/2, light grey, loose, saturated, non-plastic CLAYSTONE BEDROCK, Olive, fe stains
29						TD 29.0'

Drill Site Geologist: Steve Pargas Date: 7/13/87

Reviewed By: Joseph L. Reed Date: 9/29/87

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
7332 SOUTH ALTON WAY • SUITE H-I
ENGLEWOOD, COLORADO 80112 • 303/741-0839

BOREHOLE SUMMARY LOG

Borehole E-74 Well 37392

Project Name and Location MW Installation - NOAA Project Number Task 39

Drilling Company Bayles Driller B Roach Rig Number Failing 1500

Drilling Method(s) Rotary

Size(s) and type(s) of bit(s) 7 7/8", 3 3/4" bit

Borehole Diameter 7 7/8 in. ____ cm. 0 ft. ____ cm. to 36 ft. ____ cm.

3 3/4 in. ____ cm. 36 ft. ____ cm. to 111 ft. ____ cm.

Sampling Methods Continuous core

Total Number Soil Sampling Tubes —

Total Number Core Boxes ____

Number of Gallons Lost Drilling Fluid —

Date/Time Started Drilling 7.2.87 0943

Date/Time Completed Drilling 7.7.87 0830

Total Borehold Depth 111 ft. ____ cm.

Depth to Bedrock 35' ft. ____ cm.

Depth to Water — ft. ____ cm.

Water Level Determined By? —

Borehole Completed as Monitoring Well? NO

Date/Time Grouting Completed 1410 7.7.87

Depth of Tremmie Pipe 110'

Gallons of Grout 80 bags - cos

Materials Used 80 gals. water, 8 bags cmnt, 3/4 bag bentonite

Comments hole grouted to surface

Wellsite Geologist C D Benson Date 7.8.87

Checked for Grout Settlement on 11/18/87 by Steve Lowe

Amount of Grout Added none

All Measurements from Ground Level

Reviewed by Joseph L. Reed Date 11/18/87

Drill Site Geologist ____ Date ____

ESE, Inc. CORE LOG By CDB Date 7.8.87 BORE E-74 Well(s) _____ Page 1 of 4

BOX no.	DEPTH	Rec. / Int.	Weath. U S	Structure / Bedding: Angle	Structure / Bedding: Desc.	Hardness S H	Perm. 1° L H	Perm. 2° L H	Mineralogy: Min.	Mineralogy: Habit	Color M G	Texture / Grain Size: clist sd gr mm .01 1.0 100	Lith. Char.	Lith. Class Ft	Description / Comments CM (Scale 1" = 2 ft)
															Bedrock at 35', casing set to 36', coring start at 36'
	36				massive				carbon to 30%	frags & matrix	2.5Y N3/0 very dk. gray		carbonaceous	CL	CLAYSTONE
															End of predominant carbon
	38	1.3 / 4							nuisc 2%		2.5Y N5/0 gray		37.5		
	40														40' claystone becomes very soft & incompetent to 42.5'
1		3 / 3													
	42														sandy claystone
													42.5 SANDY Sand 25%	CL	
	44	4 / 4							carb frags 10%						
	46												46.5 Sand 5% silt 10%		sandy, silty claystone
									nuisc 3%						
	48	4.2 / 4.5			irregularly fissile to 56'										carbonaceous claystone
													49'		
2	50								carbon to 35%	frags & matrix	2.5Y N3/0 very dark gray				
	52	3.2 / 5													

WELL(S) BORE E-74

ESE, Inc.

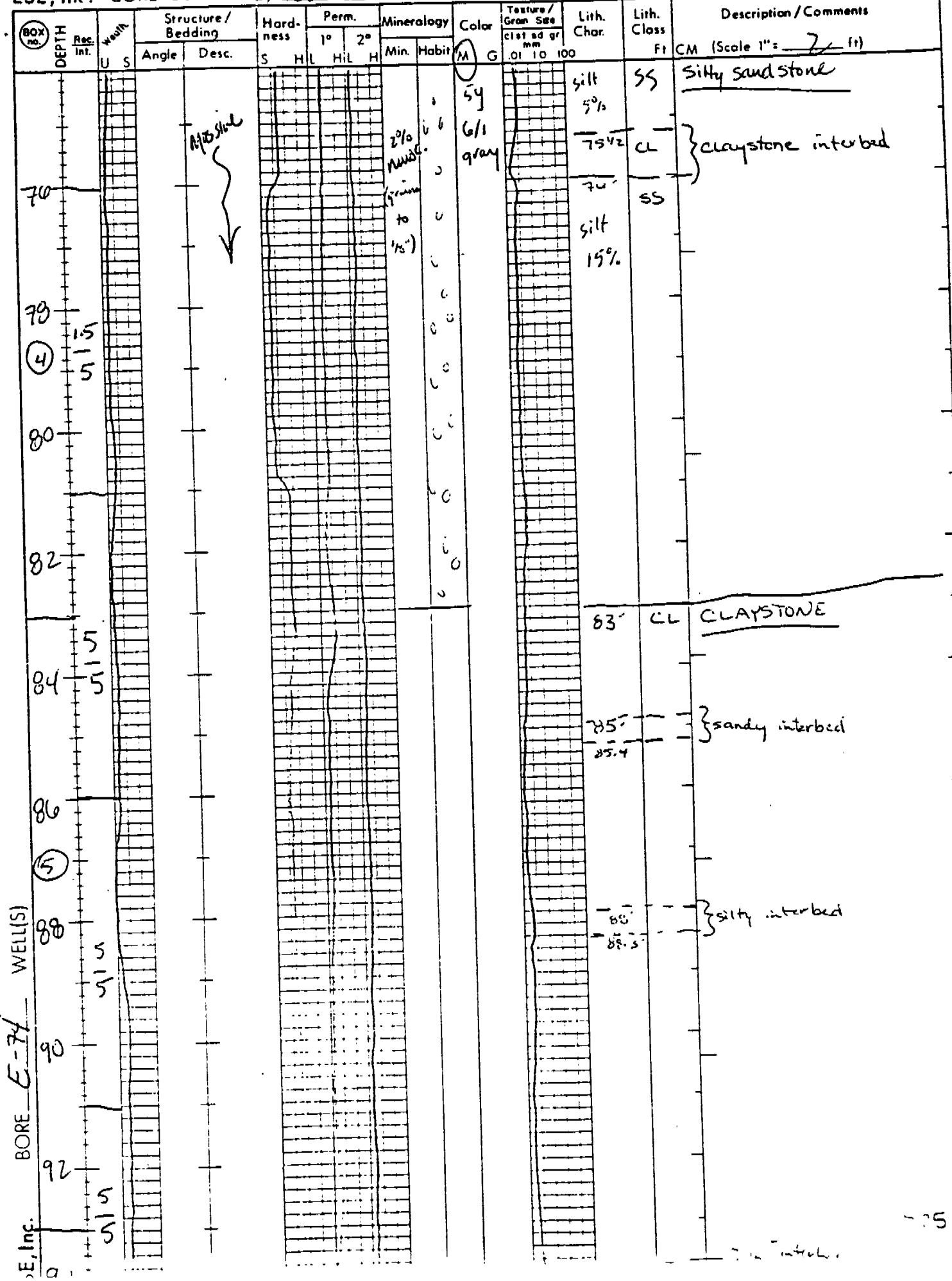
ESE, Inc. CORE LOG By CDB Date 7-9-87 BORE E-74 Well(s) _____

Box no.	Depth	Rec. / Int.	Weath. U S	Structure/Bedding Angle	Structure/Bedding Desc.	Hardness S H	Perm. 1° L H	Perm. 2° L H	Mineralogy Min.	Mineralogy Habit	Color (N) G	Texture/Grain Size clst sd gr mm .01 1.0 100	Lith. Char.	Lith. Class Ft	Description/Comments CM (Scale 1" = 2 ft)
	56				massive				cbn 10%	frag. & massive	2.5Y N3/0 very dark gray		carbonaceous	CL	CLAYSTONE
	58	1.3/5													
	60														
															End of pervasive carbon
		2.1/1											61'	CL	Core recovery from spinda
	62										5Y 5/1 gray				
	64	5/4													
(3)									cbn 5%		5Y 4/1 dark gray				
	66														
	68	5/5											68'		
									Sand no 15% cbn no 10%		5Y 6/1 gray		sand zones/areas discrete in claystone		
	70														
													71'	SS	SANDSTONE - SILTY
	72	4.1/5							cbn 5%	frag.			silt 20%		
	74														

BORE E-74 WELL(S)

ESE, Inc.

ESE, Inc. CORE LOG By CDB Date 7-9-87 BORE E-74 Well(s) _____ Page 3 of 4



SE, Inc. CORE LOG By CDB Date 7-9-87 BORE E-74 Well(s) _____ Page 4 of 4

DEPTH	Rec. Int.	Weath. U S	Structure/Bedding Angle	Structure/Bedding Desc.	Hardness S	Hardness HIL	Perm. 1° HIL	Perm. 2° H	Mineralogy Min	Mineralogy Habit	Color M	Color G	Texture/Grain Size clist sd gr mm .01 1.0 100	Lith. Char.	Lith. Class Ft	Description/Comments CM (Scale 1" = 2 ft)
											5Y 6/1	gray			CL	CLAYSTONE
				Massive										95'		silty interbed
14														96'		
18																
	5															
	5															
20																
														100'	SS	SANDSTONE
																(pyritic 1% massive pyrite)
102									cccs							
									cbn frags							
									mud	1%						
	5													102'		cccs or and more fractured texture to 104'
	5			X-bedding cbn along bedding					cbn							
104									frags							
									Rspar							
									frags	5%						
106																
														106.5	CL	CLAYSTONE
7				Massive					cbn	seam						carbonaceous seam
108																
	5															
	5															
110																
111																Total Depth 111'

→260

Frontier Logging
Lakewood, Colorado

Company: ESE
Well Hole: E-74
Area/Project: RMA
County: ADAMS COUNTY
State: COLORADO
Section:
Township:
Range:
Elevation:
Log Measured From: Ground Level

Date: JULY 7, 1987
Driller Depth: 111 Ft
Bit Size: 3 7/8"
Casing Driller: 36 Ft
Fluid in Hole: water
Density/Viscosity:
Rm @
Drilling Measured From: Ground Level

Miles Round Trip:
Standby: Hrs
Time In: 1145
Time Out: 1255
Unit No.: 110
Operator: Wm. Linton
Location: Lakewood

EQUIPMENT DATA

D Logged: 104 Ft
Natural Gamma: 200 Scale = 20 CPS per Inch
Time Constant: 2 Sec
Logging Speed: 15 Ft/Min
Auxiliary Source No/Value: CPS
Probe No: 103-1041
Probe Diameter: 1 5/8"
Detector Type Size: Xtal 3/4 x 1"
Factor: 1.60 x 10^{-5}
Dead Time: 7 Microsec
Water Factor: 1.10
Bit or Hole Size: 3 7/8"
Casing Factor:
For Well Site:
Resistance: 25 ohms/5"
SP: 20 MV/Inch

NATURAL GAMMA RERUNS (ANALOG)
(Initial log off scale)

Scale = CPS/In	TC Sec	Logging Speed Ft/Min	From Ft	To Ft	Total Ft

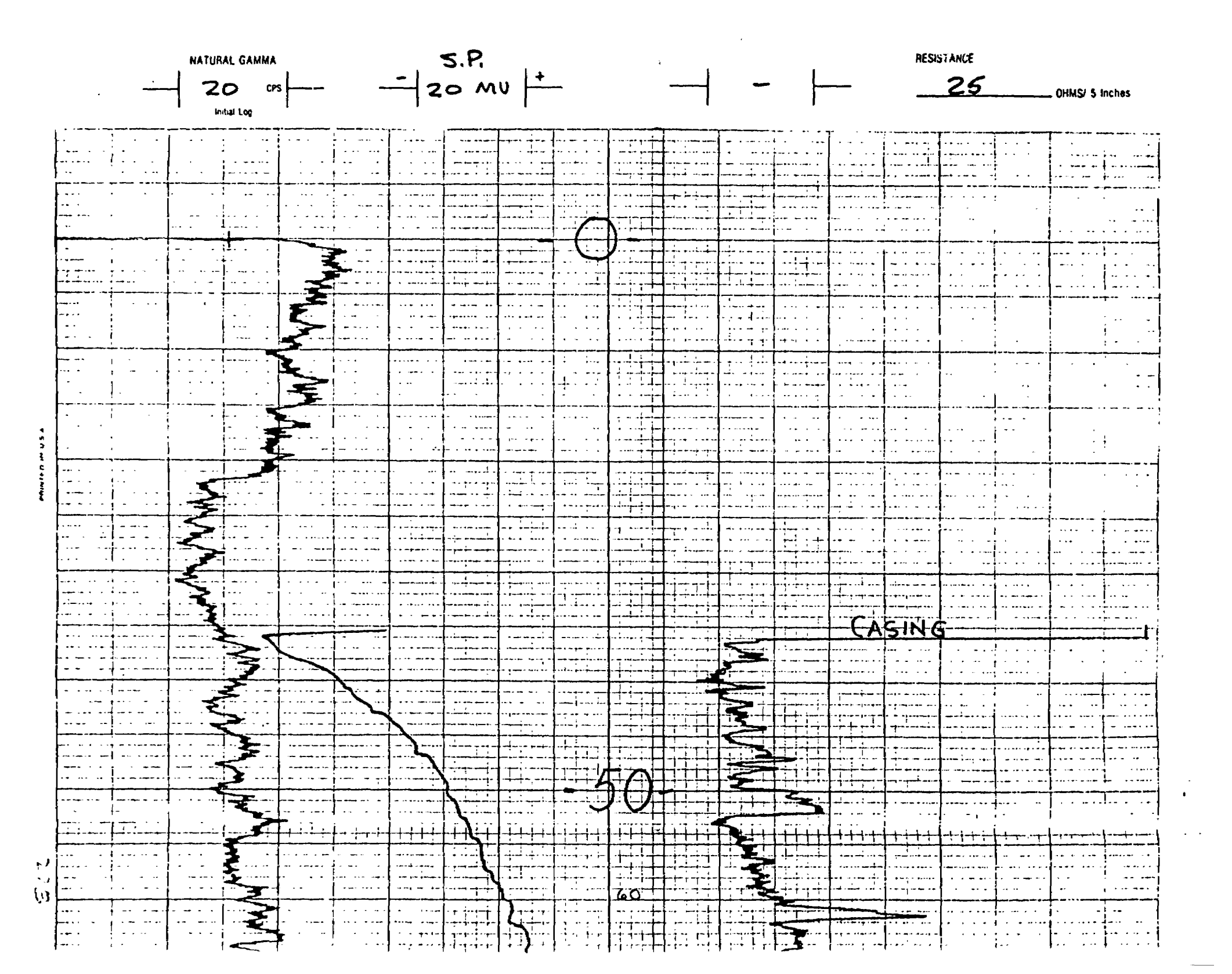
Gamma (Analog) Ft
Gamma (Digital) Ft
Caliper Ft
Temperature Ft

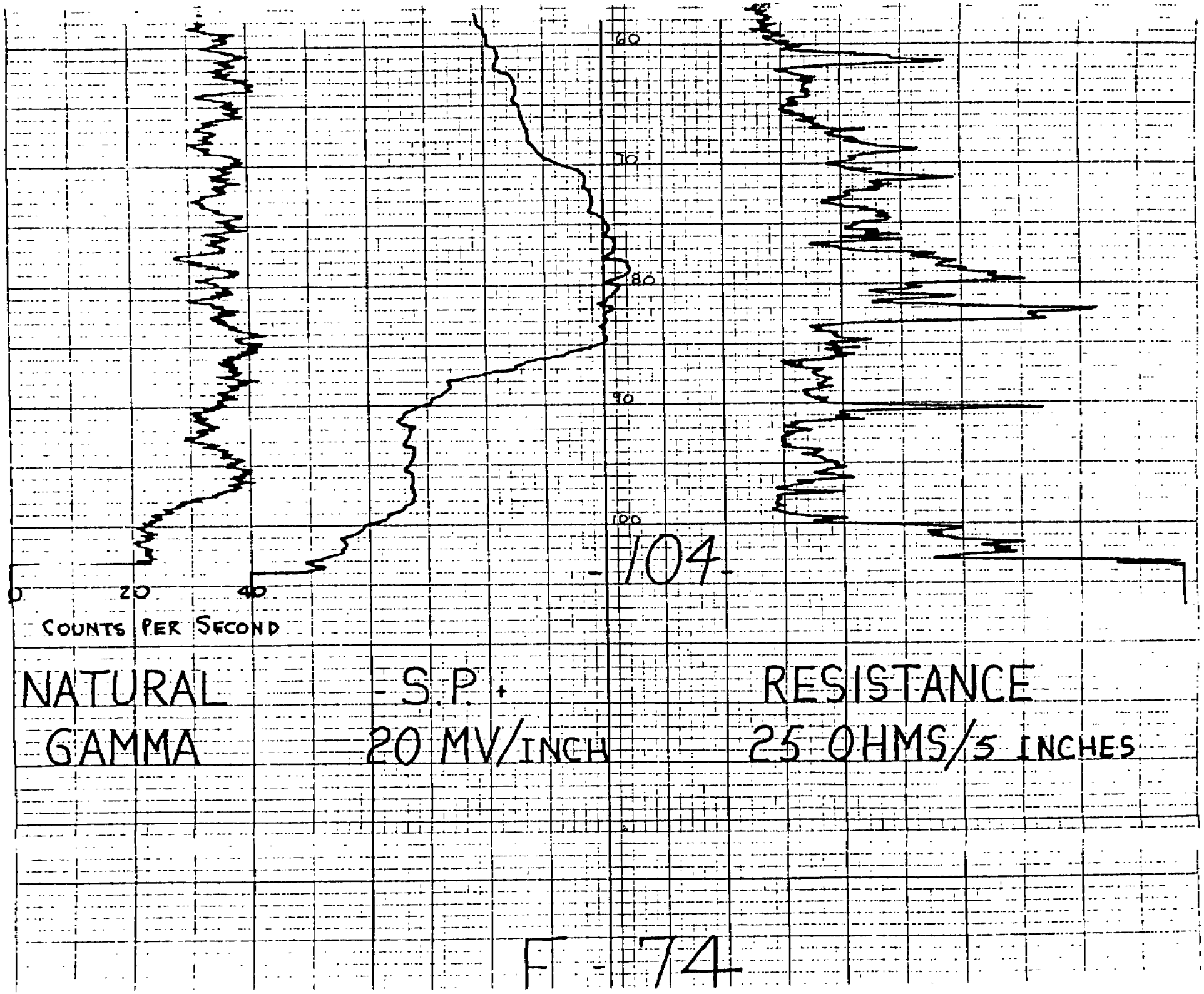
DIRECTIONAL DATA

Closure Ft
Azimuth
True Vertical Ft
Survey Depth Ft

Density Source No
Type Strength
CPS/Inch
Neutron Source No
Type Strength
CPS/Inch

NATURAL GAMMA — 20 CPS — Initial Log
S.P. — 20 MV
RESISTANCE — 25 OHMS/ 5 Inches


NATURAL GAMMA
20 CPS
Initial Log
S.P.
- 20 MV +
RESISTANCE
25 OHMS/ 5 Inches
0
CASING
-50-
60


FRONTIER LOGGING CORPORATION
60
70
80
90
100
0
20
40
COUNTS PER SECOND
-104-
NATURAL
GAMMA
-S.P.+
20 MV/INCH
RESISTANCE
25 OHMS/5 INCHES
F-74

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BOREHOLE SUMMARY LOG

JR

Borehole ESTA E-75A Well Dry Hole

Project Name and Location T-36 Yuma East Hwy 2 mi N 4th St Project Number 10053 074.10

Drilling Company Boyles Bros Driller Dave Jarvis Rig Number 5452

Drilling Method(s) Auger

Size(s) and type(s) of bit(s) _____

Borehole Diameter 7¼ in. _____ cm. _____ ft. _____ cm. to 48' ft. _____ cm.

_____ in. _____ cm. _____ ft. _____ cm. to _____ ft. _____ cm.

Sampling Methods Continuous Split spoon

Total Number Soil Sampling Tubes 24

Total Number Core Boxes 5

Number of Gallons Lost Drilling Fluid 0

Date/Time Started Drilling 4/1/87 0830

Date/Time Completed Drilling 4/1/87 1018

Total Borehold Depth 48' ft. _____ cm.

Depth to Bedrock 46' ft. _____ cm.

Depth to Water Dry ft. _____ cm.

Water Level Determined By? Samples

Borehole Completed as Monitoring Well? No

Date/Time Grouting Completed 4-1-87 12:30

Depth of Tremmie Pipe In Auger

Gallons of Grout ≈ 185

Materials Used 9 BAGS CEMENT 1 BUCKET BENTONITE

Comments During auger removal the augers brought up mud not associated with the grout. Through sample barrel's mud Saltwater after the hole was backfilled dry. No well will be installed despite the muddy augers

Wellsite Geologist Greg LA Date 4/1/87

Checked for Grout Settlement on 6/7/87 by JLR

Amount of Grout Added 0.0

All Measurements from Ground Level

Reviewed by Joseph L. Reed Date 6/7/87

Drill Site Geologist _____ Date _____

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SHEET 1 OF 5

Borehole: E-75A Well Number: Dry Hole

B.R. = 13.0'
PRG - 5/15/87

SOILS LOG
Description

MUNSELL COLORS

Depth-Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	Description
0.0			N/A		ML	ML sandy-silt, ~ 10% v. f. gr sand, 10YR, 4/2-3, dk. brn., non-plas., loose, moist, alluvium.
1.0	0-2'	2'		0-2'		
1.5						
1.8						At 1.8', sandy-silt, ~ 10% v. f. gr. sand, ~~10%~~ to calc clay & 10YR, 7/3-4, v. pale brn., non-plas., med. dense dry, alluvium.
2.0						
3.0	2-4'	2'		2-4'		
4.0						
5.0	4-6'	2'		4-6'		
6.0						At 6.0', sandy-silt, ~ 30-40% v. f. gr sand, 10YR, 5/4-6, ywsh brn., non-plas., loose, moist, alluvium.
7.0	6-8'	2'		6-8'		
8.0						
9.0	8-10'	2'		8-10'		
9.8						At 9.8', clayey-silt, ~20% clay, ~~10-15%~~ 15% v. f. gr sand (calc 10YR, 5/3-4, brn., slightly plas., soft, moist, allu
10.0	10-12'	2'		10-12'		
11.0						

Drill Site Geologist: A.E. Ortelli Date: 4/8/87

Reviewed By: Joseph L. Reed Date: 4/16/87

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Borehole: E-75A Well Number: Dry Hole

SOILS LOG
Description

Munsell Colors

Depth - Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	Description
11.0	10-12'	2'	N/A	10-12'	ML	
12.0	12-14'	2'		12-14'	CL	CL = sandy-clay, 10-20% v.f. gr sand, 10 YR, 6/2-3, light. brnsh. gray, low plas., med. stiff, moist, alluvium. Bedrock PRG
14.0	14-16'	2'		14-16'		At 15.0' silty-clay, 10-20% silt, 5-10% v.f. gr sand, 10 YR, 6/1-2, gray, med. plas., med. stiff, moist, alluvium. Bedrock PRG
16.0	16-18'	2'		16-18'		
18.0	18-20'	2'		18-20'		
20.0	20-22'	2'		20-22'	ML	ML = sandy-silt, 10-20% v.f. gr sand, 10 YR, 5/6-8, yrsh. brn., nonplas., ~~brown~~ moist, alluvium - med dense, Bedrock PRG
22.0						

LAB
Drill Site Geologist: A.E. Ostiff Date: 4/8/87

Reviewed By: David L. Reed Date: 4/16/87

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Borehole: E-75A Well Number: Dry Hole

Depth-Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
						Munsell Colors
22.0	22-24'	2'	NA	22-24'	ML	
23.0						
24.0	24-26'	2'		24-26'		
25.0					SM	SM silty-sand, ~20-30% silt, 2.5Y, 6/4, light yellowish brn., non-plas., loose, moist, alluvium. Bedrock PRC
26.0	26-28'	2'		26-28'		
27.0						
28.0	28-30'	1.4'		28-30'		
29.0						
30.0	30-32'	2'		30-32'		At 31.0', silty-sand, ~10-15% silt, 2.5Y, 5/4-6, light olive brn., non-plas., med. dense, moist, alluvium Bedrock PRC
31.0						
32.0	32-34'	2'		32-34'		
33.0						

Drill Site Geologist: A.E. Gutelius Date: 4/8/87

Reviewed By: Joseph L. Reed Date: 4/16/87

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Borehole: E-75A Well Number: Dry Hole

Depth-Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
						Munsell Colors
33.0	32-34'	2'	NA	32-34'	SM	
34.0	34-36'	2'		34-36'		
35.0						
36.0	36-38'	2'		36-38'		
37.0						
38.0	38-40'	2'		38-40'	ML	ML sandy-siltst., ~10-20% v.f.gr. sand, 2.5Y, 5/2, grysh. brn., non-plas, dense, moist, alluvium. Bedrock PRO
39.0						
40.0	40-42'	1.3'		40-42'		At 40.0' sandy-siltst., ~10-20% v.f.gr. sand, 2.5Y, 6/4, light grysh. brn., nonplas., med. dense, slightly moist alluvium Bedrock PRO
41.0						
42.0	42-44'	2'		42-44'	SM	SM silty-sandst., ~20% silt, 2.5Y, 5/4-6, light olive brn., non-plas., med. dense, slightly moist, alluvium Bedrock PRO
43.0						
44.0						

LAB
~~Drill Site~~ Geologist: A.E. Pitts Date: 4/8/87

Reviewed By: Joseph L. Reed Date: 4/16/87

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Borehole: E-75A Well Number: Dry Hole

Depth - Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
44.0						Munsell Colors
	1, 44 - 44	2'	NA	1, 44 - 44	SM	
45.0						
45.5					CL	CL silty-clayst., 5-10% silt, 2.5Y, 4/1, dk. gray brown, plas., stiff, slightly moist, bedrock.
46.0						
	1, 46 - 46	1.5'		1, 46 - 46		
47.0						
48.0						END of BORING LOG
49.0						
50.0						
51.0						AEO
52.0						
53.0						
54.0						
56.0						

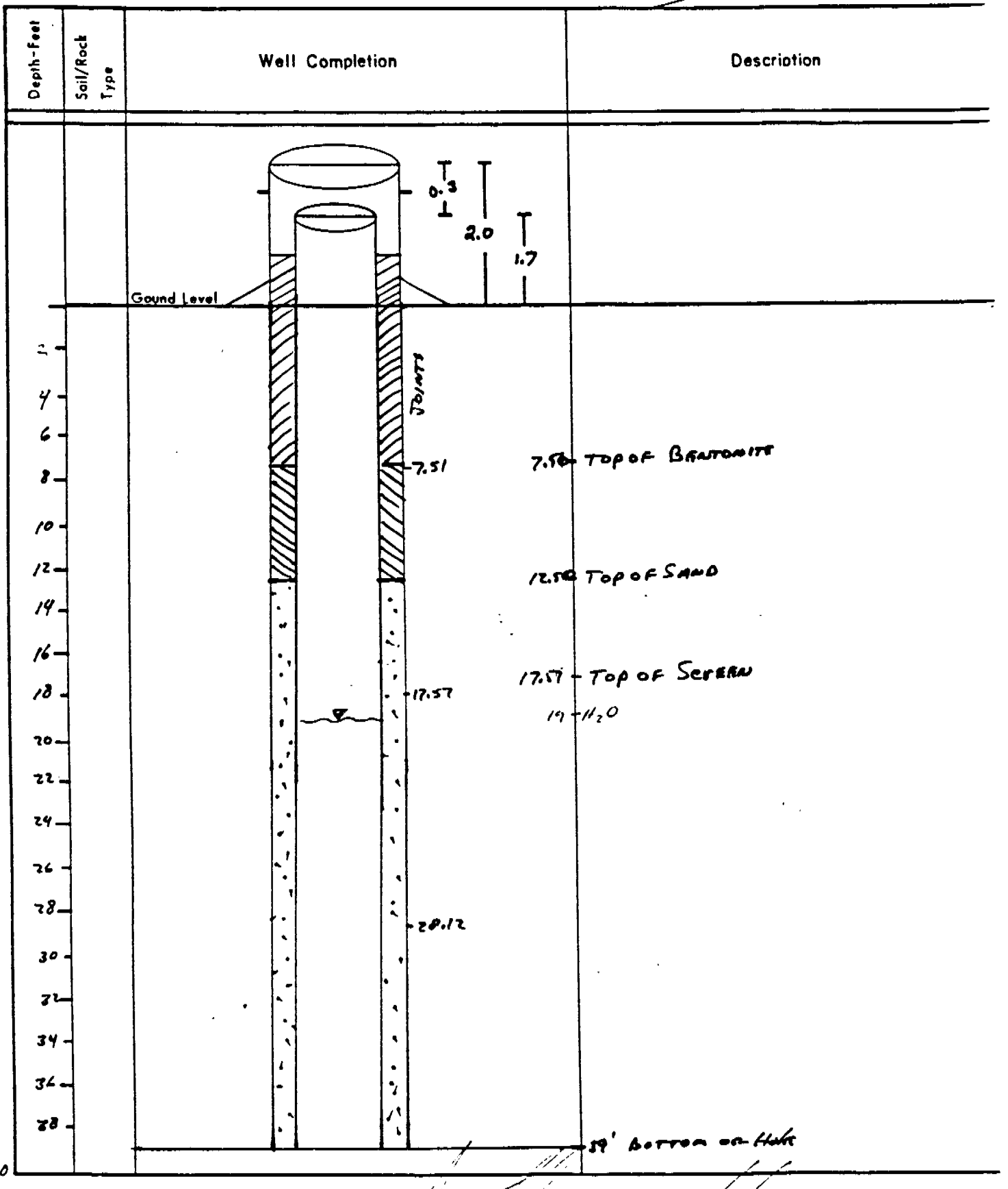
~~Drill Site~~ Geologist: A.E. Ortlieb Date: 4/8/87

Reviewed By: Joseph L. Reed Date: 4/16/87

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Borehole: E-76A

Well: E76A 37383 JR



Drill Site Geologist: _____ Date: 6/10/87

Reviewed By: Joseph L. Reid Date: 4/20/87

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WELL CONSTRUCTION SUMMARY

Borehole E-76A Well JR E76A 37383

Project Name and Location Tech 36 ½ mile E of Hwy 2 on 104th Project Number 17053074.10

Drilling Company Boyles Bros Driller Dave Jarvis Rig Number 5952

Drilling Method(s) Auger

Borehole Diameter 12¼ in. ____ cm. ____ ft. ____ cm. to 39 ft. ____ cm.
____ in. ____ cm. ____ ft. ____ cm. to ____ ft. ____ cm.

Size(s) and types of Bit(s) ____

Size and Type PVC 4"

Total Borehole Depth 39 ft. ____ cm.

Depth to Bedrock ≈38 ft. ____ cm.

Depth to Water 19 ft. ____ cm.

Water Level Determined By Samples

Length Plain PVC (total) 19.27 ft. ____ cm.

Length of Screen 21.43 ft. ____ cm.

Total Length of Well Casing 40.7 ft. ____ cm.

PVC Stick Up 1.7 ft. ____ cm.

Depth to Bottom of Screen 39.0 ft. ____ cm.

Depth to Top of Screen 17.57 ft. ____ cm.

Depth to Top of Sand 12.5 ft. ____ cm.

Depth to Top of Bentonite 7.5 ft. ____ cm.

Sampling Method(s) Continuous Split Spoon

Date/Time Start Drilling 4/2/87 10:56

Date/Time Finish Drilling 4/3/87 1030 INCLUDES REAMING

Date/Time Start Completion 4/3/87 1030

Date/Time Cement Protective Casing 4/3/87 1200

Materials Used 21-2' TUBES

Plain PVC 2-10' SECTIONS

Slotted PVC 2-10' SECTIONS

Bentonite Pellets 5 BUCKETS

Bentonite Granular —

Cement 3 BAGS

Sand 16 BAGS

Water added during completion 25

Water added during drilling 5

Total Gallons of water added 30

Drill Site Geologist Greg Lewis

Date 4/3/87

Mortar & Cement Pad

Date/Time/Personnel Internal Mortar, Cement Pad, and Weep Hole Installed 4-7-87/0900/K. Pacheco, M. Westcott

Date/Time/Personnel Casing Painted 14 4/13/87 1100 PJR

Date/Time/Personnel Numbers Painted 4/17/87 1040 PJB

Materials Used 12 bags quickete, 1/2 bag silica sand, 1/4 bag portland cement

Top of Protective Casing to Top of PVC	0.3 ft.	____ cm.	COMMENT/NOTES
Top of Protective Casing to Weep Hole	0.9 ft.	____ cm.	____
Top of Protective Casing to Internal Mortar	0.85 ft.	____ cm.	____
Top of Protective Casing to Top of Cement Pad	0.53 ft.	____ cm.	____
Top of Protective Casing to Ground Level	2.0 ft.	____ cm.	____

Reviewed By Joseph L. Reed Date 4/20/87

Drill Site Geologist [signature] Date 6/10/87 2236

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SHEET 1 OF 4

Borehole: E-76A Well Number: 37383 5121.05

SOILS LOG
Description

Munsell Colors

Depth-Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	Description
0.0	0-2'	2'	NA	0-2'	ML	ML sandy-silt, ~20% v.f. gr. sand, 10 YR, 4/3-4, dk brn., non-plas., loose, moist, alluvium.
1.0						
1.5						At 1.5', sandy-silt, ~20% v.f. gr. sand, color change to 10 YR, 5/6-8, gmsh. brn., non-plas., loose, moist, alluvium.
2.0	2-4'	2'		2-4'		
3.0						
4.0	4-6'	2'		4-6'		
5.0						
6.0	6-8'	2'		6-8'		At 7.0', sandy-silt, percent sand increases to 40% v.f. gr sand, 10 YR, 5/6-8, gmsh. brn., non-plas., loose, moist, alluvium.
7.0						
8.0	8-10'	2'		8-10'	SM	SM silty-sand, ~40% silt, 10 YR, 5/6-8, gmsh brn. non-plas., loose, moist, alluvium.
9.0						
10.0	10-12'	2'		10-12'		
12.0						

Drill Site Geologist: A.E. Jaffke Date: 4/8/87

Reviewed By: Joseph L. Reed Date: 4/16/87

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Borehole: E-76A Well Number: 37383

Depth - Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
						Munsell Colors
11.0	10-12'	2'	NA	10-12'	SM	At 11.0', ~~percent~~ silty-sand, percent of silt decreases to ~ 20% silt, 10 YR, 6/6, brownish yellow, non-plas., loose, moist, alluvium.
12.0	12-14'	2'		12-14'		
13.0						
14.0						
14.5	14-16'	2'		14-16'		At 14.5', silty-sand, percent silt decreases to 5-10% silt, 10 YR, 6/6, brnsh. yellow, non-plas., loose, moist, alluvium.
15.0						
16.0	16-18'	2'		16-18'		
17.0						
18.0	18-20'	2'		18-20'		▽ W.T. @ 19.0'
19.0					SM	At 19.0', silty-sand, 10% silt, 70% med-coarse gr. sand., 10 YR, 5/6-8, grsh. brn., non-plas., loose, saturated, alluvium.
20.0	20-22'	1.2'		20-22'		
21.0						
22.0						

Drill Site Geologist: A.R. Ortelli Date: 4/8/87

Reviewed By: Joseph L. Reed Date: 4/16/87

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Borehole: E-76A Well Number: 37383

SOILS LOG
Description

Munsell Colors

Depth - Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	Description
22.0	22-24'	2'		22-24'	SM	
23.0						
24.0	24-26'	1.5'		24-26'		
25.0						
26.0	26-28'	1.0'		26-28'		
27.0						
28.0	28-30'	2'		28-30'		
29.0						
30.0	30-32'	1.5'		30-32'		
31.0					SP	SP gravelly-sand, 10-20% gtr. gravel, 10 YR. 5/6-8, yeah. brn., non-plas, loose, saturated, alluvium.
32.0	32-35'	2'		32-35		
33.0						

Drill Site Geologist: L18 A.E. Ostle Date: 4/8/87

Reviewed By: Joseph L. Reed Date: 4/16/87

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Borehole: E-76A Well Number: 37383

Depth-Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
33.0	33-35'	2'	NA	33-35'	SP	
34.0						
35.0	35-37'	0'		35-37'		No Recovery — Sample Lost
36.0						
37.0	37-38'	1'		37-38'	SP	
38.0	38-40'			38-40'	Qal Qt	~~Clayey~~ Silt., 20-30% ~~clay~~, 10 YR, 4/4-6, dk. gmsh brn., low-plas., v. dense, wet, bedrock.
39.0						
40.0	40-41'			40-41'		
41.0						End of Boring Log
42.0						Abd
43.0						
44.0						

Drill Site Geologist: [signature] Date: 4/8/87

Reviewed By: Oscar L. Reed Date: 4/16/87

APPENDIX A
WELL DESIGNATION CRITERIA

APPENDIX A

WELL DESIGNATION CRITERIA

WELL_DESIGNATION_CATEGORY	CRITERIA
1	Wells with screen bottom less than 3.0 ft below bedrock where bedrock is siltstone or shale.
2	Wells with screen bottom less than 3.0 ft below bedrock where bedrock is sandstone and less than 20 percent of screen length is below bedrock contact. or Well with screen bottom between 3.1 ft and 6.0 ft below bedrock contact where bedrock is sandstone and between 50 percent screened in bedrock.
3	Wells with screen bottom less than 3.0 ft below bedrock contact where bedrock is sandstone and between 20 and 50 percent of screen length is below bedrock contact. or Wells with screen bottom between 3.1 ft and 6.0 ft below bedrock contact where bedrock is siltstone or shale and more than 50 percent of the screen is below bedrock. or Wells with the screened more than 6.0 ft below the bedrock contact where bedrock is siltstone or shale.

WELL_DESIGNATION_CATEGORY	CRITERIA
4	Wells with screen bottom less than 3.0 ft below bedrock contact where bedrock is sandstone and more than 50 percent of screen length is below bedrock contact. or Wells with screens more than 3.0 ft below the bedrock contact where bedrock is sandstone
5	Well is screened entirely within Denver Fm.

NOTE: If alluvium was consistently unsaturated at well site and well was screened within Denver Fm, well was considered as a Denver Fm well and data evaluated for inclusion into Denver Fm potentiometric maps and water chemistry maps.

APPENDIX B
WELL COMPLETION SUMMARIES, LITHOLOGIC LOGS, AND GEOPHYSICAL LOGS

APPENDIX C
WELL LOCATIONS, COMPLETION DATA AND SITE CONDITIONS, AND SITING RATIONALE

Alluvial Wells

Site E-38, Well 37374

Location: Site E-38 is located approximately 800 ft north of the south section line and 900 ft east of the west section line of Section 14 (T2S, R67W).

Completion Data and Site Conditions: A borehole was drilled to a total depth of 26.5 ft where silty claystone bedrock was encountered at 26.0 ft. During drilling, the water table was estimated to be at 10 ft below ground surface. Well 37374 was screened across the entire saturated thickness in predominantly silty sand material.

Siting Rationale: This installation is a cluster site which is being utilized to examine the potential for flow between the alluvium and Denver Fm aquifers and water chemistry within both aquifers. The alluvial well was installed to assess water quality and water levels in the southwest corner of Section 14. In this area, the alluvial aquifer appears to be separated from the main alluvial pathway along First Creek by a zone of unsaturated alluvium. This well is downgradient of the western portion of the NBCS and is being used to depict the water chemistry and hydrogeology along this flow pathway.

Site E-39

Location: Site E-39 is located approximately 880 ft north of the south section line and 2630 ft east of the west section line of Section 14 (T2S, R67W).

Completion Data and Site Conditions: The borehole at this site was drilled to 20.0 ft and the bedrock contact was called at 18 ft. The alluvium, which consists mostly of silty sands and clayey sands was unsaturated at this site and therefore no alluvial well was completed. The water table was encountered in the sandy claystone bedrock and was estimated to be at 19 ft below ground surface.

Siting Rationale: This alluvial well was to be part of a cluster site. However, unsaturated alluvium was encountered. Therefore, geologic data was obtained from continuous logging and the hole was abandoned in accordance with Section 3.4 of the Task 36 Technical Plan. Data obtained from this site helps to delineate the bedrock surface and a zone of unsaturated alluvium in the southern portion of Section 14.

Site E-40, Well 37370

Location: Site E-40 is located approximately 1280 ft north of the south section line and 1875 ft west of the east section line of Section 14 (T2S, R67W).

Completion_Data_and_Site_Conditions: The borehole at this site encountered water at 9 ft and the bedrock contact was estimated at 26 ft. Well 37370 was screened across the water table to the bedrock contact. The bedrock encountered at the bottom of the boring is a dark brown weathered claystone.

Siting_Rationale: The alluvial well at this site is part of a cluster installation being used to assess water chemistry and the potential for vertical flow between the alluvium and Denver Fm aquifers. The alluvial well at this site was installed to further define the hydrogeology and water chemistry along the First Creek paleochannel which has historically shown significant contaminant concentrations.

Site_E-42,_Well_37369

Location: Site E-42 is located approximately 750 ft north of the south section line and 440 ft west of the east section line of Section 14 (T2S, R67W).

Completion_Data_and_Site_Conditions: A borehole was drilled to an approximate depth of 26 ft where claystone bedrock was encountered. During drilling the water table was estimated to be 5 ft below ground surface. Well 37369 is screened across the water table to the bedrock contact in well graded gravelly sands.

Siting_Rationale: This alluvial well was installed to fill a data gap in the monitoring network just downgradient of the NBCS. This site is fundamental to the monitoring program because it depicts the hydrogeology and water chemistry along the First Creek paleochannel just west of Peoria Street where there are currently no alluvial monitoring sites. This area is suspected of significant alluvial ground water contamination because of high concentrations upgradient along the paleochannel.

Site_E-44,_Well_37373,_Well_37398,_Well_37399

Location: Site E-44 is located approximately 1950 ft north of the south section line and 1780 ft west of the east section line of Section 14 (T2S, R67W).

Completion_Data_and_Site_Conditions: The borehole at the site of Well 37373 was drilled to a total depth of 26 ft. Weathered claystone bedrock was encountered at 25.0 ft. Depth to water was estimated to be at 3.5 ft below ground surface during drilling. Alluvial borings were also drilled for Wells 37398 and 37399. At Well 37398, the boring was drilled to a total depth of 25.0 ft and weathered claystone bedrock was encountered at 23.7 ft. Depth to water was estimated at 2.2 ft below grounds surface during drilling. At Well 37399, the boring was drilled to a total depth of 24.0 ft and silty sandstone bedrock was encountered at 22.8 ft. Depth to water was estimated to be at 2.4 ft below ground surface during drilling. All three wells are screened across the

Denver Wells

Site E-34, Pilot Corehole, Well #37376 D1

Location: Site E-34 is located approximately 50 ft north of the south section line and 2575 ft east of the west section line of Section 13 (T2S R67W).

Completion Data and Site Conditions: Two Denver Fm sandstone units were encountered during drilling of the 55 ft pilot corehole. A 10 ft claystone aquitard separates the alluvium from the first sandstone unit. The two saturated sandstones are separated by only a 2-ft fractured lignitic claystone, therefore they are assumed to be hydrologically connected and Well 37376 is completed in both sandstones.

Siting Rationale: The pilot corehole at this site was drilled to provide geologic data for cross sections and a well completion. Well 37376 was installed to obtain hydrologic and water quality data in the first and second Denver Fm sandstone units downgradient of the NBCS. There are currently no first or second Denver sandstone water quality wells in service in this area. Water quality data is needed here to assess if these Denver Fm units are acting as contamination pathways beneath the NBCS.

Site E-38, Pilot Corehole, Well 37379 D1, Well 37380 D2

Location: Site E-38 is located approximately 850 ft north of the south section line and 900 ft east of the west section line of Section 14 (T3S, R67W).

Completion Data and Site Conditions: The 130 ft pilot corehole was drilled and four Denver Fm sandstone units were encountered. The alluvium is separated form the first sandstone by a 13.5-ft claystone aquitard and a 7-ft silty claystone interval. Upon review of the corehole data Well 37379 was completed in the first saturated sandstone and Well 37380 was completed in the second saturated sandstone. Wells may need to be completed in the deeper sandstones if the chemical analyses on Well 37380 show it to be contaminated.

Siting Rationale: The pilot corehole at this site was drilled to provide geologic data for cross sections and well completions. This corehole will also provide geologic data for any future interpretive work in the Denver Fm and/or any future well installations at this site. Wells 37379 and 37380 were installed to provide hydrologic and water quality data for the first and second Denver Fm sandstone units northwest of the NBCS. This well cluster will fill a large data gap that exists in the southwest corner of Section 14.

Site E-39, Pilot Corehole, Well 37387 D1, Well 37388 D2

Location: Site E-39 is located approximately 900 ft north of the south section line and 2620 ft west of the east section line of Section 14 (T2S R67W).

Completion Data and Site Conditions: The pilot corehole was drilled to a total depth of 130 ft and six Denver Fm sandstone units were encountered. The bedrock lithology is a claystone and this creates the 9-ft thick aquitard between the alluvium and the first Denver sandstone unit. Review of the pilot corehole data showed that this site is located on a bedrock high and the first sandstone unit is not correlated to sandstones in surrounding wells. Therefore, it is not likely that this hydrologic unit is contaminated and a well was not completed in this interval. Well 37387 was completed in the second saturated sandstone and Well 37388 was completed in the fourth saturated sandstone which correlated with the previously installed Denver wells.

Siting Rationale: The pilot corehole at this site was drilled to provide important geologic data for cross sections that will aid in the assessment of the lateral and northerly extent of the Denver Fm sandstone units and for the completion of Wells 37387 and 37388. This corehole will also provide geologic data for any future interpretive work in the Denver Fm and/or any future well installations at this site. There are presently no first or second Denver Fm sandstone wells in this area and monitoring wells in these sandstone units are required to assess the water quality of the Denver Fm sandstones downgradient of the barrier at this location.

Site E-40, Pilot Corehole, Well 37371 D1, Well 37372 D2

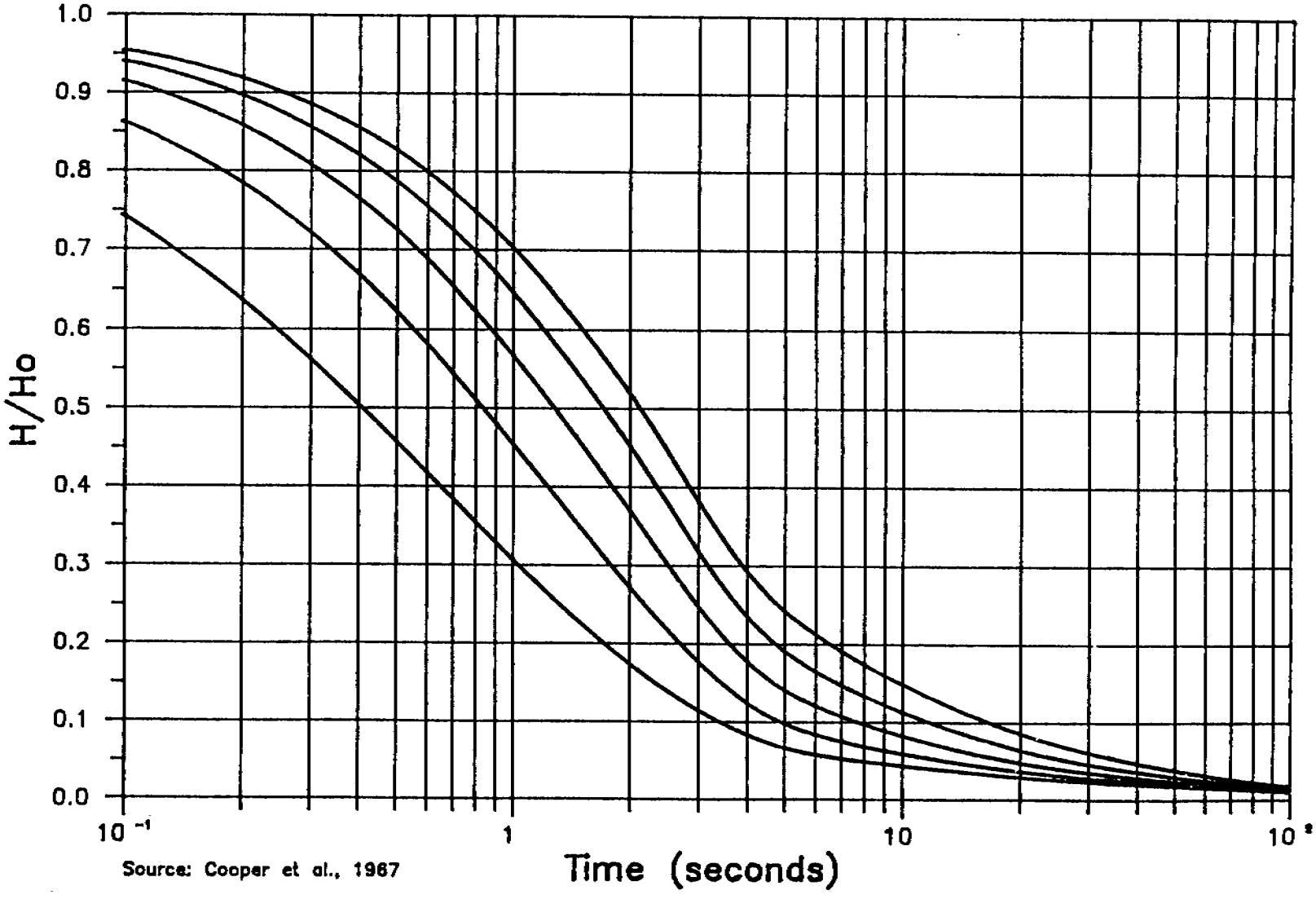
Location: Site E-40 is located approximately 1300 ft north of the south section line and 1880 ft west of the east section line of Section 14 (T2S R67W).

Completion Data and Site Conditions: The pilot corehole was drilled to an approximate total depth of 96.5 ft and three sandstones were encountered. A 4-ft clayey siltstone separates the alluvium from the first Denver sandstone and therefore it appears that this first sandstone is 2-ft hydrologically connected with the alluvium. Well 37371 is screened entirely within the first saturated sandstone. The lower sandstones are interbedded with siltstone and claystone and the pilot corehole log showed no substantial confining claystone layer between the sandstones. Therefore, the sandstones were assumed to be hydrologically connected and Well 37372 screens them as one unit.

Siting Rationale: The pilot corehole at this site was drilled to provide geologic data downgradient of the NBCS for cross sections and well completions. This corehole will also provide geologic data for any future interpretive work in the Denver Fm and/or any future well installations at this site. The Denver Fm wells are a part of a cluster site being used to assess the potential for vertical flow

APPENDIX D
SLUG TESTS: COOPER TYPE CURVES AND DATA CURVES, AND AQUIFER TEST ANALYSES

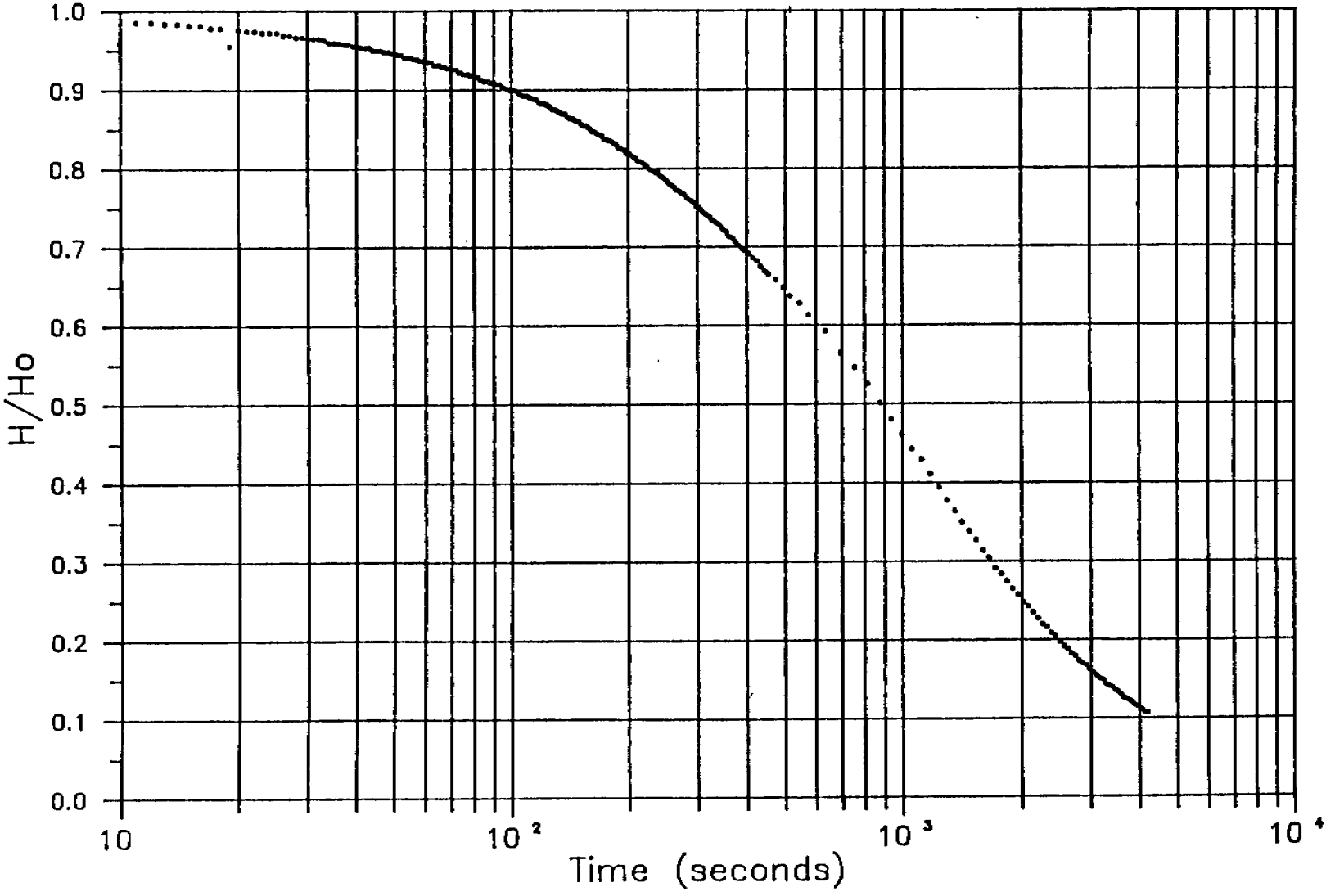
TYPE CURVES



Source: Cooper et al., 1967

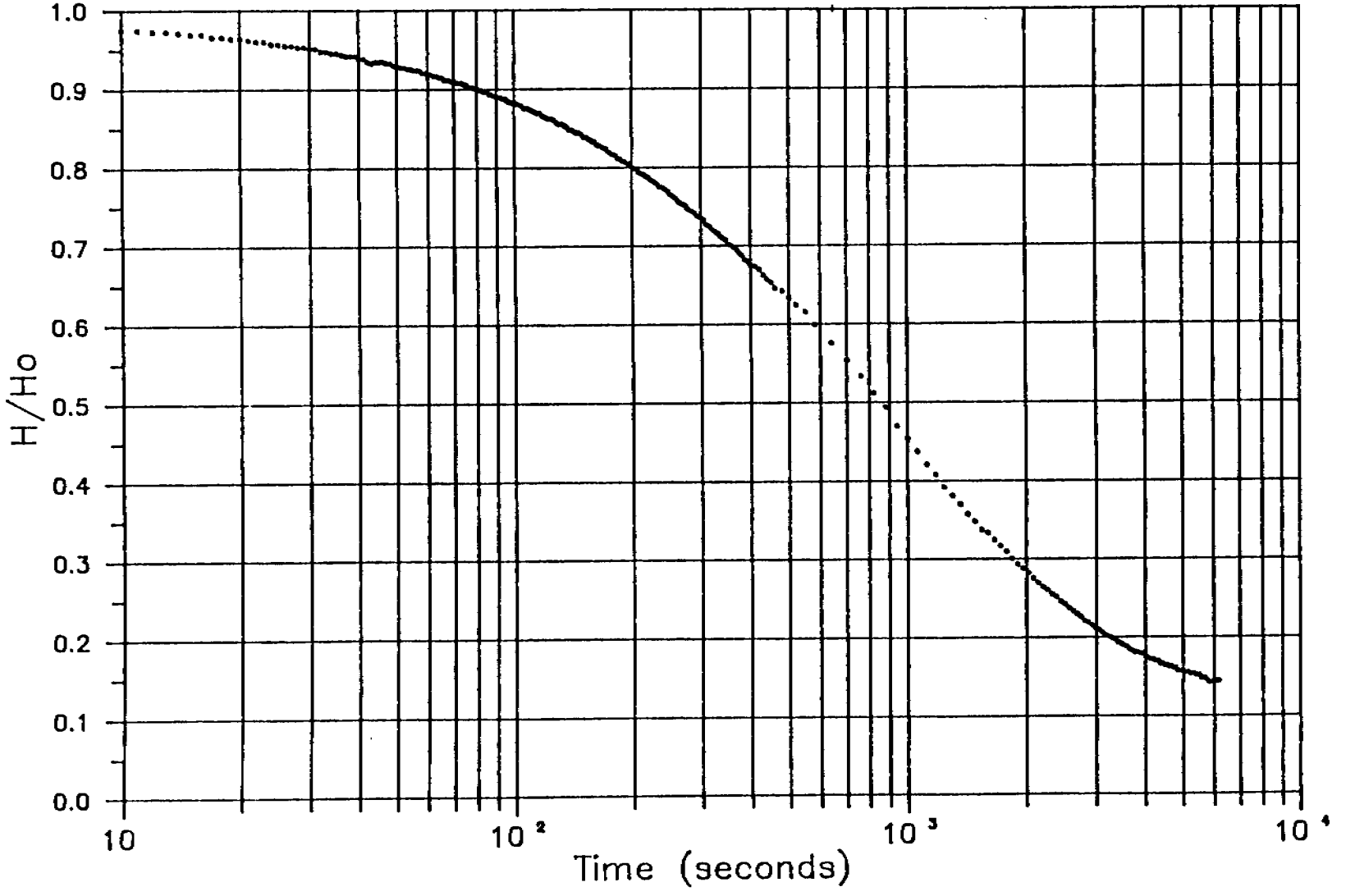
SLUG TEST: WELL #37376 (E-34)

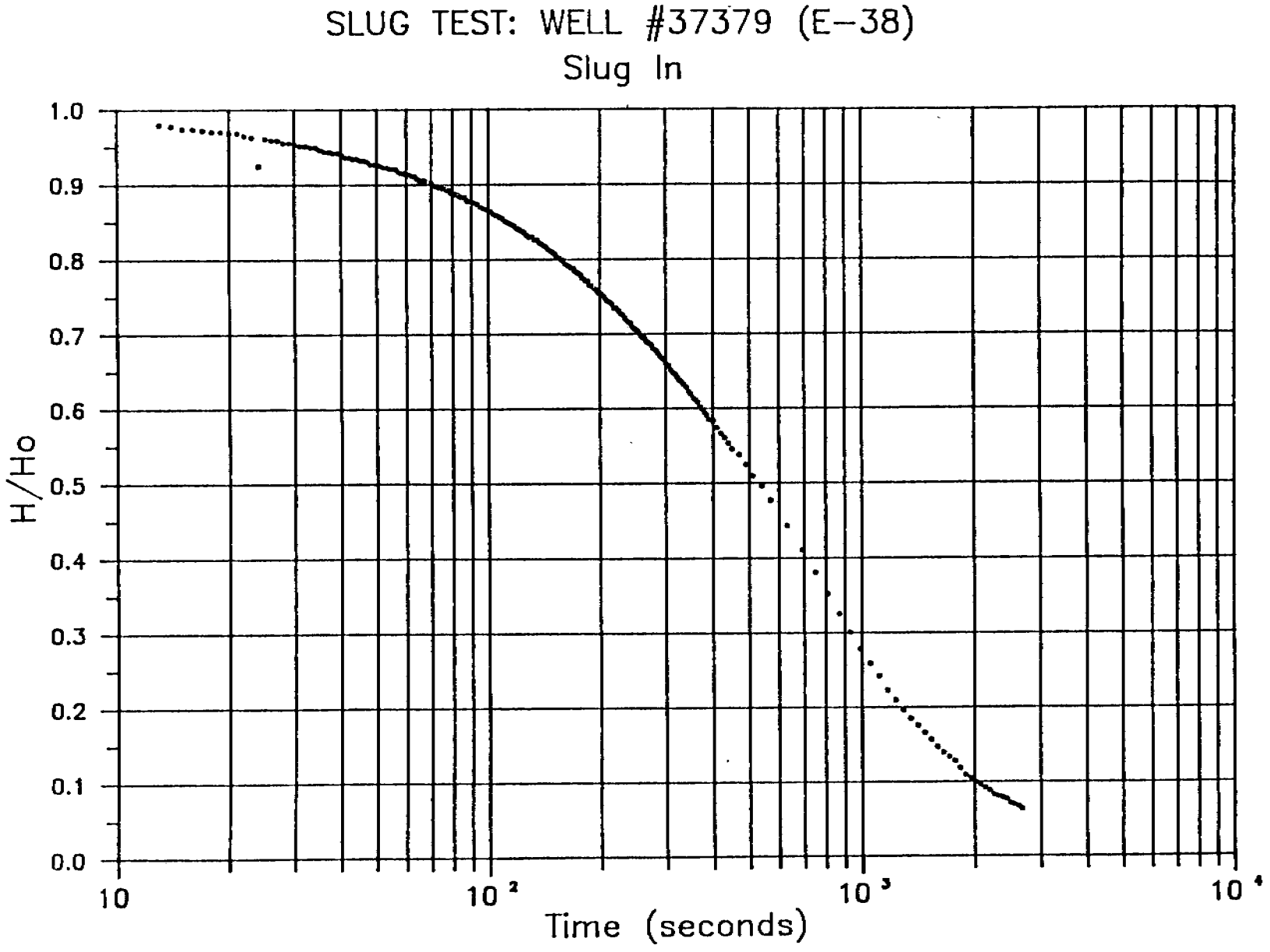
Slug In

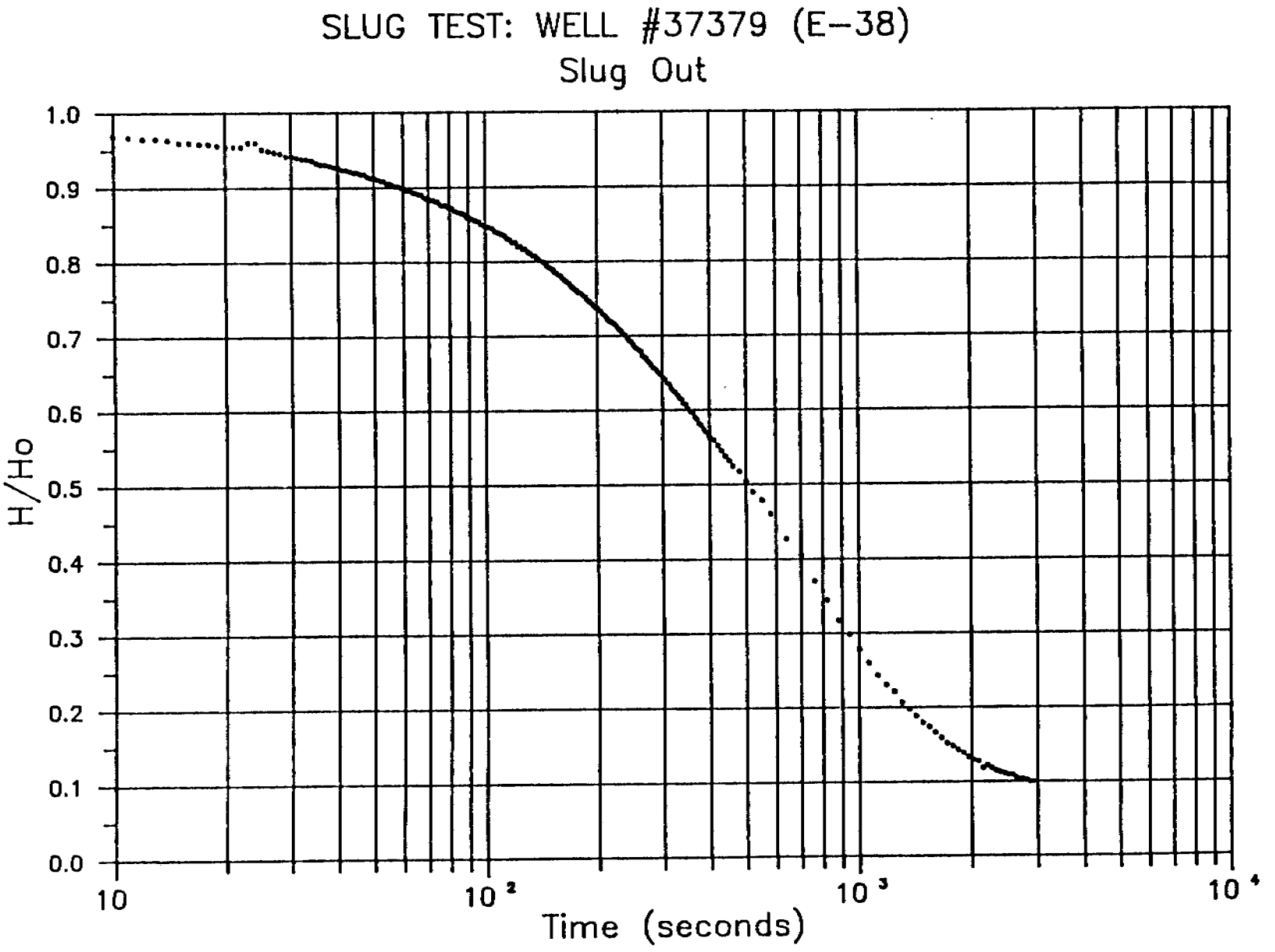


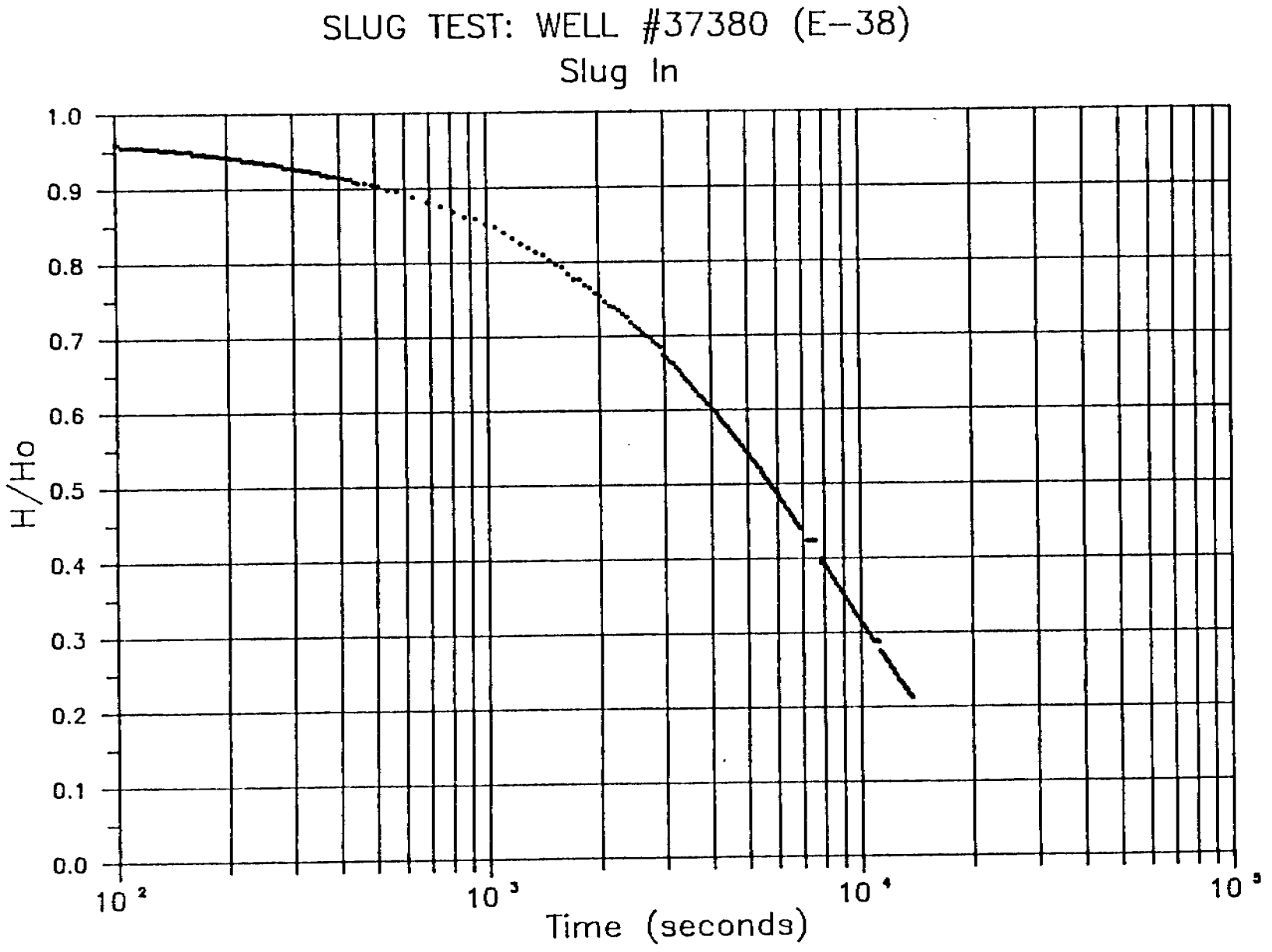
SLUG TEST: WELL #37376 (E-34)

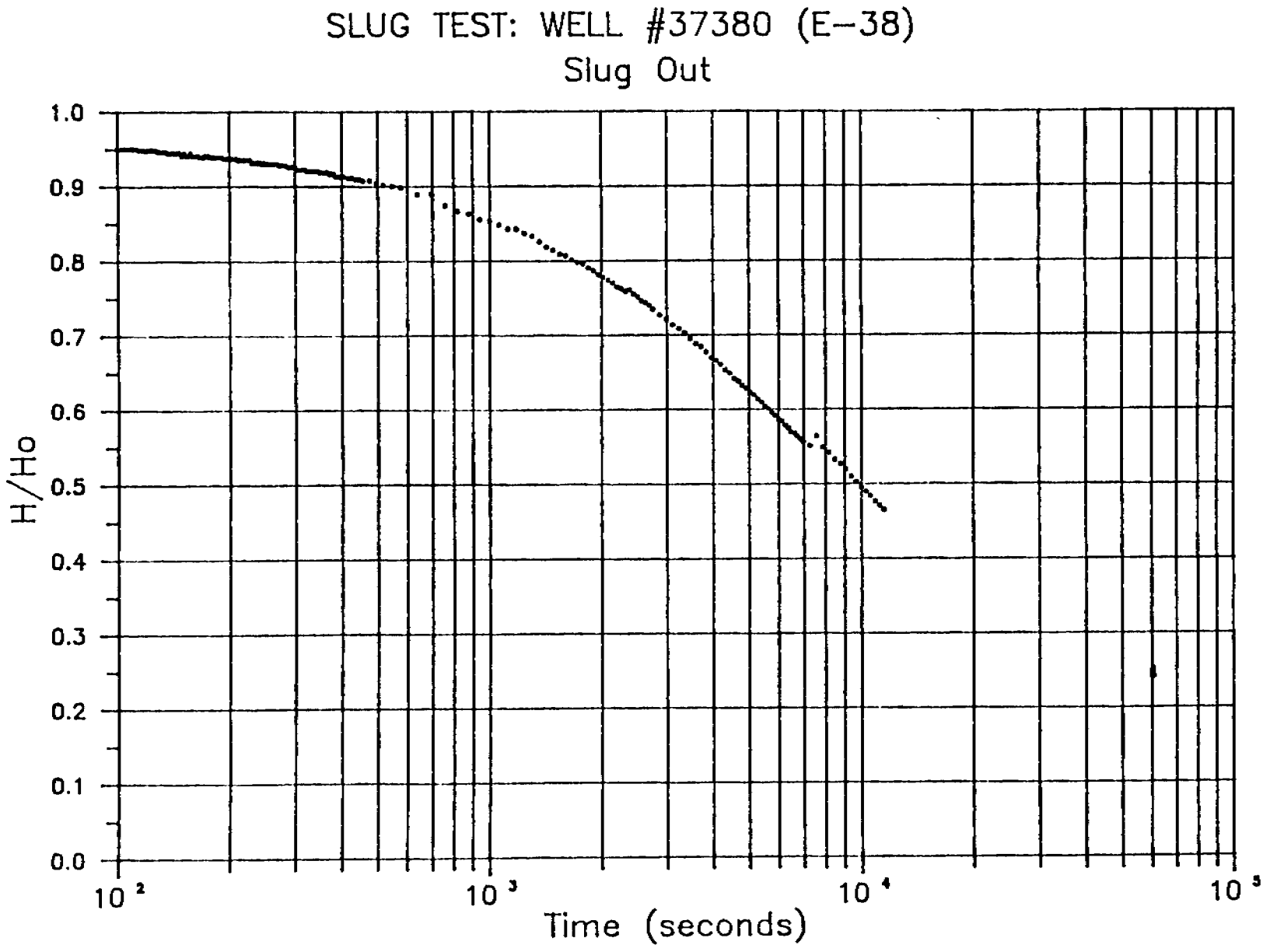
Slug Out

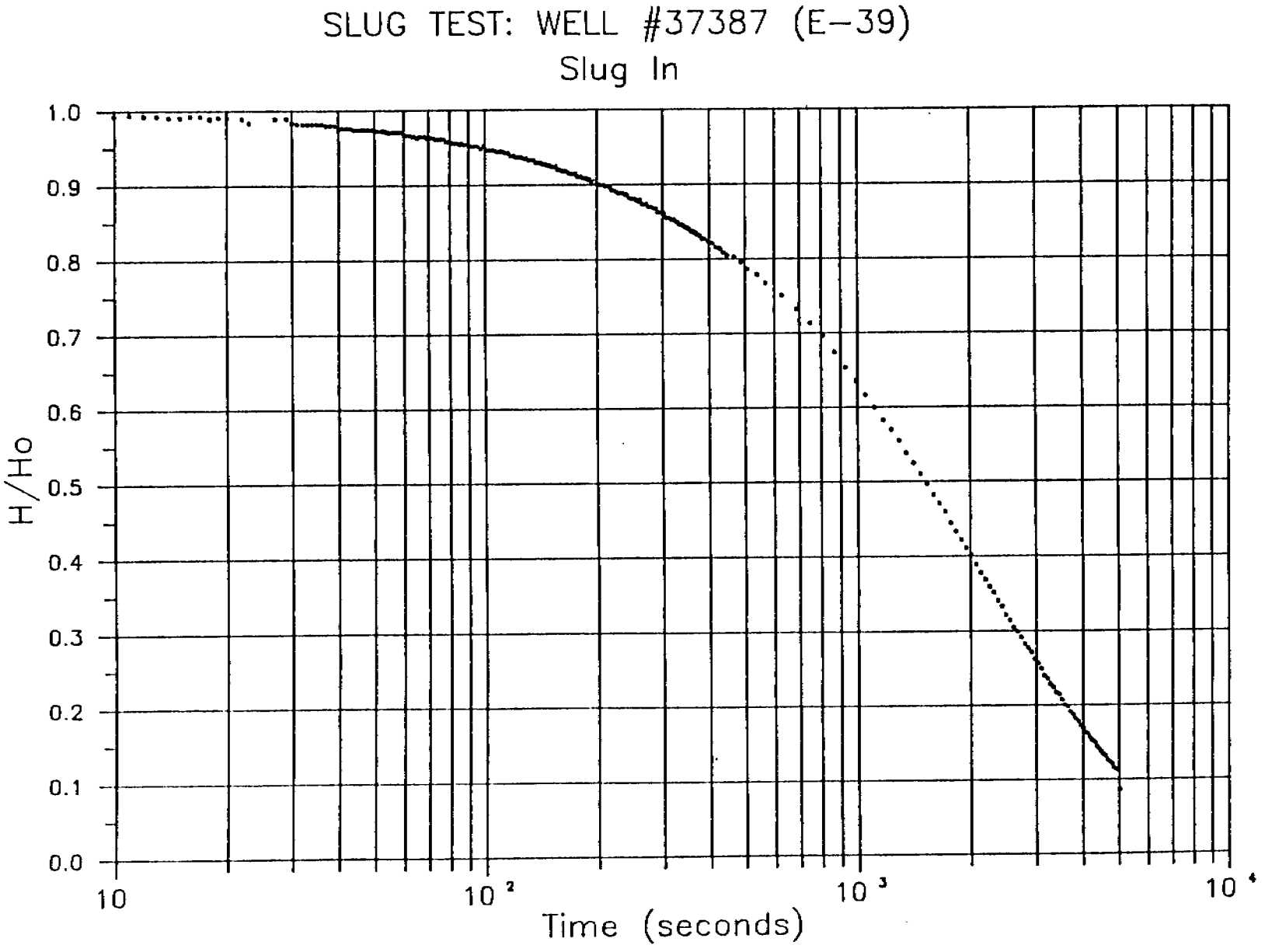


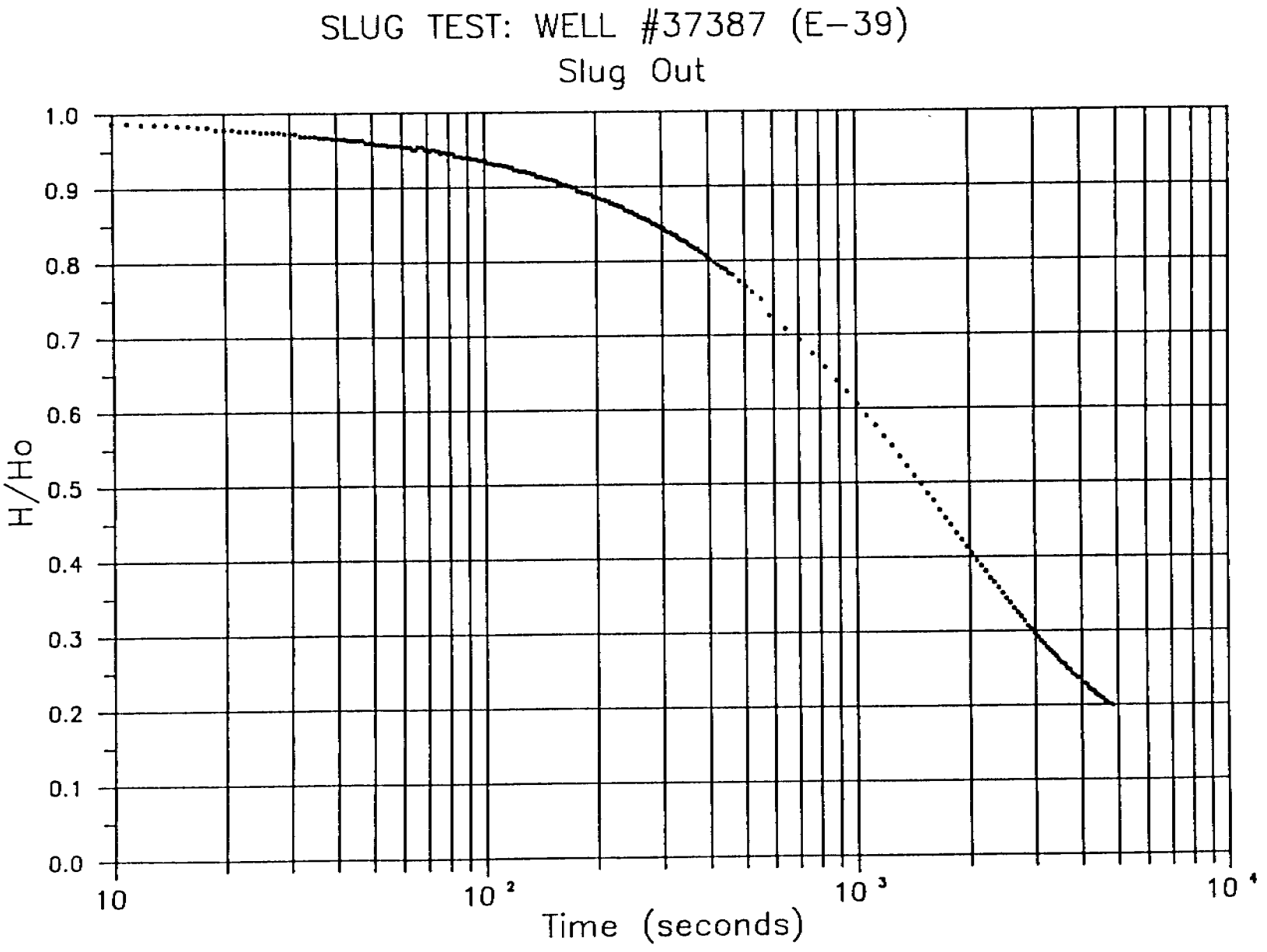

SLUG TEST: WELL #37379 (E-38)
Slug In
H/Ho
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
10
10 ²
10 ³
10 ⁴
Time (seconds)

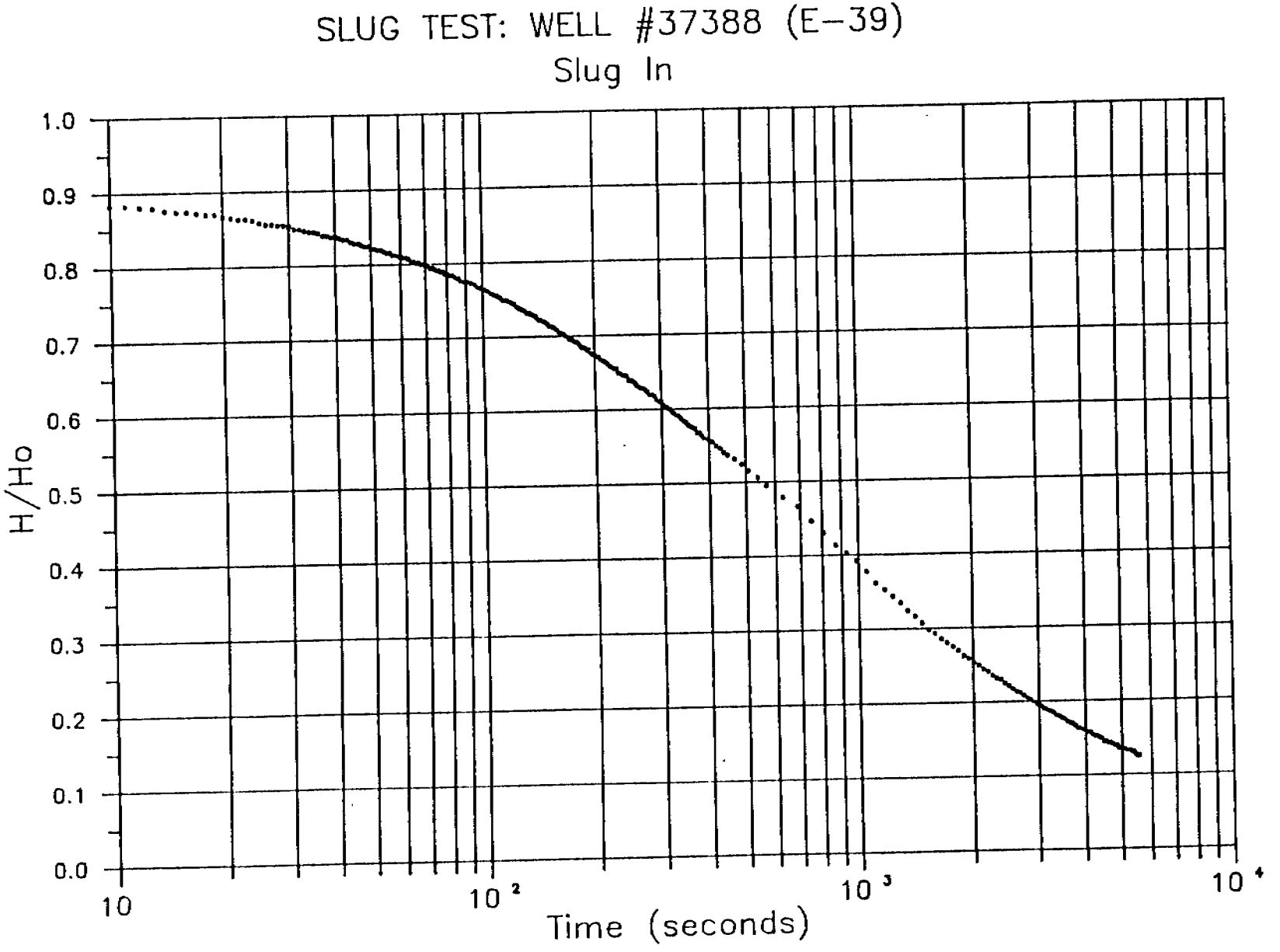

SLUG TEST: WELL #37379 (E-38)
Slug Out
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
H/Ho
10
10 ²
10 ³
10 ⁴
Time (seconds)


SLUG TEST: WELL #37380 (E-38)
Slug In
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
H/Ho
10 ²
10 ³
10 ⁴
10 ⁵
Time (seconds)


SLUG TEST: WELL #37380 (E-38)
Slug Out
H/Ho
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
10 ²
10 ³
10 ⁴
10 ⁵
Time (seconds)

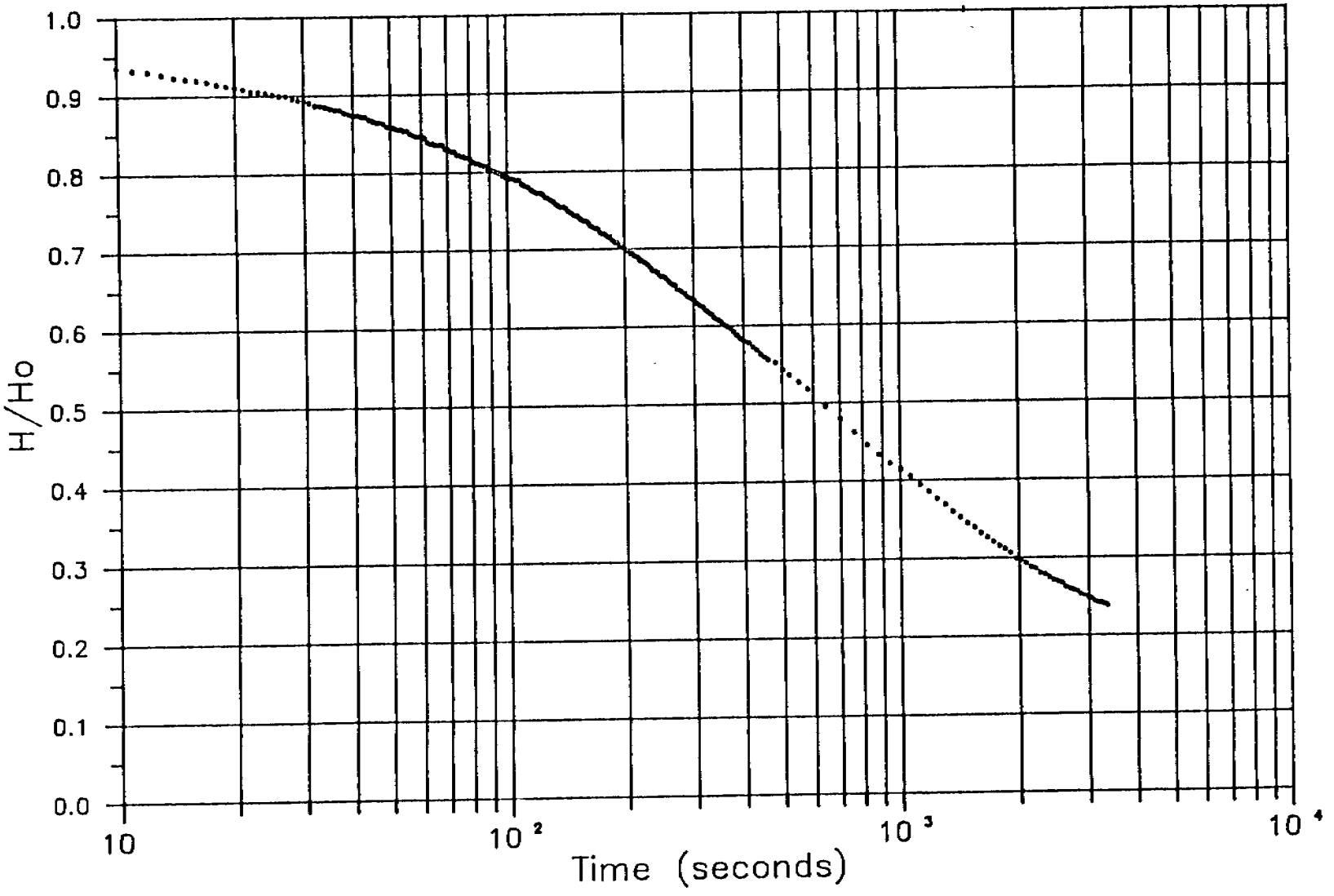

SLUG TEST: WELL #37387 (E-39)
Slug In
H/Ho
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
10
10 ²
10 ³
10 ⁴
Time (seconds)

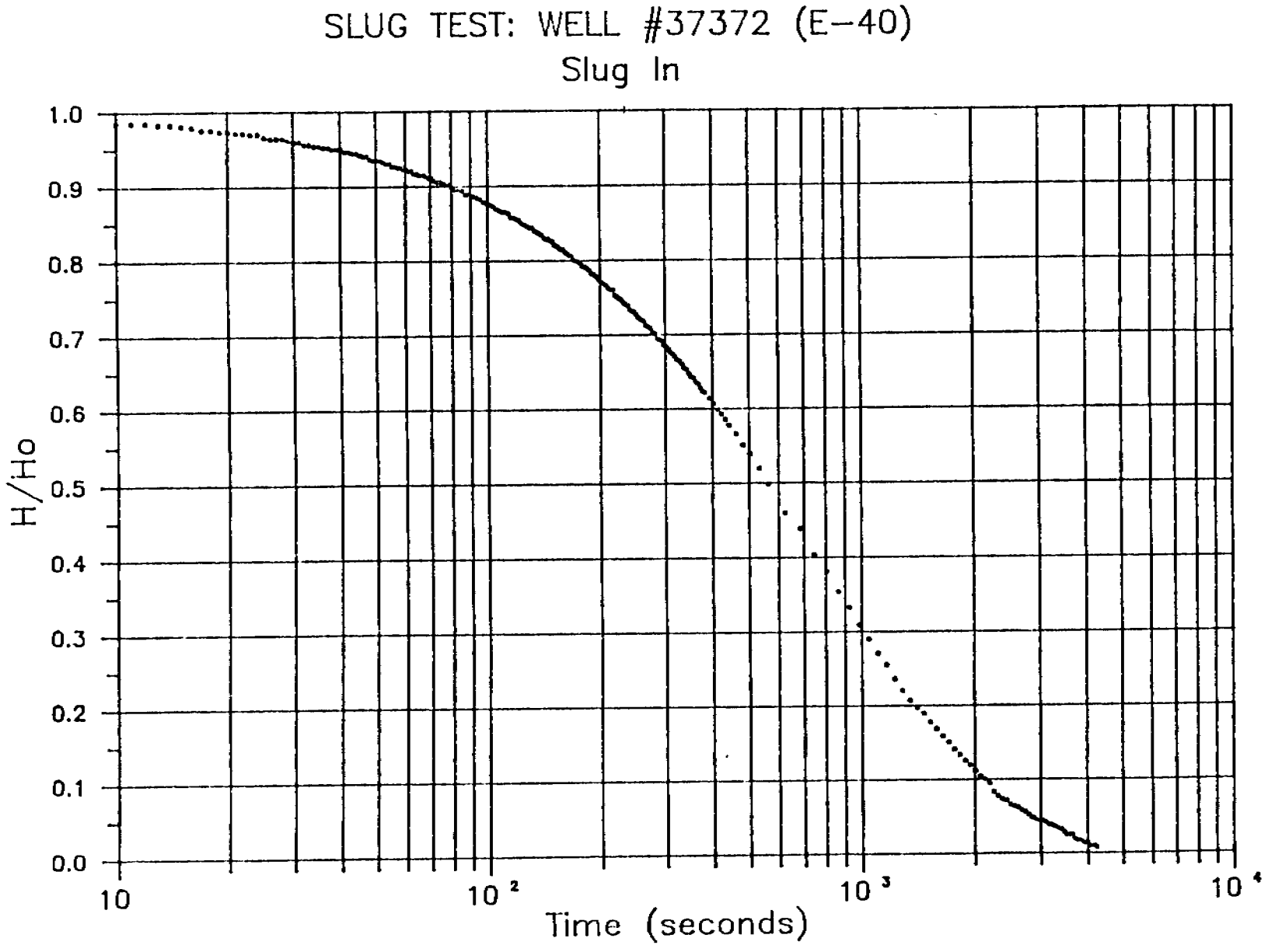

SLUG TEST: WELL #37387 (E-39)
Slug Out
H/Ho
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
10
10 ²
10 ³
10 ⁴
Time (seconds)

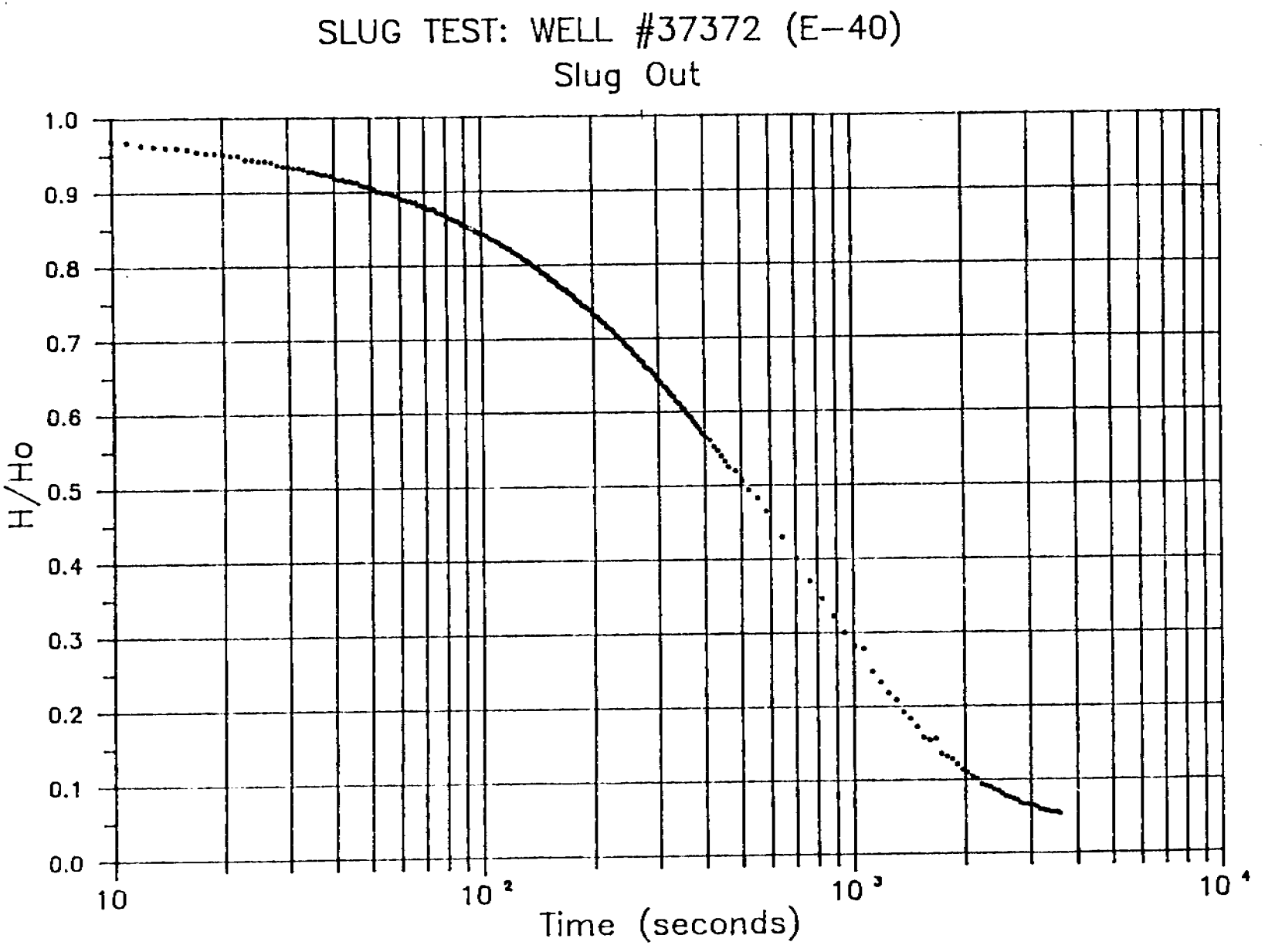

SLUG TEST: WELL #37388 (E-39)
Slug In
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
H/Ho
10
10 ²
10 ³
10 ⁴
Time (seconds)

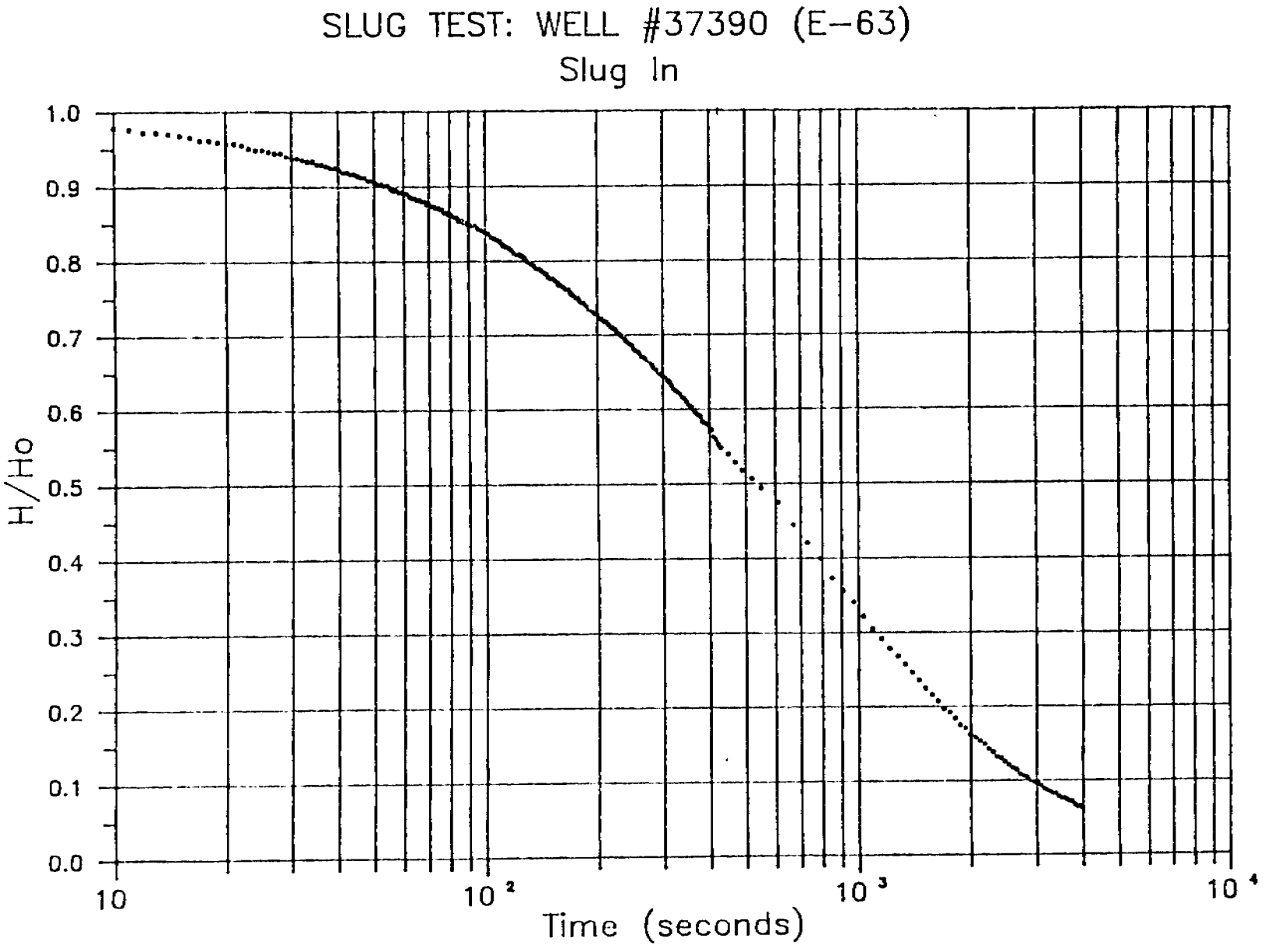
SLUG TEST: WELL #37388 (E-39)

Slug Out



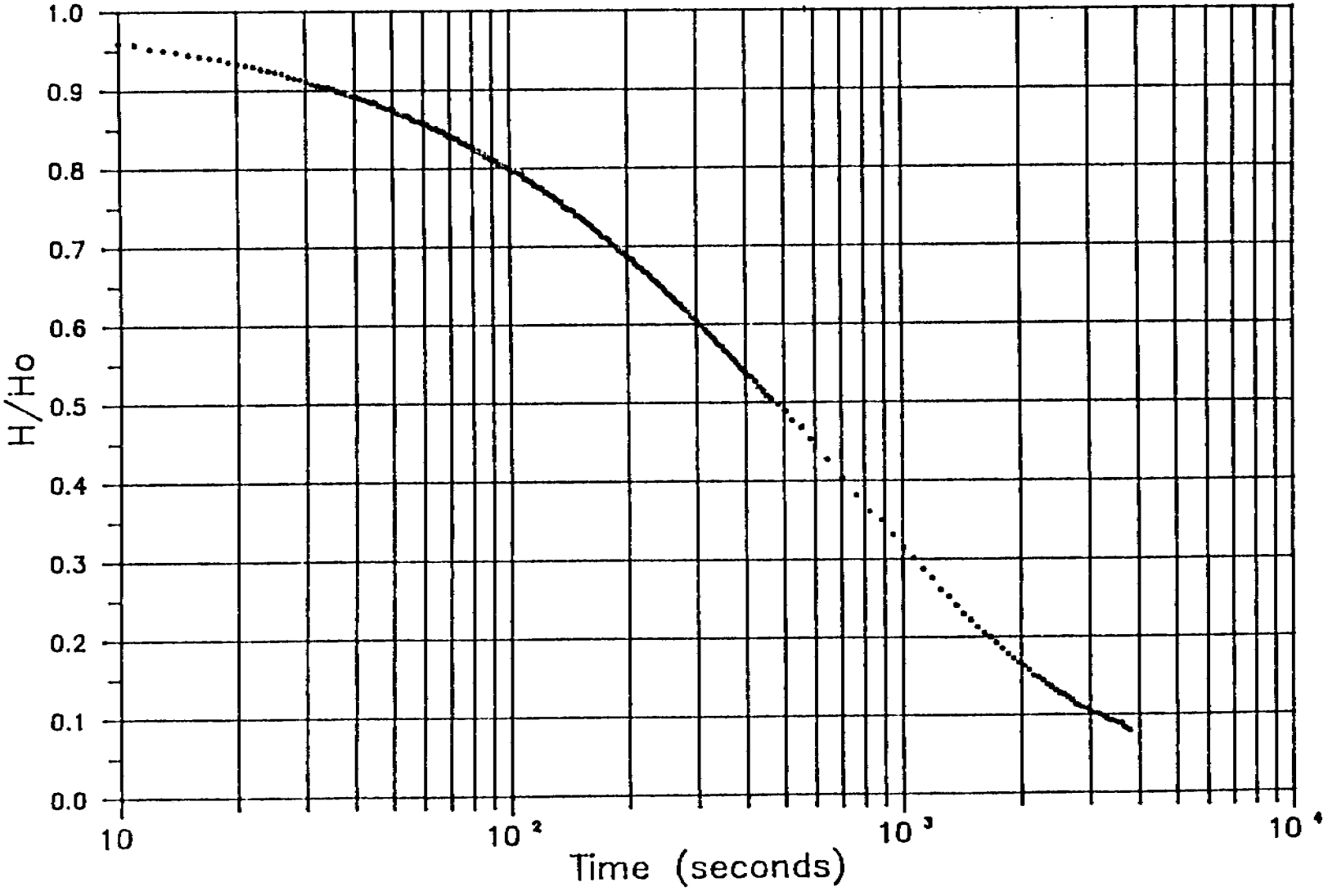

SLUG TEST: WELL #37372 (E-40)
Slug In
H/Ho
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
10
10 ²
10 ³
10 ⁴
Time (seconds)


SLUG TEST: WELL #37372 (E-40)
Slug Out
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
H/Ho
10
10 ²
10 ³
10 ⁴
Time (seconds)


SLUG TEST: WELL #37390 (E-63)
Slug In
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
H/Ho
10
10 ²
10 ³
10 ⁴
Time (seconds)

SLUG TEST: WELL #37390 (E-63)

Slug Out



D.2 WELL 37367 AQUIFER TEST ANALYSES

A Report Prepared for

Environmental Science and Engineering, Inc.
7332 S. Alton Way, Suite H
Englewood, Colorado 80112

WELL 37367 AQUIFER TEST
ROCKY MOUNTAIN ARSENAL
ADAMS COUNTY, COLORADO

HLA Job No. 17053,103.10

by

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Project Hydrogeologist

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June 20, 1988

TABLE OF CONTENTS

LIST OF TABLES iii

LIST OF ILLUSTRATIONS iv

LIST OF CALCULATION SHEETS v

I INTRODUCTION 1

II AQUIFER TEST METHODOLOGY 2

A. Discharge Rate and Measurement 3

III AQUIFER TEST RESULTS 4

A. Step-Drawdown Test 4
B. Constant-Rate Discharge Test 5

IV REFERENCES 7

TABLES

ILLUSTRATIONS

CALCULATION SHEETS

Appendix A - GEOLOGIC BORING LOGS

DISTRIBUTION

LIST OF TABLES

Table 1	Step-Drawdown Test Discharge Rate Measurement
Table 2	Constant-Rate Discharge Rate Measurements
Table 3	Summary of Well 37367 Aquifer Test
Table 4	Drawdown Data for Step-Drawdown Test - Well 37367
Table 5	Drawdown Data for Constant-Rate Test - Well 37367
Table 6	Drawdown Data for Constant-Rate Test - Well 37400
Table 7	Drawdown Data for Constant-Rate Test - Well 37401
Table 8	Residual Drawdown Data for Recovery Test - Well 37367
Table 9	Residual Drawdown Data for Recovery Test - Well 37400
Table 10	Residual Drawdown Data for Recovery Test - Well 37401

LIST OF ILLUSTRATIONS

Plate 1	Well Location Map
Plate 2	Change in Water Level versus Time for Well 37367
Plate 3	Drawdown versus Time for Well 37367 - Step-Drawdown Test
Plate 4	Drawdown versus Log Time for Well 37367
Plate 5	Residual Drawdown versus Log Dimensionless Time for Well 37367
Plate 6	Log Drawdown versus Log Time for Well 37400
Plate 7	Drawdown versus Log Time for Well 37400
Plate 8	Residual Drawdown versus Log Dimensionless Time for Well 37400
Plate 9	Log Drawdown versus Log Time for Well 37401
Plate 10	Drawdown versus Log Time for Well 37401
Plate 11	Residual Drawdown versus Log Dimensionless Time for Well 37401

LIST OF CALCULATION SHEETS

Sheet 1	Modified Non-Equilibrium Method for Well 37367
Sheet 2	Residual Drawdown Method for Well 37367
Sheet 3	Unconfined Aquifer Type Curve Method for Well 37400
Sheet 4	Modified Non-Equilibrium Method for Well 37400
Sheet 5	Residual Drawdown Method for Well 37400
Sheet 6	Unconfined Aquifer Type Curve Method for Well 37401
Sheet 7	Modified Non-Equilibrium Method for Well 37401
Sheet 8	Residual Drawdown Method for Well 37401

I. INTRODUCTION

Harding Lawson Associates (HLA) performed a series of aquifer tests for Environmental Science and Engineering, Inc. (ESE) as part of the Rocky Mountain Arsenal Task 39 Offpost RI/FS program. Step-drawdown, constant-rate discharge, and recovery tests were performed in Well 37367 (Boring E-53), located approximately 1 mile north of the Rocky Mountain Arsenal boundary in Adams County, Colorado (Plate 1). The tests were conducted from April 11 to 14, 1988, to estimate aquifer parameters including transmissivity, hydraulic conductivity, and storativity in the offpost operable unit.

II. AQUIFER TEST METHODOLOGY

Prior to the start of the aquifer tests, water levels were monitored in Well 37367 for 42.5 hours to measure any periodic or unusual water level fluctuations. Any water level trends should be identified before aquifer testing to avoid introducing error into aquifer parameter calculation by including water-level responses not attributable to pumping during the aquifer test.

The Well 37367 step-drawdown test was performed for a total of 4.2 hours on April 12, 1988. Water level changes were measured in Well 37367 using an In Situ SE1000B Hermit datalogger and pressure transducer.

The constant-rate discharge test in Well 37367 was performed April 13 through 14, 1988. Water-level changes were monitored in Wells 37367, 37400, and 37401 (Plate 1) with pressure transducers and the data stored on In Situ SE1000B Hermit dataloggers while Well 37367 was pumped for 24.0 hours. Water-level recovery was measured for 4.0 hours in all wells after the pump was shut off.

Discharge water from both the step-drawdown and constant-rate tests was pumped into three 20,000 gallon storage tankers. Disposal of this water was handled by ESE.

Well 37367 was selected as the pumping well by ESE because it is considered representative of the aquifer materials observed in the Northern Contaminant Pathway in the Offpost Operable Unit. Wells 37400 and 37401 were installed by ESE to be used as observation wells for the aquifer test. Well 37400 is 39.36 feet north of Well 37367, and Well 37401 is 81.33 feet north of Well 37367. Geologic boring logs for Wells 37367, 37400 and 3740 are in Appendix A. The geologic logs show the aquifer zone to be comprised primarily of silty and clayey fine- to coarse-grained sand, with some sandy silt.

Discharge Rate and Measurement

A totalizing Rockwell International flowmeter was to have been used to monitor flow during the aquifer tests. However, on-site calibration of the flowmeter indicated that it

was inaccurate at the low pumping rates to be used during the aquifer tests. Because no other flowmeters were available for use during the tests, a calibrated 55-gallon drum (5-gallon bucket for low flow rates) was used to measure the pumping flow rate. Flow measurements were made by timing the filling of the calibrated drum (or bucket). Flow was measured at the end of the 100-foot discharge line, located approximately 13 feet above ground level at the top of the storage tank.

During the step-drawdown test, the discharge rate of the pump in Well 37367 was increased in four increments from an initial rate of 8.1 gallons per minute (gpm) to a final rate of 36.7 gpm. Discharge rate measurements taken during each step are given in Table 1.

During the constant-rate discharge test, the discharge rate of the submersible pump in Well 37367 was held reasonably constant at an average rate of 32.3 gpm. The pumping rate varied less than 3 percent from the average throughout the test. Flow measurements were taken frequently throughout the test to verify the constancy of the discharge rate. Table 2 presents the discharge rate data for the constant-rate discharge test.

III. AQUIFER TEST RESULTS

Based upon the geologic boring log of Boring E53A (Well 37367) and water-level data, the aquifer zone tested was interpreted to be an unconfined aquifer, and appropriate analysis methods were chosen. The hydraulic properties of the aquifer were evaluated from the constant-rate and recovery test data using type curve and straight-line graphical methods (Theis, 1935; Jacob, 1950; and Prickett, 1965). Graphs of drawdown versus log time, log drawdown versus log time, and residual drawdown versus log dimensionless time were constructed for each well monitored (Plates 4 through 11). On all graphs, drawdown was corrected to account for changes in saturated thickness (Jacob, 1950). The graphs are used for solving equations which express the relationship between the hydraulic properties of an aquifer and hydraulic response of an aquifer to pumping.

Aquifer parameters calculated (Calculation Sheets 1 through 8) using water-level response data from the constant-rate discharge test are presented on Table 3. The arithmetic mean of values calculated from different analytical methods for each observation well describes the average value of transmissivity and hydraulic conductivity. Where transmissivity and hydraulic conductivity were determined at more than one observation well, the geometric mean of these values describes the average value of the parameter for the aquifer test. The arithmetic mean of all methods for all observation wells describes the average value of storativity. These methods were used to calculate mean values because transmissivity has been shown to be log normally distributed in space, and storativity to be normally distributed in space (Freeze, 1975).

A. Step-Drawdown Test

The step-drawdown test was performed in Well 37367 on April 12, 1988. A plot of water-level drawdown versus time for Well 37367 is shown on Plate 3. Drawdown data collected during the step-drawdown test are tabulated in Table 4. Flow rate measurements for each step are summarized in Table 1. The drawdown versus time plot shows a short

transitional period between changing discharge rates. Fluctuations observed in the drawdown data during later steps were caused by unstable flow rates due to a generator malfunction.

The main purpose of the step-drawdown test was to determine an optimal flow rate for the constant-rate discharge test. The optimal flow rate for the test is one that can be sustained for at least 24 hours without dewatering the well. From the step-drawdown test data, it was estimated that a flow rate of 30-35 gpm would be appropriate for the constant-rate discharge test. Under ideal circumstances, data from a step-drawdown test can be used to calculate well efficiency. However, this well parameter could not be estimated because of fluctuations in drawdown caused by the generator malfunction.

B. Constant-Rate Discharge Test

Prior to the aquifer testing, water levels were monitored in Well 37367 to assess the potential for outside influences on water levels. The results of this monitoring are shown on Plate 2. During the 42.5-hour period in which Well 37367 was monitored, water levels decreased approximately 0.2 feet. The decrease was fairly constant throughout the period, indicating that the source of the decrease was not a diurnal fluctuation. The fluctuations may possibly be attributed to seasonal variations or an unidentified pumping well.

The constant-rate discharge test was performed in Well 37367 on April 13-14, 1988. Table 3 summarizes the aquifer test results. Drawdown and recovery data collected during the constant-rate discharge test are tabulated on Tables 5 through 10. Calculations made in estimating the aquifer parameters shown in Table 3 are presented on Sheets 1-8. Graphs of the data are shown on Plates 4 through 11. Drawdown values have been corrected to account for decreasing saturated thicknesses.

Calculated transmissivity values ranged from 4,000 ft^2/day to 8,800 ft^2/day, with a geometric mean of 6,600 ft^2/day. These values are typical for the well-graded sand and gravels comprising the aquifer zone. A value of 360 ft/day was estimated for hydraulic conductivity, using the screened intervals of the observation wells as the aquifer thickness.

Three segments are observed in the drawdown data from the observation wells, representing different aquifer response conditions. For the first segment, a value of 1.9 x 10^{-3} was estimated for aquifer storativity. This value is lower than the typical value range expected for an unconfined alluvial aquifer and is indicative of the early-time or artesian response of the aquifer (Neuman, 1972). The second segment of the drawdown curve is nearly flat and indicates delayed ground-water yield following dewatering of saturated material. During this time, vertical recharge to the saturated zone by delayed yield partially compensates for drawdown from pumping. An accurate estimate of transmissivity and storativity cannot be made during this period. The late-time (third segment) response is representative of the unconfined response of the aquifer and is controlled by the specific yield of materials at the water table. Delayed yield effects were observed in the 24-hour constant-rate discharge test, and the late-time or unconfined response was not fully developed before the test was terminated. To fully develop the late-time curve, the test would have had to run for several days; it is doubtful that the additional data so gained would have added significantly to the refinement of aquifer parameter estimates. Therefore, the storativity value of 1.9 x 10^{-3}representative of the early-time artesian is the only such value which is estimated from the aquifer test, and is not representative of the late-time specific yield of the aquifer.

Table 1

Step-Drawdown Test Discharge Rate Measurements

Step 0

Time	Flow Rate (gpm)
9:11	Start of Test
9:18	7.4
9:20	8.5
9:30	8.7
10:00	5.5
10:05	5.5
10:10	8.6
10:13	8.5

Time-weighted average flow rate 8.1 gpm
Length of step: 66 min

Step 1

Time	Flow Rate (gpm)
10:17	Start of Test
10:18	18.7
10:19	14.3
10:20	13.6
10:21	13.0
10:22	14.3
10:33	15.0
10:39	13.6
10:45	15.0
10:55	15.0
11:15	14.3

Time-weighted average flow rate 14.9 gpm
Length of step: 62 min

Step 2

Time	Flow Rate (gpm)
11:21	Start of Test
11:21	25.0
11:22	25.6
11:23	26.7
11:24	28.1
11:25	30.0
11:26	30.0
11:27	28.6
11:28	28.6
11:29	28.6
11:50	28.6
12:22	28.6

Time-weighted average flow rate 28.5 gpm
Length of step: 62 min

Step 3

Time	Flow Rate (gpm)
12:24	Start of Test
12:25	42.8
12:26	40.0
12:27	39.1
12:28	39.3
12:35	36.0
12:38	36.4
12:41	36.1
13:14	35.8
13:23	35.6

Time-weighted average flow rate 36.7 gpm
Length of step: 60 min

Table 2

Constant-Rate Test Discharge Rate Measurements

Date	Time	Flow Rate (gpm)
4/13/88	15:43	Start of Test
	15:47	32.6
	15:53	32.4
	15:56	32.6
	16.25	32.8
	16:44	32.3
	17:58	32.1
	19:00	31.9
	20:00	32.8
	21:00	32.2
	22:00	32.5
	23:00	32.7
	23:58	33.1
4/14/88	01:04	32.6
	01:59	32.1
	03:00	32.0
	04:04	32.6
	05:02	32.2
	06:04	32.4
	07:05	32.5
	09:02	31.9
	11:05	32.3
	13:05	32.3
	15:30	31.9
Time-weighted average flow rate		32.3 gpm

Table 3. Summary of Well 37367 Aquifer Test

Dates Tested: April 13-14, 1988
Pumped Well: 37367
Discharge Rate: 32.3 gpm

Pumping Duration: 24.0 hours
Recovery Duration: 4.0 hours

Observation Well	Distance to Pumped Well (ft)	Magnitude Water Level Response (ft)	Method of Analysis	Transmissivity (ft^2/day)	Hydraulic Conductivity (ft/day)	Storativity (dimensionless)
37367	0	12.14	SL	4,000	210	-
			RD	7,600	400	-
37400	39.36	0.58	LL	7,200	380	1.9×10^{-3}
			SL	6,000	320	2.1×10^{-3}
			RD	7,100	370	-
37401	81.33	0.33	LL	6,300	350	1.9×10^{-3}
			SL	8,800	490	1.7×10^{-3}
			RD	7,100	390	-

T geometric = 6,600 ft^2/day
K geometric = 3.60 ft/day
S arithmetic = 1.9×10^{-3} (dimensionless)

LL = Unconfined Aquifer Type Curve Method (Prickett, 1965)
SL = Modified Non-Equilibrium Method (Jacob, 1950)
RD = Residual Drawdown Method (Theis, 1935)

Table 4.
Drawdown Data for Step - Drawdown Test
Well 37363

Pumping Well: 37367
Observation Well: 37367
Step - Drawdown Test
04/12/88

Step# 0 04/12 09:11

Elapsed Time (min)	Drawdown Value (ft)
0.0000	0.01
0.0033	0.07
0.0066	1.12
0.0099	-0.35
0.0133	-0.34
0.0166	0.13
0.0200	0.18
0.0233	0.15
0.0266	0.12
0.0300	0.11
0.0333	0.12
0.0500	0.11
0.0666	0.11
0.0833	0.10
0.1000	0.13
0.1166	0.12
0.1333	0.11
0.1500	0.11
0.1666	0.11
0.1833	0.12
0.2000	0.12
0.2166	0.12
0.2333	0.13
0.2500	0.30
0.2666	0.48
0.2833	0.60
0.3000	0.89
0.3166	1.12
0.3333	1.37
0.4167	1.86
0.5000	1.12
0.5833	0.99
0.6667	0.97
0.7500	0.95
0.8333	0.93
0.9167	0.92
1.0000	0.91
1.0833	0.93
1.1667	0.96
1.2500	0.98
1.3333	1.01
1.4166	1.03
1.5000	1.04
1.5833	1.04
1.6667	1.05

Table 4. (continued)

1.7500	1.05
1.8333	1.04
1.9167	1.06
2.0000	1.06
2.5000	1.07
3.0000	1.08
3.5000	1.06
4.0000	1.08
4.5000	1.09
5.0000	1.08
5.5000	1.06
6.0000	1.07
6.5000	1.09
7.0000	1.18
7.5000	1.21
8.0000	1.22
8.5000	1.24
9.0000	1.26
9.5000	1.25
10.0000	1.27
12.0000	1.26
14.0000	1.28
16.0000	1.29
18.0000	1.25
20.0000	1.26
22.0000	1.29
24.0000	1.27
26.0000	1.24
28.0000	1.30
30.0000	1.27
32.0000	1.27
34.0000	1.29
36.0000	1.27
38.0000	1.26
40.0000	1.26
42.0000	1.28
44.0000	1.29
46.0000	1.29
48.0000	1.26
50.0000	1.27
52.0000	0.89
54.0000	0.87
56.0000	0.86
58.0000	0.15
60.0000	1.07
62.0000	1.15
64.0000	1.17
66.0000	1.14

Step# 1 04/12 10:17

Elapsed Time (min)	Drawdown Value (ft)
0.0000	1.17

Table 4. (continued)

0.0033	1.53
0.0066	1.34
0.0099	1.21
0.0133	1.47
0.0166	1.35
0.0200	1.27
0.0233	1.32
0.0266	1.35
0.0300	1.36
0.0333	1.39
0.0500	1.49
0.0666	1.56
0.0833	1.60
0.1000	1.62
0.1166	1.66
0.1333	1.68
0.1500	1.70
0.1666	1.72
0.1833	1.72
0.2000	1.75
0.2166	1.76
0.2333	1.77
0.2500	1.78
0.2666	1.81
0.2833	1.82
0.3000	1.85
0.3166	1.83
0.3333	1.86
0.4167	1.96
0.5000	2.06
0.5833	2.11
0.6667	2.15
0.7500	2.18
0.8333	2.21
0.9167	2.25
1.0000	2.23
1.0833	2.15
1.1667	2.17
1.2500	2.14
1.3333	2.16
1.4166	2.14
1.5000	2.15
1.5833	2.15
1.6667	2.15
1.7500	2.15
1.8333	2.14
1.9167	2.14
2.0000	2.15
2.5000	2.15
3.0000	2.15
3.5000	2.17
4.0000	2.19
4.5000	2.18
5.0000	2.23
5.5000	2.22
6.0000	2.20

Table 4. (continued)

6.5000	2.21
7.0000	2.22
7.5000	2.22
8.0000	2.23
8.5000	2.24
9.0000	2.26
9.5000	2.26
10.0000	2.22
12.0000	2.23
14.0000	2.25
16.0000	2.25
18.0000	2.22
20.0000	2.23
22.0000	2.26
24.0000	2.22
26.0000	2.29
28.0000	2.27
30.0000	2.29
32.0000	2.29
34.0000	2.29
36.0000	2.29
38.0000	2.30
40.0000	2.31
42.0000	2.29
44.0000	2.31
46.0000	2.31
48.0000	2.31
50.0000	2.31
52.0000	2.30
54.0000	2.33
56.0000	2.31
58.0000	2.32
60.0000	2.31
62.0000	2.31

Step# 2 04/12 11:20

Elapsed Time (min)	Drawdown Value (ft)
0.0000	2.32
0.0033	2.33
0.0066	2.46
0.0099	2.82
0.0133	2.53
0.0166	2.53
0.0200	2.65
0.0233	2.56
0.0266	2.67
0.0300	2.62
0.0333	2.72
0.0500	2.96
0.0666	3.13
0.0833	3.30
0.1000	3.47

Table 4. (continued)

0.1166	3.58
0.1333	3.66
0.1500	3.76
0.1666	3.85
0.1833	3.89
0.2000	3.98
0.2166	3.95
0.2333	4.05
0.2500	4.05
0.2666	4.15
0.2833	4.14
0.3000	4.18
0.3166	4.23
0.3333	4.27
0.4167	4.43
0.5000	4.56
0.5833	4.61
0.6667	4.71
0.7500	4.77
0.8333	4.83
0.9167	4.88
1.0000	4.95
1.0833	5.00
1.1667	5.02
1.2500	5.07
1.3333	5.07
1.4166	5.25
1.5000	5.28
1.5833	5.32
1.6667	5.38
1.7500	5.39
1.8333	5.43
1.9167	5.51
2.0000	5.48
2.5000	5.55
3.0000	6.14
3.5000	6.40
4.0000	6.45
4.5000	6.56
5.0000	6.53
5.5000	6.41
6.0000	6.34
6.5000	6.35
7.0000	6.36
7.5000	6.42
8.0000	6.44
8.5000	6.45
9.0000	6.46
9.5000	6.49
10.0000	6.48
12.0000	6.51
14.0000	6.58
16.0000	6.60
18.0000	6.62
20.0000	6.60
22.0000	6.62

Table 4. (continued)

24.0000	6.64
26.0000	6.04
28.0000	6.73
30.0000	6.74
32.0000	6.73
34.0000	6.77
36.0000	6.79
38.0000	6.75
40.0000	6.79
42.0000	6.77
44.0000	6.77
46.0000	6.82
48.0000	6.80
50.0000	6.83
52.0000	6.81
54.0000	6.84
56.0000	6.91
58.0000	6.86
60.0000	6.87
62.0000	6.85

Step# 3 04/12 12:24

Elapsed Time (min)	Drawdown Value (ft)
0.0000	6.80
0.0033	6.88
0.0066	6.88
0.0099	6.91
0.0133	6.89
0.0166	6.90
0.0200	6.98
0.0233	7.12
0.0266	7.04
0.0300	4.07
0.0333	7.14
0.0500	7.49
0.0666	7.78
0.0833	8.07
0.1000	8.38
0.1166	8.62
0.1333	8.91
0.1500	9.09
0.1666	9.29
0.1833	9.42
0.2000	9.58
0.2166	9.78
0.2333	9.88
0.2500	9.98
0.2666	10.11
0.2833	10.19
0.3000	10.22
0.3166	10.30
0.3333	10.34

Table 4. (continued)

0.4167	10.63
0.5000	10.83
0.5833	10.94
0.6667	11.18
0.7500	11.44
0.8333	11.59
0.9167	11.75
1.0000	11.48
1.0833	11.18
1.1667	10.96
1.2500	10.87
1.3333	10.82
1.4166	10.78
1.5000	10.75
1.5833	10.80
1.6667	10.77
1.7500	10.71
1.8333	10.75
1.9167	10.76
2.0000	10.73
2.5000	10.85
3.0000	10.89
3.5000	10.33
4.0000	10.39
4.5000	10.37
5.0000	10.15
5.5000	10.36
6.0000	10.58
6.5000	10.63
7.0000	10.65
7.5000	10.64
8.0000	10.85
8.5000	10.76
9.0000	10.84
9.5000	10.81
10.0000	11.03
12.0000	10.96
14.0000	11.20
16.0000	10.81
18.0000	11.34
20.0000	11.42
22.0000	11.53
24.0000	11.52
26.0000	11.56
28.0000	11.55
30.0000	11.68
32.0000	11.66
34.0000	11.67
36.0000	11.72
38.0000	11.76
40.0000	11.78
42.0000	11.77
44.0000	11.81
46.0000	11.84
48.0000	11.40
50.0000	11.86

Table 4. (continued)

52.0000	11.69
54.0000	11.87
56.0000	11.46
58.0000	11.97
60.0000	11.94

Table 5.
Drawdown Data for Constant-Rate Test
Well 37367

Pumping Well: 37367
Observation Well: 37367
Constant - Rate Discharge Test
04/13/88 15:43

Elapsed Time (min)	Drawdown Value (ft)
0.0000	0.01
0.0033	0.01
0.0066	1.49
0.0099	1.59
0.0133	0.55
0.0166	0.00
0.0200	0.64
0.0233	0.96
0.0266	0.96
0.0300	1.04
0.0333	1.16
0.0500	1.79
0.0666	2.28
0.0833	2.71
0.1000	3.12
0.1166	3.47
0.1333	3.85
0.1500	4.21
0.1666	4.44
0.1833	4.66
0.2000	4.88
0.2166	5.09
0.2333	5.30
0.2500	5.48
0.2666	5.57
0.2833	5.69
0.3000	5.85
0.3166	6.01
0.3333	6.14
0.4167	6.71
0.5000	7.12
0.5833	7.47
0.6667	7.70
0.7500	7.97
0.8333	8.16
0.9167	8.23
1.0000	8.38
1.0833	8.51
1.1667	8.60
1.2500	8.76
1.3333	8.91
1.4166	9.00
1.5000	9.11
1.5833	9.25
1.6667	9.35
1.7500	9.44
1.8333	9.50

Table 5. (continued)

1.9167	9.59
2.0000	9.65
2.5000	9.92
3.0000	10.07
3.5000	10.10
4.0000	10.17
4.5000	10.19
5.0000	10.22
5.5000	10.22
6.0000	10.25
6.5000	10.32
7.0000	10.32
7.5000	10.27
8.0000	10.35
8.5000	10.38
9.0000	10.41
9.5000	10.40
10.0000	10.43
12.0000	10.47
14.0000	10.54
16.0000	10.53
18.0000	10.54
20.0000	10.60
22.0000	10.71
24.0000	10.74
26.0000	10.77
28.0000	10.78
30.0000	10.83
32.0000	10.79
34.0000	10.90
36.0000	10.88
38.0000	10.93
40.0000	10.92
42.0000	10.96
44.0000	10.94
46.0000	10.98
48.0000	11.02
50.0000	10.97
52.0000	11.04
54.0000	11.07
56.0000	11.05
58.0000	11.12
60.0000	11.10
62.0000	11.11
64.0000	11.18
66.0000	11.10
68.0000	11.11
70.0000	11.11
72.0000	11.15
74.0000	11.13
76.0000	11.18
78.0000	11.04
80.0000	11.02
82.0000	11.02
84.0000	11.00
86.0000	11.07

Table 5. (continued)

88.0000	11.06
90.0000	11.08
92.0000	11.06
94.0000	11.08
96.0000	11.07
98.0000	11.13
100.0000	11.11
110.0000	11.14
120.0000	11.18
130.0000	11.19
140.0000	11.25
150.0000	11.31
160.0000	11.33
170.0000	11.32
180.0000	11.41
190.0000	11.42
200.0000	11.39
210.0000	11.44
220.0000	11.47
230.0000	11.49
240.0000	11.50
250.0000	11.49
260.0000	11.50
270.0000	11.51
280.0000	11.52
290.0000	11.53
300.0000	11.54
310.0000	11.56
320.0000	11.60
330.0000	11.60
340.0000	11.58
350.0000	11.60
360.0000	11.58
370.0000	11.60
380.0000	11.67
390.0000	11.64
400.0000	11.68
410.0000	11.71
420.0000	11.70
430.0000	11.70
440.0000	11.70
450.0000	11.69
460.0000	11.72
470.0000	11.77
480.0000	11.80
490.0000	11.81
500.0000	11.74
510.0000	11.80
520.0000	11.78
530.0000	11.82
540.0000	11.83
550.0000	11.83
560.0000	11.83
570.0000	11.81
580.0000	11.78
590.0000	11.90

Table 5. (continued)

600.0000	11.89
610.0000	11.88
620.0000	11.86
630.0000	11.87
640.0000	11.87
650.0000	11.88
660.0000	11.89
670.0000	11.91
680.0000	11.88
690.0000	11.87
700.0000	11.88
710.0000	11.94
720.0000	11.93
730.0000	11.91
740.0000	11.90
750.0000	11.85
760.0000	11.92
770.0000	11.95
780.0000	11.91
790.0000	11.97
800.0000	11.91
810.0000	11.94
820.0000	11.99
830.0000	11.94
840.0000	12.02
850.0000	12.00
860.0000	11.97
870.0000	11.92
880.0000	11.95
890.0000	11.96
900.0000	11.97
910.0000	11.99
920.0000	12.05
930.0000	12.05
940.0000	12.05
950.0000	12.00
960.0000	12.05
970.0000	12.07
980.0000	12.07
990.0000	12.14
1000.0000	12.12
1030.0000	12.13
1060.0000	12.06
1090.0000	12.01
1120.0000	12.04
1150.0000	12.05
1180.0000	12.11
1210.0000	12.05
1240.0000	12.14
1270.0000	12.04
1300.0000	12.07
1330.0000	12.08
1360.0000	12.12
1390.0000	12.06
1420.0000	12.08

Table 6.
Drawdown Data for Constant-Rate Test
Well 37400

Pumping Well: 37367
Observation Well: 37400
Constant Rate Discharge Test
04/13/88 15:43

Elapsed Time (min)	Value (ft)
0.0000	0.02
0.0033	0.02
0.0066	0.02
0.0099	0.02
0.0133	0.03
0.0166	0.03
0.0200	0.02
0.0233	0.02
0.0266	0.02
0.0300	0.03
0.0333	0.03
0.0500	0.03
0.0666	0.03
0.0833	0.03
0.1000	0.03
0.1166	0.03
0.1333	0.04
0.1500	0.04
0.1666	0.05
0.1833	0.05
0.2000	0.05
0.2166	0.05
0.2333	0.05
0.2500	0.06
0.2666	0.06
0.2833	0.06
0.3000	0.06
0.3166	0.06
0.3333	0.06
0.4167	0.08
0.5000	0.09
0.5833	0.10
0.6667	0.11
0.7500	0.11
0.8333	0.11
0.9167	0.12
1.0000	0.12
1.0833	0.13
1.1667	0.13
1.2500	0.13
1.3333	0.13
1.4166	0.14
1.5000	0.15
1.5833	0.15
1.6667	0.15
1.7500	0.15
1.8333	0.16
1.9167	0.16

Table 6. (continued)

2.0000	0.16
2.5000	0.18
3.0000	0.19
3.5000	0.20
4.0000	0.21
4.5000	0.22
5.0000	0.22
5.5000	0.23
6.0000	0.24
6.5000	0.25
7.0000	0.25
7.5000	0.25
8.0000	0.26
8.5000	0.26
9.0000	0.26
9.5000	0.27
10.0000	0.27
12.0000	0.29
14.0000	0.30
16.0000	0.31
18.0000	0.33
20.0000	0.33
22.0000	0.34
24.0000	0.35
26.0000	0.36
28.0000	0.37
30.0000	0.38
32.0000	0.39
34.0000	0.39
36.0000	0.40
38.0000	0.40
40.0000	0.41
42.0000	0.42
44.0000	0.43
46.0000	0.42
48.0000	0.43
50.0000	0.43
52.0000	0.44
54.0000	0.44
56.0000	0.45
58.0000	0.46
60.0000	0.46
62.0000	0.46
64.0000	0.47
66.0000	0.47
68.0000	0.47
70.0000	0.47
72.0000	0.48
74.0000	0.48
76.0000	0.49
78.0000	0.49
80.0000	0.49
82.0000	0.49
84.0000	0.50
86.0000	0.50
88.0000	0.51

Table 6. (continued)

90.0000	0.51
92.0000	0.51
94.0000	0.51
96.0000	0.51
98.0000	0.52
100.0000	0.52
110.0000	0.53
120.0000	0.54
130.0000	0.54
140.0000	0.54
150.0000	0.55
160.0000	0.56
170.0000	0.56
180.0000	0.56
190.0000	0.56
200.0000	0.56
210.0000	0.56
220.0000	0.56
230.0000	0.56
240.0000	0.56
250.0000	0.56
260.0000	0.56
270.0000	0.56
280.0000	0.56
290.0000	0.56
300.0000	0.56
310.0000	0.56
320.0000	0.56
330.0000	0.56
340.0000	0.56
350.0000	0.56
360.0000	0.56
370.0000	0.56
380.0000	0.56
390.0000	0.56
400.0000	0.56
410.0000	0.56
420.0000	0.56
430.0000	0.56
440.0000	0.56
450.0000	0.56
460.0000	0.56
470.0000	0.56
480.0000	0.56
490.0000	0.56
500.0000	0.56
510.0000	0.56
520.0000	0.56
530.0000	0.56
540.0000	0.56
550.0000	0.56
560.0000	0.56
570.0000	0.56
580.0000	0.56
590.0000	0.56
600.0000	0.56

Table 6. (continued)

610.0000	0.56
620.0000	0.56
630.0000	0.56
640.0000	0.56
650.0000	0.56
660.0000	0.56
670.0000	0.56
680.0000	0.56
690.0000	0.56
700.0000	0.56
710.0000	0.56
720.0000	0.56
730.0000	0.56
740.0000	0.56
750.0000	0.56
760.0000	0.56
770.0000	0.56
780.0000	0.56
790.0000	0.56
800.0000	0.56
810.0000	0.57
820.0000	0.56
830.0000	0.57
840.0000	0.57
850.0000	0.57
860.0000	0.57
870.0000	0.57
880.0000	0.57
890.0000	0.57
900.0000	0.57
910.0000	0.57
920.0000	0.57
930.0000	0.57
940.0000	0.57
950.0000	0.57
960.0000	0.58
970.0000	0.58
980.0000	0.58
990.0000	0.58
1000.0000	0.58
1030.0000	0.58
1060.0000	0.58
1090.0000	0.57
1120.0000	0.57
1150.0000	0.57
1180.0000	0.57
1210.0000	0.57
1240.0000	0.56
1270.0000	0.56
1300.0000	0.57
1330.0000	0.56
1360.0000	0.57
1390.0000	0.57
1420.0000	0.57

Table 7.
Drawdown Data for Constant-Rate Test
Well 37401

Pumping Well: 37367
Observation Well: 37401
Constant Rate Discharge Test
04/13/88 15:43

Elapsed Time (min)	Drawdown Value (ft)
0.0000	0.00
0.0033	0.00
0.0066	0.00
0.0099	0.00
0.0133	0.00
0.0166	0.01
0.0200	0.01
0.0233	0.01
0.0266	0.01
0.0300	0.01
0.0333	0.01
0.0500	0.01
0.0666	0.01
0.0833	0.01
0.1000	0.01
0.1166	0.01
0.1333	0.00
0.1500	0.01
0.1666	0.01
0.1833	0.01
0.2000	0.01
0.2166	0.01
0.2333	0.01
0.2500	0.01
0.2666	0.01
0.2833	0.01
0.3000	0.01
0.3166	0.01
0.3333	0.01
0.4167	0.01
0.5000	0.02
0.5833	0.02
0.6667	0.02
0.7500	0.02
0.8333	0.02
0.9167	0.03
1.0000	0.03
1.0833	0.03
1.1667	0.04
1.2500	0.04
1.3333	0.04
1.4167	0.04
1.5000	0.04
1.5833	0.05
1.6667	0.05
1.7500	0.05
1.8333	0.05

Table 7. (continued)

1.9167	0.05
2.0000	0.06
2.5000	0.07
3.0000	0.07
3.5000	0.08
4.0000	0.09
4.5000	0.09
5.0000	0.10
5.5000	0.10
6.0000	0.11
6.5000	0.12
7.0000	0.12
7.5000	0.13
8.0000	0.13
8.5000	0.13
9.0000	0.14
9.5000	0.14
10.0000	0.15
12.0000	0.16
14.0000	0.17
16.0000	0.18
18.0000	0.18
20.0000	0.18
22.0000	0.19
24.0000	0.21
26.0000	0.19
28.0000	0.20
30.0000	0.21
32.0000	0.21
34.0000	0.21
36.0000	0.22
38.0000	0.22
40.0000	0.23
42.0000	0.24
44.0000	0.24
46.0000	0.24
48.0000	0.24
50.0000	0.23
52.0000	0.24
54.0000	0.23
56.0000	0.24
58.0000	0.24
60.0000	0.24
62.0000	0.25
64.0000	0.25
66.0000	0.24
68.0000	0.24
70.0000	0.24
72.0000	0.25
74.0000	0.26
76.0000	0.25
78.0000	0.25
80.0000	0.25
82.0000	0.25
84.0000	0.25
86.0000	0.26

Table 7. (continued)

88.0000	0.26
90.0000	0.26
92.0000	0.26
94.0000	0.26
96.0000	0.26
98.0000	0.27
100.0000	0.27
110.0000	0.26
120.0000	0.26
130.0000	0.27
140.0000	0.28
150.0000	0.27
160.0000	0.27
170.0000	0.27
180.0000	0.27
190.0000	0.27
200.0000	0.26
210.0000	0.26
220.0000	0.26
230.0000	0.26
240.0000	0.26
250.0000	0.26
260.0000	0.26
270.0000	0.27
280.0000	0.26
290.0000	0.26
300.0000	0.26
310.0000	0.26
320.0000	0.27
330.0000	0.26
340.0000	0.26
350.0000	0.26
360.0000	0.26
370.0000	0.26
380.0000	0.27
390.0000	0.27
400.0000	0.26
410.0000	0.26
420.0000	0.26
430.0000	0.26
440.0000	0.27
450.0000	0.27
460.0000	0.26
470.0000	0.26
480.0000	0.26
490.0000	0.26
500.0000	0.27
510.0000	0.27
520.0000	0.27
530.0000	0.26
540.0000	0.27
550.0000	0.26
560.0000	0.27
570.0000	0.27
580.0000	0.27
590.0000	0.27

Table 7. (continued)

600.0000	0.27
610.0000	0.27
620.0000	0.28
630.0000	0.28
640.0000	0.27
650.0000	0.27
660.0000	0.27
670.0000	0.27
680.0000	0.28
690.0000	0.28
700.0000	0.28
710.0000	0.28
720.0000	0.27
730.0000	0.27
740.0000	0.28
750.0000	0.28
760.0000	0.28
770.0000	0.27
780.0000	0.27
790.0000	0.28
800.0000	0.29
810.0000	0.29
820.0000	0.28
830.0000	0.28
840.0000	0.29
850.0000	0.28
860.0000	0.29
870.0000	0.29
880.0000	0.29
890.0000	0.29
900.0000	0.28
910.0000	0.29
920.0000	0.30
930.0000	0.30
940.0000	0.30
950.0000	0.30
960.0000	0.30
970.0000	0.29
980.0000	0.30
990.0000	0.30
1000.0000	0.30
1030.0000	0.29
1060.0000	0.31
1090.0000	0.30
1120.0000	0.30
1150.0000	0.29
1180.0000	0.32
1210.0000	0.31
1240.0000	0.29
1270.0000	0.31
1300.0000	0.33
1330.0000	0.30
1360.0000	0.31
1390.0000	0.33
1420.0000	0.32

Table 8.

Residual Drawdown Data for Recovery Test
Well 37367

Pumping Well: 37367
Observation Well: 37367
Recovery Test
04/14/88 15:43

Elapsed Time (min)	Drawdown Value (ft)
0.0000	12.10
0.0033	12.12
0.0066	11.68
0.0099	11.66
0.0133	11.45
0.0166	11.21
0.0200	10.97
0.0233	10.76
0.0266	10.55
0.0300	10.35
0.0333	10.13
0.0500	9.12
0.0666	8.26
0.0833	7.58
0.1000	7.00
0.1166	6.45
0.1333	6.03
0.1500	5.63
0.1666	5.29
0.1833	5.00
0.2000	4.75
0.2166	4.51
0.2333	4.27
0.2500	4.05
0.2666	3.83
0.2833	3.60
0.3000	3.39
0.3166	3.20
0.3333	3.05
0.4167	2.47
0.5000	2.01
0.5833	1.70
0.6667	1.47
0.7500	1.31
0.8333	1.18
0.9167	1.08
1.0000	0.99
1.0833	0.92
1.1667	0.86
1.2500	0.80
1.3333	0.75
1.4166	0.72
1.5000	0.69
1.5833	0.66
1.6667	0.64
1.7500	0.62
1.8333	0.61

Table 8. (continued)

1.9167	0.59
2.0000	0.58
2.5000	0.54
3.0000	0.50
3.5000	0.48
4.0000	0.47
4.5000	0.45
5.0000	0.45
5.5000	0.43
6.0000	0.43
6.5000	0.42
7.0000	0.42
7.5000	0.41
8.0000	0.40
8.5000	0.39
9.0000	0.38
9.5000	0.38
10.0000	0.37
12.0000	0.35
14.0000	0.33
16.0000	0.32
18.0000	0.31
20.0000	0.30
22.0000	0.29
24.0000	0.28
26.0000	0.27
28.0000	0.27
30.0000	0.26
32.0000	0.25
34.0000	0.25
36.0000	0.24
38.0000	0.24
40.0000	0.23
42.0000	0.23
44.0000	0.23
46.0000	0.22
48.0000	0.22
50.0000	0.21
52.0000	0.21
54.0000	0.21
56.0000	0.20
58.0000	0.20
60.0000	0.20
62.0000	0.20
64.0000	0.20
66.0000	0.19
68.0000	0.19
70.0000	0.09
72.0000	0.18
74.0000	0.18
76.0000	0.18
78.0000	0.18
80.0000	0.18
82.0000	0.18
84.0000	0.17
86.0000	0.17

Table 8. (continued)

88.0000	0.17
90.0000	0.17
92.0000	0.16
94.0000	0.16
96.0000	0.16
98.0000	0.16
100.0000	0.16
110.0000	0.15
120.0000	0.14
130.0000	0.13
140.0000	0.13
150.0000	0.12
160.0000	0.12
170.0000	0.11
180.0000	0.10
190.0000	0.10
200.0000	0.09
210.0000	0.09
220.0000	0.09
230.0000	0.08

Table 9.
Residual Drawdown Data for Recovery Test
Well 37400

Pumping Well: 37367
Observation Well: 37400
Recovery Test
04/14 15:36

Elapsed Time (min)	Drawdown Value (ft)
0.0000	0.58
0.0033	0.58
0.0066	0.58
0.0099	0.58
0.0133	0.58
0.0166	0.58
0.0200	0.58
0.0233	0.58
0.0266	0.58
0.0300	0.58
0.0333	0.58
0.0500	0.58
0.0666	0.58
0.0833	0.58
0.1000	0.57
0.1166	0.57
0.1333	0.57
0.1500	0.57
0.1666	0.56
0.1833	0.56
0.2000	0.56
0.2166	0.55
0.2333	0.55
0.2500	0.55
0.2666	0.55
0.2833	0.54
0.3000	0.54
0.3166	0.54
0.3333	0.54
0.4167	0.53
0.5000	0.52
0.5833	0.51
0.6667	0.50
0.7500	0.50
0.8333	0.49
0.9167	0.49
1.0000	0.49
1.0833	0.48
1.1667	0.47
1.2500	0.47
1.3333	0.47
1.4166	0.47
1.5000	0.46
1.5833	0.46
1.6667	0.46
1.7500	0.46
1.8333	0.45

Table 9. (continued)

1.9167	0.45
2.0000	0.45
2.5000	0.44
3.0000	0.42
3.5000	0.42
4.0000	0.41
4.5000	0.40
5.0000	0.40
5.5000	0.39
6.0000	0.39
6.5000	0.39
7.0000	0.38
7.5000	0.38
8.0000	0.37
8.5000	0.36
9.0000	0.36
9.5000	0.36
10.0000	0.35
12.0000	0.34
14.0000	0.32
16.0000	0.32
18.0000	0.31
20.0000	0.30
22.0000	0.30
24.0000	0.29
26.0000	0.28
28.0000	0.28
30.0000	0.28
32.0000	0.27
34.0000	0.27
36.0000	0.27
38.0000	0.27
40.0000	0.26
42.0000	0.26
44.0000	0.26
46.0000	0.26
48.0000	0.26
50.0000	0.26
52.0000	0.26
54.0000	0.25
56.0000	0.25
58.0000	0.25
60.0000	0.25
62.0000	0.25
64.0000	0.25
66.0000	0.24
68.0000	0.24
70.0000	0.24
72.0000	0.24
74.0000	0.24
76.0000	0.24
78.0000	0.24
80.0000	0.24
82.0000	0.23
84.0000	0.23
86.0000	0.23

Table 9. (continued)

88.0000	0.23
90.0000	0.23
92.0000	0.23
94.0000	0.23
96.0000	0.23
98.0000	0.22
100.0000	0.23
110.0000	0.22
120.0000	0.21
130.0000	0.20
140.0000	0.19
150.0000	0.19
160.0000	0.18
170.0000	0.17
180.0000	0.17
190.0000	0.16
200.0000	0.16
210.0000	0.15
220.0000	0.15
230.0000	0.14

Table 10.
Residual Drawdown Data for Recovery Test
Well 37401

Pumping Well: 37367
Observation Well: 37401
Recovery Test
04/14/88 15:43

Elapsed Time (min)	Drawdown Value (ft)
0.0000	0.36
0.0033	0.36
0.0066	0.36
0.0099	0.36
0.0133	0.36
0.0166	0.36
0.0200	0.36
0.0233	0.36
0.0266	0.36
0.0300	0.36
0.0333	0.36
0.0500	0.36
0.0666	0.36
0.0833	0.36
0.1000	0.36
0.1166	0.36
0.1333	0.36
0.1500	0.36
0.1666	0.36
0.1833	0.36
0.2000	0.36
0.2166	0.36
0.2333	0.36
0.2500	0.36
0.2666	0.36
0.2833	0.36
0.3000	0.36
0.3166	0.36
0.3333	0.36
0.4167	0.36
0.5000	0.36
0.5833	0.36
0.6667	0.36
0.7500	0.36
0.8333	0.36
0.9167	0.36
1.0000	0.35
1.0833	0.35
1.1667	0.35
1.2500	0.35
1.3333	0.34
1.4166	0.34
1.5000	0.34
1.5833	0.33
1.6667	0.33
1.7500	0.33
1.8333	0.32

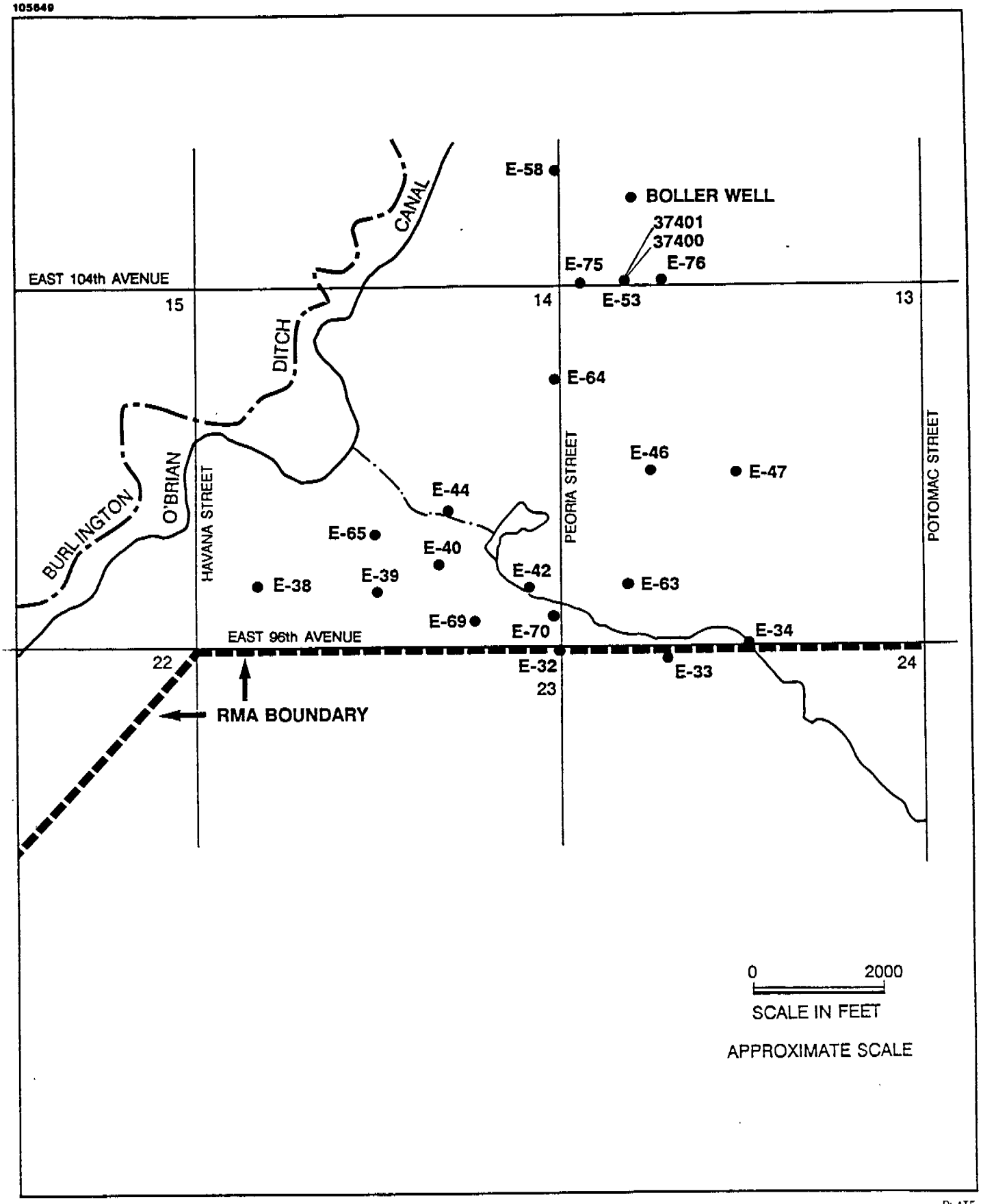
Table 10. (continued)

1.9167	0.32
2.0000	0.32
2.5000	0.32
3.0000	0.31
3.5000	0.30
4.0000	0.30
4.5000	0.30
5.0000	0.30
5.5000	0.30
6.0000	0.30
6.5000	0.30
7.0000	0.30
7.5000	0.30
8.0000	0.30
8.5000	0.29
9.0000	0.28
9.5000	0.28
10.0000	0.28
12.0000	0.26
14.0000	0.23
16.0000	0.22
18.0000	0.22
20.0000	0.22
22.0000	0.21
24.0000	0.21
26.0000	0.19
28.0000	0.19
30.0000	0.19
32.0000	0.19
34.0000	0.20
36.0000	0.19
38.0000	0.19
40.0000	0.19
42.0000	0.18
44.0000	0.18
46.0000	0.18
48.0000	0.18
50.0000	0.18
52.0000	0.18
54.0000	0.17
56.0000	0.17
58.0000	0.17
60.0000	0.17
62.0000	0.16
64.0000	0.16
66.0000	0.16
68.0000	0.15
70.0000	0.15
72.0000	0.15
74.0000	0.14
76.0000	0.14
78.0000	0.14
80.0000	0.14
82.0000	0.14
84.0000	0.13
86.0000	0.13

Table 10. (continued)

88.0000	0.13
90.0000	0.13
92.0000	0.13
94.0000	0.12
96.0000	0.12
98.0000	0.12
100.0000	0.12
110.0000	0.10
120.0000	0.09
130.0000	0.08
140.0000	0.07
150.0000	0.06
160.0000	0.06
170.0000	0.04
180.0000	0.03
190.0000	0.02
200.0000	0.02
210.0000	0.01
220.0000	0.02
230.0000	0.01

105649

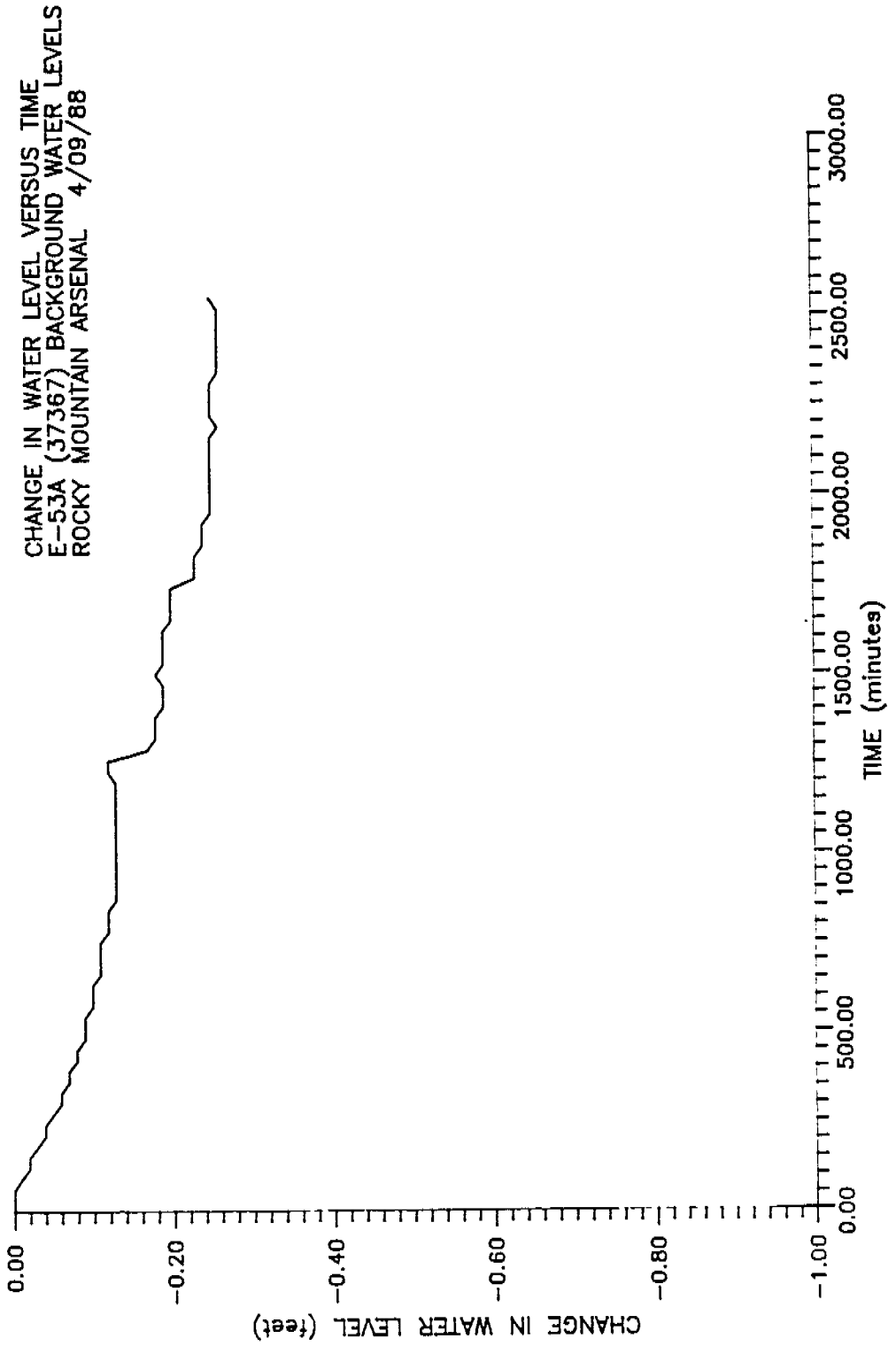


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Well Location Map
Rocky Mountain Arsenal
Adams County, Colorado

PLATE
1

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
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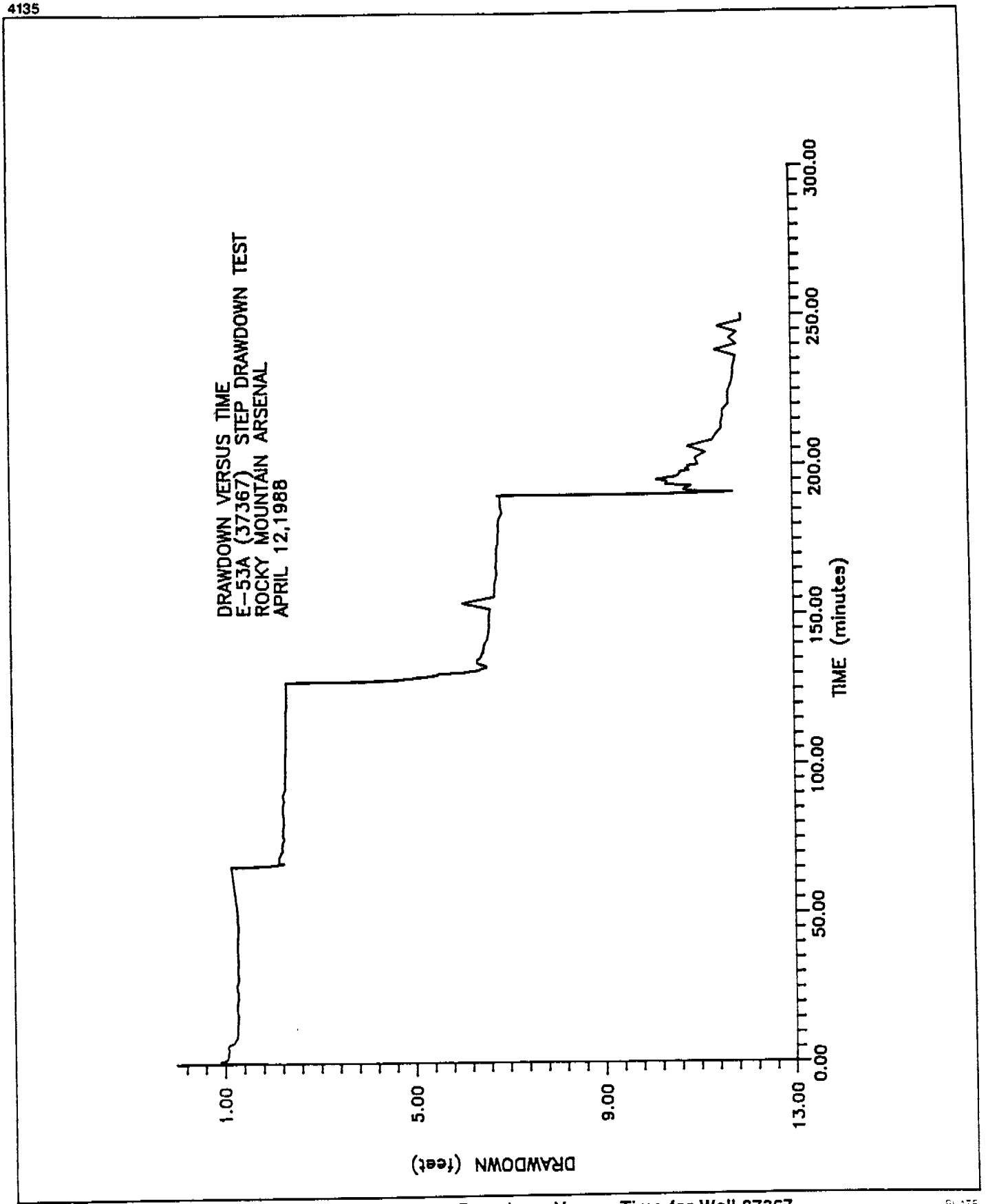


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Change in Water Level Versus Time for Well 37367
Rocky Mountain Arsenal
Adams County, Colorado

PLATE
2

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
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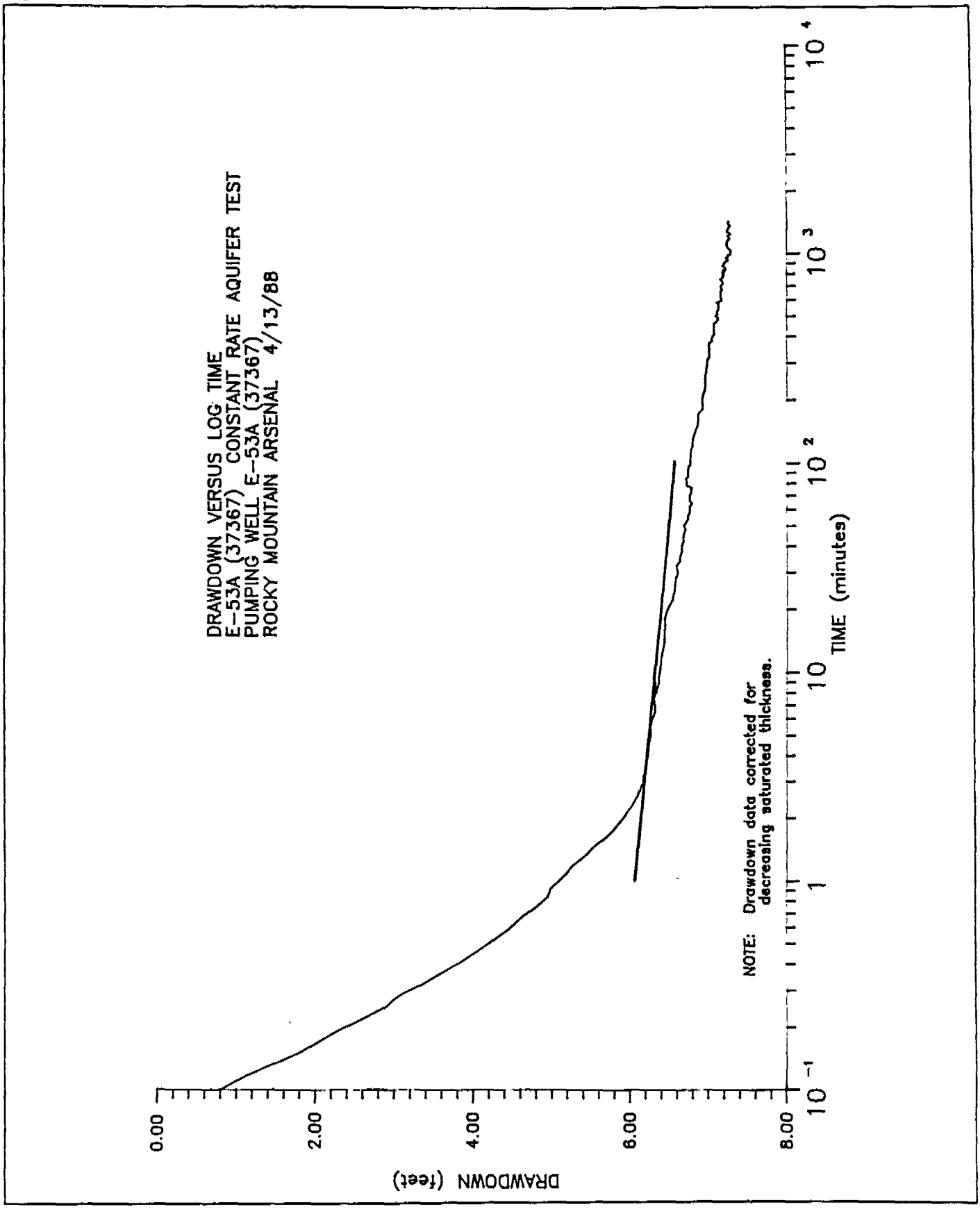


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Drawdown Versus Time for Well 37367
Step-Drawdown Test
Rocky Mountain Arsenal
Adams County, Colorado

PLATE
3

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
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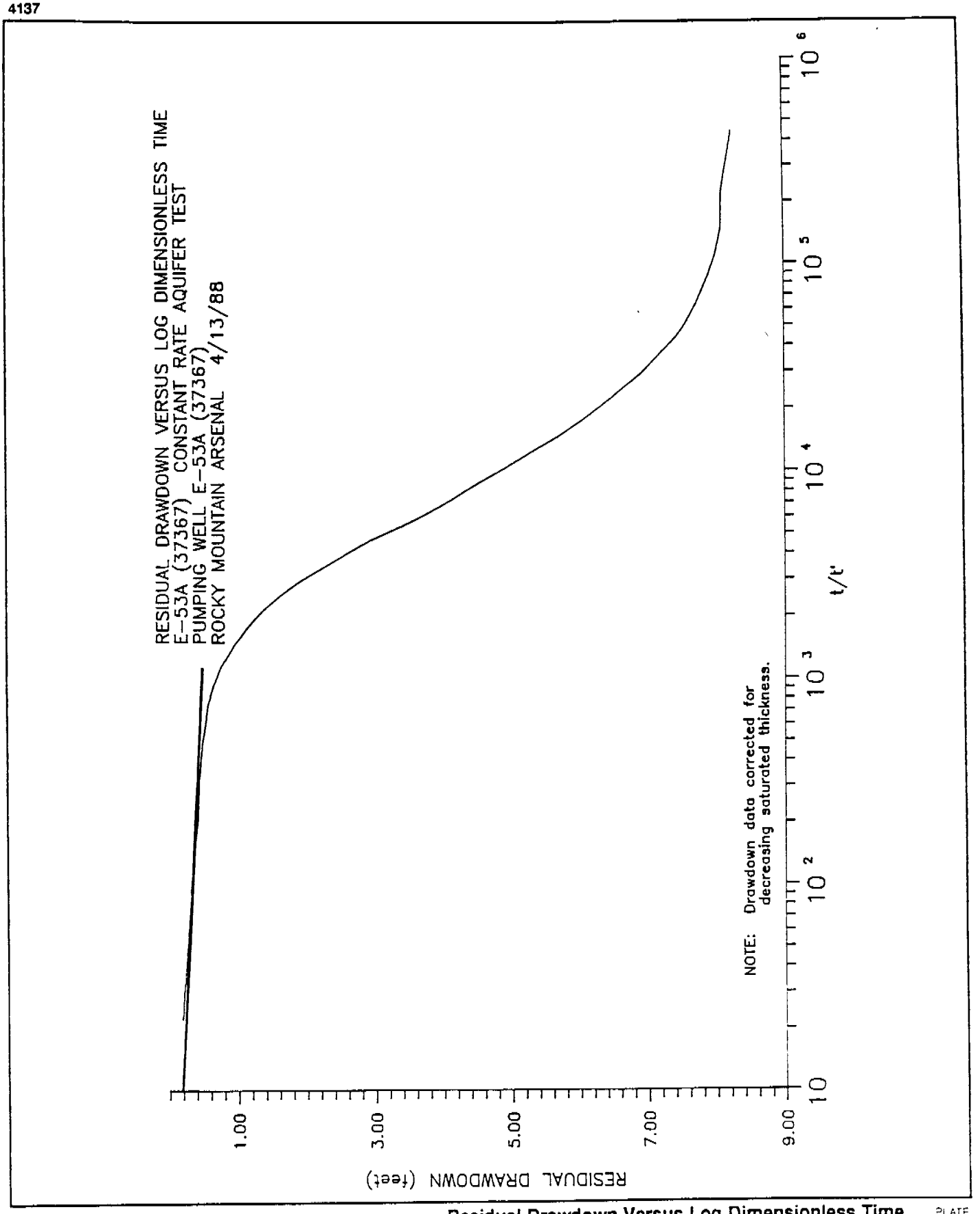


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Drawdown Versus Log Time for Well 37367
Rocky Mountain Arsenal
Adams County, Colorado

PLATE
4

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
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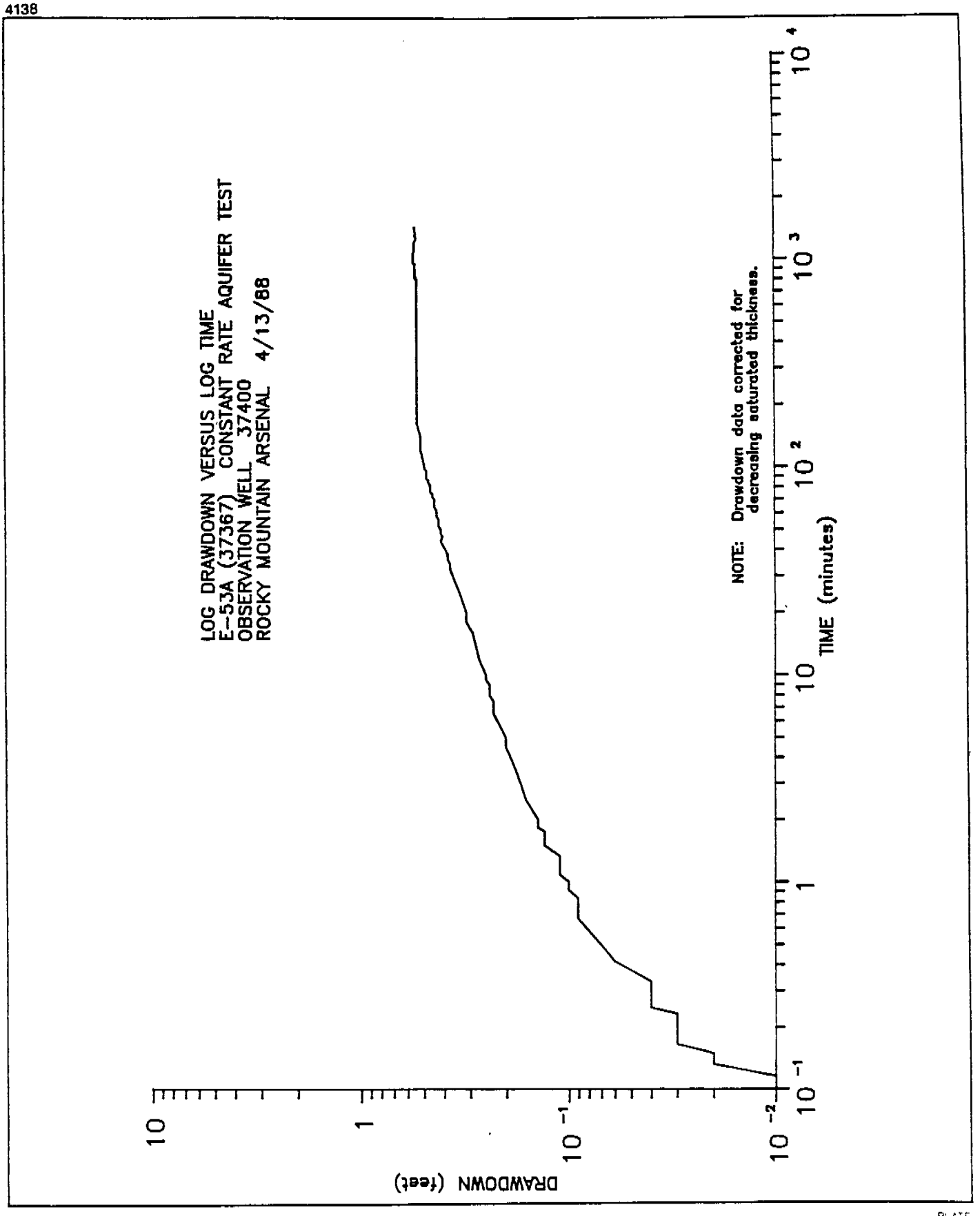


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Residual Drawdown Versus Log Dimensionless Time for Well 37367
Rocky Mountain Arsenal
Adams County, Colorado

PLATE **5**

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
MOI	17053.103.10	JMO	5/88		

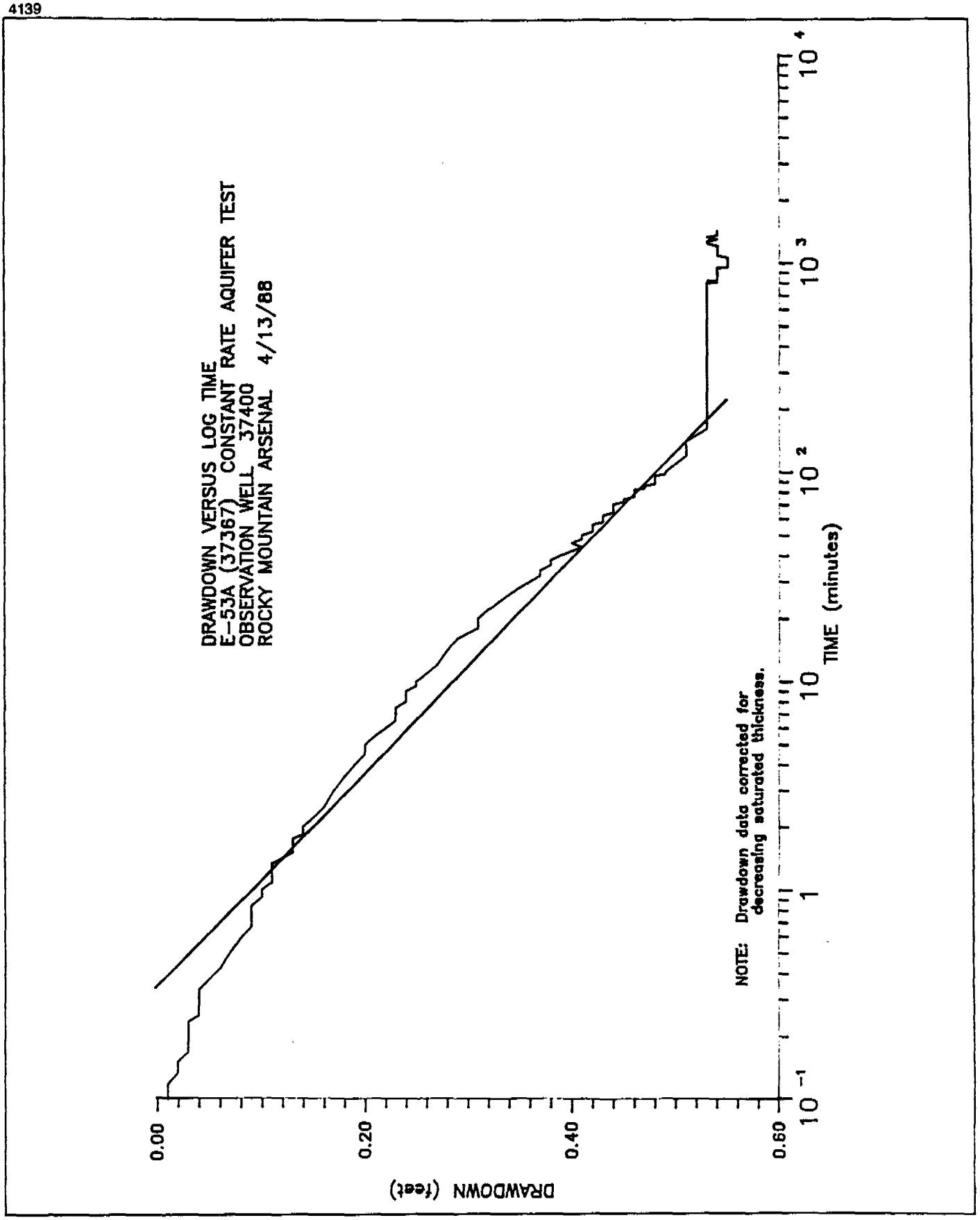


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Log Drawdown Versus Log Time for Well 37400
Rocky Mountain Arsenal
Adams County, Colorado

PLATE
6

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
MOI	17053.103.10	JMO	5/88		



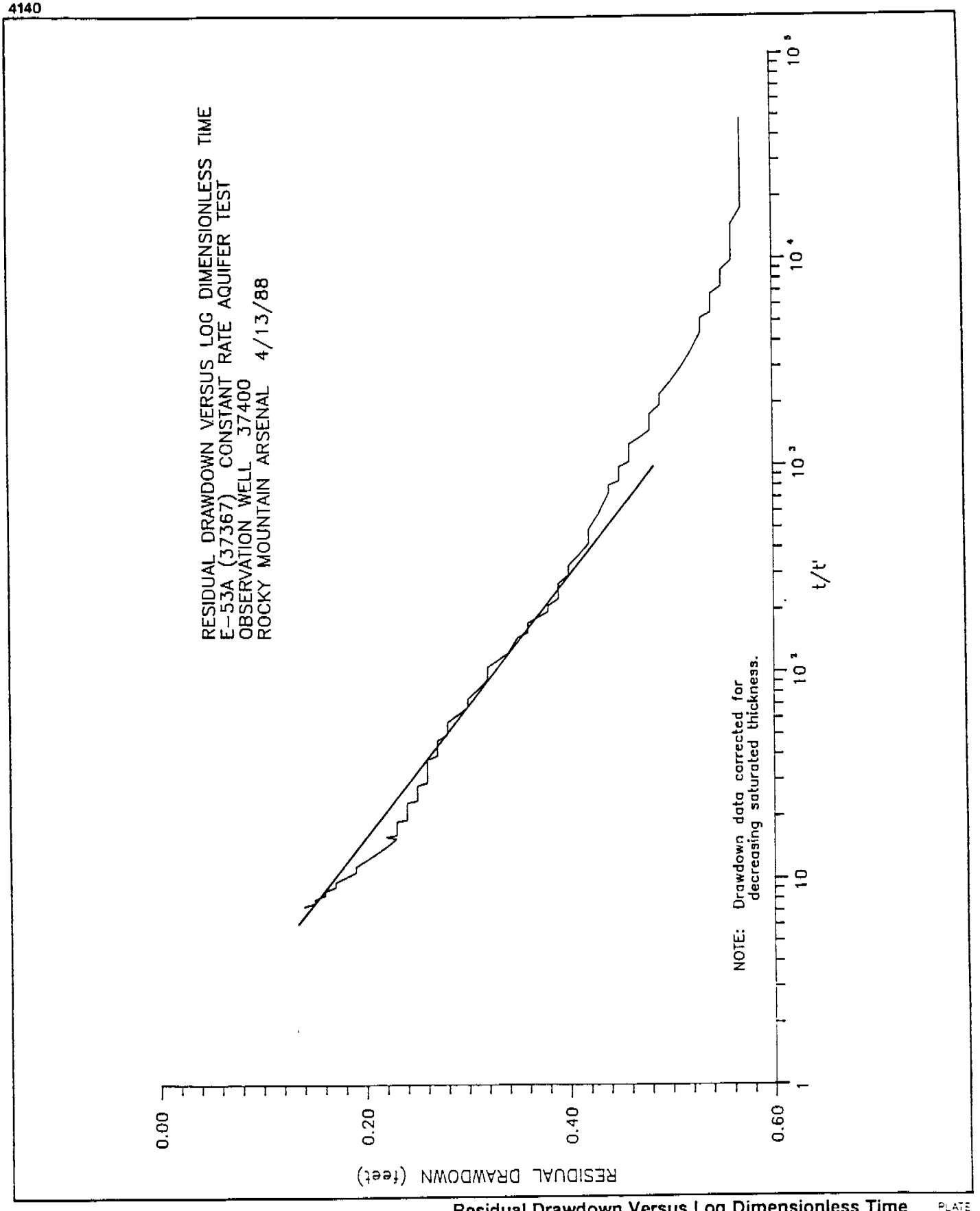
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Drawdown Versus Log Time for Well 37400
Rocky Mountain Arsenal
Adams County, Colorado

PLATE
7

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
MOI	17053,103.10		5/88		

4140

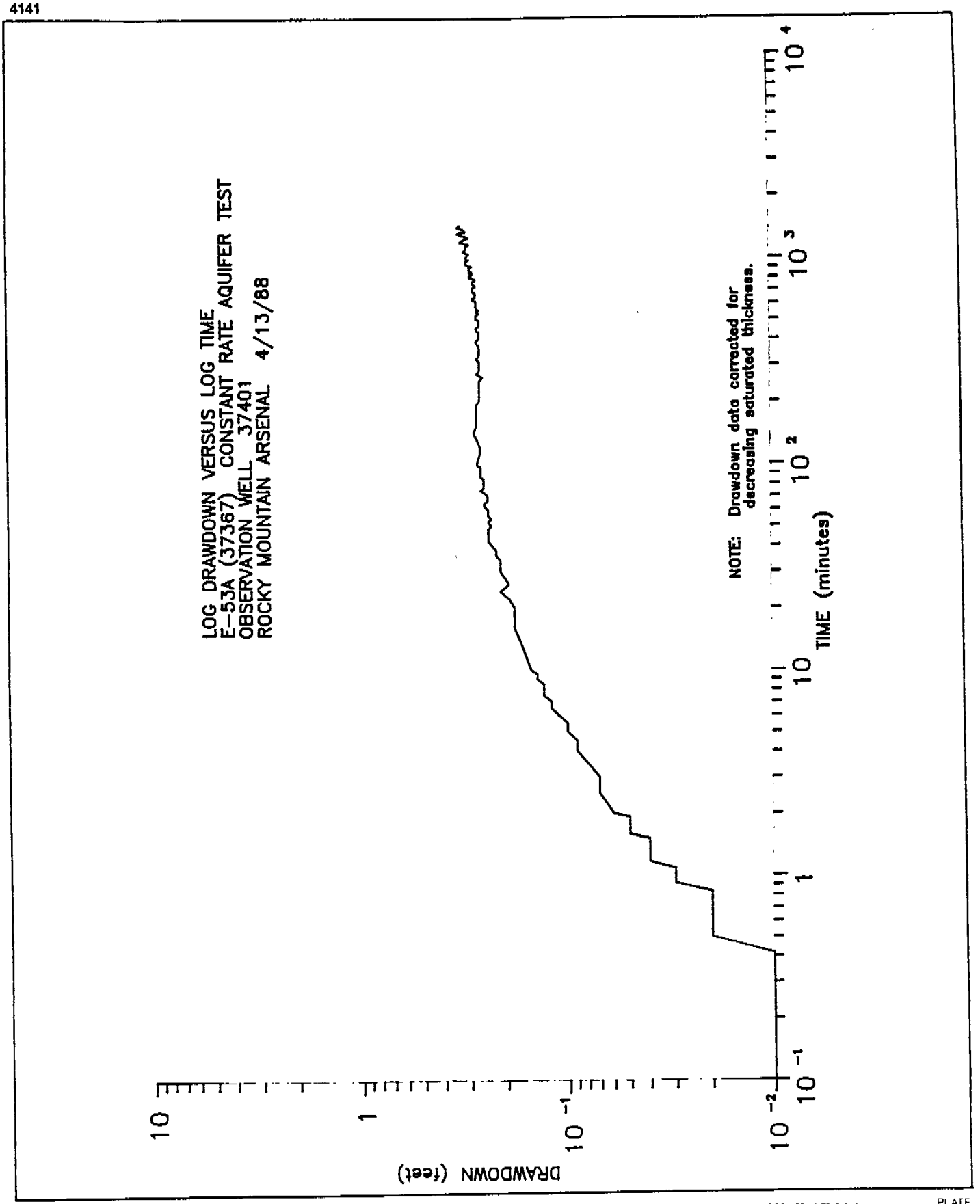


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Residual Drawdown Versus Log Dimensionless Time for Well 37400
Rocky Mountain Arsenal
Adams County, Colorado

PLATE **8**

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
MOI	17053,103.10		5/88		

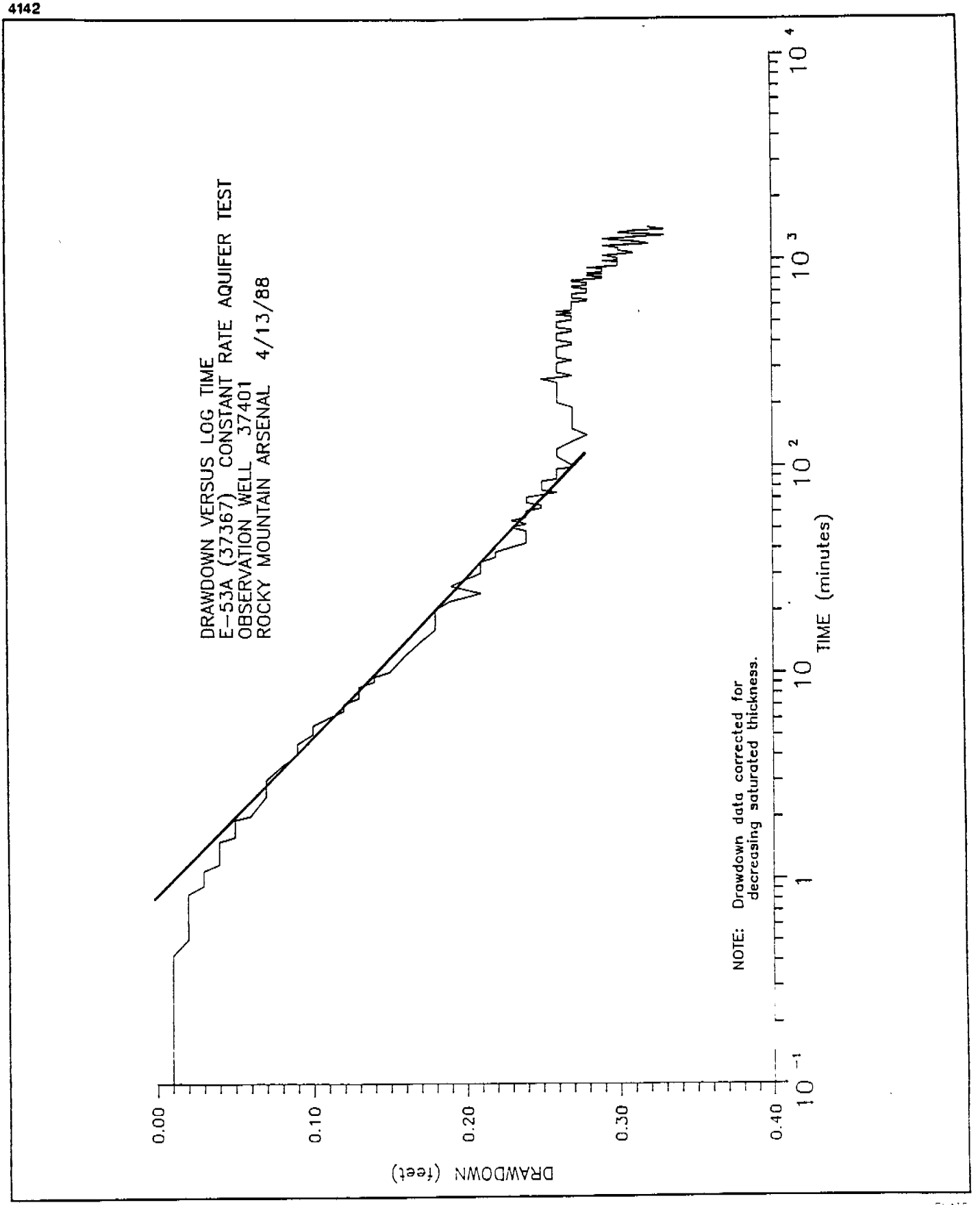


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Log Drawdown Versus Log Time for Well 37401
Rocky Mountain Arsenal
Adams County, Colorado

PLATE
9

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
MOI	17053,103.10		5/88		

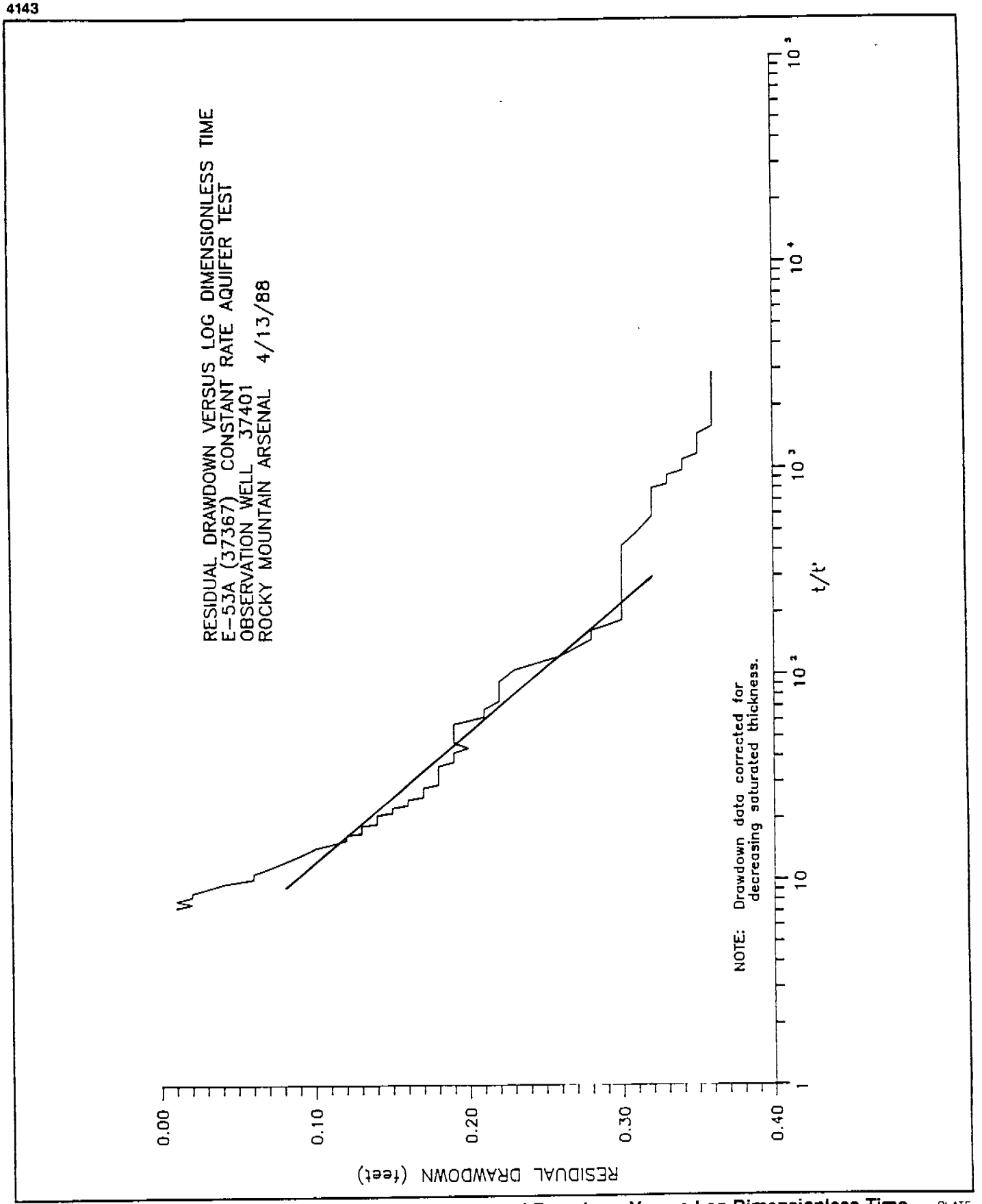


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Drawdown Versus Log Time for Well 37401
Rocky Mountain Arsenal
Adams County, Colorado

PLATE
10

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
MOI	17053,103.10		5/88		



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Residual Drawdown Versus Log Dimensionless Time for Well 337401
Rocky Mountain Arsenal
Adams County, Colorado

PLATE **11**

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
MOI	17053,103.10		5/88		

Sheet 1. Modified Non-Equilibrium Method for Well 37367

Modified Non-Equilibrium Method (Jacob, 1950)

Pumping Well 37367
Observation Well 37367
Reference Plate 4

Q	Constant Pumping Rate	32.3	gpm
Δs	Change in Drawdown per One Log Cycle	0.28	feet
b	Saturated Aquifer Thickness	19	feet

TRANSMISSIVITY (T)

$T = (264\ Q)/\ \Delta s$

$T = 30{,}000$ gpd/ft

$T = 4{,}000\ ft^2/\ day$

$T = 370\ m^2/day$

HYDRAULIC CONDUCTIVITY (K)

$K = T/b$

$K = 210$ ft/day

$K = 0.074$ cm/sec

Sheet 2. Residual Drawdown Method for Well 37367

Residual Drawdown Method (Theis, 1935)

Pumping Well 37367
Observation Well 37367
Reference Plate 5

Q	Constant Pumping Rate	32.3	gpm
Δs	Change in Drawdown per One Log Cycle	0.15	feet
b	Saturated Aquifer Thickness	19	feet

TRANSMISSIVITY (T)

$T = (264\ Q)/\ \Delta s$

$T = 57{,}000$ gpd/ft

$T = 7{,}600$ ft^2/day

$T = 710$ m^2/day

HYDRAULIC CONDUCTIVITY (K)

$K = T/b$

$K = 400$ ft/day

$K = 0.14$ cm/sec

Sheet 3. Unconfined Aquifer Type Curve Method for Well 37400

Unconfined Aquifer Type Curve Method (Prickett, 1965)

Pumping Well 37367
Observation Well 37400
Reference Plate 6

Q	Constant Pumping Rate	32.3 gpm
b	Saturated Aquifer Thickness	19 feet
r	Distance to Pumping Well	39.36 feet

Early-time type curve match point:

$1/u_A = 1.0$ $u_A = 1.0$ $W(u_A,r/D) = 1.0$ $r/D = 0.0$

s (drawdown) = 0.068 ft t (time) = 0.14 min. = 1.0×10^{-4} days

TRANSMISSIVITY (T)

$T = 114.6\ Q\ W(u_A,r/D) / s$

$T = 54{,}000$ gpd/ft

$T = 7{,}200$ ft^2/day

$T = 670$ m^2/day

HYDRAULIC CONDUCTIVITY (K)

$K = T/b$

$K = 380$ ft/day

$K = 0.13$ cm/sec

STORATIVITY (S)

$S = u_A\ Tt/1.87r^2$

$= 1.9 \times 10^{-3}$ dimensionless

Sheet 4. Modified Non-Equilibrium Method for Well 37400

Modified Non-Equilibrium Method (Jacob, 1950)

Pumping Well 37367
Observation Well 37400
Reference Plate 7

Q	Constant Pumping Rate	32.3 gpm
Δs	Change in Drawdown per One Log Cycle	0.19 feet
b	Saturated Aquifer Thickness	19 feet
t_0	Time to Zero Drawdown Intercept	0.34 min.
		1.2×10^{-4} days
r	Distance to Pumping Well	39.36 feet

TRANSMISSIVITY (T)

$T = (264\ Q)/\ \Delta s$

$T = 45{,}000$ gpd/ft

$T = 6{,}000$ ft^2/ day

$T = 560$ m^2/day

HYDRAULIC CONDUCTIVITY (K)

$K = T/b$

$K = 320$ ft/day

$K = 0.11$ cm/sec

STORATIVITY (S)

$S = 0.3\ Tt_0/r^2$

$S = 2.1 \times 10^{-3}$ dimensionless

Time (t) after which u<0.01

$t = 1.87\ r^2\ s/uT$

$t = 0.007$ days

$t = 10$ min

Sheet 5. Residual Drawdown Method for Well 37400

Residual Drawdown Method (Theis, 1935)

Pumping Well 37367
Observation Well 37400
Reference Plate 8

Q	Constant Pumping Rate	32.3	gpm
Δs	Change in Drawdown per One Log Cycle	0.16	feet
b	Saturated Aquifer Thickness	19	feet

TRANSMISSIVITY (T)

$T = (264\ Q)/\ \Delta s$

$T = 53{,}000$ gpd/ft

$T = 7{,}100$ ft^2/day

$T = 660$ m^2/day

HYDRAULIC CONDUCTIVITY (K)

$K = T/b$

$K = 370$ ft/day

$K = 0.13$ cm/sec

Sheet 6. Unconfined Aquifer Type Curve Method for Well 37401

Unconfined Aquifer Type Curve Method (Prickett, 1965)

Pumping Well 37367
Observation Well 37401
Reference Plate 9

Q	Constant Pumping Rate	32.3 gpm
b	Saturated Aquifer Thickness	18 feet
r	Distance to Pumping Well	81.33 feet

Early-time type curve match point:

$1/u_A = 1.0$ $u_A = 1.0$ $W(u_A,r/D) = 1.0$ $r/D = 2.0$

s (drawdown) = 0.078 ft t (time) = 0.7 min. = 4.9×10^{-4} days

$r/D = 0.2$

TRANSMISSIVITY (T)

$T = 114.6\ Q\ W(u_A,r/D) / s$

$T = 47{,}000$ gpd/ft

$T = 6{,}300$ ft^2/day

$T = 590$ m^2/day

HYDRAULIC CONDUCTIVITY (K)

$K = T/b$

$K = 350$ ft/day

$K = 0.12$ cm/sec

STORATIVITY (S)

$S = u_A\ Tt/1.87r^2$

$= 1.9 \times 10^{-3}$ dimensionless

Sheet 7. Modified Non-Equilibrium Method for Well 37401

Modified Non-Equilibrium Method (Jacob, 1950)

Pumping Well 37367
Observation Well 37401
Reference Plate 10

Q	Constant Pumping Rate	32.3 gpm
Δs	Change in Drawdown per One Log Cycle	0.13 feet
b	Saturated Aquifer Thickness	18 feet
t_0	Time to Zero Drawdown Intercept	0.8 min. 5.6×10^{-4} days
r	Distance to Pumping Well	81.33 feet

TRANSMISSIVITY (T)

$T = (264\ Q)/\ \Delta s$

$T = 66{,}000$ gpd/ft

$T = 8{,}800\ ft^2/\ day$

$T = 820\ m^2/day$

HYDRAULIC CONDUCTIVITY (K)

$K = T/b$

$K = 490$ ft/day

$K = 0.17$ cm/sec

STORATIVITY (S)

$S = 0.3\ Tt_0/r^2$

$S = 1.7 \times 10^{-3}$ dimensionless

Time (t) after which u<0.01

$t = 1.87\ r^2\ s/uT$

$t = 0.032$ day

$t = 46.0$ min

Sheet 8. Residual Drawdown Method for Well 37401

Residual Drawdown Method (Theis, 1935)

Pumping Well 37367
Observation Well 37401
Reference Plate 11

Q	Constant Pumping Rate	32.3	gpm
Δs	Change in Drawdown per One Log Cycle	0.16	feet
b	Saturated Aquifer Thickness	18	feet

TRANSMISSIVITY (T)

$T = (264\ Q)/\ \Delta s$

$T = 53{,}000$ gpd/ft

$T = 7{,}100$ ft^2/day

$T = 660$ m^2/day

HYDRAULIC CONDUCTIVITY (K)

$K = T/b$

$K = 390$ ft/day

$K = 0.14$ cm/sec

APPENDIX A

GEOLOGIC BORING LOGS

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
7388 SOUTH ALTON WAY • SUITE H-I
ENGLEWOOD, COLORADO 80112 • 303/741-0839

Borehole: E-53A Well Number:

Depth - Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
0						No RECOVERY
20.0		70%	E53-A	20-22'	ML	No recovery, sandy silt, 30% m-f sand, 10YR 4/4-6 dark yellowish brown, non-plastic, med-stiff, saturated Alluvium
21.0						
22.0		95%	E53-A	22-24.0'		
23.0						
24.0			E53A	24-25.0'		
25.0						

Drill Site Geologist: W. Christoph Date: 12/22/16

Reviewed By: Date:

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
7932 SOUTH ALTON WAY • SUITE H-I
ENGLEWOOD, COLORADO 80112 • 303/741-0699

Borehole: ES3A Well Number:

Depth – Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
25.0		100%	ES3A	25 – 26.5	SM	SM, Silty Sand, 20% Silt, fine grain sand, 10YR 5/4 Yellowish Brown, non-plast, Loose, Saturated Alluvium.
26.0						
26.5		110%	ES4A	26.5 – 28.0		DECREASE SAND SIZE, f. gr.
27.0						
28.0		100%	ES5A	28.0 – 29.5		
29.0						
29.5		100%	ES6A	29.5 – 31.5		
31.0						
31.5						

Drill Site Geologist: W. Cumstead Date: 12/22/26

Reviewed By: Date:

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
7392 SOUTH ALTON WAY • SUITE H-I
ENGLEWOOD, COLORADO 80112 • 303/741-0839

Borehole: E53A Well Number:

Depth – Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
31.0		100%	E53A	31 – 32.5	SM	INCREASE grain size to COARSE Increase grain size to coarse
31.5						
32.0						
32.5		100%	E53M	32.5 – 33.5		DECREASE GRAIN SIZE to fine-med grain, color change to 10YR 4/4-6 dark yellowish brn.
33.0						
33.5		50% 1.5'	E53A	33.5 → 35.0		
34.0						
35.0		1.5	E53M	35.0 → 36.5		INCREASE GRAIN SIZE to COARSE grain
36.0						
36.5		1.5	E53A	36.5 → 38.0		COARSE SAND w/ 10% GRAVEL SP PRG 8/28
37.0						

Drill Site Geologist: W. Ginestead Date: 12/20/88

Reviewed By: Date:

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
7339 SOUTH ALTON WAY • SUITE H-I
ENGLEWOOD, COLORADO 80112 • 303/741-0839

Borehole: ESSA Well Number:

Depth – Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
37.0					SM	
38.0		1.5	ESSA	38 - 39.5		
39.0						
39.5						END of Boring

Drill Site Geologist: M. Gruttadauria Date: 12/22/86

Reviewed By: Date:

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
7332 SOUTH ALTON WAY • SUITE H-1
ENGLEWOOD, COLORADO 80112 • 303/741-0839

SHEET 1 OF 4

Borehole: E-53 Well Number: OB-1 37406

Depth-Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
0	0	2/2		0	SM	Silty sand, fine grained, 45% silt, 5YR 4/4 dark yellow brown, dry, low plastic med stiff
1	↓		1	↓		
2	2			2		
2	2	2/2	2	2	SC	Clayey sand fine to medium 25% clay 10YR 4/4 dark yellowish brown, med stiff moist med plas
3	↓			↓		
4	4			4		
4	4	2/2	3	4	SM	Silty sand, fine to medium grained 30% silt 10YR 5/3 brown, non cohesive, dry
5	↓			↓		
6	6			6		
6	6	2/2	4	6	SC	Clayey sand, fine to medium grain, 30% clay 10YR 6/4 light yellowish brown, med stiff moist med plastic
7	↓			↓		
8	8			8		
8						at 8' changes to fine to coarse
9	9	2/2	5	8		
10	↓			↓		
10	10			10		at 10' very calcareous

Drill Site Geologist: ~~Dave Wood~~ / Installed / Logged) Date: 4/13/88

Reviewed By: [signature] Date: 4/20/88

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
7332 SOUTH ALTON WAY • SUITE H-I
ENGLEWOOD, COLORADO 80112 • 303/741-0636

Borehole: E-53 Well Number: OB-1 37400

Depth-Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
10	16 ↓ 18	.7/2	6	10 ↓ 12	SC	Same as above
12	12 ↓ 14	2/2	7	12 ↓ 14	SM	Silty sand fine to medium, 15% silt 10YR 5/6 yellowish brown, slightly moist low plastic med stiff
14	14 ↓ 16	2/2	8	14 ↓ 16	SC	Clayey sand, fine to medium 25% clay 10YR 5/6 yellowish brown, slightly moist med stiff, low plastic, calc nod's
						at 16' clay content increases to 35% grain size increases to fine to coarse
18	16 ↓ 18	2/2	9	16 ↓ 18		at 18' clay increases to 45%
20	18 ↓ 20	2/2	10	18 ↓ 20		

Dave West - Installer

Drill Site Geologist: [illegible] Logged Date: 4-15-88

Reviewed By: [signature] Date: 4/20/88

ESE ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
7332 SOUTH ALTON WAY • SUITE H-1
ENGLEWOOD, COLORADO 80112 • 303/741-0639

Borehole: E-53 Well Number: OB-1 37400

Depth-Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
20	20	.5/2	11	20	SC	Same as above, saturated at 20'
22	22	0/2	N/A	22		no recovery from 22 to 25-5
24	24	.5/2	12	24		
25.5					SM	Silty sand, fine to very coarse, 5% gravel & 20% silt, 10YR6/4 light yellow brown, saturated, non plastic, med dense
26	26	1	13	26		
28	28	1/1	14	28		
29	29	1/1	15	29		
30	30			30		

Drill Site Geologist: [signature] Date: 4/13/89

Reviewed By: [signature] Date: 4/20/89

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ENGLEWOOD, COLORADO 80112 • 303/741-0639

Borehole: E-53 Well Number: OB-1 37400

Depth-Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
30	30	.5/2	16	30	SM	Same as above
	32			32		
32	32	.5/2	17	32		
	34			34		
34	34	.5/2	18	34		
	36			36		gravel increases to 10% at 36'
	36	0/2	1'F	36		no recovery 36'→38'
	38			38	GP	Poorly graded gravel small to large (2.5") 30% sand fine to very coarse 10YR 5/4 yellowish brown saturated
	40					Claystone bedrock mottled, very weathered Soft claystone clasts in soft clay matrix Olive with blue-gray clasts

Drill Site Geologist: [signature] Date: 4-15-95

Reviewed By: [signature] Date: 4/20/88

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ENGLEWOOD, COLORADO 80112 • 303/741-0839

SHEET 1 OF 4

Borehole: E-53-448B-2 Well Number: 37401

Depth-Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
0					SC	SAND, 40% clay, fine to medium grained sand, 10YR 4/4, dark yellowish brown, moist, low plastic, med stiff.
1	① 0 - 2.0'	2.0/2.0	1	0-2.0'		
2						
3	② 2.0' - 4.0'	1.1/2.0	2		SM	SAND, 25% silt, fine to medium grained sand, 10YR 6/4, light yellowish brown, med stiff, light moist, v. low plastic
4						
5		0/2.0				
6	NR					
7	③ 4.0' - 8.0'	.5/2.0	3			
8						
9	④ 8.0' - 12.0'	2.0/2.0	4		SC	SAND, 20% clay, fine to medium grained sand 10YR 5/4 yellowish brown, stiff, moist, medium plastic
10	SS					

Drill Site Geologist: Dave West logged by Hansford Date: 4/15/88

Reviewed By: [signature] Date: 4-20-88

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Borehole: E-5308-2 Well Number: 37401

Depth-Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
11	(5) 8.0' to 12.0'	1.4/2.0			SC	SAND, 20% clay, fine to medium grained, 10YR 5/4 yellowish brown, stiff, moist, medium plastic
12						No Recovery 12-15'
13		0/2.0				
14						
15	(6) 12.0' - 16.0'	0.8/2.0	#5	Same as sample interval	SC	SAND, 40% clay, fine to coarse grained sand, 10YR 7/3 very pale brown, stiff, moist, medium plastic, calc.
16						
17	(7)	2.0/2.0				at 16.5' SAND, 25% clay, fine to coarse grained sand, 10YR 5/4 yellowish brown, v. tuffy moist, medium plastic, calc
18						
19	(8) 16.0' - 20.0'	2.0/2.0				
20						20'

Drill Site Geologist: Dave West logged by Steve Pace Date: 4/15/88

Reviewed By: [signature] Date: 4-20-88

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Borehole: E-53-082 Well Number: 37401

Depth-Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
20						No Recovery 20-21
21	⑨ 20.0' - 24.0'	1.1/2.0	Same as Tube 9 Sample Number	Same as Tube 9 Interval	SP	SAND, 3% silt, fine to coarse grained, 10YR 5/4 yellowish brown, loose, saturated, non plastic
22						
23	⑩	2.0/2.0			SM	SAND, 10% silt, fine to medium grained sand 10YR 5/4 yellowish brown, loose, saturated, non-plastic
24					SC	SAND, 20% clay, fine to v. coarse sand, occ. small gravel, 10YR 6/4 light yellowish brown, med dense, v. moist, low plastic
25	⑪ 24.0' - 28.0'	0/2.0				No Recovery 24-26'
26					SP	SAND, 3% silt, fine to very coarse grained, 5% small gravels, 10YR 6/4, light yellowish brown, med dense, saturated, non plastic
27		0/2.0				
28						No Recovery 28-33.5'
29	28.0' - 32.0'	0.0/2.0				
30						

Drill Site Geologist: Dave West logged by Mark Paul Date: 4/15/88

Reviewed By: [signature] Date: 4-20-88

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Borehole: E-53-08-2 Well Number: 37401

Depth-Feet	Tube Number Tube Interval	Recovery	Sample Number	Sample Interval	Unified Soil Classification	SOILS LOG Description
30						No Recovery 28-33.5'
31	28.0' - 32.0'	0/2.0				
32						
33	32.0' - 34.0'	0.4/2.0			GC	Gravel, 5% Clay, small to medium (1") gravel, 10YR 5/3, brown dense, saturated
34					SP	SAND, 5% silt, fine to very coarse grained sand, 5% gravel, small to medium gravel (2"), 10YR 5/3, brown dense, saturated
35	34.0 - 36.0	1.2/2.0	SP # Same as tube interval	Same as tube interval SP		
36						
37						
38	36.0' - 40.0'	0/4.0				
39						
40						Claystone bedrock, 5YR 5/3 olive, weathered Fe stains
42	40.0' - 42.0'	1.1/2.0				TOTAL DEPTH 42'

Drill Site Geologist: Dave West logged by [signature] Date: 4/15/88

Reviewed By: [signature] Date: 4-21-88

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VOLUME III
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PROGRAM MANAGER
RMA CONTAMINATION CLEANUP

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— COMMITTED TO PROTECTION OF THE ENVIRONMENT —

Commerce City, Colorado

Offpost Operable Unit
Remedial Investigation and Chemical
Specific Applicable or Relevant and
Appropriate Requirements
Final Report
(Version 3.1)
Volume III

Rocky Mountain Arsenal
Information Center
Commerce City, Colorado

Environmental Science And Engineering, Inc.
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Rocky Mountain Arsenal

Rocky Mountain Arsenal Information Center Commerce City, Colorado

Offpost Operable Unit
Remedial Investigation and Chemical Specific Applicable or Relevant and Appropriate Requirements
Final Report
(Version 3.1)
Volume III

December 1988

Contract Number DAAK11-84-D-0016
Task Number 39

Prepared by

ENVIRONMENTAL SCIENCE AND ENGINEERING, INC.
HARDING LAWSON AND ASSOCIATES

Prepared for

U.S. ARMY PROGRAM MANAGER'S OFFICE FOR ROCKY MOUNTAIN ARSENAL

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TABLE OF CONTENTS

Section		Page
VOLUME I		
	EXECUTIVE SUMMARY	
1.0	**INTRODUCTION**	1-1
1.1	CONDITIONS IN THE OFFPOST OPERABLE UNIT	1-5
1.2	ONGOING RESPONSE ACTIONS	1-7
1.2.1	NORTH BOUNDARY: CONTAINMENT/TREATMENT	1-7
1.2.2	NORTHWEST BOUNDARY: CONTAINMENT/TREATMENT	1-8
1.2.3	IRONDALE: CONTAINMENT/TREATMENT	1-8
1.3	SUMMARY OF TECHNICAL APPROACH	1-9
2.0	**DATA COLLECTION AND ANALYSES**	2-1
2.1	GROUND-WATER MONITORING PROGRAM	2-2
2.1.1	MONITORING NETWORK AND RATIONALE	2-3
2.1.1.1	Alluvial Aquifer Monitoring Network	2-5
2.1.1.2	Denver Fm Monitoring Network	2-11
2.1.2	GROUND-WATER MONITORING	2-15
2.1.2.1	Water Level Monitoring	2-15
2.1.2.2	Water Quality Monitoring	2-19
2.1.3	ANALYTICAL PROGRAM	2-19
2.1.4	AQUIFER TESTS	2-23
2.1.4.1	Pumping Tests	2-23
2.1.4.2	Slug Tests	2-25
2.2	SURFACE WATER MONITORING	2-26
2.2.1	ACCURACY OF RESULTS	2-31
2.3	SEDIMENT SAMPLING AND ANALYSIS	2-32
2.3.1	SITE LOCATIONS	2-32
2.3.2	FIELD SAMPLING METHODOLOGY	2-34
2.3.3	ANALYTICAL METHODS	2-35
2.4	AIR MONITORING	2-35
2.4.1	OFFPOST AIR MONITORING	2-36
2.4.2	ONPOST AIR MONITORING	2-36
2.5	BIOTA	2-39
2.5.1	METHODS OF INVESTIGATION	2-41
3.0	**GROUND-WATER CONDITIONS**	3-1
3.1	GEOLOGY	3-1
3.1.1	CHARACTERIZATION OF ALLUVIUM	3-1
3.1.1.1	Characterization of the Alluvium in the Offpost Operable Unit	3-2
3.1.2	BEDROCK SURFACE	3-8
3.1.3	CHARACTERIZATION OF THE DENVER FM	3-13
3.1.3.1	Depositional Environment	3-13
3.1.3.2	Stratigraphic Correlation within the Denver Fm	3-16
3.1.3.3	Characterization and Definition of the Denver Fm	3-17

TABLE OF CONTENTS

Section			Page
	3.1.4	CHARACTERIZATION OF ARAPAHOE FM	3-31
3.2	HYDROGEOLOGY		3-32
	3.2.1	ALLUVIAL AQUIFER	3-33
		3.2.1.1 Water Table	3-34
		3.2.1.2 Saturated Alluvial Thickness	3-43
		3.2.1.3 Aquifer Parameters	3-45
		3.2.1.4 Ground-Water Flow Directions and Qualities	3-50
		3.2.1.5 Stresses to the Alluvial Aquifer System	3-53
	3.2.2	DENVER FM	3-56
		3.2.2.1 Aquifer Recharge	3-58
		3.2.2.2 Denver Fm Zones	3-58
		3.2.2.3 Potentiometric Surface	3-59
		3.2.2.4 Hydraulic Conductivity and Transmissivity	3-64
		3.2.2.5 Discharge	3-69
		3.2.2.6 Aquifer Interactions	3-69
	3.2.3	ARAPAHOE FM	3-72
3.3	GROUND-WATER CONTAMINATION		3-74
	3.3.1	NATURE AND EXTENT OF ALLUVIAL AQUIFER CONTAMINATION	3-75
		3.3.1.1 Data Presentation	3-79
		3.3.1.2 DIMP	3-87
		3.3.1.3 DBCP	3-88
		3.3.1.4 DCPD	3-89
		3.3.1.5 Organosulfur Compounds	3-89
		3.3.1.6 1,4-Oxathiane and 1,4-Dithiane	3-91
		3.3.1.7 Organochlorine Pesticides	3-91
		3.3.1.8 Volatile Organohalogens	3-93
		3.3.1.9 Volatile Aromatics	3-97
		3.3.1.10 Inorganics	3-97
	3.3.2	NATURE AND EXTENT OF DENVER AQUIFER CONTAMINATION	3-104
		3.3.2.1 Data Presentation	3-105
		3.3.2.2 Contamination in Units Identified at NBCS	3-111
		3.3.2.3 Contamination Units Not Correlated to NBCS	3-120
	3.3.3	QA/QC DATA	3-124
		3.3.3.1 DIMP, DBCP, DCPD	3-125
		3.3.3.2 1,4-Oxathiane, 1,4-Dithiane, CPMS, CPMSO, CPMSO2	3-134
		3.3.3.3 Organochlorine Pesticides	3-134
		3.3.3.4 Volatile Organohalogens	3-134
		3.3.3.5 Volatile Aromatics	3-135
		3.3.3.6 Inorganics	3-135
		3.3.3.7 Additional Inorganics	3-135
	3.3.4	GAS CHROMATOGRAPHY/MASS SPECTOMETRY RESULTS	3-135
		3.3.4.1 Well Selection	3-136
		3.3.4.2 GC/MS Analytical Methods	3-139
		3.3.4.3 Quality Assurance/Quality Control	3-139
		3.3.4.4 Confirmation of Target Analytes and Concentrations	3-142
		3.3.4.5 Nontarget Compound Analytical Results	3-143
		3.3.4.6 Nontarget Compound Occurrence	3-145
		3.3.4.7 Conclusions	3-148
		3.3.4.8 Recommendations	3-149

TABLE OF CONTENTS

Section		Page
3.4	EVALUATION OF GROUND-WATER DATA	3-150
3.4.1	ALLUVIAL CONTAMINATION NORTH OF RMA NORTH BOUNDARY	3-151
3.4.1.1	Effects of the NBCS	3-159
3.4.1.2	Effects of Surface Water Recharge	3-180
3.4.2	DENVER CONTAMINATION NORTH OF RMA NORTH BOUNDARY	3-182
3.4.3	ALLUVIAL CONTAMINATION DOWNGRADIENT OF RMA NORTHWEST BOUNDARY	3-190
3.5	CONTAMINANT TRANSPORT MODELING	3-191
3.5.1	COMPUTER PROGRAM	3-192
3.5.2	MODEL INPUT DATA	3-192
3.5.2.1	Boundary Conditions	3-193
3.5.2.2	Irrigation Recharge, Canal Leakage and Other Recharge/Discharge	3-193
3.5.2.3	Aquifer Thickness	3-194
3.5.2.4	Porosity and Storage Coefficient	3-194
3.5.2.5	Transmissivity	3-195
3.5.2.6	Dispersivity	3-195
3.5.2.7	Chemical Character	3-195
3.5.2.8	Mass Balance	3-196
3.5.3	MODEL CALIBRATION	3-196
3.5.4	MODEL SIMULATIONS	3-197
3.5.4.1	DIMP	3-198
3.5.4.2	Dieldrin	3-199
3.5.4.3	Chloroform and DCPD	3-199
3.5.5	CONCLUSIONS	3-200
4.0	**SURFACE WATER CONDITIONS**	4-1
4.1	DESCRIPTION OF SURFACE DRAINAGES	4-1
4.2	NATURE AND EXTENT OF CONTAMINATION	4-4
4.2.1	ORGANICS	4-4
4.2.2	INORGANICS	4-11
4.3	CONTAMINANT PATHWAYS TO OFFPOST SURFACE WATER	4-13
4.3.1	FIRST CREEK	4-13
4.3.1.1	First Creek Flows From Onpost	4-14
4.3.1.2	Ground Water Discharge to First Creek Offpost	4-18
4.3.2	O'BRIAN CANAL AND BURLINGTON DITCH	4-28
4.3.3	OVERLAND FLOODING	4-31
4.4	CONCLUSION	4-32
5.0	**OFFPOST SEDIMENT CONDITIONS**	5-1
5.1	NATURE AND EXTENT OF CONTAMINATION	5-2
5.1.1	ANALYTICAL SCHEDULE	5-2
5.1.2	RESULTS OF PREVIOUS SEDIMENT STUDY	5-4
5.1.3	RESULTS OF PRESENT SEDIMENT STUDY	5-10
5.2	SEDIMENT CONTAMINATION PATHWAYS	5-12
5.3	CONCLUSIONS	5-13

TABLE OF CONTENTS

Section		Page
6.0	**AIR QUALITY CONDITIONS**	6-1
6.1	CRITERIA AIRBORNE POLLUTANTS	6-1
6.2	TOXIC AIRBORNE POLLUTANTS	6-3
6.3	CONCLUSIONS	6-10
7.0	**BIOTA CONDITIONS**	7-1
7.1	RESULTS OF HOME RANGE STUDIES	7-1
7.1.1	RING-NECKED PHEASANTS	7-1
7.1.2	DESERT COTTON TAIL RABBITS	7-5
7.2	DISCUSSION OF HOME RANGE STUDY	7-5
7.3	EVALUATION OF BIOTA CONTAMINANT PATHWAYS	7-12
8.0	**POTENTIAL CHEMICAL-SPECIFIC ARARS**	8-1
9.0	**CONCLUSIONS**	9-1
9.1	GROUND WATER	9-1
9.2	SURFACE WATER AND SEDIMENTS	9-4
9.3	AIR	9-6
9.4	BIOTA	9-6
10.0	**REFERENCES**	10-1
11.0	**ACRONYMS AND ABBREVIATIONS**	11-1

VOLUME II

APPENDICES

APPENDIX A -- WELL DESIGNATION CRITERIA

APPENDIX B -- WELL COMPLETION SUMMARIES, LITHOLOGIC LOGS, AND GEOPHYSICAL LOGS

APPENDIX C -- WELL LOCATIONS, COMPLETION DATA AND SITE CONDITIONS, AND SITING RATIONAL

C.1 ALLUVIAL WELLS
C.2 DENVER WELLS

APPENDIX D -- SLUG TESTS: COOPER TYPE CURVES AND DATA CURVES, AND AQUIFER TEST ANALYSES

D.1 SLUG TESTS: COOPER TYPE CURVES AND DATA CURVES
D.2 WELL 37367 AQUIFER TEST ANALYSES

TABLE OF CONTENTS

Section — Page

VOLUME_III

APPENDIX E -- GEOLOGIC AND HYDROLOGIC PRODUCTS

APPENDIX F -- CONTAMINANT DISTRIBUTION MAPS, CONTAMINANT POINT PLOTS, AND WATER QUALITY DATA

F.1 CONTAMINANT DISTRIBUTION AND POINT PLOT MAPS
F.2 WATER QUALITY DATA
F.3 GC/MS ANALYTICAL RESULTS

APPENDIX G -- CONTAMINANT TRANSPORT MODEL RESULTS

APPENDIX H -- POTENTIAL CHEMICAL-SPECIFIC ARARS FOR OFFPOST OPERABLE UNIT ROCKY MOUNTAIN ARSENAL

APPENDIX I -- CONTAMINANT DISTRIBUTION PLOTS FROM OFFPOST CONTAMINATION ASSESSMENT REPORT

APPENDIX J -- COMMENTS AND RESPONSES TO THE OFFPOST OPERABLE UNIT REMEDIAL INVESTIGATION AND CHEMICAL SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS, DRAFT FINAL REPORT (VERSION 2.1), AUGUST 1988

LIST OF FIGURES

Figure		Page
1.0-1	Location Map of Rocky Mountain Arsenal	1-2
1.0-2	Offpost Operable Unit	1-3
2.1-1	Location Map of Alluvial Wells in the Offpost Operable Unit	2-6
2.1-2	New Alluvial Sites	2-7
2.1-3	Generalized Alluvial Aquifer Monitor Well Construction	2-8
2.1-4	Location Map of Denver Wells in the Offpost Operable Unit	2-12
2.1-5	New Denver Sites	2-13
2.1-6	Generalized Bedrock Aquifer Monitor Well Construction (First Sandstone)	2-16
2.1-7	Generalized Bedrock Aquifer Monitor Well Construction (Second Sandstone)	2-17
2.1-8	Idealized Diagram of Slug-in Aquifer	2-27
2.2-1	Locations for Surface Water Sampling in the Offpost Operable Unit	2-29
2.2-2	Offpost Operable Unit Surface Water Gaging Station Locations	2-30
2.3-1	Locations for Sediment Sampling in Offpost Operable Unit	2-33
3.1-1	Geologic Map of Rocky Mountain Arsenal Area	3-3
3.1-2	Quarternary Columnar Section	3-4
3.1-3	Unified Soil Classification (ASTM D-2487)	3-5
3.1-4	Generalized East-West Alluvial Cross-Section from the South Platte River to the Northeast Corner of Rocky Mountain Arsenal	3-6
3.1-5	East-West Geologic Cross-Section NB Downgradient 30.6	3-9
3.1-6	Southwest-Northeast Geologic Cross-Section NWB Downgradient 3.5	3-10
3.1-7	Bedrock Surface Elevation Map in the Offpost Operable Unit Near the Rocky Mountain Arsenal Boundaries	3-12
3.1-8	Schematic Diagrams Depicting Denver Fm Depositional Environments	3-15

LIST OF FIGURES

Figure		Page
3.1-9	Location of Geologic Cross Sections in the Vicinity of the Offpost Operable Unit	3-18
3.1-10	Southwest-Northeast Geologic Cross Section NWB Upgradient 7.8	3-20
3.1-11	Southeast-Northwest Geologic Cross Section NWB 0.0	3-21
3.1-12	Subcrop Map of Denver Fm Zones	3-23
3.1-13	East-West Geologic Cross Section NB Slurry Wall	3-26
3.1-14	North-South Geologic Cross Section NB 0.0	3-27
3.1-15	Subcrop Map of Denver Fm Sandstone Units in the Offpost Area Downgradient of the NBCS	3-30
3.2-1	Water Table Elevation Map in the Offpost Operable Unit Near the RMA Boundaries (Spring, 1987)	3-35
3.2-2	Historical Hydrograph for Well 37309	3-38
3.2-3	Historical Hydrograph for Well 37335	3-39
3.2-4	Seasonal Hydrograph for Wells 37308 and 37309	3-41
3.2-5	1986 Seasonal Hydrograph for Well 37335	3-42
3.2-6	Saturated Thickness Map for the Alluvial Aquifer in the Offpost Operable Unit Near the Rocky Mountain Arsenal Boundaries (Summer, 1987)	3-44
3.2-7	Location of Alluvial Aquifer Tests	3-46
3.2-8	Potentiometric Surface Map of Denver Fm Zone 2 (Spring 1987)	3-61
3.2-9	Potentiometric Surface Map of Denver Fm Zone 3 (Spring 1987)	3-62
3.2-10	Potentiometric Surface Map of Denver Fm Zone 4 (Spring 1987)	3-63
3.2-11	Location of Denver Fm Aquifer Tests	3-65
3.3-1	DIMP Assessment in Alluvial Wells for Consumptive Use--Phase I and II and Revision III-360° Programs	3-76

LIST OF FIGURES

Figure		Page
3.3-2	Generalized Pre-system Alluvial Flow Pathways (February-March, 1978 water table)	3-86a
3.3-3	Water Chemistry Data for Denver Fm Unit NBW#1A, Summer Quarter, 1987	3-107
3.3-4	Water Chemistry Data for Denver Fm Unit NBW#1, Spring and Summer Quarters, 1987	3-108
3.3-5	Water Chemistry Data for Denver Fm Unit NBW#2, Summer Quarter, 1987	3-109
3.3-6	Water Chemistry Data for Offpost Denver Fm Wells Not Correlated to Sandstone Units Identified at NBCS	3-110
3.3-7	Location of Offpost Wells Sampled for GC/MS Analyses	3-138
3.4-1	Scatter Diagram Comparing Organic Carbon Concentrations Versus Medium Grain Size	3-158
3.4-2	Historical DIMP Concentrations for Well 37307	3-165
3.4-3	Historical DCPD Concentrations for Well 37307	3-166
3.4-4	Historical DIMP Concentrations for Well 37308	3-168
3.4-5	Historical DCPD Concentrations for Well 37308	3-169
3.4-6	Historical Dieldrin Concentrations for Well 37308	3-170
3.4-7	Historical DIMP Concentrations for Well 37309	3-172
3.4-8	Historical DCPD Concentrations for Well 37309	3-173
3.4-9	Historical DBCP Concentrations for Well 37309	3-174
3.4-10	Historical DIMP Concentrations for Well 37312	3-175
3.4-11	Historical DCPD Concentrations for Well 37312	3-177
3.4-12	Historical Dieldrin Concentrations for Well 37312	3-178
3.4-13	Historical DIMP Concentrations for Well 37313	3-179
4.1-1	Locations of Offpost Surface Water Sampling Locations	4-2
4.2-1	Organic Contaminants Observed in Multiple Samples at Offpost Surface Water Stations	4-8
4.2-2	Relationship Between First Creek Discharges and DIMP Concentrations	4-10

LIST OF FIGURES

Figure		Page
4.3-1	First Creek Water Quality Stations Onpost	4-16
4.3-2	Zones of Potential Ground-Water Discharge to First Creek Onpost	4-17
4.3-3	DIMP Concentration Distribution, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	4-19
4.3-4	Monthly Discharge Values at First Creek Gaging Stations	4-22
4.3-5	Change In First Creek Flows Offpost Versus Discharge at Highway 2 Station	4-24
4.3-6	Flow Frequency Histogram For First Creek at Highway 2 Station (July 1986 through August 1987)	4-25
4.3-7	Estimated Ground-Water Elevations Along First Creek from the RMA North Boundary to Highway 2	4-27
4.3-8	Estimated Ground-Water Elevations Versus Stream Bed Elevations for O'Brian Canal and Burlington Ditch	4-30
4.3-9	Surface Water Drainage Basins at RMA and in Offpost Operable Unit	4-33
5.1-1	Contaminant Volatility Versus Sorption	5-3
5.1-2	Offpost Sediment Sampling Locations (April 1986)	5-8
7.1-1	Home Ranges of Ring-necked Pheasants	7-4
7.1-2	Home Ranges of Cottontail Rabbits	7-10
7.2-1	Preliminary Vegetation Map of Rocky Mountain Arsenal	7-13
E-1	East-West Geologic Cross-Section NB Downgradient 59.0 (104th Avenue)	
E-2	Bedrock Elevation Map	
E-3	Net Sand Isopach Contour Map of Regional Denver Formation Zone 2	
E-4	Net Sand Isopach Contour Map of Regional Denver Formation Zone 3	
E-5	Net Sand Isopach Contour Map of Regional Denver Formation Zone 4	
E-6	Isopach Map of the NBW#1A and NBE#1 Sandstone Units	

LIST OF FIGURES

Figure		Page
E-7	Isopach Map of the NBW#1 Sandstone Unit	
E-8	Isopach Map of the NBW#2 Sandstone Unit	
E-9	Isopach Map of the NBW#3 Sandstone Unit	
E-10	Water Table Elevation Map, Spring 1987	
E-11	Water Table Elevation Map, Summer 1987	
E-12	Historical Hydrograph for Well 37308	
E-13	Historical Hydrograph for Well 37334	
E-14	Saturated Thickness Map for Alluvial Aquifer	
E-15	Potentiometric Surface Map of Denver Fm Unit NBW#1A, February 1988	
E-16	Potentiometric Surface Map of Denver Fm Unit NBW#1, February 1988	
E-17	Potentiometric Surface Map of Denver Fm Unit NBW#2, February 1988	
E-18	Potentiometric Surface Map of Denver Fm Unit NBW#3, February 1988	
F-1	DIMP Concentration Distribution, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-2	DIMP Concentration Distribution, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-3	DBCP Concentration Distribution, ug/l 3rd Quarter, FY87, Alluvial Aquifer	
F-4	DBCP Concentration Distribution, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-5	DCPD Concentration Distribution, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-6	DCPD Concentration Distribution, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-7	CPMSO2 Concentration Distribution, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-8	CPMSO2 Concentration Distribution, ug/l, 4th Quarter, FY87,	

LIST OF FIGURES

Figure		Page
	Alluvial Aquifer	
F-9	CPMSO Concentration Distribution, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-10	CPMSO Concentration Distribution, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-11	CPMS Concentration Distribution, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-12	CPMS Concentration Distribution, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-13	1,4-Dithiane Concentration Distribution, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-14	1,4-Dithiane Concentration Distribution, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-15	1,4-Oxathiane Concentration Distribution, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-16	1,4-Oxathiane Concentration Distribution, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-17	Dieldrin Concentration Distribution, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-18	Dieldrin Concentration Distribution, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-19	Endrin Concentration Distribution, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-20	Endrin Concentration Distribution, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-21	Organochlorine Pesticides Concentrations Exceeding Certified Reporting Limits, ug/l, p,p-DDE, p,p-DDT, Aldrin, Isodrin, 3rd Quarter, FY87, Alluvial Aquifer	
F-22	Organochlorine Pesticides Concentrations Exceeding Certified Reporting Limits, ug/l, p,p-DDE, p,p-DDT, Aldrin, Isodrin, 4th Quarter, FY87, Alluvial Aquifer	
F-23	Chloroform Concentration Distribution, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-24	Chloroform Concentration Distribution, ug/l, 4th Quarter, FY87, Alluvial Aquifer	

LIST OF FIGURES

Figure		Page
F-25	Tetrachloroethene Concentration Distribution, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-26	Tetrachloroethene Concentration Distribution, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-27	Trichloroethene Concentration Distribution, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-28	Trichloroethene Concentration Distribution, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-29	1,2-Dichloroethene Concentration Distribution, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-30	1,2-Dichloroethene Concentration Distribution, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-31	Chlorobenzene Concentrations Exceeding Certified Reporting Limits, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-32	Chlorobenzene Concentrations Exceeding Certified Reporting Limits, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-33	Volatile Organohalogens (CCL4, 12DCE, 11DCLE, 111TCE, 12TCE, CH2CL2) Exceeding Certified Reporting Limits, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-34	Volatile Organohalogens (CCL4, 12DCE, 11DCLE, 111TCE, 12TCE, CH2CL2) Exceeding Certified Reporting Limits, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-35	Benzene Concentrations Exceeding Certified Reporting Limits, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-36	Benzene Concentrations Exceeding Certified Reporting Limits, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-37	Volatile Aromatics (Ethylbenzene, m-Xylene, o,p-Xylene) Exceeding Certified Reporting Limits, ug/l, 3rd Quarter, Alluvial Aquifer	
F-38	Chloride Concentration Distribution, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-39	Chloride Concentration Distribution, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-40	Fluoride Concentration Distribution, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	

LIST OF FIGURES

Figure		Page
F-41	Fluoride Concentration Distribution, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-42	Arsenic and Mercury Concentrations Exceeding Certified Reporting Limits, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-43	Arsenic and Mercury Concentrations Exceeding Certified Reporting Limits, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-44	Sulfate Concentration Distribution, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-45	Sulfate Concentration Distribution, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-46	Calcium Concentration Distribution, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-47	Calcium Concentration Distribution, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-48	Potassium Concentration Distribution, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-49	Potassium Concentration Distribution, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-50	Sodium Concentration Distribution, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-51	Sodium Concentration Distribution, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-52	Magnesium Concentration Distribution, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-53	Magnesium Concentration Distribution, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-54	Nitrate Concentration Distribution, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-55	Nitrate Concentration Distribution, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-56	Zinc Concentration Distribution, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-57	Zinc Concentration Distribution, ug/l, 4th Quarter, FY87, Alluvial Aquifer	

LIST OF FIGURES

Figure		Page
F-58	Cadmium Concentrations Exceeding Certified Reporting Limits, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-59	Cadmium Concentrations Exceeding Certified Reporting Limits, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-60	Lead Concentrations Exceeding Certified Reporting Limits, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-61	Lead Concentrations Exceeding Certified Reporting Limits, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-62	Chromium Concentrations Exceeding Certified Reporting Limits, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-63	Chromium Concentrations Exceeding Certified Reporting Limits, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-64	Copper Concentrations Exceeding Certified Reporting Limits, ug/l, 3rd Quarter, FY87, Alluvial Aquifer	
F-65	Copper Concentrations Exceeding Certified Reporting Limits, ug/l, 4th Quarter, FY87, Alluvial Aquifer	
F-66	Water Chemistry Data for Denver Fm Unit NBW#1A, Spring Quarter, 1987	
F-67	Water Chemistry Data for Denver Fm Unit NBW#2, Spring Quarter, 1987	
F-68	Water Chemistry Data for Denver Fm Unit NBW#3, Spring and Summer Quarters, 1987	
F-69	Water Chemistry Data for Denver Fm Unit NBE#2, Spring and Summer Quarters, 1987	
F-70	Water Chemistry Data for Denver Fm Units NBE#3 and NBE#4, Spring and Summer Quarters, 1987	
F-71	Nontarget Compounds (Bis (2-ethylhexyl) pthalate, Caprolactum) Identified by GC/MS Analysis, ug/l, Task 4 and Task 44, Alluvial Aquifer	
F-72	Nontarget Compound (Dichlorobenzene) Identified by GC/MS Analysis, ug/l, Task 4 and Task 44, Alluvial Aquifer	
G-1	Index Map of Model Area	
G-2	Finite Element Mesh	

LIST OF FIGURES

Figure		Page
G-3	Water Balance of Model Area	
G-4	Auqifer Thickness Map	
G-5a	Transmissivity Map: Contour Interval 1,000-5,000 ft^2/day	
G-5b	Transmissivity Map: Contour Interval 5,000-25,000 ft^2/day	
G-6	Measured Spring 1987 Water Table Map	
G-7	Model Calculated Steady State Water Table Map	
G-8a	DIMP 1987 Concentrations: Contour Interval 20-100 ug/l	
G-8b	DIMP 1987 Concentrations: Contour Interval 100-200 ug/l	
G-8c	DIMP 1987 Concentrations: Contour Interval 200-1,000 ug/l	
G-9a	DIMP Concentrations in 1992 (5 years) with Existing North Boundary Recharge Operations: Contour Interval (20-100 ug/l)	
G-9b	DIMP Concentrations in 1992 (5 years) with Existing North Boundary Recharge Operations: Contour Interval (100-200 ug/l)	
G-9c	DIMP Concentrations in 1992 (5 years) with Existing North Boundary Recharge Operations: Contour Interval (200-800 ug/l)	
G-10a	DIMP Concentrations in 1997 (10 years) with Existing North Boundary Recharge Operations: Contour Interval (20-100 ug/l)	
G-10b	DIMP Concentrations in 1997 (10 years) with Existing North Boundary Recharge Operations: Contour Interval (100-700 ug/l)	
G-11a	DIMP Concentrations in 2007 (20 years) with Existing North Boundary Recharge Operations: Contour Interval (20-100 ug/l)	
G-11b	DIMP Concentrations in 2007 (20 years) with Existing North Boundary Recharge Operations: Contour Interval (100-300 ug/l)	
G-12	DIMP Concentrations in 2017 (30 years) with Existing North Boundary Recharge Operations: Contour Interval (20-180 ug/l)	

LIST OF FIGURES

Figure		Page
G-13a	DIMP Concentrations in 1992 (5 years) with North Boundary Recharge Operation for Natural Flow Conditions: Contour Interval (20-100 ug/l)	
G-13b	DIMP Concentrations in 1992 (5 years) with North Boundary Recharge Operation for Natural Flow Conditions: Contour Interval (100-200 ug/l)	
G-13c	DIMP Concentrations in 1992 (5 years) with North Boundary Recharge Operation for Natural Flow Conditions: Contour Interval (200-800 ug/l)	
G-14a	DIMP Concentrations in 1997 (10 years) with North Boundary Recharge Operation for Natural Flow Conditions: Contour Interval (20-100 ug/l)	
G-14b	DIMP Concentrations in 1997 (10 years) with North Boundary Recharge Operation for Natural Flow Conditions: Contour Interval (100-700 ug/l)	
G-15a	DIMP Concentrations in 2007 (20 years) with North Boundary Recharge Operation for Natural Flow Conditions: Contour Interval (20-100 ug/l)	
G-15b	DIMP Concentrations in 2007 (20 years) with North Boundary Recharge Operation for Natural Flow Conditions: Contour Interval (100-300 ug/l)	
G-16	DIMP Concentrations in 2017 (30 years) with North Boundary Recharge Operation for Natural Flow Conditions: Contour Interval (20-180 ug/l)	
G-17a	DIMP Concentrations in 1992 (5 years) with Existing South Adams County Well Field: Contour Interval (20-100 ug/l)	
G-17b	DIMP Concentrations in 1992 (5 years) with Existing South Adams County Well Field: Contour Interval (100-200 ug/l)	
G-17c	DIMP Concentrations in 1992 (5 years) with Existing South Adams County Well Field: Contour Interval (200-800 ug/l)	
G-18a	DIMP Concentrations in 1997 (10 years) with Existing South Adams County Well Field: Contour Interval (20-100 ug/l)	
G-18b	DIMP Concentrations in 1997 (10 years) with Existing South Adams County Well Field: Contour Interval (100-700 ug/l)	
G-19a	DIMP Concentrations in 2007 (20 years) with Existing South Adams County Well Field: Contour Interval (20-100 ug/l)	

LIST OF FIGURES

Figure		Page
G-19b	DIMP Concentrations in 2007 (20 years) with Existing South Adams County Well Field: Contour Interval (100-300 ug/l)	
G-20	DIMP Concentrations in 2017 (30 years) with Existing South Adams County Well Field: Contour Interval (20-180 ug/l)	
G-21a	DIMP Concentrations in 1992 (5 years) for Proposed South Adams County Well Field: Contour Interval (20-100 ug/l)	
G-21b	DIMP Concentrations in 1992 (5 years) for Proposed South Adams County Well Field: Contour Interval (100-200 ug/l)	
G-21c	DIMP Concentrations in 1992 (5 years) for Proposed South Adams County Well Field: Contour Interval (200-800 ug/l)	
G-22a	DIMP Concentrations in 1997 (10 years) for Proposed South Adams County Well Field: Contour Interval (20-100 ug/l)	
G-22b	DIMP Concentrations in 1997 (10 years) for Proposed South Adams County Well Field: Contour Interval (100-700 ug/l)	
G-23a	DIMP Concentrations in 2007 (20 years) for Proposed South Adams County Well Field: Contour Interval (20-100 ug/l)	
G-23b	DIMP Concentrations in 2007 (20 years) for Proposed South Adams County Well Field: Contour Interval (100-300 ug/l)	
G-24	DIMP Concentrations in 2017 (30 years) for Proposed South Adams County Well Field: Contour Interval (20-180 ug/l)	
G-25	Dieldrin 1987 Concentrations	
G-26	Dieldrin Concentrations in 1992 (5 years) with Existing North Boundary Recharge Operations	
G-27	Dieldrin Concentrations in 1997 (10 years) with Existing North Boundary Recharge Operations	
G-28	Dieldrin Concentrations in 2007 (20 years) with Existing North Boundary Recharge Operations	
G-29	Dieldrin Concentrations in 2017 (30 years) with Existing North Boundary Recharge Operations	
G-30	Dieldrin Concentrations in 1992 (5 years) with North Boundary Recharge Operation for Natural Flow Conditions	
G-31	Dieldrin Concentrations in 1997 (10 years) with North Boundary Recharge Operation for Natural Flow Conditions	

LIST OF FIGURES

Figure		Page
G-32	Dieldrin Concentrations in 2007 (20 years) with North Boundary Recharge Operation for Natural Flow Conditions	
G-33	Dieldrin Concentrations in 2017 (30 years) with North Boundary Recharge Operation for Natural Flow Conditions	
G-34	Dieldrin Concentrations in 1992 (5 years) with Existing South Adams County Well Field	
G-35	Dieldrin Concentrations in 1997 (10 years) with Existing South Adams County Well Field	
G-36	Dieldrin Concentrations in 2007 (20 years) with Existing South Adams County Well Field	
G-37	Dieldrin Concentrations in 2017 (30 years) with Existing South Adams County Well Field	
G-38	Dieldrin Concentrations in 1992 (5 years) for Proposed South Adams County Well Field	
G-39	Dieldrin Concentrations in 1997 (10 years) for Proposed South Adams County Well Field	
G-40	Dieldrin Concentrations in 2007 (20 years) for Proposed South Adams County Well Field	
G-41	Dieldrin Concentrations in 2017 (30 years) for Proposed South Adams County Well Field	
G-42	Chloroform Concentrations for 1987	
G-43	Chloroform Concentrations in 1992 (5 years) with Existing South Adams County Well Field	
G-44	Chloroform Concentrations in 1997 (10 years) with Existing South Adams County Well Field	
G-45	Chloroform Concentrations in 2007 (20 years) with Existing South Adams County Well Field	
G-46	Chloroform Concentrations in 2017 (30 years) with Existing South Adams County Well Field	
G-47	DCPD Concentrations in 1987	
G-48	DCPD Concentrations in 1992 (5 years) with Existing South Adams County Well Field	
G-49	DCPD Concentrations in 1997 (10 years) with Existing South Adams County Well Field	

LIST OF FIGURES

Figure		Page
G-50	DCPD Concentrations in 2007 (20 years) with Existing South Adams County Well Field	
G-51	DCPD Concentrations in 2017 (30 years) with Existing South Adams County Well Field	
I-1	Aromatic and Halogenated Aliphatic Solvent Assessment RMA Offpost First Quarter Sampling of Wells	
I-2	Aromatic and Halogenated Aliphatic Solvent Assessment RMA Offpost Second Quarter Sampling of Wells	
I-3	Chlorinated Pesticide Assessment RMA Offpost First Quarter Sampling of Wells	
I-4	Chlorinated Pesticide Assessment RMA Offpost Second Quarter Sampling of Wells	
I-5	Organosulfur Compounds Assessment RMA Offpost First Quarter Sampling of Wells	
I-6	Organosulfur Compounds Assessment RMA Offpost Second Quarter Sampling of Wells	
I-7	DBCP Assessment RMA Offpost First Quarter Sampling of Wells	
I-8	DBCP Assessment RMA Offpost Second Quarter Sampling of Wells	
I-9	DCPD Assessment RMA Offpost First Quarter Sampling of Wells	

LIST OF TABLES

Table		Page
2.1-1	Aquifer Designations for Wells in Offpost Operable Unit	2-9
2.1-2	Completion Data for New Alluvial Wells	2-14
2.1-3	Completion Data for New Denver Wells	2-18
2.1-4	Chemical Analyses-Offpost Operable Unit Analytical Program	2-21
2.4-1	Summary of Previous Air Quality Monitoring Programs at RMA	2-38
3.2-1	Transmissivity (T), Hydraulic Conductivity (K), and Apparent Specific Yield (SYA) from Pumping Tests	3-48
3.2-2	Hydraulic Conductivity of Combined Soil Groups in the Alluvial Aquifer	3-51
3.2-3	Slug Test Results for Denver Fm Units Near the North Boundary of RMA	3-66
3.2-4	Water Elevations for Well Cluster Sites in the Offpost Operable Unit	3-71
3.3-1	Frequency of Detection and Range of Concentrations for Target Analytes--Spring 1987	3-80
3.3-2	Frequency of Detection and Range of Concentrations for Target Analytes--Summer 1987	3-82
3.3-3	Representative Concentrations for Naturally Occurring Constituents in Upgradient Alluvial Wells	3-98
3.3-4	Typical Background Water Chemistry From the Denver Fm	3-118
3.3-5	Additional Inorganic Parameters for Wells 37379 and 37380, Spring and Summer 1987	3-121
3.3-6	Field QA/QC Procedures	3-126
3.3-7	Duplicate Data: DIMP, DBCP, DCPD, (ug/l)	3-127
3.3-8	Duplicate Data: 1,4-Oxathiane, 1,4-Dithiane, CPMS, CPMSO, CPMSO2 (ug/l)	3-128
3.3-9	Duplicate Data: Organochlorine Pesticides (ug/l)	3-129
3.3-10	Duplicate Data: Volatile Organohalogens (ug/l)	3-130
3.3-11	Duplicate Data: Volatile Aromatics (ug/l)	3-131

LIST OF TABLES

Table		Page
3.3-12	Duplicate Data: Inorganics (ug/l)	3-132
3.3-13	Duplicate Data: Additional Inorganics (ug/l)	3-133
3.3-14	Offpost Wells from which Water Samples were Collected and Submitted for GC/MS Analysis	3-137
3.3-15	GC/MS Target Analytes	3-140
3.3-16	Certified Reporting Limit for GC Analyses and Apparent Method Detection Limit for GC/MS Analyses	3-141a
3.3-17	Frequency of Detection for Tentatively Identified Compounds	3-146
3.4-1	Estimated Range of K_d Values	3-156
3.4-2	Comparison of Chloride Concentrations Upgradient and Downgradient of Irrigation Canals (mg/l)	3-183
3.4-3	Selected Organic Contaminant Concentrations in Task 39 Cluster Wells (ug/l)	3-184
3.4-4	Benzene and Chlorobenzene Concentrations in Task 39 Cluster Wells (ug/l)	3-185
3.4-5	Fluoride, Chloride, and Sulfate Concentrations in Task 39 Cluster Wells (ug/l)	3-186
4.1-1	Comparison of Average Monthly Flows for South Platte River, Burlington Ditch, O'Brian Canal, and First Creek in the RMA Offpost Operable Unit (All Values in Acre-Feet)	4-3
4.2-1	Summary of Organic Contaminant Concentrations in Offpost Surface Water	4-5
4.2-2	Inorganic Concentration Ranges at Offpost Surface Water Sampling Stations (ug/l)	4-7
4.3-1	Summary of Organic Contaminant Concentrations Onpost in First Creek and Its Potential Tributaries	4-15
5.1-1	Analyte Schedule and Certified Reporting Limits for Sediment Analyses Performed for Offpost Contamination Assessment Report	5-5
5.1-2	Metal Concentrations in Offpost Sediment Samples from Offpost Contamination Assessment Report	5-7
5.1-3	Sediment Analyses (April 14, 1988 Sampling)	5-11

LIST OF TABLES

Table		Page
5.2-1	Representative Metals Concentrations in Wastewater Sludge (ug/g)	5-14
5.3-1	Metal Concentrations Commonly Found in Uncontaminated Freshwater Sediments (ug metal/gm dry sediment)	5-15
6.1-1	Summary of Air Quality Parameters in the Vicinity of the Rocky Mountain Arsenal	6-2
6.2-1	Airborne Organic Compounds at Rocky Mountain Arsenal	6-4
6.2-2	Airborne Metals at the Rocky Mountain Arsenal	6-9
7.1-1	Pheasant Home Range Estimates	7-2
7.1-2	Final Status of Animal and Transmitter	7-6
7.1-3	Cottontail Home Range Estimates	7-9

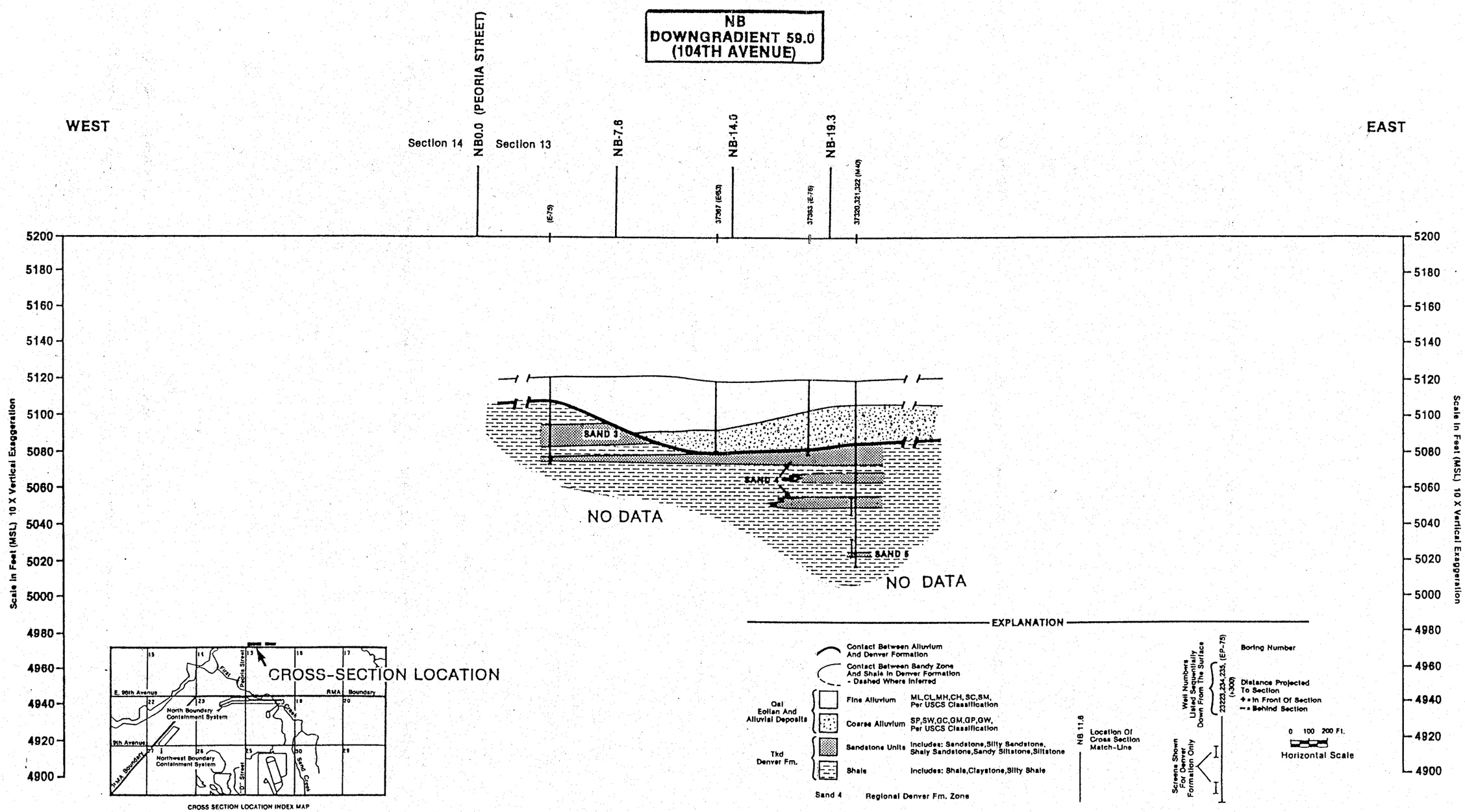


Figure E-1

EAST-WEST GEOLOGIC CROSS-SECTION NB DOWNGRADIENT 59.0 (104th. Ave.)

SOURCE: ESE, 1988

Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland

FIGURE E-2
BEDROCK ELEVATION MAP
IS NOW LOCATED IN THE BACK OF THIS DOCUMENT

APPENDIX E
GEOLOGIC AND HYDROGEOLOGIC PRODUCTS

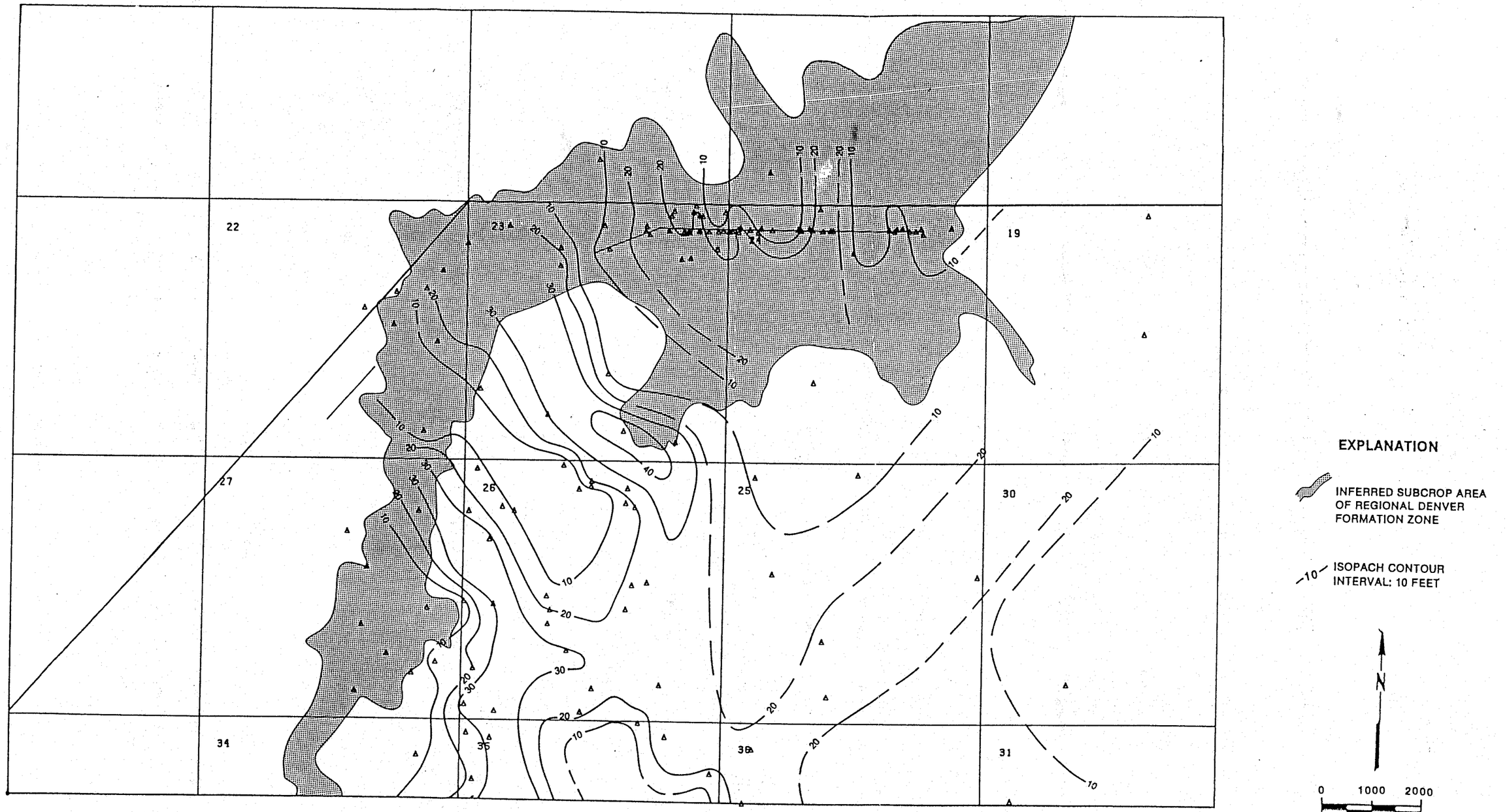


Figure E-3

NET SAND ISOPACH CONTOUR MAP OF REGIONAL DENVER FORMATION ZONE 2

SOURCE: ESE, 1988

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Aberdeen Proving Ground, Maryland

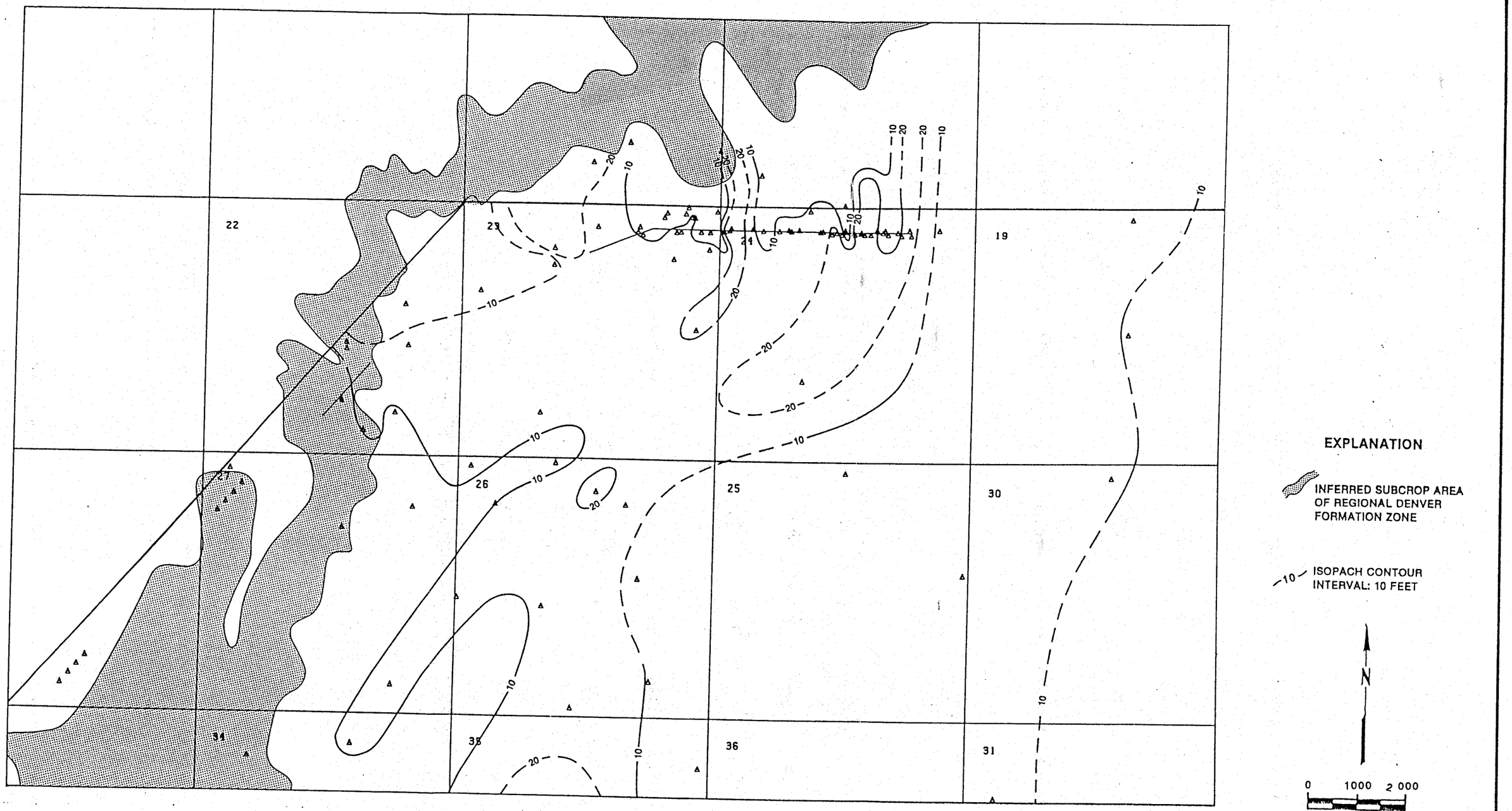


Figure E-4

NET SAND ISOPACH CONTOUR MAP OF REGIONAL DENVER FORMATION ZONE 3

SOURCE: ESE, 1988

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Aberdeen Proving Ground, Maryland

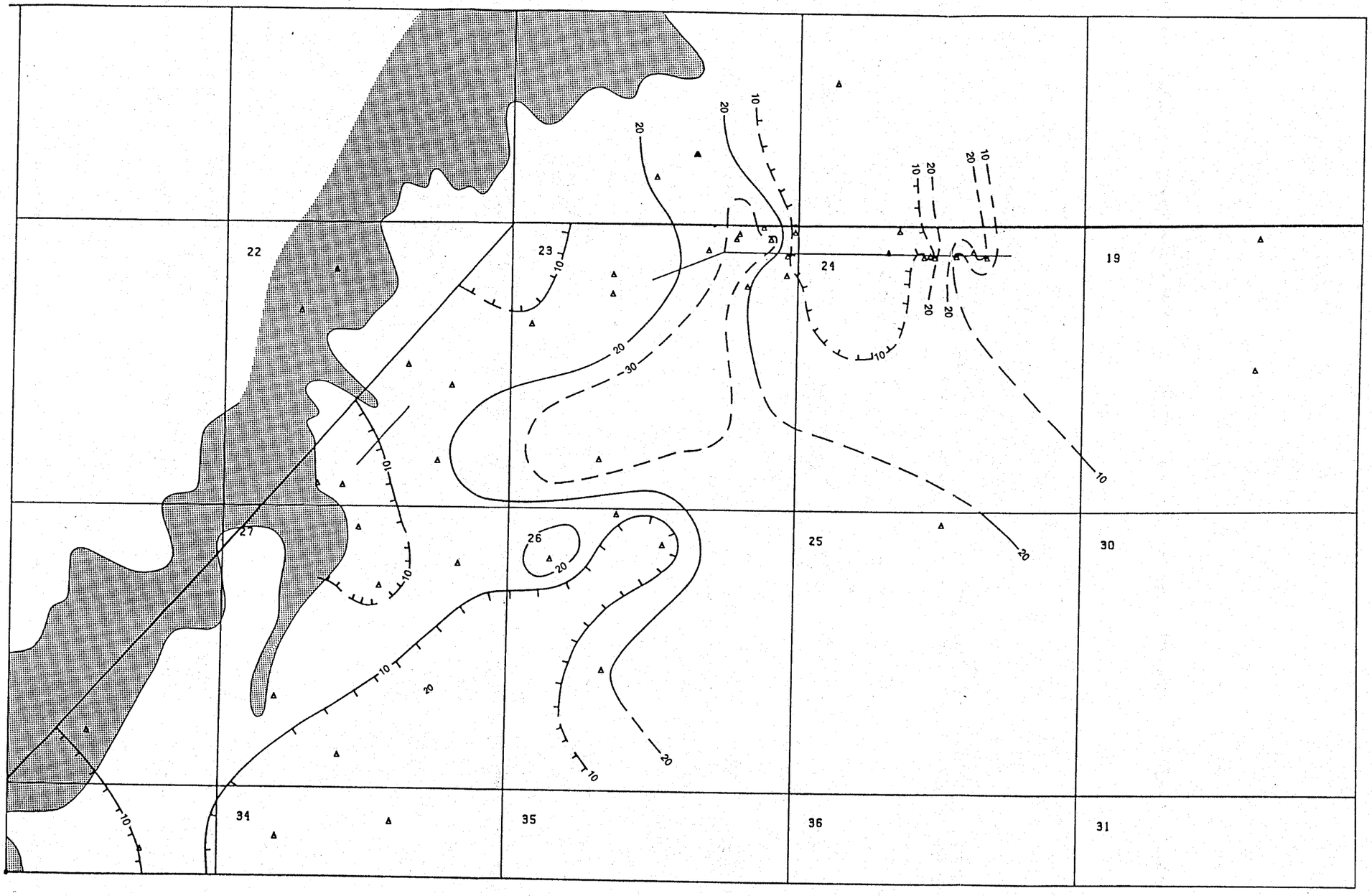


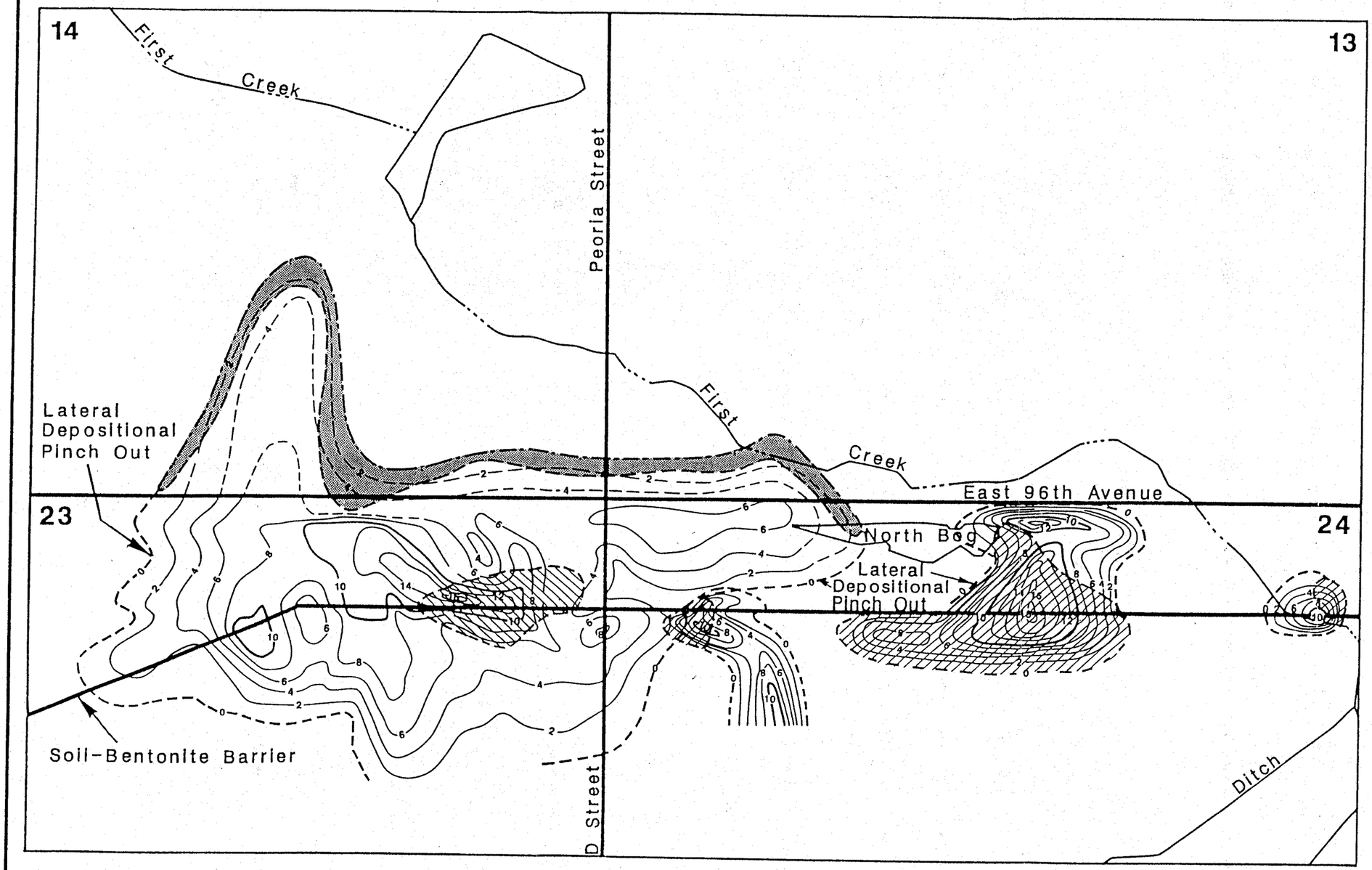
Figure E-5

NET SAND ISOPACH CONTOUR MAP OF REGIONAL DENVER FORMATION ZONE 4

SOURCE: ESE, 1988

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EXPLANATION

Erosional Truncation of the Sandstone Unit

Inferred Area of Subcrop, NBW #1A Sandstone Unit

Inferred Area of Subcrop, NBE #1 Sandstone Unit

Areal Geologic Contact Between NBW #1A and NBW #1 Sandstone Units

N

0 250 500

Scale In Feet

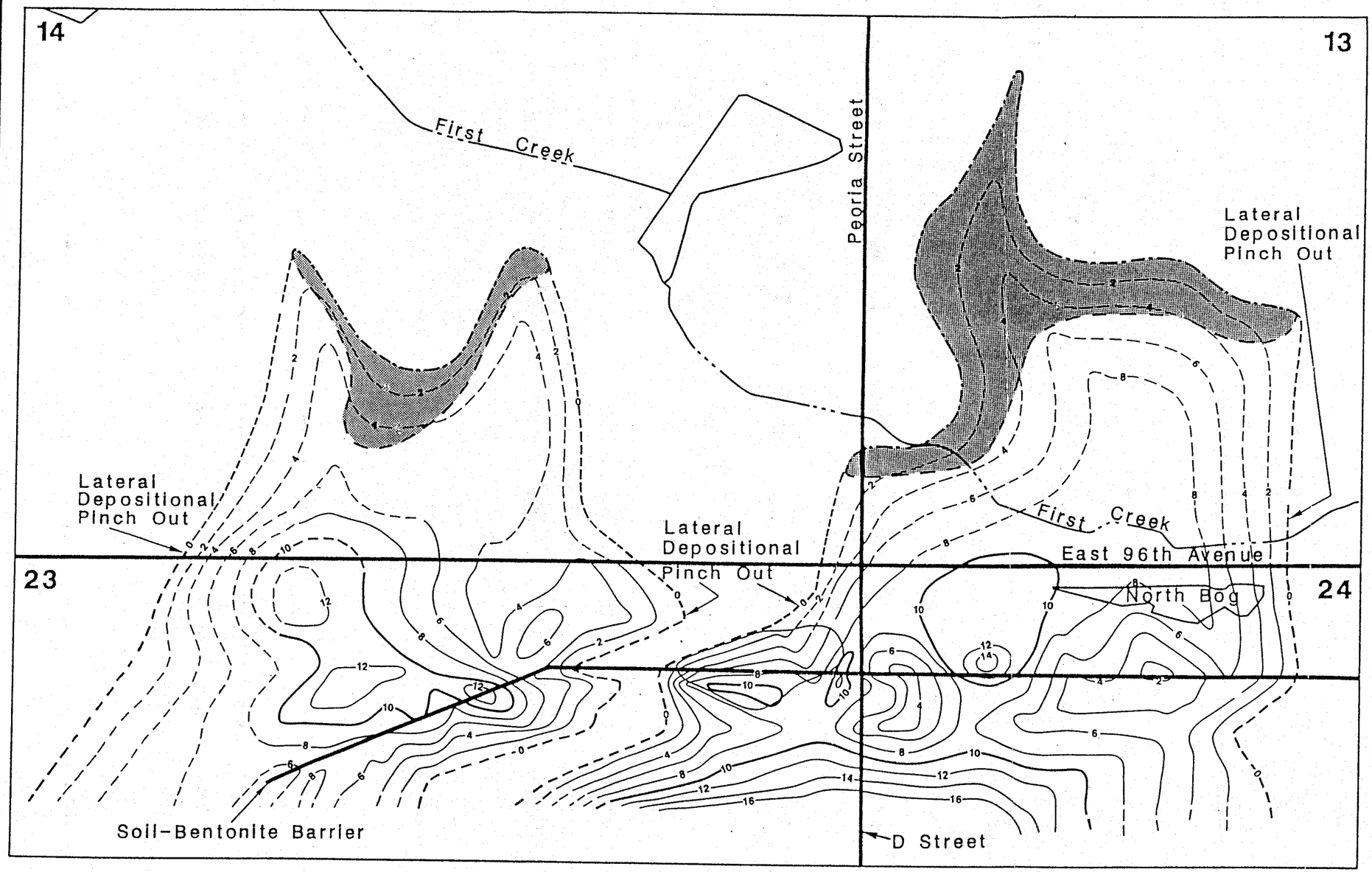
Figure E-6

ISOPACH MAP OF THE NBW#1A AND NBE#1 SANDSTONE UNITS

SOURCE: HLA, 1988

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EXPLANATION

Erosional Truncation of the Sandstone Unit.

Inferred Area of Subcrop, NBW #1 Sandstone Unit

Contour Interval = 2 Feet

N

0 250 500

Scale In Feet

Figure E-7

ISOPACH MAP OF THE NBW#1 SANDSTONE UNIT

SOURCE: HLA, 1988

Prepared for:
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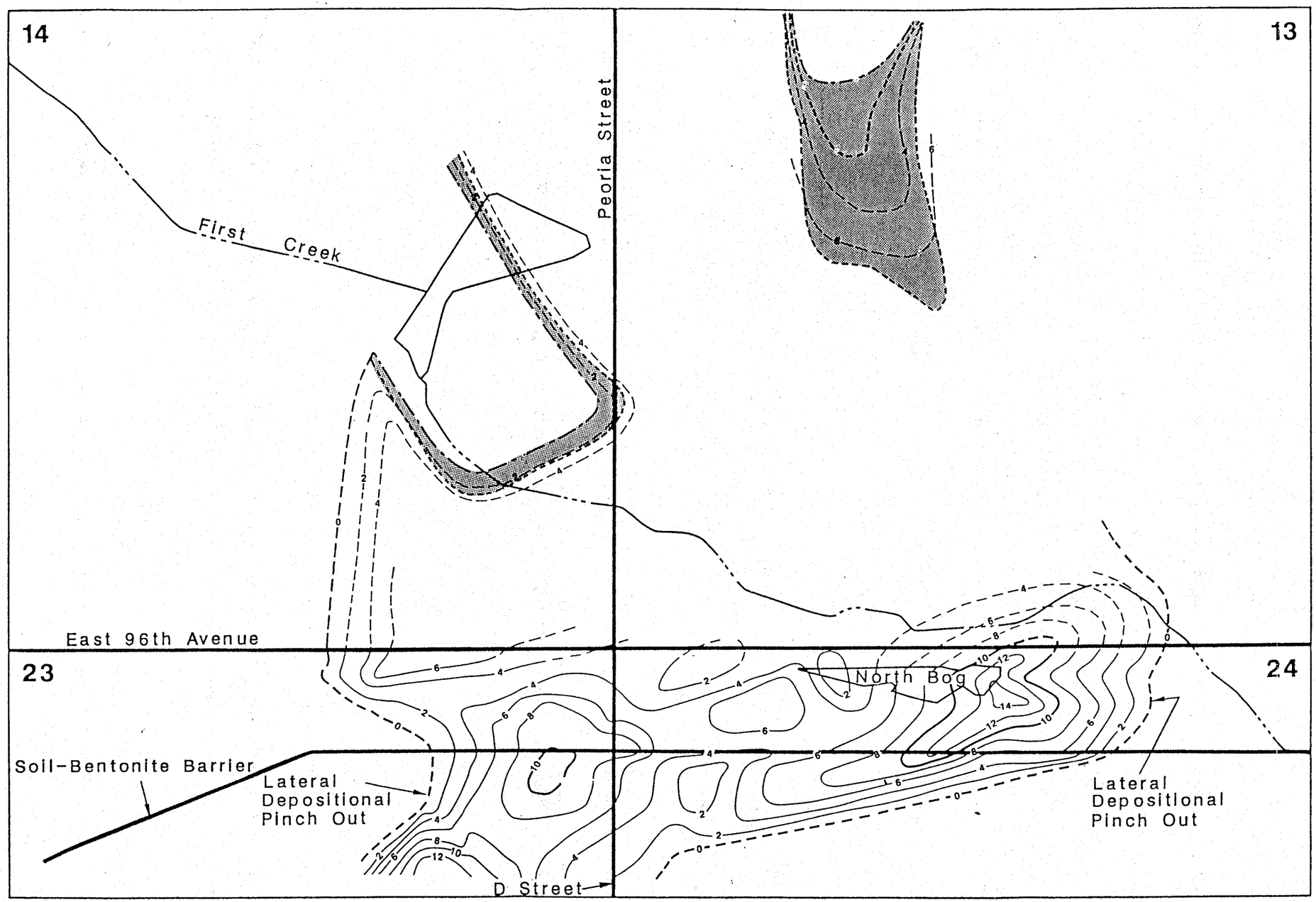


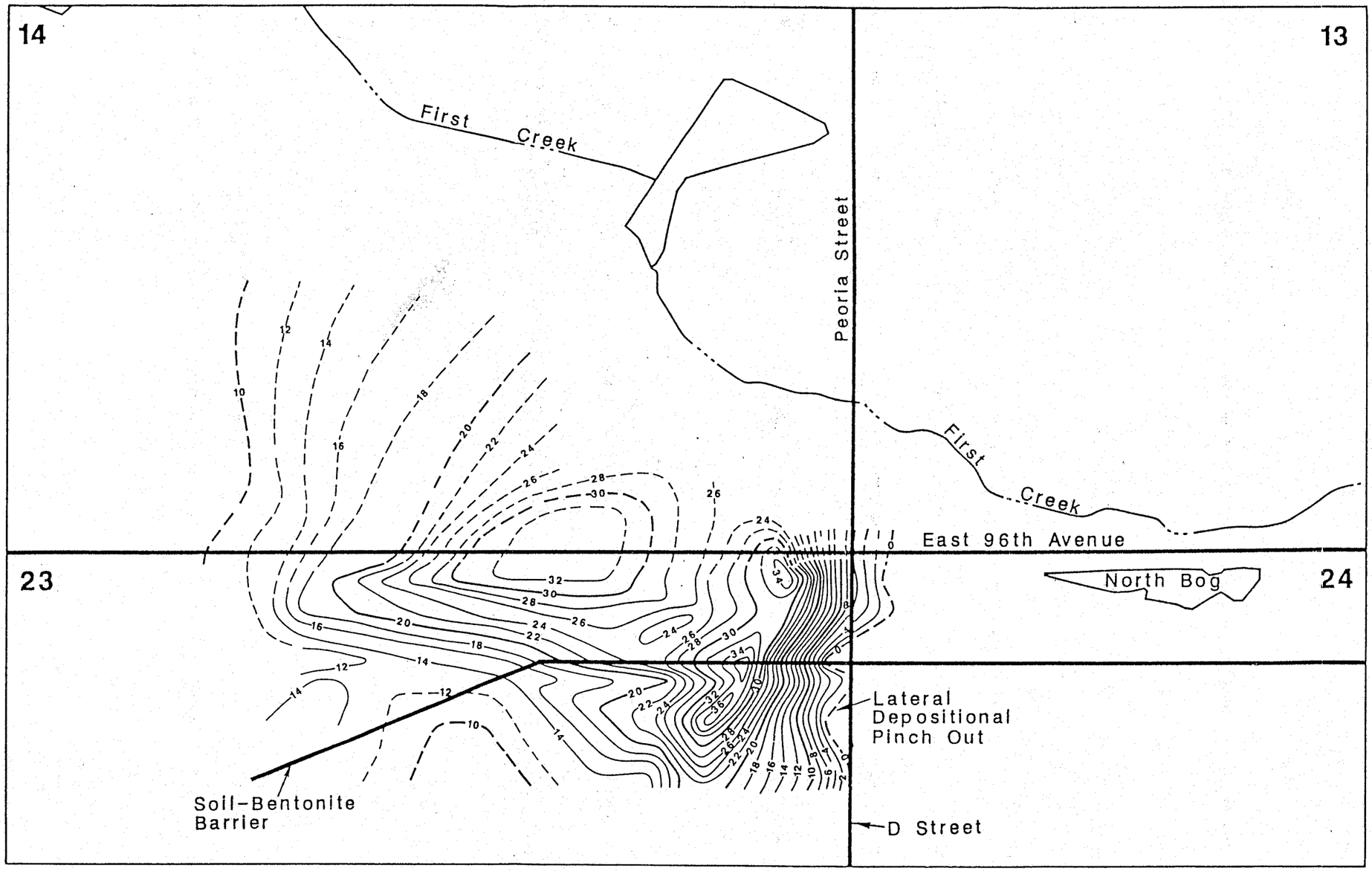
Figure E-8

ISOPACH MAP OF THE NBW#2 SANDSTONE UNIT

SOURCE: HLA, 1988

Prepared for:
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Aberdeen Proving Ground, Maryland



EXPLANATION

Contour Interval = 2 Feet

N

0 250 500

Scale In Feet

Figure E-9

ISOPACH MAP OF THE NBW#3 SANDSTONE UNIT

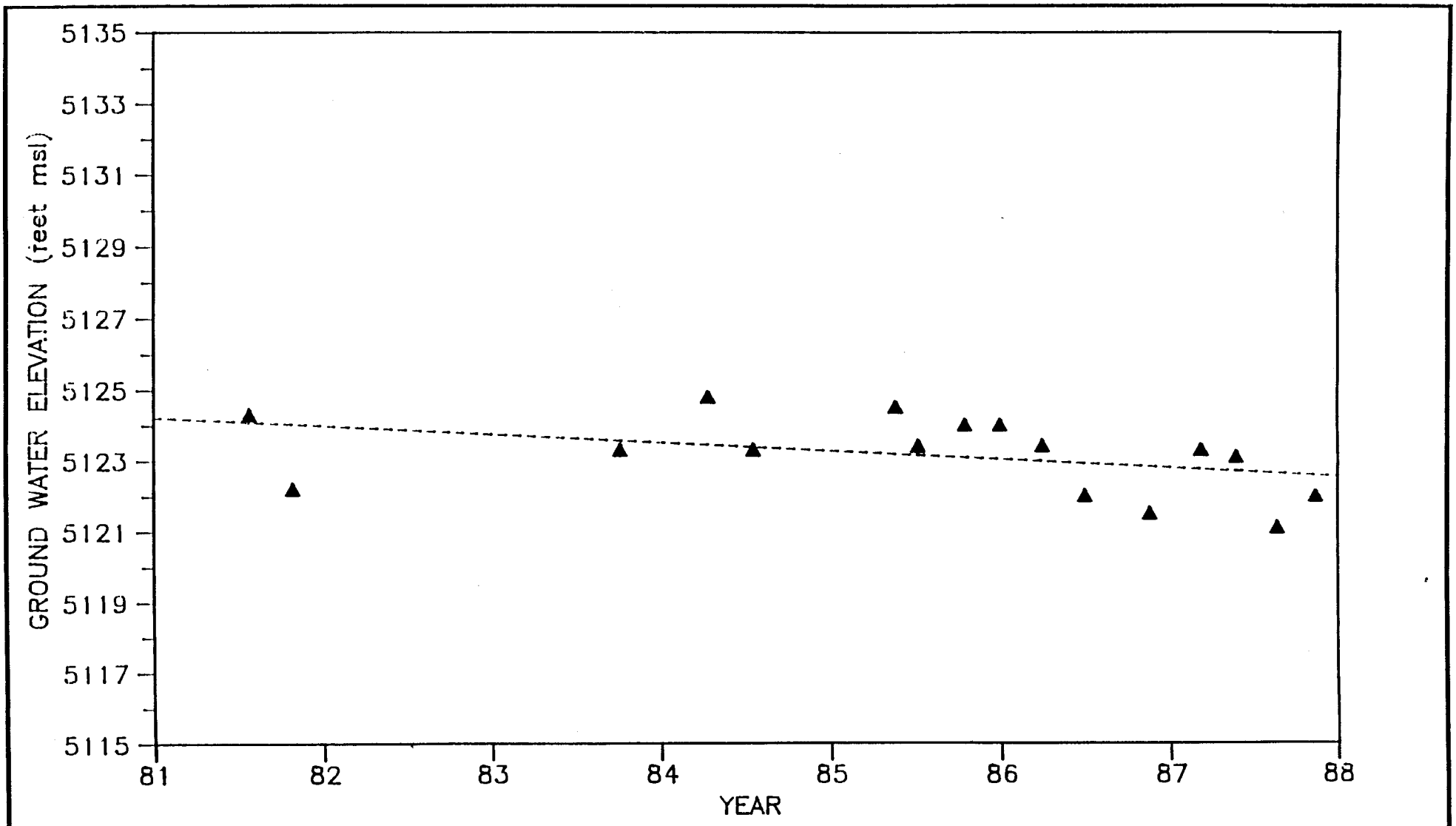
SOURCE: HLA, 1988

Prepared for:
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Aberdeen Proving Ground, Maryland

FIGURE E-10
WATER TABLE ELEVATION MAP SPRING,
1987 IS LOCATED IN THE
BACK OF THIS DOCUMENT

FIGURE E-11
WATER TABLE ELEVATION MAP SUMMER,
1987 IS NOW LOCATED IN THE
BACK OF THIS DOCUMENT



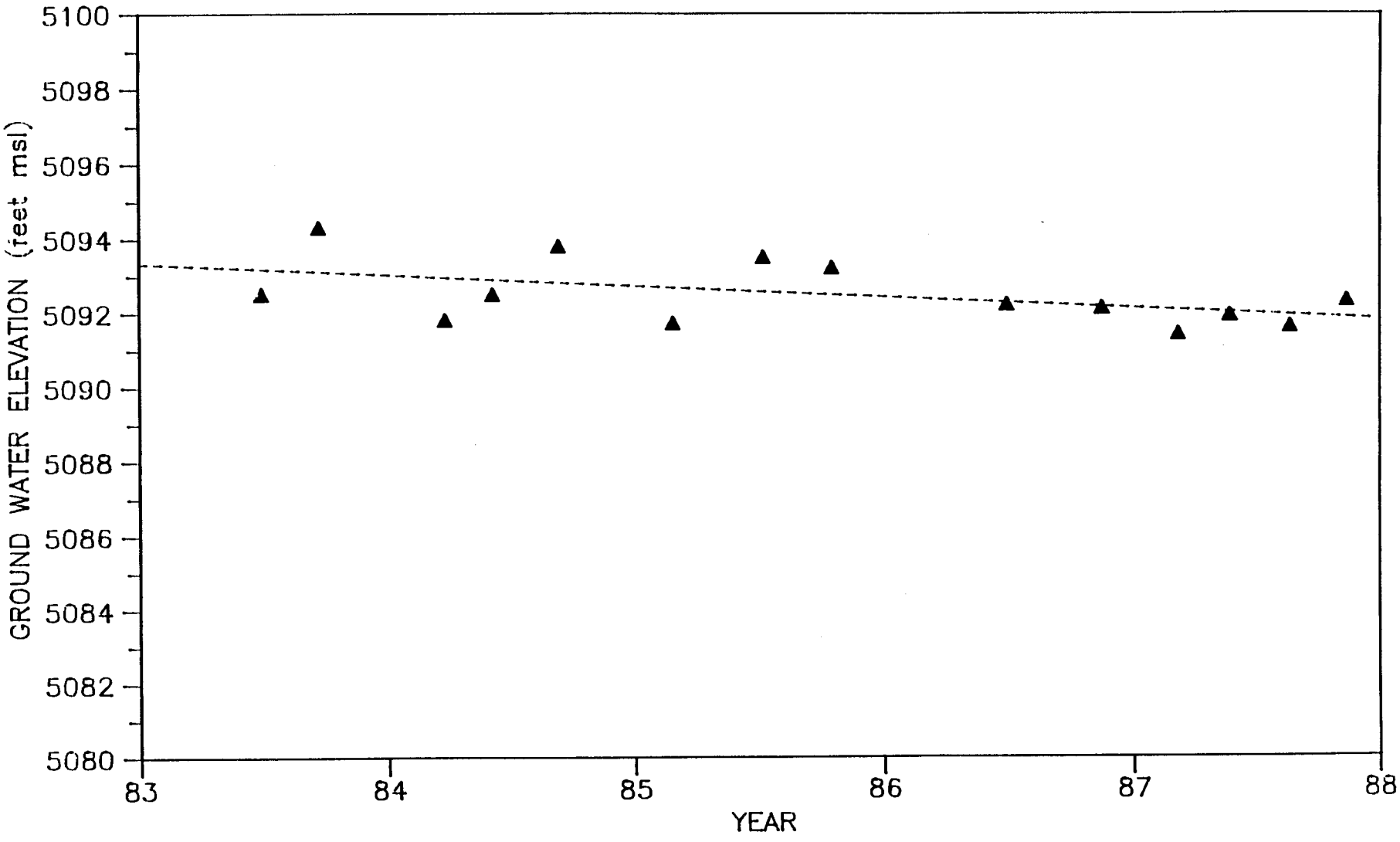
Note : Regression line equation is Y = -.24X + 5143.5

Figure E-12
HISTORICAL HYDROGRAPH
FOR WELL #37308

SOURCE: ESE, 1988

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Note : Regression line equation is Y = -.31X + 5118.9

Figure E-13
HISTORICAL HYDROGRAPH
FOR WELL #37334

SOURCE: ESE, 1988

Prepared for:
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For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland

FIGURE E-14
SATURATED THICKNESS MAP SUMMER, 1987 IS LOCATED IN THE BACK OF THIS DOCUMENT

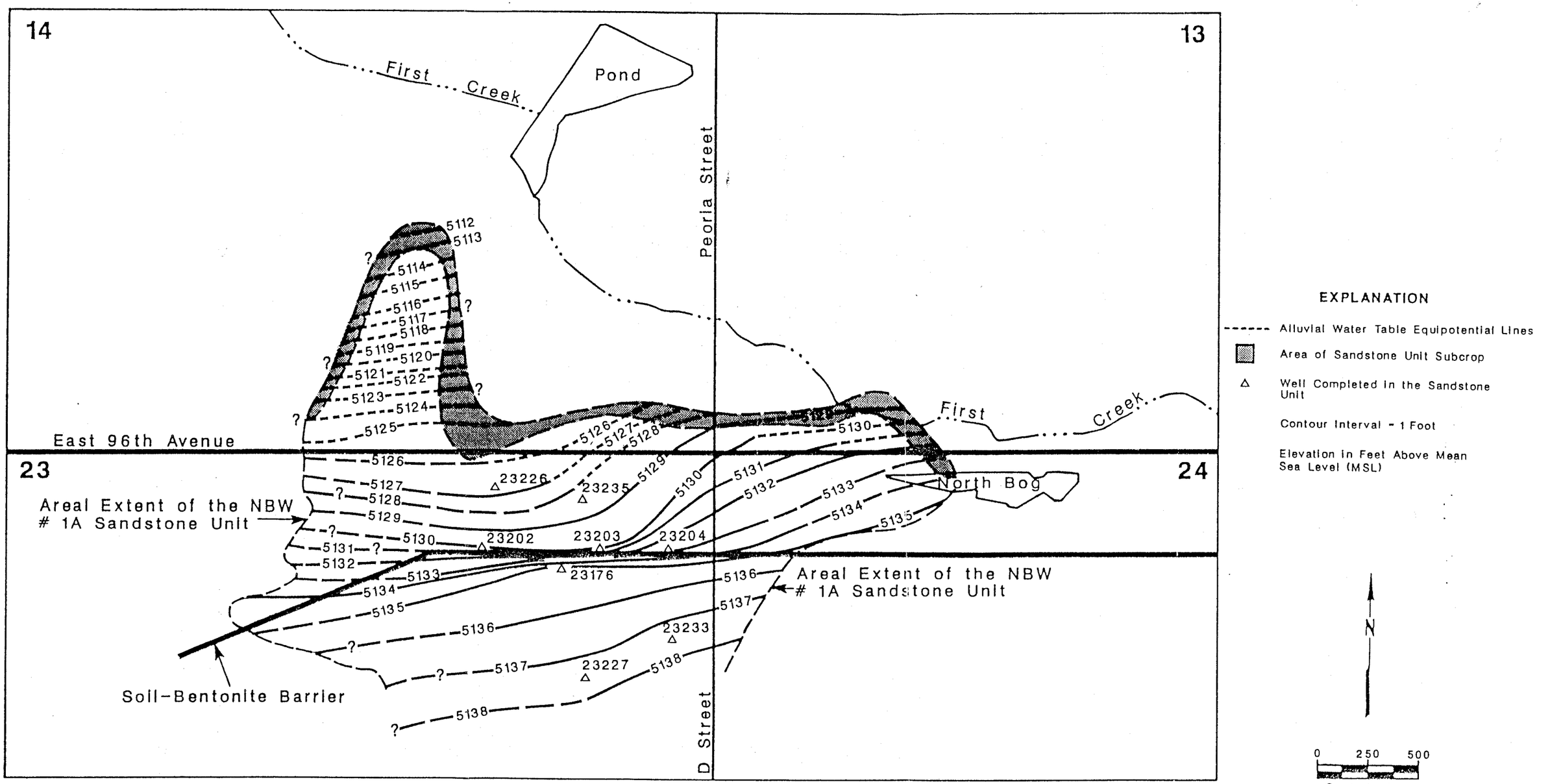


Figure E-15
POTENTIOMETRIC SURFACE MAP OF DENVER FM UNIT NBW#1A
FEBRUARY, 1988

SOURCE: HLA, 1988

Prepared for:
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For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland

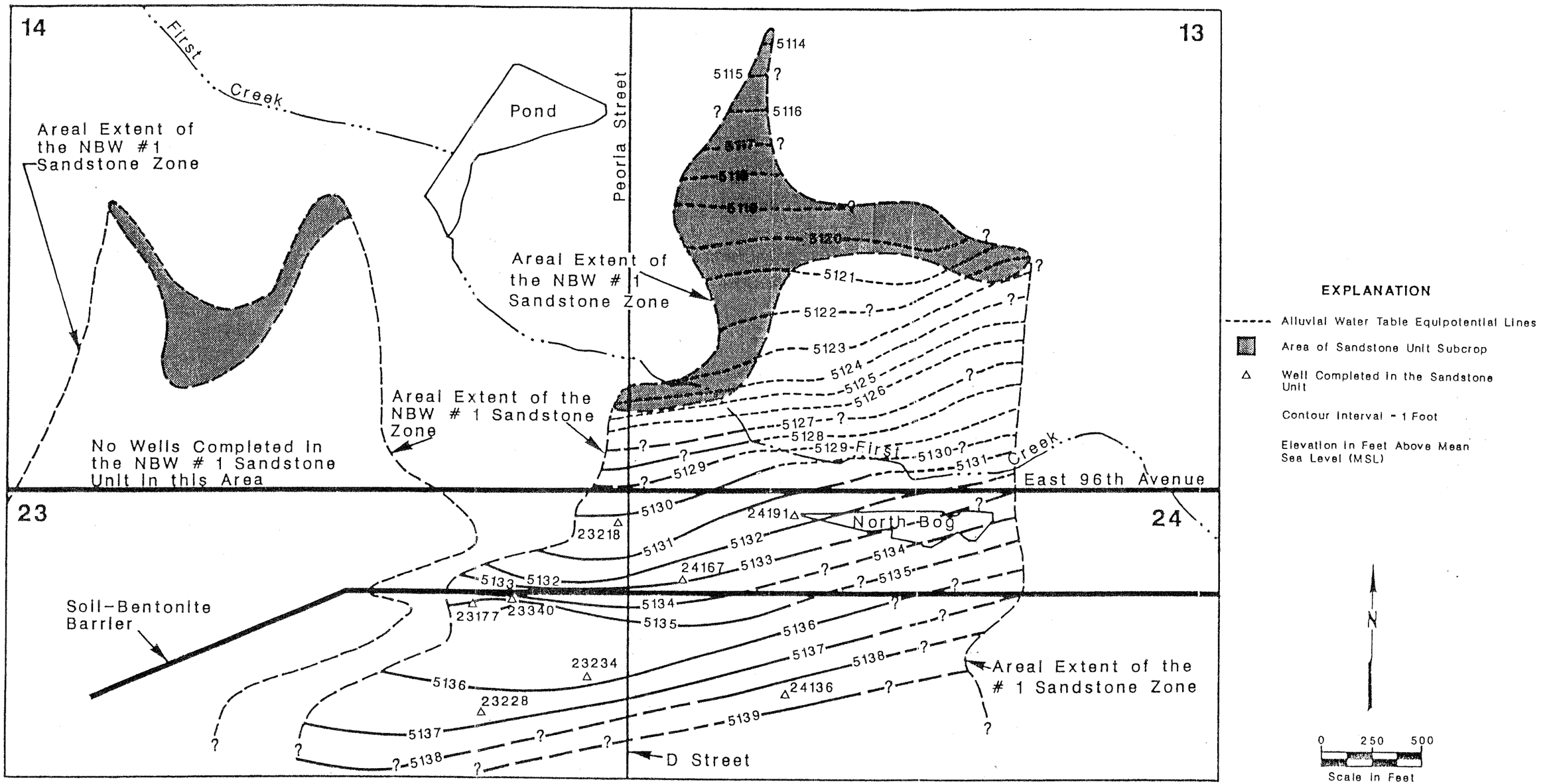


Figure E-16
POTENTIOMETRIC SURFACE MAP OF DENVER FM UNIT NBW#1
FEBRUARY, 1988

SOURCE: HLA, 1988

Prepared for:
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For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland

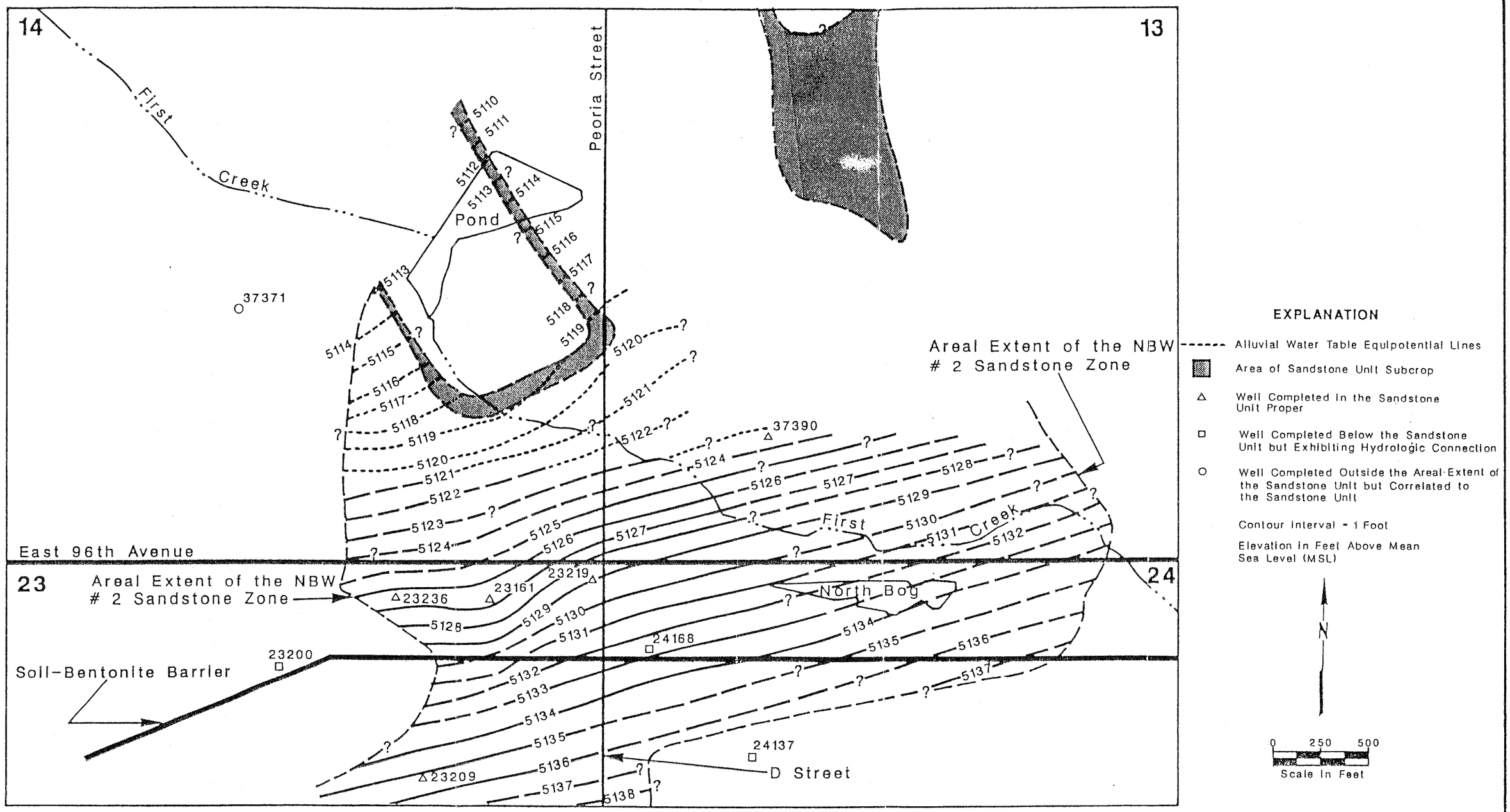
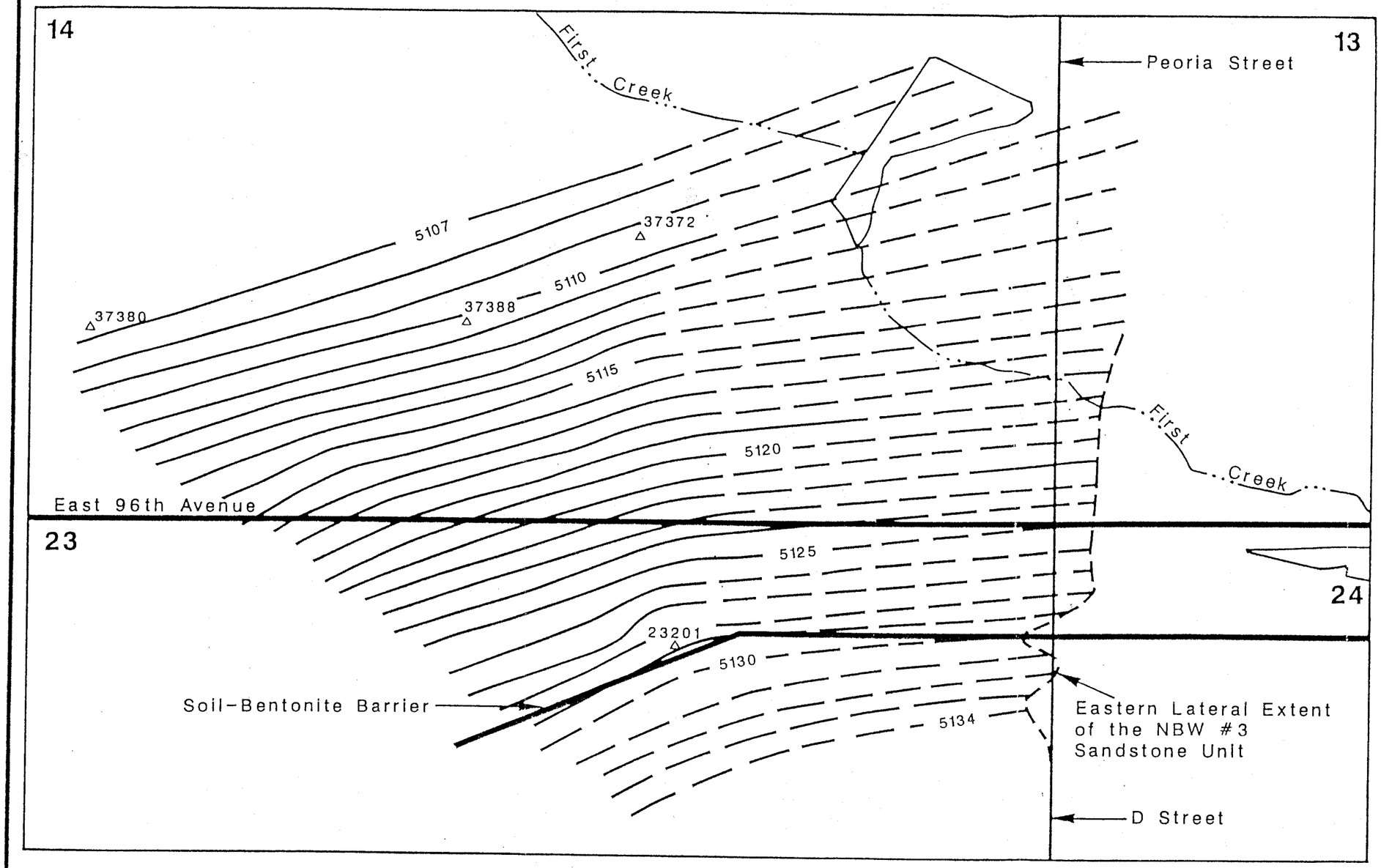


Figure E-17
POTENTIOMETRIC SURFACE MAP OF DENVER FM UNIT NBW#2
FEBRUARY, 1988

SOURCE: HLA, 1988

Prepared for:
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Aberdeen Proving Ground, Maryland



EXPLANATION

△ Well Completed in the Sandstone Unit

Contour Interval = 1 Foot

Elevation in Feet Above Mean Sea Level (MSL)

N

0 250 500

Scale In Feet

Figure E-18
POTENTIOMETRIC SURFACE MAP OF DENVER FM UNIT NBW#3
FEBRUARY, 1988
SOURCE: HLA, 1988

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Aberdeen Proving Ground, Maryland

APPENDIX F
CONTAMINANT DISTRIBUTION MAPS, CONTAMINANT POINT PLOTS, AND WATER QUALITY DATA

F.1 CONTAMINANT DISTRIBUTION AND POINT PLOT MAPS

ALLUVIAL AQUIFER

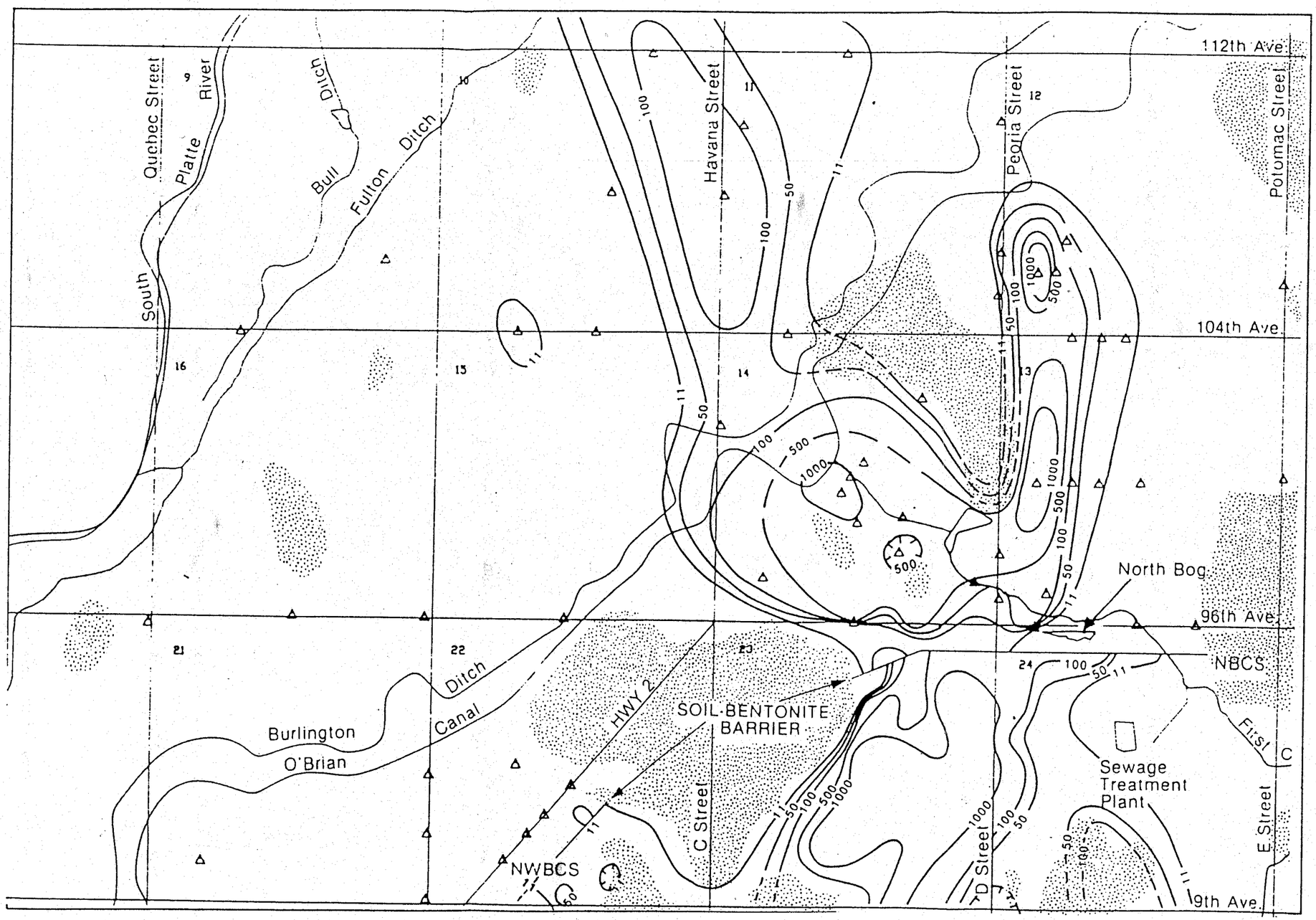


Figure F-1
DIMP CONCENTRATION DISTRIBUTION, ug/l, 3RD QUARTER, FY87, ALLUVIAL AQUIFER

SOURCE:ESE,1988

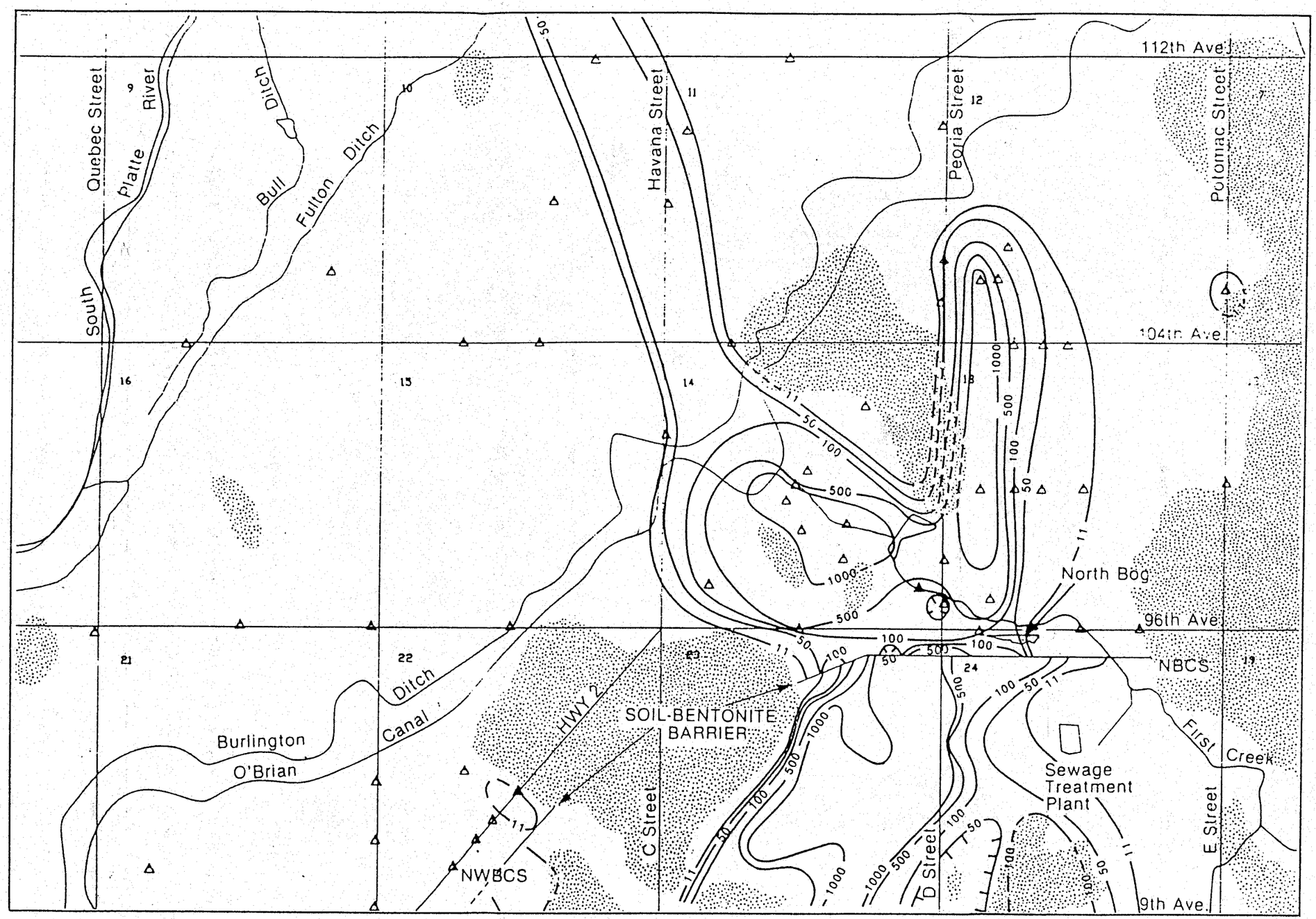
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For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland

DENVER FM

F.2 WATER QUALITY DATA

GROUND WATER



EXPLANATION

ALL CONCENTRATIONS IN MICROGRAMS PER LITER (ug/l)

1 ISOCONCENTRATION LINE

NWBCS: NORTHWEST BOUNDARY CONTAINMENT SYSTEM

NBCS: NORTH BOUNDARY CONTAINMENT SYSTEM.

△ MONITORING WELL LOCATION

UNSATURATED ALLUVIUM

N

0 1000 2000

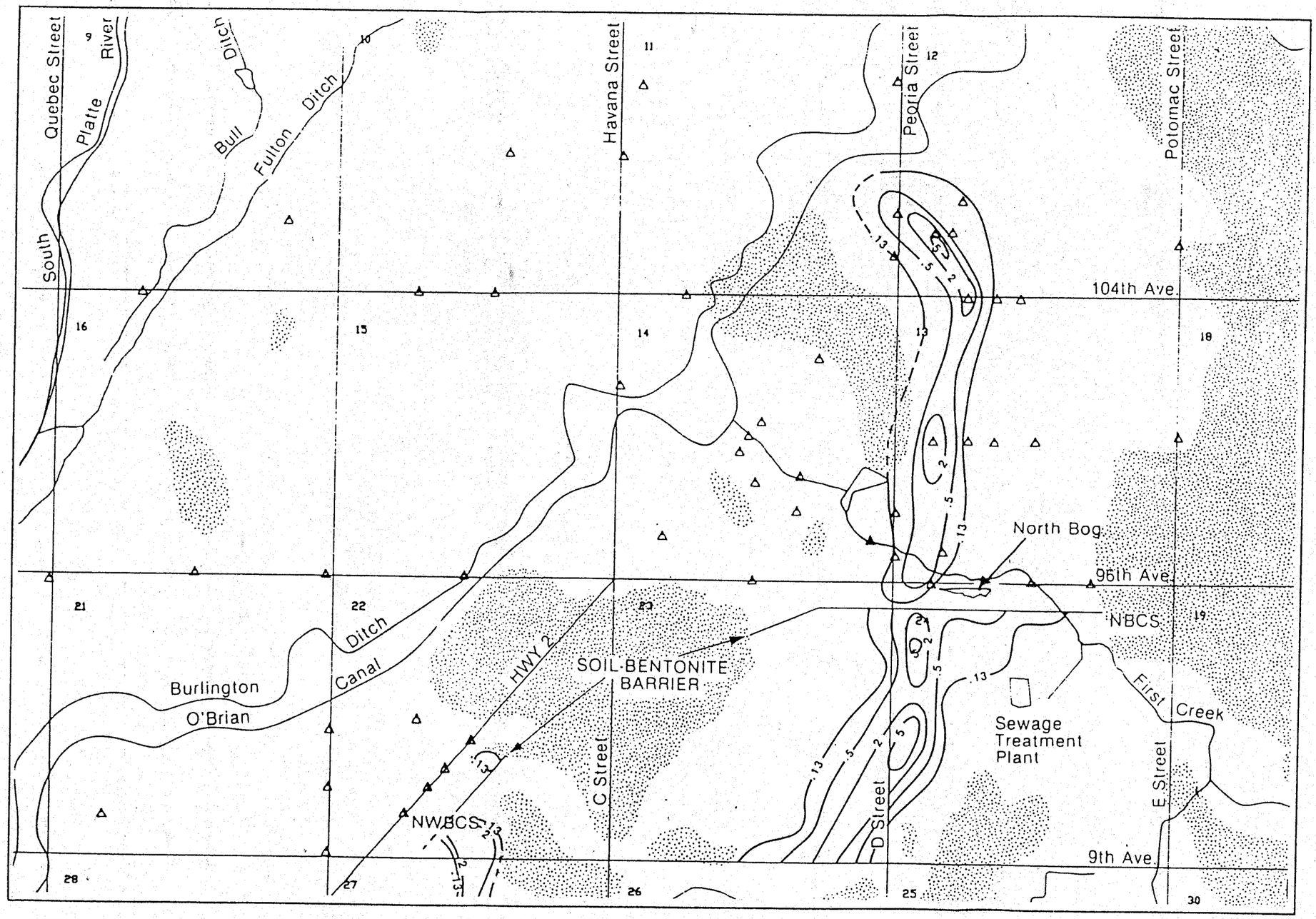
Scale In Feet

Figure F-2
DIMP CONCENTRATION DISTRIBUTION, ug/l, 4TH QUARTER, FY87, ALLUVIAL AQUIFER

SOURCE:ESE,1988

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Aberdeen Proving Ground, Maryland



EXPLANATION

ALL CONCENTRATIONS IN MICROGRAMS PER LITER (ug/l)

1 — ISOCONCENTRATION LINE

NWBCS: NORTHWEST BOUNDARY CONTAINMENT SYSTEM

NBCS: NORTH BOUNDARY CONTAINMENT SYSTEM.

△ MONITORING WELL LOCATION

UNSATURATED ALLUVIUM

N

0 1000 2000

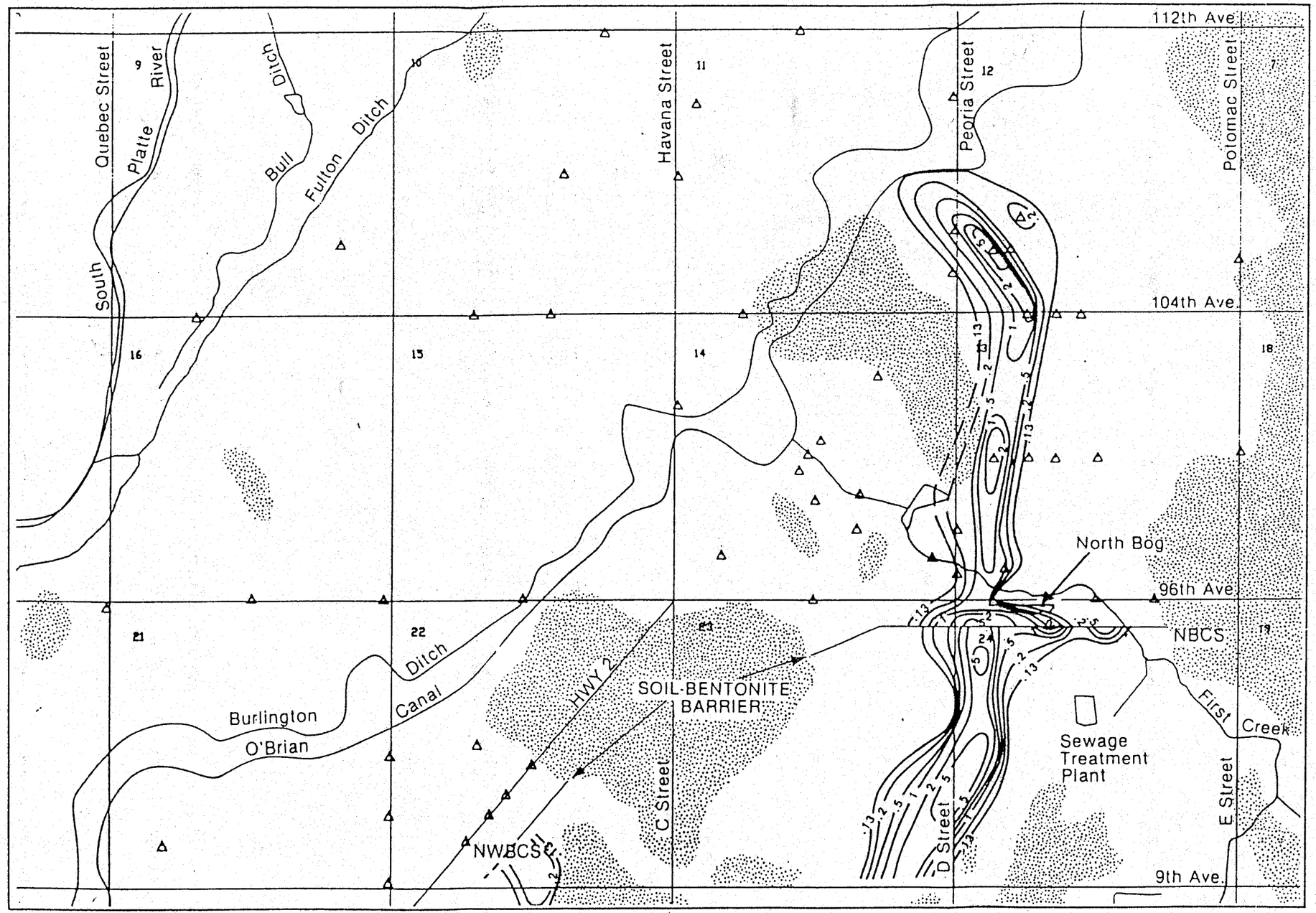
Scale In Feet

Figure F-3
DBCP CONCENTRATION DISTRIBUTION, ug/l, 3RD QUARTER,
FY87, ALLUVIAL AQUIFER

SOURCE:ESE,1988

Prepared for:
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For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland



EXPLANATION

ALL CONCENTRATIONS IN MICROGRAMS PER LITER (ug/l)

1 ISOCONCENTRATION LINE

NWBCS: NORTHWEST BOUNDARY CONTAINMENT SYSTEM

NBCS: NORTH BOUNDARY CONTAINMENT SYSTEM.

△ MONITORING WELL LOCATION

UNSATURATED ALLUVIUM

N

0 1000 2000

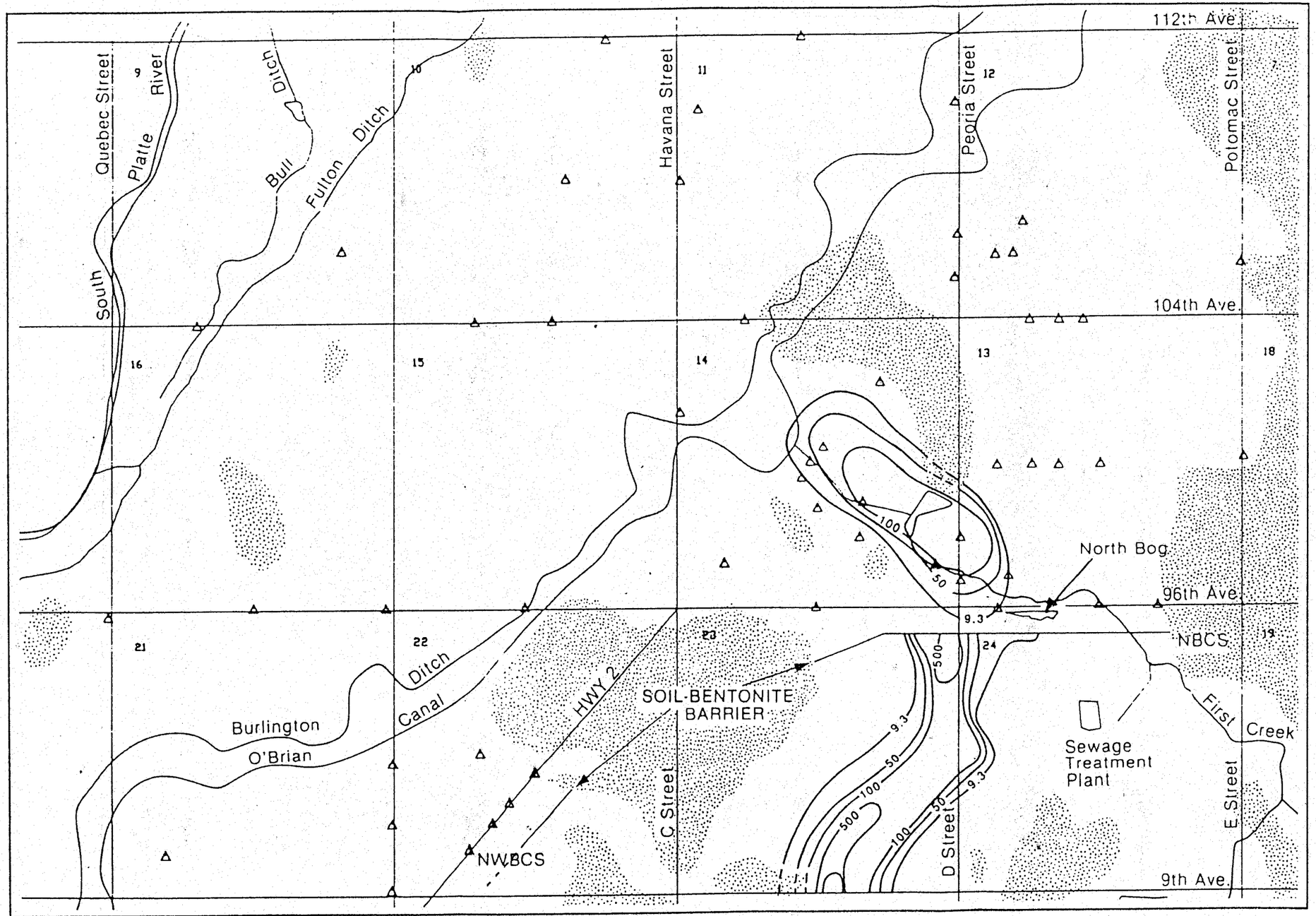
Scale In Feet

Figure F-4
DBCP CONCENTRATION DISTRIBUTION, ug/l, 4TH QUARTER, FY87, ALLUVIAL AQUIFER

SOURCE:ESE,1988

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Aberdeen Proving Ground, Maryland



EXPLANATION

ALL CONCENTRATIONS IN MICROGRAMS PER LITER (ug/l)

1 — ISOCONCENTRATION LINE

NWBCS: NORTHWEST BOUNDARY CONTAINMENT SYSTEM

NBCS: NORTH BOUNDARY CONTAINMENT SYSTEM.

△ MONITORING WELL LOCATION

UNSATURATED ALLUVIUM

N

0 1000 2000

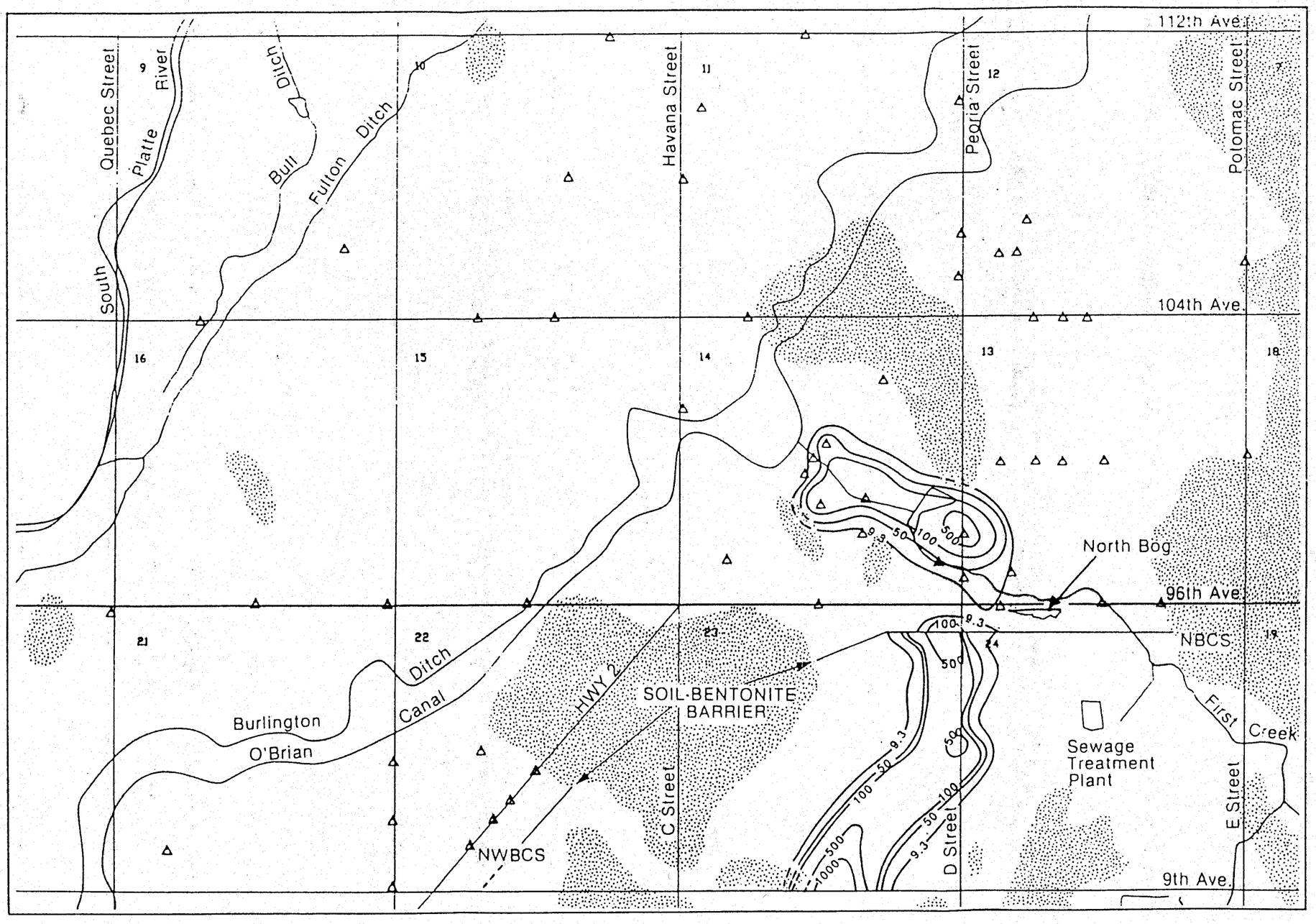
Scale In Feet

Figure F-5
DCPD CONCENTRATION DISTRIBUTION, ug/l, 3RD QUARTER,
FY87, ALLUVIAL AQUIFER

SOURCE:ESE,1988

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Aberdeen Proving Ground, Maryland



EXPLANATION

ALL CONCENTRATIONS IN MICROGRAMS PER LITER (ug/l)

1 — ISOCONCENTRATION LINE

NWBCS: NORTHWEST BOUNDARY CONTAINMENT SYSTEM

NBCS: NORTH BOUNDARY CONTAINMENT SYSTEM.

△ MONITORING WELL LOCATION

UNSATURATED ALLUVIUM

N

0 1000 2000

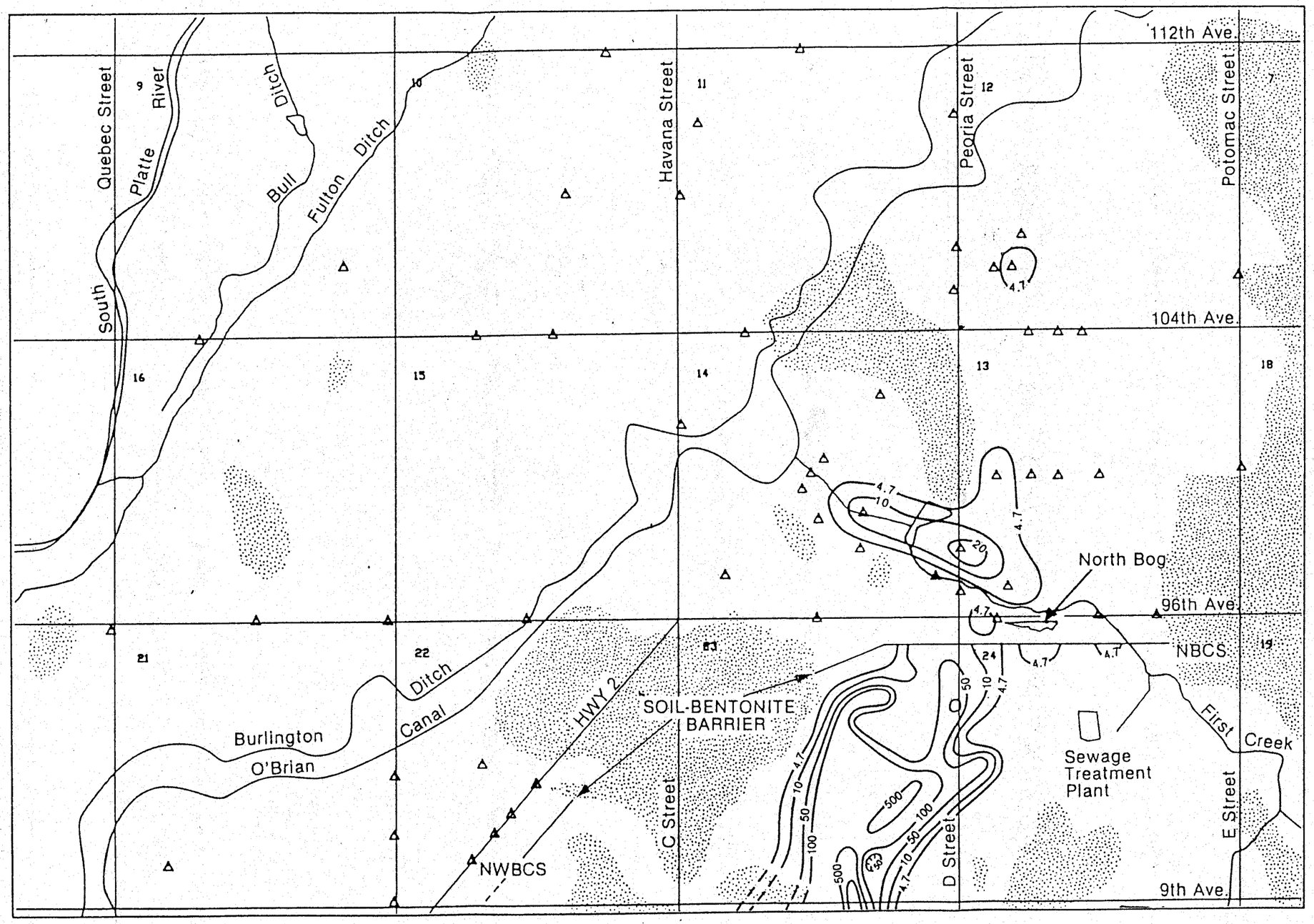
Scale In Feet

Figure F-6
DCDP CONCENTRATION DISTRIBUTION, ug/l, 4TH QUARTER,
FY87, ALLUVIAL AQUIFER

SOURCE:ESE,1988

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland



EXPLANATION

ALL CONCENTRATIONS IN MICROGRAMS PER LITER (ug/l)

1 ISOCONCENTRATION LINE

NWBCS: NORTHWEST BOUNDARY CONTAINMENT SYSTEM

NBCS: NORTH BOUNDARY CONTAINMENT SYSTEM.

△ MONITORING WELL LOCATION

UNSATURATED ALLUVIUM

N

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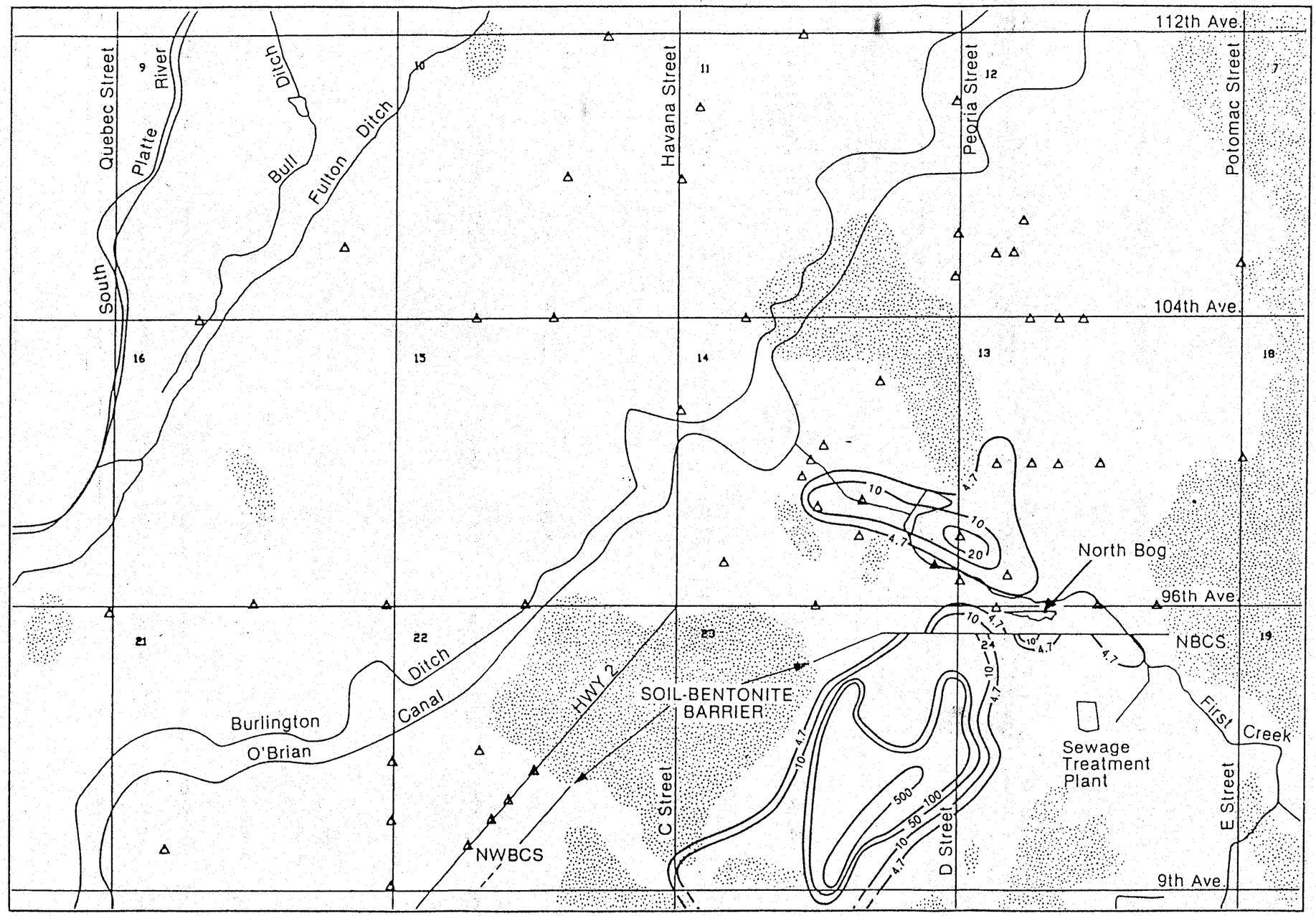
Scale In Feet

Figure F-7
CPMSO2 CONCENTRATION DISTRIBUTION,ug/l,
3RD QUARTER, FY87, ALLUVIAL AQUIFER

SOURCE:ESE,1988

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland



EXPLANATION

ALL CONCENTRATIONS IN MICROGRAMS PER LITER (ug/l)

1 — ISOCONCENTRATION LINE

NWBCS: NORTHWEST BOUNDARY CONTAINMENT SYSTEM

NBCS: NORTH BOUNDARY CONTAINMENT SYSTEM.

△ MONITORING WELL LOCATION

UNSATURATED ALLUVIUM

N

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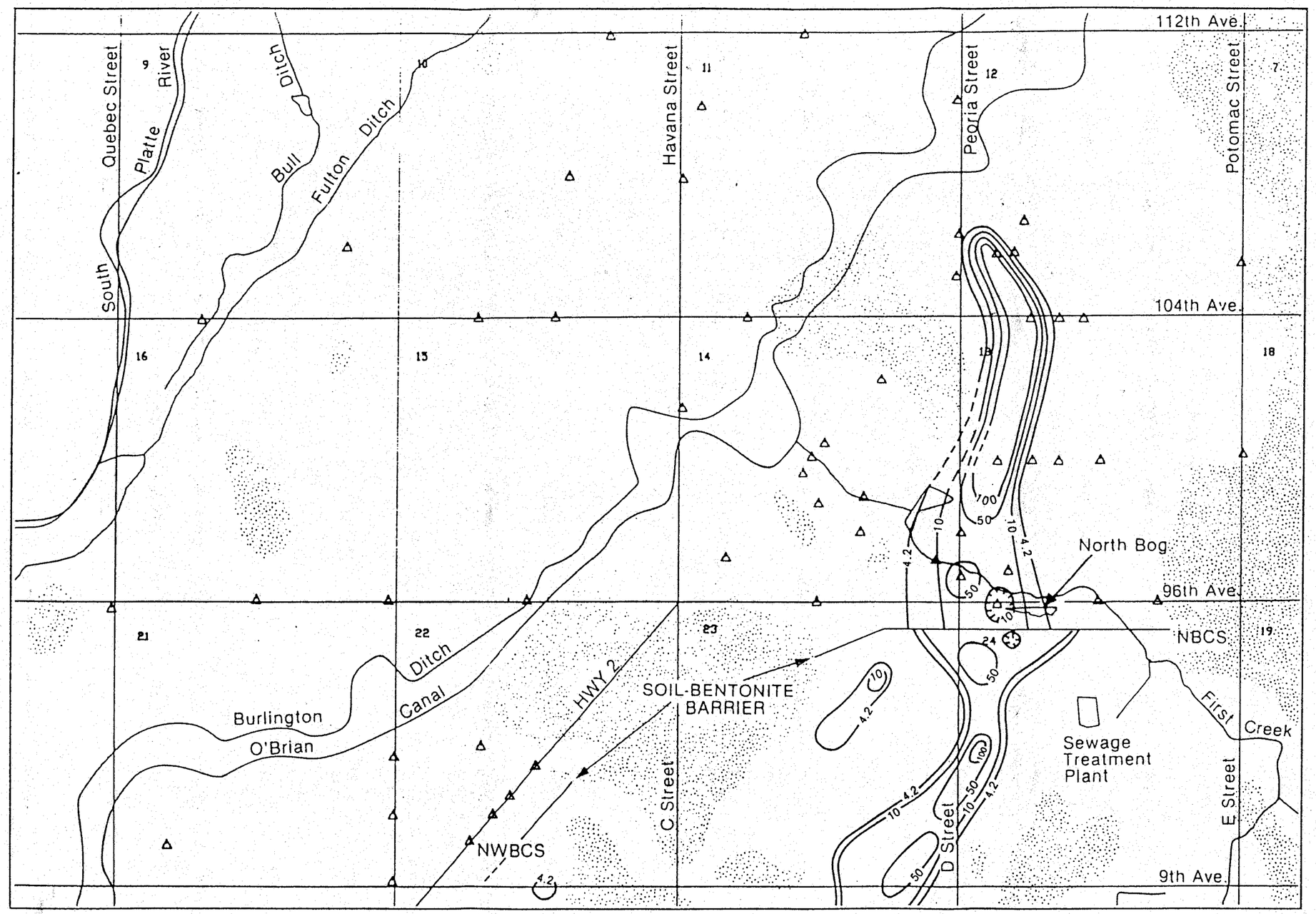
Scale In Feet

Figure F-8
CPMSO2 CONCENTRATION DISTRIBUTION, ug/l,
4TH QUARTER, FY87, ALLUVIAL AQUIFER

SOURCE:ESE,1988

Prepared for:
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Aberdeen Proving Ground, Maryland



EXPLANATION

ALL CONCENTRATIONS IN MICROGRAMS PER LITER (ug/l)

1 — ISOCONCENTRATION LINE

NWBCS: NORTHWEST BOUNDARY CONTAINMENT SYSTEM

NBCS: NORTH BOUNDARY CONTAINMENT SYSTEM.

△ MONITORING WELL LOCATION

UNSATURATED ALLUVIUM

N

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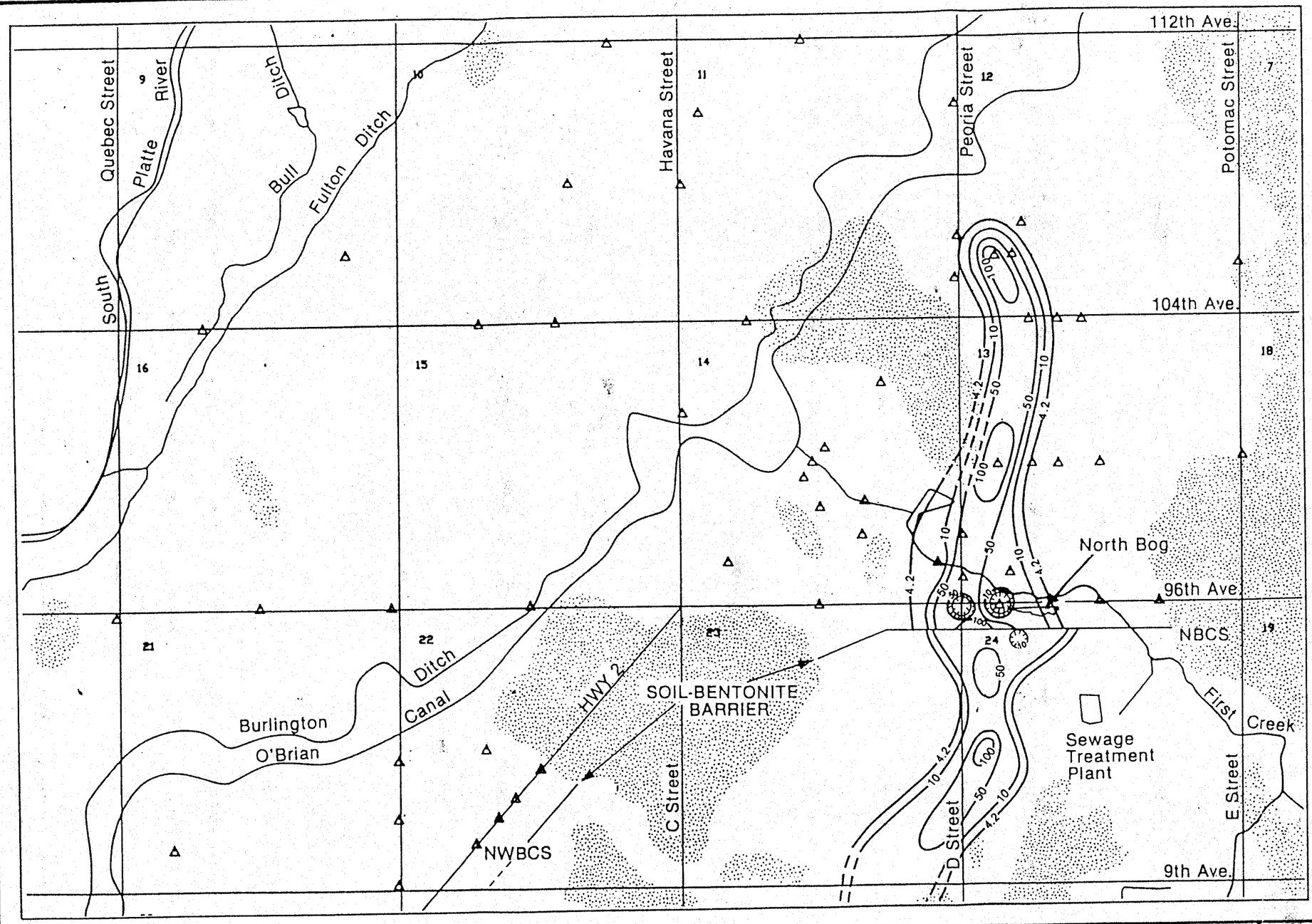
Scale In Feet

Figure F-9
CPMSO CONCENTRATION DISTRIBUTION, ug/l,
3RD QUARTER, FY87, ALLUVIAL AQUIFER

SOURCE:ESE,1988

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland



EXPLANATION

ALL CONCENTRATIONS IN MICROGRAMS PER LITER (ug/l)

1 ISOCONCENTRATION LINE

NWBCS: NORTHWEST BOUNDARY CONTAINMENT SYSTEM

NBCS: NORTH BOUNDARY CONTAINMENT SYSTEM.

△ MONITORING WELL LOCATION

UNSATURATED ALLUVIUM

N

0 1000 2000

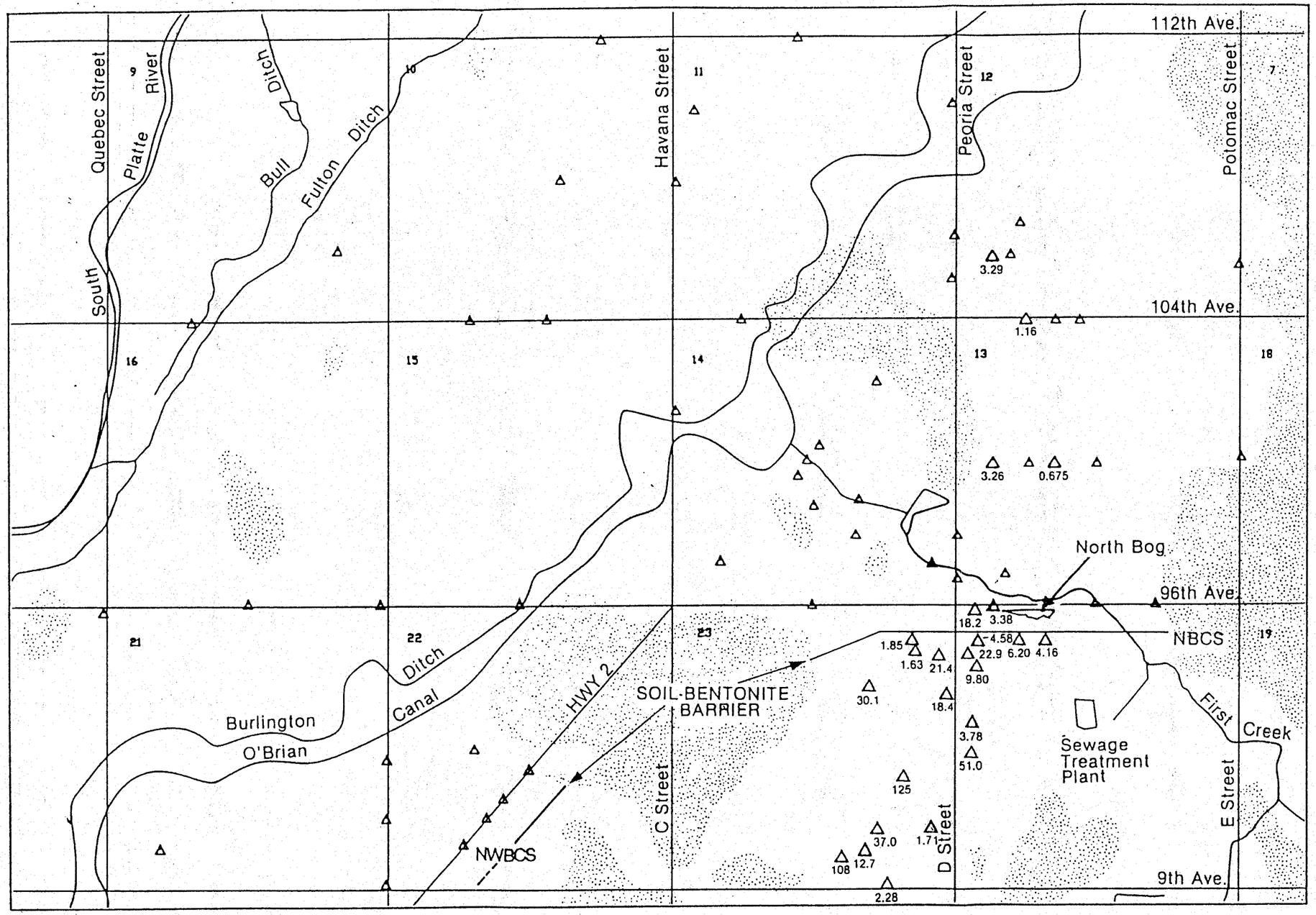
Scale In Feet

Figure F-10
CPMSO CONCENTRATION DISTRIBUTION, ug/l,
4TH QUARTER, FY87, ALLUVIAL AQUIFER

SOURCE:ESE,1988

Prepared for:
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For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland



EXPLANATION

5.42 CONCENTRATION IN MICROGRAMS PER LITER (ug/l)

NWBCS: NORTHWEST BOUNDARY CONTAINMENT SYSTEM

NBCS: NORTH BOUNDARY CONTAINMENT SYSTEM.

△ MONITORING WELL LOCATION

UNSATURATED ALLUVIUM

N

0 1000 2000

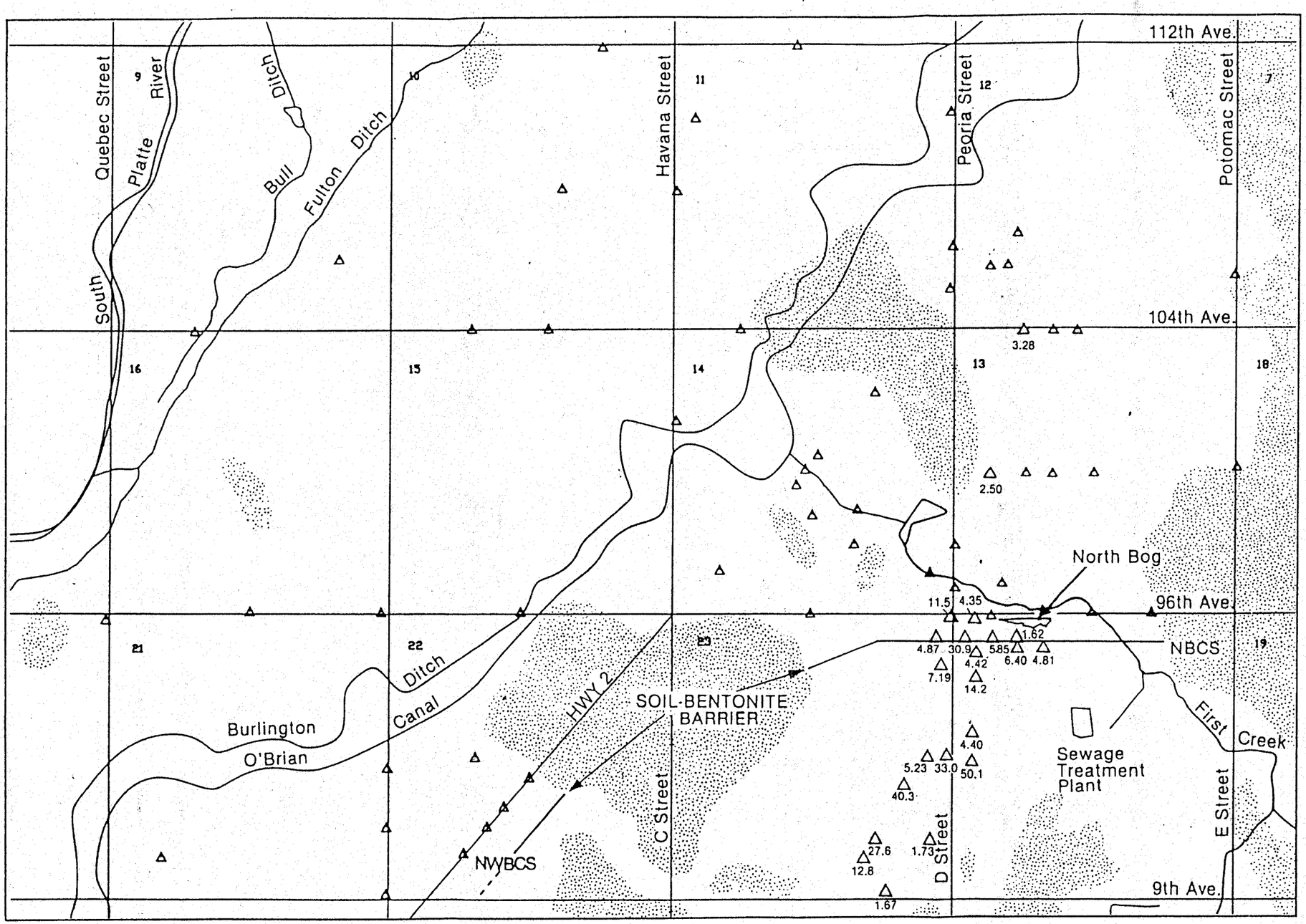
Scale In Feet

Figure F-11
CPMS CONCENTRATIONS EXCEEDING CERTIFIED REPORTING LIMITS, ug/l,
3RD QUARTER, FY87, ALLUVIAL AQUIFER

SOURCE:ESE,1988

Prepared for:
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For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland



EXPLANATION

5.42 CONCENTRATION IN MICROGRAMS PER LITER (ug/l)

NWBCS: NORTHWEST BOUNDARY CONTAINMENT SYSTEM

NBCS: NORTH BOUNDARY CONTAINMENT SYSTEM.

△ MONITORING WELL LOCATION

UNSATURATED ALLUVIUM

N

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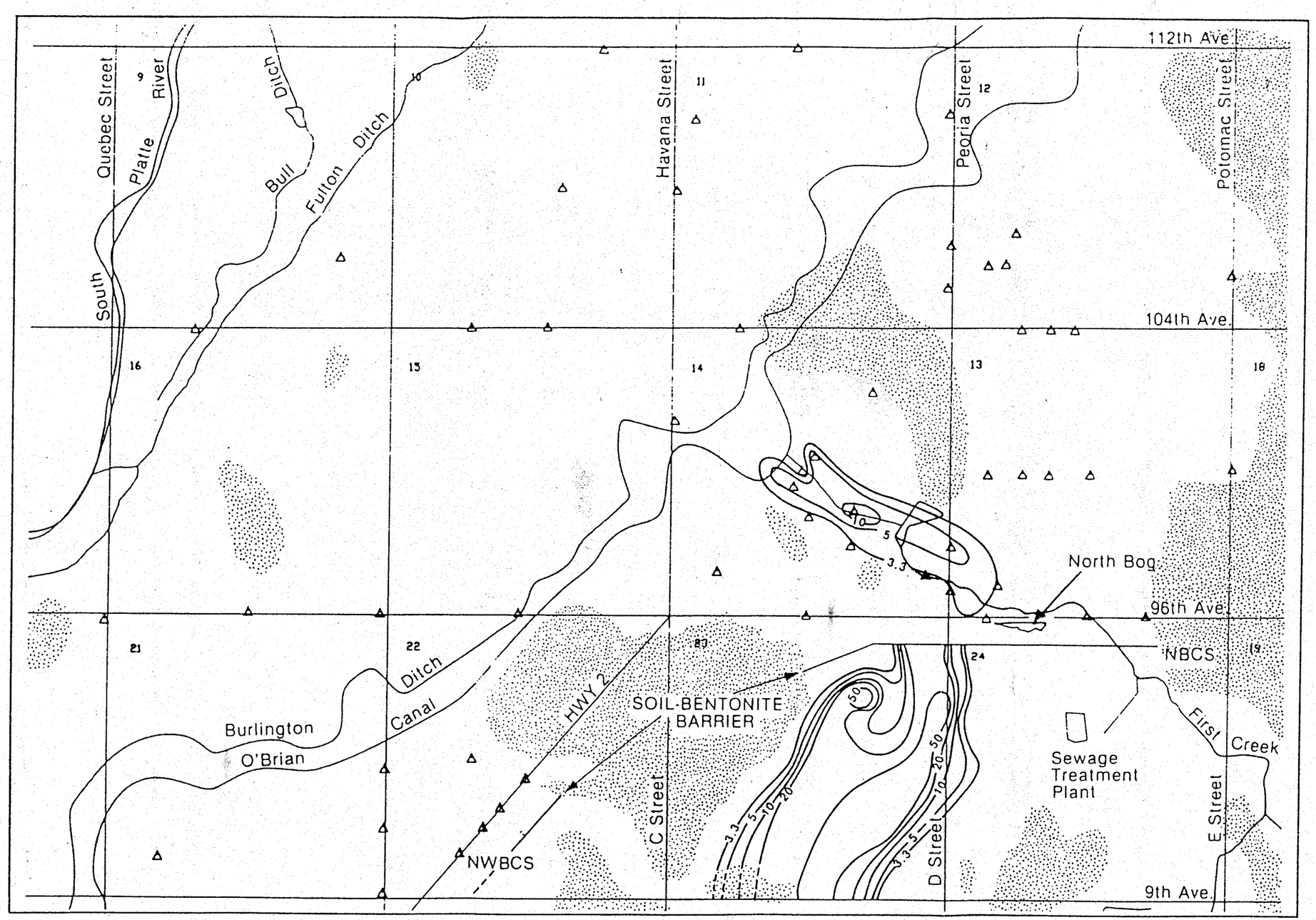
Scale In Feet

Figure F-12
CPMS CONCENTRATIONS EXCEEDING CERTIFIED REPORTING LIMITS, ug/l,
4TH QUARTER, FY87, ALLUVIAL AQUIFER

SOURCE:ESE,1988

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For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland



EXPLANATION

ALL CONCENTRATIONS IN MICROGRAMS PER LITER (ug/l)

1 — ISOCONCENTRATION LINE

NWBCS: NORTHWEST BOUNDARY CONTAINMENT SYSTEM

NBCS: NORTH BOUNDARY CONTAINMENT SYSTEM.

△ MONITORING WELL LOCATION

UNSATURATED ALLUVIUM

N

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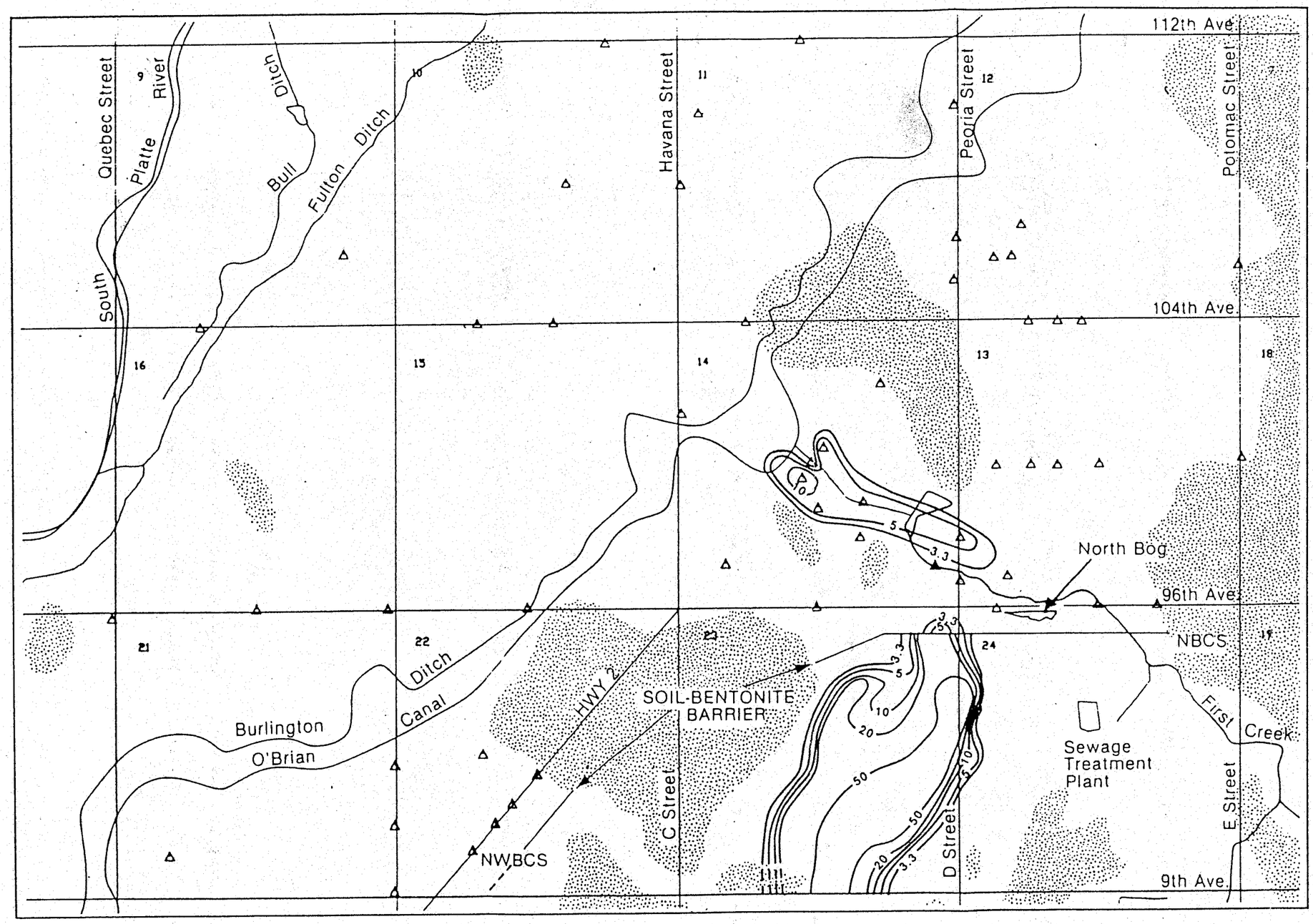
Scale In Feet

Figure F-13
1,4 DITHIANE CONCENTRATION DISTRIBUTION, ug/l,
3RD QUARTER, FY87,ALLUVIAL AQUIFER

SOURCE:ESE,1988

Prepared for:
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Aberdeen Proving Ground, Maryland



EXPLANATION

ALL CONCENTRATIONS IN MICROGRAMS PER LITER (ug/l)

1 — ISOCONCENTRATION LINE

NWBCS: NORTHWEST BOUNDARY CONTAINMENT SYSTEM

NBCS: NORTH BOUNDARY CONTAINMENT SYSTEM.

△ MONITORING WELL LOCATION

UNSATURATED ALLUVIUM

N

0 1000 2000

Scale In Feet

Figure F-14
1,4 DITHIANE CONCENTRATION DISTRIBUTION, ug/l,
4TH QUARTER, FY87, ALLUVIAL AQUIFER

SOURCE:ESE,1988

Prepared for:
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For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland

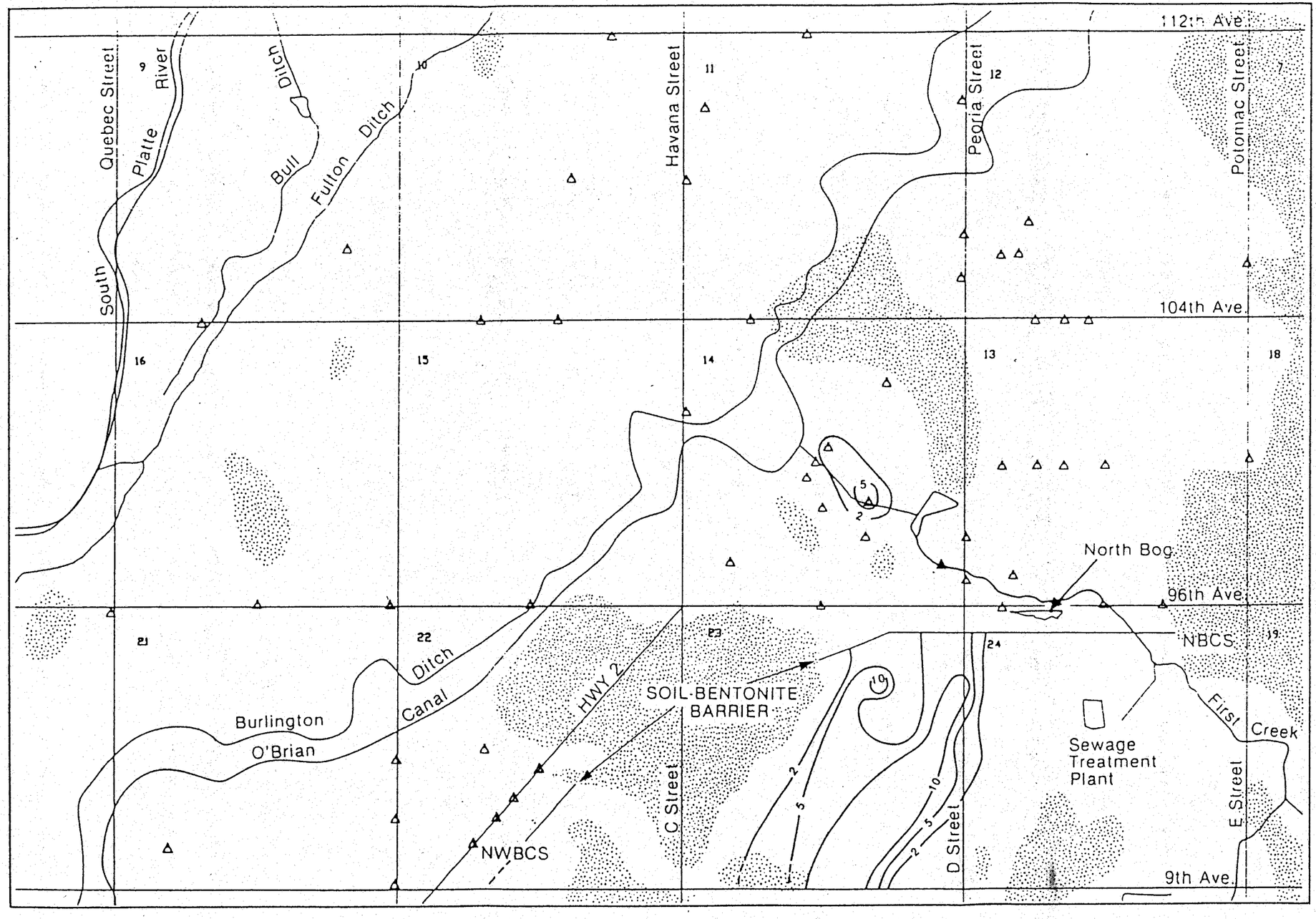
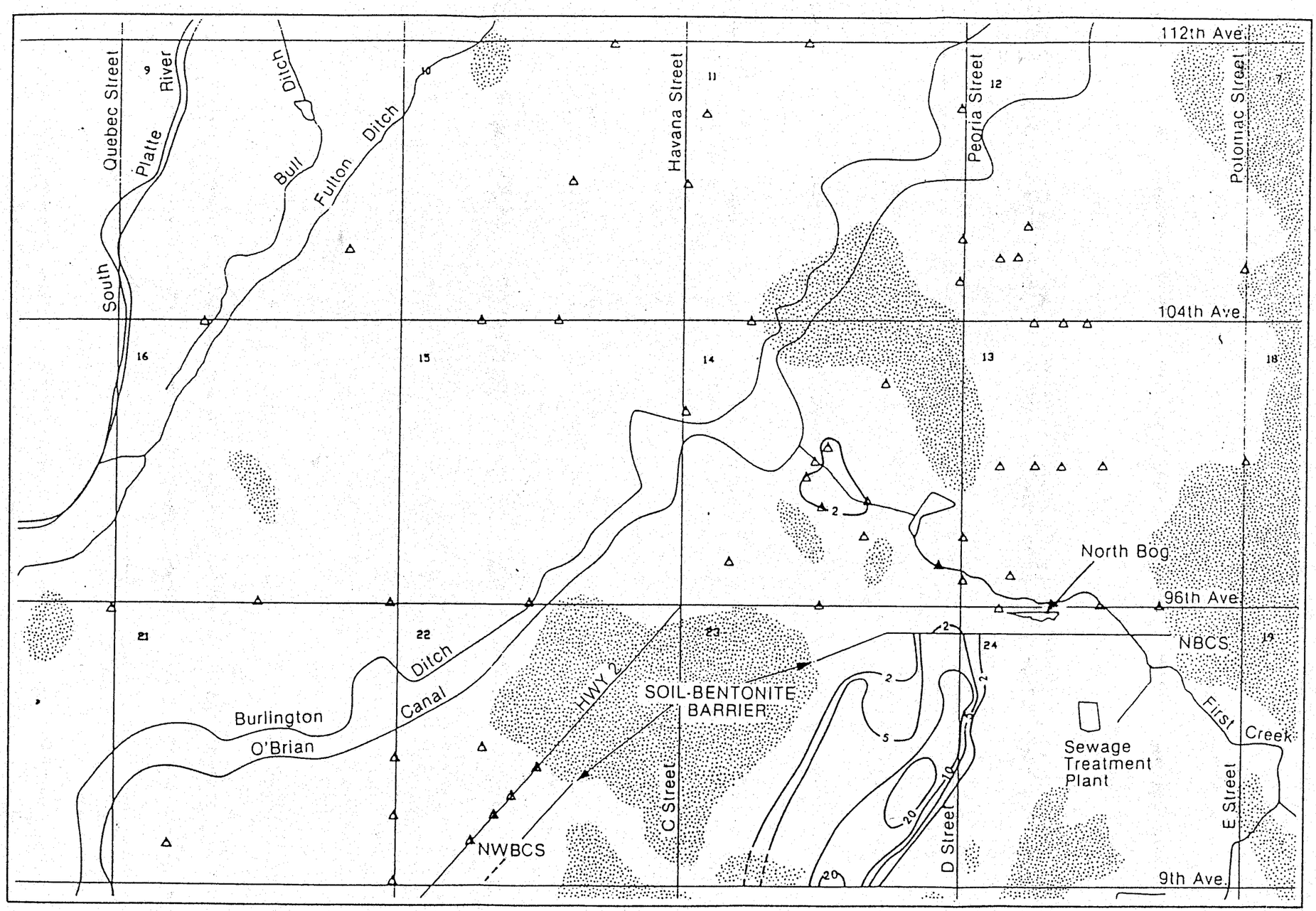


Figure F-15
1,4 OXATHIANE CONTENTRATION DISTRIBUTION, ug/l,
3RD QUARTER, FY87, ALLUVIAL AQUIFER

SOURCE:ESE,1988

Prepared for:
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Aberdeen Proving Ground, Maryland



EXPLANATION

ALL CONCENTRATIONS IN MICROGRAMS PER LITER (ug/l)

1 — ISOCONCENTRATION LINE

NWBCS: NORTHWEST BOUNDARY CONTAINMENT SYSTEM

NBCS: NORTH BOUNDARY CONTAINMENT SYSTEM.

△ MONITORING WELL LOCATION

UNSATURATED ALLUVIUM

N

0 1000 2000

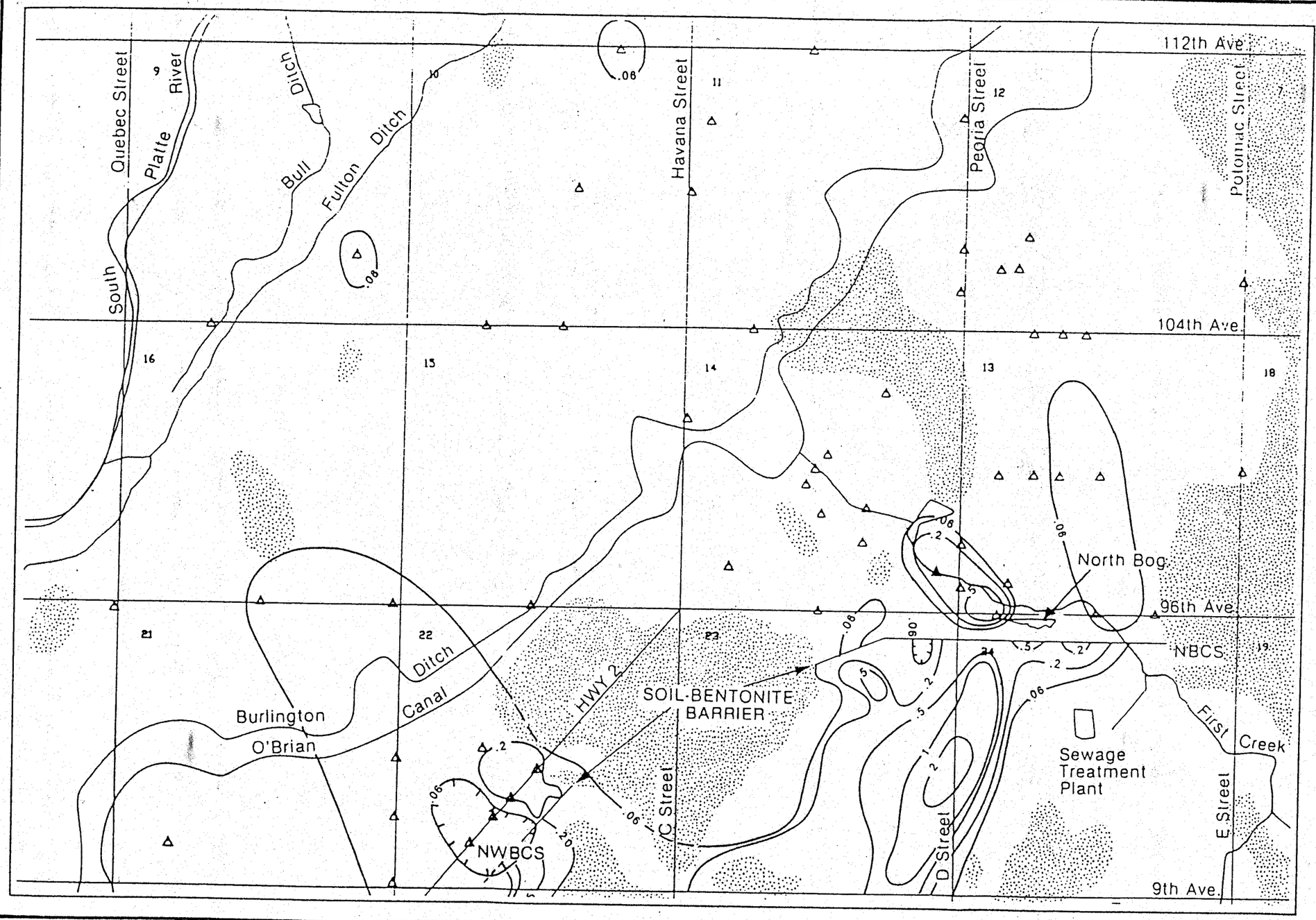
Scale In Feet

Figure F-16
1,4 OXATHAINE CONCENTRATION DISTRIBUTION, ug/l,
4TH QUARTER, FY87, ALLUVIAL AQUIFER

SOURCE:ESE,1988

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Aberdeen Proving Ground, Maryland



EXPLANATION

ALL CONCENTRATIONS IN MICROGRAMS PER LITER (ug/l)

1 — ISOCONCENTRATION LINE

NWBCS: NORTHWEST BOUNDARY CONTAINMENT SYSTEM

NBCS: NORTH BOUNDARY CONTAINMENT SYSTEM.

△ MONITORING WELL LOCATION

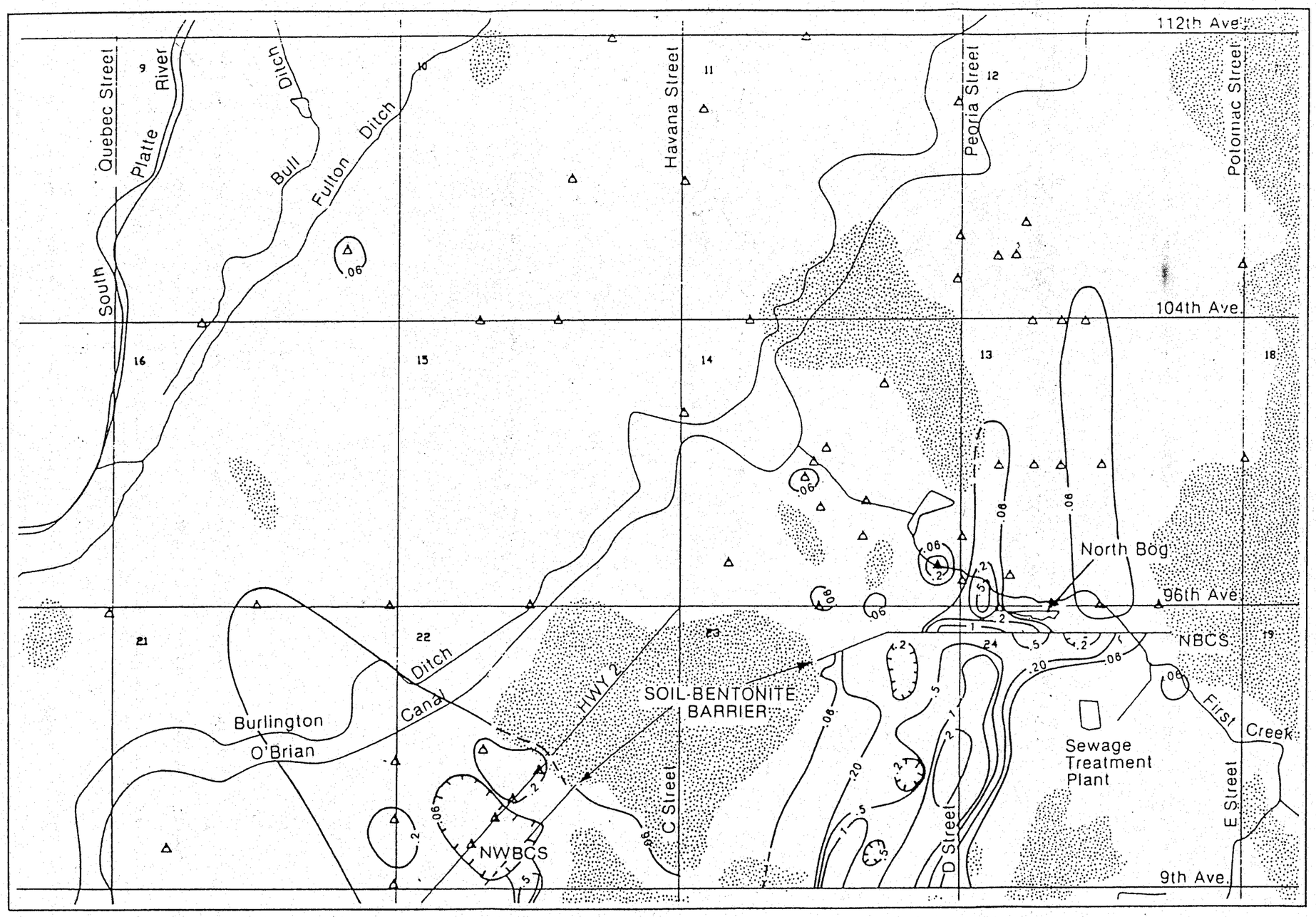
UNSATURATED ALLUVIUM

Figure F-17
DIELDRIN CONCENTRATION DISTRIBUTION, ug/l, 3RD QUARTER, FY87, ALLUVIAL AQUIFER

SOURCE:ESE,1988

Prepared for:
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For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland



EXPLANATION

ALL CONCENTRATIONS IN MICROGRAMS PER LITER (ug/l)

1 ISOCONCENTRATION LINE

NWBCS: NORTHWEST BOUNDARY CONTAINMENT SYSTEM

NBCS: NORTH BOUNDARY CONTAINMENT SYSTEM.

MONITORING WELL LOCATION

UNSATURATED ALLUVIUM

N

0 1000 2000

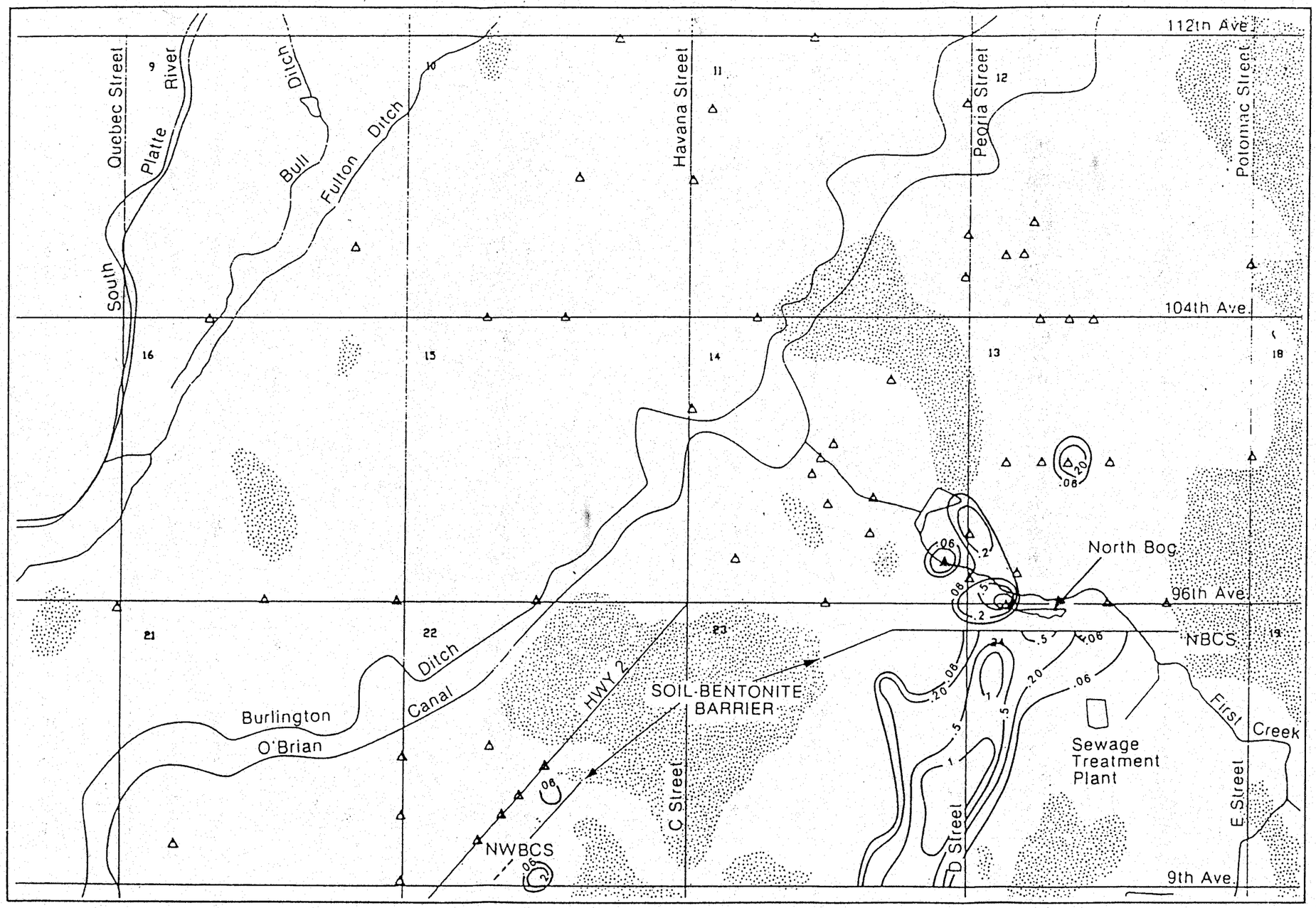
Scale In Feet

Figure F-18
DIELDRIN CONCENTRATION DISTRIBUTION, ug/l, 4TH QUARTER, FY87, ALLUVIAL AQUIFER

SOURCE:ESE, 1988

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EXPLANATION

ALL CONCENTRATIONS IN MICROGRAMS PER LITER (ug/l)

1 — ISOCONCENTRATION LINE

NWBCS: NORTHWEST BOUNDARY CONTAINMENT SYSTEM

NBCS: NORTH BOUNDARY CONTAINMENT SYSTEM.

△ - MONITORING WELL LOCATION

UNSATURATED ALLUVIUM

N

0 1000 2000

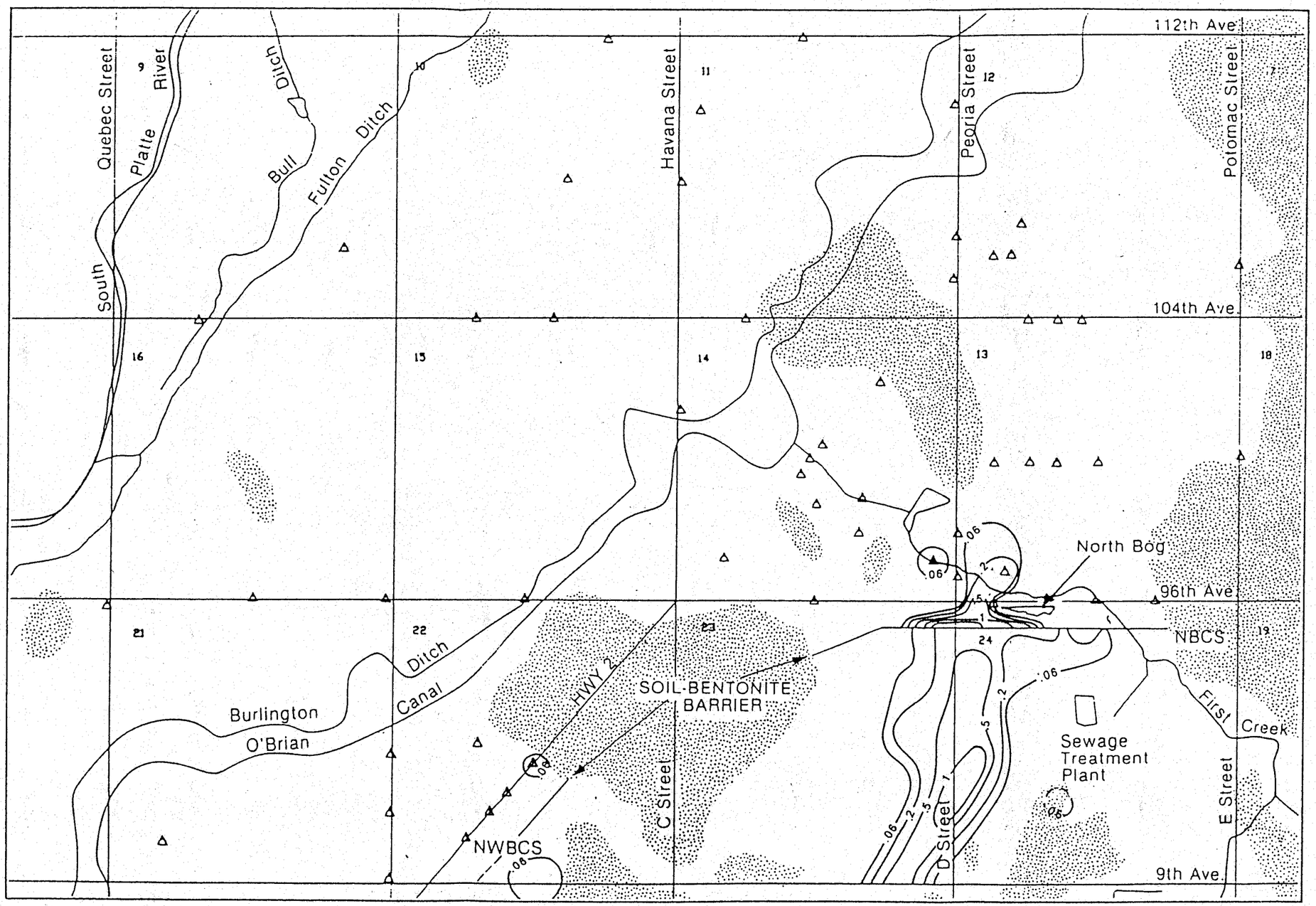
Scale In Feet

Figure F-19
ENDRIN CONCENTRATION DISTRIBUTION, ug/l, 3RD QUARTER, FY87, ALLUVIAL AQUIFER

SOURCE:ESE,1988

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EXPLANATION

ALL CONCENTRATIONS IN MICROGRAMS PER LITER (ug/l)

1 — ISOCONCENTRATION LINE

NWBCS: NORTHWEST BOUNDARY CONTAINMENT SYSTEM

NBCS: NORTH BOUNDARY CONTAINMENT SYSTEM.

△ MONITORING WELL LOCATION

UNSATURATED ALLUVIUM

N

0 1000 2000

Scale In Feet

Figure F-20
ENDRIN CONCENTRATION DISTRIBUTION, ug/l, 4TH QUARTER, FY87, ALLUVIAL AQUIFER

SOURCE:ESE,1988

Prepared for:
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Aberdeen Proving Ground, Maryland

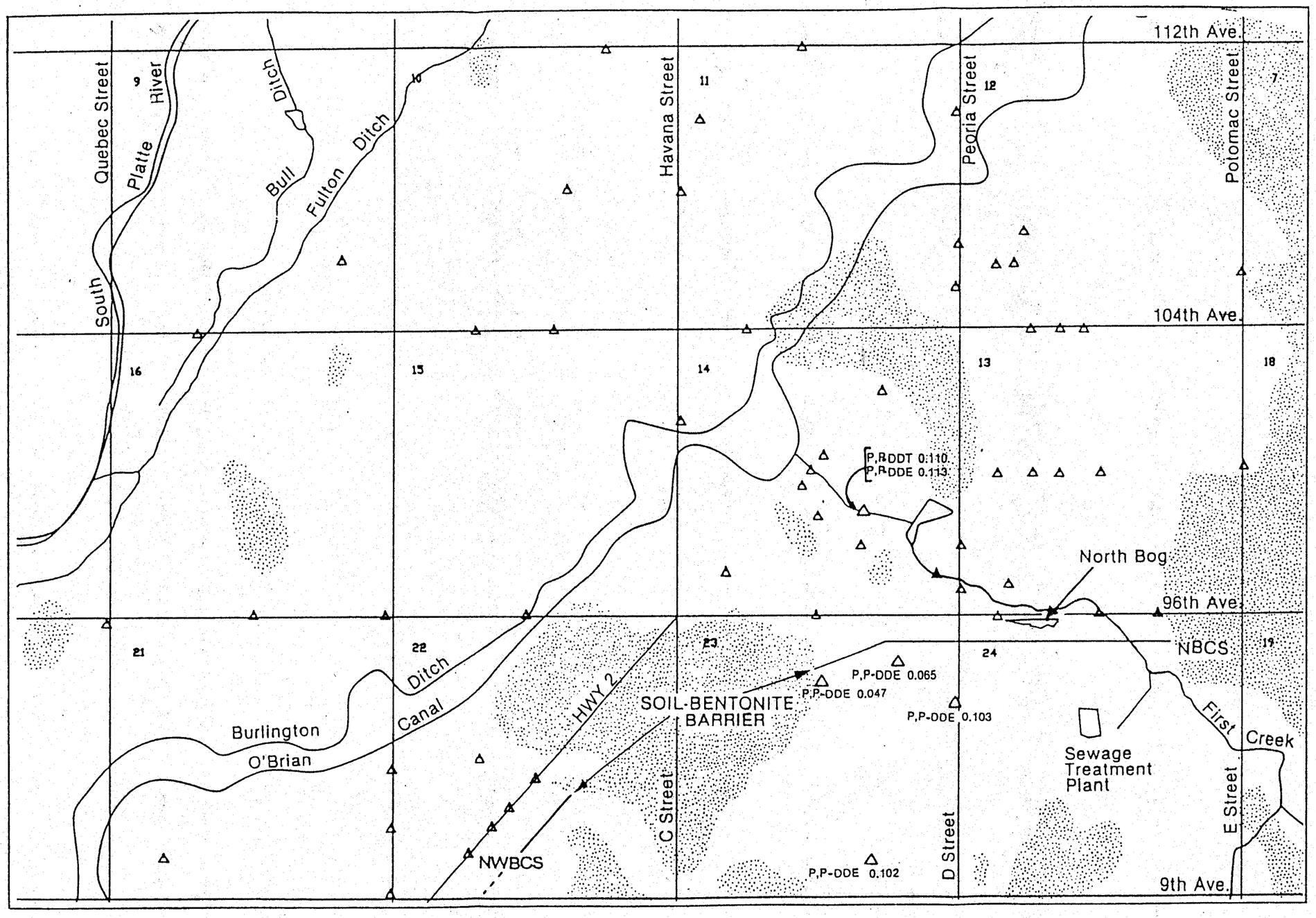
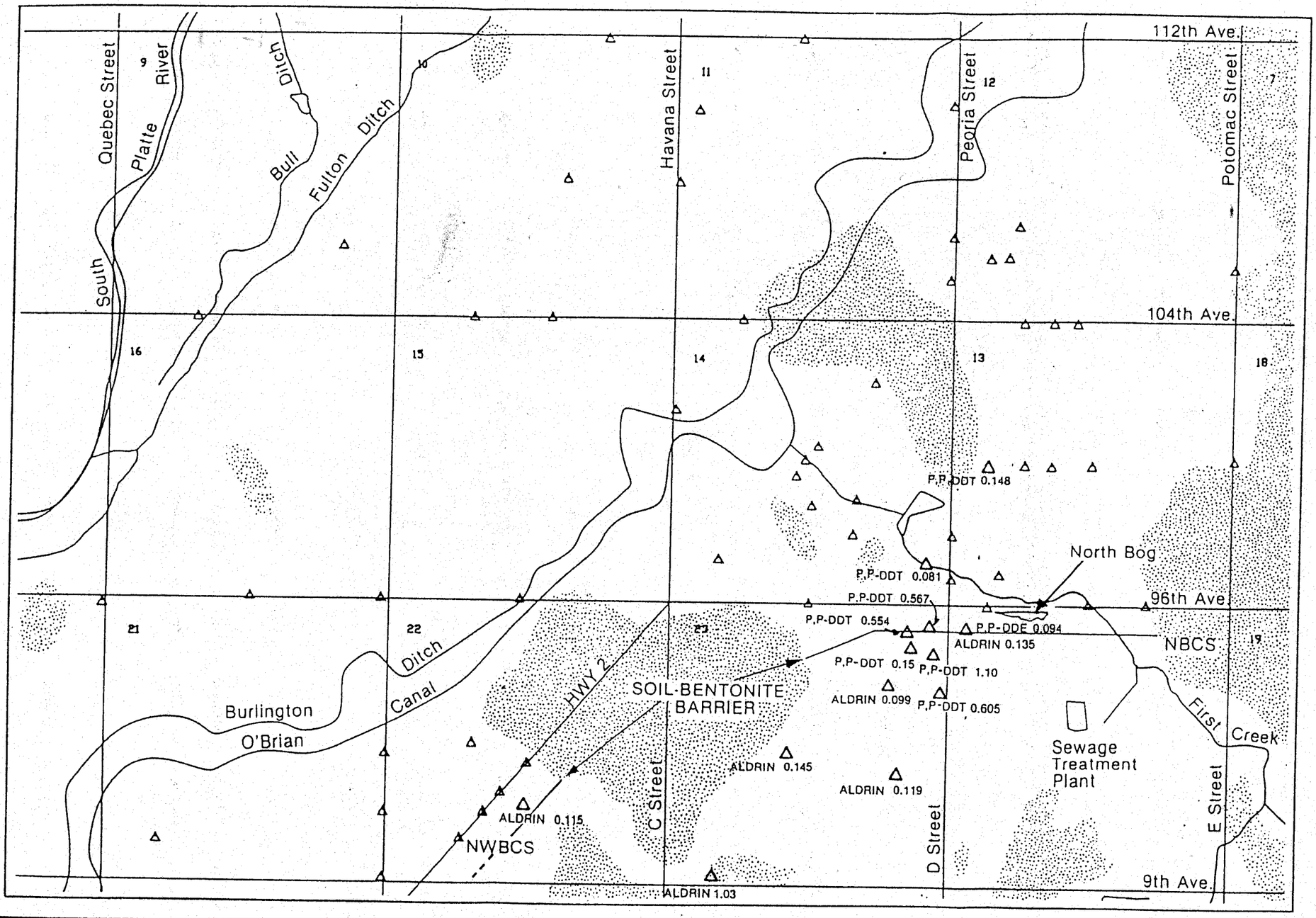


Figure F-21
ORGANOCHLORINE PESTICIDES (P,P-DDE, P,P-DDT, ALDRIN, ISODRIN) CONCENTRATIONS EXCEEDING CERTIFIED REPORTING LIMITS, ug/l, 3RD QUARTER, FY87, ALLUVIAL AQUIFER

SOURCE: ESE, 1988

Prepared for:
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For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland



EXPLANATION

5.42 CONCENTRATION IN MICROGRAMS PER LITER (ug/l)

NWBCS: NORTHWEST BOUNDARY CONTAINMENT SYSTEM

NBCS: NORTH BOUNDARY CONTAINMENT SYSTEM.

△ MONITORING WELL LOCATION

UNSATURATED ALLUVIUM

N

0 1000 2000

Scale In Feet

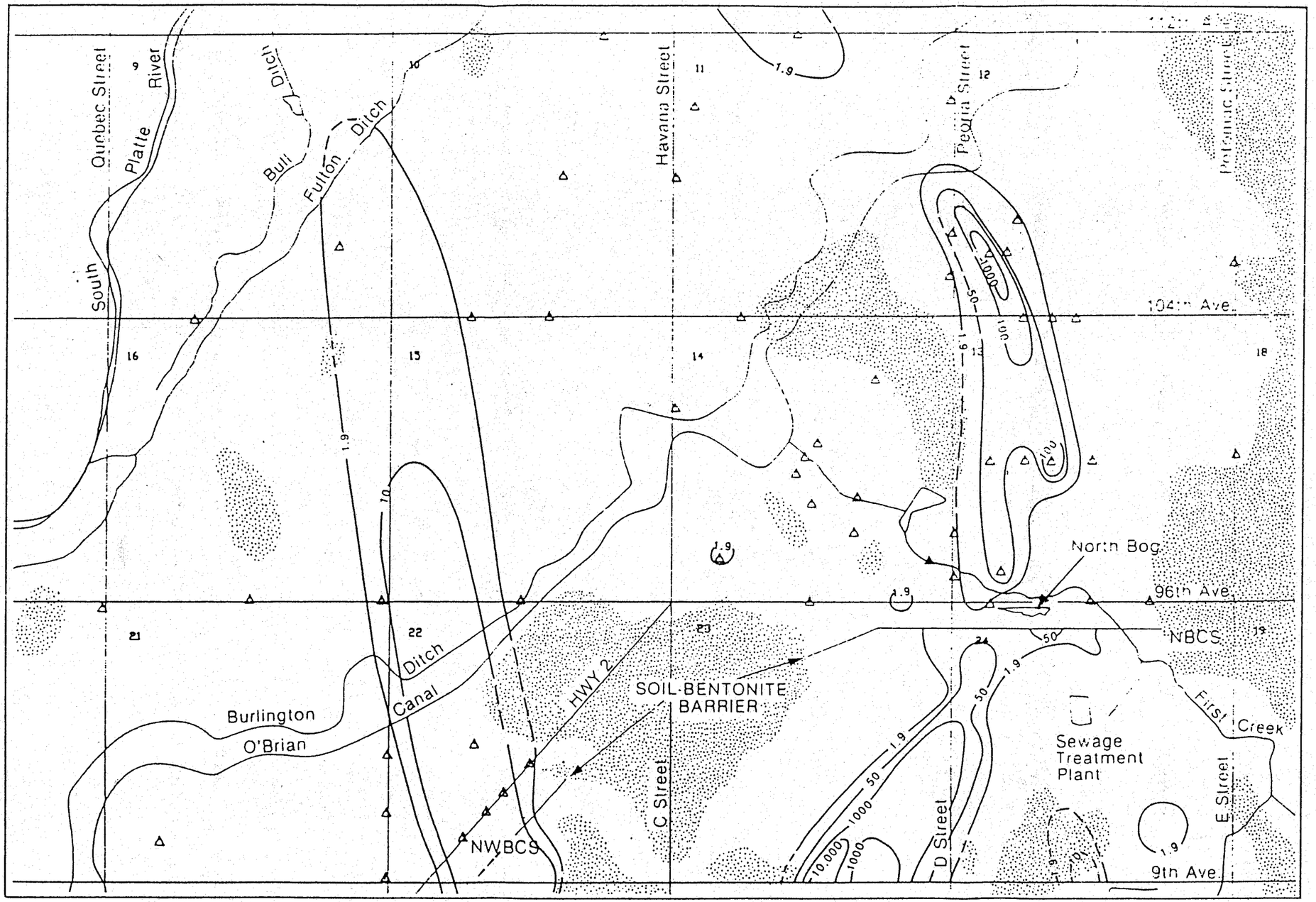
Figure F-22

ORGANOCHLORINE PESTICIDES (P,P-DDE, P,P-DDT, ALDRIN, ISODRIN) CONCENTRATIONS EXCEEDING CERTIFIED REPORTING LIMITS, ug/l, 4TH QUARTER, FY87, ALLUVIAL AQUIFER

SOURCE: ESE, 1988

Prepared for:
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Aberdeen Proving Ground, Maryland



EXPLANATION

ALL CONCENTRATIONS IN MICROGRAMS PER LITER (ug/l)

1 — ISOCONCENTRATION LINE

NWBCS: NORTHWEST BOUNDARY CONTAINMENT SYSTEM

NBCS: NORTH BOUNDARY CONTAINMENT SYSTEM.

△ MONITORING WELL LOCATION

UNSATURATED ALLUVIUM

N

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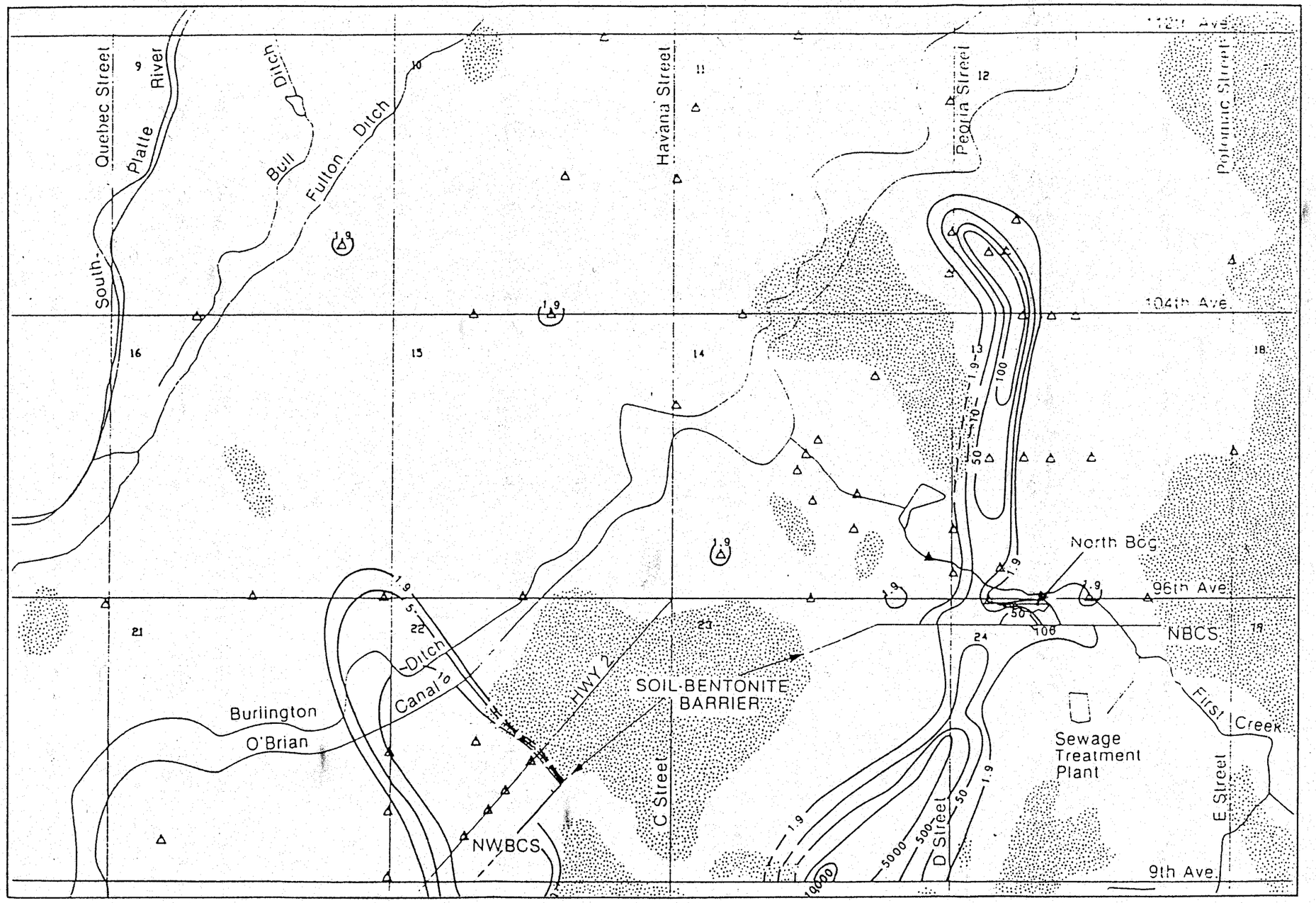
Scale in Feet

Figure F-23
CHLOROFORM CONCENTRATION DISTRIBUTION, ug/l,
3RD QUARTER, FY87, ALLUVIAL AQUIFER

SOURCE:ESE,1988

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland



EXPLANATION

ALL CONCENTRATIONS IN MICROGRAMS PER LITER (ug/l)

—1— ISOCONCENTRATION LINE

NWBCS: NORTHWEST BOUNDARY CONTAINMENT SYSTEM

NBCS: NORTH BOUNDARY CONTAINMENT SYSTEM.

△ MONITORING WELL LOCATION

UNSATURATED ALLUVIUM

N

0 1000 2000

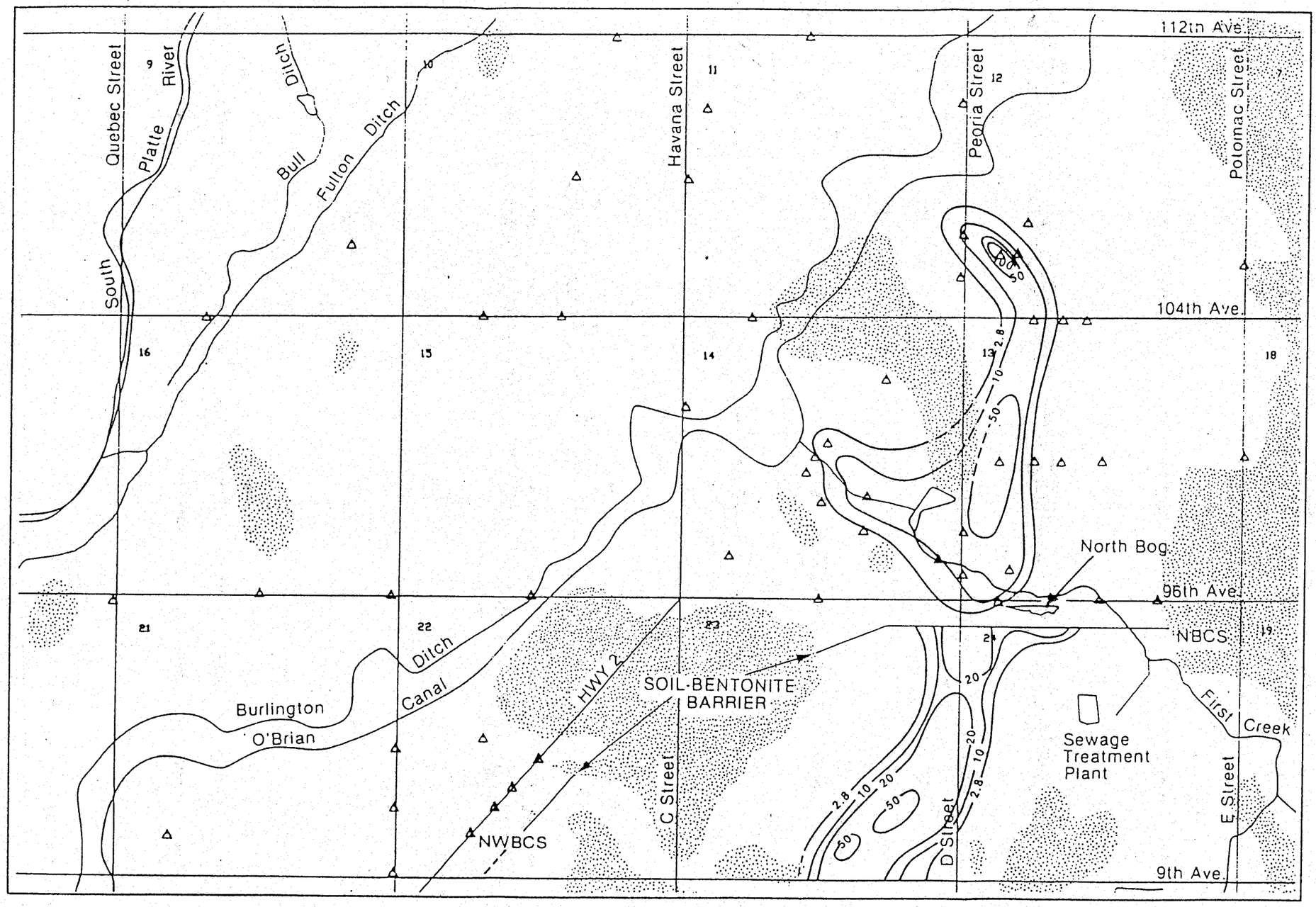
Scale In Feet

Figure F-24
CHLOROFORM CONCENTRATION DISTRIBUTION, ug/l,
4TH QUARTER, FY87, ALLUVIAL AQUIFER

SOURCE:ESE,1988

Prepared for:
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For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland



EXPLANATION

ALL CONCENTRATIONS IN MICROGRAMS PER LITER (ug/l)

1 — ISOCONCENTRATION LINE

NWBCS: NORTHWEST BOUNDARY CONTAINMENT SYSTEM

NBCS: NORTH BOUNDARY CONTAINMENT SYSTEM.

△ MONITORING WELL LOCATION

UNSATURATED ALLUVIUM

N

0 1000 2000

Scale In Feet

Figure F-25
TETRACHLOROETHENE CONCENTRATION DISTRIBUTION, ug/l,
3RD QUARTER, FY87, ALLUVIAL AQUIFER

SOURCE:ESE,1988

Prepared for:
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For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland

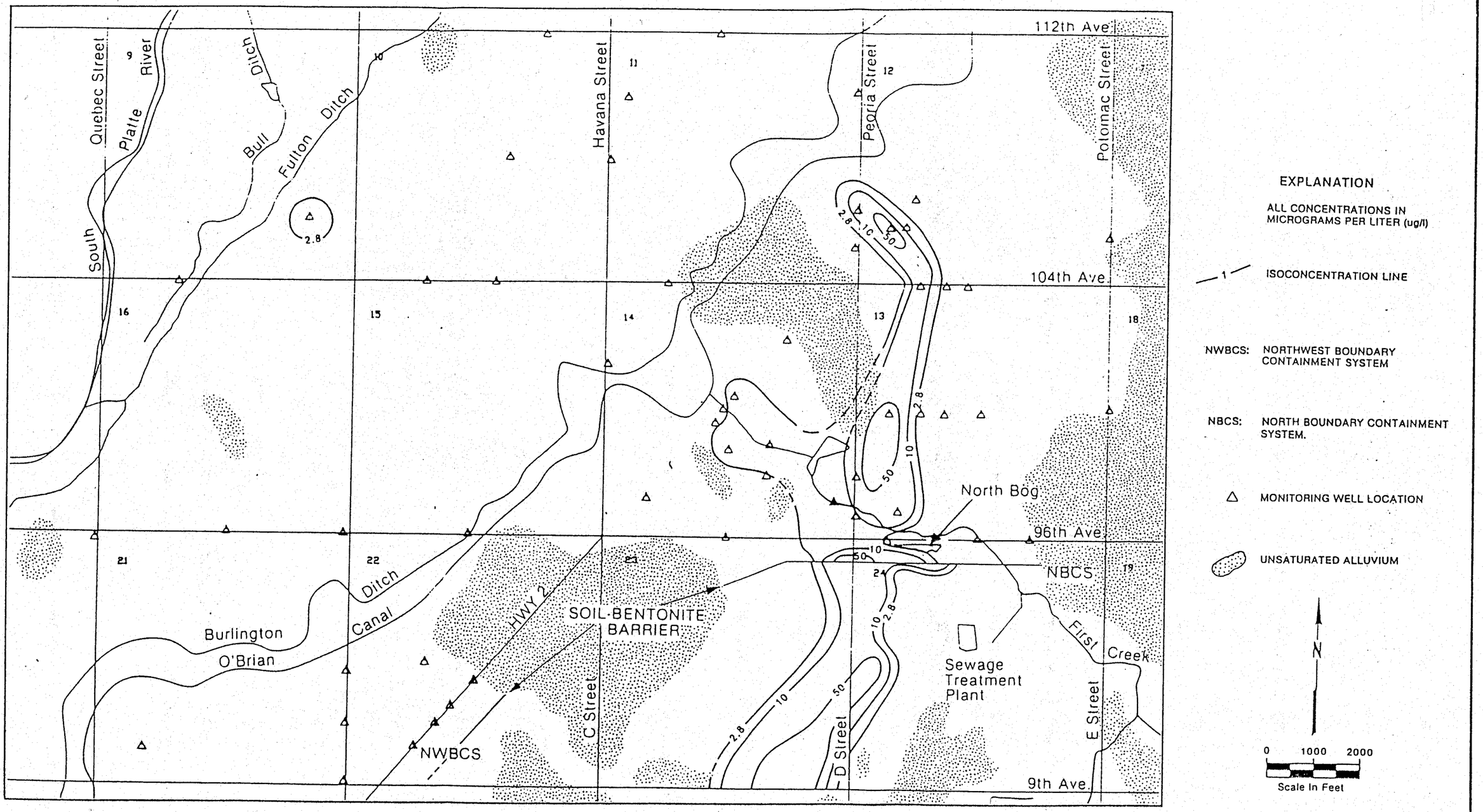
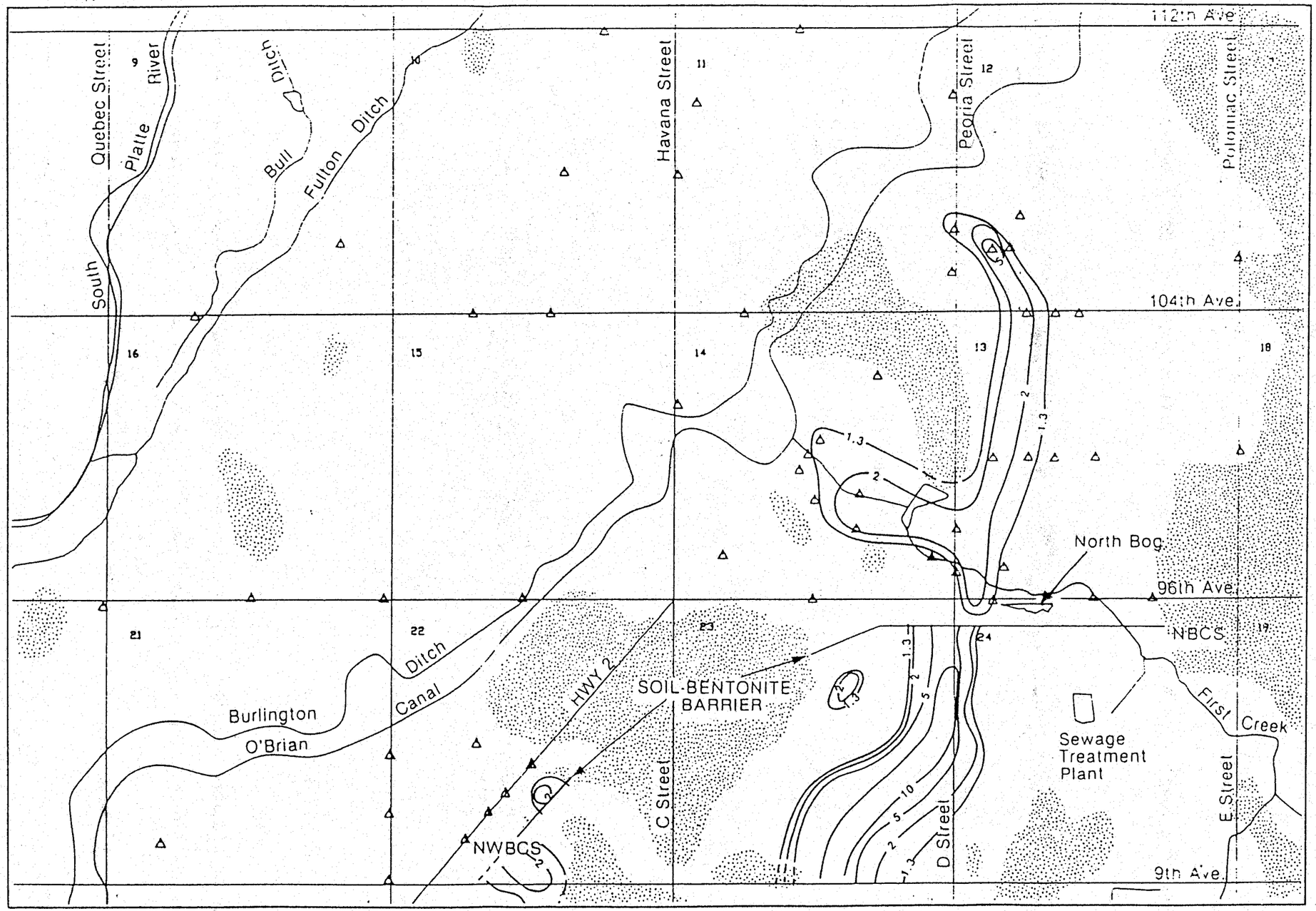


Figure F-26
TETRACHLOROETHENE CONCENTRATION DISTRIBUTION, ug/l,
4TH QUARTER, FY87, ALLUVIAL AQUIFER

SOURCE:ESE,1988

Prepared for:
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For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland



EXPLANATION

ALL CONCENTRATIONS IN MICROGRAMS PER LITER (ug/l)

1 — ISOCONCENTRATION LINE

NWBCS: NORTHWEST BOUNDARY CONTAINMENT SYSTEM

NBCS: NORTH BOUNDARY CONTAINMENT SYSTEM.

△ MONITORING WELL LOCATION

UNSATURATED ALLUVIUM

N

0 1000 2000

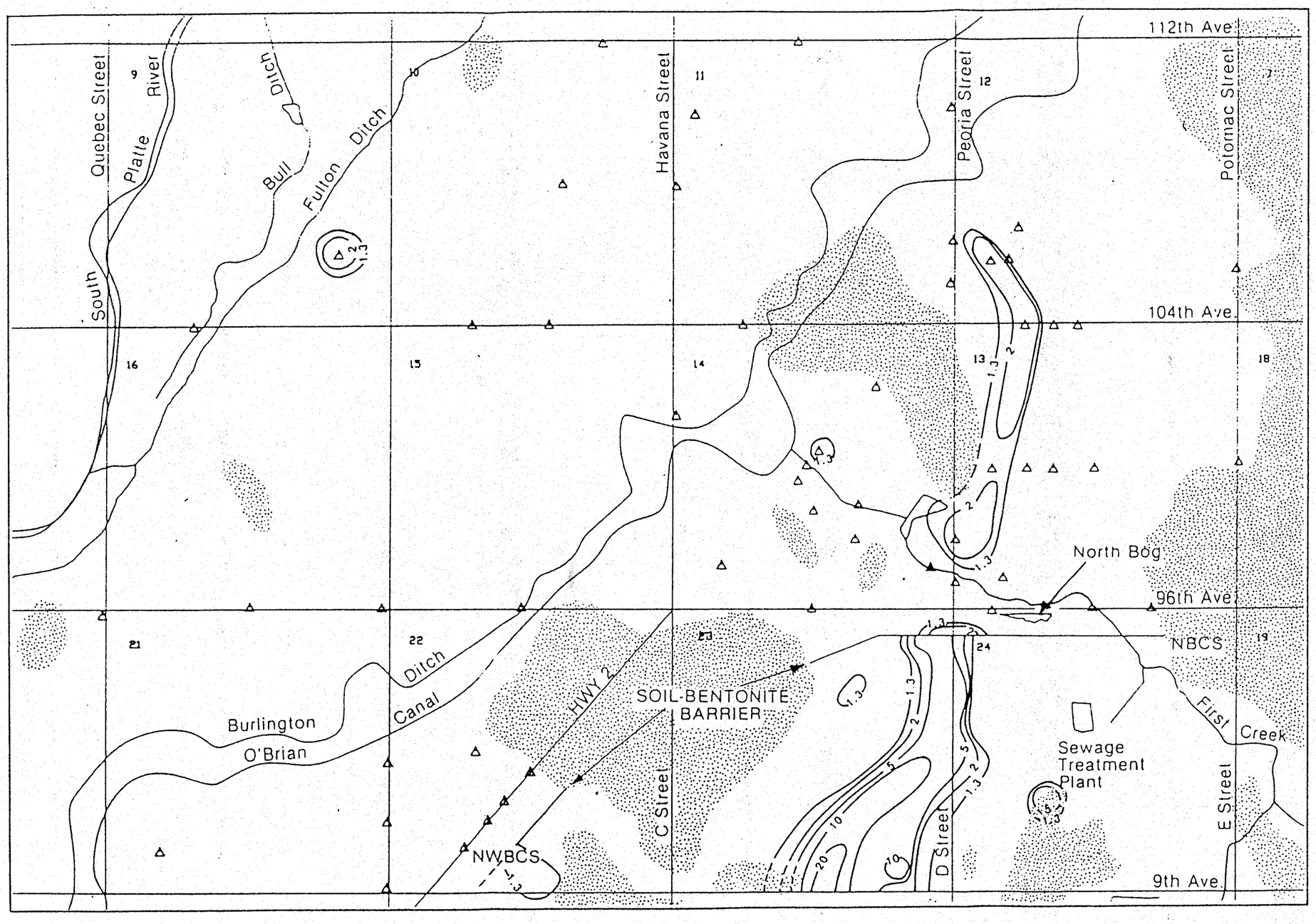
Scale In Feet

Figure F-27
TRICHLOROETHENE CONCENTRATION DISTRIBUTION, ug/l,
3RD QUARTER, FY87, ALLUVIAL AQUIFER

SOURCE:ESE,1988

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland



EXPLANATION

ALL CONCENTRATIONS IN MICROGRAMS PER LITER (ug/l)

1 — ISOCONCENTRATION LINE

NWBCS: NORTHWEST BOUNDARY CONTAINMENT SYSTEM

NBCS: NORTH BOUNDARY CONTAINMENT SYSTEM.

△ MONITORING WELL LOCATION

UNSATURATED ALLUVIUM

N

0 1000 2000

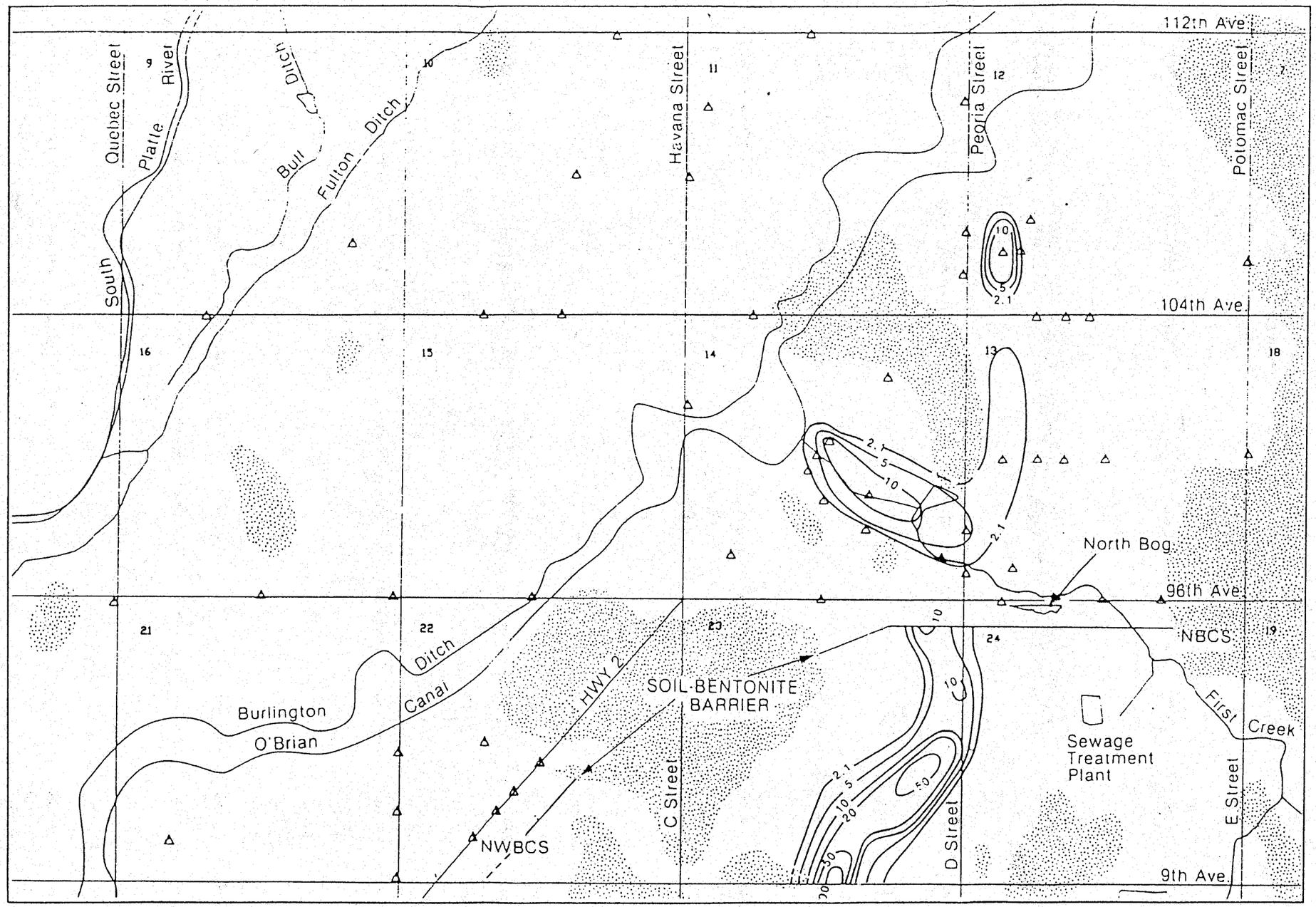
Scale In Feet

Figure F-28
TRICHLOROETHENE CONCENTRATION DISTRIBUTION, ug/l,
4TH QUARTER, FY87, ALLUVIAL AQUIFER

SOURCE:ESE,1988

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland



EXPLANATION

ALL CONCENTRATIONS IN MICROGRAMS PER LITER (ug/l)

1 — ISOCONCENTRATION LINE

NWBCS: NORTHWEST BOUNDARY CONTAINMENT SYSTEM

NBCS: NORTH BOUNDARY CONTAINMENT SYSTEM.

△ MONITORING WELL LOCATION

UNSATURATED ALLUVIUM

N

0 1000 2000

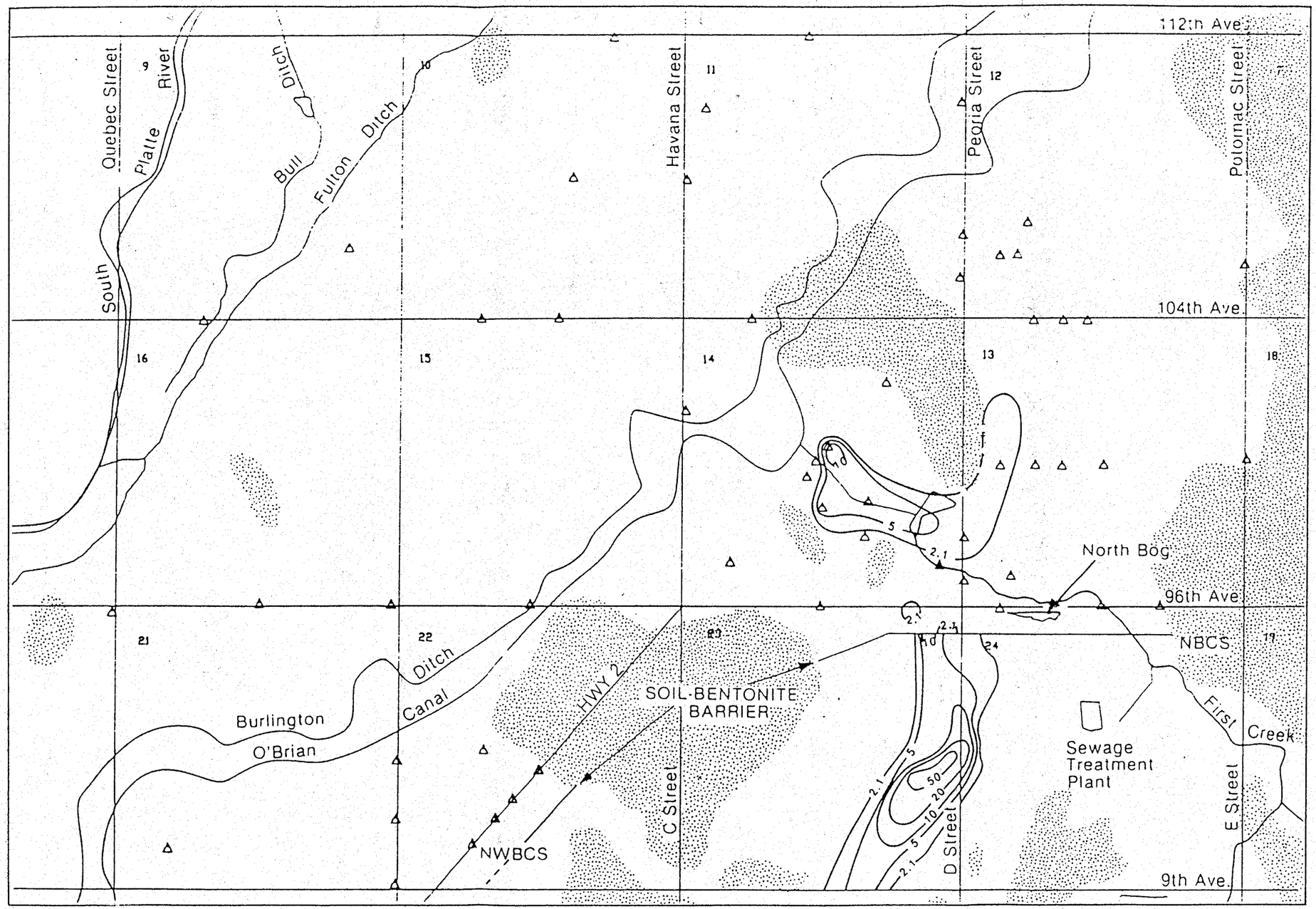
Scale In Feet

Figure F-29
1,2 DICHLOROETHANE CONCENTRATION DISTRIBUTION, ug/l,
3RD QUARTER, FY87, ALLUVIAL AQUIFER

SOURCE:ESE,1988

Prepared for:
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For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland



EXPLANATION

ALL CONCENTRATIONS IN MICROGRAMS PER LITER (ug/l)

1 — ISOCONCENTRATION LINE

NWBCS: NORTHWEST BOUNDARY CONTAINMENT SYSTEM

NBCS: NORTH BOUNDARY CONTAINMENT SYSTEM.

△ MONITORING WELL LOCATION

UNSATURATED ALLUVIUM

N

0 1000 2000

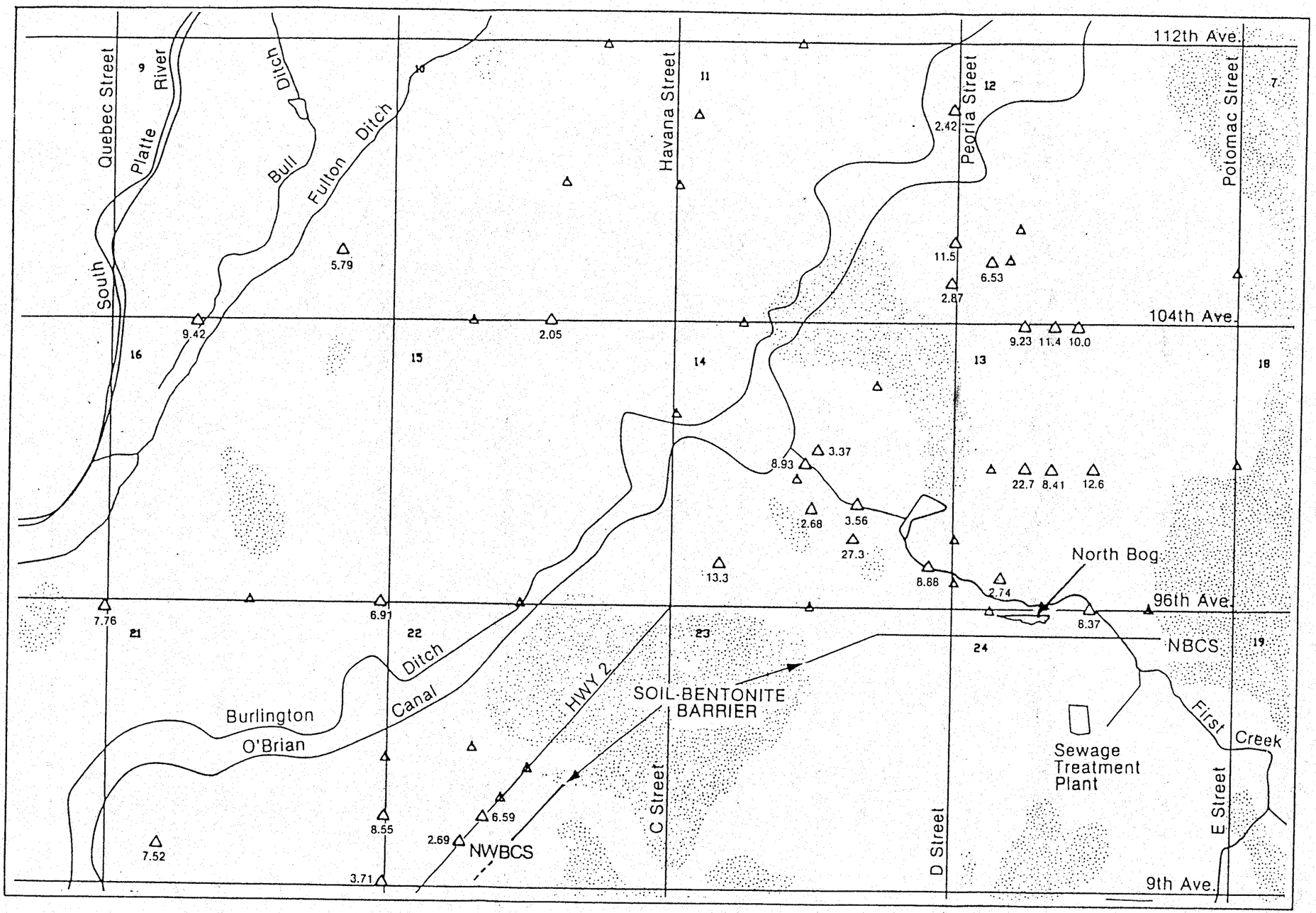
Scale In Feet

Figure F-30
1,2 DICHLOROETHANE CONCENTRATION DISTRIBUTION, ug/l,
4TH QUARTER, FY87, ALLUVIAL AQUIFER

SOURCE:ESE,1988

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland



EXPLANATION

5.42 CONCENTRATION IN MICROGRAMS PER LITER (ug/l)

NWBCS: NORTHWEST BOUNDARY CONTAINMENT SYSTEM

NBCS: NORTH BOUNDARY CONTAINMENT SYSTEM.

△ MONITORING WELL LOCATION

UNSATURATED ALLUVIUM

N

0 1000 2000

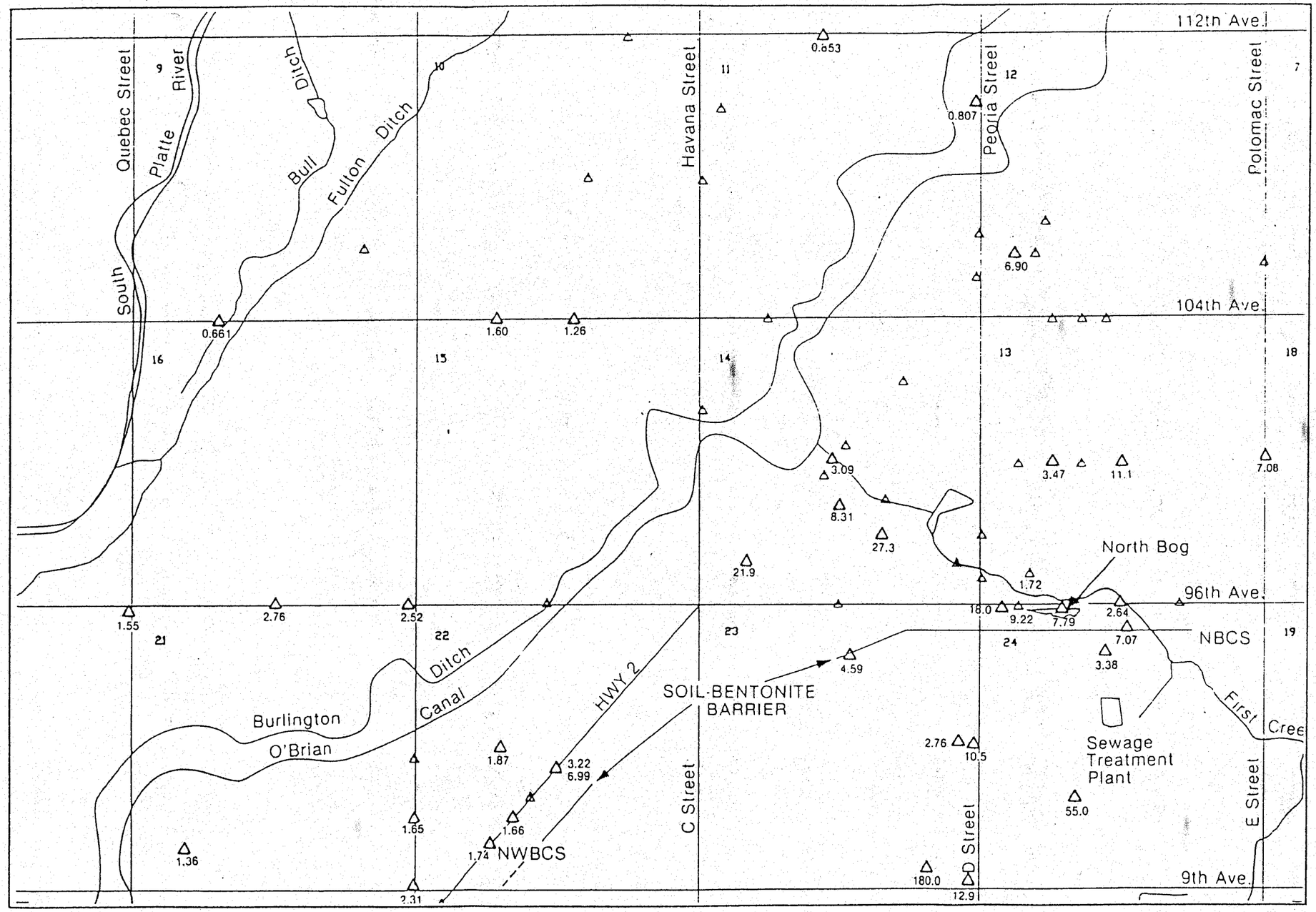
Scale In Feet

Figure F-31
CHLOROBENZENE CONCENTRATIONS EXCEEDING CERTIFIED REPORTING LIMITS, ug/l,
3RD QUARTER, FY87, ALLUVIAL AQUIFER

SOURCE:ESE,1988

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland



EXPLANATION

5.42 CONCENTRATION IN MICROGRAMS PER LITER (ug/l)

NWBCS: NORTHWEST BOUNDARY CONTAINMENT SYSTEM

NBCS: NORTH BOUNDARY CONTAINMENT SYSTEM.

△ MONITORING WELL LOCATION

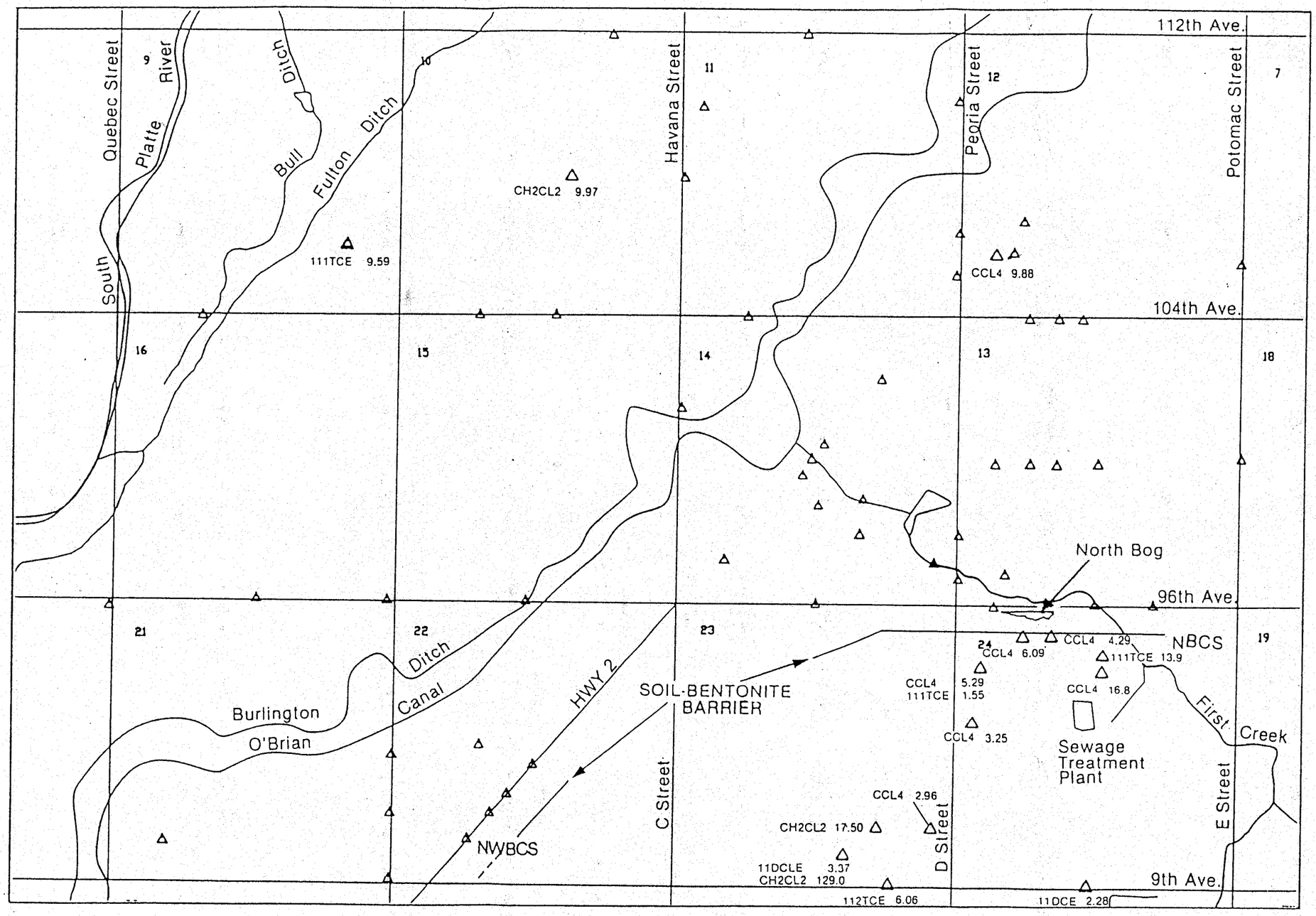
UNSATURATED ALLUVIUM

Figure F-32
CHLOROBENZENE CONCENTRATIONS EXCEEDING CERTIFIED REPORTING LIMITS, ug/l,
4TH QUARTER, FY 87, ALLUVIAL AQUIFER

SOURCE:ESE,1988

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland



EXPLANATION

5.42 CONCENTRATION IN MICROGRAMS PER LITER (ug/l)

NWBCS: NORTHWEST BOUNDARY CONTAINMENT SYSTEM

NBCS: NORTH BOUNDARY CONTAINMENT SYSTEM.

△ MONITORING WELL LOCATION

UNSATURATED ALLUVIUM

N

0 1000 2000

Scale In Feet

Figure F-33
VOLATILE ORGANOHALOGENS (CCL_4, 12DCE, 11DCE, 11DCLE, 111TCE, 12TCE, CH_2CL_2) CONCENTRATIONS EXCEEDING CERTIFIED REPORTING LIMITS, ug/l, 3RD QUARTER, FY87 ALLUVIAL AQUIFER
SOURCE:ESE,1988

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland

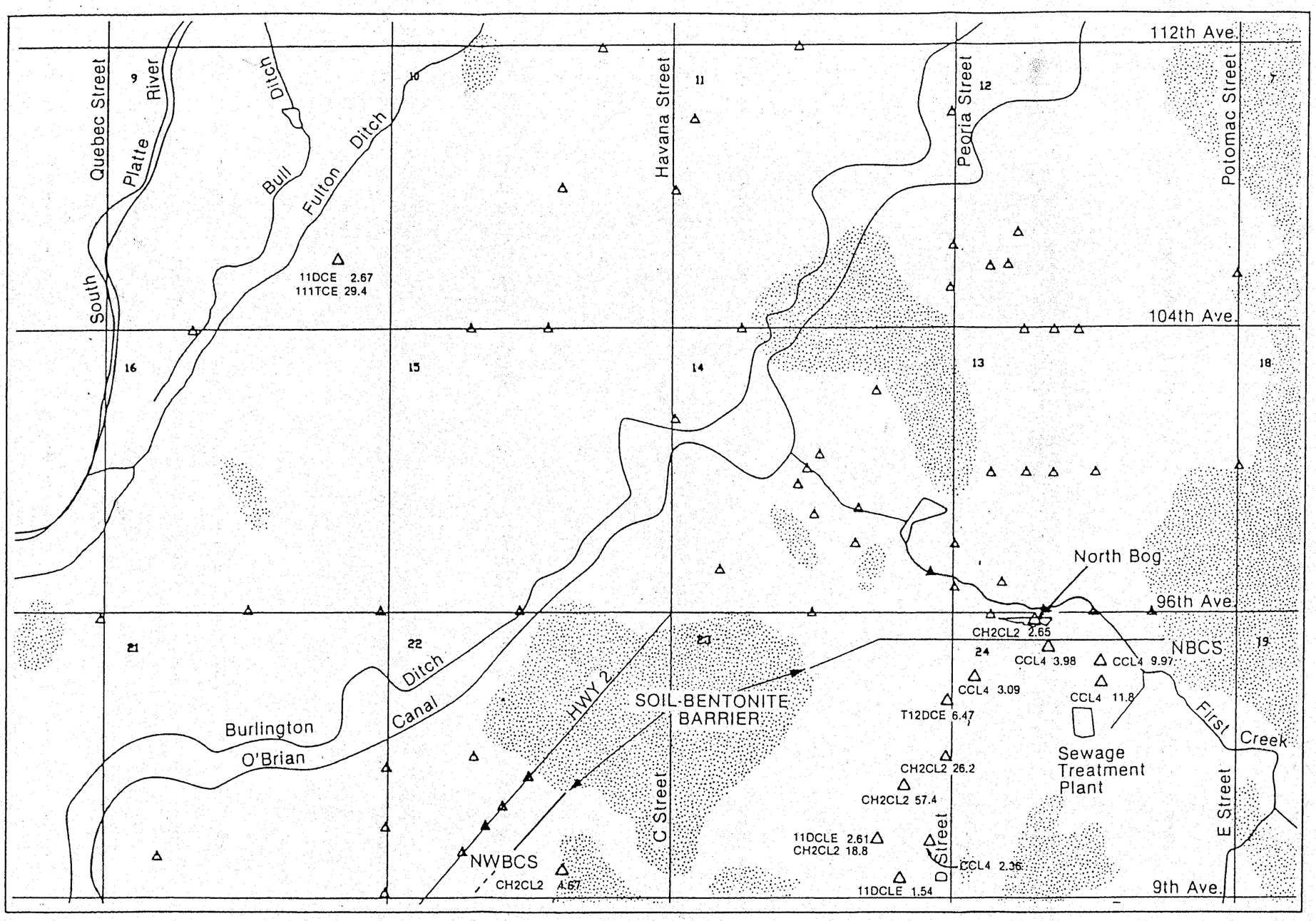
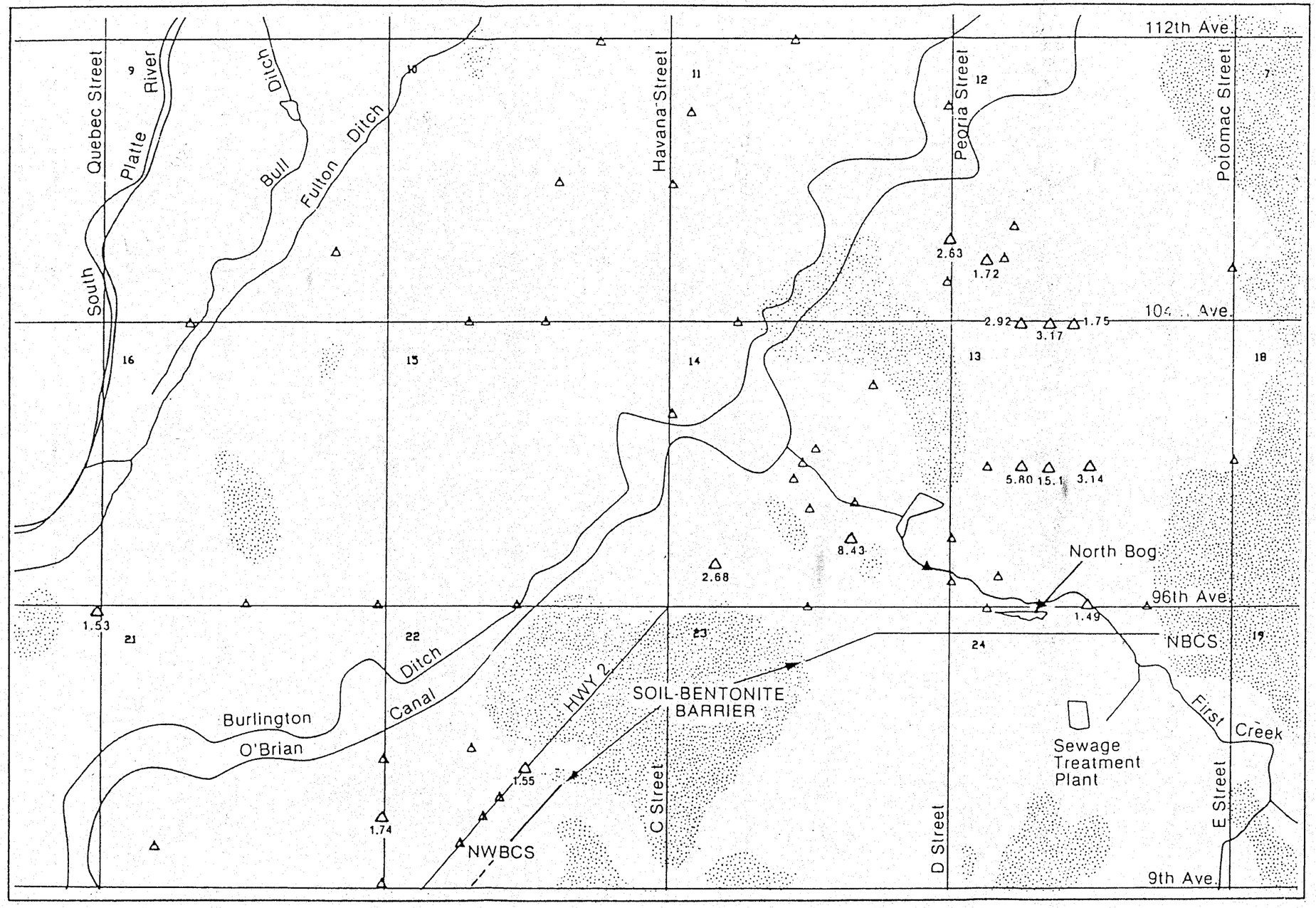


Figure F-34
VOLATILE ORGANOHALOGENS (CCL_4, 12DCE, 11DCE, 11DCLE, 111TCE, 12TCE, CH_2CL_2)
EXCEEDING CERTIFIED REPORTING LIMITS, ug/l, 4TH QUARTER, FY87,
ALLUVIAL AQUIFER
SOURCE: ESE, 1988

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland



EXPLANATION

5.42 CONCENTRATION IN MICROGRAMS PER LITER (ug/l)

NWBCS: NORTHWEST BOUNDARY CONTAINMENT SYSTEM

NBCS: NORTH BOUNDARY CONTAINMENT SYSTEM.

△ MONITORING WELL LOCATION

UNSATURATED ALLUVIUM

N

0 1000 2000

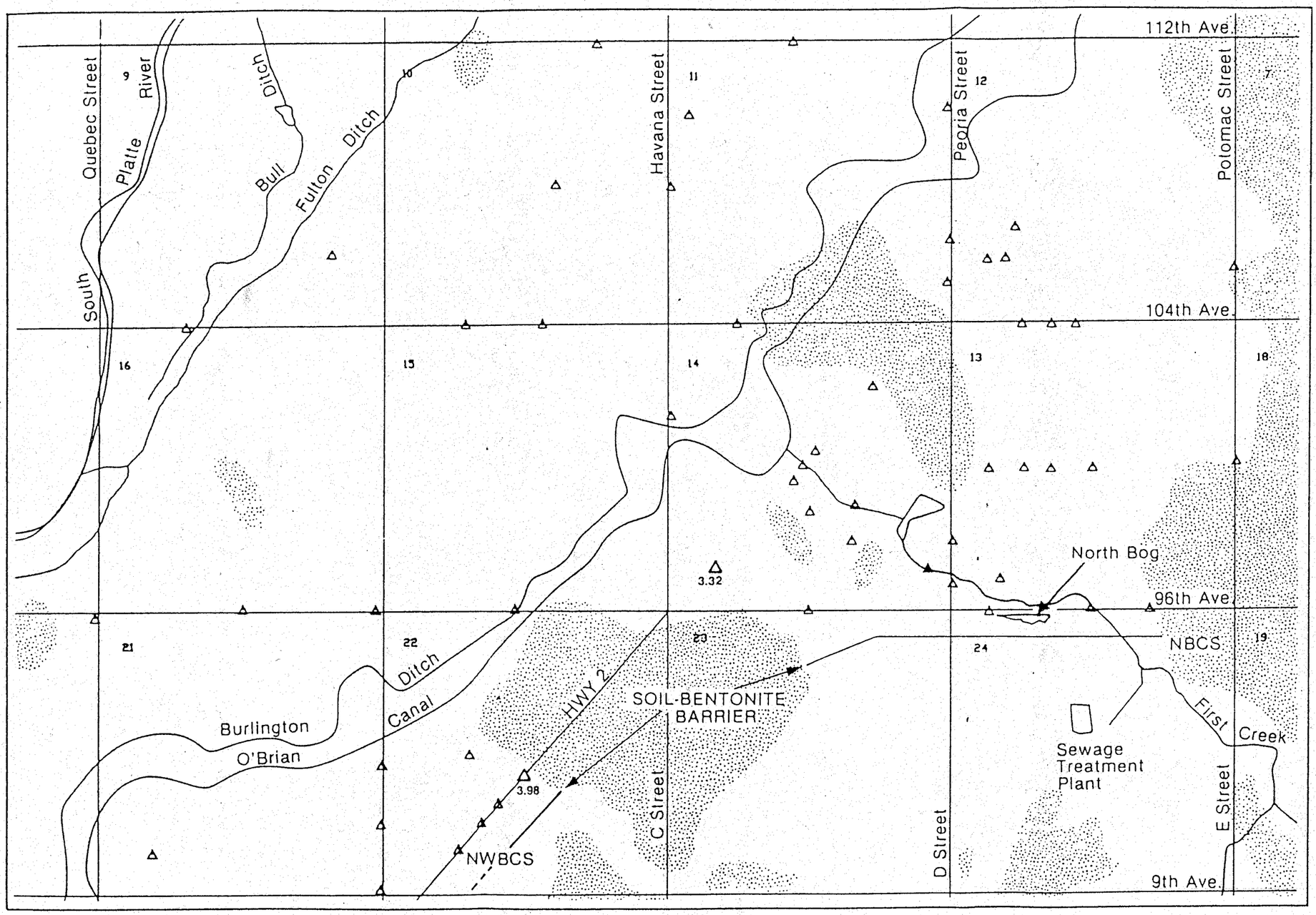
Scale In Feet

Figure F-35
BENZENE CONCENTRATIONS EXCEEDING CERTIFIED REPORTING LIMITS, ug/l,
3RD QUARTER, FY 87, ALLUVIAL AQUIFER

SOURCE:ESE,1988

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland



EXPLANATION

5.42 CONCENTRATION IN MICROGRAMS PER LITER (ug/l)

NWBCS: NORTHWEST BOUNDARY CONTAINMENT SYSTEM

NBCS: NORTH BOUNDARY CONTAINMENT SYSTEM.

△ MONITORING WELL LOCATION

UNSATURATED ALLUVIUM

N

0 1000 2000

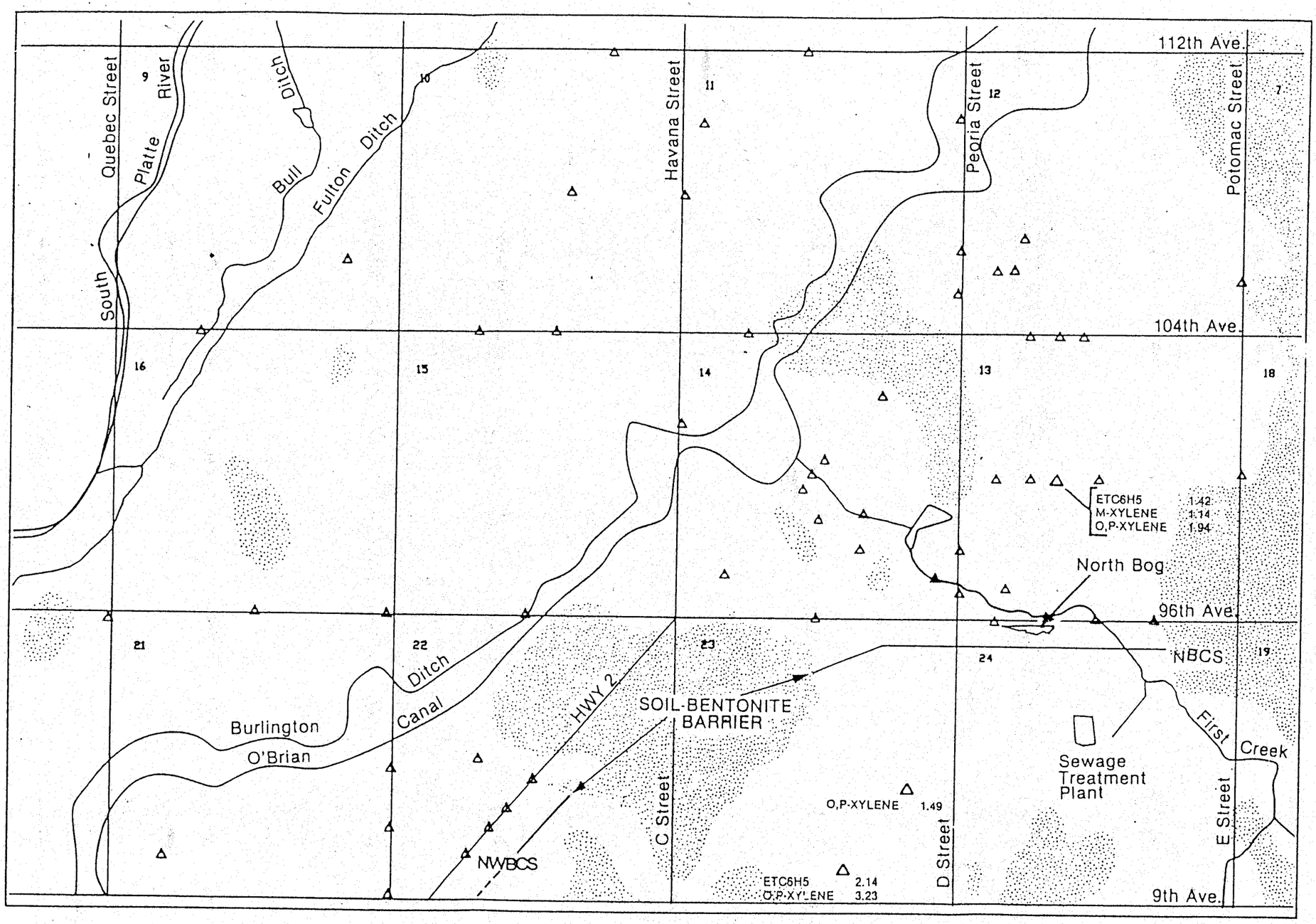
Scale In Feet

Figure F-36
BENZENE CONCENTRATIONS EXCEEDING CERTIFIED REPORTING LIMITS, ug/l,
4TH QUARTER, FY87, ALLUVIAL AQUIFER

SOURCE:ESE,1988

Prepared for:
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For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland



EXPLANATION

5.42 CONCENTRATION IN MICROGRAMS PER LITER (ug/l)

NWBCS: NORTHWEST BOUNDARY CONTAINMENT SYSTEM

NBCS: NORTH BOUNDARY CONTAINMENT SYSTEM.

△ MONITORING WELL LOCATION

UNSATURATED ALLUVIUM

N

0 1000 2000

Scale In Feet

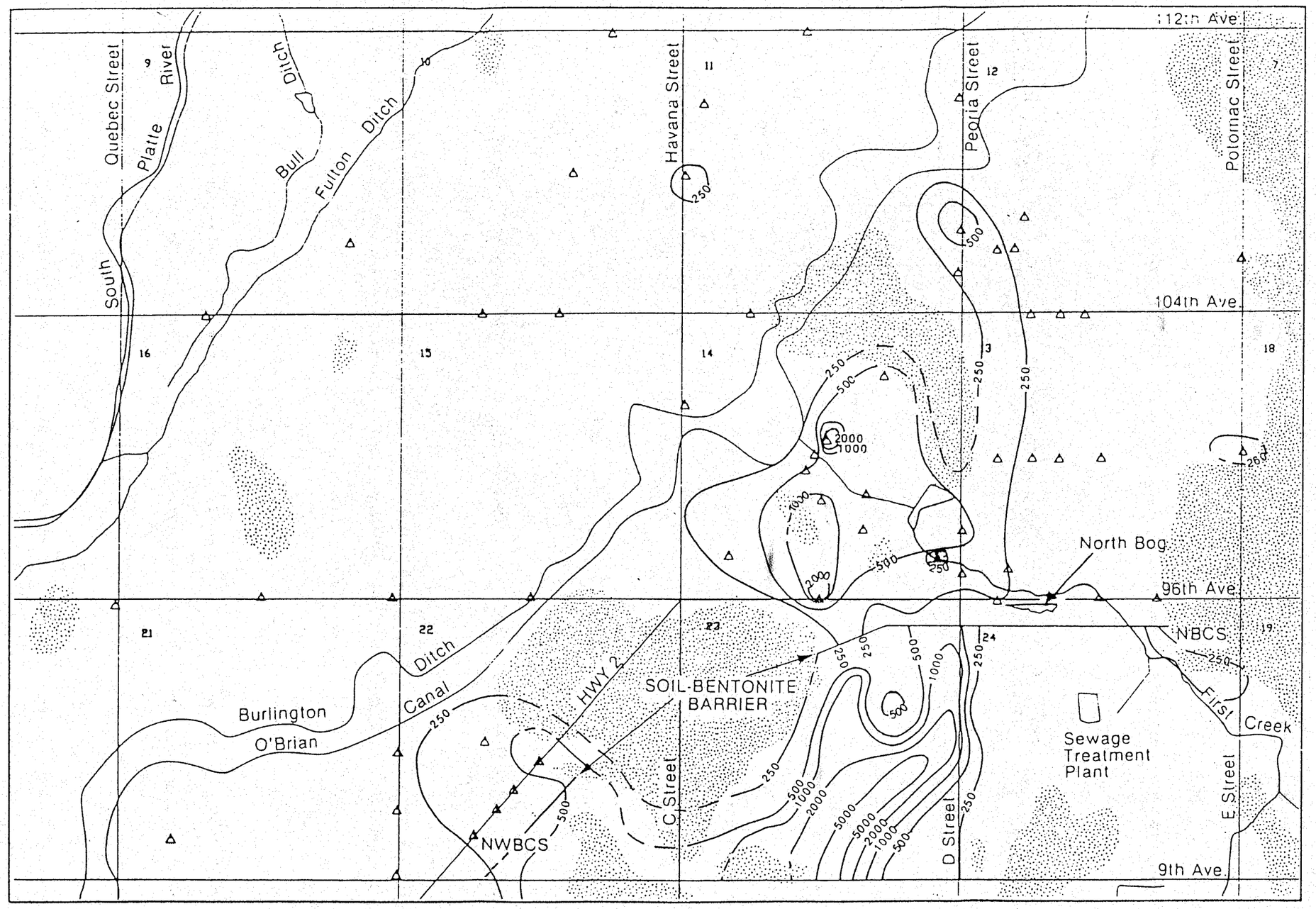
Figure F-37

VOLATILE AROMATICS (ETHYLBENZENE, M-XYLENE, O,P-XYLENE) EXCEEDING CERTIFIED REPORTING LIMITS, ug/l, 3RD QUARTER, FY87, ALLUVIAL AQUIFER

SOURCE: ESE, 1988

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Aberdeen Proving Ground, Maryland



EXPLANATION

ALL CONCENTRATIONS IN MILLIGRAMS PER LITER(mg/l)

1 — ISOCONCENTRATION LINE

NWBCS: NORTHWEST BOUNDARY CONTAINMENT SYSTEM

NBCS: NORTH BOUNDARY CONTAINMENT SYSTEM.

△ MONITORING WELL LOCATION

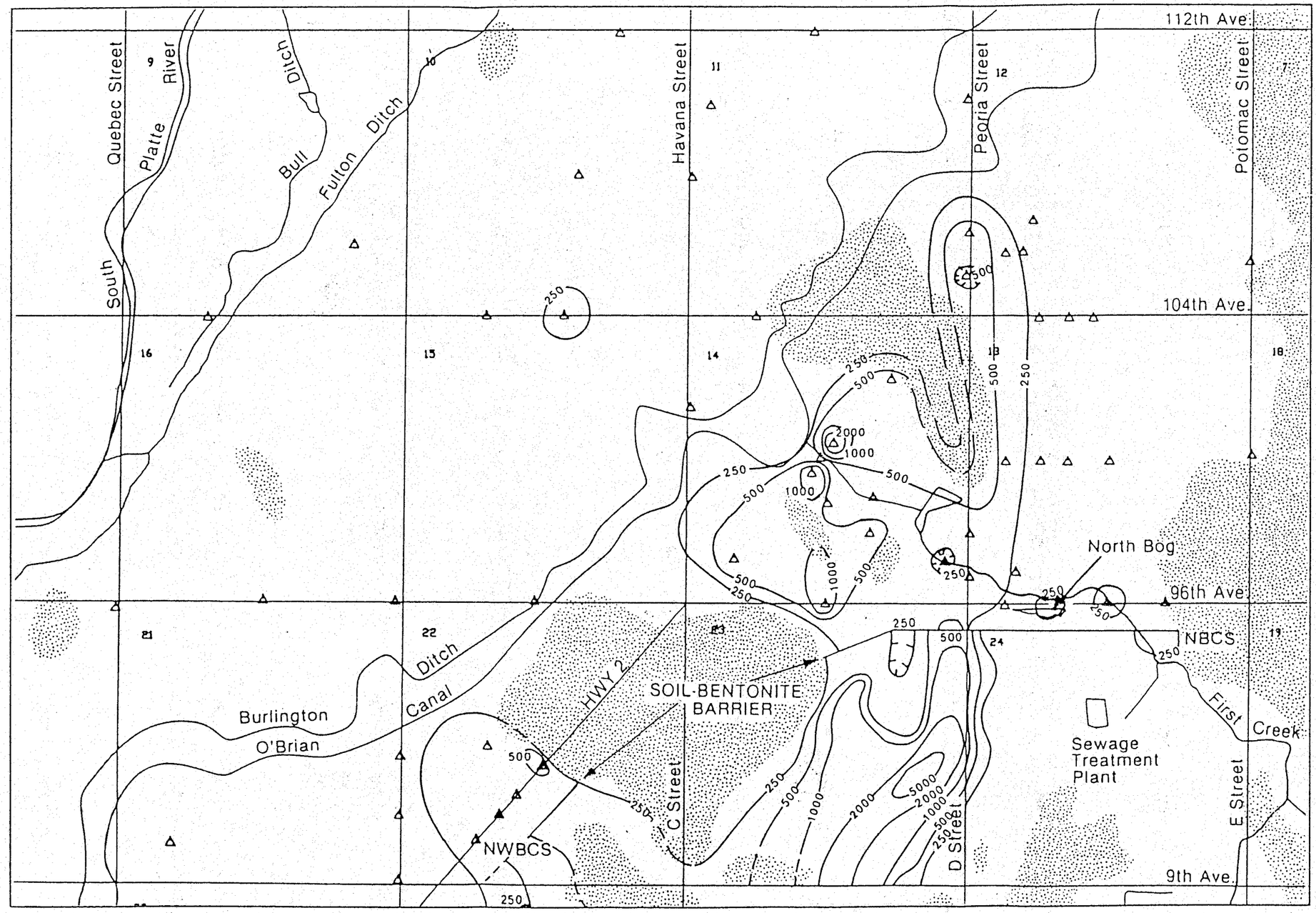
UNSATURATED ALLUVIUM

Figure F-38
CHLORIDE CONCENTRATION DISTRIBUTION, mg/l,
3RD QUARTER, FY87, ALLUVIAL AQUIFER

SOURCE:ESE,1988

Prepared for:
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For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland



EXPLANATION

ALL CONCENTRATIONS IN MILLIGRAMS PER LITER (mg/l)

1 — ISOCONCENTRATION LINE

NWBCS: NORTHWEST BOUNDARY CONTAINMENT SYSTEM

NBCS: NORTH BOUNDARY CONTAINMENT SYSTEM.

△ MONITORING WELL LOCATION

UNSATURATED ALLUVIUM

N

0 1000 2000

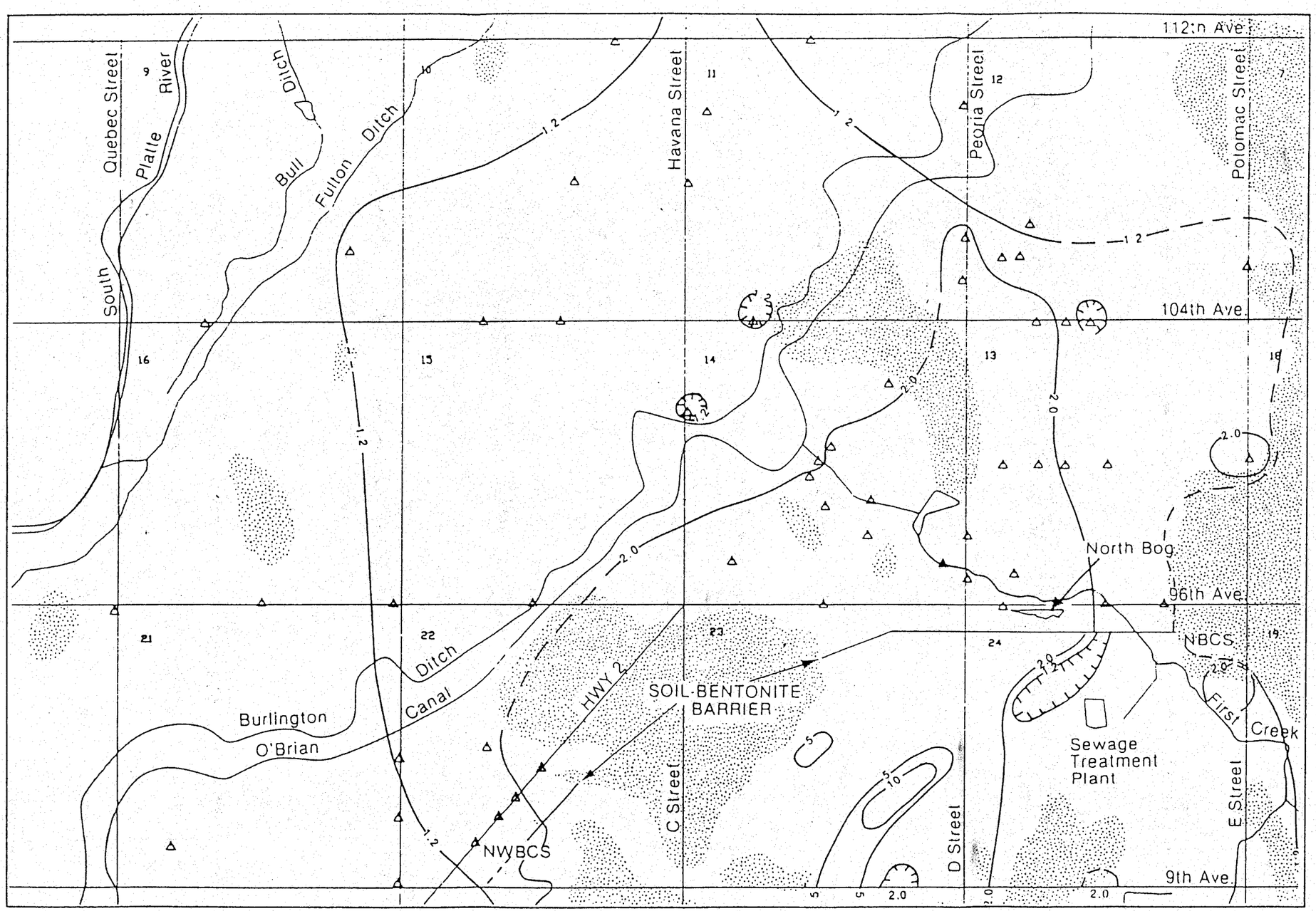
Scale In Feet

Figure F-39
CHLORIDE CONCENTRATION DISTRIBUTION, mg/l,
4TH QUARTER, FY87, ALLUVIAL AQUIFER

SOURCE:ESE,1988

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland



EXPLANATION

ALL CONCENTRATIONS IN MILLIGRAMS PER LITER (mg/l)

1 — ISOCONCENTRATION LINE

NWBCS: NORTHWEST BOUNDARY CONTAINMENT SYSTEM

NBCS: NORTH BOUNDARY CONTAINMENT SYSTEM.

△ MONITORING WELL LOCATION

UNSATURATED ALLUVIUM

N

0 1000 2000

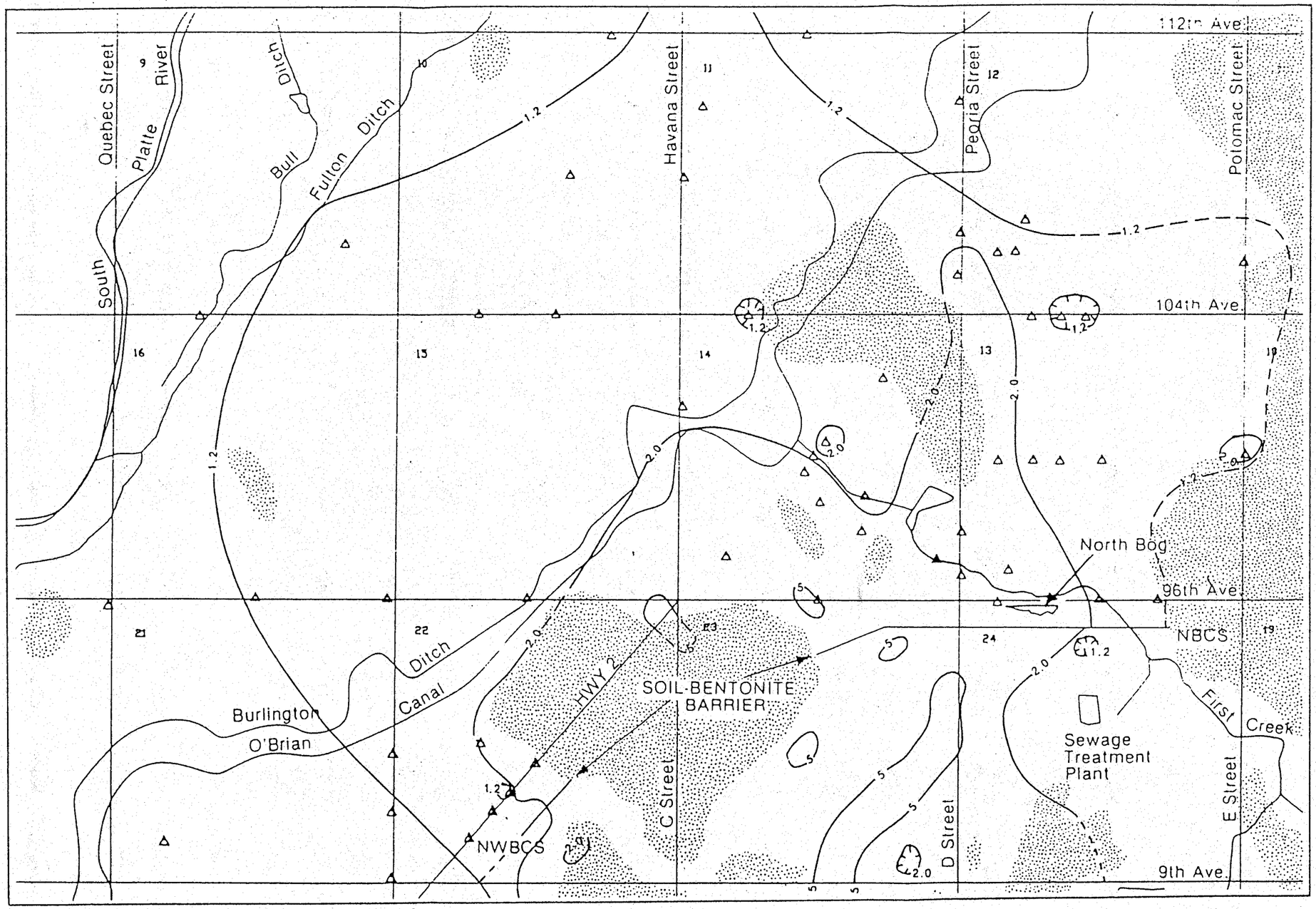
Scale In Feet

Figure F-40
FLUORIDE CONCENTRATION DISTRIBUTION, mg/l,
3RD QUARTER, FY87, ALLUVIAL AQUIFER

SOURCE:FSE,1988

Prepared for:
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EXPLANATION

ALL CONCENTRATIONS IN MILLIGRAMS PER LITER (mg/l)

1 — ISOCONCENTRATION LINE

NWBCS: NORTHWEST BOUNDARY CONTAINMENT SYSTEM

NBCS: NORTH BOUNDARY CONTAINMENT SYSTEM.

△ MONITORING WELL LOCATION

UNSATURATED ALLUVIUM

N

0 1000 2000

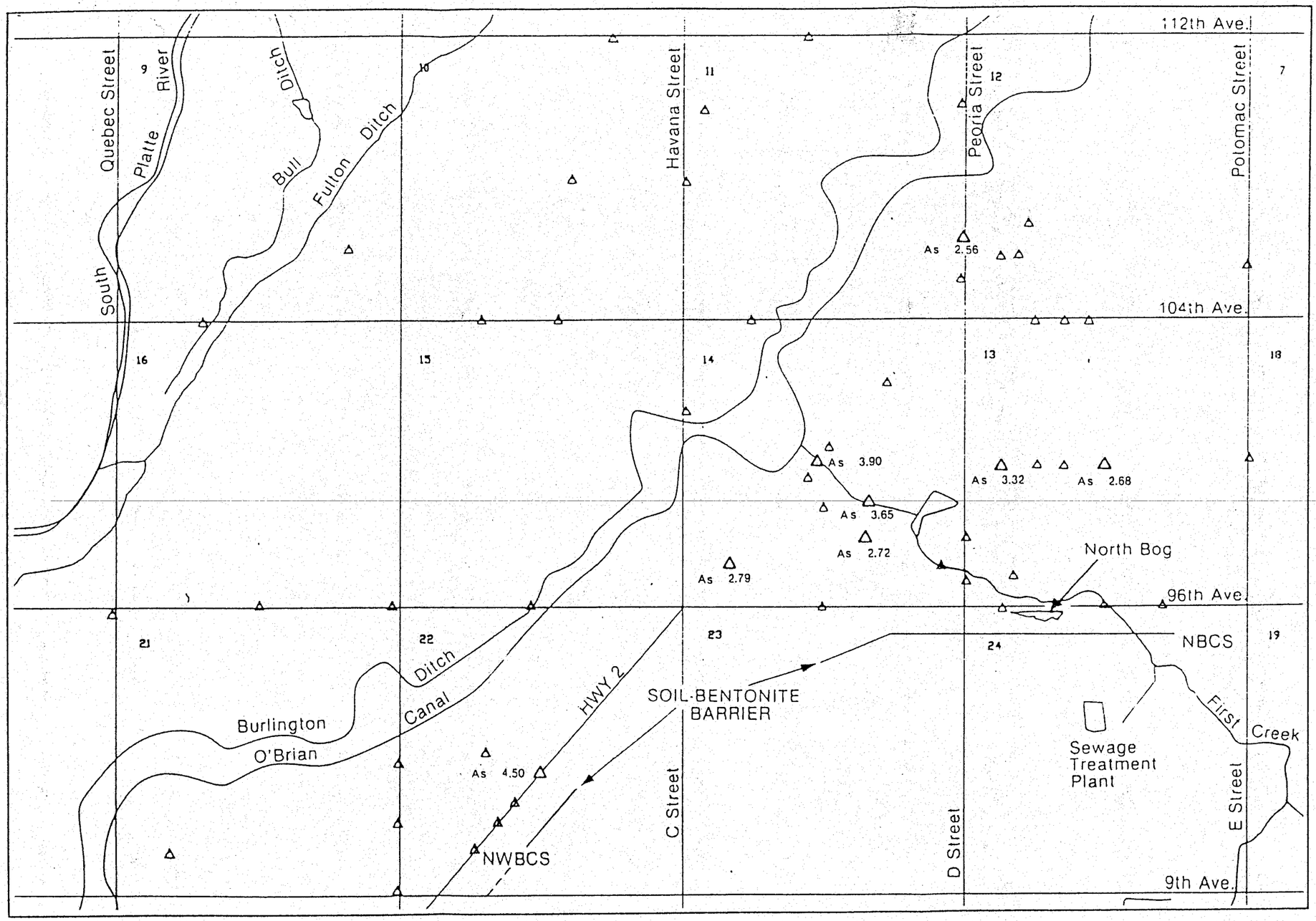
Scale In Feet

Figure F-41
FLUORIDE CONCENTRATION DISTRIBUTION, mg/l,
4TH QUARTER, FY87, ALLUVIAL AQUIFER

SOURCE:ESE,1988

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EXPLANATION

5.42 CONCENTRATION IN MICROGRAMS PER LITER (ug/l)

NWBCS: NORTHWEST BOUNDARY CONTAINMENT SYSTEM

NBCS: NORTH BOUNDARY CONTAINMENT SYSTEM.

△ MONITORING WELL LOCATION

UNSATURATED ALLUVIUM

Figure F-42
ARSENIC (As) AND MERCURY (Hg) CONCENTRATIONS EXCEEDING CERTIFIED REPORTING LIMITS, ug/l,3RD QUARTER, FY87, ALLUVIAL AQUIFER

SOURCE:ESE,1988

Prepared for:
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For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland

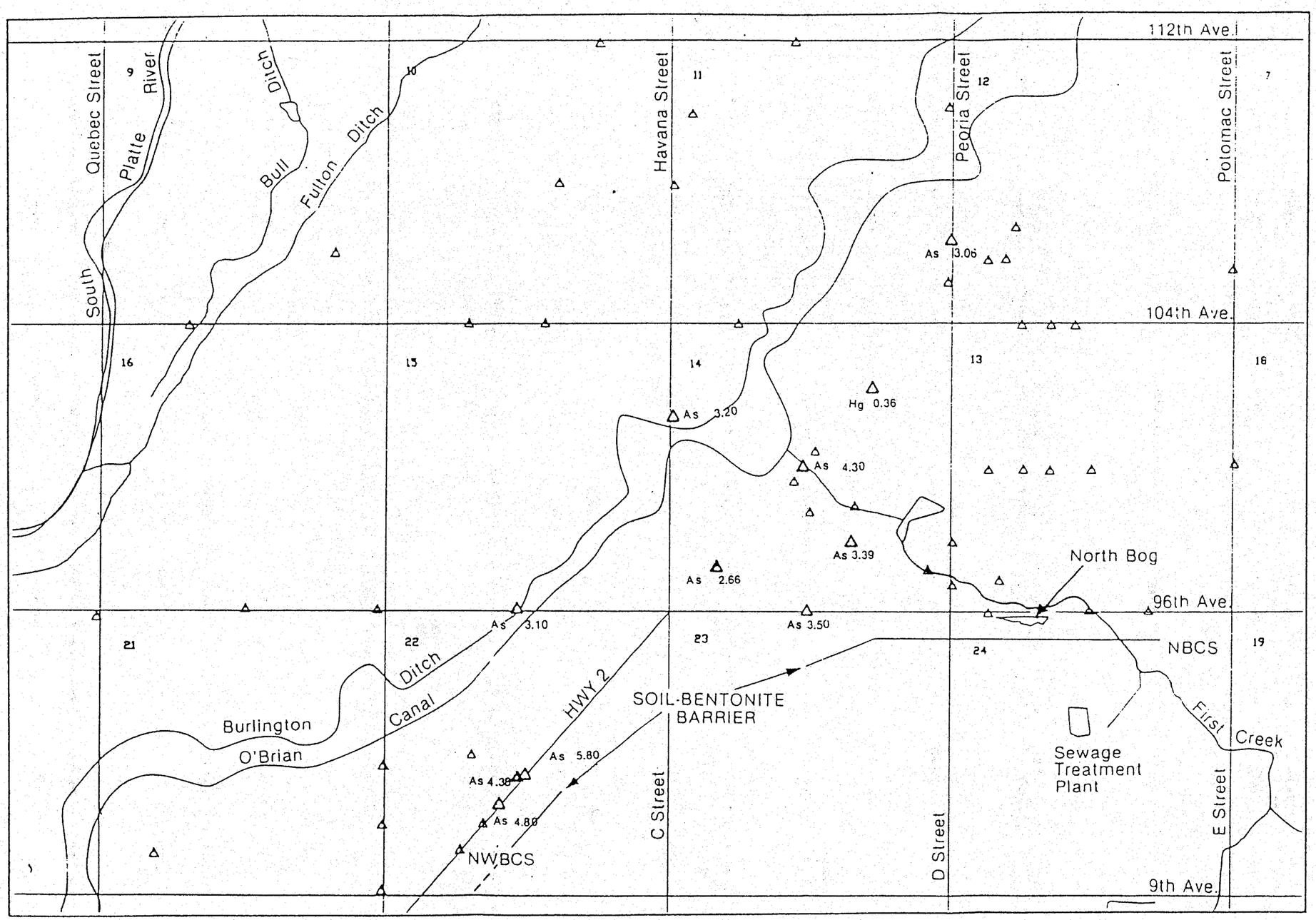
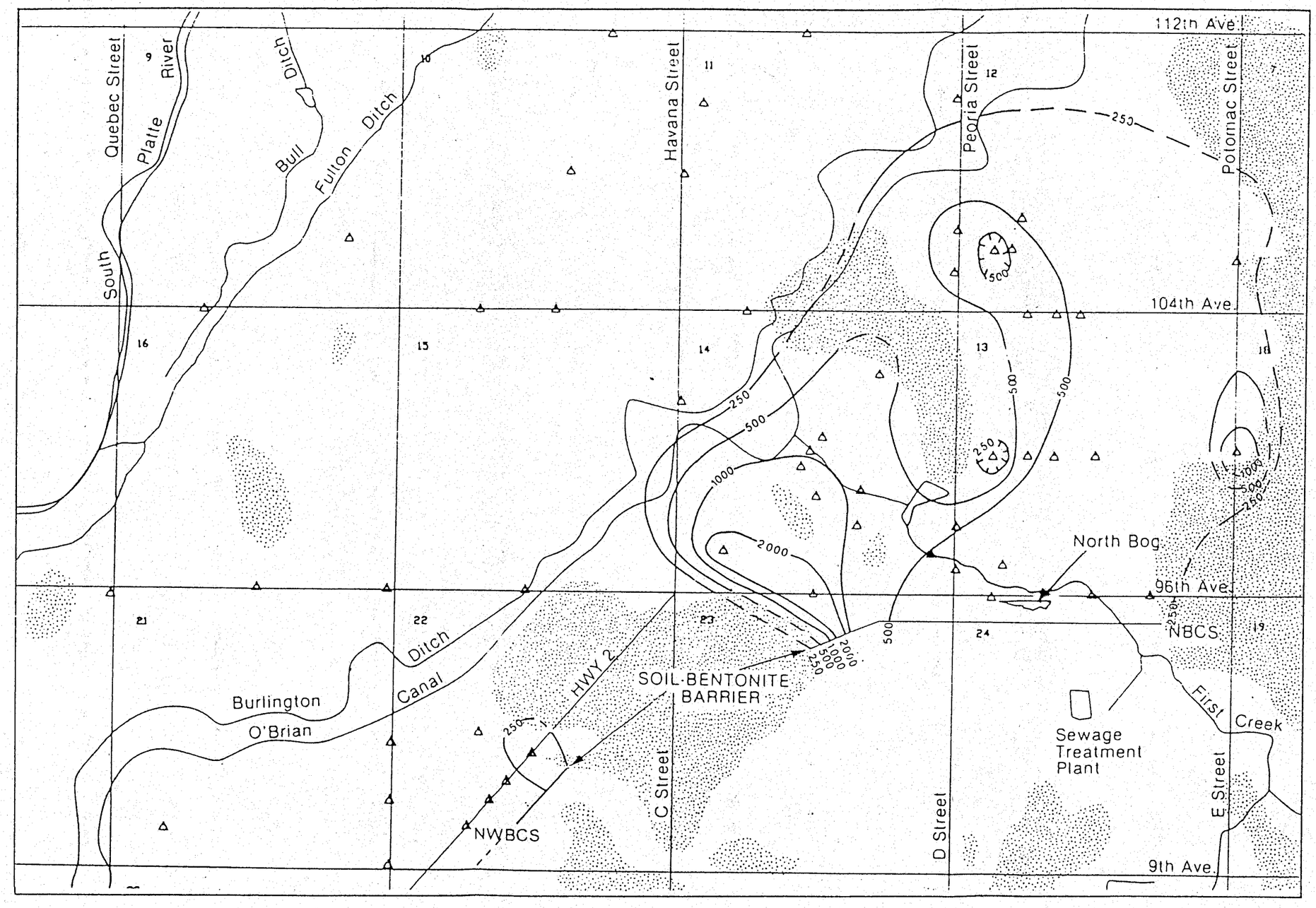


Figure F-43
ARSENIC (As) AND MERCURY (Hg) CONCENTRATIONS EXCEEDING CERTIFIED REPORTING LIMITS, ug/l, 4TH QUARTER, FY87, ALLUVIAL AQUIFER

SOURCE:ESE,1988

Prepared for:
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For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland



EXPLANATION

ALL CONCENTRATIONS IN MILLIGRAMS PER LITER (mg/l)

1 — ISOCONCENTRATION LINE

NWBCS: NORTHWEST BOUNDARY CONTAINMENT SYSTEM

NBCS: NORTH BOUNDARY CONTAINMENT SYSTEM.

△ MONITORING WELL LOCATION

UNSATURATED ALLUVIUM

N

0 1000 2000

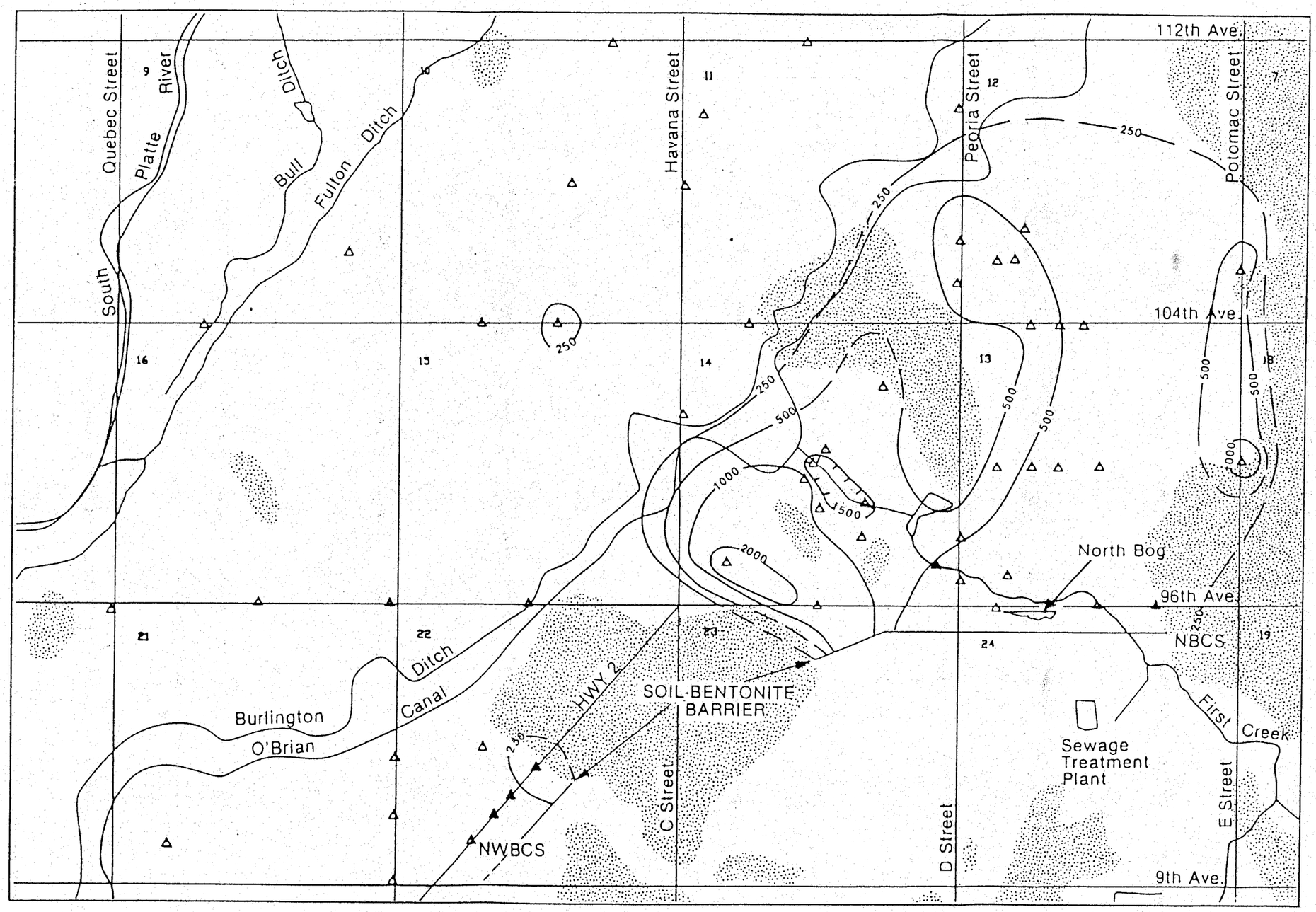
Scale In Feet

Figure F-44
SULFATE CONCENTRATION DISTRIBUTION, mg/l,
3RD QUARTER, FY87, ALLUVIAL AQUIFER

SOURCE:ESE,1988

Prepared for:
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For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland



EXPLANATION

ALL CONCENTRATIONS IN MILLIGRAMS PER LITER (mg/l)

1 — ISOCONCENTRATION LINE

NWBCS: NORTHWEST BOUNDARY CONTAINMENT SYSTEM

NBCS: NORTH BOUNDARY CONTAINMENT SYSTEM.

△ MONITORING WELL LOCATION

UNSATURATED ALLUVIUM

N

0 1000 2000

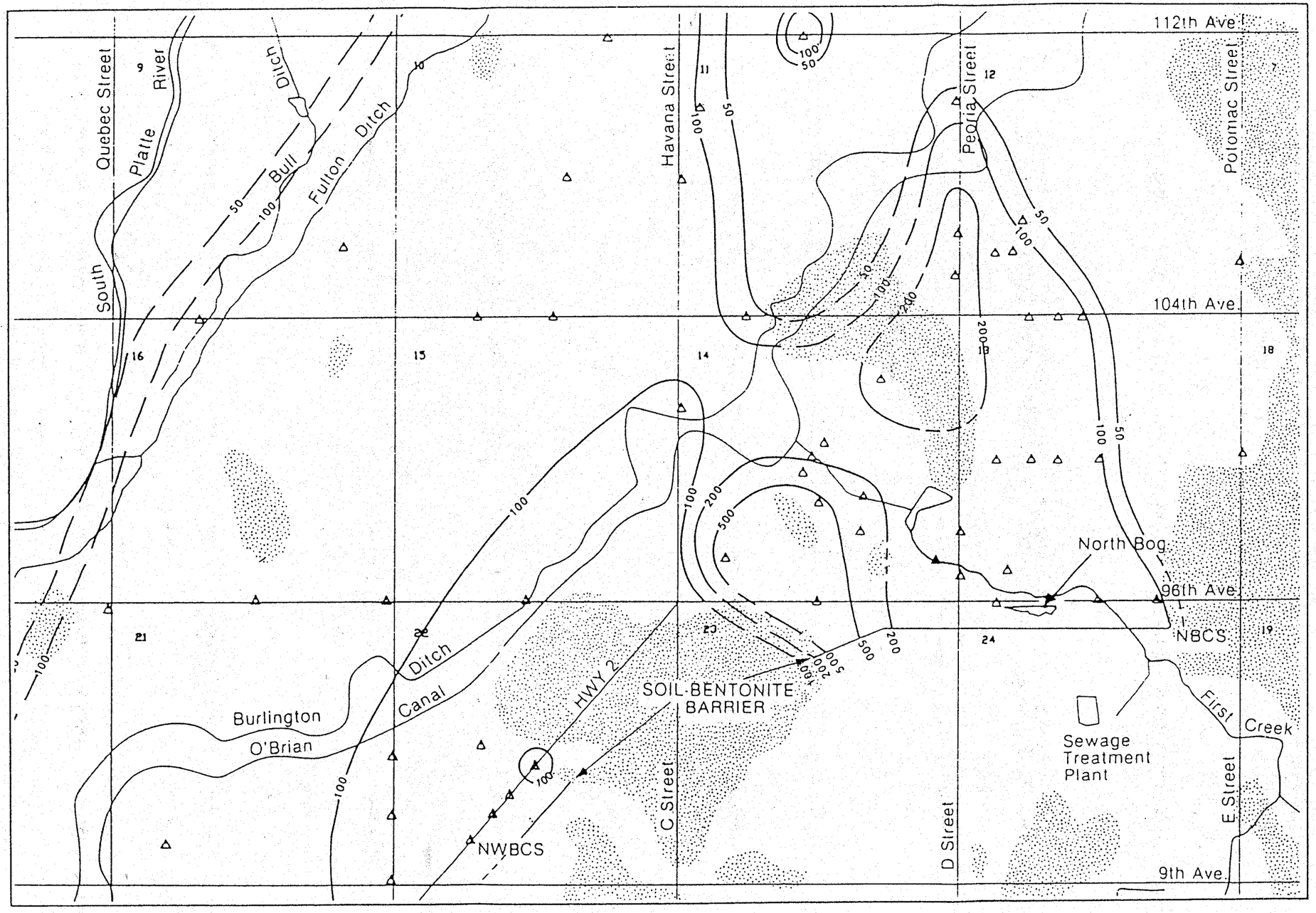
Scale In Feet

Figure F-45
SULFATE CONCENTRATION DISTRIBUTION, mg/l,
4TH QUARTER, FY87, ALLUVIAL AQUIFER

SOURCE:ESE,1988

Prepared for:
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For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland



EXPLANATION

ALL CONCENTRATIONS IN MILLIGRAMS PER LITER (mg/l)

1 — ISOCONCENTRATION LINE

NWBCS: NORTHWEST BOUNDARY CONTAINMENT SYSTEM

NBCS: NORTH BOUNDARY CONTAINMENT SYSTEM.

△ MONITORING WELL LOCATION

UNSATURATED ALLUVIUM

N

0 1000 2000

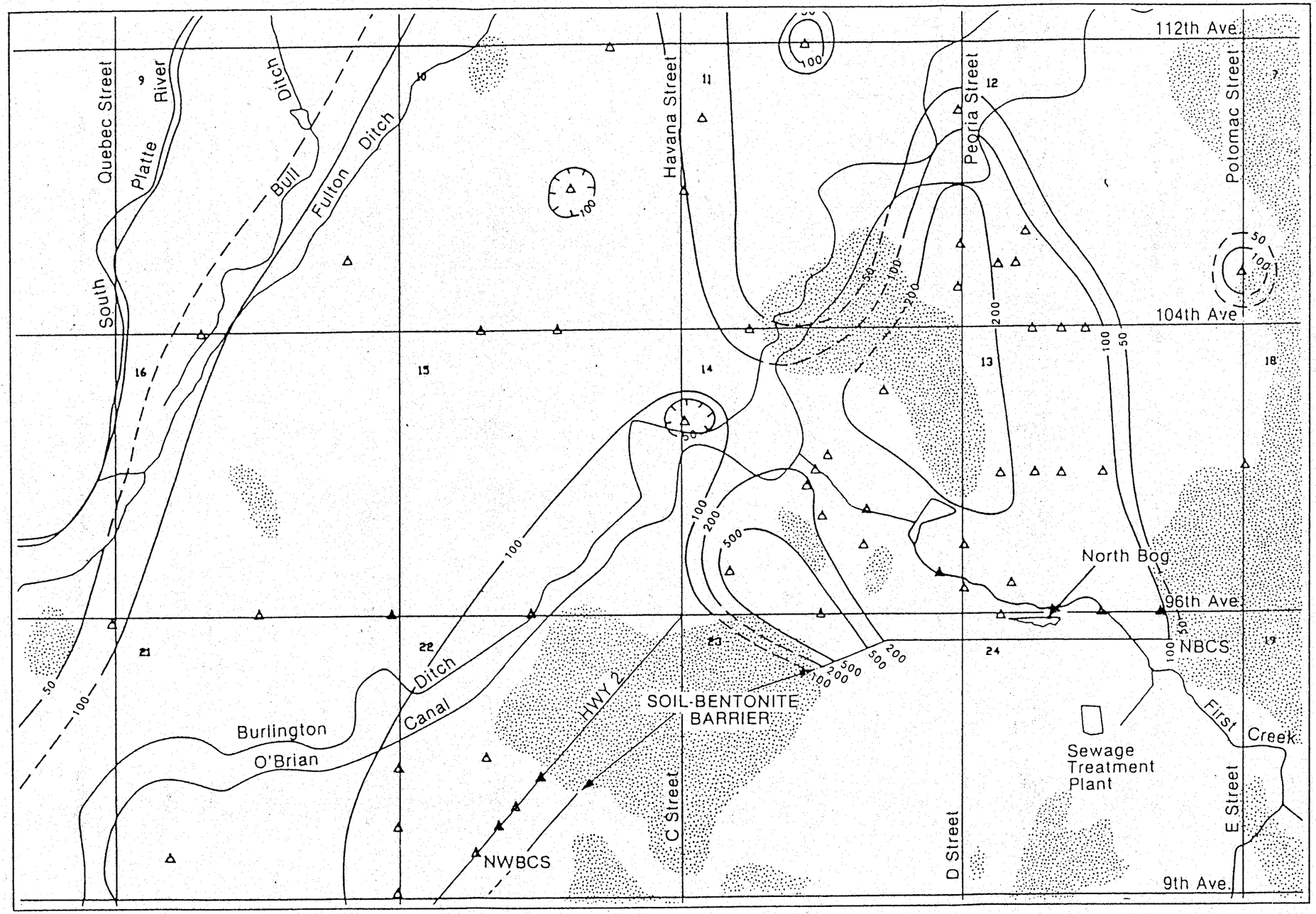
Scale In Feet

Figure F-46
CALCIUM CONCENTRATION DISTRIBUTION, mg/l,
3RD QUARTER, FY87, ALLUVIAL AQUIFER

SOURCE:ESE,1988

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland



EXPLANATION

ALL CONCENTRATIONS IN MILLIGRAMS PER LITER (mg/l)

1 ISOCONCENTRATION LINE

NWBCS: NORTHWEST BOUNDARY CONTAINMENT SYSTEM

NBCS: NORTH BOUNDARY CONTAINMENT SYSTEM.

△ MONITORING WELL LOCATION

UNSATURATED ALLUVIUM

N

0 1000 2000

Scale In Feet

Figure F-47
CALCIUM CONCENTRATION DISTRIBUTION, mg/l,
4TH QUARTER, FY87, ALLUVIAL AQUIFER

SOURCE:ESE,1988

Prepared for:
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Aberdeen Proving Ground, Maryland

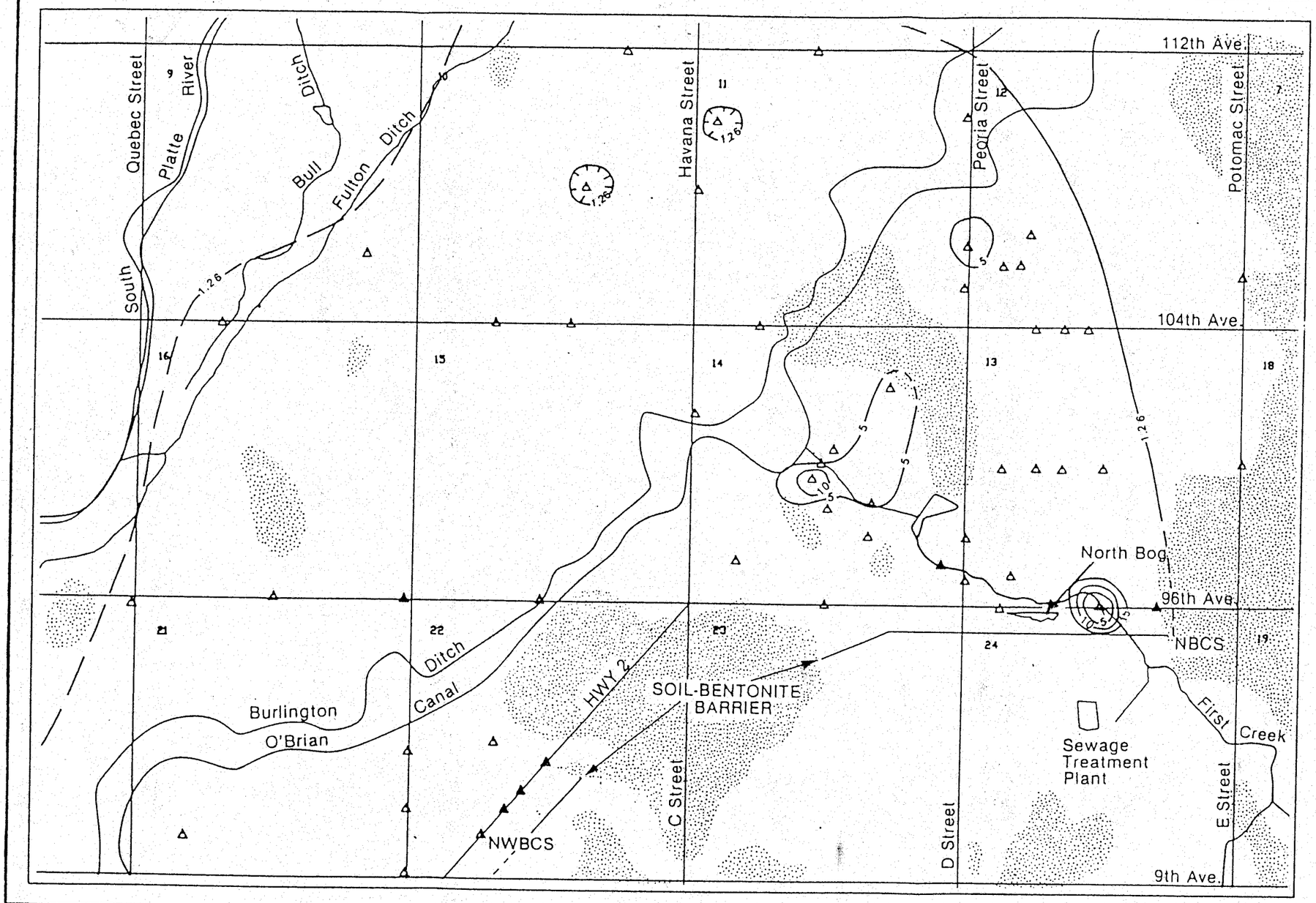


Figure F-48
POTASSIUM CONCENTRATION DISTRIBUTION, mg/l,
3RD QUARTER, FY87, ALLUVIAL AQUIFER

SOURCE:ESE,1988

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland

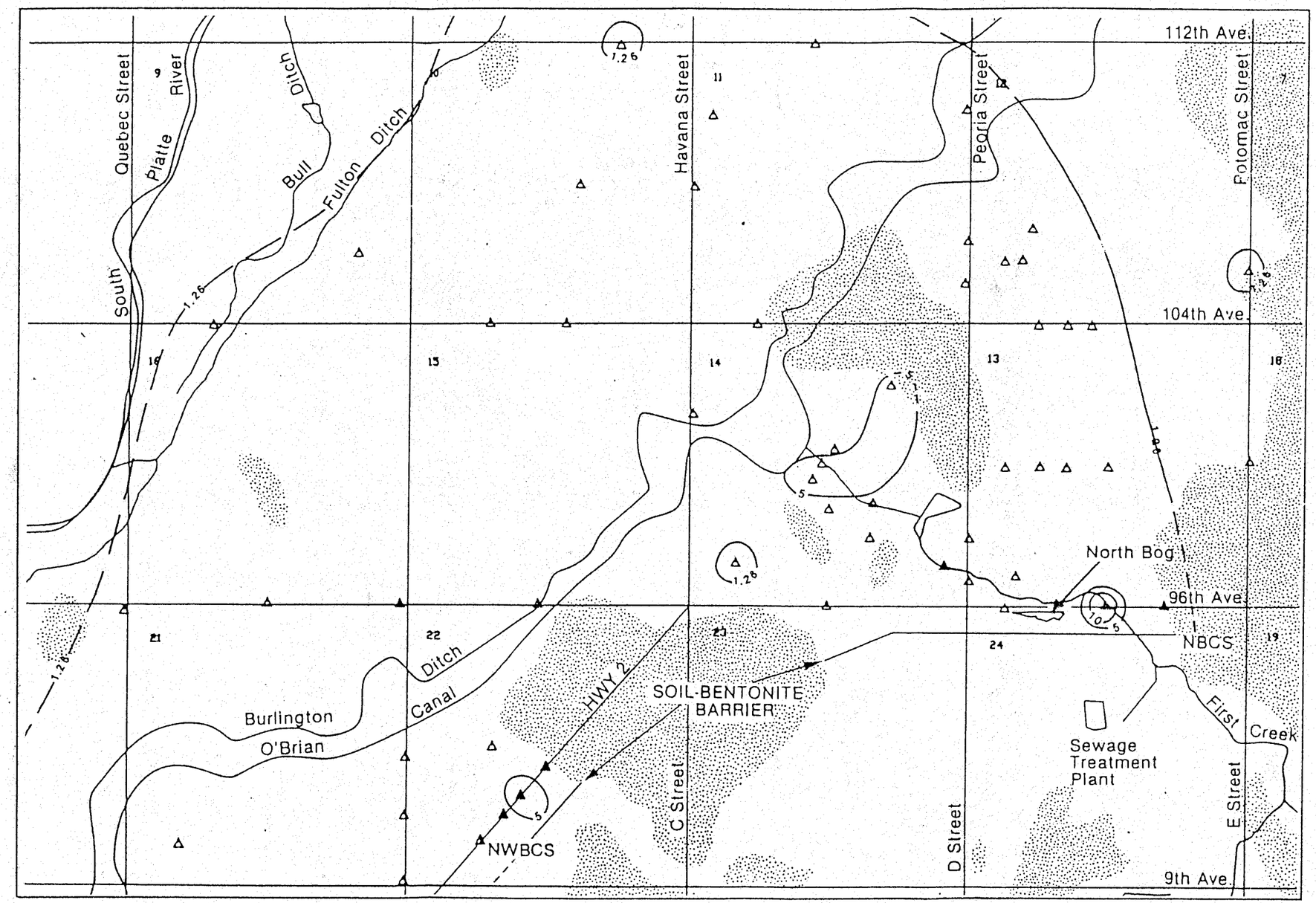
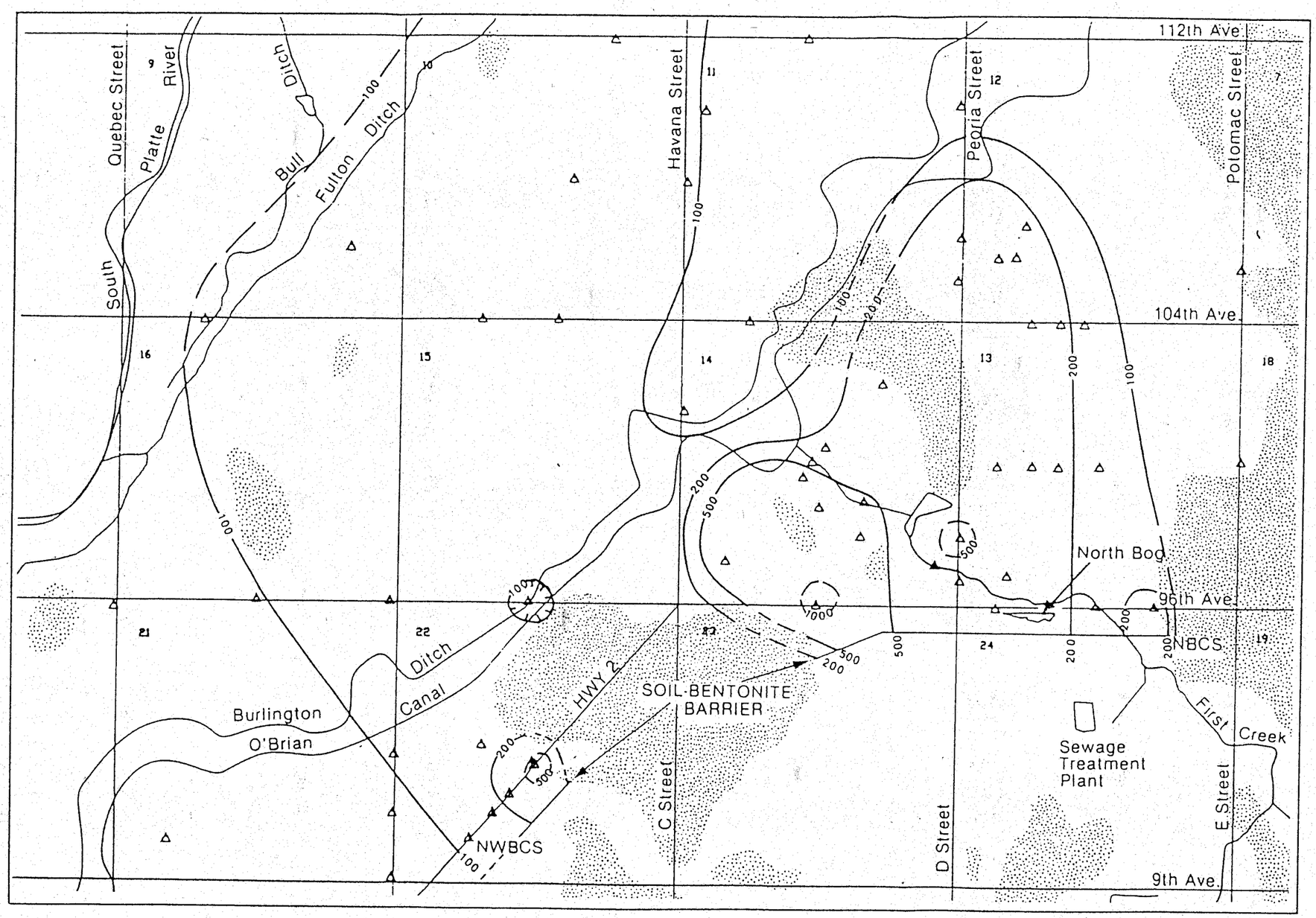


Figure F-49
POTASSIUM CONCENTRATION DISTRIBUTION, mg/l,
4TH QUARTER, FY87, ALLUVIAL AQUIFER

SOURCE:ESE, 1988

Prepared for:
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For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland



EXPLANATION

ALL CONCENTRATIONS IN MILLIGRAMS PER LITER (mg/l)

1 — ISOCONCENTRATION LINE

NWBCS: NORTHWEST BOUNDARY CONTAINMENT SYSTEM

NBCS: NORTH BOUNDARY CONTAINMENT SYSTEM.

△ MONITORING WELL LOCATION

UNSATURATED ALLUVIUM

N

0 1000 2000

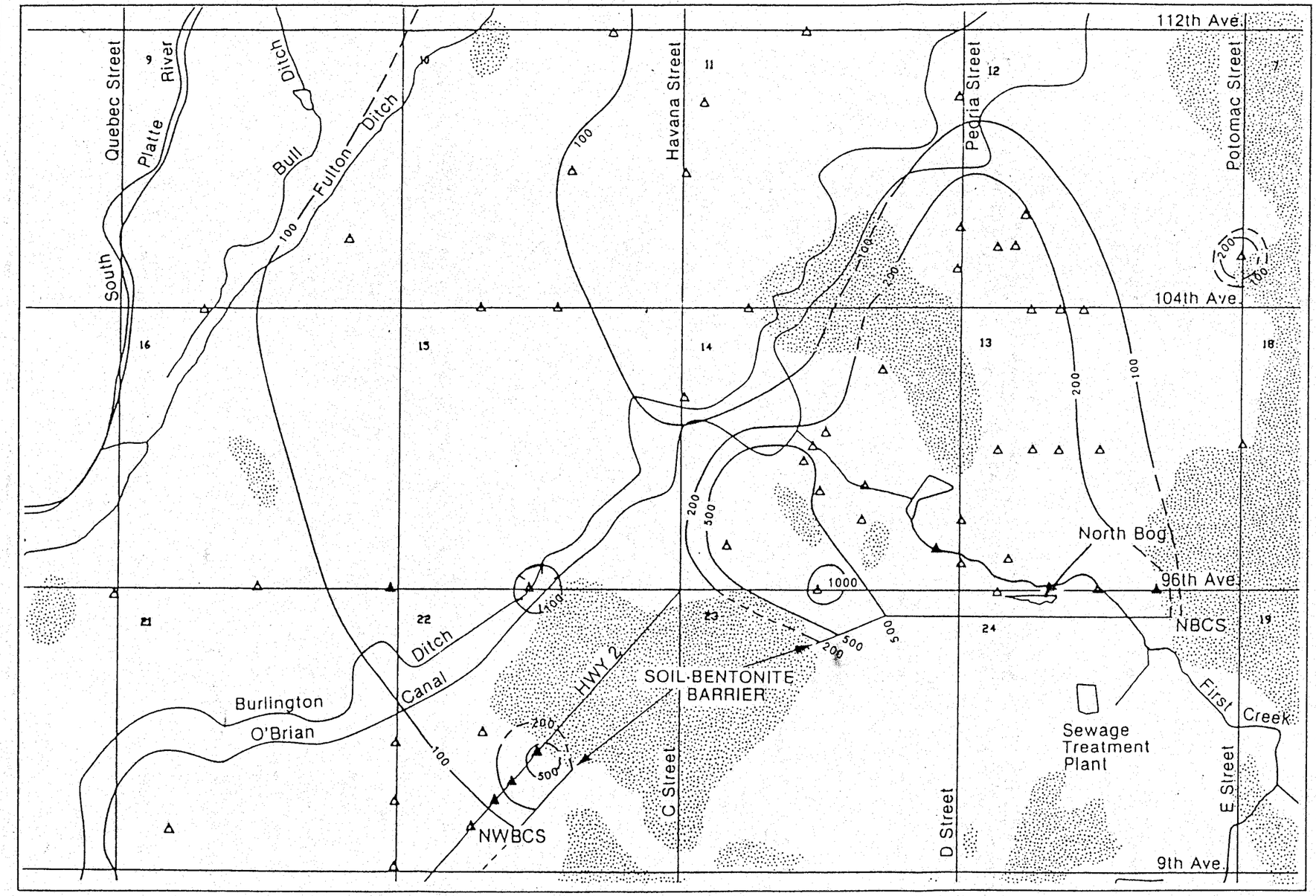
Scale In Feet

Figure F-50
SODIUM CONCENTRATION DISTRIBUTION, mg/l,
3RD QUARTER, FY87, ALLUVIAL AQUIFER

SOURCE:ESE,1988

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland



EXPLANATION

ALL CONCENTRATIONS IN MILLIGRAMS PER LITER (mg/l)

1 — ISOCONCENTRATION LINE

NWBCS: NORTHWEST BOUNDARY CONTAINMENT SYSTEM

NBCS: NORTH BOUNDARY CONTAINMENT SYSTEM.

△ MONITORING WELL LOCATION

UNSATURATED ALLUVIUM

N

0 1000 2000

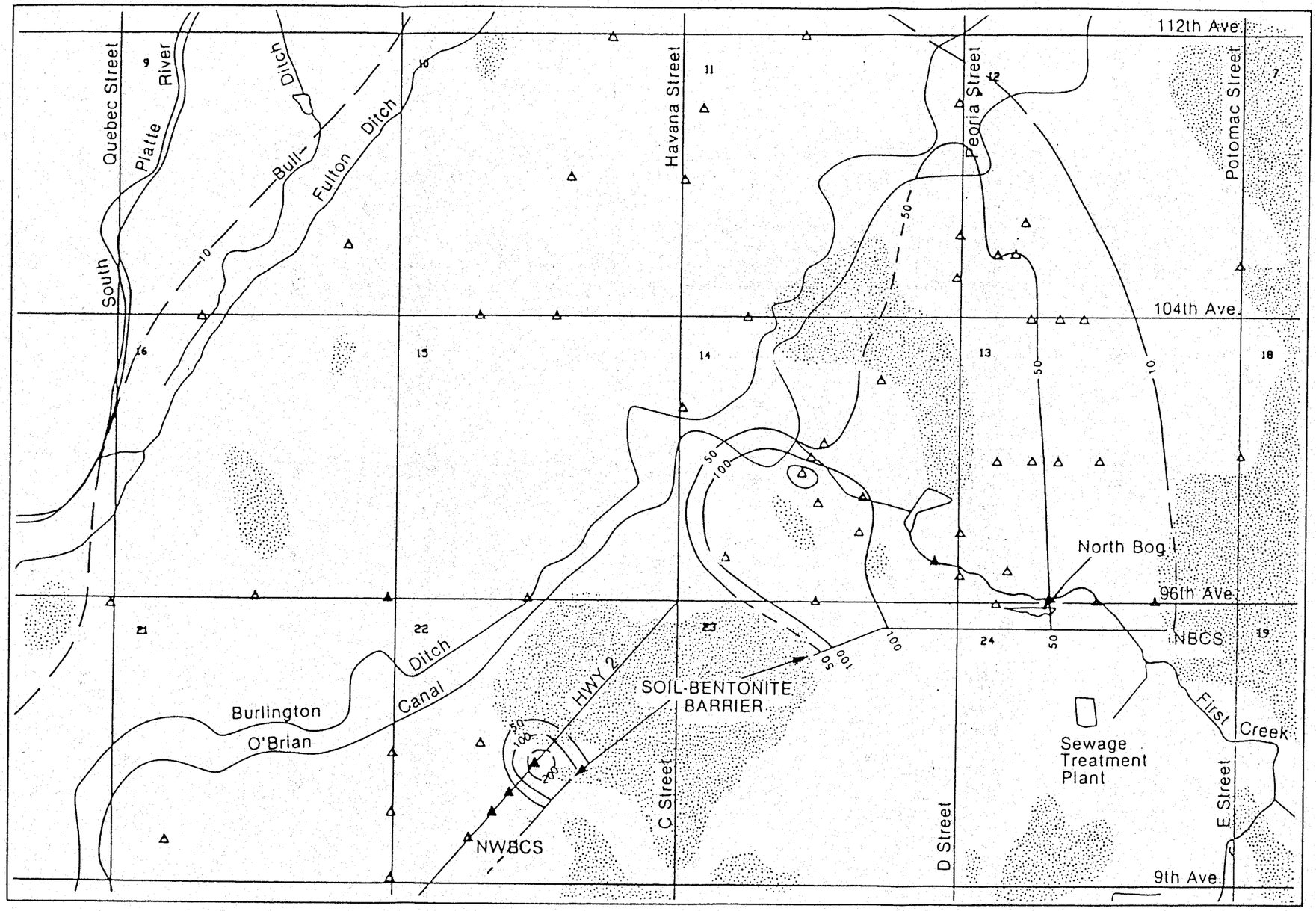
Scale In Feet

Figure F-51
SODIUM CONCENTRATION DISTRIBUTION, mg/l,
4TH QUARTER, FY87, ALLUVIAL AQUIFER

SOURCE:ESE,1988

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland



EXPLANATION

ALL CONCENTRATIONS IN MILLIGRAMS PER LITER (mg/l)

1 ISOCONCENTRATION LINE

NWBCS: NORTHWEST BOUNDARY CONTAINMENT SYSTEM

NBCS: NORTH BOUNDARY CONTAINMENT SYSTEM.

△ MONITORING WELL LOCATION

UNSATURATED ALLUVIUM

N

0 1000 2000

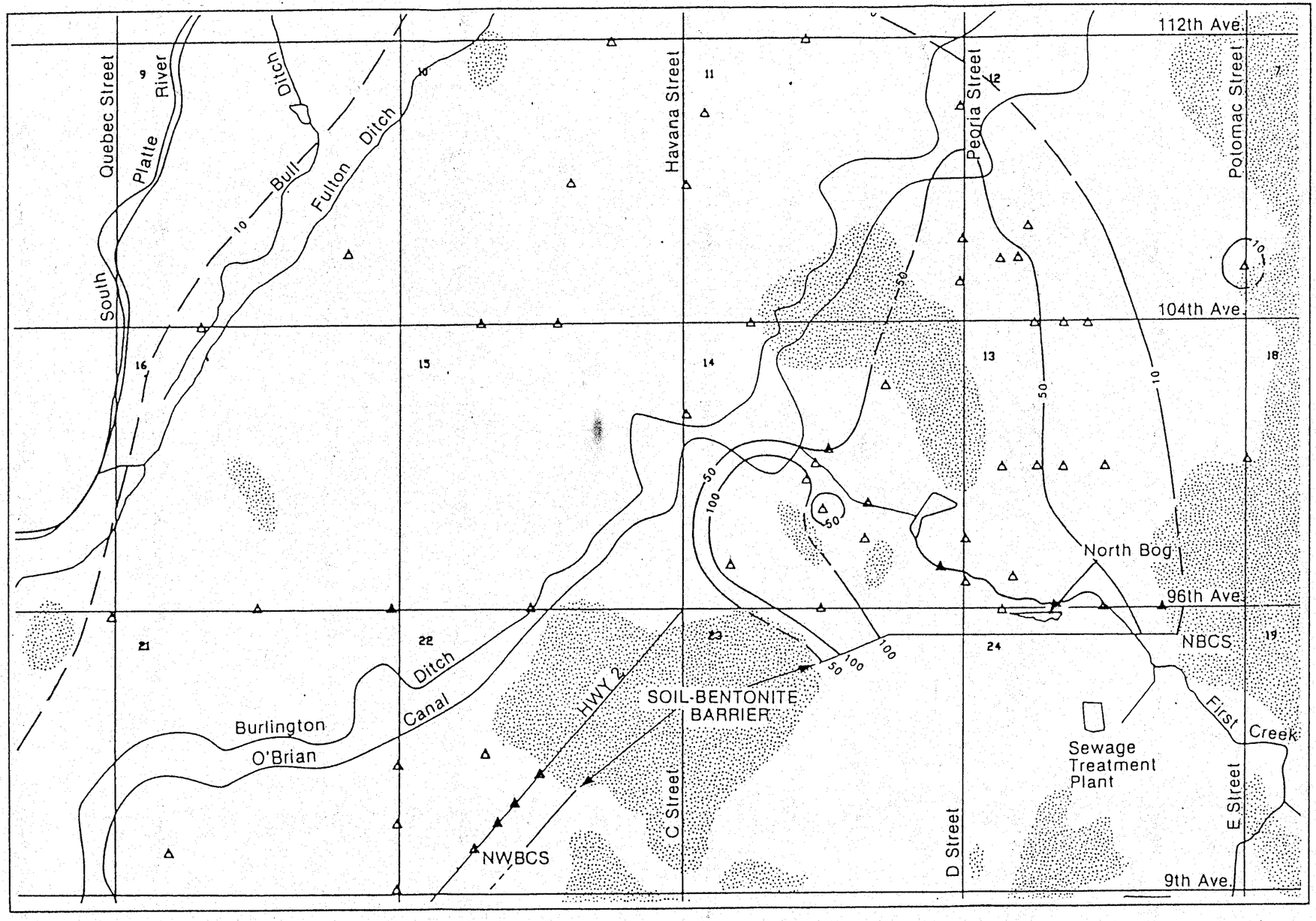
Scale In Feet

Figure F-52
MAGNESIUM CONCENTRATION DISTRIBUTION, mg/l,
3RD QUARTER, FY87, ALLUVIAL AQUIFER

SOURCE:ESE, 1988

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland



EXPLANATION

ALL CONCENTRATIONS IN MILLIGRAMS PER LITER (mg/l)

1 — ISOCONCENTRATION LINE

NWBCS: NORTHWEST BOUNDARY CONTAINMENT SYSTEM

NBCS: NORTH BOUNDARY CONTAINMENT SYSTEM.

△ MONITORING WELL LOCATION

UNSATURATED ALLUVIUM

N

0 1000 2000

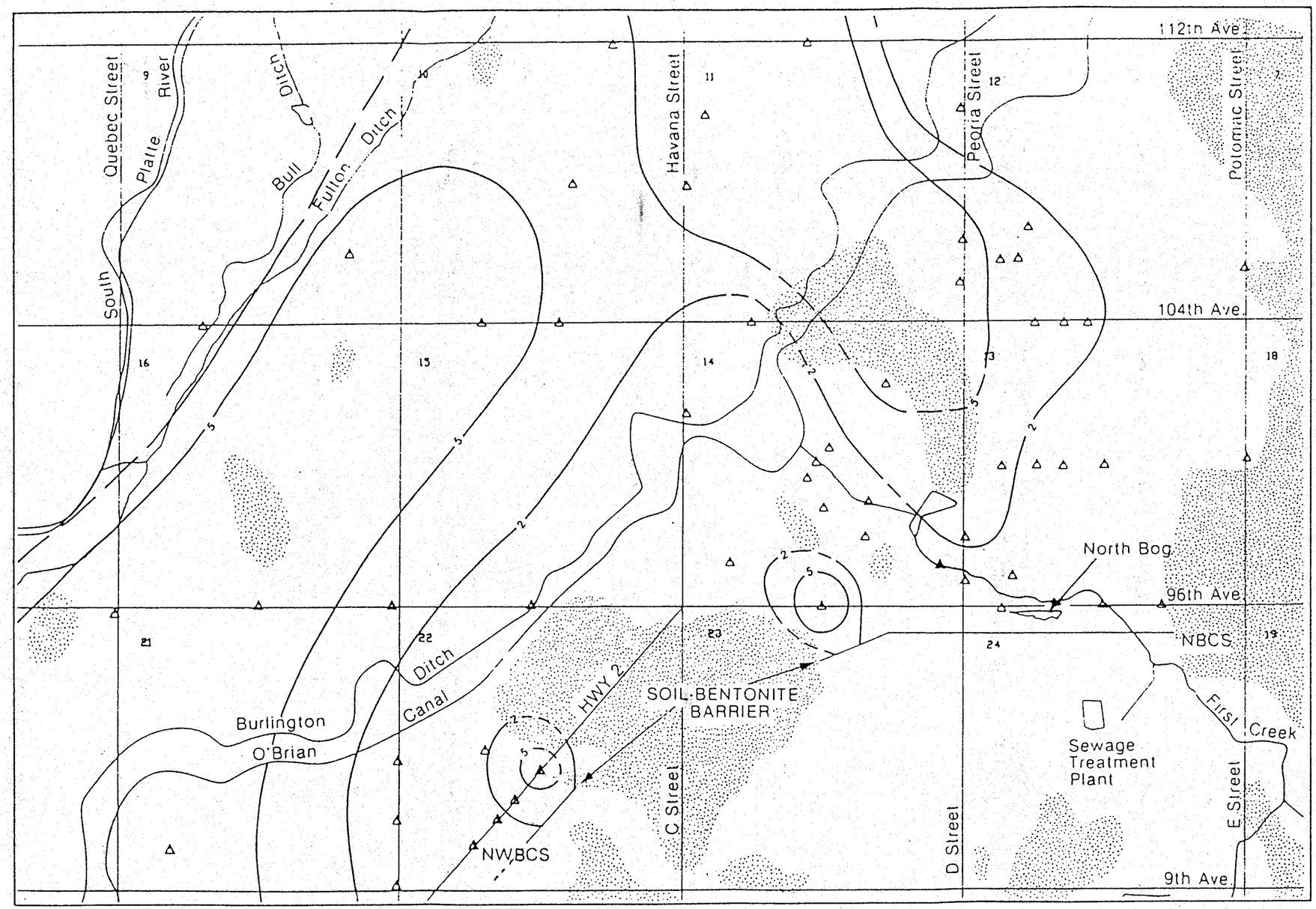
Scale In Feet

Figure F-53
MAGNESIUM CONCENTRATION DISTRIBUTION, mg/l,
4TH QUARTER, FY87, ALLUVIAL AQUIFER

SOURCE:ESE,1988

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland



EXPLANATION

ALL CONCENTRATIONS IN MILLIGRAMS PER LITER (mg/l)

1 — ISOCONCENTRATION LINE

NWBCS: NORTHWEST BOUNDARY CONTAINMENT SYSTEM

NBCS: NORTH BOUNDARY CONTAINMENT SYSTEM.

△ MONITORING WELL LOCATION

UNSATURATED ALLUVIUM

N

0 1000 2000

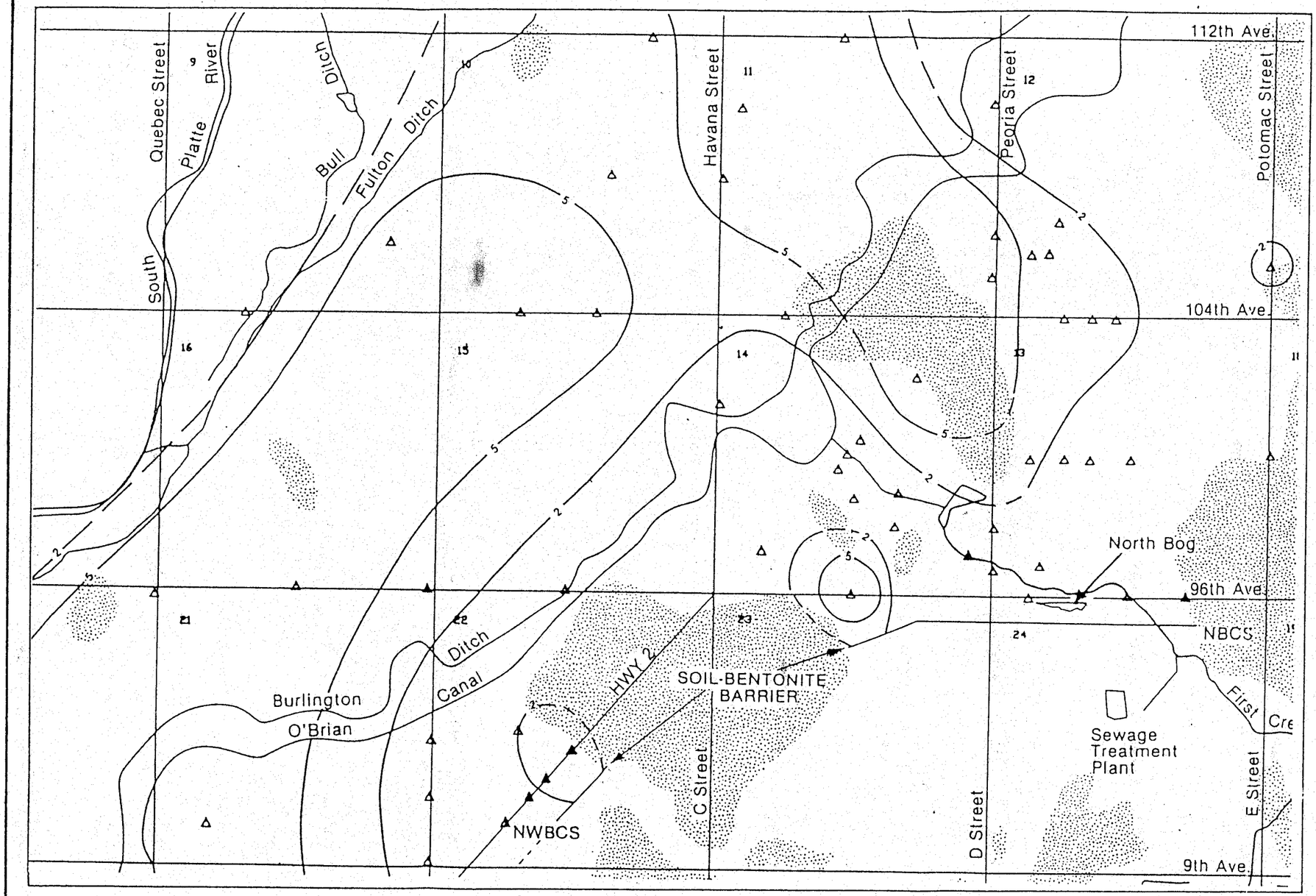
Scale In Feet

Figure F-54
NITRATE CONCENTRATION DISTRIBUTION, mg/l,
3RD QUARTER, FY87, ALLUVIAL AQUIFER

SOURCE:ESE,1988

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland



EXPLANATION

ALL CONCENTRATIONS IN MILLIGRAMS PER LITER (mg/l)

1 ISOCONCENTRATION LINE

NWBCS: NORTHWEST BOUNDARY CONTAINMENT SYSTEM

NBCS: NORTH BOUNDARY CONTAINMENT SYSTEM.

△ MONITORING WELL LOCATION

UNSATURATED ALLUVIUM

N

0 1000 2000

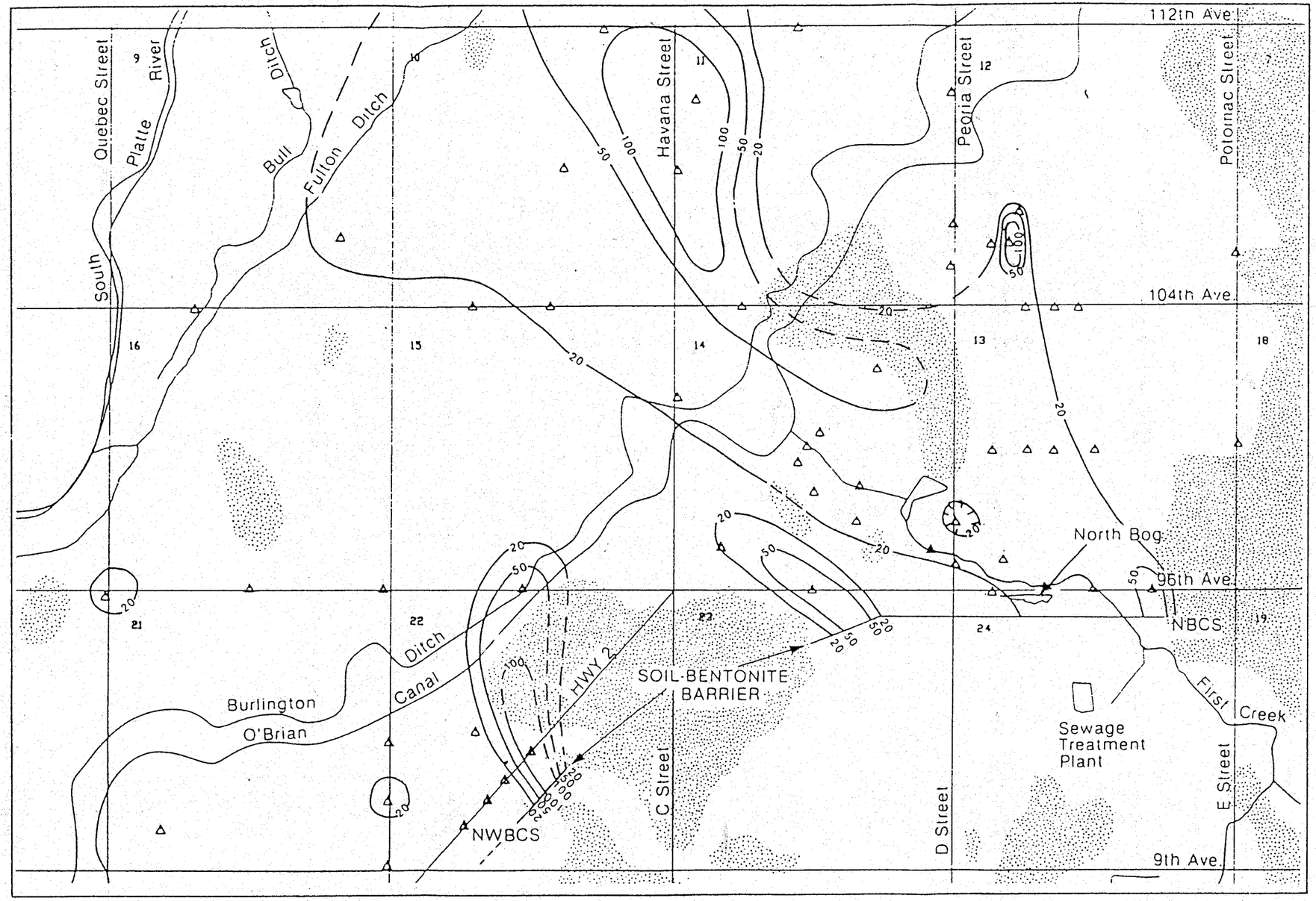
Scale In Feet

Figure F-55
NITRATE CONCETRATION DISTRIBUTION, mg/l,
4TH QUARTER, FY87, ALLUVIAL AQUIFER

SOURCE:ESE,1988

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland



EXPLANATION

ALL CONCENTRATIONS IN MICROGRAMS PER LITER (ug/l)

1 — ISOCONCENTRATION LINE

NWBCS: NORTHWEST BOUNDARY CONTAINMENT SYSTEM

NBCS: NORTH BOUNDARY CONTAINMENT SYSTEM.

△ MONITORING WELL LOCATION

UNSATURATED ALLUVIUM

N

0 1000 2000

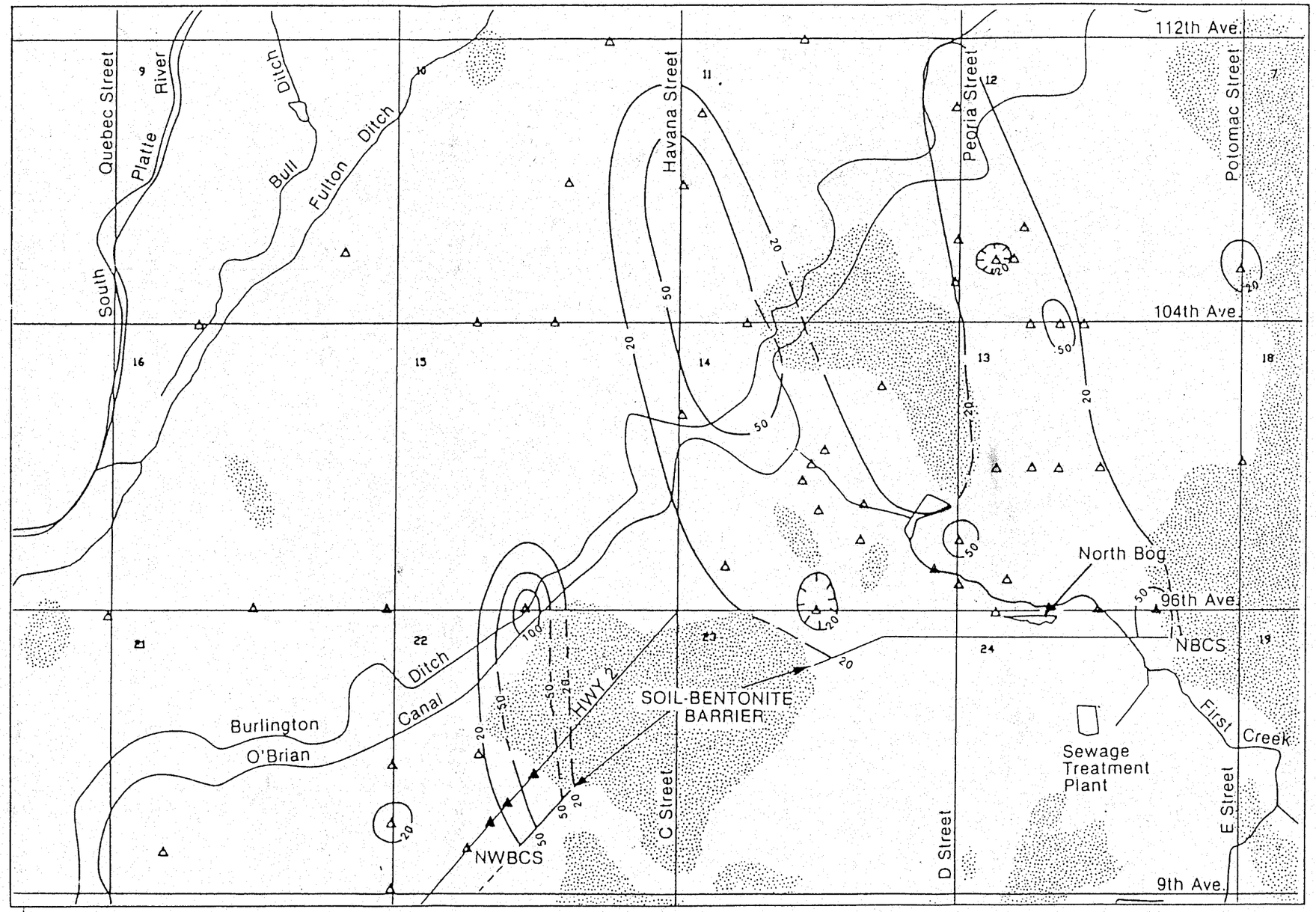
Scale In Feet

Figure F-56
ZINC CONCENTRATION DISTRIBUTION, ug/l,
3RD QUARTER, FY87, ALLUVIAL AQUIFER

SOURCE:ESE,1988

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland



EXPLANATION

ALL CONCENTRATIONS IN MICROGRAMS PER LITER (ug/l)

1 — ISOCONCENTRATION LINE

NWBCS: NORTHWEST BOUNDARY CONTAINMENT SYSTEM

NBCS: NORTH BOUNDARY CONTAINMENT SYSTEM.

△ MONITORING WELL LOCATION

UNSATURATED ALLUVIUM

N

0 1000 2000

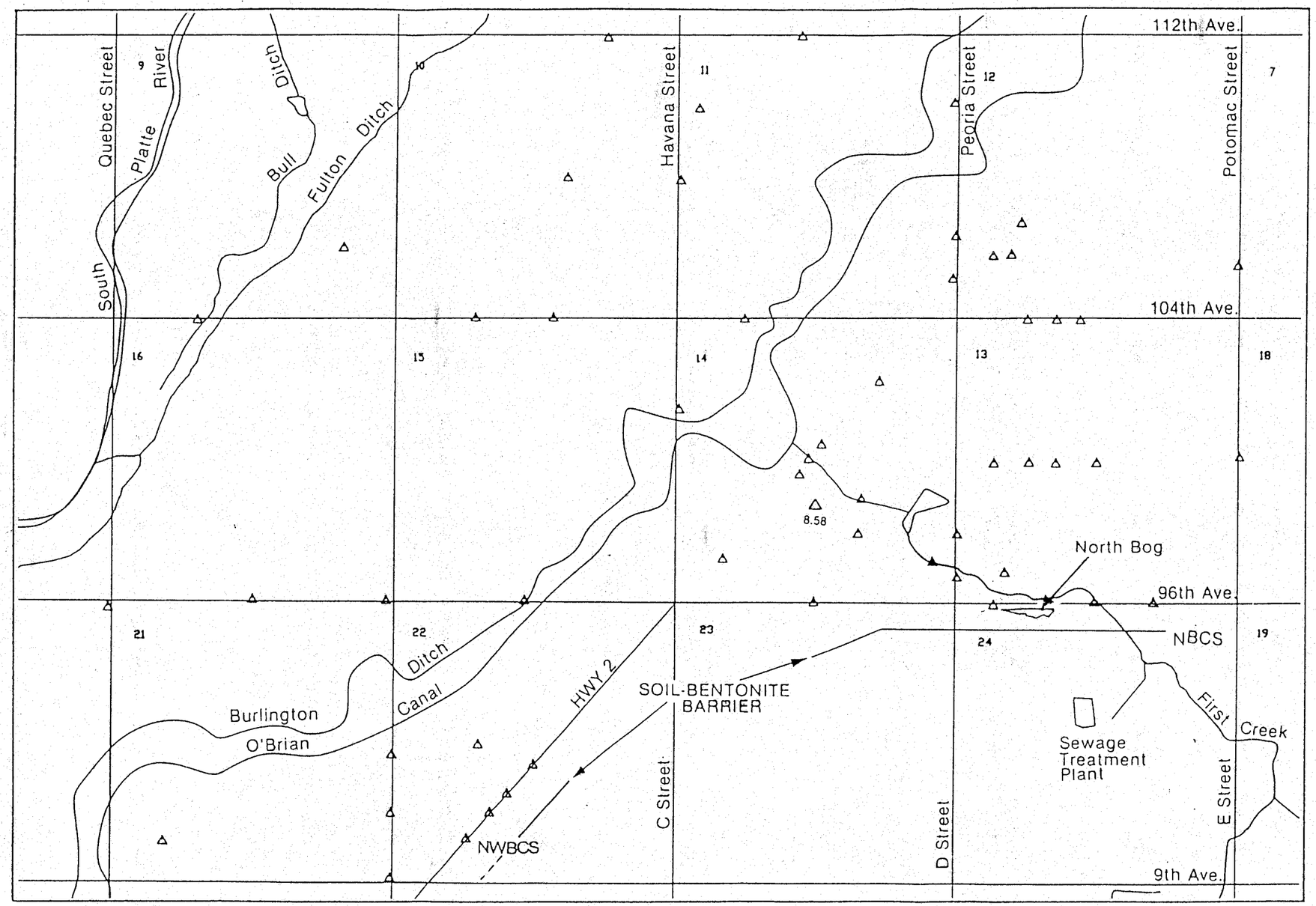
Scale In Feet

Figure F-57
ZINC CONCENTRATION DISTRIBUTION, ug/l,
4TH QUARTER, FY87, ALLUVIAL AQUIFER

SOURCE:ESE,1988

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland



EXPLANATION

5.42 CONCENTRATION IN MICROGRAMS PER LITER (ug/l)

NWBCS: NORTHWEST BOUNDARY CONTAINMENT SYSTEM

NBCS: NORTH BOUNDARY CONTAINMENT SYSTEM.

△ MONITORING WELL LOCATION

UNSATURATED ALLUVIUM

N

0 1000 2000

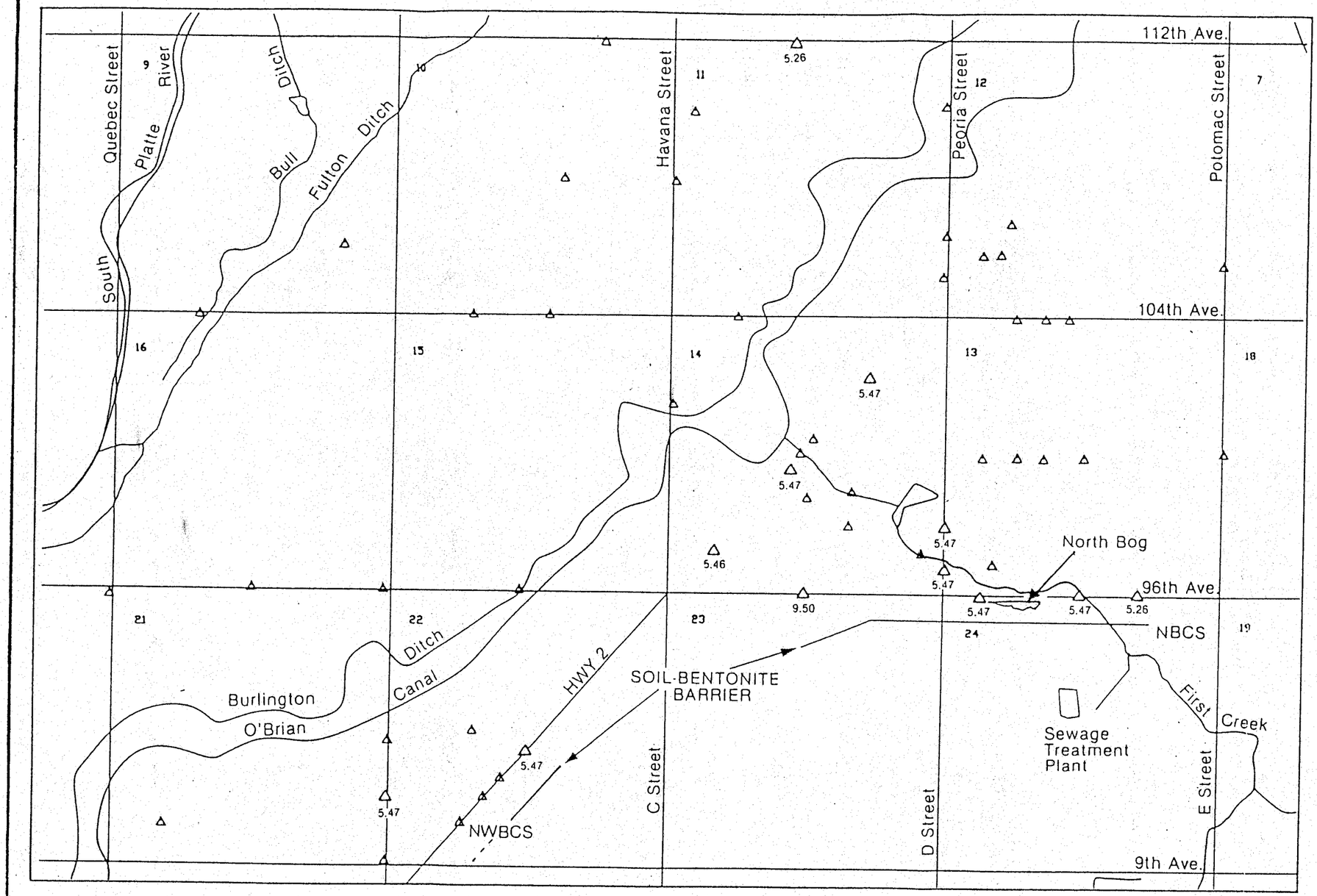
Scale In Feet

Figure F-58
CADMIUM CONCENTATIONS EXCEEDING CERTIFIED REPORTING LIMITS, ug/l,
3RD QUARTER, FY87, ALLUVIAL AQUIFER

SOURCE:ESE,1988

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland



EXPLANATION

5.42 CONCENTRATION IN MICROGRAMS PER LITER (ug/l)

NWBCS: NORTHWEST BOUNDARY CONTAINMENT SYSTEM

NBCS: NORTH BOUNDARY CONTAINMENT SYSTEM.

△ MONITORING WELL LOCATION

UNSATURATED ALLUVIUM

N

0 1000 2000

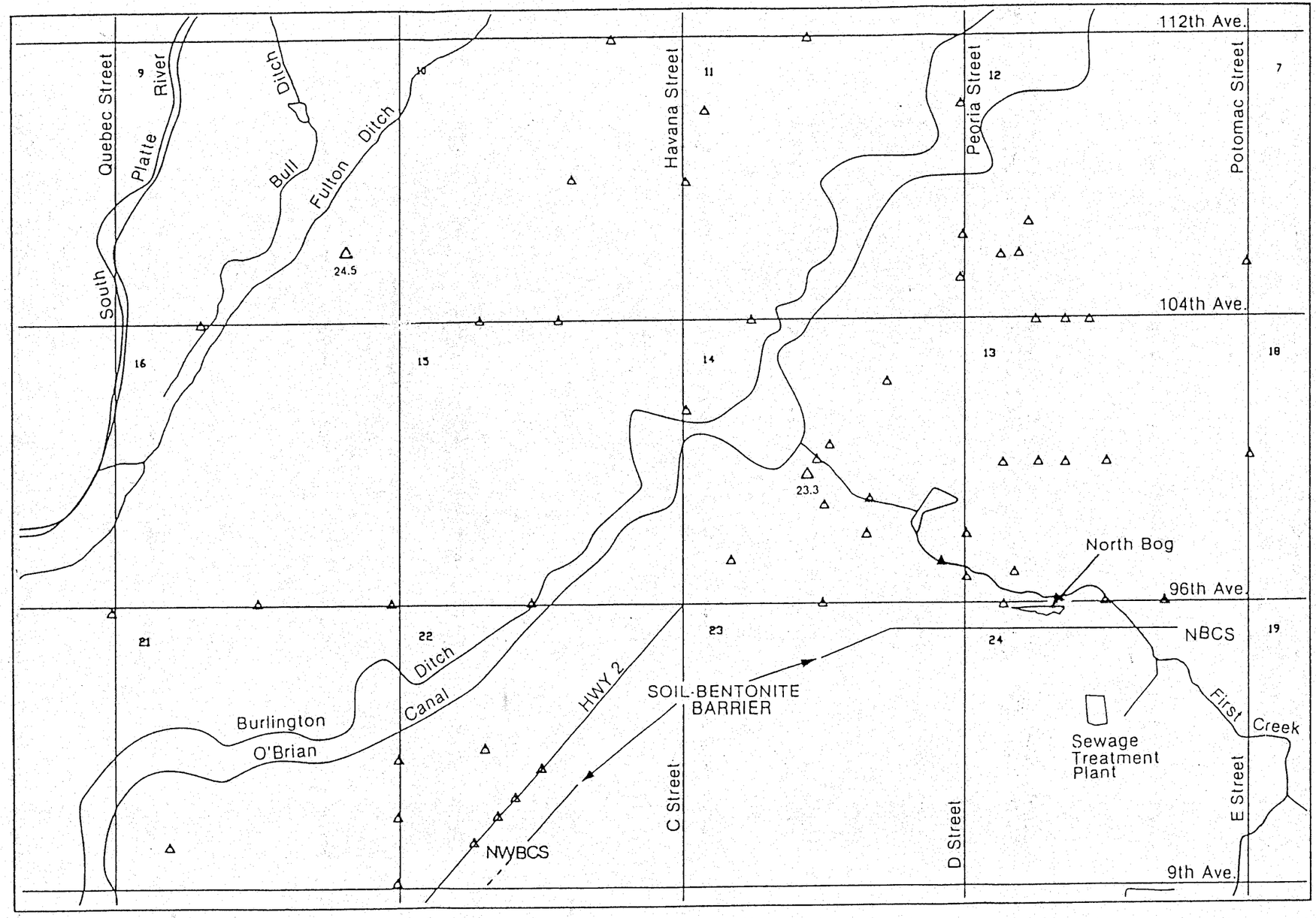
Scale In Feet

Figure F-59
CADMIUM CONCENTRATIONS EXCEEDING CERTIFIED REPORTING LIMITS, ug/l,
4TH QUARTER, FY87, ALLUVIAL AQUIFER

SOURCE:ESE,1988

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland



EXPLANATION

5.42 CONCENTRATION IN MICROGRAMS PER LITER (ug/l)

NWBCS: NORTHWEST BOUNDARY CONTAINMENT SYSTEM

NBCS: NORTH BOUNDARY CONTAINMENT SYSTEM.

△ MONITORING WELL LOCATION

UNSATURATED ALLUVIUM

N

0 1000 2000

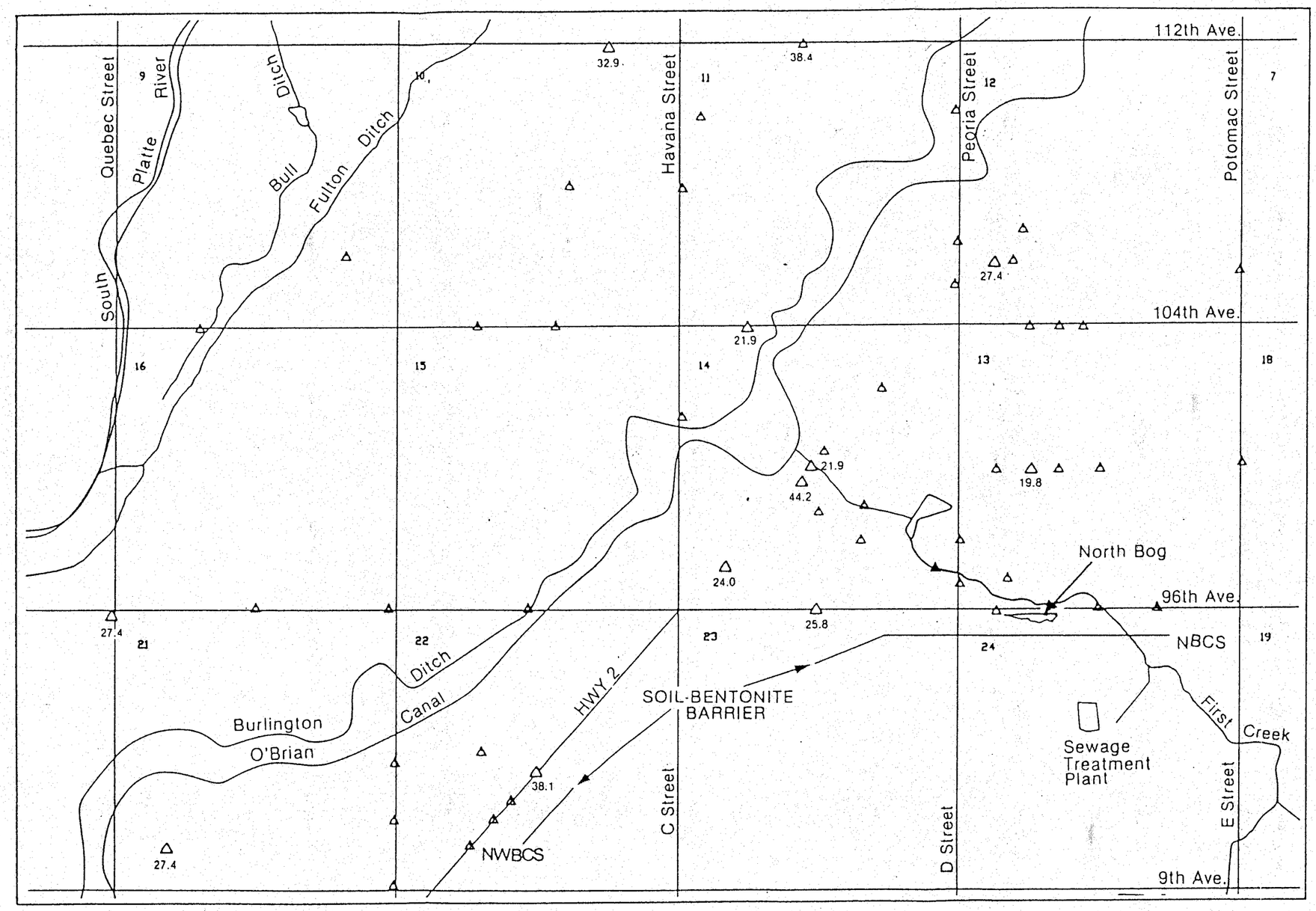
Scale In Feet

Figure F-60
LEAD CONCENTRATIONS EXCEEDING CERTIFIED REPORTING LIMITS, ug/l,
3RD QUARTER, FY87, ALLUVIAL AQUIFER

SOURCE:ESE,1988

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland



EXPLANATION

5.42 CONCENTRATION IN MICROGRAMS PER LITER (ug/l)

NWBCS: NORTHWEST BOUNDARY CONTAINMENT SYSTEM

NBCS: NORTH BOUNDARY CONTAINMENT SYSTEM.

△ MONITORING WELL LOCATION

UNSATURATED ALLUVIUM

N

0 1000 2000

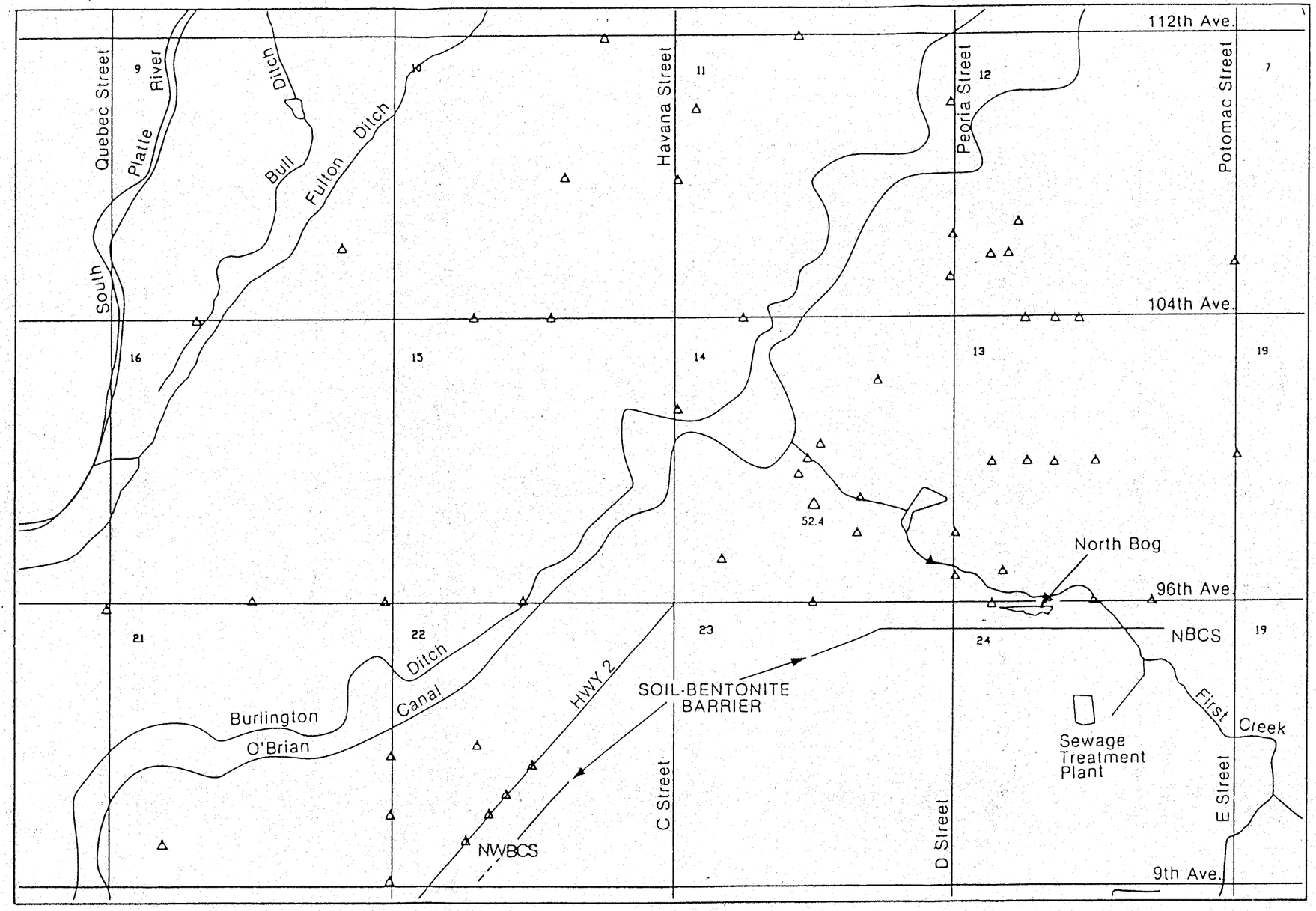
Scale In Feet

Figure F-61
LEAD CONCENTRATIONS EXCEEDING CERTIFIED REPORTING LIMITS, ug/l,
4TH QUARTER, FY87, ALLUVIAL AQUIFER

SOURCE:ESE,1988

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland



EXPLANATION

5.42 CONCENTRATION IN MICROGRAMS PER LITER (ug/l)

NWBCS: NORTHWEST BOUNDARY CONTAINMENT SYSTEM

NBCS: NORTH BOUNDARY CONTAINMENT SYSTEM.

△ MONITORING WELL LOCATION

UNSATURATED ALLUVIUM

N

0 1000 2000

Scale In Feet

Figure F-62
CHROMIUM CONCENTRATIONS EXCEEDING CERTIFIED REPORTING LIMITS, ug/l,
3RD QUARTER, FY87, ALLUVIAL AQUIFER

SOURCE:ESE,1988

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland

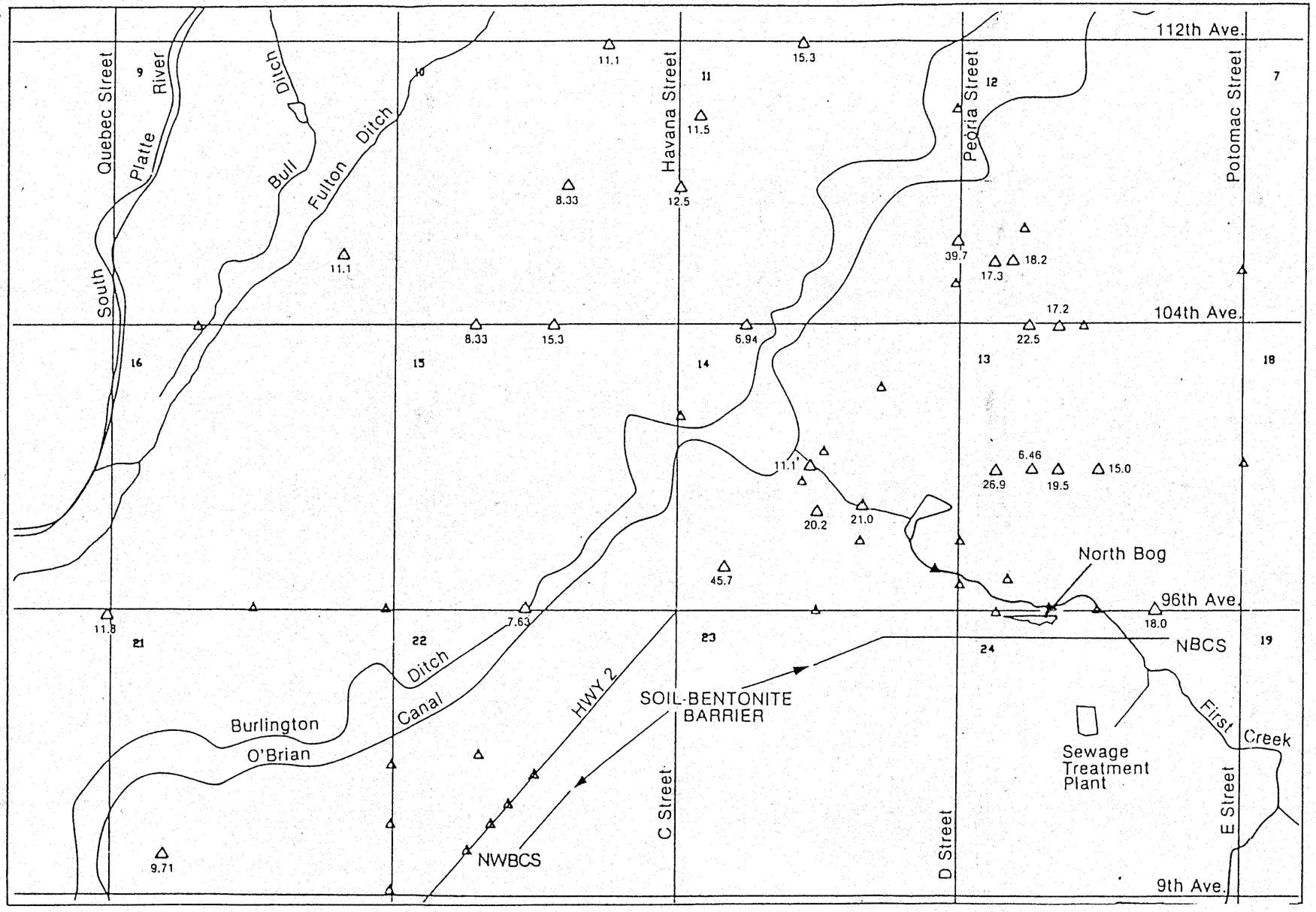
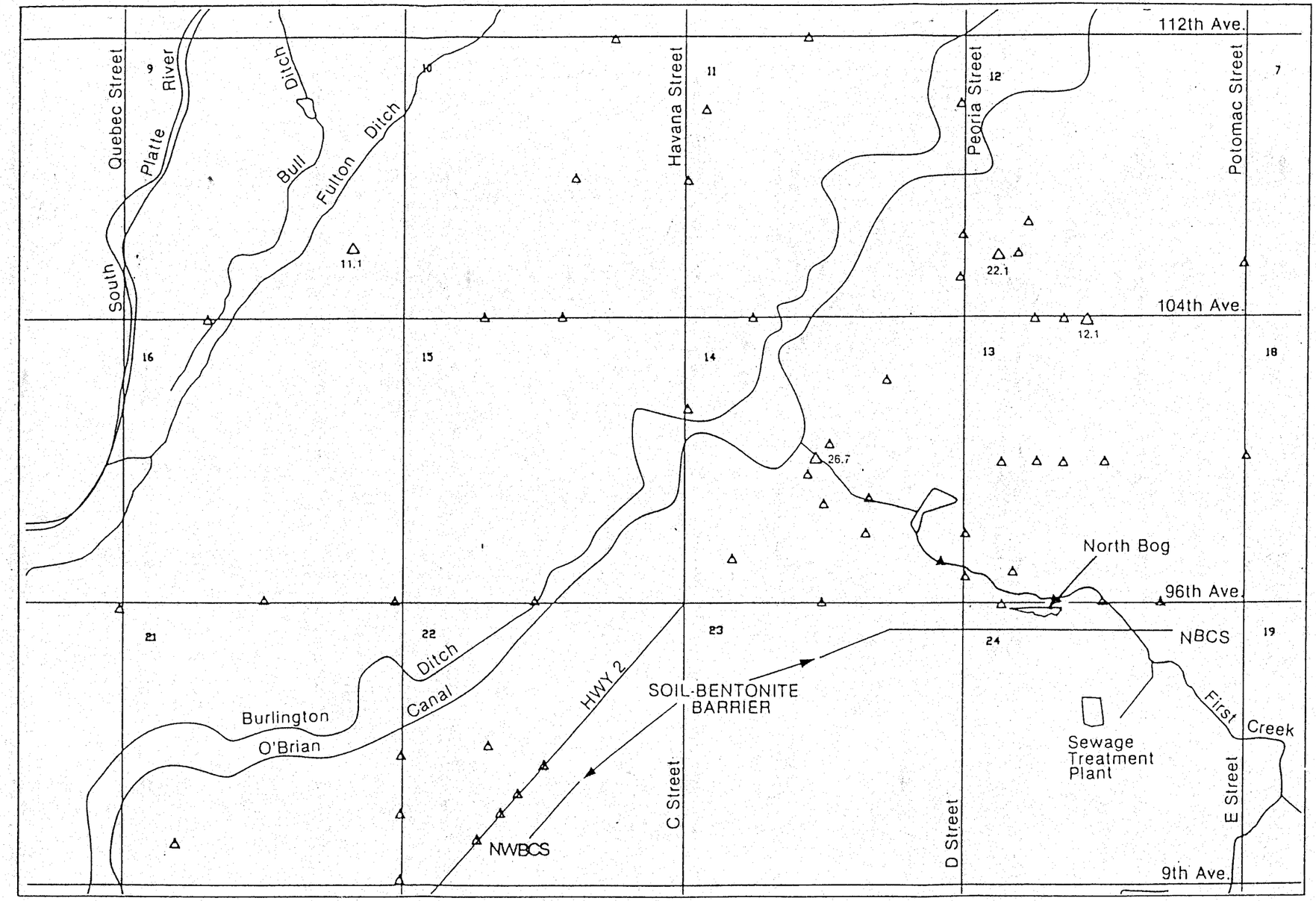


Figure F-63
CHROMIUM CONCENTRATIONS EXCEEDING CERTIFIED REPORTING LIMITS, ug/l,
4TH QUARTER, FY87, ALLUVIAL AQUIFER

SOURCE:ESE, 1988

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland



EXPLANATION

5.42 CONCENTRATION IN MICROGRAMS PER LITER (ug/l)

NWBCS: NORTHWEST BOUNDARY CONTAINMENT SYSTEM

NBCS: NORTH BOUNDARY CONTAINMENT SYSTEM.

△ MONITORING WELL LOCATION

UNSATURATED ALLUVIUM

N

0 1000 2000

Scale In Feet

Figure F-64
COPPER CONCENTRATIONS EXCEEDING CERTIFIED REPORTING LIMITS, ug/l,
3RD QUARTER, FY87, ALLUVIAL AQUIFER

SOURCE:ESE,1988

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland

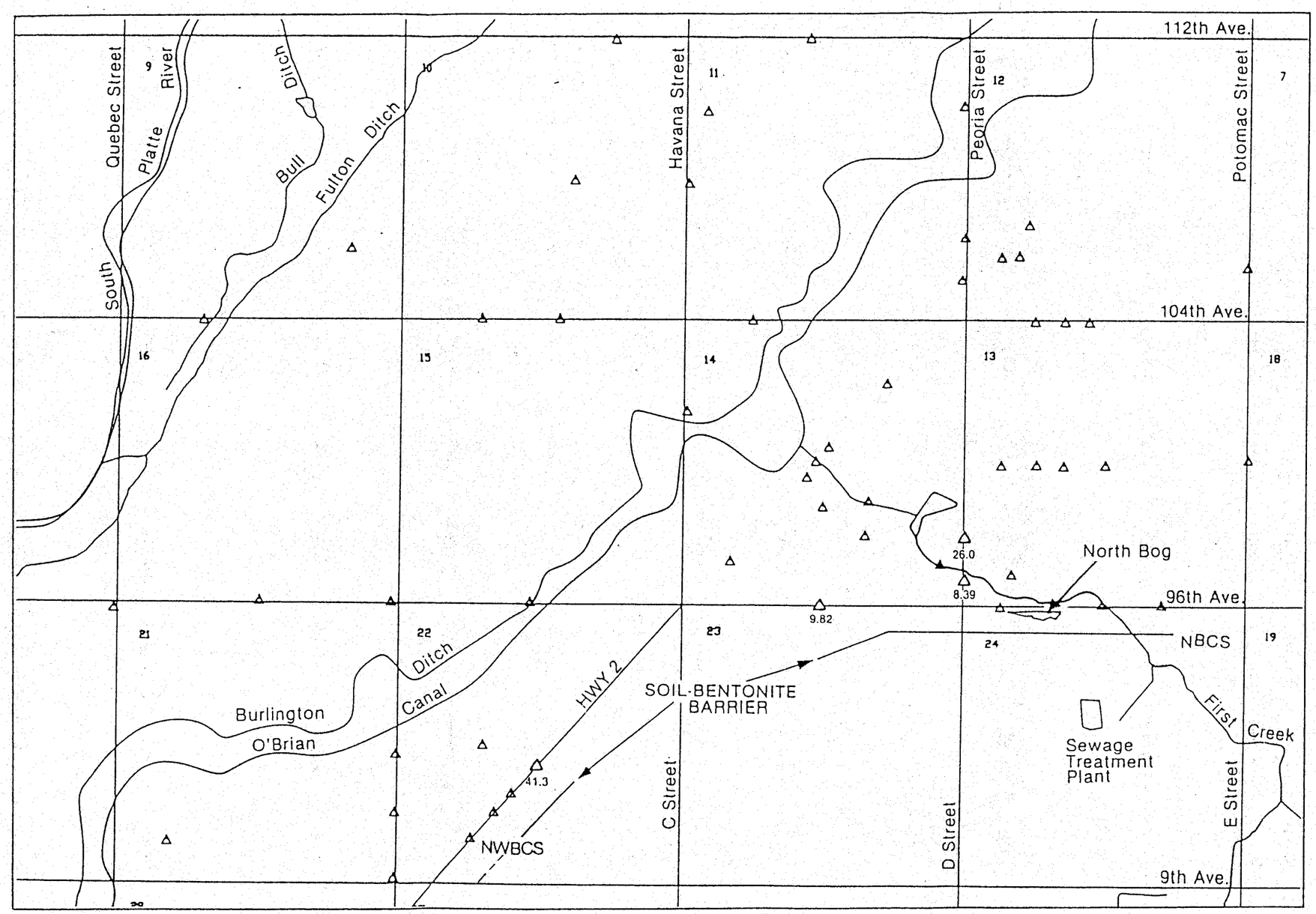
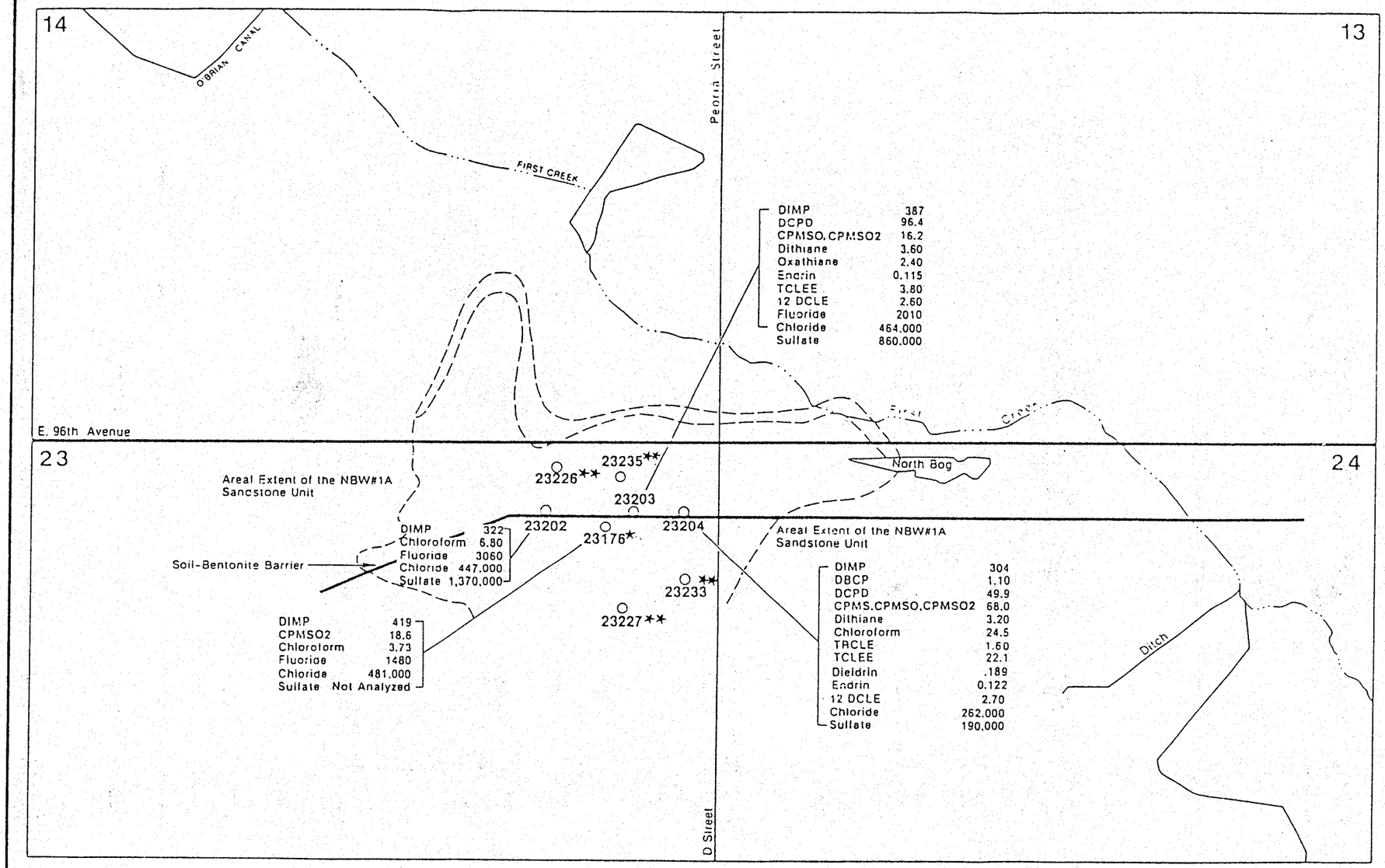


Figure F-65
COPPER CONCENTRATIONS EXCEEDING CERTIFIED REPORTING LIMITS, ug/l,
4TH QUARTER, FY87, ALLUVIAL AQUIFER

SOURCE:ESE,1988

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland



EXPLANATION

★ Initial Screening Program (ISP) Data.

★★ Not completed at time of sampling.

All concentrations in micrograms per liter (ug/l).

NOTE: Chemical concentrations presented are above certified reporting limits

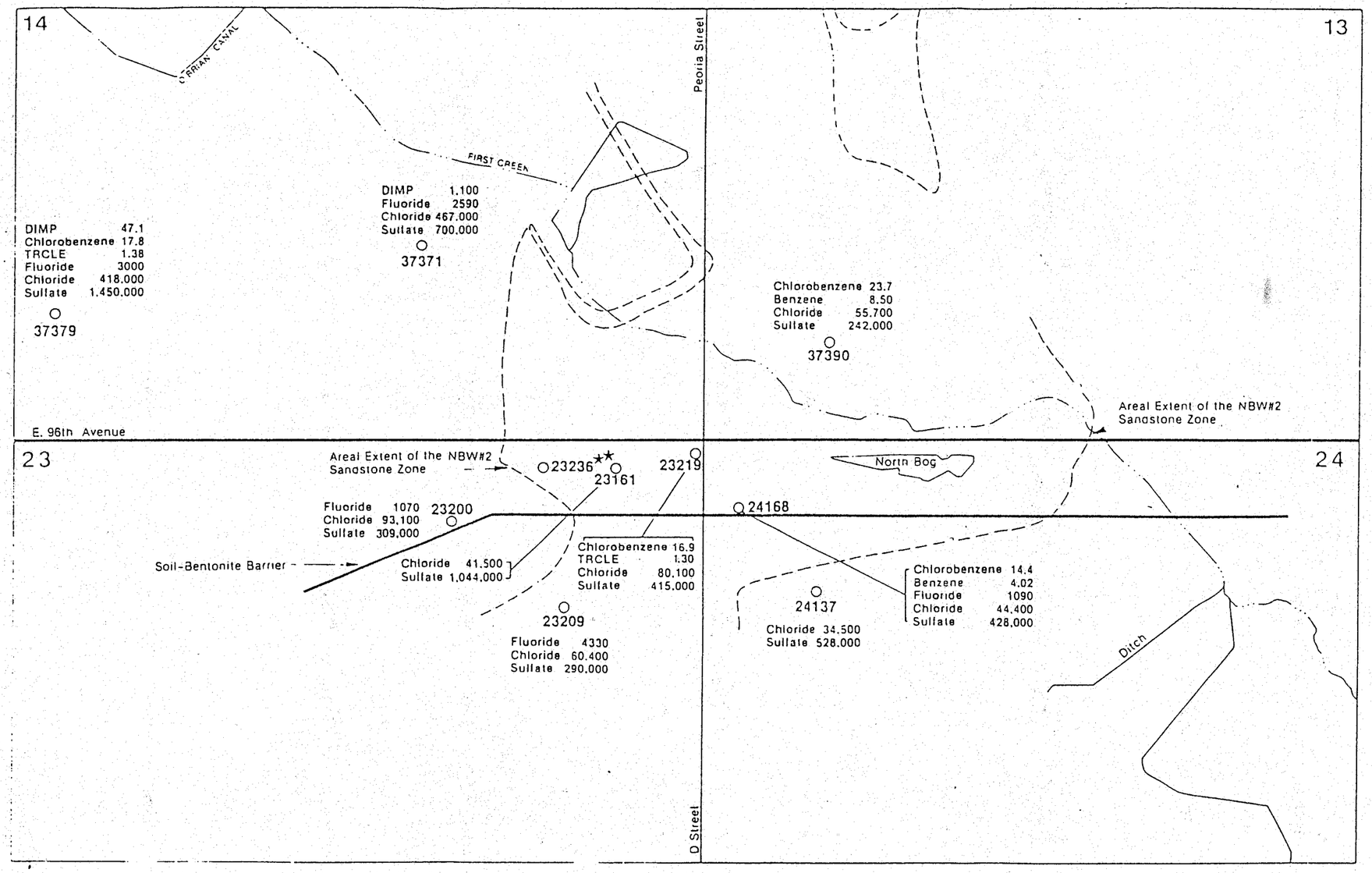
Figure F-66

WATER CHEMISTRY DATA FOR DENVER FM UNIT NBW#1A
SPRING QUARTER, 1987

SOURCE: ESE, 1988

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland



EXPLANATION

★★ Not completed at time of sampling.

All concentrations in micrograms per liter (ug/l).

NOTE: Chemical concentrations presented are above certified reporting limits.

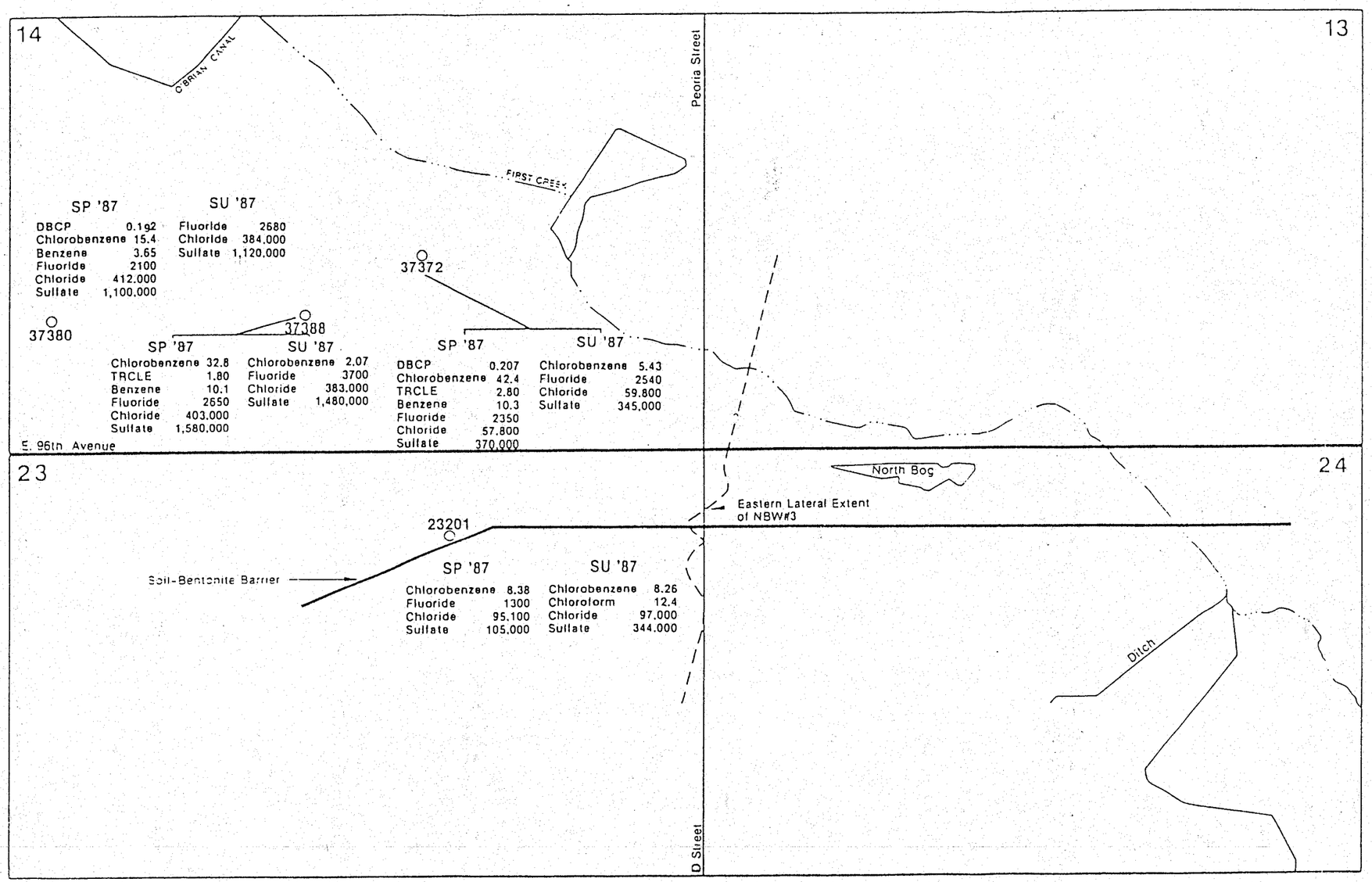
Figure F-67

WATER CHEMISTRY DATA FOR DENVER FM UNIT NBW#2
SPRING QUARTER, 1987

SOURCE. ESE. 1988

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland



EXPLANATION

All concentrations in micrograms per liter (ug/l).

N

0 500 1000

Scale in Feet

NOTE: Chemical concentrations presented are above certified reporting limits

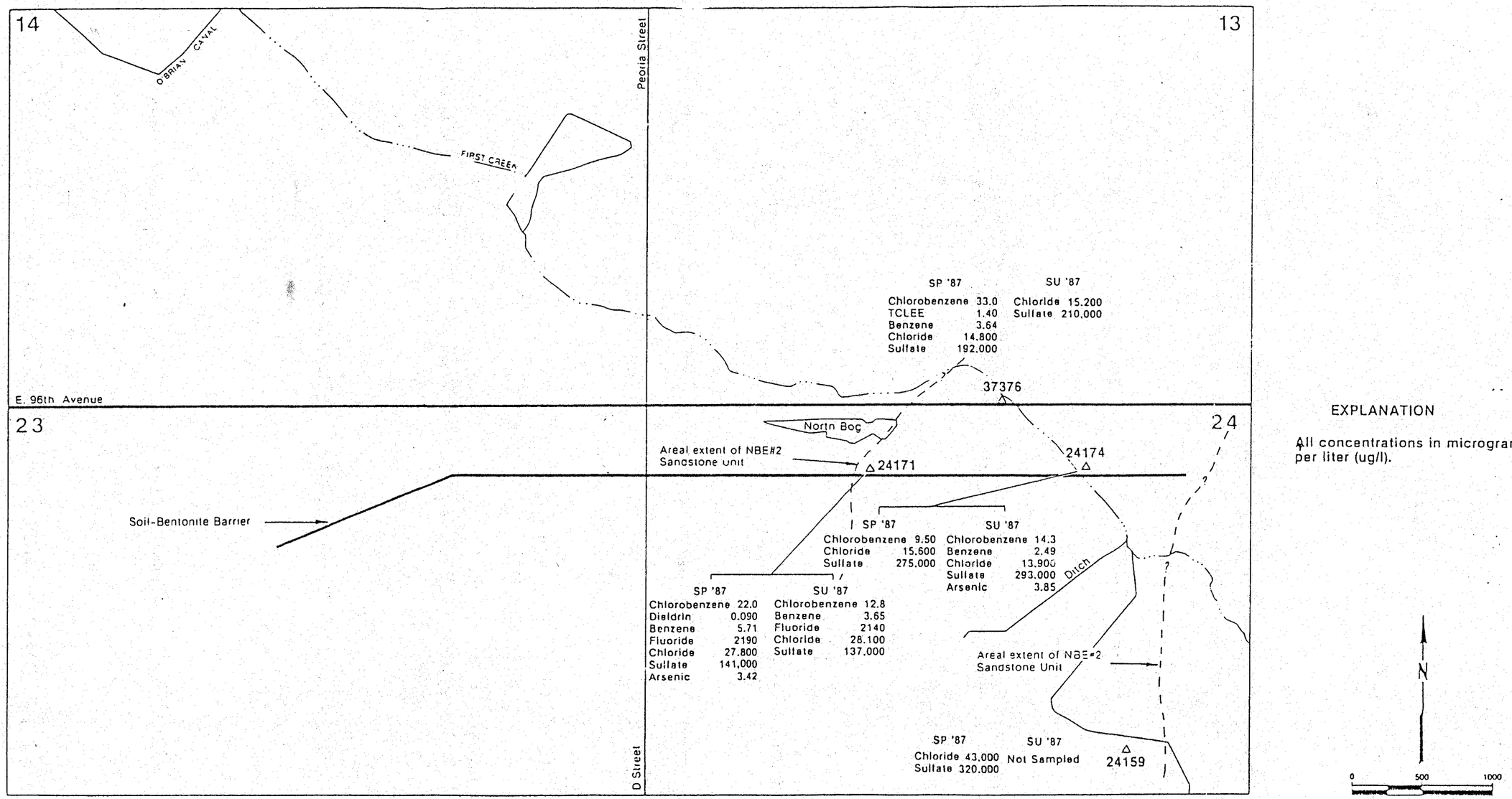
Figure F-68

WATER CHEMISTRY DATA FOR DENVER FM UNIT NBW#3
SPRING AND SUMMER QUARTERS, 1987

SOURCE: ESE, 1988

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland



NOTE: Chemical concentrations presented are above certified reporting limits.

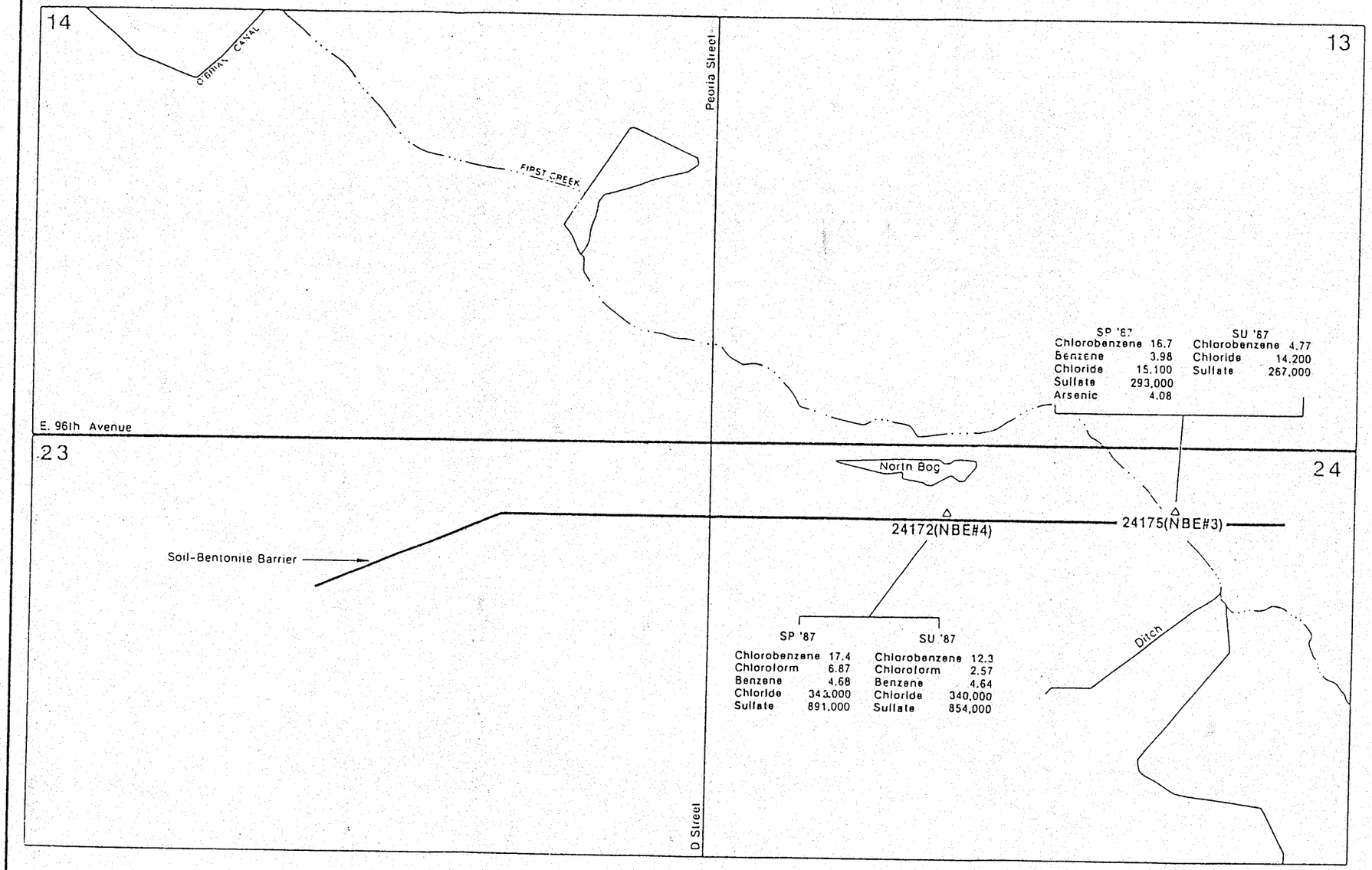
Figure F-69

WATER CHEMISTRY DATA FOR DENVER FM UNIT NBE#2
SPRING AND SUMMER QUARTERS, 1987

SOURCE: ESE, 1988

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland



NOTE: Chemical concentrations presented are above certified reporting limits.

Figure F-70

WATER CHEMISTRY DATA FOR DENVER FM UNITS NBE#3 AND NBE#4, SPRING AND SUMMER QUARTERS, 1987

SOURCE: ESE, 1988

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland

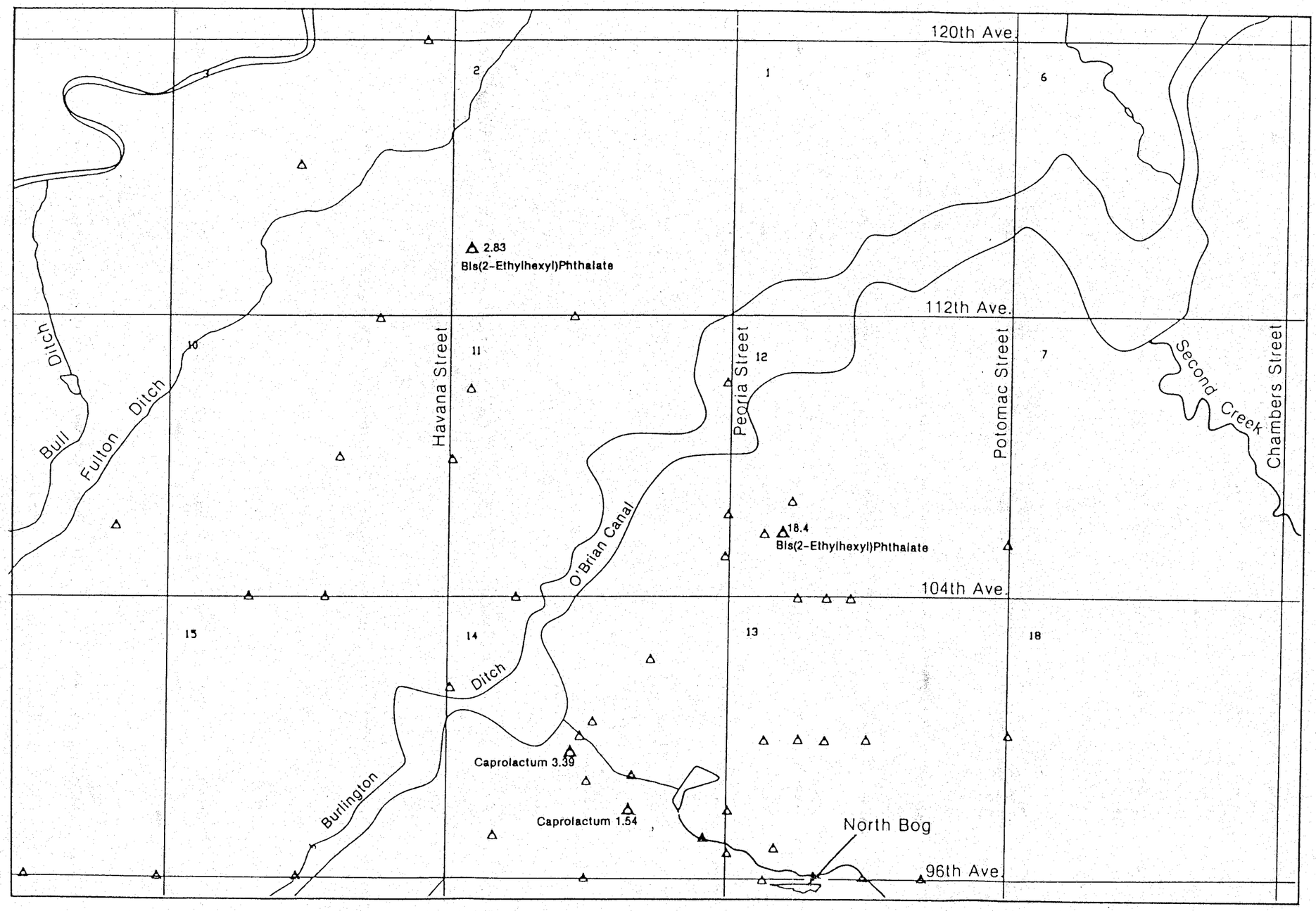


Figure F-71

NONTARGET COMPOUNDS (BIS(2-ETHYLHEXYL)PHTHALATE, CAPROLACTUM) IDENTIFIED BY GC/MS ANALYSIS, ug/l, TASKS 4 AND 44, ALLUVIAL AQUIFER

SOURCE: Hunter/ESE, 1988

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland

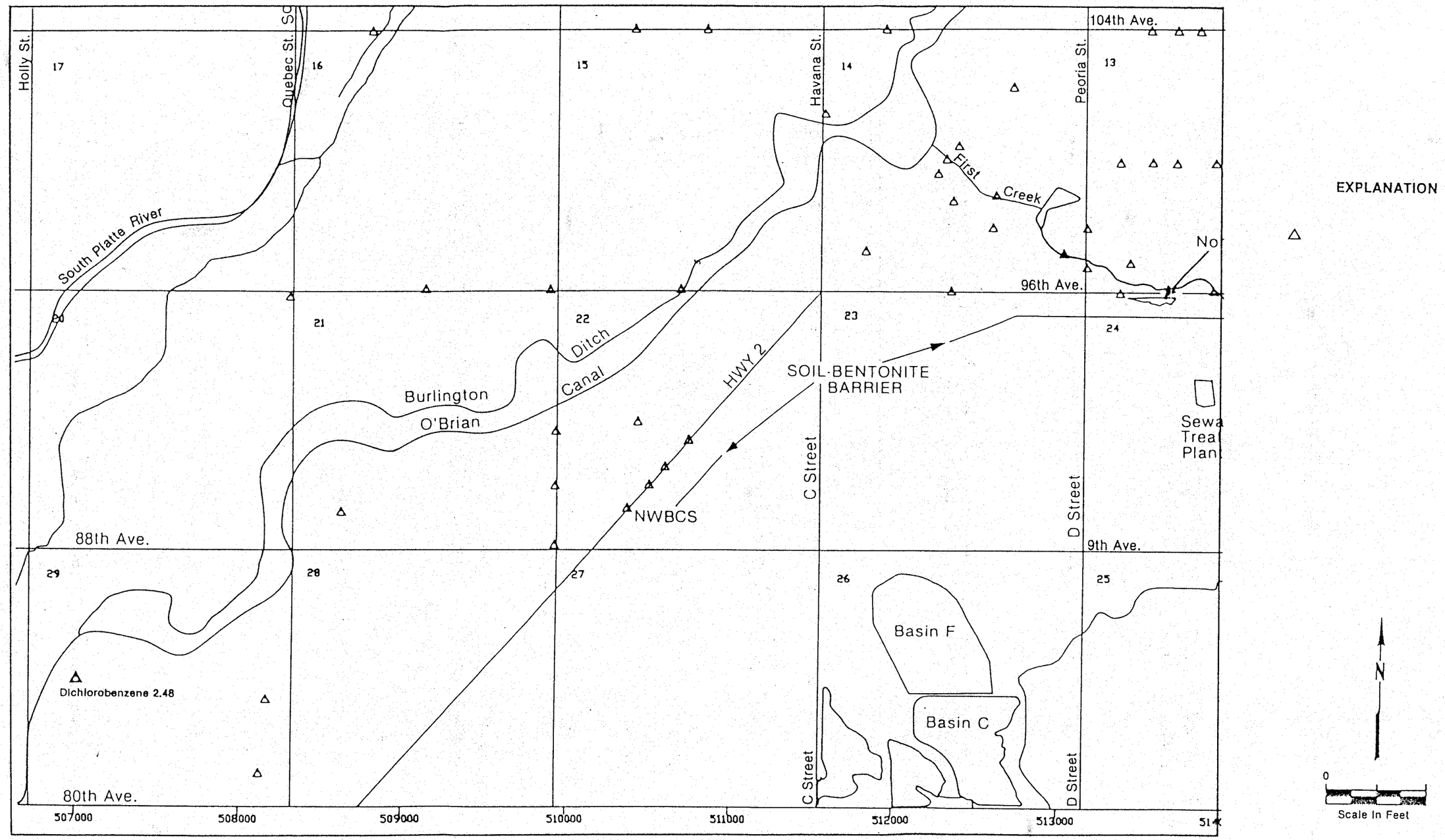


Figure F-72

NONTARGET COMPOUND (DICHLOROBENZENE) IDENTIFIED BY GC/MS ANALYSIS, ug/l, TASK 4 AND 44, ALLUVIAL AQUIFER

SOURCE: Hunter/ESE, 1988

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland

TASK 39 WATER CHEMISTRY SUMMARY
SOURCE, ESE 1988

WELL #	AQUIFER	SCREENED INTERVAL	CASING DIAMETER	BEDROCK DEPTH	BEDROCK LITHOLOGY	WQAQ	DENVER SAND
37308	ALL	0.0- 0.0	2.0	20.5	SH	1	

COMPOUND	3RD QUARTER FY87	4TH QUARTER FY87
111TCE	<1.700	<1.700
112TCE	<1.000	<1.000
11DCE	<1.100	<1.100
11DCLE	<1.200	<1.200
12DCLE	1.690	0.604
ALDRN	<0.070	<0.070
AS	<3.070	<3.070
BTZ	<2.000	<2.000
C6H6	<1.340	<1.340
CA	120000.000	111000.000
CCL4	<2.400	<2.400
CD	<5.160	5.470
CH2CL2	<5.000	<5.000
CHCL3	<1.400	<1.400
CL	275000.000	267000.000
CL6CP	<0.070	<0.070
CLC6H5	<0.580	<0.580
CLDAN	.	.
CPMS	<1.300	<1.300
CPMSO	59.100	63.800
CPMSO2	<4.700	<4.700
CR	<5.960	.
CU	<7.940	8.390
DBCP	<0.130	<0.130
DCPD	54.100	30.500
DIMP	78.400	43.700
DITH	<1.100	<1.100
DLDRN	0.291	<0.060
DMDS	<1.800	<1.800
DMMP	<15.200	<15.200
ENDRN	<0.052	<0.052
ETC6H5	<1.280	<1.280
FL	2090.000	2190.000
HG	<0.240	<0.480
ISODR	<0.060	<0.060
K	4130.000	4640.000
MEC6H5	<1.210	<1.210
MG	68100.000	64400.000
MIBK	<12.900	<12.900
MXYLEN	<1.350	<1.350
NA	272000.000	276000.000
NIT	667.000	924.000
OXAT	<2.000	<2.000
PB	<18.600	<18.600
PPDDE	<0.053	<0.053
PPDDT	<0.070	<0.070
SO4	430000.000	409000.000
T12DCE	<1.200	<1.200
TCLEE	14.400	9.360
TRCLE	<1.100	<1.100
XYLEN	<2.470	<2.470
ZN	21.600	23.400

TASK 39 WATER CHEMISTRY SUMMARY
SOURCE, ESE 1988

WELL #	AQUIFER	SCREENED INTERVAL	CASING DIAMETER	BEDROCK DEPTH	BEDROCK LITHOLOGY	WQAQ	DENVER SAND
37309	ALL	0.0- 0.0	2.0	23.0	SH	1	

COMPOUND	3RD QUARTER FY87	4TH QUARTER FY87
111TCE	<1.700	<1.700
112TCE	<1.000	<1.000
11DCE	<1.100	<1.100
11DCLE	<1.200	<1.200
12DCLE	6.270	4.150
ALDRN	<0.700	<0.070
AS	<3.070	<3.070
BTZ	<2.000	<2.000
C6H6	<1.340	<1.340
CA	144000.000	117000.000
CCL4	<2.400	<2.400
CD	<5.160	5.470
CH2CL2	<5.000	<5.000
CHCL3	<1.400	<1.400
CL	624000.000	444000.000
CL6CP	<0.700	<0.070
CLC6H5	<0.580	<0.580
CLDAN	.	.
CPMS	<1.300	<1.300
CPMSO	27.100	55.500
CPMSO2	32.600	39.300
CR	<5.960	.
CU	<7.940	26.000
DBCP	0.176	0.229
DCPD	475.000	529.000
DIMP	829.000	765.000
DITH	6.480	5.930
DLDRN	<0.600	<0.060
DMDS	<1.800	<1.800
DMMP	<15.200	<76.000
ENDRN	<0.520	<0.052
ETC6H5	<1.280	<1.280
FL	2790.000	3060.000
HG	<0.240	<0.480
ISODR	<0.600	<0.060
K	2580.000	2580.000
MEC6H5	<1.210	<1.210
MG	71400.000	56100.000
MIBK	<12.900	<12.900
MXYLEN	<1.350	<1.350
NA	539000.000	432000.000
NIT	2180.000	1750.000
OXAT	<2.000	<2.000
PB	<18.600	<18.600
PPDDE	<0.530	<0.053
PPDDT	<0.700	<0.070
SO4	591000.000	585000.000
T12DCE	<1.200	<1.200
TCLEE	45.400	46.500
TRCLE	3.160	2.300
XYLEN	<2.470	<2.470
ZN	<20.100	56.000

TASK 39 WATER CHEMISTRY SUMMARY
SOURCE, ESE 1988

WELL #	AQUIFER	SCREENED INTERVAL	CASING DIAMETER	BEDROCK DEPTH	BEDROCK LITHOLOGY	WQAQ	DENVER SAND
37312	ALL	0.0- 0.0	2.0	13.5	SH	1	

COMPOUND	3RD QUARTER FY87	4TH QUARTER FY87
111TCE	<1.700	<1.700
112TCE	<1.000	<1.000
11DCE	<1.100	<1.100
11DCLE	<1.200	<1.200
12DCLE	<0.610	<0.610
ALDRN	<0.070	<0.070
AS	<3.070	<3.070
BTZ	<2.000	<2.000
C6H6	<1.340	<1.340
CA	135000.000	116000.000
CCL4	<2.400	<2.400
CD	<5.160	5.470
CH2CL2	<5.000	<5.000
CHCL3	<1.400	<1.400
CL	258000.000	228000.000
CL6CP	<0.070	<0.070
CLC6H5	<0.580	<0.580
CLDAN	.	.
CPMS	<1.300	<1.300
CPMSO	<4.200	<4.200
CPMSO2	<4.700	<4.700
CR	<5.960	.
CU	<7.940	<7.940
DBCP	<0.130	<0.130
DCPD	<9.310	<9.310
DIMP	<10.500	<10.500
DITH	<1.100	<1.100
DLDRN	1.620	0.135
DMDS	<1.800	<1.800
DMMP	<15.200	<15.200
ENDRN	1.510	<0.052
ETC6H5	<1.280	<1.280
FL	2090.000	2310.000
HG	<0.240	<0.480
ISODR	<0.060	<0.060
K	2430.000	4040.000
MEC6H5	<1.210	<1.210
MG	72500.000	61700.000
MIBK	<12.900	<12.900
MXYLEN	<1.350	<1.350
NA	250000.000	228000.000
NIT	1020.000	1050.000
OXAT	<2.000	<2.000
PB	<18.600	<18.600
PPDDE	<0.053	<0.053
PPDDT	<0.070	<0.070
SO4	481000.000	415000.000
T12DCE	<1.200	<1.200
TCLEE	<1.300	<1.300
TRCLE	<1.100	<1.100
XYLEN	<2.470	<2.470
ZN	<20.100	149.000

TASK 39 WATER CHEMISTRY SUMMARY
SOURCE, ESE 1988

WELL #	AQUIFER	SCREENED INTERVAL	CASING DIAMETER	BEDROCK DEPTH	BEDROCK LITHOLOGY	WQAQ	DENVER SAND
37313	ALL	0.0- 0.0	2.0	28.8	SS	3	

COMPOUND	3RD QUARTER FY87	4TH QUARTER FY87
111TCE	<1.700	<1.700
112TCE	<1.000	<1.000
11DCE	<1.100	<1.100
11DCLE	<1.200	<1.200
12DCLE	<0.610	0.679
ALDRN	<0.070	<0.070
AS	<3.070	<3.070
BTZ	<2.000	<2.000
C6H6	<1.340	<1.340
CA	270000.000	262000.000
CCL4	<2.400	<2.400
CD	<5.160	5.470
CH2CL2	<5.000	<5.000
CHCL3	<1.400	<1.400
CL	730000.000	1130000.000
CL6CP	<0.070	<0.070
CLC6H5	<0.580	<0.580
CLDAN	.	.
CPMS	<1.300	<1.300
CPMSO	<4.200	<4.200
CPMSO2	<4.700	<4.700
CR	<5.960	.
CU	<7.940	<7.940
DBCP	<0.130	<0.130
DCPD	<9.310	<9.310
DIMP	2170.000	3850.000
DITH	8.970	11.000
DLDRN	<0.060	0.086
DMDS	<1.800	<1.800
DMMP	<15.200	<304.000
ENDRN	<0.052	<0.052
ETC6H5	<1.280	<1.280
FL	2030.000	2780.000
HG	<0.240	<0.480
ISODR	<0.060	<0.060
K	12300.000	9430.000
MEC6H5	<1.210	<1.210
MG	> 400000.000	117000.000
MIBK	<12.900	<12.900
MXYLEN	<1.350	<1.350
NA	600000.000	821000.000
NIT	85.400	236.000
OXAT	<2.000	4.400
PB	23.300	44.200
PPDDE	<0.053	<0.053
PPDDT	<0.070	<0.070
SO4	1030000.000	1170000.000
T12DCE	<1.200	<1.200
TCLEE	<1.300	<1.300
TRCLE	<1.100	<1.100
XYLEN	<2.470	<2.470
ZN	22.100	34.600

TASK 39 WATER CHEMISTRY SUMMARY
SOURCE, ESE 1988

WELL #	AQUIFER	SCREENED INTERVAL	CASING DIAMETER	BEDROCK DEPTH	BEDROCK LITHOLOGY	WQAQ	DENVER SAND
37316	DEN	88.1- 96.2	4.0	31.0	SH	5	5

COMPOUND	3RD QUARTER FY87	4TH QUARTER FY87
111TCE	<1.090	<1.090
112TCE	<1.630	<1.630
11DCE	<1.850	<1.850
11DCLE	<1.930	<1.930
12DCLE	<2.070	<2.070
ALDRN	<0.083	<0.083
AS	<2.500	<2.500
BTZ	<1.140	<1.140
C6H6	<1.920	2.780
CA	.	.
CCL4	<1.690	<1.690
CD	.	.
CH2CL2	<2.480	<2.480
CHCL3	<1.880	<1.880
CL	74500.000	85500.000
CL6CP	<0.083	<0.083
CLC6H5	<1.360	<1.360
CLDAN	<0.152	<0.152
CPMS	<1.080	<1.080
CPMSO	<1.980	<1.980
CPMSO2	<2.240	<2.240
CR	.	.
CU	.	.
DBCP	<0.130	<0.130
DCPD	<9.310	<9.310
DIMP	27.000	<10.100
DITH	<1.590	<1.590
DLDRN	<0.054	<0.054
DMDS	<1.160	<1.160
DMMP	<15.200	<16.300
ENDRN	<0.060	<0.060
ETC6H5	<0.620	<0.620
FL	2060.000	2090.000
HG	.	.
ISODR	<0.056	<0.056
K	.	.
MEC6H5	<2.100	<2.100
MG	.	.
MIBK	<12.900	<12.900
MXYLEN	<1.040	<1.040
NA	.	.
NIT	.	.
OXAT	<1.350	<1.350
PB	.	.
PPDDE	<0.046	<0.046
PPDDT	<0.059	<0.059
SO4	505000.000	508000.000
T12DCE	<1.750	<1.750
TCLEE	<2.760	<2.760
TRCLE	<1.310	<1.310
XYLEN	<1.340	<1.340
ZN	.	.

TASK 39 WATER CHEMISTRY SUMMARY
SOURCE, ESE 1988

WELL #	AQUIFER	SCREENED INTERVAL	CASING DIAMETER	BEDROCK DEPTH	BEDROCK LITHOLOGY	WQAQ	DENVER SAND
37317	DEN	51.2- 60.6	4.0	31.1	SH	5	4

COMPOUND	3RD QUARTER FY87	4TH QUARTER FY87
111TCE	<1.090	<1.090
112TCE	<1.630	<1.630
11DCE	<1.850	<1.850
11DCLE	<1.930	<1.930
12DCLE	<2.070	<2.070
ALDRN	<0.083	<0.083
AS	<2.500	<2.500
BTZ	<1.140	<1.140
C6H6	<1.920	<1.920
CA	.	.
CCL4	<1.690	<1.690
CD	.	.
CH2CL2	<2.480	<2.480
CHCL3	<1.880	<1.880
CL	56000.000	61800.000
CL6CP	<0.083	<0.083
CLC6H5	<1.360	<1.360
CLDAN	<0.152	<0.152
CPMS	<1.080	<1.080
CPMSO	<1.980	<1.980
CPMSO2	<2.240	<2.240
CR	.	.
CU	.	.
DBCP	<0.130	<0.130
DCPD	<9.310	<9.310
DIMP	<10.500	<10.100
DITH	<1.590	<1.590
DLDRN	<0.054	<0.054
DMDS	<1.160	<1.160
DMMP	<15.200	<16.300
ENDRN	<0.060	<0.060
ETC6H5	<0.620	<0.620
FL	1290.000	1170.000
HG	.	.
ISODR	<0.056	<0.056
K	.	.
MEC6H5	<2.100	<2.100
MG	.	.
MIBK	<12.900	<12.900
MXYLEN	<1.040	<1.040
NA	.	.
NIT	.	.
OXAT	<1.350	<1.350
PB	.	.
PPDDE	<0.046	<0.046
PPDDT	<0.059	<0.059
SO4	627000.000	659000.000
T12DCE	<1.750	<1.750
TCLEE	<2.760	<2.760
TRCLE	<1.310	<1.310
XYLEN	<1.340	<1.340
ZN	.	.

TASK 39 WATER CHEMISTRY SUMMARY
SOURCE, ESE 1988

WELL #	AQUIFER	SCREENED INTERVAL	CASING DIAMETER	BEDROCK DEPTH	BEDROCK LITHOLOGY	WQAQ	DENVER SAND
37318	DEN	41.8- 50.7	4.0	27.0	SH	5	3

COMPOUND	3RD QUARTER FY87	4TH QUARTER FY87
111TCE	<1.090	<1.090
112TCE	<1.630	<1.630
11DCE	<1.850	<1.850
11DCLE	<1.930	<1.930
12DCLE	<2.070	<2.070
ALDRN	<0.083	<0.083
AS	<2.500	<2.500
BTZ	<1.140	<1.140
C6H6	<1.920	2.470
CA	.	.
CCL4	<1.690	<1.690
CD	.	.
CH2CL2	<2.480	<2.480
CHCL3	<1.880	5.510
CL	44300.000	39000.000
CL6CP	<0.083	<0.083
CLC6H5	<1.360	12.000
CLDAN	<0.152	<0.152
CPMS	<1.080	<1.080
CPMSO	<1.980	<1.980
CPMSO2	<2.240	<2.240
CR	.	.
CU	.	.
DBCP	<0.130	<0.130
DCPD	<9.310	<9.310
DIMP	<10.500	<10.100
DITH	<1.590	<1.590
DLDRN	<0.054	<0.054
DMDS	<1.160	<1.160
DMMP	<15.200	<16.300
ENDRN	<0.060	<0.060
ETC6H5	<0.620	<0.620
FL	<1000.000	<1000.000
HG	.	.
ISODR	<0.056	<0.056
K	.	.
MEC6H5	<2.100	<2.100
MG	.	.
MIBK	<12.900	<12.900
MXYLEN	<1.040	<1.040
NA	.	.
NIT	.	.
OXAT	<1.350	<1.350
PB	.	.
PPDDE	<0.046	<0.046
PPDDT	<0.059	<0.059
SO4	313000.000	314000.000
T12DCE	<1.750	<1.750
TCLEE	<2.760	<2.760
TRCLE	<1.310	<1.310
XYLEN	<1.340	<1.340
ZN	.	.

TASK 39 WATER CHEMISTRY SUMMARY
SOURCE, ESE 1988

WELL #	AQUIFER	SCREENED INTERVAL	CASING DIAMETER	BEDROCK DEPTH	BEDROCK LITHOLOGY	WQAQ	DENVER SAND
37319	DEN	145.4-154.5	4.0	29.0	SH	5	6

COMPOUND	3RD QUARTER FY87	4TH QUARTER FY87
111TCE	<1.090	<1.090
112TCE	<1.630	<1.630
11DCE	<1.850	<1.850
11DCLE	<1.930	<1.930
12DCLE	<2.070	<2.070
ALDRN	<0.083	<0.083
AS	<2.500	<2.500
BTZ	<1.140	<1.140
C6H6	<1.920	<1.920
CA	.	.
CCL4	<1.690	<1.690
CD	.	.
CH2CL2	6.760	9.040
CHCL3	3.100	<1.880
CL	6110.000	5290.000
CL6CP	<0.083	<0.083
CLC6H5	<1.360	<1.360
CLDAN	<0.152	<0.152
CPMS	<1.080	<1.080
CPMSO	<1.980	<1.980
CPMSO2	<2.240	<2.240
CR	.	.
CU	.	.
DBCP	<0.130	<0.130
DCPD	<9.310	<9.310
DIMP	<10.500	<10.100
DITH	<1.590	<1.590
DLDRN	<0.054	<0.054
DMDS	<1.160	<1.160
DMMP	<15.200	<16.300
ENDRN	<0.060	<0.060
ETC6H5	<0.620	<0.620
FL	1670.000	1600.000
HG	.	.
ISODR	<0.056	<0.056
K	.	.
MEC6H5	<2.100	<2.100
MG	.	.
MIBK	<12.900	<12.900
MXYLEN	<1.040	<1.040
NA	.	.
NIT	.	.
OXAT	<1.350	<1.350
PB	.	.
PPDDE	<0.046	<0.046
PPDDT	<0.059	<0.059
SO4	20200.000	18600.000
T12DCE	<1.750	<1.750
TCLEE	<2.760	<2.760
TRCLE	<1.310	<1.310
XYLEN	<1.340	<1.340
ZN	.	.

TASK 39 WATER CHEMISTRY SUMMARY
SOURCE, ESE 1988

WELL #	AQUIFER	SCREENED INTERVAL	CASING DIAMETER	BEDROCK DEPTH	BEDROCK LITHOLOGY	WQAQ	DENVER SAND
37320	ALL	22.7- 32.7	4.0	35.0	SS	1	

COMPOUND	3RD QUARTER FY87	4TH QUARTER FY87
111TCE	<1.700	<1.700
112TCE	<1.000	<1.000
11DCE	<1.100	<1.100
11DCLE	<1.200	<1.200
12DCLE	<0.610	<0.610
ALDRN	<0.070	<0.070
AS	<3.070	<3.070
BTZ	<2.000	<2.000
C6H6	1.750	<1.340
CA	127000.000	122000.000
CCL4	<2.400	<2.400
CD	<5.160	<5.160
CH2CL2	<5.000	<5.000
CHCL3	<1.400	<1.400
CL	155000.000	150000.000
CL6CP	<0.070	<0.070
CLC6H5	10.000	<0.580
CLDAN	.	.
CPMS	<1.300	<1.300
CPMSO	<4.200	<4.200
CPMSO2	<4.700	<4.700
CR	<5.960	.
CU	12.100	<7.940
DBCP	<0.130	<0.130
DCPD	<9.310	<9.310
DIMP	21.500	18.900
DITH	<1.100	<1.100
DLDRN	<0.060	0.140
DMDS	<1.800	<1.800
DMMP	<15.200	<15.200
ENDRN	<0.052	<0.052
ETC6H5	<1.280	<1.280
FL	<1220.000	<1220.000
HG	<0.480	<0.480
ISODR	<0.060	<0.060
K	2890.000	3350.000
MEC6H5	<1.210	<1.210
MG	44300.000	43000.000
MIBK	<12.900	<12.900
MXYLEN	<1.350	<1.350
NA	176000.000	177000.000
NIT	4200.000	3680.000
OXAT	<2.000	<2.000
PB	<18.600	<18.600
PPDDE	<0.053	<0.053
PPDDT	<0.070	<0.070
SO4	413000.000	375000.000
T12DCE	<1.200	<1.200
TCLEE	<1.300	<1.300
TRCLE	<1.100	<1.100
XYLEN	<2.470	<2.470
ZN	<20.100	<20.100

TASK 39 WATER CHEMISTRY SUMMARY
SOURCE, ESE 1988

WELL #	AQUIFER	SCREENED INTERVAL	CASING DIAMETER	BEDROCK DEPTH	BEDROCK LITHOLOGY	WQAQ	DENVER SAND
37321	DEN	64.0- 73.9	4.0	35.0	SS	5	4

COMPOUND	3RD QUARTER FY87	4TH QUARTER FY87
111TCE	<1.090	<1.090
112TCE	<1.630	<1.630
11DCE	<1.850	<1.850
11DCLE	<1.930	<1.930
12DCLE	<2.070	<2.070
ALDRN	<0.083	<0.083
AS	<2.500	<2.500
BTZ	<1.140	<1.140
C6H6	<1.920	<1.920
CA	.	.
CCL4	<1.690	<1.690
CD	.	.
CH2CL2	<2.480	<2.480
CHCL3	<1.880	<1.880
CL	16800.000	16700.000
CL6CP	<0.083	<0.083
CLC6H5	3.600	2.980
CLDAN	<0.152	<0.152
CPMS	<1.080	<1.080
CPMSO	<1.980	<1.980
CPMSO2	<2.240	<2.240
CR	.	.
CU	.	.
DBCP	<0.130	<0.130
DCPD	<9.310	<9.310
DIMP	<10.500	<10.100
DITH	<1.590	<1.590
DLDRN	<0.054	<0.054
DMDS	<1.160	<1.160
DMMP	<30.400	<16.300
ENDRN	<0.060	<0.060
ETC6H5	<0.620	<0.620
FL	<1000.000	<1000.000
HG	.	.
ISODR	<0.056	<0.056
K	.	.
MEC6H5	<2.100	<2.100
MG	.	.
MIBK	<12.900	<12.900
MXYLEN	<1.040	<1.040
NA	.	.
NIT	.	.
OXAT	<1.350	<1.350
PB	.	.
PPDDE	<0.046	<0.046
PPDDT	<0.059	<0.059
SO4	216000.000	219000.000
T12DCE	<1.750	<1.750
TCLEE	<2.760	<2.760
TRCLE	<1.310	<1.310
XYLEN	<1.340	<1.340
ZN	.	.

TASK 39 WATER CHEMISTRY SUMMARY
SOURCE, ESE 1988

WELL #	AQUIFER	SCREENED INTERVAL	CASING DIAMETER	BEDROCK DEPTH	BEDROCK LITHOLOGY	WQAQ	DENVER SAND
37322	DEN	87.8- 96.9	4.0	35.0	SS	5	5

COMPOUND	3RD QUARTER FY87	4TH QUARTER FY87
111TCE	<1.090	<1.090
112TCE	<1.630	<1.630
11DCE	<1.850	<1.850
11DCLE	<1.930	<1.930
12DCLE	<2.070	<2.070
ALDRN	<0.083	<0.083
AS	<2.500	<2.500
BTZ	<1.140	<1.140
C6H6	<1.920	<1.920
CA	.	.
CCL4	<1.690	<1.690
CD	.	.
CH2CL2	<2.480	<2.480
CHCL3	<1.880	<1.880
CL	17100.000	16600.000
CL6CP	<0.083	<0.083
CLC6H5	7.740	<1.360
CLDAN	<0.152	<0.152
CPMS	<1.080	<1.080
CPMSO	<1.980	<1.980
CPMSO2	<2.240	<2.240
CR	.	.
CU	.	.
DBCP	<0.130	<0.130
DCPD	<9.310	<9.310
DIMP	<10.500	<10.100
DITH	<1.590	<1.590
DLDRN	<0.054	<0.054
DMDS	<1.160	<1.160
DMMP	<15.200	<16.300
ENDRN	<0.060	<0.060
ETC6H5	<0.620	<0.620
FL	<1000.000	<1000.000
HG	.	.
ISODR	<0.056	<0.056
K	.	.
MEC6H5	<2.100	<2.100
MG	.	.
MIBK	<12.900	<12.900
MXYLEN	<1.040	<1.040
NA	.	.
NIT	.	.
OXAT	<1.350	<1.350
PB	.	.
PPDDE	<0.046	<0.046
PPDDT	<0.059	<0.059
SO4	207000.000	209000.000
T12DCE	<1.750	<1.750
TCLEE	<2.760	<2.760
TRCLE	<1.310	<1.310
XYLEN	<1.340	<1.340
ZN	.	.

TASK 39 WATER CHEMISTRY SUMMARY
SOURCE, ESE 1988

WELL #	AQUIFER	SCREENED INTERVAL	CASING DIAMETER	BEDROCK DEPTH	BEDROCK LITHOLOGY	WQAQ	DENVER SAND
37323	DEN	16.5- 26.3	4.0	10.0	SH	5	2

COMPOUND	3RD QUARTER FY87	4TH QUARTER FY87
111TCE	<1.090	<1.090
112TCE	<1.630	<1.630
11DCE	<1.850	<1.850
11DCLE	<1.930	<1.930
12DCLE	<2.070	<2.070
ALDRN	<0.083	<0.083
AS	<2.500	<2.500
BTZ	<1.140	<1.140
C6H6	<1.920	2.730
CA	.	.
CCL4	<1.690	<1.690
CD	.	.
CH2CL2	<2.480	<2.480
CHCL3	36.700	42.000
CL	238000.000	286000.000
CL6CP	<0.083	<0.083
CLC6H5	<1.360	15.500
CLDAN	<0.152	<0.152
CPMS	<1.080	<1.080
CPMSO	<1.980	<1.980
CPMSO2	<2.240	<2.240
CR	.	.
CU	.	.
DBCP	<0.130	0.164
DCPD	<9.310	<9.310
DIMP	15.700	76.600
DITH	<1.590	<1.590
DLDRN	<0.054	<0.054
DMDS	<1.160	<1.160
DMMP	<15.200	<16.300
ENDRN	<0.060	<0.060
ETC6H5	<0.620	<0.620
FL	2310.000	2770.000
HG	.	.
ISODR	<0.056	<0.056
K	.	.
MEC6H5	<2.100	<2.100
MG	.	.
MIBK	<12.900	<12.900
MXYLEN	<1.040	<1.040
NA	.	.
NIT	.	.
OXAT	<1.350	<1.350
PB	.	.
PPDDE	<0.046	<0.046
PPDDT	<0.059	<0.059
SO4	1020000.000	1180000.000
T12DCE	<1.750	<1.750
TCLEE	<2.760	<2.760
TRCLE	<1.310	<1.310
XYLEN	<1.340	<1.340
ZN	.	.

TASK 39 WATER CHEMISTRY SUMMARY
SOURCE, ESE 1988

WELL #	AQUIFER	SCREENED INTERVAL	CASING DIAMETER	BEDROCK DEPTH	BEDROCK LITHOLOGY	WQAQ	DENVER SAND
37327	ALL	29.6- 34.5	4.0	34.9	SH	1	

COMPOUND	3RD QUARTER FY87	4TH QUARTER FY87
111TCE	<1.090	<1.090
112TCE	<1.630	<1.630
11DCE	<1.850	<1.850
11DCLE	<1.930	<1.930
12DCLE	<2.070	<2.070
ALDRN	<0.083	<0.083
AS	<2.500	<2.500
BTZ	<1.140	<1.140
C6H6	<1.920	<1.920
CA	.	.
CCL4	<1.690	<1.690
CD	.	.
CH2CL2	<2.480	<2.480
CHCL3	<1.880	<1.880
CL	257000.000	250000.000
CL6CP	<0.083	<0.083
CLC6H5	<1.360	7.080
CLDAN	<0.152	<0.152
CPMS	<1.080	<1.080
CPMSO	<1.980	<1.980
CPMSO2	<2.240	<2.240
CR	.	.
CU	.	.
DBCP	<0.130	<0.130
DCPD	<9.310	<9.310
DIMP	<10.500	<10.100
DITH	<1.590	<3.340
DLDRN	<0.054	<0.054
DMDS	<1.160	<1.160
DMMP	<15.200	<16.300
ENDRN	<0.060	<0.060
ETC6H5	<0.620	<0.620
FL	2700.000	2670.000
HG	.	.
ISODR	<0.056	<0.056
K	.	.
MEC6H5	<2.100	<2.100
MG	.	.
MIBK	<12.900	<12.900
MXYLEN	<1.040	<1.040
NA	.	.
NIT	.	.
OXAT	<1.350	<1.350
PB	.	.
PPDDE	<0.046	<0.046
PPDDT	<0.059	<0.059
SO4	1190000.000	1200000.000
T12DCE	<1.750	<1.750
TCLEE	<2.760	<2.760
TRCLE	<1.310	<1.310
XYLEN	<1.340	<1.340
ZN	.	.

TASK 39 WATER CHEMISTRY SUMMARY
SOURCE, ESE 1988

WELL #	AQUIFER	SCREENED INTERVAL	CASING DIAMETER	BEDROCK DEPTH	BEDROCK LITHOLOGY	WQAQ	DENVER SAND
37330	ALL	37.5- 57.2	4.0	57.0	SH	1	

COMPOUND	3RD QUARTER FY87	4TH QUARTER FY87
111TCE	<1.090	<1.090
112TCE	<1.630	<1.630
11DCE	<1.850	<1.850
11DCLE	<1.930	<1.930
12DCLE	<2.070	<2.070
ALDRN	<0.083	<0.083
AS	<2.500	<2.500
BTZ	<1.140	<1.140
C6H6	<1.920	<1.920
CA	.	.
CCL4	<1.690	<1.690
CD	.	.
CH2CL2	<2.480	<2.480
CHCL3	18.100	17.200
CL	291000.000	319000.000
CL6CP	<0.083	<0.083
CLC6H5	2.690	1.740
CLDAN	<0.152	<0.152
CPMS	<1.080	<1.080
CPMSO	<1.980	<1.980
CPMSO2	<2.240	<2.240
CR	.	.
CU	.	.
DBCP	<0.130	<0.130
DCPD	<9.310	<9.310
DIMP	<10.500	<10.100
DITH	<1.590	<3.340
DLDRN	<0.054	<0.054
DMDS	<1.160	<1.160
DMMP	<30.400	<16.300
ENDRN	<0.060	<0.060
ETC6H5	<0.620	<0.620
FL	1630.000	1620.000
HG	.	.
ISODR	<0.056	<0.056
K	.	.
MEC6H5	<2.100	<2.100
MG	.	.
MIBK	<12.900	<12.900
MXYLEN	<1.040	<1.040
NA	.	.
NIT	.	.
OXAT	<1.350	<1.350
PB	.	.
PPDDE	<0.046	<0.046
PPDDT	<0.059	<0.059
SO4	154000.000	168000.000
T12DCE	<1.750	<1.750
TCLEE	<2.760	<2.760
TRCLE	<1.310	<1.310
XYLEN	<1.340	<1.340
ZN	.	.

TASK 39 WATER CHEMISTRY SUMMARY
SOURCE, ESE 1988

WELL #	AQUIFER	SCREENED INTERVAL	CASING DIAMETER	BEDROCK DEPTH	BEDROCK LITHOLOGY	WQAQ	DENVER SAND
37331	ALL	39.6- 48.6	4.0	48.0	SH	1	

COMPOUND	3RD QUARTER FY87	4TH QUARTER FY87
111TCE	<1.090	<1.090
112TCE	<1.630	<1.630
11DCE	<1.850	<1.850
11DCLE	<1.930	<1.930
12DCLE	<2.070	<2.070
ALDRN	<0.083	<0.083
AS	<2.500	<2.500
BTZ	<1.140	<1.140
C6H6	<1.920	<1.920
CA	.	.
CCL4	<1.690	<1.690
CD	.	.
CH2CL2	<2.480	<2.480
CHCL3	25.800	19.900
CL	327000.000	338000.000
CL6CP	<0.083	<0.083
CLC6H5	6.590	1.660
CLDAN	<0.152	<0.152
CPMS	<1.080	<1.080
CPMSO	<1.980	<1.980
CPMSO2	<2.240	<2.240
CR	.	.
CU	.	.
DBCP	<0.130	<0.130
DCPD	<9.310	<9.310
DIMP	<10.500	<10.100
DITH	<1.590	<3.340
DLDRN	<0.054	<0.054
DMDS	<1.160	<1.160
DMMP	<15.200	<16.300
ENDRN	<0.060	<0.060
ETC6H5	<0.620	<0.620
FL	1730.000	1560.000
HG	.	.
ISODR	<0.056	<0.056
K	.	.
MEC6H5	<2.100	<2.100
MG	.	.
MIBK	<12.900	<12.900
MXYLEN	<1.040	<1.040
NA	.	.
NIT	.	.
OXAT	<1.350	<1.350
PB	.	.
PPDDE	<0.046	<0.046
PPDDT	<0.059	<0.059
SO4	169000.000	178000.000
T12DCE	<1.750	<1.750
TCLEE	<2.760	<2.760
TRCLE	<1.310	<1.310
XYLEN	<1.340	<1.340
ZN	.	.

TASK 39 WATER CHEMISTRY SUMMARY
SOURCE, ESE 1988

WELL #	AQUIFER	SCREENED INTERVAL	CASING DIAMETER	BEDROCK DEPTH	BEDROCK LITHOLOGY	WQAQ	DENVER SAND
37332	ALL	46.9- 51.4	4.0	51.0	SH	1	

COMPOUND	3RD QUARTER FY87	4TH QUARTER FY87
111TCE	<1.700	<1.700
112TCE	<1.000	<1.000
11DCE	<1.100	<1.100
11DCLE	<1.200	<1.200
12DCLE	<0.610	<0.610
ALDRN	<0.070	<0.070
AS	4.500	5.800
BTZ	<2.000	<2.000
C6H6	<1.340	<1.340
CA	116000.000	96700.000
CCL4	<2.400	<2.400
CD	<5.160	5.470
CH2CL2	<5.000	<5.000
CHCL3	<1.400	3.390
CL	714000.000	609000.000
CL6CP	<0.070	<0.070
CLC6H5	<0.580	3.220
CLDAN	.	.
CPMS	<1.300	<1.300
CPMSO	<4.200	<4.200
CPMSO2	<4.700	<4.700
CR	<5.960	.
CU	<7.940	41.300
DBCP	<0.130	<0.130
DCPD	<9.310	<9.310
DIMP	<10.500	<10.500
DITH	<1.100	<1.100
DLDRN	0.711	1.020
DMDS	<1.800	<1.800
DMMP	<15.200	<15.200
ENDRN	<0.052	<0.052
ETC6H5	<1.280	<1.280
FL	2540.000	2610.000
HG	<0.240	<0.480
ISODR	<0.060	<0.060
K	3970.000	3780.000
MEC6H5	<1.210	<1.210
MG	> 200000.000	34200.000
MIBK	<12.900	<12.900
MXYLEN	<1.350	<1.350
NA	501000.000	506000.000
NIT	5130.000	4360.000
OXAT	<2.000	<2.000
PB	<18.600	38.100
PPDDE	<0.053	<0.053
PPDDT	<0.070	<0.070
SO4	393000.000	331000.000
T12DCE	<1.200	<1.200
TCLEE	<1.300	<1.300
TRCLE	<1.100	<1.100
XYLEN	<2.470	<2.470
ZN	131.000	54.000

TASK 39 WATER CHEMISTRY SUMMARY
SOURCE, ESE 1988

WELL #	AQUIFER	SCREENED INTERVAL	CASING DIAMETER	BEDROCK DEPTH	BEDROCK LITHOLOGY	WQAQ	DENVER SAND
37333	ALL	38.4- 47.7	4.0	47.0	SH	1	

COMPOUND	3RD QUARTER FY87	4TH QUARTER FY87
111TCE	<1.700	<1.700
112TCE	<1.000	<1.000
11DCE	<1.100	<1.100
11DCLE	<1.200	<1.200
12DCLE	<0.610	<0.610
ALDRN	<0.070	<0.070
AS	<3.070	4.800
BTZ	<2.000	<2.000
C6H6	<1.340	<1.340
CA	80100.000	85700.000
CCL4	<2.400	<2.400
CD	<5.160	<5.160
CH2CL2	<5.000	<5.000
CHCL3	13.500	11.600
CL	394000.000	372000.000
CL6CP	<0.070	<0.070
CLC6H5	<0.580	<0.580
CLDAN	.	.
CPMS	<1.300	<1.300
CPMSO	<4.200	<4.200
CPMSO2	<4.700	<4.700
CR	<5.960	.
CU	<7.940	<7.940
DBCP	<0.130	<0.130
DCPD	<9.310	<9.310
DIMP	<10.500	<10.500
DITH	<1.100	<1.100
DLDRN	0.205	0.226
DMDS	<1.800	<1.800
DMMP	<15.200	<15.200
ENDRN	<0.052	<0.052
ETC6H5	<1.280	<1.280
FL	<1220.000	<1220.000
HG	<0.240	<0.480
ISODR	<0.060	<0.060
K	4740.000	5580.000
MEC6H5	<1.210	<1.210
MG	10500.000	13800.000
MIBK	<12.900	<12.900
MXYLEN	<1.350	<1.350
NA	233000.000	247000.000
NIT	3330.000	2920.000
OXAT	<2.000	<2.000
PB	<18.600	<18.600
PPDDE	<0.053	<0.053
PPDDT	<0.070	<0.070
SO4	157000.000	153000.000
T12DCE	<1.200	<1.200
TCLEE	<1.300	<1.300
TRCLE	<1.100	<1.100
XYLEN	<2.470	<2.470
ZN	<20.100	33.600

TASK 39 WATER CHEMISTRY SUMMARY
SOURCE, ESE 1988

WELL #	AQUIFER	SCREENED INTERVAL	CASING DIAMETER	BEDROCK DEPTH	BEDROCK LITHOLOGY	WQAQ	DENVER SAND
37334	ALL	42.3- 67.3	4.0	64.0	SH	2	

COMPOUND	3RD QUARTER FY87	4TH QUARTER FY87
111TCE	<1.090	<1.090
112TCE	<1.630	<1.630
11DCE	<1.850	<1.850
11DCLE	<1.930	<1.930
12DCLE	<2.070	<2.070
ALDRN	<0.083	<0.083
AS	<2.500	<2.500
BTZ	<1.140	<1.140
C6H6	<1.920	<1.920
CA	.	.
CCL4	<1.690	<1.690
CD	.	.
CH2CL2	<2.480	<2.480
CHCL3	<1.880	<1.880
CL	72000.000	76900.000
CL6CP	<0.083	<0.083
CLC6H5	3.710	2.310
CLDAN	<0.152	<0.152
CPMS	<1.080	<1.080
CPMSO	<1.980	<1.980
CPMSO2	<2.240	<2.240
CR	.	.
CU	.	.
DBCP	<0.130	<0.130
DCPD	<9.310	<9.310
DIMP	<10.500	<10.100
DITH	<1.590	<3.340
DLDRN	0.169	0.154
DMDS	<1.160	<1.160
DMMP	<30.400	<16.300
ENDRN	<0.060	<0.060
ETC6H5	<0.620	<0.620
FL	<1000.000	<1000.000
HG	.	.
ISODR	<0.056	<0.056
K	.	.
MEC6H5	<2.100	<2.100
MG	.	.
MIBK	<12.900	<12.900
MXYLEN	<1.040	<1.040
NA	.	.
NIT	.	.
OXAT	<1.350	<1.350
PB	.	.
PPDDE	<0.046	<0.046
PPDDT	<0.059	<0.059
SO4	64800.000	67100.000
T12DCE	<1.750	<1.750
TCLEE	<2.760	<2.760
TRCLE	<1.310	<1.310
XYLEN	<1.340	<1.340
ZN	.	.

TASK 39 WATER CHEMISTRY SUMMARY
SOURCE, ESE 1988

WELL #	AQUIFER	SCREENED INTERVAL	CASING DIAMETER	BEDROCK DEPTH	BEDROCK LITHOLOGY	WQAQ	DENVER SAND
37335	ALL	38.2- 57.6	4.0	51.0	SH	3	

COMPOUND	3RD QUARTER FY87	4TH QUARTER FY87
111TCE	<1.700	<1.700
112TCE	<1.000	<1.000
11DCE	<1.100	<1.100
11DCLE	<1.200	<1.200
12DCLE	<0.610	<0.610
ALDRN	<0.070	<0.070
AS	<3.070	<3.070
BTZ	<2.000	<2.000
C6H6	1.740	<1.340
CA	69800.000	67400.000
CCL4	<2.400	<2.400
CD	<5.160	5.470
CH2CL2	<5.000	<5.000
CHCL3	<1.400	<1.400
CL	112000.000	111000.000
CL6CP	<0.070	<0.070
CLC6H5	8.550	1.650
CLDAN	.	.
CPMS	<1.300	<1.300
CPMSO	<4.200	<4.200
CPMSO2	<4.700	<4.700
CR	<5.960	.
CU	<7.940	<7.940
DBCP	<0.130	<0.130
DCPD	<9.310	<9.310
DIMP	<10.500	<10.500
DITH	<1.100	<1.100
DLDRN	0.065	0.328
DMDS	<1.800	<1.800
DMMP	<15.200	<15.200
ENDRN	<0.052	<0.052
ETC6H5	<1.280	<1.280
FL	<1220.000	<1220.000
HG	<0.240	<0.480
ISODR	<0.060	<0.060
K	2430.000	2920.000
MEC6H5	<1.210	<1.210
MG	13600.000	13900.000
MIBK	<12.900	<12.900
MXYLEN	<1.350	<1.350
NA	80900.000	75200.000
NIT	255.000	236.000
OXAT	<2.000	<2.000
PB	<18.600	<18.600
PPDDE	<0.053	<0.053
PPDDT	<0.070	<0.070
SO4	54400.000	51000.000
T12DCE	<1.200	<1.200
TCLEE	<1.300	<1.300
TRCLE	<1.100	<1.100
XYLEN	<2.470	<2.470
ZN	39.800	21.400

TASK 39 WATER CHEMISTRY SUMMARY
SOURCE, ESE 1988

WELL #	AQUIFER	SCREENED INTERVAL	CASING DIAMETER	BEDROCK DEPTH	BEDROCK LITHOLOGY	WQAQ	DENVER SAND
37336	ALL	19.3- 38.9	4.0	39.0	SH	1	

COMPOUND	3RD QUARTER FY87	4TH QUARTER FY87
111TCE	<1.090	<1.090
112TCE	<1.630	<1.630
11DCE	<1.850	<1.850
11DCLE	<1.930	<1.930
12DCLE	<2.070	<2.070
ALDRN	<0.083	<0.083
AS	<2.500	<2.500
BTZ	<1.140	<1.140
C6H6	<1.920	<1.920
CA	.	.
CCL4	<1.690	<1.690
CD	.	.
CH2CL2	<2.480	<2.480
CHCL3	9.230	5.410
CL	225000.000	226000.000
CL6CP	<0.083	<0.083
CLC6H5	6.910	2.520
CLDAN	<0.152	<0.152
CPMS	<1.080	<1.080
CPMSO	<1.980	<1.980
CPMSO2	<2.240	<2.240
CR	.	.
CU	.	.
DBCP	<0.130	<0.130
DCPD	<9.310	<9.310
DIMP	<10.500	<10.100
DITH	<1.590	<3.340
DLDRN	0.082	<0.054
DMDS	<1.160	<1.160
DMMP	<15.200	<16.300
ENDRN	<0.060	<0.060
ETC6H5	<0.620	<0.620
FL	1360.000	1590.000
HG	.	.
ISODR	<0.056	<0.056
K	.	.
MEC6H5	<2.100	<2.100
MG	.	.
MIBK	<12.900	<12.900
MXYLEN	<1.040	<1.040
NA	.	.
NIT	.	.
OXAT	<1.350	<1.350
PB	.	.
PPDDE	<0.046	<0.046
PPDDT	<0.059	<0.059
SO4	159000.000	189000.000
T12DCE	<1.750	<1.750
TCLEE	<2.760	<2.760
TRCLE	<1.310	<1.310
XYLEN	<1.340	<1.340
ZN	.	.

TASK 39 WATER CHEMISTRY SUMMARY
SOURCE, ESE 1988

WELL #	AQUIFER	SCREENED INTERVAL	CASING DIAMETER	BEDROCK DEPTH	BEDROCK LITHOLOGY	WQAQ	DENVER SAND
37337	ALL	25.8- 40.3	4.0	32.1	SH	3	

COMPOUND	3RD QUARTER FY87	4TH QUARTER FY87
111TCE	<1.090	<1.090
112TCE	<1.630	<1.630
11DCE	<1.850	<1.850
11DCLE	<1.930	<1.930
12DCLE	<2.070	<2.070
ALDRN	<0.083	<0.083
AS	<2.500	<2.500
BTZ	<1.140	<1.140
C6H6	<1.920	<1.920
CA	.	.
CCL4	<1.690	<1.690
CD	.	.
CH2CL2	<2.480	<2.480
CHCL3	<1.880	<1.880
CL	63000.000	67000.000
CL6CP	<0.083	<0.083
CLC6H5	<1.360	2.760
CLDAN	<0.152	<0.152
CPMS	<1.080	<1.080
CPMSO	<1.980	<1.980
CPMSO2	<2.240	<2.240
CR	.	.
CU	.	.
DBCP	<0.130	<0.130
DCPD	<9.310	<9.310
DIMP	<10.500	<10.100
DITH	<1.590	<1.590
DLDRN	0.068	0.062
DMDS	<1.160	<1.160
DMMP	<30.400	<16.300
ENDRN	<0.060	<0.060
ETC6H5	<0.620	<0.620
FL	1000.000	1310.000
HG	.	.
ISODR	<0.056	<0.056
K	.	.
MEC6H5	<2.100	<2.100
MG	.	.
MIBK	<12.900	<12.900
MXYLEN	<1.040	<1.040
NA	.	.
NIT	.	.
OXAT	<1.350	<1.350
PB	.	.
PPDDE	<0.046	<0.046
PPDDT	<0.059	<0.059
SO4	123000.000	105000.000
T12DCE	<1.750	<1.750
TCLEE	<2.760	<2.760
TRCLE	<1.310	<1.310
XYLEN	<1.340	<1.340
ZN	.	.

TASK 39 WATER CHEMISTRY SUMMARY
SOURCE, ESE 1988

WELL #	AQUIFER	SCREENED INTERVAL	CASING DIAMETER	BEDROCK DEPTH	BEDROCK LITHOLOGY	WQAQ	DENVER SAND
37338	ALL	6.8- 29.2	4.0	23.5	SH	2	

COMPOUND	3RD QUARTER FY87	4TH QUARTER FY87
111TCE	<1.700	<1.700
112TCE	<1.000	<1.000
11DCE	<1.100	<1.100
11DCLE	<1.200	<1.200
12DCLE	<0.610	<0.610
ALDRN	<0.070	<0.070
AS	<3.070	<3.070
BTZ	<2.000	<2.000
C6H6	1.490	<1.340
CA	127000.000	162000.000
CCL4	<2.400	<2.400
CD	<5.160	5.470
CH2CL2	<5.000	<5.000
CHCL3	<1.400	2.030
CL	148000.000	260000.000
CL6CP	<0.070	<0.070
CLC6H5	8.370	2.640
CLDAN	.	.
CPMS	<1.300	<1.300
CPMSO	<4.200	<4.200
CPMSO2	<4.700	<4.700
CR	<5.960	.
CU	<7.940	<7.940
DBCP	<0.130	<0.130
DCPD	<9.310	<9.310
DIMP	<10.500	<10.500
DITH	<1.100	<1.100
DLDRN	0.062	0.108
DMDS	<1.800	<1.800
DMMP	<15.200	<15.200
ENDRN	<0.052	<0.052
ETC6H5	<1.280	<1.280
FL	1400.000	1880.000
HG	<0.240	<0.480
ISODR	<0.060	<0.060
K	16000.000	8660.000
MEC6H5	<1.210	<1.210
MG	41900.000	54000.000
MIBK	<12.900	<12.900
MXYLEN	<1.350	<1.350
NA	180000.000	242000.000
NIT	1040.000	1320.000
OXAT	<2.000	<2.000
PB	<18.600	<18.600
PPDDE	<0.053	<0.053
PPDDT	<0.070	<0.070
SO4	392000.000	449000.000
T12DCE	<1.200	<1.200
TCLEE	<1.300	<1.300
TRCLE	<1.100	<1.100
XYLEN	<2.470	<2.470
ZN	25.600	41.800

TASK 39 WATER CHEMISTRY SUMMARY
SOURCE, ESE 1988

WELL #	AQUIFER	SCREENED INTERVAL	CASING DIAMETER	BEDROCK DEPTH	BEDROCK LITHOLOGY	WQAQ	DENVER SAND
37339	ALL	11.7- 22.3	4.0	20.0	SH	1	

COMPOUND	3RD QUARTER FY87	4TH QUARTER FY87
111TCE	<1.700	<1.700
112TCE	<1.000	<1.000
11DCE	<1.100	<1.100
11DCLE	<1.200	<1.200
12DCLE	<0.610	<0.610
ALDRN	<0.070	<0.070
AS	<3.070	3.500
BTZ	<2.000	<2.000
C6H6	<1.340	<1.340
CA	537000.000	668000.000
CCL4	<2.400	<2.400
CD	<5.160	9.500
CH2CL2	<5.000	<5.000
CHCL3	<1.400	<1.400
CL	2020000.000	1990000.000
CL6CP	<0.070	<0.070
CLC6H5	<0.580	<0.580
CLDAN	.	.
CPMS	<1.300	<1.300
CPMSO	<4.200	<4.200
CPMSO2	<4.700	<4.700
CR	<5.960	.
CU	<7.940	9.820
DBCP	<0.130	<0.130
DCPD	<9.310	<9.310
DIMP	515.000	546.000
DITH	<1.100	<1.100
DLDRN	<0.060	0.128
DMDS	<1.800	<1.800
DMMP	<15.200	<76.000
ENDRN	<0.052	<0.052
ETC6H5	<1.280	<1.280
FL	4230.000	4650.000
HG	<0.240	<0.480
ISODR	<0.060	<0.060
K	3510.000	3610.000
MEC6H5	<1.210	<1.210
MG	167000.000	174000.000
MIBK	<12.900	<12.900
MXYLEN	<1.350	<1.350
NA	1060000.000	1220000.000
NIT	9230.000	8920.000
OXAT	<2.000	<2.000
PB	<18.600	25.800
PPDDE	<0.053	<0.053
PPDDT	<0.070	<0.070
SO4	2180000.000	1970000.000
T12DCE	<1.200	<1.200
TCLEE	<1.300	<1.300
TRCLE	<1.100	<1.100
XYLEN	<2.470	<2.470
ZN	93.900	152.000

TASK 39 WATER CHEMISTRY SUMMARY
SOURCE, ESE 1988

WELL #	AQUIFER	SCREENED INTERVAL	CASING DIAMETER	BEDROCK DEPTH	BEDROCK LITHOLOGY	WQAQ	DENVER SAND
37340	ALL	23.5- 34.1	4.0	32.0	SH	1	

COMPOUND	3RD QUARTER FY87	4TH QUARTER FY87
111TCE	<1.700	<1.700
112TCE	<1.000	<1.000
11DCE	<1.100	<1.100
11DCLE	<1.200	<1.200
12DCLE	<0.610	<0.610
ALDRN	.	<0.070
AS	.	<3.070
BTZ	.	<2.000
C6H6	<1.340	<1.340
CA	.	149000.000
CCL4	<2.400	<2.400
CD	.	<5.160
CH2CL2	<5.000	<5.000
CHCL3	<1.400	<1.400
CL	.	220000.000
CL6CP	.	<0.070
CLC6H5	<0.580	<0.580
CLDAN	.	.
CPMS	.	<1.300
CPMSO	.	<4.200
CPMSO2	.	<4.700
CR	.	.
CU	.	<7.940
DBCP	<0.130	<0.130
DCPD	.	<9.310
DIMP	.	35.300
DITH	.	<1.100
DLDRN	.	<0.060
DMDS	.	<1.800
DMMP	.	<15.200
ENDRN	.	0.164
ETC6H5	<1.280	<1.280
FL	.	1700.000
HG	.	<0.480
ISODR	.	<0.060
K	.	4290.000
MEC6H5	<1.210	<1.210
MG	.	35900.000
MIBK	.	<12.900
MXYLEN	<1.350	<1.350
NA	.	299000.000
NIT	.	4110.000
OXAT	.	<2.000
PB	.	<18.600
PPDDE	.	<0.053
PPDDT	.	<0.070
SO4	.	563000.000
T12DCE	<1.200	<1.200
TCLEE	<1.300	<1.300
TRCLE	<1.100	<1.100
XYLEN	<2.470	<2.470
ZN	.	31.600

TASK 39 WATER CHEMISTRY SUMMARY
SOURCE, ESE 1988

WELL #	AQUIFER	SCREENED INTERVAL	CASING DIAMETER	BEDROCK DEPTH	BEDROCK LITHOLOGY	WQAQ	DENVER SAND
37341	ALL	20.3- 50.7	4.0	48.0	SS	2	

COMPOUND	3RD QUARTER FY87	4TH QUARTER FY87
111TCE	<1.700	<1.700
112TCE	<1.000	<1.000
11DCE	<1.100	<1.100
11DCLE	<1.200	<1.200
12DCLE	<0.610	<0.610
ALDRN	<0.070	<0.070
AS	<3.070	<3.070
BTZ	<2.000	<2.000
C6H6	<1.340	<1.340
CA	65300.000	70500.000
CCL4	<2.400	<2.400
CD	<5.160	<5.160
CH2CL2	<5.000	<5.000
CHCL3	<1.400	<1.400
CL	47500.000	50500.000
CL6CP	<0.070	<0.070
CLC6H5	2.420	0.807
CLDAN	.	.
CPMS	<1.300	<1.300
CPMSO	<4.200	<4.200
CPMSO2	<4.700	<4.700
CR	<5.960	.
CU	<7.940	<7.940
DBCP	<0.130	<0.130
DCPD	<9.310	<9.310
DIMP	<10.500	<10.500
DITH	<1.100	<1.100
DLDRN	<0.060	<0.060
DMDS	<1.800	<1.800
DMMP	<30.400	<15.200
ENDRN	<0.052	<0.052
ETC6H5	<1.280	<1.280
FL	<1220.000	<1220.000
HG	<0.480	<0.240
ISODR	<0.060	<0.060
K	4280.000	4640.000
MEC6H5	<1.210	<1.210
MG	13100.000	15500.000
MIBK	<12.900	<12.900
MXYLEN	<1.350	<1.350
NA	60700.000	64600.000
NIT	725.000	878.000
OXAT	<2.000	<2.000
PB	<18.600	<18.600
PPDDE	<0.053	<0.053
PPDDT	<0.070	<0.070
SO4	103000.000	120000.000
T12DCE	<1.200	<1.200
TCLEE	<1.300	<1.300
TRCLE	<1.100	<1.100
XYLEN	<2.470	<2.470
ZN	<20.100	48.900

TASK 39 WATER CHEMISTRY SUMMARY
SOURCE, ESE 1988

WELL #	AQUIFER	SCREENED INTERVAL	CASING DIAMETER	BEDROCK DEPTH	BEDROCK LITHOLOGY	WQAQ	DENVER SAND
37342	ALL	12.9- 29.0	4.0	27.5	SH	1	

COMPOUND	3RD QUARTER FY87	4TH QUARTER FY87
111TCE	<1.700	<1.700
112TCE	<1.000	<1.000
11DCE	<1.100	<1.100
11DCLE	<1.200	<1.200
12DCLE	1.470	1.110
ALDRN	<0.070	<0.070
AS	<3.070	<3.070
BTZ	<2.000	<2.000
C6H6	<1.340	<1.340
CA	311000.000	287000.000
CCL4	<2.400	<2.400
CD	<5.160	5.470
CH2CL2	<5.000	<5.000
CHCL3	<1.400	<1.400
CL	576000.000	586000.000
CL6CP	<0.070	<0.070
CLC6H5	<0.580	<0.580
CLDAN	.	.
CPMS	<1.300	<1.300
CPMSO	<4.200	<4.200
CPMSO2	<4.700	<4.700
CR	<5.960	.
CU	<7.940	<7.940
DBCP	<0.130	<0.130
DCPD	<9.310	<9.310
DIMP	41.100	44.000
DITH	<1.100	<1.100
DLDRN	<0.060	<0.060
DMDS	<1.800	<1.800
DMMP	<15.200	<15.200
ENDRN	<0.052	<0.052
ETC6H5	<1.280	<1.280
FL	1460.000	1510.000
HG	<0.240	0.360
ISODR	<0.060	<0.060
K	6130.000	6600.000
MEC6H5	<1.210	<1.210
MG	74500.000	65700.000
MIBK	<12.900	<12.900
MXYLEN	<1.350	<1.350
NA	444000.000	426000.000
NIT	5650.000	8210.000
OXAT	<2.000	<2.000
PB	<18.600	<18.600
PPDDE	<0.053	<0.053
PPDDT	<0.070	<0.070
SO4	883000.000	861000.000
T12DCE	<1.200	<1.200
TCLEE	2.200	2.190
TRCLE	<1.100	<1.100
XYLEN	<2.470	<2.470
ZN	82.900	<20.100

TASK 39 WATER CHEMISTRY SUMMARY
SOURCE, ESE 1988

WELL #	AQUIFER	SCREENED INTERVAL	CASING DIAMETER	BEDROCK DEPTH	BEDROCK LITHOLOGY	WQAQ	DENVER SAND
37343	ALL	3.7- 35.1	4.0	35.5	SH	1	

COMPOUND	3RD QUARTER FY87	4TH QUARTER FY87
111TCE	<1.700	<1.700
112TCE	<1.000	<1.000
11DCE	<1.100	<1.100
11DCLE	<1.200	<1.200
12DCLE	2.240	0.801
ALDRN	<0.070	<0.070
AS	3.900	4.300
BTZ	<2.000	<2.000
C6H6	<1.340	<1.340
CA	144000.000	119000.000
CCL4	<2.400	<2.400
CD	<5.160	<5.160
CH2CL2	<5.000	<5.000
CHCL3	<1.400	<1.400
CL	333000.000	223000.000
CL6CP	<0.070	<0.070
CLC6H5	8.930	3.090
CLDAN	.	.
CPMS	<1.300	<1.300
CPMSO	<4.200	<4.200
CPMSO2	<4.700	<4.700
CR	<5.960	11.100
CU	26.700	<7.940
DBCP	<0.130	<0.130
DCPD	16.800	11.900
DIMP	966.000	468.000
DITH	1.830	1.900
DLDRN	<0.060	<0.060
DMDS	<1.800	<1.800
DMMP	<152.000	<76.000
ENDRN	<0.052	<0.052
ETC6H5	<1.280	<1.280
FL	1600.000	1750.000
HG	<0.240	<0.480
ISODR	<0.060	<0.060
K	4590.000	5580.000
MEC6H5	<1.210	<1.210
MG	54000.000	50200.000
MIBK	<12.900	<12.900
MXYLEN	<1.350	<1.350
NA	270000.000	250000.000
NIT	190.000	100.000
OXAT	<2.000	<2.000
PB	<18.600	21.900
PPDDE	<0.053	<0.053
PPDDT	<0.070	<0.070
SO4	428000.000	355000.000
T12DCE	<1.200	<1.200
TCLEE	<1.300	<1.300
TRCLE	<1.100	<1.100
XYLEN	<2.470	<2.470
ZN	24.400	36.900

TASK 39 WATER CHEMISTRY SUMMARY
SOURCE, ESE 1988

WELL #	AQUIFER	SCREENED INTERVAL	CASING DIAMETER	BEDROCK DEPTH	BEDROCK LITHOLOGY	WQAQ	DENVER SAND
37344	ALL	15.5- 40.9	4.0	42.0	SS	2	

COMPOUND	3RD QUARTER FY87	4TH QUARTER FY87
111TCE	<1.700	<17.000
112TCE	<1.000	<1.000
11DCE	<1.100	<1.100
11DCLE	<1.200	<1.200
12DCLE	13.700	<6.100
ALDRN	<0.070	<0.070
AS	<3.070	<3.070
BTZ	<2.000	<2.000
C6H6	1.720	<1.340
CA	177000.000	183000.000
CCL4	9.880	<24.000
CD	<5.160	<5.160
CH2CL2	<5.000	<5.000
CHCL3	1370.000	1180.000
CL	402000.000	427000.000
CL6CP	<0.070	<0.070
CLC6H5	6.530	6.900
CLDAN	.	.
CPMS	3.290	<1.300
CPMSO	110.000	101.000
CPMSO2	<4.700	<4.700
CR	<5.960	17.300
CU	22.100	<7.940
DBCP	10.600	13.300
DCPD	<9.310	<9.310
DIMP	1160.000	1030.000
DITH	<1.100	<1.100
DLDRN	<0.060	<0.060
DMDS	<1.800	<1.800
DMMP	<380.000	<152.000
ENDRN	<0.052	<0.052
ETC6H5	<1.280	<1.280
FL	1350.000	1330.000
HG	<0.480	<0.480
ISODR	<0.060	<0.060
K	4740.000	4210.000
MEC6H5	<1.210	<1.210
MG	48800.000	51700.000
MIBK	<12.900	<12.900
MXYLEN	<1.350	<1.350
NA	292000.000	323000.000
NIT	2670.000	2760.000
OXAT	<2.000	<2.000
PB	<18.600	27.400
PPDDE	<0.053	<0.053
PPDDT	<0.070	<0.070
SO4	495000.000	505000.000
T12DCE	<1.200	<1.200
TCLEE	115.000	112.000
TRCLE	7.060	7.710
XYLEN	<2.470	<2.470
ZN	<20.100	<20.100

TASK 39 WATER CHEMISTRY SUMMARY
SOURCE, ESE 1988

WELL #	AQUIFER	SCREENED INTERVAL	CASING DIAMETER	BEDROCK DEPTH	BEDROCK LITHOLOGY	WQAQ	DENVER SAND
37345	ALL	16.4- 37.1	4.0	37.5	SH	1	

COMPOUND	3RD QUARTER FY87	4TH QUARTER FY87
111TCE	<1.700	<1.700
112TCE	<1.000	<1.000
11DCE	<1.100	<1.100
11DCLE	<1.200	<1.200
12DCLE	<0.610	<0.610
ALDRN	<0.070	<0.070
AS	<3.070	3.100
BTZ	<2.000	<2.000
C6H6	<1.340	<1.340
CA	74700.000	83000.000
CCL4	<2.400	<2.400
CD	<5.160	<5.160
CH2CL2	<5.000	<5.000
CHCL3	<1.400	<1.400
CL	52000.000	60500.000
CL6CP	<0.070	<0.070
CLC6H5	<0.580	<0.580
CLDAN	.	.
CPMS	<1.300	<1.300
CPMSO	<4.200	<4.200
CPMSO2	<4.700	<4.700
CR	<5.960	7.630
CU	<7.940	<7.940
DBCP	<0.130	<0.130
DCPD	<9.310	<9.310
DIMP	<10.500	<10.500
DITH	<1.100	<1.100
DLDRN	<0.060	<0.060
DMDS	<1.800	<1.800
DMMP	<15.200	<15.200
ENDRN	<0.052	<0.052
ETC6H5	<1.280	<1.280
FL	1270.000	1240.000
HG	<0.240	<0.480
ISODR	<0.060	<0.060
K	1660.000	3180.000
MEC6H5	<1.210	<1.210
MG	16200.000	17900.000
MIBK	<12.900	<12.900
MXYLEN	<1.350	<1.350
NA	69500.000	79500.000
NIT	668.000	446.000
OXAT	<2.000	<2.000
PB	<18.600	<18.600
PPDDE	<0.053	<0.053
PPDDT	<0.070	<0.070
SO4	153000.000	186000.000
T12DCE	<1.200	<1.200
TCLEE	<1.300	<1.300
TRCLE	<1.100	<1.100
XYLEN	<2.470	<2.470
ZN	77.100	100.000

TASK 39 WATER CHEMISTRY SUMMARY
SOURCE, ESE 1988

WELL #	AQUIFER	SCREENED INTERVAL	CASING DIAMETER	BEDROCK DEPTH	BEDROCK LITHOLOGY	WQAQ	DENVER SAND
37346	ALL	8.6- 24.0	4.0	24.0	SH	1	

COMPOUND	3RD QUARTER FY87	4TH QUARTER FY87
111TCE	<1.700	<1.700
112TCE	<1.000	<1.000
11DCE	<1.100	<1.100
11DCLE	<1.200	<1.200
12DCLE	<0.610	<0.610
ALDRN	<0.070	<0.070
AS	<3.070	3.200
BTZ	<2.000	<2.000
C6H6	<1.340	<1.340
CA	91800.000	48700.000
CCL4	<2.400	<2.400
CD	<5.160	<5.160
CH2CL2	<5.000	<5.000
CHCL3	<1.400	<1.400
CL	73900.000	40900.000
CL6CP	<0.070	<0.070
CLC6H5	<0.580	<0.580
CLDAN	.	.
CPMS	<1.300	<1.300
CPMSO	<4.200	<4.200
CPMSO2	<4.700	<4.700
CR	<5.960	<5.960
CU	<7.940	<7.940
DBCP	<0.130	<0.130
DCPD	<9.310	<9.310
DIMP	52.200	<10.500
DITH	<1.100	<1.100
DLDRN	<0.060	<0.060
DMDS	<1.800	<1.800
DMMP	<15.200	<15.200
ENDRN	<0.052	<0.052
ETC6H5	<1.280	<1.280
FL	<1220.000	1300.000
HG	<0.240	<0.240
ISODR	<0.060	<0.060
K	3660.000	2670.000
MEC6H5	<1.210	<1.210
MG	17200.000	10500.000
MIBK	<12.900	<12.900
MXYLEN	<1.350	<1.350
NA	71800.000	64100.000
NIT	722.000	292.000
OXAT	<2.000	<2.000
PB	<18.600	<18.600
PPDDE	<0.053	<0.053
PPDDT	<0.070	<0.070
SO4	159000.000	79500.000
T12DCE	<1.200	<1.200
TCLEE	<1.300	<1.300
TRCLE	<1.100	<1.100
XYLEN	<2.470	<2.470
ZN	42.800	49.500

TASK 39 WATER CHEMISTRY SUMMARY
SOURCE, ESE 1988

WELL #	AQUIFER	SCREENED INTERVAL	CASING DIAMETER	BEDROCK DEPTH	BEDROCK LITHOLOGY	WQAQ	DENVER SAND
37347	ALL	23.2- 33.8	4.0	33.5	SH	1	

COMPOUND	3RD QUARTER FY87	4TH QUARTER FY87
111TCE	<1.700	<1.700
112TCE	<1.000	<1.000
11DCE	<1.100	<1.100
11DCLE	<1.200	<1.200
12DCLE	<0.610	<0.610
ALDRN	<0.070	<0.070
AS	<3.070	<3.070
BTZ	<2.000	<2.000
C6H6	<1.340	<1.340
CA	70500.000	72000.000
CCL4	<2.400	<2.400
CD	<5.160	<5.160
CH2CL2	<5.000	<5.000
CHCL3	<1.400	<1.400
CL	55500.000	54900.000
CL6CP	<0.070	<0.070
CLC6H5	<0.580	<0.580
CLDAN	.	.
CPMS	<1.300	<1.300
CPMSO	<4.200	<4.200
CPMSO2	<4.700	<4.700
CR	<5.960	6.940
CU	<7.940	<7.940
DBCP	<0.130	<0.130
DCPD	<9.310	<9.310
DIMP	33.500	<10.500
DITH	<1.100	<1.100
DLDRN	<0.060	<0.060
DMDS	<1.800	<1.800
DMMP	<15.200	<15.200
ENDRN	<0.052	<0.052
ETC6H5	<1.280	<1.280
FL	<1220.000	<1220.000
HG	<0.240	<0.240
ISODR	<0.060	<0.060
K	3050.000	3440.000
MEC6H5	<1.210	<1.210
MG	16000.000	17800.000
MIBK	<12.900	<12.900
MXYLEN	<1.350	<1.350
NA	69500.000	69100.000
NIT	1180.000	2710.000
OXAT	<2.000	<2.000
PB	<18.600	21.900
PPDDE	<0.053	<0.053
PPDDT	<0.070	<0.070
SO4	112000.000	109000.000
T12DCE	<1.200	<1.200
TCLEE	<1.300	<1.300
TRCLE	<1.100	<1.100
XYLEN	<2.470	<2.470
ZN	52.200	61.200

TASK 39 WATER CHEMISTRY SUMMARY
SOURCE, ESE 1988

WELL #	AQUIFER	SCREENED INTERVAL	CASING DIAMETER	BEDROCK DEPTH	BEDROCK LITHOLOGY	WQAQ	DENVER SAND
37348	ALL	16.4- 42.0	4.0	41.0	SH	1	

COMPOUND	3RD QUARTER FY87	4TH QUARTER FY87
111TCE	<1.700	<1.700
112TCE	<1.000	<1.000
11DCE	<1.100	<1.100
11DCLE	<1.200	<1.200
12DCLE	<0.610	<0.610
ALDRN	<0.070	<0.070
AS	<3.070	<3.070
BTZ	<2.000	<2.000
C6H6	<1.340	<1.340
CA	148000.000	191000.000
CCL4	<2.400	<2.400
CD	<5.160	<5.160
CH2CL2	<5.000	<5.000
CHCL3	<1.400	2.200
CL	189000.000	325000.000
CL6CP	<0.070	<0.070
CLC6H5	2.050	1.260
CLDAN	.	.
CPMS	<1.300	<1.300
CPMSO	<4.200	<4.200
CPMSO2	<4.700	<4.700
CR	<5.960	15.300
CU	<7.940	<7.940
DBCP	<0.130	<0.130
DCPD	<9.310	<9.310
DIMP	<10.500	<10.500
DITH	<1.100	<1.100
DLDRN	<0.060	<0.060
DMDS	<1.800	<1.800
DMMP	<15.200	<15.200
ENDRN	<0.052	<0.052
ETC6H5	<1.280	<1.280
FL	1470.000	1360.000
HG	<0.480	<0.480
ISODR	<0.060	<0.060
K	2430.000	3520.000
MEC6H5	<1.210	<1.210
MG	35100.000	46100.000
MIBK	<12.900	<12.900
MXYLEN	<1.350	<1.350
NA	124000.000	164000.000
NIT	4010.000	7170.000
OXAT	<2.000	<2.000
PB	<18.600	<18.600
PPDDE	<0.053	<0.053
PPDDT	<0.070	<0.070
SO4	334000.000	370000.000
T12DCE	<1.200	<1.200
TCLEE	<1.300	1.720
TRCLE	<1.100	<1.100
XYLEN	<2.470	<2.470
ZN	34.600	<20.100

TASK 39 WATER CHEMISTRY SUMMARY
SOURCE, ESE 1988

WELL #	AQUIFER	SCREENED INTERVAL	CASING DIAMETER	BEDROCK DEPTH	BEDROCK LITHOLOGY	WQAQ	DENVER SAND
37349	ALL	23.2- 43.6	4.0	44.0	SH	1	

COMPOUND	3RD QUARTER FY87	4TH QUARTER FY87
111TCE	<1.700	<1.700
112TCE	<1.000	<1.000
11DCE	<1.100	<1.100
11DCLE	<1.200	<1.200
12DCLE	<0.610	<0.610
ALDRN	<0.070	<0.070
AS	<3.070	<3.070
BTZ	<2.000	<2.000
C6H6	<1.340	<1.340
CA	181000.000	101000.000
CCL4	<2.400	<2.400
CD	<5.160	<5.160
CH2CL2	<5.000	<5.000
CHCL3	<1.400	<1.400
CL	277000.000	115000.000
CL6CP	<0.070	<0.070
CLC6H5	<0.580	<0.580
CLDAN	.	.
CPMS	<1.300	<1.300
CPMSO	<4.200	<4.200
CPMSO2	<4.700	<4.700
CR	<5.960	12.500
CU	<7.940	<7.940
DBCP	<0.130	<0.130
DCPD	<9.310	<9.310
DIMP	456.000	78.400
DITH	<1.100	<1.100
DLDRN	<0.060	<0.060
DMDS	<1.800	<1.800
DMMP	<15.200	<15.200
ENDRN	<0.052	<0.052
ETC6H5	<1.280	<1.280
FL	1250.000	1290.000
HG	<0.240	<0.240
ISODR	<0.060	<0.060
K	3050.000	2500.000
MEC6H5	<1.210	<1.210
MG	47100.000	26600.000
MIBK	<12.900	<12.900
MXYLEN	<1.350	<1.350
NA	127000.000	91500.000
NIT	6790.000	5650.000
OXAT	<2.000	<2.000
PB	<18.600	<18.600
PPDDE	<0.053	<0.053
PPDDT	<0.070	<0.070
SO4	311000.000	176000.000
T12DCE	<1.200	<1.200
TCLEE	<1.300	<1.300
TRCLE	<1.100	<1.100
XYLEN	<2.470	<2.470
ZN	116.000	73.800

TASK 39 WATER CHEMISTRY SUMMARY
SOURCE, ESE 1988

WELL #	AQUIFER	SCREENED INTERVAL	CASING DIAMETER	BEDROCK DEPTH	BEDROCK LITHOLOGY	WQAQ	DENVER SAND
37350	ALL	26.9- 52.3	4.0	52.5	SH	1	

COMPOUND	3RD QUARTER FY87	4TH QUARTER FY87
111TCE	<1.700	<1.700
112TCE	<1.000	<1.000
11DCE	<1.100	<1.100
11DCLE	<1.200	<1.200
12DCLE	<0.610	<0.610
ALDRN	<0.070	<0.070
AS	<3.070	<3.070
BTZ	<2.000	<2.000
C6H6	<1.340	<1.340
CA	114000.000	113000.000
CCL4	<2.400	<2.400
CD	<5.160	5.260
CH2CL2	<5.000	<5.000
CHCL3	2.120	<1.400
CL	86100.000	85000.000
CL6CP	<0.070	<0.070
CLC6H5	<0.580	0.853
CLDAN	.	.
CPMS	<1.300	<1.300
CPMSO	<4.200	<4.200
CPMSO2	<4.700	<4.700
CR	<5.960	15.300
CU	<7.940	<7.940
DBCP	<0.130	<0.130
DCPD	<9.310	<9.310
DIMP	16.600	<10.500
DITH	<1.100	<1.100
DLDRN	<0.060	<0.060
DMDS	<1.800	<1.800
DMMP	<15.200	<15.200
ENDRN	<0.052	<0.052
ETC6H5	<1.280	<1.280
FL	<1220.000	<1220.000
HG	<0.480	<0.240
ISODR	<0.060	<0.060
K	3660.000	4120.000
MEC6H5	<1.210	<1.210
MG	30200.000	31900.000
MIBK	<12.900	<12.900
MXYLEN	<1.350	<1.350
NA	83400.000	93300.000
NIT	7010.000	5020.000
OXAT	<2.000	<2.000
PB	<18.600	38.400
PPDDE	<0.053	<0.053
PPDDT	<0.070	<0.070
SO4	218000.000	205000.000
T12DCE	<1.200	<1.200
TCLEE	<1.300	<1.300
TRCLE	<1.100	<1.100
XYLEN	<2.470	<2.470
ZN	<20.100	<20.100

TASK 39 WATER CHEMISTRY SUMMARY
SOURCE, ESE 1988

WELL #	AQUIFER	SCREENED INTERVAL	CASING DIAMETER	BEDROCK DEPTH	BEDROCK LITHOLOGY	WQAQ	DENVER SAND
37351	ALL	17.9- 38.5	4.0	36.0	SS	2	

COMPOUND	3RD QUARTER FY87	4TH QUARTER FY87
111TCE	<1.700	<1.700
112TCE	<1.000	<1.000
11DCE	<1.100	<1.100
11DCLE	<1.200	<1.200
12DCLE	<0.610	<0.610
ALDRN	<0.070	<0.070
AS	<3.070	<3.070
BTZ	<2.000	<2.000
C6H6	<1.340	<1.340
CA	139000.000	114000.000
CCL4	<2.400	<2.400
CD	<5.160	<5.160
CH2CL2	<5.000	<5.000
CHCL3	<1.400	<1.400
CL	128000.000	123000.000
CL6CP	<0.070	<0.070
CLC6H5	<1.730	1.600
CLDAN	.	.
CPMS	<1.300	<1.300
CPMSO	<4.200	<4.200
CPMSO2	<4.700	<4.700
CR	<5.960	8.330
CU	<7.940	<7.940
DBCP	<0.130	<0.130
DCPD	<9.310	<9.310
DIMP	12.400	<10.500
DITH	<1.100	<1.100
DLDRN	<0.060	<0.060
DMDS	<1.800	<1.800
DMMP	<30.400	<15.200
ENDRN	<0.052	<0.052
ETC6H5	<1.280	<1.280
FL	1690.000	1720.000
HG	<0.480	<0.240
ISODR	<0.060	<0.060
K	1840.000	2500.000
MEC6H5	<1.210	<1.210
MG	38000.000	31700.000
MIBK	<12.900	<12.900
MXYLEN	<1.350	<1.350
NA	135000.000	120000.000
NIT	7890.000	8060.000
OXAT	<2.000	<2.000
PB	<18.600	<18.600
PPDDE	<0.053	<0.053
PPDDT	<0.070	<0.070
SO4	206000.000	194000.000
T12DCE	<1.200	<1.200
TCLEE	<1.300	<1.300
TRCLE	<1.100	<1.100
XYLEN	<2.470	<2.470
ZN	<20.100	<20.100

TASK 39 WATER CHEMISTRY SUMMARY
SOURCE, ESE 1988

WELL #	AQUIFER	SCREENED INTERVAL	CASING DIAMETER	BEDROCK DEPTH	BEDROCK LITHOLOGY	WQAQ	DENVER SAND
37352	ALL	29.8- 38.3	4.0	37.9	SH	1	

COMPOUND	3RD QUARTER FY87	4TH QUARTER FY87
111TCE	<1.700	<1.700
112TCE	<1.000	<1.000
11DCE	<1.100	<1.100
11DCLE	<1.200	<1.200
12DCLE	<0.610	<0.610
ALDRN	<0.070	<0.070
AS	<3.070	<3.070
BTZ	<2.000	<2.000
C6H6	<1.340	<1.340
CA	112000.000	92500.000
CCL4	<2.400	<2.400
CD	<5.160	<5.160
CH2CL2	9.970	<5.000
CHCL3	<1.400	<1.400
CL	82200.000	78400.000
CL6CP	<0.070	<0.070
CLC6H5	<0.580	<0.580
CLDAN	.	.
CPMS	<1.300	<1.300
CPMSO	<4.200	<4.200
CPMSO2	<4.700	<4.700
CR	<5.960	8.330
CU	<7.940	<7.940
DBCP	<0.130	<0.130
DCPD	<9.310	<9.310
DIMP	<10.500	<10.500
DITH	<1.100	<1.100
DLDRN	<0.060	<0.060
DMDS	<1.800	<1.800
DMMP	<15.200	<15.200
ENDRN	<0.052	<0.052
ETC6H5	<1.280	<1.280
FL	1380.000	1320.000
HG	<0.240	<0.240
ISODR	<0.060	<0.060
K	<1260.000	1810.000
MEC6H5	<1.210	<1.210
MG	28200.000	23200.000
MIBK	<12.900	<12.900
MXYLEN	<1.350	<1.350
NA	112000.000	92200.000
NIT	3360.000	2980.000
OXAT	<2.000	<2.000
PB	<18.600	<18.600
PPDDE	<0.053	<0.053
PPDDT	<0.070	<0.070
SO4	177000.000	169000.000
T12DCE	<1.200	<1.200
TCLEE	<1.300	<1.300
TRCLE	<1.100	<1.100
XYLEN	<2.470	<2.470
ZN	37.900	<20.100

TASK 39 WATER CHEMISTRY SUMMARY
SOURCE, ESE 1988

WELL #	AQUIFER	SCREENED INTERVAL	CASING DIAMETER	BEDROCK DEPTH	BEDROCK LITHOLOGY	WQAQ	DENVER SAND
37353	ALL	27.1- 42.4	4.0	44.0	SH	1	

COMPOUND	3RD QUARTER FY87	4TH QUARTER FY87
111TCE	<1.700	<1.700
112TCE	<1.000	<1.000
11DCE	<1.100	<1.100
11DCLE	<1.200	<1.200
12DCLE	<0.610	<0.610
ALDRN	<0.070	<0.070
AS	<3.070	<3.070
BTZ	<2.000	<2.000
C6H6	<1.340	<1.340
CA	119000.000	117000.000
CCL4	<2.400	<2.400
CD	<5.160	<5.160
CH2CL2	<5.000	<5.000
CHCL3	<1.400	<1.400
CL	119000.000	103000.000
CL6CP	<0.070	<0.070
CLC6H5	<0.580	<0.580
CLDAN	.	.
CPMS	<1.300	<1.300
CPMSO	<4.200	<4.200
CPMSO2	<4.700	<4.700
CR	<5.960	11.100
CU	<7.940	<7.940
DBCP	<0.130	<0.130
DCPD	<9.310	<9.310
DIMP	103.000	73.700
DITH	<1.100	<1.100
DLDRN	0.156	<0.060
DMDS	<1.800	<1.800
DMMP	<15.200	<15.200
ENDRN	<0.052	<0.052
ETC6H5	<1.280	<1.280
FL	<1220.000	<1220.000
HG	<0.240	<0.240
ISODR	<0.060	<0.060
K	1690.000	<1260.000
MEC6H5	<1.210	<1.210
MG	32500.000	32400.000
MIBK	<12.900	<12.900
MXYLEN	<1.350	<1.350
NA	135000.000	123000.000
NIT	4030.000	4220.000
OXAT	<2.000	<2.000
PB	<18.600	32.900
PPDDE	<0.053	<0.053
PPDDT	<0.070	<0.070
SO4	187000.000	189000.000
T12DCE	<1.200	<1.200
TCLEE	<1.300	<1.300
TRCLE	<1.100	<1.100
XYLEN	<2.470	<2.470
ZN	97.900	<20.100

TASK 39 WATER CHEMISTRY SUMMARY
SOURCE, ESE 1988

WELL #	AQUIFER	SCREENED INTERVAL	CASING DIAMETER	BEDROCK DEPTH	BEDROCK LITHOLOGY	WQAQ	DENVER SAND
37354	ALL	13.8- 49.1	4.0	49.0	SH	1	

COMPOUND	3RD QUARTER FY87	4TH QUARTER FY87
111TCE	<1.700	<1.700
112TCE	<1.000	<1.000
11DCE	<1.100	<1.100
11DCLE	<1.200	<1.200
12DCLE	<0.610	<0.610
ALDRN	<0.070	<0.070
AS	<3.070	<3.070
BTZ	<2.000	<2.000
C6H6	1.510	<1.340
CA	108000.000	77100.000
CCL4	<2.400	<2.400
CD	<5.160	<5.160
CH2CL2	<5.000	<5.000
CHCL3	3.380	<1.400
CL	87300.000	65700.000
CL6CP	<0.070	<0.070
CLC6H5	7.340	0.622
CLDAN	.	.
CPMS	<1.300	<1.300
CPMSO	<4.200	<4.200
CPMSO2	<4.700	<4.700
CR	<5.960	8.330
CU	<7.940	<7.940
DBCP	<0.130	<0.130
DCPD	<9.310	<9.310
DIMP	13.100	<10.500
DITH	<1.100	<1.100
DLDRN	<0.060	<0.060
DMDS	<1.800	<1.800
DMMP	<15.200	<15.200
ENDRN	<0.052	<0.052
ETC6H5	<1.280	<1.280
FL	1300.000	1280.000
HG	<0.480	<0.240
ISODR	<0.060	<0.060
K	2150.000	2500.000
MEC6H5	<1.210	<1.210
MG	28200.000	21000.000
MIBK	<12.900	<12.900
MXYLEN	<1.350	<1.350
NA	106000.000	93100.000
NIT	7750.000	6310.000
OXAT	<2.000	<2.000
PB	<18.600	<18.600
PPDDE	<0.053	<0.053
PPDDT	<0.070	<0.070
SO4	160000.000	138000.000
T12DCE	<1.200	<1.200
TCLEE	<1.300	<1.300
TRCLE	<1.100	<1.100
XYLEN	<2.470	<2.470
ZN	22.600	<20.100

TASK 39 WATER CHEMISTRY SUMMARY
SOURCE, ESE 1988

WELL #	AQUIFER	SCREENED INTERVAL	CASING DIAMETER	BEDROCK DEPTH	BEDROCK LITHOLOGY	WQAQ	DENVER SAND
37355	ALL	11.1- 71.7	4.0	70.0	SH	1	

COMPOUND	3RD QUARTER FY87	4TH QUARTER FY87
111TCE	9.590	29.400
112TCE	<1.000	<1.000
11DCE	<1.100	2.670
11DCLE	<1.200	<1.200
12DCLE	<0.610	<0.610
ALDRN	<0.070	<0.070
AS	<3.070	<3.070
BTZ	<2.000	<2.000
C6H6	<1.340	<1.340
CA	148000.000	134000.000
CCL4	<2.400	<2.400
CD	<5.160	<5.160
CH2CL2	<5.000	<5.000
CHCL3	3.250	2.360
CL	196000.000	203000.000
CL6CP	<0.070	<0.070
CLC6H5	5.790	<0.580
CLDAN	.	.
CPMS	<1.300	<1.300
CPMSO	<4.200	<4.200
CPMSO2	<4.700	<4.700
CR	<5.960	11.100
CU	11.100	<7.940
DBCP	<0.130	<0.130
DCPD	<9.310	<9.310
DIMP	<10.500	<10.500
DITH	<1.100	<1.100
DLDRN	0.116	0.087
DMDS	<1.800	<1.800
DMMP	<15.200	<15.200
ENDRN	<0.052	<0.052
ETC6H5	<1.280	<1.280
FL	1640.000	1630.000
HG	<0.240	<0.240
ISODR	<0.060	<0.060
K	2000.000	3090.000
MEC6H5	<1.210	<1.210
MG	37000.000	35200.000
MIBK	<12.900	<12.900
MXYLEN	<1.350	<1.350
NA	157000.000	155000.000
NIT	6270.000	6480.000
OXAT	<2.000	<2.000
PB	24.500	<18.600
PPDDE	<0.053	<0.053
PPDDT	<0.070	<0.070
SO4	208000.000	202000.000
T12DCE	<1.200	<1.200
TCLEE	1.480	5.520
TRCLE	<1.100	2.120
XYLEN	<2.470	<2.470
ZN	35.200	<20.100

TASK 39 WATER CHEMISTRY SUMMARY
SOURCE, ESE 1988

WELL #	AQUIFER	SCREENED INTERVAL	CASING DIAMETER	BEDROCK DEPTH	BEDROCK LITHOLOGY	WQAQ	DENVER SAND
37356	ALL	8.3- 38.4	4.0	38.5	SH	1	

COMPOUND	3RD QUARTER FY87	4TH QUARTER FY87
111TCE	<1.700	<1.700
112TCE	<1.000	<1.000
11DCE	<1.100	<1.100
11DCLE	<1.200	<1.200
12DCLE	<0.610	<0.610
ALDRN	<0.070	<0.070
AS	<3.070	<3.070
BTZ	<2.000	<2.000
C6H6	<1.340	<1.340
CA	106000.000	109000.000
CCL4	<2.400	<2.400
CD	<5.160	<5.160
CH2CL2	<5.000	<5.000
CHCL3	<1.400	<1.400
CL	95000.000	105000.000
CL6CP	<0.070	<0.070
CLC6H5	7.390	1.720
CLDAN	.	.
CPMS	<1.300	<1.300
CPMSO	<4.200	<4.200
CPMSO2	<4.700	<4.700
CR	<5.960	9.020
CU	<7.940	<7.940
DBCP	<0.130	<0.130
DCPD	<9.310	<9.310
DIMP	57.400	54.100
DITH	<1.100	<1.100
DLDRN	<0.060	<0.060
DMDS	<1.800	<1.800
DMMP	<15.200	<15.200
ENDRN	<0.052	<0.052
ETC6H5	<1.280	<1.280
FL	<1220.000	<1220.000
HG	<0.240	<0.240
ISODR	<0.060	<0.060
K	3390.000	2520.000
MEC6H5	<1.210	<1.210
MG	25900.000	27300.000
MIBK	<12.900	<12.900
MXYLEN	<1.350	<1.350
NA	111000.000	122000.000
NIT	4680.000	6770.000
OXAT	<2.000	<2.000
PB	<18.600	21.900
PPDDE	<0.053	<0.053
PPDDT	<0.070	<0.070
SO4	155000.000	186000.000
T12DCE	<1.200	<1.200
TCLEE	<1.300	<1.300
TRCLE	<1.100	<1.100
XYLEN	<2.470	<2.470
ZN	29.900	<20.100

TASK 39 WATER CHEMISTRY SUMMARY
SOURCE, ESE 1988

WELL #	AQUIFER	SCREENED INTERVAL	CASING DIAMETER	BEDROCK DEPTH	BEDROCK LITHOLOGY	WQAQ	DENVER SAND
37357	ALL	4.5- 19.7	4.0	19.0	SH	1	

COMPOUND	3RD QUARTER FY87	4TH QUARTER FY87
111TCE	<1.700	<1.700
112TCE	<1.000	<1.000
11DCE	<1.100	<1.100
11DCLE	<1.200	<1.200
12DCLE	<0.610	<0.610
ALDRN	<0.070	<0.070
AS	<3.070	<3.070
BTZ	<2.000	<2.000
C6H6	<1.340	<1.340
CA	121000.000	82400.000
CCL4	<2.400	<2.400
CD	<5.160	<5.160
CH2CL2	<5.000	<5.000
CHCL3	24.300	4.680
CL	126000.000	84500.000
CL6CP	<0.070	<0.070
CLC6H5	<0.580	1.100
CLDAN	.	.
CPMS	<1.300	<1.300
CPMSO	<4.200	<4.200
CPMSO2	<4.700	<4.700
CR	<5.960	13.900
CU	<7.940	<7.940
DBCP	<0.130	<0.130
DCPD	<9.310	<9.310
DIMP	29.600	16.200
DITH	<1.100	<1.100
DLDRN	<0.060	<0.060
DMDS	<1.800	<1.800
DMMP	<15.200	<15.200
ENDRN	<0.052	<0.052
ETC6H5	<1.280	<1.280
FL	<1220.000	1220.000
HG	<0.240	<0.240
ISODR	<0.060	<0.060
K	6640.000	6670.000
MEC6H5	<1.210	<1.210
MG	32900.000	22500.000
MIBK	<12.900	<12.900
MXYLEN	<1.350	<1.350
NA	137000.000	98500.000
NIT	10300.000	10700.000
OXAT	<2.000	<2.000
PB	<18.600	21.900
PPDDE	<0.053	<0.053
PPDDT	<0.070	<0.070
SO4	192000.000	168000.000
T12DCE	<1.200	<1.200
TCLEE	3.390	<1.300
TRCLE	<1.100	<1.100
XYLEN	<2.470	<2.470
ZN	67.400	<20.100

TASK 39 WATER CHEMISTRY SUMMARY
SOURCE, ESE 1988

WELL #	AQUIFER	SCREENED INTERVAL	CASING DIAMETER	BEDROCK DEPTH	BEDROCK LITHOLOGY	WQAQ	DENVER SAND
37358	ALL	44.3- 59.9	4.0	59.0	SH	1	

COMPOUND	3RD QUARTER FY87	4TH QUARTER FY87
111TCE	<1.700	<1.700
112TCE	<1.000	<1.000
11DCE	<1.100	<1.100
11DCLE	<1.200	<1.200
12DCLE	<0.610	<0.610
ALDRN	<0.070	<0.070
AS	<3.070	<3.070
BTZ	<2.000	<2.000
C6H6	<1.340	<1.340
CA	135000.000	121000.000
CCL4	<2.400	<2.400
CD	<5.160	<5.160
CH2CL2	<5.000	<5.000
CHCL3	<1.400	<1.400
CL	73800.000	78000.000
CL6CP	<0.070	<0.070
CLC6H5	<0.580	<0.580
CLDAN	.	.
CPMS	<1.300	<1.300
CPMSO	<4.200	<4.200
CPMSO2	<4.700	<4.700
CR	<5.960	8.330
CU	<7.940	<7.940
DBCP	<0.130	<0.130
DCPD	<9.310	<9.310
DIMP	<10.500	<10.500
DITH	<1.100	<1.100
DLDRN	<0.060	<0.060
DMDS	<1.800	<1.800
DMMP	<15.200	<15.200
ENDRN	<0.052	<0.052
ETC6H5	<1.280	<1.280
FL	<1220.000	<1220.000
HG	<0.240	<0.240
ISODR	<0.060	<0.060
K	2150.000	2360.000
MEC6H5	<1.210	<1.210
MG	15000.000	14900.000
MIBK	<12.900	<12.900
MXYLEN	<1.350	<1.350
NA	73200.000	70400.000
NIT	3460.000	2410.000
OXAT	<2.000	<2.000
PB	<18.600	<18.600
PPDDE	<0.053	<0.053
PPDDT	<0.070	<0.070
SO4	123000.000	111000.000
T12DCE	<1.200	<1.200
TCLEE	<1.300	<1.300
TRCLE	<1.100	<1.100
XYLEN	<2.470	<2.470
ZN	<20.100	<20.100

TASK 39 WATER CHEMISTRY SUMMARY
SOURCE, ESE 1988

WELL #	AQUIFER	SCREENED INTERVAL	CASING DIAMETER	BEDROCK DEPTH	BEDROCK LITHOLOGY	WQAQ	DENVER SAND
37359	ALL	23.2- 43.7	4.0	42.9	SH	1	

COMPOUND	3RD QUARTER FY87	4TH QUARTER FY87
111TCE	3.700	4.540
112TCE	<1.000	<1.000
11DCE	<1.100	<1.100
11DCLE	2.310	1.950
12DCLE	<0.610	<0.610
ALDRN	<0.070	<0.070
AS	<3.070	<3.070
BTZ	<2.000	<2.000
C6H6	<1.340	<1.340
CA	229000.000	187000.000
CCL4	<2.400	<2.400
CD	<5.160	<5.160
CH2CL2	<5.000	<5.000
CHCL3	<1.400	<1.400
CL	134000.000	129000.000
CL6CP	<0.070	<0.070
CLC6H5	<0.580	1.010
CLDAN	.	.
CPMS	<1.300	<1.300
CPMSO	<4.200	<4.200
CPMSO2	<4.700	<4.700
CR	<5.960	11.100
CU	<7.940	<7.940
DBCP	<0.130	<0.130
DCPD	<9.310	<9.310
DIMP	<10.500	<10.500
DITH	<1.100	<1.100
DLDRN	<0.060	<0.060
DMDS	<1.800	<1.800
DMMP	<15.200	<15.200
ENDRN	<0.052	<0.052
ETC6H5	<1.280	<1.280
FL	<1220.000	<1220.000
HG	<0.240	<0.240
ISODR	<0.060	<0.060
K	4470.000	5580.000
MEC6H5	<1.210	<1.210
MG	31800.000	26200.000
MIBK	<12.900	<12.900
MXYLEN	<1.350	<1.350
NA	165000.000	142000.000
NIT	9060.000	5610.000
OXAT	<2.000	<2.000
PB	<18.600	<18.600
PPDDE	<0.053	<0.053
PPDDT	<0.070	<0.070
SO4	333000.000	327000.000
T12DCE	1.260	<1.200
TCLEE	3.950	3.670
TRCLE	5.130	6.560
XYLEN	<2.470	<2.470
ZN	<20.100	<20.100

TASK 39 WATER CHEMISTRY SUMMARY
SOURCE, ESE 1988

WELL #	AQUIFER	SCREENED INTERVAL	CASING DIAMETER	BEDROCK DEPTH	BEDROCK LITHOLOGY	WQAQ	DENVER SAND
37360	ALL	26.4-101.9	4.0	101.5	SH	1	

COMPOUND	3RD QUARTER FY87	4TH QUARTER FY87
111TCE	<1.700	<1.700
112TCE	<1.000	<1.000
11DCE	<1.100	<1.100
11DCLE	<1.200	<1.200
12DCLE	<0.610	<0.610
ALDRN	<0.070	<0.070
AS	<3.070	<3.070
BTZ	<2.000	<2.000
C6H6	<1.340	<1.340
CA	137000.000	120000.000
CCL4	<2.400	<2.400
CD	<5.160	<5.160
CH2CL2	<5.000	<5.000
CHCL3	<1.400	<1.400
CL	62200.000	63300.000
CL6CP	<0.070	<0.070
CLC6H5	7.520	1.360
CLDAN	.	.
CPMS	<1.300	<1.300
CPMSO	<4.200	<4.200
CPMSO2	<4.700	<4.700
CR	<5.960	9.710
CU	<7.940	<7.940
DBCP	<0.130	<0.130
DCPD	<9.310	<9.310
DIMP	<10.500	<10.500
DITH	<1.100	<1.100
DLDRN	<0.060	<0.060
DMDS	<1.800	<1.800
DMMP	<15.200	<15.200
ENDRN	<0.052	<0.052
ETC6H5	<1.280	<1.280
FL	<1220.000	<1220.000
HG	<0.240	<0.240
ISODR	<0.060	<0.060
K	2920.000	2840.000
MEC6H5	<1.210	<1.210
MG	14900.000	12500.000
MIBK	<12.900	<12.900
MXYLEN	<1.350	<1.350
NA	71900.000	65100.000
NIT	8900.000	8940.000
OXAT	<2.000	<2.000
PB	<18.600	27.400
PPDDE	<0.053	<0.053
PPDDT	<0.070	<0.070
SO4	132000.000	130000.000
T12DCE	<1.200	<1.200
TCLEE	<1.300	<1.300
TRCLE	<1.100	<1.100
XYLEN	<2.470	<2.470
ZN	<20.100	<20.100

TASK 39 WATER CHEMISTRY SUMMARY
SOURCE, ESE 1988

WELL #	AQUIFER	SCREENED INTERVAL	CASING DIAMETER	BEDROCK DEPTH	BEDROCK LITHOLOGY	WQAQ	DENVER SAND
37361	ALL	21.7- 92.3	4.0	92.0	SH	1	

COMPOUND	3RD QUARTER FY87	4TH QUARTER FY87
111TCE	<1.700	<1.700
112TCE	<1.000	<1.000
11DCE	<1.100	<1.100
11DCLE	<1.200	<1.200
12DCLE	<0.610	<0.610
ALDRN	<0.070	<0.070
AS	<3.070	<3.070
BTZ	<2.000	<2.000
C6H6	1.530	<1.340
CA	120000.000	95300.000
CCL4	<2.400	<2.400
CD	<5.160	<5.160
CH2CL2	<5.000	<5.000
CHCL3	<1.400	<1.400
CL	62300.000	51100.000
CL6CP	<0.070	<0.070
CLC6H5	7.760	1.550
CLDAN	.	.
CPMS	<1.300	<1.300
CPMSO	<4.200	<4.200
CPMSO2	<4.700	<4.700
CR	<5.960	11.800
CU	<7.940	<7.940
DBCP	<0.130	<0.130
DCPD	<9.310	<9.310
DIMP	<10.500	<10.500
DITH	<1.100	<1.100
DLDRN	<0.060	<0.060
DMDS	<1.800	<1.800
DMMP	<15.200	<15.200
ENDRN	<0.052	<0.052
ETC6H5	<1.280	<1.280
FL	<1220.000	<1220.000
HG	<0.240	<0.240
ISODR	<0.060	<0.060
K	2000.000	3350.000
MEC6H5	<1.210	<1.210
MG	15600.000	14600.000
MIBK	<12.900	<12.900
MXYLEN	<1.350	<1.350
NA	81100.000	65000.000
NIT	7890.000	5520.000
OXAT	<2.000	<2.000
PB	<18.600	27.400
PPDDE	<0.053	<0.053
PPDDT	<0.070	<0.070
SO4	143000.000	126000.000
T12DCE	<1.200	<1.200
TCLEE	<1.300	<1.300
TRCLE	<1.100	<1.100
XYLEN	<2.470	<2.470
ZN	22.800	<20.100

TASK 39 WATER CHEMISTRY SUMMARY
SOURCE, ESE 1988

WELL #	AQUIFER	SCREENED INTERVAL	CASING DIAMETER	BEDROCK DEPTH	BEDROCK LITHOLOGY	WQAQ	DENVER SAND
37362	ALL	34.5- 45.2	4.0	42.5	SH	1	

COMPOUND	3RD QUARTER FY87	4TH QUARTER FY87
111TCE	<1.700	<1.700
112TCE	<1.000	<1.000
11DCE	<1.100	<1.100
11DCLE	<1.200	<1.200
12DCLE	<0.610	<0.610
ALDRN	<0.070	<0.070
AS	<3.070	<3.070
BTZ	<2.000	<2.000
C6H6	<1.340	<1.340
CA	158000.000	147000.000
CCL4	<2.400	<2.400
CD	<5.160	5.260
CH2CL2	<5.000	<5.000
CHCL3	<1.400	1.320
CL	234000.000	231000.000
CL6CP	<0.070	<0.070
CLC6H5	<0.580	<0.580
CLDAN	.	.
CPMS	<1.300	<1.300
CPMSO	<4.200	<4.200
CPMSO2	<4.700	<4.700
CR	<5.960	18.000
CU	<7.940	<7.940
DBCP	<0.130	<0.130
DCPD	<9.310	<9.310
DIMP	<10.500	<10.500
DITH	<1.100	<1.100
DLDRN	<0.060	<0.060
DMDS	<1.800	<1.800
DMMP	<15.200	<15.200
ENDRN	<0.052	<0.052
ETC6H5	<1.280	<1.280
FL	1770.000	1760.000
HG	<0.240	<0.240
ISODR	<0.060	<0.060
K	2460.000	3350.000
MEC6H5	<1.210	<1.210
MG	53800.000	47400.000
MIBK	<12.900	<12.900
MXYLEN	<1.350	<1.350
NA	314000.000	269000.000
NIT	1700.000	1760.000
OXAT	<2.000	<2.000
PB	<18.600	<18.600
PPDDE	<0.053	<0.053
PPDDT	<0.070	<0.070
SO4	449000.000	450000.000
T12DCE	<1.200	<1.200
TCLEE	<1.300	<1.300
TRCLE	<1.100	<1.100
XYLEN	<2.470	<2.470
ZN	55.100	74.800

TASK 39 WATER CHEMISTRY SUMMARY
SOURCE, ESE 1988

WELL #	AQUIFER	SCREENED INTERVAL	CASING DIAMETER	BEDROCK DEPTH	BEDROCK LITHOLOGY	WQAQ	DENVER SAND
37363	ALL	6.9- 32.2	4.0	32.1	SS	2	

COMPOUND	3RD QUARTER FY87	4TH QUARTER FY87
111TCE	<1.700	<1.700
112TCE	<1.000	<1.000
11DCE	<1.100	<1.100
11DCLE	<1.200	<1.200
12DCLE	<0.610	<0.610
ALDRN	<0.070	<0.070
AS	<3.070	.
BTZ	<2.000	<2.000
C6H6	<1.340	<1.340
CA	105000.000	72700.000
CCL4	<2.400	<2.400
CD	<5.160	<5.160
CH2CL2	<5.000	<5.000
CHCL3	<1.400	<1.400
CL	98600.000	86900.000
CL6CP	<0.070	<0.070
CLC6H5	9.420	0.661
CLDAN	.	.
CPMS	<1.300	<1.300
CPMSO	<4.200	<4.200
CPMSO2	<4.700	<4.700
CR	<5.960	<5.960
CU	<7.940	<7.940
DBCP	<0.130	<0.130
DCPD	<9.310	<9.310
DIMP	<10.500	<10.500
DITH	<1.100	<1.100
DLDRN	<0.060	<0.060
DMDS	<1.800	<1.800
DMMP	<15.200	<15.200
ENDRN	<0.052	<0.052
ETC6H5	<1.280	<1.280
FL	<1220.000	<1220.000
HG	<0.240	<0.240
ISODR	<0.060	<0.060
K	2460.000	2190.000
MEC6H5	<1.210	<1.210
MG	23600.000	16200.000
MIBK	<12.900	<12.900
MXYLEN	<1.350	<1.350
NA	111000.000	85100.000
NIT	870.000	<10.000
OXAT	<2.000	<2.000
PB	<18.600	<18.600
PPDDE	<0.053	<0.053
PPDDT	<0.070	<0.070
SO4	180000.000	175000.000
T12DCE	<1.200	<1.200
TCLEE	<1.300	<1.300
TRCLE	<1.100	<1.100
XYLEN	<2.470	<2.470
ZN	<20.100	<20.100

TASK 39 WATER CHEMISTRY SUMMARY
SOURCE, ESE 1988

WELL #	AQUIFER	SCREENED INTERVAL	CASING DIAMETER	BEDROCK DEPTH	BEDROCK LITHOLOGY	WQAQ	DENVER SAND
37364	ALL	6.8- 27.3	4.0	28.9	SH	1	

COMPOUND	3RD QUARTER FY87	4TH QUARTER FY87
111TCE	<1.700	<1.700
112TCE	<1.000	<1.000
11DCE	<1.100	<1.100
11DCLE	<1.200	<1.200
12DCLE	<0.610	<0.610
ALDRN	<0.070	<0.070
AS	6.200	.
BTZ	<2.000	<2.000
C6H6	<1.340	<1.340
CA	36200.000	32000.000
CCL4	<2.400	<2.400
CD	<5.160	<5.160
CH2CL2	<5.000	<5.000
CHCL3	<1.400	<1.400
CL	31800.000	37300.000
CL6CP	<0.070	<0.070
CLC6H5	4.690	1.000
CLDAN	.	.
CPMS	<1.300	<1.300
CPMSO	<4.200	<4.200
CPMSO2	<4.700	<4.700
CR	<5.960	8.640
CU	<7.940	<7.940
DBCP	<0.130	<0.130
DCPD	<9.310	<9.310
DIMP	<10.500	<10.500
DITH	<1.100	<1.100
DLDRN	<0.060	<0.060
DMDS	<1.800	<1.800
DMMP	<15.200	<15.200
ENDRN	<0.052	<0.052
ETC6H5	<1.280	<1.280
FL	1200.000	<1220.000
HG	<0.240	<0.240
ISODR	<0.060	<0.060
K	4160.000	4680.000
MEC6H5	<1.210	<1.210
MG	7410.000	6800.000
MIBK	<12.900	<12.900
MXYLEN	<1.350	<1.350
NA	57400.000	49100.000
NIT	1280.000	113.000
OXAT	<2.000	<2.000
PB	<18.600	<18.600
PPDDE	<0.053	<0.053
PPDDT	<0.070	<0.070
SO4	70100.000	81000.000
T12DCE	<1.200	<1.200
TCLEE	<1.300	<1.300
TRCLE	<1.100	<1.100
XYLEN	<2.470	<2.470
ZN	<20.100	<20.100

TASK 39 WATER CHEMISTRY SUMMARY
SOURCE, ESE 1988

WELL #	AQUIFER	SCREENED INTERVAL	CASING DIAMETER	BEDROCK DEPTH	BEDROCK LITHOLOGY	WQAQ	DENVER SAND
37365	DEN	49.1- 59.7	4.0	33.5	SH	5	4

COMPOUND	3RD QUARTER FY87	4TH QUARTER FY87
111TCE	.	<1.700
112TCE	.	<1.000
11DCE	.	<1.100
11DCLE	.	<1.200
12DCLE	.	<0.610
ALDRN	.	<0.070
AS	.	.
BTZ	.	<2.000
C6H6	.	<1.340
CA	.	35000.000
CCL4	.	<2.400
CD	.	<5.160
CH2CL2	.	<5.000
CHCL3	.	<1.400
CL	.	45100.000
CL6CP	.	<0.070
CLC6H5	.	<0.580
CLDAN	.	.
CPMS	.	<1.300
CPMSO	.	<4.200
CPMSO2	.	<4.700
CR	.	<5.960
CU	.	<7.940
DBCP	.	<0.130
DCPD	.	<9.310
DIMP	.	11.500
DITH	.	<1.100
DLDRN	.	<0.060
DMDS	.	<1.800
DMMP	.	<15.200
ENDRN	.	<0.052
ETC6H5	.	<1.280
FL	.	<1220.000
HG	.	<0.240
ISODR	.	<0.060
K	.	<1260.000
MEC6H5	.	<1.210
MG	.	4030.000
MIBK	.	<12.900
MXYLEN	.	<1.350
NA	.	277000.000
NIT	.	844.000
OXAT	.	<2.000
PB	.	<18.600
PPDDE	.	<0.053
PPDDT	.	0.070
SO4	.	256000.000
T12DCE	.	<1.200
TCLEE	.	<1.300
TRCLE	.	<1.100
XYLEN	.	<2.470
ZN	.	<20.100

TASK 39 WATER CHEMISTRY SUMMARY
SOURCE, ESE 1988

WELL #	AQUIFER	SCREENED INTERVAL	CASING DIAMETER	BEDROCK DEPTH	BEDROCK LITHOLOGY	WQAQ	DENVER SAND
37367	ALL	11.5- 38.4	4.0	0.0		1	

COMPOUND	3RD QUARTER FY87	4TH QUARTER FY87
111TCE	<1.090	<1.090
112TCE	<1.630	<1.630
11DCE	<1.850	<1.850
11DCLE	<1.930	<1.930
12DCLE	<2.070	<2.070
ALDRN	<0.083	<0.083
AS	<2.500	<2.500
BTZ	<1.140	<1.140
C6H6	2.920	<1.920
CA	158000.000	161000.000
CCL4	<1.690	<1.690
CD	<5.160	<5.160
CH2CL2	<2.480	<2.480
CHCL3	127.000	116.000
CL	201000.000	175000.000
CL6CP	<0.083	<0.083
CLC6H5	9.230	<1.360
CLDAN	<0.152	<0.152
CPMS	4.160	3.280
CPMSO	113.000	92.400
CPMSO2	4.310	4.320
CR	<5.960	22.500
CU	<7.940	<7.940
DBCP	2.570	2.100
DCPD	<9.310	<9.310
DIMP	397.000	486.000
DITH	<3.340	<3.340
DLDRN	<0.054	<0.054
DMDS	<1.160	<1.160
DMMP	<15.200	<163.000
ENDRN	<0.060	<0.060
ETC6H5	<0.620	<0.620
FL	2050.000	1360.000
HG	.	<0.500
ISODR	<0.056	<0.056
K	.	3310.000
MEC6H5	<2.100	<2.100
MG	50900.000	50200.000
MIBK	<12.900	<12.900
MXYLEN	<1.040	<1.040
NA	265000.000	259000.000
NIT	2820.000	2710.000
OXAT	<1.350	<1.350
PB	<18.600	<18.600
PPDDE	<0.046	<0.046
PPDDT	<0.059	<0.059
SO4	578000.000	508000.000
T12DCE	<1.750	<1.750
TCLEE	35.800	30.000
TRCLE	4.100	3.720
XYLEN	<1.340	<1.340
ZN	<20.100	45.900

TASK 39 WATER CHEMISTRY SUMMARY
SOURCE, ESE 1988

WELL #	AQUIFER	SCREENED INTERVAL	CASING DIAMETER	BEDROCK DEPTH	BEDROCK LITHOLOGY	WQAQ	DENVER SAND
37368	ALL	18.1- 34.3	4.0	0.0		1	

COMPOUND	3RD QUARTER FY87	4TH QUARTER FY87
111TCE	<1.090	<1.090
112TCE	<1.630	<1.630
11DCE	<1.850	<1.850
11DCLE	<1.930	<1.930
12DCLE	<2.070	<2.070
ALDRN	<0.083	<0.083
AS	2.560	3.060
BTZ	<1.140	<1.140
C6H6	2.630	<1.920
CA	367000.000	361000.000
CCL4	<1.690	<1.690
CD	<5.160	<5.160
CH2CL2	<2.480	<2.480
CHCL3	29.900	32.800
CL	690000.000	564000.000
CL6CP	<0.083	<0.083
CLC6H5	11.500	<1.360
CLDAN	<0.152	<0.152
CPMS	<1.080	<1.080
CPMSO	3.430	3.400
CPMSO2	<2.240	<2.240
CR	<5.960	39.700
CU	<7.940	<7.940
DBCP	1.110	0.975
DCPD	<9.310	<9.310
DIMP	55.700	60.800
DITH	<3.340	<3.340
DLDRN	<0.054	<0.054
DMDS	<1.160	<1.160
DMMP	<15.200	<16.300
ENDRN	<0.060	<0.060
ETC6H5	<0.620	<0.620
FL	2580.000	1960.000
HG	.	<0.500
ISODR	<0.056	<0.056
K	.	4320.000
MEC6H5	<2.100	<2.100
MG	96500.000	88800.000
MIBK	<12.900	<12.900
MXYLEN	<1.040	<1.040
NA	384000.000	372000.000
NIT	9020.000	8840.000
OXAT	<1.350	<1.350
PB	<18.600	<18.600
PPDDE	<0.046	<0.046
PPDDT	<0.059	<0.059
SO4	784000.000	696000.000
T12DCE	<1.750	<1.750
TCLEE	16.000	13.100
TRCLE	1.930	<1.310
XYLEN	<1.340	<1.340
ZN	<20.100	27.900

TASK 39 WATER CHEMISTRY SUMMARY
SOURCE, ESE 1988

WELL #	AQUIFER	SCREENED INTERVAL	CASING DIAMETER	BEDROCK DEPTH	BEDROCK LITHOLOGY	WQAQ	DENVER SAND
37369	ALL	4.1- 25.2	4.0	0.0		1	

COMPOUND	3RD QUARTER FY87	4TH QUARTER FY87
111TCE	<1.090	<1.090
112TCE	<1.630	<1.630
11DCE	<1.850	<1.850
11DCLE	<1.930	<1.930
12DCLE	3.000	<2.070
ALDRN	<0.083	<0.083
AS	<2.500	<2.500
BTZ	<1.140	<1.140
C6H6	<1.920	<1.920
CA	.	.
CCL4	<1.690	<1.690
CD	.	.
CH2CL2	<2.480	<2.480
CHCL3	<1.880	<1.880
CL	210000.000	245000.000
CL6CP	<0.083	<0.083
CLC6H5	8.880	<1.360
CLDAN	<0.152	<0.152
CPMS	<1.080	<1.080
CPMSO	8.590	7.230
CPMSO2	4.110	4.120
CR	.	.
CU	.	.
DBCP	<0.130	<0.130
DCPD	59.400	48.900
DIMP	251.000	287.000
DITH	<3.340	<3.340
DLDRN	0.333	0.245
DMDS	<1.160	<1.160
DMMP	<76.000	<163.000
ENDRN	0.428	0.063
ETC6H5	<0.620	<0.620
FL	2690.000	2890.000
HG	.	.
ISODR	<0.056	<0.056
K	.	.
MEC6H5	<2.100	<2.100
MG	.	.
MIBK	<12.900	<12.900
MXYLEN	<1.040	<1.040
NA	.	.
NIT	.	.
OXAT	<1.350	<1.350
PB	.	.
PPDDE	<0.046	<0.046
PPDDT	<0.059	0.081
SO4	391000.000	482000.000
T12DCE	<1.750	<1.750
TCLEE	8.960	7.890
TRCLE	<1.310	<1.310
XYLEN	<1.340	<1.340
ZN	.	.

TASK 39 WATER CHEMISTRY SUMMARY
SOURCE, ESE 1988

WELL #	AQUIFER	SCREENED INTERVAL	CASING DIAMETER	BEDROCK DEPTH	BEDROCK LITHOLOGY	WQAQ	DENVER SAND
37370	ALL	4.4- 25.8	4.0	0.0		1	

COMPOUND	3RD QUARTER FY87	4TH QUARTER FY87
111TCE	<1.090	<1.090
112TCE	<1.630	<1.630
11DCE	<1.850	<1.850
11DCLE	<1.930	<1.930
12DCLE	<2.070	<2.070
ALDRN	<0.083	<0.083
AS	2.720	3.390
BTZ	<1.140	<1.140
C6H6	8.430	<1.920
CA	.	.
CCL4	<1.690	<1.690
CD	.	.
CH2CL2	<2.480	<2.480
CHCL3	<1.880	<1.880
CL	568000.000	518000.000
CL6CP	<0.083	<0.083
CLC6H5	27.300	<1.360
CLDAN	<0.152	<0.152
CPMS	<1.080	<1.080
CPMSO	<1.980	<1.980
CPMSO2	<2.230	<2.240
CR	.	.
CU	.	.
DBCP	<0.130	<0.130
DCPD	<9.310	<9.310
DIMP	278.000	1130.000
DITH	<3.340	<3.340
DLDRN	<0.054	<0.054
DMDS	<1.160	<1.160
DMMP	<76.000	<163.000
ENDRN	<0.060	<0.060
ETC6H5	<0.620	<0.620
FL	2550.000	2810.000
HG	.	.
ISODR	<0.056	<0.056
K	.	.
MEC6H5	<2.100	<2.100
MG	.	.
MIBK	<12.900	<12.900
MXYLEN	<1.040	<1.040
NA	.	.
NIT	.	.
OXAT	<1.350	<1.350
PB	.	.
PPDDE	<0.046	<0.046
PPDDT	<0.059	<0.059
SO4	899000.000	932000.000
T12DCE	<1.750	<1.750
TCLEE	<2.760	<2.760
TRCLE	2.650	<1.310
XYLEN	<1.340	<1.340
ZN	.	.

TASK 39 WATER CHEMISTRY SUMMARY
SOURCE, ESE 1988

WELL #	AQUIFER	SCREENED INTERVAL	CASING DIAMETER	BEDROCK DEPTH	BEDROCK LITHOLOGY	WQAQ	DENVER SAND
37371	DEN	28.3- 39.0	4.0	0.0		5	3

COMPOUND	3RD QUARTER FY87	4TH QUARTER FY87
111TCE	<1.090	<1.090
112TCE	<1.630	<1.630
11DCE	<1.850	<1.850
11DCLE	<1.930	<1.930
12DCLE	<2.070	<2.070
ALDRN	<0.083	<0.083
AS	<2.500	<2.500
BTZ	<1.140	<1.140
C6H6	<1.920	<1.920
CA	231000.000	231000.000
CCL4	<1.690	<1.690
CD	<5.160	<5.160
CH2CL2	<2.480	<2.480
CHCL3	<1.880	<1.880
CL	467000.000	429000.000
CL6CP	<0.083	<0.083
CLC6H5	<1.360	<1.360
CLDAN	<0.152	<0.152
CPMS	<1.080	<1.080
CPMSO	<1.980	<1.980
CPMSO2	<2.240	<2.240
CR	<5.960	<5.960
CU	<7.940	<7.940
DBCP	<0.130	<0.130
DCPD	<9.310	16.600
DIMP	1100.000	1480.000
DITH	<3.340	<3.340
DLDRN	<0.054	<0.054
DMDS	<1.160	<1.160
DMMP	<15.200	<163.000
ENDRN	<0.060	<0.060
ETC6H5	<0.620	<0.620
FL	2590.000	2740.000
HG	.	.
ISODR	<0.056	<0.056
K	.	.
MEC6H5	<2.100	<2.100
MG	61900.000	61900.000
MIBK	<12.900	<12.900
MXYLEN	<1.040	<1.040
NA	428000.000	428000.000
NIT	838.000	838.000
OXAT	<1.350	<1.350
PB	<18.600	<18.600
PPDDE	<0.046	<0.046
PPDDT	<0.059	<0.059
SO4	700000.000	678000.000
T12DCE	<1.750	<1.750
TCLEE	<2.760	<2.760
TRCLE	<1.310	<1.310
XYLEN	<1.340	<1.340
ZN	<20.100	<20.100

TASK 39 WATER CHEMISTRY SUMMARY
SOURCE, ESE 1988

WELL #	AQUIFER	SCREENED INTERVAL	CASING DIAMETER	BEDROCK DEPTH	BEDROCK LITHOLOGY	WQAQ	DENVER SAND
37372	DEN	61.5- 88.5	0.0	0.0		5	4

COMPOUND	3RD QUARTER FY87	4TH QUARTER FY87
111TCE	<1.090	<1.090
112TCE	<1.630	<1.630
11DCE	<1.850	<1.850
11DCLE	<1.930	<1.930
12DCLE	<2.070	<2.070
ALDRN	<0.083	<0.083
AS	<2.500	<2.500
BTZ	<1.140	<1.140
C6H6	10.300	<1.920
CA	.	.
CCL4	<1.690	<1.690
CD	.	.
CH2CL2	.	<2.480
CHCL3	<1.880	<1.880
CL	57800.000	59600.000
CL6CP	<0.083	<0.083
CLC6H5	42.400	4.980
CLDAN	<0.152	<0.152
CPMS	<1.080	<1.080
CPMSO	<1.980	<1.980
CPMSO2	<2.230	<2.240
CR	.	.
CU	.	.
DBCP	0.207	<0.130
DCPD	<9.310	<9.310
DIMP	.	<10.100
DITH	<3.340	<3.340
DLDRN	<0.054	<0.054
DMDS	<1.160	<1.160
DMMP	.	<16.300
ENDRN	<0.060	<0.060
ETC6H5	<0.620	<0.620
FL	2350.000	2530.000
HG	.	.
ISODR	<0.056	<0.056
K	.	.
MEC6H5	<2.100	<2.100
MG	.	.
MIBK	<12.900	<12.900
MXYLEN	<1.040	<1.040
NA	.	.
NIT	.	.
OXAT	<1.350	<1.350
PB	.	.
PPDDE	<0.046	<0.046
PPDDT	<0.059	<0.059
SO4	370000.000	345000.000
T12DCE	<1.750	<1.750
TCLEE	<2.760	<2.760
TRCLE	2.830	<1.310
XYLEN	<1.340	<1.340
ZN	.	.

TASK 39 WATER CHEMISTRY SUMMARY
SOURCE, ESE 1988

WELL #	AQUIFER	SCREENED INTERVAL	CASING DIAMETER	BEDROCK DEPTH	BEDROCK LITHOLOGY	WQAQ	DENVER SAND
37373	ALL	4.3- 25.7	0.0	0.0		1	

COMPOUND	3RD QUARTER FY87	4TH QUARTER FY87
111TCE	<1.090	<1.090
112TCE	<1.630	<1.630
11DCE	<1.850	<1.850
11DCLE	<1.930	<1.930
12DCLE	18.200	5.170
ALDRN	<0.083	<0.083
AS	3.650	<2.500
BTZ	<1.140	<1.140
C6H6	<1.920	<1.920
CA	329000.000	167000.000
CCL4	<1.690	<1.690
CD	<5.160	<5.160
CH2CL2	<2.480	<2.480
CHCL3	<1.880	<1.880
CL	744000.000	271000.000
CL6CP	<0.083	<0.083
CLC6H5	3.560	<1.360
CLDAN	<0.152	<0.152
CPMS	<1.080	<1.080
CPMSO	4.090	2.220
CPMSO2	16.100	15.100
CR	<5.960	21.000
CU	<7.940	<7.940
DBCP	<0.130	<0.130
DCPD	430.000	210.000
DIMP	.	2220.000
DITH	19.300	5.290
DLDRN	<0.054	<0.054
DMDS	<1.160	<1.160
DMMP	.	<163.000
ENDRN	<0.060	<0.060
ETC6H5	<0.620	<0.620
FL	2620.000	1520.000
HG	.	<0.500
ISODR	<0.056	<0.056
K	.	2860.000
MEC6H5	<2.100	<2.100
MG	108000.000	50500.000
MIBK	<12.900	<12.900
MXYLEN	<1.040	<1.040
NA	589000.000	307000.000
NIT	59.600	57.100
OXAT	5.100	1.760
PB	<18.600	<18.600
PPDDE	0.113	<0.046
PPDDT	0.110	<0.059
SO4	921000.000	467000.000
T12DCE	<1.750	<1.750
TCLEE	15.700	6.340
TRCLE	3.570	<1.310
XYLEN	<1.340	<1.340
ZN	29.800	24.900

TASK 39 WATER CHEMISTRY SUMMARY
SOURCE, ESE 1988

WELL #	AQUIFER	SCREENED INTERVAL	CASING DIAMETER	BEDROCK DEPTH	BEDROCK LITHOLOGY	WQAQ	DENVER SAND
37374	ALL	8.7- 24.9	4.0	0.0		1	

COMPOUND	3RD QUARTER FY87	4TH QUARTER FY87
111TCE	<1.090	<1.090
112TCE	<1.630	<1.630
11DCE	<1.850	<1.850
11DCLE	<1.930	<1.930
12DCLE	<2.070	<2.070
ALDRN	<0.083	<0.083
AS	2.790	2.660
BTZ	<1.140	<1.140
C6H6	2.680	3.320
CA	557000.000	527000.000
CCL4	<1.690	<1.690
CD	<5.160	5.460
CH2CL2	<2.480	<2.480
CHCL3	2.930	3.020
CL	386000.000	716000.000
CL6CP	<0.083	<0.083
CLC6H5	13.300	21.900
CLDAN	<0.152	<0.152
CPMS	<1.080	<1.080
CPMSO	<1.980	<1.980
CPMSO2	<2.240	<2.240
CR	<5.960	45.700
CU	<7.940	<7.940
DBCP	<0.130	<0.130
DCPD	<9.310	<9.310
DIMP	445.000	472.000
DITH	<3.340	<3.340
DLDRN	<0.054	<0.054
DMDS	<1.160	<1.160
DMMP	<15.200	<163.000
ENDRN	<0.060	<0.060
ETC6H5	<0.620	<0.620
FL	4170.000	<10000.000
HG	.	<0.500
ISODR	<0.056	<0.056
K	.	1110.000
MEC6H5	<2.100	<2.100
MG	160000.000	143000.000
MIBK	<12.900	<12.900
MXYLEN	<1.040	<1.040
NA	754000.000	624000.000
NIT	938.000	1150.000
OXAT	<1.350	<1.350
PB	<18.600	24.000
PPDDE	<0.046	<0.046
PPDDT	<0.059	<0.059
SO4	2140000.000	2020000.000
T12DCE	<1.750	<1.750
TCLEE	<2.760	<2.760
TRCLE	<1.310	<1.310
XYLEN	<1.340	<1.340
ZN	<20.100	28.900

TASK 39 WATER CHEMISTRY SUMMARY
SOURCE, ESE 1988

WELL #	AQUIFER	SCREENED INTERVAL	CASING DIAMETER	BEDROCK DEPTH	BEDROCK LITHOLOGY	WQAQ	DENVER SAND
37376	DEN	40.3- 51.0	4.0	0.0		5	3

COMPOUND	3RD QUARTER FY87	4TH QUARTER FY87
111TCE	<1.090	<1.090
112TCE	<1.630	<1.630
11DCE	<1.850	<1.850
11DCLE	<1.930	<1.930
12DCLE	<2.070	<2.070
ALDRN	<0.083	<0.083
AS	<2.500	<2.500
BTZ	<1.140	<1.140
C6H6	3.640	<1.920
CA	.	.
CCL4	<1.690	<1.690
CD	.	.
CH2CL2	<2.480	<2.480
CHCL3	<1.880	<1.880
CL	14800.000	15200.000
CL6CP	<0.083	<0.083
CLC6H5	33.000	<1.360
CLDAN	<0.152	<0.152
CPMS	<1.080	<1.080
CPMSO	<1.980	<1.980
CPMSO2	<2.240	<2.240
CR	.	.
CU	.	.
DBCP	<0.130	<0.130
DCPD	<9.310	<9.310
DIMP	<10.500	<10.100
DITH	<3.340	<3.340
DLDRN	<0.054	<0.054
DMDS	<1.160	<1.160
DMMP	<15.200	<16.300
ENDRN	<0.060	<0.060
ETC6H5	<0.620	<0.620
FL	<1000.000	<1000.000
HG	.	.
ISODR	<0.056	<0.056
K	.	.
MEC6H5	<2.100	<2.100
MG	.	.
MIBK	<12.900	<12.900
MXYLEN	<1.040	<1.040
NA	.	.
NIT	.	.
OXAT	<1.350	<1.350
PB	.	.
PPDDE	<0.046	<0.046
PPDDT	<0.059	<0.059
SO4	192000.000	210000.000
T12DCE	<1.750	<1.750
TCLEE	<2.760	<2.760
TRCLE	1.380	<1.310
XYLEN	<1.340	<1.340
ZN	.	.

TASK 39 WATER CHEMISTRY SUMMARY
SOURCE, ESE 1988

WELL #	AQUIFER	SCREENED INTERVAL	CASING DIAMETER	BEDROCK DEPTH	BEDROCK LITHOLOGY	WQAQ	DENVER SAND
37377	ALL	22.7- 38.9	4.0	0.0		1	

COMPOUND	3RD QUARTER FY87	4TH QUARTER FY87
111TCE	<1.090	<1.090
112TCE	<1.630	<1.630
11DCE	<1.850	<1.850
11DCLE	<1.930	<1.930
12DCLE	<2.070	<2.070
ALDRN	<0.083	<0.083
AS	<2.500	<2.500
BTZ	<1.140	<1.140
C6H6	5.800	<1.920
CA	151000.000	135000.000
CCL4	<1.690	<1.690
CD	<5.160	<5.160
CH2CL2	<2.480	<2.480
CHCL3	2.250	<1.880
CL	165000.000	161000.000
CL6CP	<0.083	<0.083
CLC6H5	22.700	3.470
CLDAN	<0.152	<0.152
CPMS	<1.080	<1.080
CPMSO	3.070	2.540
CPMSO2	<2.240	<2.240
CR	<5.960	6.460
CU	<7.940	<7.940
DBCP	<0.130	<0.130
DCPD	<9.310	<9.310
DIMP	63.100	57.400
DITH	<3.340	<3.340
DLDRN	<0.054	<0.054
DMDS	<1.160	<1.160
DMMP	<15.200	<16.300
ENDRN	<0.060	<0.060
ETC6H5	<0.620	<0.620
FL	2340.000	1850.000
HG	.	<0.500
ISODR	<0.056	<0.056
K	.	2810.000
MEC6H5	<2.100	<2.100
MG	56900.000	50600.000
MIBK	<12.900	<12.900
MXYLEN	<1.040	<1.040
NA	229000.000	208000.000
NIT	697.000	.
OXAT	<1.350	<1.350
PB	<18.600	19.800
PPDDE	<0.046	<0.046
PPDDT	<0.059	<0.059
SO4	506000.000	477000.000
T12DCE	<1.750	<1.750
TCLEE	<2.760	<2.760
TRCLE	1.710	<1.310
XYLEN	<1.340	<1.340
ZN	29.400	45.600

TASK 39 WATER CHEMISTRY SUMMARY
SOURCE, ESE 1988

WELL #	AQUIFER	SCREENED INTERVAL	CASING DIAMETER	BEDROCK DEPTH	BEDROCK LITHOLOGY	WQAQ	DENVER SAND
37378	ALL	23.8- 34.7	4.0	0.0		1	

COMPOUND	3RD QUARTER FY87	4TH QUARTER FY87
111TCE	<1.090	<1.090
112TCE	<1.630	<1.630
11DCE	<1.850	<1.850
11DCLE	<1.930	<1.930
12DCLE	<2.070	<2.070
ALDRN	<0.083	<0.083
AS	2.680	<2.500
BTZ	<1.140	<1.140
C6H6	3.140	<1.920
CA	113000.000	117000.000
CCL4	<1.690	<1.690
CD	<5.160	<5.160
CH2CL2	<2.480	<2.480
CHCL3	<1.880	<1.880
CL	104000.000	89700.000
CL6CP	<0.083	<0.083
CLC6H5	12.600	11.100
CLDAN	<0.152	<0.152
CPMS	<1.080	<1.080
CPMSO	<1.980	<1.980
CPMSO2	<2.240	<2.240
CR	<5.960	15.000
CU	<7.940	<7.940
DBCP	<0.130	<0.130
DCPD	<9.310	<9.310
DIMP	<10.500	11.600
DITH	<3.340	<3.340
DLDRN	0.073	0.080
DMDS	<1.160	<1.160
DMMP	<15.200	<16.300
ENDRN	<0.060	<0.060
ETC6H5	<0.620	<0.620
FL	1360.000	1680.000
HG	.	<0.500
ISODR	<0.056	<0.056
K	.	2040.000
MEC6H5	<2.100	<2.100
MG	36800.000	36300.000
MIBK	<12.900	<12.900
MXYLEN	<1.040	<1.040
NA	173000.000	164000.000
NIT	1350.000	1250.000
OXAT	<1.350	<1.350
PB	<18.600	<18.600
PPDDE	<0.046	<0.046
PPDDT	<0.059	<0.059
SO4	327000.000	327000.000
T12DCE	<1.750	<1.750
TCLEE	<2.760	<2.760
TRCLE	<1.310	<1.310
XYLEN	<1.340	<1.340
ZN	<20.100	<20.100

TASK 39 WATER CHEMISTRY SUMMARY
SOURCE, ESE 1988

WELL #	AQUIFER	SCREENED INTERVAL	CASING DIAMETER	BEDROCK DEPTH	BEDROCK LITHOLOGY	WQAQ	DENVER SAND
37379	DEN	39.3- 55.5	4.0	0.0		5	3

COMPOUND	3RD QUARTER FY87	4TH QUARTER FY87
111TCE	<1.090	<1.090
112TCE	<1.630	<1.630
11DCE	<1.850	<1.850
11DCLE	<1.930	<1.930
12DCLE	<2.070	<2.070
ALDRN	<0.083	<0.083
AS	<2.500	<2.500
BTZ	<1.140	<1.140
C6H6	5.760	<1.920
CA	272000.000	251000.000
CCL4	<1.690	<1.690
CD	<5.160	<5.160
CH2CL2	<2.480	<2.480
CHCL3	<1.880	<1.880
CL	418000.000	427000.000
CL6CP	<0.083	<0.083
CLC6H5	17.800	<1.360
CLDAN	<0.152	<0.152
CPMS	<1.080	<1.080
CPMSO	<1.980	<1.980
CPMSO2	<2.240	<2.240
CR	<5.960	25.400
CU	<7.940	<7.940
DBCP	<0.130	<0.130
DCPD	<9.310	<9.310
DIMP	47.100	53.700
DITH	<3.340	<3.340
DLDRN	<0.054	<0.054
DMDS	<1.160	<1.160
DMMP	<15.200	<16.300
ENDRN	<0.060	<0.060
ETC6H5	<0.620	<0.620
FL	3000.000	2760.000
HG	.	<0.500
ISODR	<0.056	<0.056
K	.	2330.000
MEC6H5	<2.100	<2.100
MG	41900.000	45100.000
MIBK	<12.900	<12.900
MXYLEN	<1.040	<1.040
NA	729000.000	577000.000
NIT	2070.000	1940.000
OXAT	<1.350	<1.350
PB	<18.600	<18.600
PPDDE	<0.046	<0.046
PPDDT	<0.059	<0.059
SO4	1450000.000	1600000.000
T12DCE	<1.750	<1.750
TCLEE	<2.760	<2.760
TRCLE	1.370	<1.310
XYLEN	<1.340	<1.340
ZN	210.000	37.900

TASK 39 WATER CHEMISTRY SUMMARY
SOURCE, ESE 1988

WELL #	AQUIFER	SCREENED INTERVAL	CASING DIAMETER	BEDROCK DEPTH	BEDROCK LITHOLOGY	WQAQ	DENVER SAND
37380	DEN	64.3- 75.0	4.0	0.0		5	4

COMPOUND	3RD QUARTER FY87	4TH QUARTER FY87
111TCE	<1.090	<1.090
112TCE	<1.630	<1.630
11DCE	<1.850	<1.850
11DCLE	<1.930	<1.930
12DCLE	<2.070	<2.070
ALDRN	<0.083	<0.083
AS	<2.500	<2.500
BTZ	<1.140	<1.140
C6H6	3.650	<1.920
CA	.	133000.000
CCL4	<1.690	<1.690
CD	.	<5.160
CH2CL2	<2.480	<2.480
CHCL3	<1.880	<1.880
CL	412000.000	384000.000
CL6CP	<0.083	<0.083
CLC6H5	15.400	<1.360
CLDAN	<0.152	<0.152
CPMS	<1.080	<1.080
CPMSO	<1.980	<1.980
CPMSO2	<2.240	<2.240
CR	.	12.000
CU	.	<7.940
DBCP	0.191	<0.130
DCPD	<9.310	<9.310
DIMP	<10.500	<10.100
DITH	<3.340	<3.340
DLDRN	<0.054	<0.054
DMDS	<1.160	<1.160
DMMP	<15.200	<16.300
ENDRN	<0.060	<0.060
ETC6H5	<0.620	<0.620
FL	2100.000	2680.000
HG	<0.359	<0.500
ISODR	<0.056	<0.056
K	5580.000	3210.000
MEC6H5	<2.100	<2.100
MG	.	6580.000
MIBK	<12.900	<12.900
MXYLEN	<1.040	<1.040
NA	.	589000.000
NIT	.	147.000
OXAT	<1.350	<1.350
PB	.	<18.600
PPDDE	<0.046	<0.046
PPDDT	<0.059	<0.059
SO4	1100000.000	1120000.000
T12DCE	<1.750	<1.750
TCLEE	<2.760	<2.760
TRCLE	<1.310	<1.310
XYLEN	<1.340	<1.340
ZN	.	<20.100

TASK 39 WATER CHEMISTRY SUMMARY
SOURCE, ESE 1988

WELL #	AQUIFER	SCREENED INTERVAL	CASING DIAMETER	BEDROCK DEPTH	BEDROCK LITHOLOGY	WQAQ	DENVER SAND
37381	ALL	7.3- 28.5	4.0	0.0		1	

COMPOUND	3RD QUARTER FY87	4TH QUARTER FY87
111TCE	<1.090	<1.090
112TCE	<1.630	<1.630
11DCE	<1.850	<1.850
11DCLE	<1.930	<1.930
12DCLE	<2.070	5.280
ALDRN	<0.083	<0.083
AS	<2.500	<2.500
BTZ	<1.140	<1.140
C6H6	<1.920	<1.920
CA	600000.000	162000.000
CCL4	<1.690	<1.690
CD	8.580	<5.160
CH2CL2	<2.480	<2.480
CHCL3	<1.880	<1.880
CL	1060000.000	283000.000
CL6CP	<0.083	<0.083
CLC6H5	2.680	8.310
CLDAN	<0.152	<0.152
CPMS	<1.080	<1.080
CPMSO	3.640	2.420
CPMSO2	<2.240	13.900
CR	52.400	20.200
CU	<7.940	<7.940
DBCP	<0.130	<0.130
DCPD	<9.310	236.000
DIMP	.	2410.000
DITH	<3.340	5.320
DLDRN	<0.054	<0.054
DMDS	<1.160	<1.160
DMMP	.	<163.000
ENDRN	<0.060	<0.060
ETC6H5	<0.620	<0.620
FL	3650.000	2650.000
HG	.	<0.500
ISODR	<0.056	<0.056
K	.	2810.000
MEC6H5	<2.100	<2.100
MG	148000.000	49100.000
MIBK	<12.900	<12.900
MXYLEN	<1.040	<1.040
NA	504000.000	326000.000
NIT	.	<10.000
OXAT	<1.350	1.830
PB	<18.600	<18.600
PPDDE	<0.046	<0.046
PPDDT	<0.059	<0.059
SO4	1420000.000	503000.000
T12DCE	<1.750	<1.750
TCLEE	<2.760	7.100
TRCLE	<1.310	<1.310
XYLEN	<1.340	<1.340
ZN	40.900	<20.100

TASK 39 WATER CHEMISTRY SUMMARY
SOURCE, ESE 1988

WELL #	AQUIFER	SCREENED INTERVAL	CASING DIAMETER	BEDROCK DEPTH	BEDROCK LITHOLOGY	WQAQ	DENVER SAND
37382	DEN	33.6- 50.0	4.0	0.0		3	3

COMPOUND	3RD QUARTER FY87	4TH QUARTER FY87
111TCE	.	<1.090
112TCE	.	<1.630
11DCE	.	<1.850
11DCLE	.	<1.930
12DCLE	.	<2.070
ALDRN	.	<0.083
AS	.	<2.500
BTZ	.	<1.140
C6H6	.	<1.920
CA	.	.
CCL4	.	<1.690
CD	.	.
CH2CL2	.	<2.480
CHCL3	.	16.600
CL	.	281000.000
CL6CP	.	<0.083
CLC6H5	.	1.870
CLDAN	.	<0.152
CPMS	.	<1.080
CPMSO	.	<1.980
CPMSO2	.	<2.240
CR	.	.
CU	.	.
DBCP	.	<0.130
DCPD	.	<9.310
DIMP	.	<10.100
DITH	.	<1.590
DLDRN	.	0.273
DMDS	.	<1.160
DMMP	.	<16.300
ENDRN	.	<0.060
ETC6H5	.	<0.620
FL	.	2340.000
HG	.	.
ISODR	.	<0.056
K	.	.
MEC6H5	.	<2.100
MG	.	.
MIBK	.	<12.900
MXYLEN	.	<1.040
NA	.	.
NIT	.	.
OXAT	.	<1.350
PB	.	.
PPDDE	.	<0.046
PPDDT	.	<0.059
SO4	.	180000.000
T12DCE	.	<1.750
TCLEE	.	<2.760
TRCLE	.	<1.310
XYLEN	.	<1.340
ZN	.	.

TASK 39 WATER CHEMISTRY SUMMARY
SOURCE, ESE 1988

WELL #	AQUIFER	SCREENED INTERVAL	CASING DIAMETER	BEDROCK DEPTH	BEDROCK LITHOLOGY	WQAQ	DENVER SAND
37383	ALL	17.6- 39.0	4.0	0.0		1	

COMPOUND	3RD QUARTER FY87	4TH QUARTER FY87
111TCE	<1.090	<1.090
112TCE	<1.630	<1.630
11DCE	<1.850	<1.850
11DCLE	<1.930	<1.930
12DCLE	<2.070	<2.070
ALDRN	<0.083	<0.083
AS	<2.500	<2.500
BTZ	<1.140	<1.140
C6H6	3.170	<1.920
CA	162000.000	154000.000
CCL4	<1.690	<1.690
CD	<5.160	<5.160
CH2CL2	<2.480	<2.480
CHCL3	<1.880	<1.880
CL	131000.000	112000.000
CL6CP	<0.083	<0.083
CLC6H5	11.400	<1.360
CLDAN	<0.152	<0.152
CPMS	<1.080	<1.080
CPMSO	<1.980	<1.980
CPMSO2	<2.240	<2.240
CR	<5.960	17.200
CU	<7.940	<7.940
DBCP	<0.130	<0.130
DCPD	<9.310	<9.310
DIMP	51.300	61.900
DITH	<3.340	<3.340
DLDRN	<0.054	<0.054
DMDS	<1.160	<1.160
DMMP	<15.200	<16.300
ENDRN	<0.060	<0.060
ETC6H5	<0.620	<0.620
FL	1580.000	939.000
HG	.	<0.500
ISODR	<0.056	<0.056
K	.	2960.000
MEC6H5	<2.100	<2.100
MG	49900.000	45000.000
MIBK	<12.900	<12.900
MXYLEN	<1.040	<1.040
NA	233000.000	218000.000
NIT	2280.000	2170.000
OXAT	<1.350	<1.350
PB	<18.600	<18.600
PPDDE	<0.046	<0.046
PPDDT	<0.059	<0.059
SO4	570000.000	505000.000
T12DCE	<1.750	<1.750
TCLEE	<2.760	<2.760
TRCLE	<1.310	<1.310
XYLEN	<1.340	<1.340
ZN	<20.100	66.900

TASK 39 WATER CHEMISTRY SUMMARY
SOURCE, ESE 1988

WELL #	AQUIFER	SCREENED INTERVAL	CASING DIAMETER	BEDROCK DEPTH	BEDROCK LITHOLOGY	WQAQ	DENVER SAND
37385	ALL	29.9-51.5	4.0	51.0	SH	1	

COMPOUND	3RD QUARTER FY87	4TH QUARTER FY87	2ND QUARTER FY88
111TCE	.	.	<1.090
112TCE	.	.	<1.630
11DCE	.	.	<1.850
11DCLE	.	.	<1.930
12DCLE	.	.	<2.070
ALDRN	.	.	<0.083
AS	.	.	<2.500
BTZ	.	.	.
C6H6	.	.	0.860
CA	.	.	.
CCL4	.	.	<1.690
CD	.	.	.
CH2CL2	.	.	17.500
CHCL3	.	.	<2.480
CL	.	.	352000.000
CL6CP	.	.	<0.083
CLC6H5	.	.	7.360
CLDAN	.	.	<0.152
CPMS	.	.	.
CPMSO	.	.	.
CPMSO2	.	.	.
CR	.	.	.
CU	.	.	.
DBCP	.	.	<0.130
DCPD	.	.	.
DIMP	.	.	<10.100
DITH	.	.	.
DLDRN	.	.	<0.054
DMDS	.	.	.
DMMP	.	.	<16.300
ENDRN	.	.	<0.060
ETC6H5	.	.	0.0090
FL	.	.	1340.000
HG	.	.	.
ISODR	.	.	<0.056
K	.	.	.
MEC6H5	.	.	.
MG	.	.	.
MIBK	.	.	.
MXYLEN	.	.	0.0230
NA	.	.	.
NIT	.	.	.
OXAT	.	.	.
PB	.	.	.
PPDDE	.	.	<0.046
PPDDT	.	.	<0.059
SO4	.	.	167000.000
T12DCE	.	.	<1.800
TCLEE	.	.	<2.800
TRCLE	.	.	<1.300
XYLEN	.	.	0.1890
ZN	.	.	.

TASK 39 WATER CHEMISTRY SUMMARY
SOURCE, ESE 1988

WELL #	AQUIFER	SCREENED INTERVAL	CASING DIAMETER	BEDROCK DEPTH	BEDROCK LITHOLOGY	WQAQ	DENVER SAND
37386	ALL	39.5- 50.4	4.0	0.0		1	

COMPOUND	3RD QUARTER FY87	4TH QUARTER FY87
111TCE	.	<1.090
112TCE	.	<1.630
11DCE	.	<1.850
11DCLE	.	<1.930
12DCLE	.	<2.070
ALDRN	.	<0.083
AS	.	4.380
BTZ	.	<1.140
C6H6	.	3.980
CA	.	.
CCL4	.	<1.690
CD	.	.
CH2CL2	.	<2.480
CHCL3	.	10.500
CL	.	502000.000
CL6CP	.	<0.083
CLC6H5	.	6.990
CLDAN	.	<0.152
CPMS	.	<1.080
CPMSO	.	<1.980
CPMSO2	.	<2.240
CR	.	.
CU	.	.
DBCP	.	<0.130
DCPD	.	<9.310
DIMP	.	12.000
DITH	.	<1.590
DLDRN	.	0.472
DMDS	.	<1.160
DMMP	.	<16.300
ENDRN	.	0.067
ETC6H5	.	<0.620
FL	.	3570.000
HG	.	.
ISODR	.	<0.056
K	.	.
MEC6H5	.	<2.100
MG	.	.
MIBK	.	<12.900
MXYLEN	.	<1.040
NA	.	.
NIT	.	.
OXAT	.	<1.350
PB	.	.
PPDDE	.	<0.046
PPDDT	.	<0.059
SO4	.	300000.000
T12DCE	.	<1.750
TCLEE	.	<2.760
TRCLE	.	<1.310
XYLEN	.	<1.340
ZN	.	.

TASK 39 WATER CHEMISTRY SUMMARY
SOURCE, ESE 1988

WELL #	AQUIFER	SCREENED INTERVAL	CASING DIAMETER	BEDROCK DEPTH	BEDROCK LITHOLOGY	WQAQ	DENVER SAND
37387	DEN	36.8- 42.6	4.0	0.0		5	2

COMPOUND	3RD QUARTER FY87	4TH QUARTER FY87
111TCE	<1.090	<1.090
112TCE	<1.630	<1.630
11DCE	<1.850	<1.850
11DCLE	<1.930	<1.930
12DCLE	<2.070	<2.070
ALDRN	<0.083	<0.083
AS	<2.500	<2.500
BTZ	<1.140	<1.140
C6H6	73.800	<1.920
CA	206000.000	206000.000
CCL4	<1.690	<1.690
CD	<5.160	<5.160
CH2CL2	<2.480	<2.480
CHCL3	8.620	<1.880
CL	303000.000	287000.000
CL6CP	<0.083	<0.083
CLC6H5	74.700	<1.360
CLDAN	<0.152	<0.152
CPMS	<1.080	<1.080
CPMSO	<1.980	<1.980
CPMSO2	<2.240	<2.240
CR	8.140	8.140
CU	<7.940	<7.940
DBCP	0.779	<0.130
DCPD	<9.310	<9.310
DIMP	<10.500	<10.100
DITH	<3.340	<3.340
DLDRN	<0.054	<0.054
DMDS	<1.160	<1.160
DMMP	<15.200	<16.300
ENDRN	<0.060	<0.060
ETC6H5	1.320	<0.620
FL	3220.000	4820.000
HG	.	.
ISODR	<0.056	<0.056
K	.	.
MEC6H5	<2.100	<2.100
MG	35600.000	35600.000
MIBK	<12.900	<12.900
MXYLEN	1.370	<1.040
NA	1170000.000	1170000.000
NIT	17200.000	17200.000
OXAT	<1.350	<1.350
PB	<18.600	<18.600
PPDDE	<0.046	<0.046
PPDDT	<0.059	<0.059
SO4	2350000.000	2260000.000
T12DCE	<1.750	<1.750
TCLEE	<2.760	<2.760
TRCLE	8.680	<1.310
XYLEN	3.600	<1.340
ZN	<20.100	<20.100

TASK 39 WATER CHEMISTRY SUMMARY
SOURCE, ESE 1988

WELL #	AQUIFER	SCREENED INTERVAL	CASING DIAMETER	BEDROCK DEPTH	BEDROCK LITHOLOGY	WQAQ	DENVER SAND
37388	DEN	69.8- 86.0	4.0	0.0		5	4

COMPOUND	3RD QUARTER FY87	4TH QUARTER FY87
111TCE	<1.090	<1.090
112TCE	<1.630	<1.630
11DCE	<1.850	<1.850
11DCLE	<1.930	<1.930
12DCLE	<2.070	<2.070
ALDRN	<0.083	<0.083
AS	<2.500	<2.500
BTZ	<1.140	<1.140
C6H6	10.100	<1.920
CA	.	.
CCL4	<1.690	<1.690
CD	.	.
CH2CL2	<2.480	<2.480
CHCL3	<1.880	<1.880
CL	403000.000	383000.000
CL6CP	<0.083	<0.083
CLC6H5	32.800	2.070
CLDAN	<0.152	<0.152
CPMS	<1.080	<1.080
CPMSO	<1.980	<1.980
CPMSO2	<2.230	<2.240
CR	.	.
CU	.	.
DBCP	<0.130	<0.130
DCPD	<9.310	<9.310
DIMP	<10.500	<10.100
DITH	<3.340	<3.340
DLDRN	<0.054	<0.054
DMDS	<1.160	<1.160
DMMP	<15.200	<16.300
ENDRN	<0.060	<0.060
ETC6H5	<0.620	<0.620
FL	2650.000	3700.000
HG	.	.
ISODR	<0.056	<0.056
K	.	.
MEC6H5	<2.100	<2.100
MG	.	.
MIBK	<12.900	<12.900
MXYLEN	<1.040	<1.040
NA	.	.
NIT	.	.
OXAT	<1.350	<1.350
PB	.	.
PPDDE	<0.046	<0.046
PPDDT	<0.059	<0.059
SO4	1580000.000	1480000.000
T12DCE	<1.750	<1.750
TCLEE	<2.760	<2.760
TRCLE	1.830	<1.310
XYLEN	<1.340	<1.340
ZN	.	.

TASK 39 WATER CHEMISTRY SUMMARY
SOURCE, ESE 1988

WELL #	AQUIFER	SCREENED INTERVAL	CASING DIAMETER	BEDROCK DEPTH	BEDROCK LITHOLOGY	WQAQ	DENVER SAND
37389	A/D	8.4- 35.2	4.0	0.0		3	

COMPOUND	3RD QUARTER FY87	4TH QUARTER FY87
111TCE	<1.090	<1.090
112TCE	<1.630	<1.630
11DCE	<1.850	<1.850
11DCLE	<1.930	<1.930
12DCLE	<2.070	<2.070
ALDRN	<0.083	<0.083
AS	<2.500	<2.500
BTZ	<1.140	<1.140
C6H6	<1.920	<1.920
CA	141000.000	141000.000
CCL4	<1.690	<1.690
CD	<5.160	<5.160
CH2CL2	<2.480	<2.480
CHCL3	56.500	23.700
CL	217000.000	204000.000
CL6CP	<0.083	<0.083
CLC6H5	2.740	1.720
CLDAN	<0.152	<0.152
CPMS	<1.080	<1.080
CPMSO	9.520	13.700
CPMSO2	5.490	8.860
CR	<5.960	<5.960
CU	<7.940	<7.940
DBCP	0.400	0.560
DCPD	<9.310	<9.310
DIMP	343.000	912.000
DITH	<3.340	<3.340
DLDRN	<0.054	<0.054
DMDS	<1.160	<1.160
DMMP	<15.200	<163.000
ENDRN	<0.060	0.411
ETC6H5	<0.620	<0.620
FL	2190.000	2810.000
HG	.	.
ISODR	<0.056	<0.056
K	.	.
MEC6H5	<2.100	<2.100
MG	53800.000	53800.000
MIBK	<12.900	<12.900
MXYLEN	<1.040	<1.040
NA	219000.000	219000.000
NIT	163.000	163.000
OXAT	<1.350	<1.350
PB	<18.600	<18.600
PPDDE	<0.046	<0.046
PPDDT	<0.059	<0.059
SO4	405000.000	412000.000
T12DCE	<1.750	<1.750
TCLEE	28.500	28.100
TRCLE	<1.310	<1.310
XYLEN	<1.340	<1.340
ZN	21.200	21.200

RMA SURFACE WATER

STORET CODE:				98552	81512	81580	98560	98561	98562	98563	98564	34010	34030	34371	98553	98554	98555
METHOD CODE:				T8	U8	U8	U8	U8	U8	U8	U8	W8	W8	W8	W8	W8	X8
PARAMETER:				DMMP	BTZ	DMDS	CPMSO2	CPMSO	CPMS	1,4-DITH	1,4-OXAT	TOLUEN	BENZENE	ETHYLBENZ	M-XYL	O&P-XYL	CL
UNITS:				UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L
FLD.GRP.	#	SAMPLE ID	DATE TIME														
OFQ1W	72	01CDD	12/14/85 09:15	<15.2			<4.70	<4.20	<1.30	<1.10	<2.00	<1.21	<1.34		<1.35	<2.47	146000
OPSW	1	01CDD	04/07/86 09:30	<15.2			<4.70	<4.20	<11.7	<11.3	<20.0	<1.21	<1.34	<1.28	<1.35	<2.47	55400
OPSW2	1	01CDD	06/12/86 13:30	<15.2		<1.80	<4.70	<4.20	<1.30	<1.10	<2.00	<1.21	<1.34	<1.28	<1.35	<2.47	62000
OPS3	1	01CDD	09/04/86 09:20	<15.2		<1.80	<4.70	<4.20	<1.30	<1.10	<2.00	<1.21	<1.34	<1.28	<1.35	<2.47	72900
T440S1	1	01CDD	12/16/86 12:50	<15.2	<2.00	<1.80	<4.70	<4.20	<1.30	<1.10	<2.00	<1.21	<1.34	<1.28	<1.35	<2.47	105000
T440S2	1	01CDD	03/26/87 13:30	<15.2	<2.00	<1.80	<4.70	<4.20	<1.30	<1.10	<2.00	<1.21	14.6	<1.28	<1.35	<2.47	109000
T440S3	1	01CDD	06/16/87 11:04	<15.2	<2.00	<1.80	<4.70	<4.20	<1.30	<1.10	<2.00	<1.21	<1.34	<1.28	<1.35	<2.47	53000
T440S4	1	01CDD	10/16/87 10:41	<15.2	<2.00	<1.80	<4.70	<4.20	<1.30	<1.10	<2.00	<1.21	<1.34	<1.28	<1.35	<2.47	91000
OPSW	2	01DCC	04/07/86 08:30	<15.2			<4.70	<4.20	<11.7	<11.3	<20.0	<1.21	<1.34	<1.28	<1.35	<2.47	55200
OPSW2	2	01DCC	06/12/86 13:00	<15.2		<1.80	<4.70	<4.20	<1.30	<1.10	<2.00	<1.21	<1.34	<1.28	<1.35	<2.47	39700
OPS3	2	01DCC	09/04/86 08:50	<15.2		<1.80	<4.70	<4.20	<1.30	<1.10	<2.00	<1.21	<1.34	<1.28	<1.35	<2.47	50900
T440S1	2	01DCC	12/16/86 12:20	<15.2	<2.00	<1.80	<4.70	<4.20	<1.30	<1.10	<2.00	<1.21	<1.34	<1.28	<1.35	<2.47	93300
T440S2	2	01DCC	03/26/87 12:30	<15.2	<2.00	<1.80	<4.70	<4.20	<1.30	<1.10	<2.00	<1.21	<1.34	<1.28	<1.35	<2.47	61600
T440S3	2	01DCC	06/16/87 10:30	<15.2	<2.00	<1.80	<4.70	<4.20	<1.30	<1.10	<2.00	<1.21	<1.34	<1.28	<1.35	<2.47	22600
T440S4	2	01DCC	10/16/87 09:45	<15.2	<2.00	<1.80	<4.70	<4.20	<1.30	<1.10	<2.00	<1.21	<1.34	<1.28	<1.35	<2.47	56200
OPSW	6	06CBB	04/07/86 14:30	<15.2			<4.70	<4.20	<11.7	<11.3	<20.0	<1.21	<1.34	<1.28	<1.35	<2.47	56300
OPSW2	6	06CBB	06/16/86 14:00	<15.2		<1.80	<4.70	<4.20	<1.30	<1.10	<2.00	<1.21	<1.34	<1.28	<1.35	<2.47	40800
OPS3	6	06CBB	09/04/86 11:50	<15.2		<1.80	<4.70	<4.20	<1.30	<1.10	<2.00	<1.21	<1.34	<1.28	<1.35	<2.47	50600
T440S3	6	06CBB	06/16/87 13:17	<15.2	<2.00	<1.80	<4.70	<4.20	<1.30	<1.10	<2.00	<1.21	<1.34	<1.28	<1.35	<2.47	26300
T440S4	6	06CBB	10/12/87 13:20	<15.2	<2.00	<1.80	<4.70	<4.20	<1.30	<1.10	<2.00	<1.21	<1.34	<1.28	<1.35	<2.47	83500
OFQ1W	44	07ABB	11/21/85 08:30	<15.2			NA	NA	NA	NA	NA	<1.21	<1.34		<1.35	<2.47	336000
OPSW	5	07ABB	04/02/86 16:45	<15.2			<4.70	<4.20	<11.7	<11.3	<20.0	<1.21	<1.34	<1.28	<1.35	<2.47	322000
OPSW2	5	07ABB	06/12/86 15:30	<15.2		<1.80	<4.70	<4.20	<1.30	<1.10	<2.00	<1.21	<1.34	<1.28	<1.35	<2.47	24900

RMA SURFACE WATER

STORET CODE:				98556	98581	32102	32106	34301	34423	34475	34496	34501	34506	34511	34531	34546	39180
METHOD CODE:				X8	X8	Y8	Y8	Y8	Y8	Y8	Y8	Y8	Y8	Y8	Y8	Y8	Y8
PARAMETER:				FL	SO4	CCL4	CHCL3	CLC6H5	METHYLCL	TCLEE	11DCLE	11DCE	111TCE	112TCE	12DCLE	T12DCE	TRCLE
UNITS:				UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L
FLD.GRP.	#	SAMPLE ID	DATE TIME														
OPQ1W	72	01CDD	12/14/85 09:15	1330		<2.40	<1.40	<0.580		<1.30						<1.20	<5.50
OPSW	1	01CDD	04/07/86 09:30	<1200	174000	<2.40	<1.40	<0.580	<5.00	<1.30	<1.20	<1.10	<1.70	<1.00	<0.610	<1.20	<1.10
OPSW2	1	01CDD	06/12/86 13:30	<1200	248000	<2.40	<1.40	<0.580	<5.00	<1.30	<1.20	<1.10	<1.70	<1.00	<0.610	<1.20	<1.10
OPS3	1	01CDD	09/04/86 09:20	<1200	206000	<2.40	<1.40	<0.580	<5.00	<1.30	<1.20	<1.10	<1.70	<1.00	<0.610	<1.20	<1.10
T440S1	1	01CDD	12/16/86 12:50	<1200	278000	<2.40	<1.40	<0.580	<5.00	7.34	<1.20	<1.10	<1.70	<1.00	<0.610	<1.20	<1.10
T440S2	1	01CDD	03/26/87 13:30	<1200	316000	<2.40	<1.40	<0.580	<5.00	2.77	<1.20	<1.10	<1.70	<1.00	<0.610	1.82	<1.10
T440S3	1	01CDD	06/16/87 11:04	<1220	136000	<2.40	<1.40	<0.580	<5.00	<1.30	<1.20	<1.10	<1.70	<1.00	<0.610	<1.20	<1.10
T440S4	1	01CDD	10/16/87 10:41	<1220	226000	<2.40	1.20	<0.580	<5.00	3.80	<1.20	<1.10	<1.70	<1.00	<0.610	<1.20	<1.10
OPSW	2	01DCC	04/07/86 08:30	<1200	101000	<2.40	<1.40	<0.580	<5.00	<1.30	<1.20	<1.10	<1.70	<1.00	<0.610	<1.20	<1.10
OPSW2	2	01DCC	06/12/86 13:00	<1200	104000	<2.40	<1.40	<0.580	<5.00	<1.30	<1.20	<1.10	<1.70	<1.00	<0.610	<1.20	<1.10
OPS3	2	01DCC	09/04/86 08:50	<1200	88100	<2.40	<1.40	<0.580	<5.00	<1.30	<1.20	<1.10	<1.70	<1.00	<0.610	<1.20	<1.10
T440S1	2	01DCC	12/16/86 12:20	<1200	181000	<2.40	<1.40	<0.580	<5.00	<1.30	<1.20	<1.10	<1.70	<1.00	<0.610	<1.20	<1.10
T440S2	2	01DCC	03/26/87 12:30	<1200	131000	<2.40	<1.40	<0.580	<5.00	<1.30	<1.20	<1.10	<1.70	<1.00	<0.610	<1.20	<1.10
T440S3	2	01DCC	06/16/87 10:30	<1220	39300	<2.40	<1.40	<0.580	<5.00	<1.30	<1.20	<1.10	<1.70	<1.00	<0.610	<1.20	<1.10
T440S4	2	01DCC	10/16/87 09:45	<1220	156000	<2.40	<1.40	<0.580	<5.00	<1.30	<1.20	<1.10	<1.70	<1.00	<0.610	<1.20	<1.10
OPSW	6	06CBB	04/07/86 14:30	<1200	126000	<2.40	<1.40	<0.580	<5.00	<1.30	<1.20	<1.10	<1.70	<1.00	<0.610	<1.20	<1.10
OPSW2	6	06CBB	06/16/86 14:00	<1200	99600	<2.40	<1.40	<0.580	<5.00	<1.30	<1.20	<1.10	<1.70	<1.00	<0.610	<1.20	<1.10
OPS3	6	06CBB	09/04/86 11:50	<1200	83600	<2.40	<1.40	<0.580	<5.00	<1.30	<1.20	<1.10	<1.70	<1.00	<0.610	<1.20	<1.10
T440S3	6	06CBB	06/16/87 13:17	<1220	43700	<2.40	<1.40	<0.580	<5.00	<1.30	<1.20	<1.10	<1.70	<1.00	<0.610	<1.20	<1.10
T440S4	6	06CBB	10/12/87 13:20	<1220	191000	<2.40	<1.40	<0.580	<5.00	<1.30	<1.20	<1.10	<1.70	<1.00	<0.610	<1.20	<1.10
OPQ1W	44	07ABB	11/21/85 08:30	2710		<2.40	<1.40	<0.580		<1.30						<1.20	<1.10
OPSW	5	07ABB	04/02/86 16:45	2700	2080000	<2.40	<1.40	<0.580	<5.00	<1.30	<1.20	<1.10	<1.70	<1.00	<0.610	<1.20	<1.10
OPSW2	5	07ABB	06/12/86 15:30	<1200	142000	<2.40	<1.40	<0.580	<5.00	<1.30	<1.20	<1.10	<1.70	<1.00	<0.610	<1.20	<1.10

RMA SURFACE WATER

STORET CODE:				71999	72005	99720	99758	99759	1002	82034	1027	1034	1042	1051	1092	82032	82033
METHOD CODE:				0	0	0	0	0	A8	AA8	B8	B8	B8	B8	B8	B8	B8
PARAMETER:				SAM TYPE	S TECH	INSTAL	DEPTH	SITE TYPE	ARSENIC	K	CADMIUM	CR	COPPER	LEAD	ZINC	CA	MG
UNITS:						SAMPLE	CM		UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L
FLD.GRP.	#	SAMPLE ID	DATE TIME														
OPS3	5	07ABB	09/04/86 13:11	SW	G	RE	0.0	STRM	<4.00	2640	<5.20	<6.00	<7.90	<18.5	<20.1	51000	14100
T440S1	5	07ABB	12/16/86 14:01	SW	G	RE	0.0	STRM	<3.90	3710	<5.16	12.3	<7.94	<18.6	36.4	79800	15400
T440S2	5	07ABB	03/27/87 09:31	SW	G	RE	0.0	CREK	<2.50	5080	<5.16	16.2	<7.94	<18.6	173	246000	81600
T440S3	5	07ABB	06/16/87 00:00	SW	G	RE	0.0	CREK	<3.07	2550	<5.16	<5.96	<7.94	<18.6	<20.1	63700	14400
OFQ1W	43	07BAA	11/21/85 11:00	SW	G	RE	0.0	DTCH									
OPSW	4	07BAA	04/02/86 16:30	SW	G	RE	0.0	DTCH	NA	4020	<5.20	<6.00	<7.90	<18.5	45.8	90300	18900
OPSW2	4	07BAA	06/12/86 15:10	SW	G	RE	0.0	DTCH	4.35	3640	<5.20	<6.00	<7.90	<18.5	33.4	76900	12200
OPS3	4	07BAA	09/04/86 13:41	SW	G	RE	0.0	DTCH	<4.00	3700	<5.20	<6.00	<7.90	<18.5	25.8	51100	11800
T440S1	4	07BAA	12/16/86 14:11	SW	G	RE	0.0	DTCH	6.26	2960	<5.16	<11.9	<7.94	<18.6	<20.1	306000	92900
T440S2	4	07BAA	03/27/87 10:00	SW	G	RE	0.0	DTCH	<2.50	5080	<5.16	<5.96	<7.94	<18.6	22.7	69200	13900
T440S3	4	07BAA	06/16/87 14:21	SW	G	RE	0.0	DTCH	<3.07	1770	<5.16	<5.96	<7.94	<18.6	<20.1	27400	7190
T440S4	4	07BAA	10/12/87 12:38	SW	G	RE	0.0	DTCH	<3.07	4500	<5.16	16.3	<7.94	<18.6	67.2	105000	22200
T4-SW	9	08001	12/20/85 09:05	SW	G	RE	0.0	STRM									
OFQ1W	50	08ADD	11/22/85 09:00	SW	G	RE	0.0	CREK									
OFQ1W	66	08ADD	12/20/85 15:15	SW	G	RE	0.0	CREK									
OPSW	11	08ADD	04/02/86 10:45	SW	G	RE	0.0	CREK	6.55	4410	<5.20	<6.00	<7.90	<18.5	24.2	117000	26900
OPSW2	11	08ADD	06/12/86 09:00	SW	G	RE	0.0	CREK	<3.90	4230	<5.20	<6.00	<7.90	<18.5	<20.1	115000	20600
OPS3	11	08ADD	09/04/86 11:00	SW	G	RE	0.0	STRM	<4.00	5640	<5.20	<6.00	<7.90	<18.5	<20.1	99000	20000
T440S1	11	08ADD	12/16/86 10:50	SW	G	RE	0.0	STRM	<3.90	3710	<5.16	<11.9	<7.94	<18.6	25.2	86000	18500
T440S2	11	08ADD	03/26/87 11:00	SW	G	RE	0.0	CREK	<2.50	5480	13.7	<5.96	21.1	<18.6	<20.1	82100	19000
T440S3	11	08ADD	06/16/87 09:33	SW	G	RE	0.0	CREK	<3.07	2460	<5.16	<5.96	<7.94	<18.6	<20.1	24400	21600
T440S4	11	08ADD	10/16/87 12:37	SW	G	RE	0.0	CREK	<3.07	5240	<5.16	12.5	<7.94	21.9	<20.1	95100	20400
OFQ1W	42	12AAB	11/19/85 14:15	SW	G	RE	0.0	RVER									
OPSW2	3	12AAB	06/16/86 12:45	SW	G	RE	0.0	RVER	<3.90	11300	<51.6	<59.6	<79.4	<186	<201	60200	10200
OPS3	3	12AAB	09/05/86 12:51	SW	G	RE	0.0	RVER	4.72	7930	<5.20	<6.00	<7.90	<18.5	<20.1	101000	17100
T440S1	3	12AAB	12/17/86 11:15	SW	G	RE	0.0	RVER	<3.90	7670	<5.16	<11.9	<7.94	<18.6	47.0	64500	13300
T440S2	3	12AAB	03/27/87 10:31	SW	G	RE	0.0	RVER	<2.50	10600	<5.16	6.21	10.7	<18.6	79.6	76200	15300
T440S3	3	12AAB	06/17/87 11:34	SW	G	RE	0.0	RVER	<3.07	3930	<5.16	<5.96	<7.94	<18.6	56.2	40200	8160
T440S4	3	12AAB	09/24/87 11:23	SW	G	RE	0.0	RVER	<3.07	8820	<5.16	14.4	<7.94	<18.6	26.0	86500	17400
OPSW	3	12ABB	04/07/86 12:45	SW	G	RE	0.0	RVER	<3.90	4530	28.6	31.3	32.1	28.6	81.1	70400	12800
OFQ1W	49	13DCC	11/22/85 09:45	SW	G	RE	0.0	CREK									
OFQ1W	77	13DCC	12/20/85 11:00	SW	G	RE	0.0	CREK									
OPSW	10	13DCC	04/02/86 12:30	SW	G	RE	0.0	CREK	<3.90	4530	<5.20	<6.00	<7.90	<18.5	29.5	112000	44600
T440S2	10	13DCC	03/26/87 14:14	SW	G	RE	0.0	CREK		6670	<5.16	<5.96	<7.94	<18.6	<20.1	10300	3300
T440S3	10	13DCC	06/17/87 12:52	SW	G	RE	0.0	CREK	3.50	5500	<5.16	<5.96	<7.94	<18.6	41.4	113000	36100

RMA SURFACE WATER

STORET CODE:				82035	71900	99133	77985	81596	34386	39300	39320	39330	39380	39390	39430	39350	98551
METHOD CODE:				B8	L8	Q8	R8	R8	S8	S8	S8	S8	S8	S8	S8	MM8	T8
PARAMETER:				NA	MERCURY	DBCP	DCPD	NIBK	HCCPD	P,P'-DDT	P,P'-DDE	ALDRIN	DIELDRIN	ENDRIN	ISODRIN	CHLORDANE	DIMP
UNITS:				UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L
FLD.GRP.	#	SAMPLE ID	DATE TIME														
OPS3	5	07ABB	09/04/86 13:11	47900	<0.240	<0.130	<9.31	<12.9	<0.070	<0.070	<0.053	<0.070	<0.060	<0.052	<0.060		<10.5
T440S1	5	07ABB	12/16/86 14:01	99100	<0.500	<0.130	<9.31	<12.9	<0.070	<0.070	<0.053	<0.070	<0.060	<0.052	<0.060		<10.5
T440S2	5	07ABB	03/27/87 09:31	544000	<0.359	<0.130	<9.31	<12.9	<0.070	<0.070	<0.053	<0.070	<0.060	<0.052	<0.060		<10.5
T440S3	5	07ABB	06/16/87 00:00	71000	1.17	<0.130	<9.31	<12.9	<0.070	<0.070	<0.053	<0.070	<0.060	<0.052	<0.060		<10.5
OPQ1W	43	07BAA	11/21/85 11:00			<0.130	<9.31					<0.070	<0.060	<0.050	<0.060		22.0
OPSW	4	07BAA	04/02/86 16:30	93900	<0.240	<0.130	<9.31	<12.9	<0.070	<0.053	<0.053	<0.070	<0.060	<0.052	<0.060		<10.5
OPSW2	4	07BAA	06/12/86 15:10	52600	<0.240	<0.130	<9.31	<12.9	<0.070	<0.070	<0.053	<0.070	<0.060	<0.052	<0.060		<10.5
OPS3	4	07BAA	09/04/86 13:41	36600	<0.240	<0.130	<9.31	<12.9	<0.070	<0.070	<0.053	<0.070	<0.060	<0.052	<0.060		<10.5
T440S1	4	07BAA	12/16/86 14:11	615000	<0.500	<0.130	<9.31	<12.9	<0.070	<0.070	<0.053	<0.070	<0.060	<0.052	<0.060		<10.5
T440S2	4	07BAA	03/27/87 10:00	66200	<0.359	<0.130	<9.31	<12.9	<0.070	<0.070	<0.053	<0.070	<0.060	<0.052	<0.060		<10.5
T440S3	4	07BAA	06/16/87 14:21	22600	<0.240	<0.130	<9.31	<12.9	<0.070	<0.070	<0.053	<0.070	<0.060	<0.052	<0.060		<10.5
T440S4	4	07BAA	10/12/87 12:38	96500	<0.240	<0.130	<9.31	<12.9	<0.070	<0.070	<0.053	<0.070	<0.060	<0.052	<0.060		<10.5
T4-SW	9	08001	12/20/85 09:05			<0.130	<9.31	<13.0	NA	<0.050	<0.050	0.200	<0.060	<0.050	<0.060		<10.0
OPQ1W	50	08ADD	11/22/85 09:00			<0.130	<9.31					<0.070	0.060	<0.050	<0.060		<10.0
OPQ1W	66	08ADD	12/20/85 15:15			<0.130	<9.31					<0.070	<0.060	<0.050	<0.060		11.0
OPSW	11	08ADD	04/02/86 10:45	92600	<0.240	<0.130	<9.31	<12.9	<0.070	<0.053	<0.053	<0.070	<0.060	<0.052	<0.060		<10.5
OPSW2	11	08ADD	06/12/86 09:00	61200	<0.240	<0.130	<9.31	<12.9	<0.070	<0.070	<0.053	<0.070	<0.060	<0.052	<0.060		<10.5
OPS3	11	08ADD	09/04/86 11:00	60100	<0.240	<0.130	<9.31	<12.9	<0.070	<0.070	<0.053	<0.070	<0.060	<0.052	<0.060		<10.5
T440S1	11	08ADD	12/16/86 10:50	60500	<0.500	<0.130	<9.31	<12.9	<0.070	<0.070	<0.053	<0.070	<0.060	<0.052	<0.060		<10.5
T440S2	11	08ADD	03/26/87 11:00	59800	<0.359	<0.130	<9.31	<12.9	<0.070	<0.070	<0.053	<0.070	<0.060	<0.052	<0.060		<10.5
T440S3	11	08ADD	06/16/87 09:33	66700	<0.240	<0.130	<9.31	<12.9	<0.070	<0.070	<0.053	<0.070	<0.060	<0.052	<0.060		<10.5
T440S4	11	08ADD	10/16/87 12:37	62400	<0.240		<9.31	<12.9	<0.070	<0.070	<0.053	<0.070	<0.060	<0.052	<0.060		<10.5
OPQ1W	42	12AAB	11/19/85 14:15			<0.130	<9.31					0.100	<0.060	<0.050	<0.060		<10.0
OPSW2	3	12AAB	06/16/86 12:45	68800	<0.240	<0.130	<9.31	<12.9	<0.070	<0.070	<0.053	<0.070	<0.060	<0.052	<0.060		<10.5
OPS3	3	12AAB	09/05/86 12:51	113000	<0.240	<0.130	<9.31	<12.9	<0.070	<0.070	<0.053	<0.070	<0.060	<0.052	<0.060		<10.5
T440S1	3	12AAB	12/17/86 11:15	118000	<0.500	<0.130	<9.31	<12.9	<0.070	<0.070	<0.053	<0.070	<0.060	<0.052	<0.060		<10.5
T440S2	3	12AAB	03/27/87 10:31	120000	<0.359	<0.130	<9.31	<12.9	<0.070	<0.070	<0.053	<0.070	<0.060	<0.052	<0.060		<10.5
T440S3	3	12AAB	06/17/87 11:34	40900	<0.240	<0.130	<9.31	<12.9	<0.070	<0.070	<0.053	<0.070	<0.060	<0.052	<0.060		<10.5
T440S4	3	12AAB	09/24/87 11:23	134000	<0.480	<0.130	<9.31	<12.9	<0.070	<0.070	<0.053	<0.070	<0.060	<0.052	<0.060		<10.5
OPSW	3	12ABB	04/07/86 12:45	77200	<0.240	<0.130	<9.31	<12.9	<0.070	<0.053	<0.053	<0.070	<0.060	<0.052	<0.060		<10.5
OPQ1W	49	13DCC	11/22/85 09:45			<0.130	<9.31					<0.070	0.080	<0.050	<0.060		<10.0
OPQ1W	77	13DCC	12/20/85 11:00			<0.130	<9.31					0.200	<0.060	<0.050	<0.060		17.0
OPSW	10	13DCC	04/02/86 12:30	174000	<0.240	<0.130	<9.31	<12.9	<0.070	<0.053	<0.053	<0.070	<0.060	<0.052	<0.060		<10.5
T440S2	10	13DCC	03/26/87 14:14	12200	<0.359	<0.130	<9.31	<12.9	<0.070	<0.070	<0.053	<0.070	<0.060	<0.052	<0.060		<10.5
T440S3	10	13DCC	06/17/87 12:52	129000	<0.240	<0.130	<9.31	<12.9	<0.070	<0.070	<0.053	<0.070	<0.060	<0.052	<0.060		<10.5

RMA SURFACE WATER

STORET CODE:				98552	81512	81580	98560	98561	98562	98563	98564	34010	34030	34371	98553	98554	98555
METHOD CODE:				T8	U8	U8	U8	U8	U8	U8	U8	W8	W8	W8	W8	W8	X8
PARAMETER:				DMMP	BTZ	DMDS	CPMSO2	CPMSO	CPMS	1,4-DITH	1,4-OXAT	TOLUEN	BENZENE	ETHYLBENZ	M-XYL	O&P-XYL	CL
UNITS:				UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L
FLD.GRP.	#	SAMPLE ID	DATE TIME														
OPS3	5	07ABB	09/04/86 13:11	<15.2		<1.80	<4.70	<4.20	<1.30	<1.10	<2.00	<1.21	<1.34	<1.28	<1.35	<2.47	56700
T440S1	5	07ABB	12/16/86 14:01	<15.2	<2.00	<1.80	<4.70	<4.20	<1.30	<1.10	<2.00	<1.21	<1.34	<1.28	<1.35	<2.47	90000
T440S2	5	07ABB	03/27/87 09:31	<15.2	<2.00	<1.80	<4.70	<4.20	<1.30	<1.10	<2.00	<1.21	<1.34	<1.28	<1.35	<2.47	231000
T440S3	5	07ABB	06/16/87 00:00	<15.2	<2.00	<1.80	<4.70	<4.20	<1.30	<1.10	<2.00	<1.21	<1.34	<1.28	<1.35	<2.47	41600
OPQ1W	43	07BAA	11/21/85 11:00	<15.2			NA	NA	NA	NA	NA	<1.21	<1.34		<1.35	<2.47	150000
OPSW	4	07BAA	04/02/86 16:30	<15.2			<4.70	<4.20	<11.7	<11.3	<20.0	<1.21	<1.34	<1.28	<1.35	<2.47	76200
OPSW2	4	07BAA	06/12/86 15:10	<15.2		<1.80	<4.70	<4.20	<1.30	<1.10	<2.00	<1.21	<1.34	<1.28	<1.35	<2.47	37900
OPS3	4	07BAA	09/04/86 13:41	<15.2		<1.80	<4.70	<4.20	<1.30	<1.10	<2.00	<1.21	<1.34	<1.28	<1.35	<2.47	50900
T440S1	4	07BAA	12/16/86 14:11	<15.2	<2.00	<1.80	<4.70	<4.20	<1.30	<1.10	<2.00	<1.21	<1.34	<1.28	<1.35	<2.47	250000
T440S2	4	07BAA	03/27/87 10:00	<15.2	<2.00	<1.80	<4.70	<4.20	<1.30	<1.10	<2.00	<1.21	<1.34	<1.28	<1.35	<2.47	57100
T440S3	4	07BAA	06/16/87 14:21	<15.2	<2.00	<1.80	<4.70	<4.20	<1.30	<1.10	<2.00	<1.21	<1.34	<1.28	<1.35	<2.47	23900
T440S4	4	07BAA	10/12/87 12:38	<15.2	<2.00	<1.80	<4.70	<4.20	<1.30	<1.10	<2.00	<1.21	<1.34	<1.28	<1.35	<2.47	66400
T4-SW	9	08001	12/20/85 09:05	<15.2			<4.70	<4.20	<1.30	<1.10	<2.00	<1.21	<1.34	<1.00	<1.35	<2.47	52500
OPQ1W	50	08ADD	11/22/85 09:00	<15.2			NA	NA	NA	NA	NA	NA	NA		NA	NA	53700
OPQ1W	66	08ADD	12/20/85 15:15	<15.2			<4.70	<4.20	<1.30	<1.10	<2.00	<1.21	<1.34		<1.35	<2.47	56900
OPSW	11	08ADD	04/02/86 10:45	<15.2			<4.70	<4.20	<11.7	<11.3	<20.0	<1.21	<1.34	<1.28	<1.35	<2.47	63300
OPSW2	11	08ADD	06/12/86 09:00	<15.2		<1.80	<4.70	<4.20	<1.30	<1.10	<2.00	<1.21	<1.34	<1.28	<1.35	<2.47	44800
OPS3	11	08ADD	09/04/86 11:00	<15.2		<1.80	<4.70	<4.20	<1.30	<1.10	<2.00	<1.21	<1.34	<1.28	<1.35	<2.47	58200
T440S1	11	08ADD	12/16/86 10:50	<15.2	<2.00	<1.80	<4.70	<4.20	<1.30	<1.10	<2.00	<1.21	<1.34	<1.28	<1.35	<2.47	46700
T440S2	11	08ADD	03/26/87 11:00	<15.2	<2.00	<1.80	<4.70	<4.20	<1.30	<1.10	<2.00	<1.21	<1.34	<1.28	<1.35	<2.47	48600
T440S3	11	08ADD	06/16/87 09:33	<15.2	<2.00	<1.80	<4.70	<4.20	<1.30	<1.10	<2.00	<1.21	<1.34	<1.28	<1.35	<2.47	50800
T440S4	11	08ADD	10/16/87 12:37	<15.2	<2.00	<1.80	<4.70	<4.20	<1.30	<1.10	<2.00	<1.21	<1.34	<1.28	<1.35	<2.47	46300
OPQ1W	42	12AAB	11/19/85 14:15	<15.2			<4.70	<4.20	<1.30	<1.10	<2.00	<1.21	<1.34		<1.35	<2.47	82400
OPSW2	3	12AAB	06/16/86 12:45	<15.2		<1.80	<4.70	<4.20	<1.30	<1.10	<2.00	<1.21	<1.34	<1.28	<1.35	<2.47	31100
OPS3	3	12AAB	09/05/86 12:51	<15.2		<1.80	<4.70	<4.20	<1.30	<1.10	<2.00	<1.21	<1.34	<1.28	<1.35	<2.47	88700
T440S1	3	12AAB	12/17/86 11:15	<15.2	<2.00	<1.80	<4.70	<4.20	<1.30	<1.10	<2.00	<1.21	<1.34	<1.28	<1.35	<2.47	112000
T440S2	3	12AAB	03/27/87 10:31	<15.2	<2.00	<1.80	<4.70	<4.20	<1.30	<1.10	<2.00	<1.21	<1.34	<1.28	<1.35	<2.47	103000
T440S3	3	12AAB	06/17/87 11:34	<15.2	<2.00	<1.80	<4.70	<4.20	<1.30	<1.10	<2.00	<1.21	<1.34	<1.28	<1.35	<2.47	36200
T440S4	3	12AAB	09/24/87 11:23	<15.2	<2.00	<1.80	<4.70	<4.20	<1.30	<1.10	<2.00	<1.21	<1.34	<1.28	<1.35	<2.47	103000
OPSW	3	12ABB	04/07/86 12:45	<15.2			<4.70	<4.20	<11.7	<11.3	<20.0	<1.21	<1.34	<1.28	<1.35	<2.47	53900
OPQ1W	49	13DCC	11/22/85 09:45	<15.2			NA	NA	NA	NA	NA	NA	NA		NA	NA	84200
OPQ1W	77	13DCC	12/20/85 11:00	<15.2			<4.70	<4.20	<1.30	<1.10	<2.00	<1.21	<1.34		<1.35	<2.47	88700
OPSW	10	13DCC	04/02/86 12:30	<15.2			<4.70	<4.20	<11.7	<11.3	<20.0	<1.21	<1.34	<1.28	<1.35	<2.47	111000
T440S2	10	13DCC	03/26/87 14:14	<15.2	<2.00	<1.80	<4.70	<4.20	<1.30	<1.10	<2.00	<1.21	<1.34	<1.28	<1.35	<2.47	96800
T440S3	10	13DCC	06/17/87 12:52	<15.2	<2.00	<1.80	<4.70	<4.20	<1.30	<1.10	<2.00	<1.21	<1.34	<1.28	<1.35	<2.47	78100

RMA SURFACE WATER

STORET CODE:			98556	98581	32102	32106	34301	34423	34475	34496	34501	34506	34511	34531	34546	39180
METHOD CODE:			X8	X8	Y8	Y8	Y8	Y8	Y8	Y8	Y8	Y8	Y8	Y8	Y8	Y8
PARAMETER:			FL	SO4	CCL4	CHCL3	CLC6H5	METHYLCL	TCLEE	11DCLE	11DCE	111TCE	112TCE	12DCLE	T12DCE	TRCLE
UNITS:			UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L
FLD.GRP.	#	SAMPLE ID DATE TIME														
OPS3	5	07ABB 09/04/86 13:11	<1200	129000	<2.40	<1.40	<0.580	<5.00	<1.30	<1.20	<1.10	<1.70	<1.00	<0.610	<1.20	<1.10
T440S1	5	07ABB 12/16/86 14:01	<1200	173000	<2.40	<1.40	<0.580	<5.00	<1.30	<1.20	<1.10	<1.70	<1.00	<0.610	<1.20	<1.10
T440S2	5	07ABB 03/27/87 09:31	1590	1530000	<2.40	<1.40	<0.580	<5.00	<1.30	<1.20	<1.10	<1.70	<1.00	<0.610	<1.20	<1.10
T440S3	5	07ABB 06/16/87 00:00	<1220	197000	<2.40	<1.40	<0.580	<5.00	<1.30	<1.20	<1.10	<1.70	<1.00	<0.610	<1.20	<1.10
OFQ1W	43	07BAA 11/21/85 11:00	1550		<2.40	<1.40	<0.580		<1.30						<1.20	<1.10
OPSW	4	07BAA 04/02/86 16:30	<1200	151000	<2.40	<1.40	<0.580	<5.00	<1.30	<1.20	<1.10	<1.70	<1.00	<0.610	<1.20	<1.10
OPSW2	4	07BAA 06/12/86 15:10	<1200	103000	<2.40	7.96	<0.580	<5.00	<1.30	<1.20	<1.10	<1.70	<1.00	<0.610	<1.20	<1.10
OPS3	4	07BAA 09/04/86 13:41	<1200	83600	<2.40	<1.40	<0.580	<5.00	<1.30	<1.20	<1.10	<1.70	<1.00	<0.610	<1.20	<1.10
T440S1	4	07BAA 12/16/86 14:11	1730	1730000	<2.40	<1.40	<0.580	<5.00	<1.30	<1.20	<1.10	<1.70	<1.00	<0.610	<1.20	<1.10
T440S2	4	07BAA 03/27/87 10:00	<1200	133000	<2.40	<1.40	<0.580	<5.00	<1.30	<1.20	<1.10	<1.70	<1.00	1.17	<1.20	<1.10
T440S3	4	07BAA 06/16/87 14:21	<1220	43000	<2.40	<1.40	<0.580	<5.00	<1.30	<1.20	<1.10	<1.70	<1.00	<0.610	<1.20	<1.10
T440S4	4	07BAA 10/12/87 12:38	<1220	178000	<2.40	<1.40	<0.580	<5.00	<1.30	<1.20	<1.10	<1.70	<1.00	<0.610	<1.20	<1.10
T4-SW	9	08001 12/20/85 09:05	<1200		<2.40	<1.40	<0.580	<5.00	<1.30	<1.20	<1.10	<1.70	<1.00	<0.610	<1.20	<1.10
OFQ1W	50	08ADD 11/22/85 09:00	<1200		NA	NA	NA		NA						NA	NA
OFQ1W	66	08ADD 12/20/85 15:15	<1200		<2.40	<1.40	<0.580		<1.30						<1.20	<1.10
OPSW	11	08ADD 04/02/86 10:45	<1200	141000	<2.40	<1.40	<0.580	<5.00	<1.30	<1.20	<1.10	<1.70	<1.00	<0.610	<1.20	<1.10
OPSW2	11	08ADD 06/12/86 09:00	<1200	123000	<2.40	<1.40	<0.580	<5.00	<1.30	<1.20	<1.10	<1.70	<1.00	<0.610	<1.20	<1.10
OPS3	11	08ADD 09/04/86 11:00	<1200	127000	<2.40	<1.40	<0.580	<5.00	<1.30	<1.20	<1.10	<1.70	<1.00	<0.610	<1.20	<1.10
T440S1	11	08ADD 12/16/86 10:50	<1200	133000	<2.40	<1.40	<0.580	<5.00	<1.30	<1.20	<1.10	<1.70	<1.00	<0.610	<1.20	<1.10
T440S2	11	08ADD 03/26/87 11:00	<1200	11800	<2.40	<1.40	<0.580	<5.00	<1.30	<1.20	<1.10	<1.70	<1.00	<0.610	<1.20	<1.10
T440S3	11	08ADD 06/16/87 09:33	<1220	122000	<2.40	<1.40	<0.580	<5.00	<1.30	<1.20	<1.10	<1.70	<1.00	<0.610	<1.20	<1.10
T440S4	11	08ADD 10/16/87 12:37	<1220	124000	<2.40	<1.40	<0.580	<5.00	<1.30	<1.20	<1.10	<1.70	<1.00	<0.610	<1.20	<1.10
T4-SW	11	11001 12/20/85 13:45	<1200		<2.40	<1.40	<0.580	<5.00	<1.30	<1.20	<1.10	<1.70	<1.00	<0.610	<1.20	<1.10
OFQ1W	42	12AAB 11/19/85 14:15	<1200		<2.40	<1.40	<0.580		<1.30						<1.20	<5.50
OPSW2	3	12AAB 06/16/86 12:45	<1200	85700	<2.40	<1.40	<0.580	<5.00	<1.30	<1.20	<1.10	<1.70	<1.00	<0.610	<1.20	<1.10
OPS3	3	12AAB 09/05/86 12:51	<1200	163000	<2.40	<1.40	<0.580	<5.00	<1.30	<1.20	<1.10	<1.70	<1.00	<0.610	<1.20	<1.10
T440S1	3	12AAB 12/17/86 11:15	<1200	193000	<2.40	<1.40	<0.580	<5.00	<1.30	<1.20	<1.10	<1.70	<1.00	<0.610	<1.20	<1.10
T440S2	3	12AAB 03/27/87 10:31	<1200	193000	<2.40	<1.40	<0.580	<5.00	<1.30	<1.20	<1.10	<1.70	<1.00	<0.610	<1.20	<1.10
T440S3	3	12AAB 06/17/87 11:34	<1220	84700	<2.40	<1.40	<0.580	<5.00	<1.30	<1.20	<1.10	<1.70	<1.00	<0.610	<1.20	<1.10
T440S4	3	12AAB 09/24/87 11:23	<1220	199000	<2.40	<1.40	<0.580	<5.00	<1.30	<1.20	<1.10	<1.70	<1.00	<0.610	<1.20	<1.10
OPSW	3	12ABB 04/07/86 12:45	<1200	121000	<2.40	<1.40	<0.580	<5.00	<1.30	<1.20	<1.10	<1.70	<1.00	<0.610	<1.20	<1.10
OFQ1W	49	13DCC 11/22/85 09:45	<1200		NA	NA	NA		NA						NA	NA
OFQ1W	77	13DCC 12/20/85 11:00	<1200		<2.40	<1.40	<0.580		<1.30						<1.20	<1.10
OPSW	10	13DCC 04/02/86 12:30	<1200	281000	<2.40	<1.40	<0.580	<5.00	<1.30	<1.20	<1.10	<1.70	<1.00	<0.610	<1.20	<1.10
T440S2	10	13DCC 03/26/87 14:14	<1200	268000	<2.40	<1.40	<0.580	<5.00	<1.30	<1.20	<1.10	<1.70	<1.00	<0.610	<1.20	<1.10
T440S3	10	13DCC 06/17/87 12:52	<1220	254000	<2.40	<1.40	<0.580	<5.00	<1.30	<1.20	<1.10	<1.70	<1.00	<0.610	<1.20	<1.10

RMA SURFACE WATER

STORET CODE:				82035	71900	99133	77985	81596	34386	39300	39320	39330	39380	39390	39430	39350	98551
METHOD CODE:				B8	L8	Q8	R8	R8	S8	S8	S8	S8	S8	S8	S8	M8	T8
PARAMETER:				NA	MERCURY	DBCP	DCPD	MIBK	HCCPD	P,P'-DDT	P,P'-DDE	ALDRIN	DIELDRIN	ENDRIN	ISODRIN	CHLORDANE	DIMP
UNITS:				UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L
FLD.GRP.	#	SAMPLE ID	DATE TIME														
OFQ1W	48	14BDD	12/14/85 10:00			<0.130	<9.31					<0.070	<0.060	<0.050	<0.060		58.0
OPSW	9	14BDD	04/02/86 14:00	213000	<0.240	<0.130	<9.31	<12.9	<0.070	<0.053	<0.053	<0.070	0.062	<0.052	<0.060		69.8
OPSW2	9	14BDD	06/16/86 14:40	302000	<0.240	<0.130	24.2	<12.9	<0.070	<0.070	<0.053	<0.070	<0.060	<0.052	<0.060		466
T440S1	9	14BDD	12/16/86 13:21	261000	<0.500	<0.130	31.5	<12.9	<0.070	<0.070	<0.053	<0.070	<0.060	<0.052	<0.060		550
T440S2	9	14BDD	03/26/87 15:20	157000	<0.359	<0.130	<9.31	<12.9	<0.070	<0.070	<0.053	<0.070	<0.060	<0.052	<0.060		89.3
T440S3	9	14BDD	06/17/87 13:20	158000	<0.240	<0.130	<9.31	<12.9	<0.070	<0.070	<0.053	<0.070	<0.060	<0.052	<0.060		74.6
T440S4	9	14BDD	10/12/87 16:49	253000	<0.240	<0.130	<9.31	<12.9	<0.070	<0.070	<0.053	<0.070	<0.060	<0.052	<0.060		196
OPSW	7	22CAA	04/15/86 10:45	73700	<0.240	<0.130	NA	NA	<0.070	<0.053	<0.053	<0.070	<0.060	<0.052	<0.060		<10.5
OPSW2	7	22CAA	06/16/86 10:00	63200	IL	<0.130	<9.31	<12.9	<0.070	<0.070	<0.053	<0.070	<0.060	<0.052	<0.060		<10.5
OPS3	7	22CAA	09/05/86 11:00	68700	<0.240	<0.130	<9.31	<12.9	<0.070	<0.070	<0.053	<0.070	<0.060	<0.052	<0.060		<10.5
T440S2	7	22CAA	04/08/87 11:11	89000	<0.359	<0.130	<9.31	<12.9	NA	NA	NA	NA	NA	NA	NA		11.7
T440S3	7	22CAA	06/17/87 09:26	58800	<0.240	<0.130	<9.31	<12.9	<0.070	<0.070	<0.053	<0.070	<0.060	<0.052	<0.060		<10.5
T440S4	7	22CAA	10/23/87 09:41	NA	NA	<0.130	<9.31	<12.9	<0.070	<0.070	<0.053	<0.070	<0.060	<0.052	<0.060		<10.5
OFQ1W	47	33ABB	12/12/85 10:00			<0.130	<9.31					0.100	<0.060	0.400	<0.060		<10.0
OPSW	8	33ABB	04/15/86 08:30	58600	<0.240	<0.130	NA	NA	<0.070	<0.053	<0.053	<0.070	<0.060	<0.052	<0.060		<10.5
OPSW2	8	33ABB	06/16/86 12:00	45100	<0.240	<0.130	<9.31	<12.9	<0.070	<0.070	<0.053	<0.070	<0.060	<0.052	<0.060		<10.5
OPS3	8	33ABB	09/05/86 11:40	123000	<0.240	<0.130	<9.31	<12.9	<0.070	<0.070	<0.053	<0.070	<0.060	<0.052	<0.060		<10.5
T440S1	8	33ABB	12/17/86 09:40	101000	<0.500	<0.130	<9.31	<12.9	<0.070	<0.070	<0.053	<0.070	<0.060	<0.052	<0.060		<10.5
T440S2	8	33ABB	04/08/87 12:11	60800	<0.359	<0.130	<9.31	<12.9	NA	NA	NA	NA	NA	NA	NA		<10.5
T440S3	8	33ABB	06/17/87 10:48	25000	<0.240	<0.130	<9.31	<12.9	<0.070	<0.070	<0.053	<0.070	<0.060	<0.052	<0.060		<10.5
T440S4	8	33ABB	10/23/87 10:55	65800	<0.240	<0.130	<9.31	<12.9	<0.070	<0.070	<0.053	<0.070	<0.060	<0.052	<0.060		<10.5

RMA SURFACE WATER

STORET CODE:				98552	81512	81580	98560	98561	98562	98563	98564	34010	34030	34371	98553	98554	98555
METHOD CODE:				T8	U8	U8	U8	U8	U8	U8	U8	W8	W8	W8	W8	W8	X8
PARAMETER:				DMHP	BTZ	DMDS	CPMSO2	CPMSO	CPMS	1,4-DITH	1,4-OXAT	TOLUEN	BENZENE	ETHYLBENZ	M-XYL	O&P-XYL	CL
UNITS:				UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L
FLD.GRP.	#	SAMPLE ID	DATE TIME														
OFQ1W	48	14BDD	12/14/85 10:00	<15.2			<4.70	<4.20	<1.30	<1.10	<2.00	<1.21	<1.34		<1.35	<2.47	142000
OPSW	9	14BDD	04/02/86 14:00	<15.2			<4.70	<4.20	<11.7	<11.3	<20.0	<1.21	<1.34	<1.28	<1.35	<2.47	157000
OPSW2	9	14BDD	06/16/86 14:40	<15.2		<1.80	<4.70	<4.20	<1.30	2.21	<2.00	<1.21	<1.34	<1.28	<1.35	<2.47	295000
T440S1	9	14BDD	12/16/86 13:21	<15.2	<2.00	<1.80	5.20	<4.20	<1.30	2.76	<2.00	<1.21	<1.34	<1.28	<1.35	<2.47	286000
T440S2	9	14BDD	03/26/87 15:20	<15.2	<2.00	<1.80	<4.70	<4.20	<1.30	<1.10	<2.00	<1.21	<1.34	<1.28	<1.35	<2.47	147000
T440S3	9	14BDD	06/17/87 13:20	<15.2	<2.00	<1.80	<4.70	<4.20	<1.30	<1.10	<2.00	<1.21	<1.34	<1.28	<1.35	<2.47	131000
T440S4	9	14BDD	10/12/87 16:49	<15.2	<2.00	<1.80	<4.70	<4.20	<1.30	<1.10	<2.00	<1.21	<1.34	<1.28	<1.35	<2.47	185000
OPSW	7	22CAA	04/15/86 10:45	<15.2			<4.70	<4.20	<1.30	<1.10	<2.00	<1.21	<1.34	<1.28	<1.35	<2.47	50500
OPSW2	7	22CAA	06/16/86 10:00	<15.2		<1.80	<4.70	<4.20	<1.30	<1.10	<2.00	<1.21	<1.34	<1.28	<1.35	<2.47	61100
OPS3	7	22CAA	09/05/86 11:00	<15.2		<1.80	<4.70	<4.20	<1.30	<1.10	<2.00	<1.21	<1.34	<1.28	<1.35	<2.47	51500
T440S2	7	22CAA	04/08/87 11:11	<15.2	NA	NA	NA	NA	NA	NA	NA	<1.21	<1.34	<1.28	<1.35	<2.47	70500
T440S3	7	22CAA	06/17/87 09:26	<15.2	<2.00	<1.80	<4.70	<4.20	<1.30	<1.10	<2.00	<1.21	<1.34	<1.28	<1.35	<2.47	59900
T440S4	7	22CAA	10/23/87 09:41	<15.2	<2.00	<1.80	<4.70	<4.20	<1.30	<1.10	<2.00	<1.21	<1.34	<1.28	<1.35	<2.47	51400
OFQ1W	47	33ABB	12/12/85 10:00	<15.2			<4.70	<4.20	<1.30	<1.10	<2.00	<1.21	<1.34		<1.35	<2.47	54800
OPSW	8	33ABB	04/15/86 08:30	<15.2			<4.70	<4.20	<1.30	<1.10	<2.00	<1.21	<1.34	<1.28	<1.35	<2.47	51300
OPSW2	8	33ABB	06/16/86 12:00	<15.2		<1.80	<4.70	<4.20	<1.30	<1.10	<2.00	<1.21	<1.34	<1.28	<1.35	<2.47	38600
OPS3	8	33ABB	09/05/86 11:40	<15.2		<1.80	<4.70	<4.20	<1.30	<1.10	<2.00	<1.21	<1.34	<1.28	<1.35	<2.47	55300
T440S1	8	33ABB	12/17/86 09:40	<15.2	<2.00	<1.80	<4.70	<4.20	<1.30	<1.10	<2.00	<1.21	<1.34	<1.28	<1.35	<2.47	97800
T440S2	8	33ABB	04/08/87 12:11	<15.2	NA	NA	NA	NA	NA	NA	NA	<1.21	<1.34	<1.28	<1.35	<2.47	55700
T440S3	8	33ABB	06/17/87 10:48	<15.2	<2.00	<1.80	<4.70	<4.20	<1.30	<1.10	<2.00	<1.21	<1.34	<1.28	<1.35	<2.47	24200
T440S4	8	33ABB	10/23/87 10:55	<15.2	<2.00	<1.80	<4.70	<4.20	<1.30	<1.10	<2.00	<1.21	<1.34	<1.28	<1.35	<2.47	53400

RMA SURFACE WATER

STORET CODE:				98556	98581	32102	32106	34301	34423	34475	34496	34501	34506	34511	34531	34546	39180
METHOD CODE:				I8	I8	Y8	Y8	Y8	Y8	Y8	Y8	Y8	Y8	Y8	Y8	Y8	Y8
PARAMETER:				FL	SO4	CCL4	CHCL3	CLC6H5	METHYLCL	TCLEE	11DCLE	11DCE	111TCE	112TCE	12DCLE	T12DCE	TRCLE
UNITS:				UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L
FLD.GRP.	#	SAMPLE ID	DATE TIME														
OFQ1W	48	14BDD	12/14/85 10:00	1470		<2.40	<1.40	<0.580		<1.30						<1.20	<1.10
OPSW	9	14BDD	04/02/86 14:00	1460	300000	<2.40	<1.40	<0.580	<5.00	<1.30	<1.20	<1.10	<1.70	<1.00	<0.610	<1.20	<1.10
OPSW2	9	14BDD	06/16/86 14:40	1780	410000	<2.40	<1.40	<0.580	<5.00	<1.30	<1.20	<1.10	<1.70	<1.00	<0.610	<1.20	<1.10
T440S1	9	14BDD	12/16/86 13:21	1560	396000	<2.40	<1.40	<0.580	<5.00	<1.30	<1.20	<1.10	<1.70	<1.00	0.754	<1.20	<1.10
T440S2	9	14BDD	03/26/87 15:20	1280	328000	<2.40	<1.40	<0.580	<5.00	<1.30	<1.20	<1.10	<1.70	<1.00	<0.610	<1.20	<1.10
T440S3	9	14BDD	06/17/87 13:20	1290	288000	<2.40	<1.40	<0.580	<5.00	<1.30	<1.20	<1.10	<1.70	<1.00	<0.610	<1.20	<1.10
T440S4	9	14BDD	10/12/87 16:49	1910	369000	<2.40	<1.40	<0.580	<5.00	<1.30	<1.20	<1.10	<1.70	<1.00	<0.610	<1.20	<1.10
OPSW	7	22CAA	04/15/86 10:45	<1200	104000	<2.40	<1.40	<0.580	<5.00	<1.30	<1.20	<1.10	<1.70	<1.00	<0.610	<1.20	<1.10
OPSW2	7	22CAA	06/16/86 10:00	<1200	118000	<2.40	<1.40	<0.580	<5.00	<1.30	<1.20	<1.10	<1.70	<1.00	<0.610	<1.20	<1.10
OPS3	7	22CAA	09/05/86 11:00	<1200	102000	<2.40	<1.40	<0.580	<5.00	<1.30	<1.20	<1.10	<1.70	<1.00	<0.610	<1.20	<1.10
T440S2	7	22CAA	04/08/87 11:11	<1220	136000	<2.40	<1.40	<0.580	<5.00	<1.30	<1.20	<1.10	<1.70	<1.00	<0.610	<1.20	<1.10
T440S3	7	22CAA	06/17/87 09:26	<1220	98600	<2.40	<1.40	<0.580	<5.00	<1.30	<1.20	<1.10	<1.70	<1.00	<0.610	<1.20	<1.10
T440S4	7	22CAA	10/23/87 09:41	<1220	127000	<2.40	<1.40	<0.580	<5.00	<1.30	<1.20	<1.10	<1.70	<1.00	<0.610	<1.20	<1.10
OFQ1W	47	33ABB	12/12/85 10:00	<1200		<2.40	3.08	<0.580		<1.30						<1.20	<1.10
OPSW	8	33ABB	04/15/86 08:30	<1200	94200	<2.40	<1.40	<0.580	<5.00	<1.30	<1.20	<1.10	<1.70	<1.00	<0.610	<1.20	<1.10
OPSW2	8	33ABB	06/16/86 12:00	<1200	96500	<2.40	<1.40	<0.580	<5.00	<1.30	<1.20	<1.10	<1.70	<1.00	<0.610	<1.20	<1.10
OPS3	8	33ABB	09/05/86 11:40	<1200	99300	<2.40	<1.40	<0.580	<5.00	<1.30	<1.20	<1.10	<1.70	<1.00	<0.610	<1.20	<1.10
T440S1	8	33ABB	12/17/86 09:40	<1200	176000	<2.40	<1.40	<0.580	<5.00	<1.30	<1.20	<1.10	<1.70	<1.00	<0.610	<1.20	<1.10
T440S2	8	33ABB	04/08/87 12:11	<1220	112000	<2.40	<1.40	<0.580	<5.00	<1.30	<1.20	<1.10	<1.70	<1.00	<0.610	<1.20	<1.10
T440S3	8	33ABB	06/17/87 10:48	<1220	41800	<2.40	<1.40	<0.580	<5.00	<1.30	<1.20	<1.10	<1.70	<1.00	<0.610	<1.20	<1.10
T440S4	8	33ABB	10/23/87 10:55	<1220	138000	<2.40	<1.40	<0.580	<5.00	<1.30	<1.20	<1.10	<1.70	<1.00	<0.610	<1.20	<1.10

F.3 GC/MS ANALYTICAL RESULTS

GC/MS TRIP BLANK DATA

GCMS TRIP BLANKS

STORET CODE:				34371	34030	81596	81580	34496	34531	34506	34511	34423	32106	32102	34546	34010	34301
METHOD CODE:				M8	M8	M8	M8	M8	M8	M8	M8	M8	M8	M8	M8	M8	M8
PARAMETER:				ETHYBENZ	BENZENE	MIBK	DMDS	11DCLE	12DCLE	111TCE	112TCE	METHYLCL	CHCL3	CCL4	T12DCE	TOLUEN	CLC6H5
UNITS:				UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L
FLD.GRP.	#	SAMPLE ID	DATE TIME														
T4TBKC	2	TBK2	06/04/86 00:00	<1.0	<1.0	<2.0	<3.0	<2.0	<1.0	<1.0	<1.0	<5.00	<1.00	<2.0	<2.0	<1.0	<2.0
T4TBKC	3	TBK3	06/05/86 00:00	<1.0	<1.0	<2.0	<3.0	<2.0	<1.0	<1.0	<1.0	<5.00	<1.00	<2.0	<2.0	<1.0	<2.0
T4TBKC	5	TBK5	06/12/86 00:00	<1.0	<1.0	<2.0	<3.0	<2.0	<1.0	<1.0	<1.0	<5.00	<1.00	<2.0	<2.0	<1.0	<2.0
T4TBKC	6	TBK6	06/23/86 00:00	<1.0	<1.0	<2.0	<3.0	<2.0	<1.0	3.9	<1.0	<5.00	<1.00	<2.0	<2.0	<1.0	<2.0
T4TBKC	7	TBK7	06/24/86 00:00	<1.0	<1.0	<2.0	<3.0	<2.0	<1.0	<1.0	<1.0	<5.00	<1.00	<2.0	<2.0	<1.0	<2.0
T4TBKC	8	TBK8	06/24/86 00:00	<1.0	<1.0	<2.0	<3.0	<2.0	<1.0	<1.0	<1.0	<5.00	<1.00	<2.0	<2.0	<1.0	<2.0
T4TBKC	9	TBK9	06/26/86 00:00	<1.0	<1.0	<2.0	<3.0	<2.0	<1.0	<1.0	<1.0	<5.00	<1.00	<2.0	<2.0	<1.0	<2.0
T4TBKC	10	TBK10	06/27/86 00:00	<1.0	<1.0	<2.0	<3.0	<2.0	<1.0	<1.0	<1.0	<5.00	<1.00	<2.0	<2.0	<1.0	<2.0
T4TBKC	11	TBK11	06/30/86 08:52	<1.0	<1.0	<2.0	<3.0	<2.0	<1.0	<1.0	<1.0	<5.00	<1.00	<2.0	<2.0	<1.0	<2.0
T4TBKC	12	TBK12	07/01/86 00:00	<1.0	<1.0	<2.0	<3.0	<2.0	<1.0	<1.0	<1.0	<5.00	<1.00	<2.0	<2.0	<1.0	<2.0
T4TBC	3	TB3	08/28/86 00:00	<1.0	<1.0	<2.0	<3.0	<2.0	<1.0	<1.0	<1.0	<5.00	<1.00	<2.0	<2.0	<1.0	<2.0
T4TBC	4	TB4	09/02/86 00:00	<1.0	<1.0	<2.0	<3.0	<2.0	<1.0	<1.0	<1.0	6.66	<1.00	<2.0	<2.0	<1.0	<2.0
T4TBC	5	TB5	09/03/86 00:00	<1.0	<1.0	<2.0	<3.0	<2.0	<1.0	<1.0	<1.0	5.88	<1.00	<2.0	<2.0	<1.0	<2.0
T4TBC	6	TB6	09/04/86 00:00	<1.0	<1.0	<2.0	<3.0	<2.0	<1.0	<1.0	<1.0	6.79	14.3	<2.0	<2.0	1.3	<2.0
T4TBC	7	TB7	09/05/86 00:00	<1.0	<1.0	<2.0	<3.0	<2.0	<1.0	<1.0	<1.0	6.41	<1.00	<2.0	<2.0	<1.0	<2.0
T4TBC	8	TB8	09/08/86 00:00	<1.0	<1.0	<2.0	<3.0	<2.0	<1.0	<1.0	<1.0	<5.00	<1.00	<2.0	<2.0	1.9	<2.0
OPTBC	4	TB4	09/12/86 00:00	<1.0	<1.0	<2.0	<3.0	<2.0	<1.0	<1.0	<1.0	<5.00	<1.00	<2.0	<2.0	<1.0	<2.0
T4TBC	9	TB9	09/15/86 00:00	<1.0	<1.0	<2.0	<3.0	<2.0	<1.0	<1.0	<1.0	<5.00	<1.00	<2.0	<2.0	<1.0	<2.0
T4TBC	10	TB10	09/17/86 00:00	<1.0	<1.0	<2.0	<3.0	<2.0	<1.0	<1.0	<1.0	<5.00	<1.00	<2.0	<2.0	<1.0	<2.0
T4TBC	11	TB11	09/18/86 00:00	<1.0	<1.0	<2.0	<3.0	<2.0	<1.0	<1.0	<1.0	<5.00	<1.00	<2.0	<2.0	<1.0	<2.0
T4TBC	12	TB12	09/19/86 00:00	<1.0	<1.0	<2.0	<3.0	<2.0	<1.0	<1.0	<1.0	8.45	<1.00	<2.0	<2.0	<1.0	<2.0
T4TBC	13	TB13	09/22/86 00:00	<1.0	<1.0	<2.0	<3.0	<2.0	<1.0	<1.0	<1.0	<5.00	<1.00	<2.0	<2.0	1.1	<2.0
T4TBC	14	TB14	09/23/86 00:00	<1.0	<1.0	<2.0	<3.0	<2.0	<1.0	<1.0	<1.0	<5.00	<1.00	<2.0	<2.0	<1.0	<2.0
T4TBC	15	TB15	09/24/86 00:00	<1.0	<1.0	<2.0	<3.0	<2.0	<1.0	<1.0	<1.0	<5.00	<1.00	<2.0	<2.0	<1.0	<2.0
T4TBC	16	TB16	09/26/86 00:00	<1.0	<1.0	<2.0	<3.0	<2.0	<1.0	<1.0	<1.0	<5.00	<1.00	<2.0	<2.0	<1.0	<2.0
T4TBC	17	TB17	09/29/86 00:00	<1.0	<1.0	<2.0	<3.0	<2.0	<1.0	<1.0	<1.0	<5.00	<1.00	<2.0	<2.0	<1.0	<2.0
T44GMS3	50	TB1	05/05/87 00:00	<1.0	<1.0	<2.0	<3.0	<2.0	<1.0	<1.0	<1.0	<5.00	<1.00	<2.0	<2.0	<1.0	<2.0
T44GMS3	51	TB2	05/06/87 00:00	<1.0	<1.0	<2.0	<3.0	<2.0	<1.0	<1.0	<1.0	<5.00	<1.00	<2.0	<2.0	<1.0	<2.0
T44GMS3	52	TB3	05/08/87 00:00	<1.0	<1.1	<2.0	<2.5	<2.0	<1.0	<1.0	<1.0	15.9	<1.00	<1.5	<1.2	<1.0	<2.1
T44GMS3	53	TB4	05/11/87 00:00	<1.0	<1.1	<2.0	<2.5	<2.0	<1.0	<1.0	<1.0	<4.80	<1.00	<1.5	<1.2	<1.0	<2.1
T44GMS3	54	TB5	05/12/87 00:00	<1.0	<1.1	<2.0	<2.5	<2.0	<1.0	<1.0	<1.0	<4.80	<1.00	<1.5	<1.2	<1.0	<2.1
T44GMS3	55	TB6	05/13/87 07:52	<1.0	<1.1	<2.0	<2.5	<2.0	<1.0	<1.0	<1.0	<4.80	<1.00	<1.5	<1.2	<1.0	<2.1
T44GMS3	56	TB7	05/18/87 00:00	<1.0	<1.1	<2.0	<2.5	<2.0	<1.0	<1.0	<1.0	<4.80	<1.00	<1.5	<1.2	<1.0	<2.1
T44GMS3	57	TB8	05/19/87 00:00	<1.0	<1.1	<2.0	<2.5	<2.0	<1.0	<1.0	<1.0	9.81	<1.00	<1.5	<1.2	<1.0	<2.1
T44GMS3	59	TB10	07/09/87 07:20	<1.0	<1.1	<2.0	<2.5	<2.0	<1.0	<1.0	<1.0	5.72	<1.00	<1.5	<1.2	<1.0	<2.1

GCMS TRIP BLANKS

STORET CODE:				34475	39180	98553	98554	99133	77985	98633
METHOD CODE:				M8	M8	M8	M8	M8	M8	M8
PARAMETER:				TCLEE	TRCLE	M-XYLENE	OP-XYL	DBCP	DCPD	BCHD
UNITS:				UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L
FLD.GRP.	#	SAMPLE ID	DATE TIME							
T4TBKC	2	TBK2	06/04/86 00:00	<1.0	<1.0	<1.0	<2.0	<4.0	<2.0	<1.0
T4TBKC	3	TBK3	06/05/86 00:00	<1.0	<1.0	<1.0	<2.0	<4.0	<2.0	<1.0
T4TBKC	5	TBK5	06/12/86 00:00	<1.0	<1.0	<1.0	<2.0	<4.0	<2.0	<1.0
T4TBKC	6	TBK6	06/23/86 00:00	<1.0	<1.0	<1.0	<2.0	<4.0	<2.0	<1.0
T4TBKC	7	TBK7	06/24/86 00:00	<1.0	<1.0	<1.0	<2.0	<4.0	<2.0	<1.0
T4TBKC	8	TBK8	06/24/86 00:00	<1.0	<1.0	<1.0	<2.0	<4.0	<2.0	<1.0
T4TBKC	9	TBK9	06/26/86 00:00	<1.0	<1.0	<1.0	<2.0	<4.0	<2.0	<1.0
T4TBKC	10	TBK10	06/27/86 00:00	<1.0	<1.0	<1.0	<2.0	<4.0	<2.0	<1.0
T4TBKC	11	TBK11	06/30/86 08:52	<1.0	<1.0	<1.0	<2.0	<4.0	<2.0	<1.0
T4TBKC	12	TBK12	07/01/86 00:00	<1.0	<1.0	<1.0	<2.0	<4.0	<2.0	<1.0
T4TBC	3	TB3	08/28/86 00:00	<1.0	<1.0	<1.0	<2.0	<4.0	<2.0	<1.0
T4TBC	4	TB4	09/02/86 00:00	<1.0	<1.0	<1.0	<2.0	<4.0	<2.0	<1.0
T4TBC	5	TB5	09/03/86 00:00	<1.0	<1.0	<1.0	<2.0	<4.0	<2.0	<1.0
T4TBC	6	TB6	09/04/86 00:00	<1.0	<1.0	<1.0	<2.0	<4.0	<2.0	<1.0
T4TBC	7	TB7	09/05/86 00:00	<1.0	<1.0	<1.0	<2.0	<4.0	<2.0	<1.0
T4TBC	8	TB8	09/08/86 00:00	<1.0	<1.0	<1.0	<2.0	<4.0	<2.0	<1.0
OPTBC	4	TB4	09/12/86 00:00	<1.0	<1.0	<1.0	<2.0	<4.0	<2.0	<1.0
T4TBC	9	TB9	09/15/86 00:00	<1.0	<1.0	<1.0	<2.0	<4.0	<2.0	<1.0
T4TBC	10	TB10	09/17/86 00:00	<1.0	<1.0	<1.0	<2.0	<4.0	<2.0	<1.0
T4TBC	11	TB11	09/18/86 00:00	<1.0	<1.0	<1.0	<2.0	<4.0	<2.0	<1.0
T4TBC	12	TB12	09/19/86 00:00	<1.0	<1.0	<1.0	<2.0	<4.0	<2.0	<1.0
T4TBC	13	TB13	09/22/86 00:00	<1.0	<1.0	<1.0	<2.0	<4.0	<2.0	<1.0
T4TBC	14	TB14	09/23/86 00:00	<1.0	<1.0	<1.0	<2.0	<4.0	<2.0	<1.0
T4TBC	15	TB15	09/24/86 00:00	<1.0	<1.0	<1.0	<2.0	<4.0	<2.0	<1.0
T4TBC	16	TB16	09/26/86 00:00	<1.0	<1.0	<1.0	<2.0	<4.0	<2.0	<1.0
T4TBC	17	TB17	09/29/86 00:00	<1.0	<1.0	<1.0	<2.0	<4.0	<2.0	<1.0
T44GMS3	50	TB1	05/05/87 00:00	<1.0	<1.0	<1.0	<2.0	<4.0	<2.0	<1.0
T44GMS3	51	TB2	05/06/87 00:00	<1.0	<1.0	<1.0	<2.0	<4.0	<2.0	<1.0
T44GMS3	52	TB3	05/08/87 00:00	<1.0	<1.0	<1.0	<2.0	<3.8	<1.1	<1.0
T44GMS3	53	TB4	05/11/87 00:00	<1.0	<1.0	<1.0	<2.0	<3.8	<1.1	<1.0
T44GMS3	54	TB5	05/12/87 00:00	<1.0	<1.0	<1.0	<2.0	<3.8	<1.1	<1.0
T44GMS3	55	TB6	05/13/87 07:52	<1.0	<1.0	<1.0	<2.0	<3.8	<1.1	<1.0
T44GMS3	56	TB7	05/18/87 00:00	<1.0	<1.0	<1.0	<2.0	<3.8	<1.1	<1.0
T44GMS3	57	TB8	05/19/87 00:00	<1.0	<1.0	<1.0	<2.0	<3.8	<1.1	<1.0
T44GMS3	59	TB10	07/09/87 07:20	<1.0	<1.0	1.4	<2.0	<3.8	<1.1	<1.0

3RD QUARTER FY 1986 TASK 4 GC/MS CONFIRMATION DATA

FIELD GROUP NUMBERS TC44, T4BWC, AND OPW2C ARE GC/MS RESULTS

SAMPLE LIST T4C

STORET CODE:				98551	34386	39330	39430	39320	39380	39390	39300	81580	98564	98563	98562	81512	98561
METHOD CODE:				BB8	S8	S8	S8	S8	S8	S8	S8	U8	U8	U8	U8	U8	U8
PARAMETER:				DIMP	HCCPD	ALDRIN	ISODRIN	P,P'-DDE	DIELDRIN	ENDRIN	P,P'-DDT	DMDS	1,4-OXAT	1,4-DITH	CPMS	BTZ	CPMSO
UNITS:				UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L
FLD.GRP.	#	SAMPLE ID	DATE TIME														
T4CC	3	01020	06/25/86 10:30	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	25.4	<14.0		<17.0
T4CW	3	01020	06/25/86 10:30	<11	<0.070	<0.070	<0.060	<0.053	<0.060	<0.052	<0.070	<1.80	4.96	33.5	<1.30		<4.20
T4BW	9	11002	05/29/86 08:45	<11	<0.070	<0.070	<0.060	<0.053	<0.060	<0.052	<0.070	<1.80	<2.00	<1.10	<1.30		<4.20
T4BWC	2	11002	05/29/86 08:45	*<5.7	*<11.0	*<4.70	*<5.90	*<4.70	*<4.70	*<7.60	*<10.0	<3.00	*<6.10	*<11.0	*<14.0		*<17.0
T4CC	4	02019	06/24/86 09:06	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
T4CW	15	02019	06/24/86 09:06	<11	<0.070	<0.070	<0.060	<0.053	<0.060	<0.052	<0.070	<1.80	<2.00	<1.10	<1.30		<4.20
T4CC	5	02030	06/27/86 14:01	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
T4CW	17	02030	06/27/86 14:01	<11	<0.070	<0.070	<0.060	<0.053	<0.060	<0.052	<0.070	<1.80	<2.00	<1.10	<1.30		<4.20
T4CC	6	02035	06/25/86 09:02	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
T4CW	20	02035	06/25/86 09:02	<11	<0.070	<0.070	<0.060	<0.053	<0.060	<0.052	<0.070	<1.80	<2.00	<1.10	<1.30		<4.20
T4CC	7	02037	06/23/86 11:26	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
T4CW	22	02037	06/23/86 11:26	<11	<0.070	<0.070	<0.060	<0.053	0.437	<0.052	<0.070	<1.80	<2.00	<1.10	<1.30		<4.20
T4CC	8	02038	06/23/86 15:55	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
T4CW	23	02038	06/23/86 15:55	<11	<0.070	<0.070	<0.060	<0.053	0.229	<0.052	<0.070	<1.80	<2.00	<1.10	<1.30		<4.20
T4CC	9	02039	06/24/86 10:05	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
T4CW	24	02039	06/24/86 10:05	<11	<0.070	<0.070	<0.060	<0.053	<0.060	<0.052	<0.070	<1.80	<2.00	<1.10	<1.30		<4.20
T4CC	11	22021	06/12/86 09:37	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
T4CW	26	22021	06/12/86 09:37	<11	<0.070	<0.070	<0.060	<0.053	<0.060	<0.052	<0.070	<1.80	<2.00	<1.10	<1.30		<4.20
T4CC	12	22024	06/12/86 07:28	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
T4CW	27	22024	06/12/86 07:28	<11	<0.070	<0.070	<0.060	<0.053	<0.060	<0.052	<0.070	<1.80	<2.00	<1.10	<1.30		<4.20
T4CC	13	23142	06/26/86 08:47	650	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	28.2	<14.0		<17.0
T4CW	34	23142	06/26/86 08:47	96	<0.350	<0.350	<0.300	<0.265	<0.300	<0.260	<0.350	<1.80	3.64	17.8	<1.30		<4.20
T4CC	15	23177	06/12/86 15:00	24	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
T4CW	36	23177	06/12/86 15:00	33	<0.070	0.107	<0.060	<0.053	<0.060	<0.052	<0.070	<1.80	<2.00	<1.10	<1.30		<4.20
T4CC	16	23179	06/12/86 09:42	510	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	3.56	9.36	43.7	34.7		<17.0
T4CW	37	23179	06/12/86 09:42	590	1.92	<0.700	<0.060	<0.530	<0.060	<0.520	<0.700	<1.80	15.8	78.5	66.3		29.1
T4CC	17	23185	06/19/86 10:03	3000	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
T4CW	41	23185	06/19/86 10:03	4800	<0.070	0.455	<0.060	<0.053	<0.060	<0.052	<0.070	<1.80	2.35	2.85	2.32		<4.20
T4CC	18	23188	06/19/86 11:46	670	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	45.1	<14.0		<17.0
T4CW	44	23188	06/19/86 11:46	1100	<0.070	0.192	<0.060	<0.053	0.083	0.110	0.095	<1.80	3.71	31.2	<1.30		<4.20
T4CC	19	23190	06/19/86 12:41	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
T4CW	45	23190	06/19/86 12:41	<11	<0.070	<0.070	<0.060	<0.053	<0.060	<0.052	<0.070	<1.80	<2.00	<1.10	<1.30		<4.20
T4BW	16	24150	05/29/86 09:00	<11	<0.070	<0.070	<0.060	<0.053	<0.060	<0.052	<0.070	<1.80	<2.00	<1.10	<1.30		<4.20
T4BWC	3	24150	05/29/86 09:00	*<5.7	*<11.0	*<4.70	*<5.90	*<4.70	*<4.70	*<7.60	*<10.0	<3.00	*<6.10	*<11.0	*<14.0		*<17.0
T4CC	20	24178	06/19/86 14:22	210	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		67.8
T4CW	50	24178	06/19/86 14:22	290	<0.140	<0.140	<0.120	<0.106	0.865	0.739	<0.140	<1.80	<2.00	<1.10	20.6		122
T4CC	21	25023	06/25/86 08:36	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
T4CW	59	25023	06/25/86 08:36	<11	<0.070	<0.070	<0.060	<0.053	<0.060	<0.052	<0.070	<1.80	<2.00	<1.10	<1.30		<4.20
T4CC	23	26041	06/27/86 10:28	2300	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	183	<6.10	64.9	<14.0		<17.0
T4CW	65	26041	06/27/86 10:28	3100	<0.700	6.53	<0.600	<0.530	<0.600	<0.520	<0.700	<1.80	<2.00	56.1	<1.30		<4.20
T4CC	22	26066	06/25/86 09:25	78	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	39.1	268	<14.0		<17.0
T4CW	64	26066	06/25/86 09:25	80	<0.070	<0.070	<0.060	<0.053	<0.060	<0.052	<0.070	<1.80	32.8	342	1.39		<4.20
T4CC	24	26073	06/26/86 09:52	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
T4CW	66	26073	06/26/86 09:52	<11	<0.700	<0.700	<0.600	<0.530	<0.600	<0.520	<0.700	<1.80	<2.00	<1.10	<1.30		<4.20
T4CC	25	26083	06/23/86 14:52	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
T4CW	68	26083	06/23/86 14:52	<11	<0.070	<0.070	<0.060	<0.053	<0.060	<0.052	<0.070	<1.80	<2.00	<1.10	<1.30		<4.20
T4CC	26	26084	06/23/86 13:57	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
T4CW	69	26084	06/23/86 13:57	<11	<0.070	<0.070	<0.060	<0.053	0.204	<0.052	<0.070	<1.80	<2.00	<1.10	<1.30		<4.20
T4CC	27	26085	06/26/86 14:20	92	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
T4CW	70	26085	06/26/86 14:20	110	<0.700	1.85	<0.600	<0.530	<0.600	<0.520	<0.700	<1.80	<2.00	<1.10	<1.30		<4.20

SAMPLE LIST T4C

STORET CODE:				81596	34030	34010	34371	98553	98554	34423	34501	34496	34546	32106	34531	34506	32102
METHOD CODE:				R8	W8	W8	W8	W8	W8	Y8	Y8	Y8	Y8	Y8	Y8	Y8	Y8
PARAMETER:				MIBK	BENZENE	TOLUEN	ETHYLBENZ	M-XYL	O&P-XYL	METHYLCL	11DCE	11DCLE	T12DCE	CHCL3	12DCLE	111TCE	CCL4
UNITS:				UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L
FLD.GRP.	#	SAMPLE ID	DATE TIME														
T4CC	3	01020	06/25/86 10:30	<2.00	<10.0	<1.00	<1.00	<1.00	<2.00	11.4		16.6	4.19	1170	1.53	2.71	<2.00
T4CW	3	01020	06/25/86 10:30	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	6.16	2.75	<24.0	<12.0	>200	<6.10	<17.0	<24.0
T4BW	9	11002	05/29/86 08:45	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	<0.610	<1.70	<2.40
T4BWC	2	11002	05/29/86 08:45	<2.00	1.96	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	<1.00	<1.00	<1.00	<2.00
T4CC	4	02019	06/24/86 09:06	5.71	16.5	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	<1.00	<1.00	<1.00	<2.00
T4CW	15	02019	06/24/86 09:06	<12.9	37.2	4.52	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	<0.610	<1.70	<2.40
T4CC	5	02030	06/27/86 14:01	<2.00	<1.00	1.49	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	168	<1.00	<1.00	8.84
T4CW	17	02030	06/27/86 14:01	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	115	<0.610	<1.70	9.53
T4CC	6	02035	06/25/86 09:02	<2.00	<1.00	<1.00	<1.00	<1.00	<2.00	14.9		7.52	<2.00	283	<1.00	<1.00	7.84
T4CW	20	02035	06/25/86 09:02	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	8.38	<1.20	195	<0.610	<1.70	7.54
T4CC	7	02037	06/23/86 11:26	<2.00	<1.00	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	5.58	<1.00	<1.00	<2.00
T4CW	22	02037	06/23/86 11:26	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	2.79	<0.610	<1.70	<2.40
T4CC	8	02038	06/23/86 15:55	<2.00	<1.00	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	9.18	<1.00	<1.00	<2.00
T4CW	23	02038	06/23/86 15:55	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	7.44	<0.610	<1.70	<2.40
T4CC	9	02039	06/24/86 10:05	<2.00	<1.00	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	<1.00	<1.00	<1.00	<2.00
T4CW	24	02039	06/24/86 10:05	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	<0.610	<1.70	<2.40
T4CC	11	22021	06/12/86 09:37	<2.00	<1.00	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	17.5	<1.00	<1.00	<2.00
T4CW	26	22021	06/12/86 09:37	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	11.6	<0.610	<1.70	<2.40
T4CC	12	22024	06/12/86 07:28	<2.00	<1.00	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	<1.00	<1.00	<1.00	<2.00
T4CW	27	22024	06/12/86 07:28	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	<0.610	<1.70	<2.40
T4CC	13	23142	06/26/86 08:47	<2.00	<1.00	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	<1.00	<1.00	<1.00	<2.00
T4CW	34	23142	06/26/86 08:47	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	<0.610	<1.70	<2.40
T4CC	15	23177	06/12/86 15:00	<2.00	<1.00	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	1.99	<1.00	<1.00	<2.00
T4CW	36	23177	06/12/86 15:00	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	<0.610	<1.70	<2.40
T4CC	16	23179	06/12/86 09:42	<2.00	40.2	<1.00	<1.00	<1.00	3.24	104		3.40	<2.00	32000	115	<1.00	<2.00
T4CW	37	23179	06/12/86 09:42	<12.9	38.7	2.71	3.59	<1.35	3.52	125	<1.10	3.70	<1.20	22500	<0.610	<1.70	<2.40
T4CC	17	23185	06/19/86 10:03	<2.00	<1.00	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	<1.00	<1.00	<1.00	<2.00
T4CW	41	23185	06/19/86 10:03	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	<0.610	<1.70	<2.40
T4CC	18	23188	06/19/86 11:46	<2.00	<1.00	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	<1.00	1.53	<1.00	<2.00
T4CW	44	23188	06/19/86 11:46	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	1.59	<1.70	<2.40
T4CC	19	23190	06/19/86 12:41	<2.00	<1.00	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	<1.00	<1.00	<1.00	<2.00
T4CW	45	23190	06/19/86 12:41	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	<0.610	<1.70	<2.40
T4BW	16	24150	05/29/86 09:00	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	<0.610	<1.70	<2.40
T4BWC	3	24150	05/29/86 09:00	<2.00	3.70	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	<1.00	<1.00	<1.00	<2.00
T4CC	20	24178	06/19/86 14:22	<2.00	<1.00	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	1120	1.79	<1.00	4.53
T4CW	50	24178	06/19/86 14:22	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	504	<0.610	<1.70	4.22
T4CC	21	25023	06/25/86 08:36	<2.00	<1.00	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	<1.00	<1.00	<1.00	<2.00
T4CW	59	25023	06/25/86 08:36	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	<0.610	<1.70	<2.40
T4CC	23	26041	06/27/86 10:28	32.7	58.1	953	<1.00	<1.00	<2.00	<5.00		<2.00	2.19	<1.00	140	<1.00	<2.00
T4CW	65	26041	06/27/86 10:28	<12.9	50.6	1070	<1.28	1.71	19.2	<5.00	<1.10	<1.20	<1.20	<1.40	2.25	<1.70	<2.40
T4CC	22	26066	06/25/86 09:25	<2.00	2.10	<1.00	<1.00	<1.00	<2.00	10.2		<2.00	<2.00	<1.00	<1.00	<1.00	<2.00
T4CW	64	26066	06/25/86 09:25	<12.9	2.17	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	<0.610	<1.70	<2.40
T4CC	24	26073	06/26/86 09:52	<2.00	<1.00	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	15.1	<1.00	<1.00	5.10
T4CW	66	26073	06/26/86 09:52	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	12.0	<0.610	<1.70	5.75
T4CC	25	26083	06/23/86 14:52	<2.00	<1.00	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	<1.00	<1.00	<1.00	<2.00
T4CW	68	26083	06/23/86 14:52	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	<0.610	<1.70	<2.40
T4CC	26	26084	06/23/86 13:57	<2.00	16.4	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	<1.00	<1.00	<1.00	<2.00
T4CW	69	26084	06/23/86 13:57	<12.9	6.81	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	<0.610	<1.70	<2.40
T4CC	27	26085	06/26/86 14:20	<2.00	<1.00	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	27.0	<1.00	<1.00	<2.00
T4CW	70	26085	06/26/86 14:20	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	21.1	<0.610	<1.70	<2.40

SAMPLE LIST T4C

STORET CODE:				34511	34475	34301
METHOD CODE:				Y8	Y8	Y8
PARAMETER:				112TCE	TCLEE	CLC6H5
UNITS:				UG/L	UG/L	UG/L
FLD.GRP.	#	SAMPLE ID	DATE TIME			
T4CC	3	01020	06/25/86 10:30	<1.00	8.03	50.3
T4CW	3	01020	06/25/86 10:30	<100	4.67	12.7
T4BW	9	11002	05/29/86 08:45	<1.00	<1.30	<0.580
T4BWC	2	11002	05/29/86 08:45	<1.00	<1.00	<2.00
T4CC	4	02019	06/24/86 09:06	<1.00	<1.00	<2.00
T4CW	15	02019	06/24/86 09:06	<1.00	<1.30	<0.580
T4CC	5	02030	06/27/86 14:01	<1.00	<1.00	<2.00
T4CW	17	02030	06/27/86 14:01	<1.00	<1.30	<0.580
T4CC	6	02035	06/25/86 09:02	<1.00	2.63	<2.00
T4CW	20	02035	06/25/86 09:02	<1.00	<1.30	8.64
T4CC	7	02037	06/23/86 11:26	<1.00	<1.00	<2.00
T4CW	22	02037	06/23/86 11:26	<1.00	<1.30	<0.580
T4CC	8	02038	06/23/86 15:55	<1.00	<1.00	<2.00
T4CW	23	02038	06/23/86 15:55	<1.00	<1.30	<0.580
T4CC	9	02039	06/24/86 10:05	<1.00	<1.00	<2.00
T4CW	24	02039	06/24/86 10:05	<1.00	<1.30	<0.580
T4CC	11	22021	06/12/86 09:37	<1.00	<1.00	<2.00
T4CW	26	22021	06/12/86 09:37	<1.00	<1.30	<0.580
T4CC	12	22024	06/12/86 07:28	<1.00	<1.00	<2.00
T4CW	27	22024	06/12/86 07:28	<1.00	<1.30	<0.580
T4CC	13	23142	06/26/86 08:47	<1.00	<1.00	<2.00
T4CW	34	23142	06/26/86 08:47	<5.00	<1.30	<0.580
T4CC	15	23177	06/12/86 15:00	<1.00	<1.00	<2.00
T4CW	36	23177	06/12/86 15:00	<1.00	<1.30	<0.580
T4CC	16	23179	06/12/86 09:42	<1.00	75.2	<2.00
T4CW	37	23179	06/12/86 09:42	<1.00	75.5	<0.580
T4CC	17	23185	06/19/86 10:03	<1.00	<1.00	<2.00
T4CW	41	23185	06/19/86 10:03	<1.00	<1.30	<0.580
T4CC	18	23188	06/19/86 11:46	<1.00	<1.00	<2.00
T4CW	44	23188	06/19/86 11:46	<1.00	<1.30	<0.580
T4CC	19	23190	06/19/86 12:41	<1.00	<1.00	<2.00
T4CW	45	23190	06/19/86 12:41	<1.00	<1.30	<0.580
T4BW	16	24150	05/29/86 09:00	<1.00	<1.30	<0.580
T4BWC	3	24150	05/29/86 09:00	<1.00	<1.00	<2.00
T4CC	20	24178	06/19/86 14:22	<1.00	57.4	<2.00
T4CW	50	24178	06/19/86 14:22	<1.00	49.2	<0.580
T4CC	21	25023	06/25/86 08:36	<1.00	<1.00	<2.00
T4CW	59	25023	06/25/86 08:36	<1.00	<1.30	<0.580
T4CC	23	26041	06/27/86 10:28	<1.00	<1.00	2.16
T4CW	65	26041	06/27/86 10:28	<1.00	<1.30	2.77
T4CC	22	26066	06/25/86 09:25	<1.00	4.27	9.67
T4CW	64	26066	06/25/86 09:25	<1.00	3.96	7.60
T4CC	24	26073	06/26/86 09:52	<1.00	<1.00	<2.00
T4CW	66	26073	06/26/86 09:52	<1.00	<1.30	<0.580
T4CC	25	26083	06/23/86 14:52	<1.00	<1.00	<2.00
T4CW	68	26083	06/23/86 14:52	<1.00	<1.30	<0.580
T4CC	26	26084	06/23/86 13:57	<1.00	<1.00	<2.00
T4CW	69	26084	06/23/86 13:57	<1.00	<1.30	<0.580
T4CC	27	26085	06/26/86 14:20	<1.00	<1.00	<2.00
T4CW	70	26085	06/26/86 14:20	<1.00	<1.30	<0.580

SAMPLE LIST T4C

STORET CODE:					99133	99133	99133	77985	77985	77985
METHOD CODE:					Q8	BB8	M8	R8	BB8	M8
PARAMETER:					DBCP	DBCP	DBCP	DCPD	DCPD	DCPD
UNITS:					UG/L	UG/L	UG/L	UG/L	UG/L	UG/L
FLD.GRP.	#	SAMPLE ID	DATE	TIME						
T4CC	3	01020	06/25/86	10:30		27	16		<4.7	<2.0
T4CW	3	01020	06/25/86	10:30	16.1			<9.31		
T4BW	9	11002	05/29/86	08:45	<0.130			<9.31		
T4BWC	2	11002	05/29/86	08:45		*<15	<4.0		*<4.7	<2.0
T4CC	4	02019	06/24/86	09:06		<15	<4.0		<4.7	<2.0
T4CW	15	02019	06/24/86	09:06	<0.130			<9.31		
T4CC	5	02030	06/27/86	14:01		<15	<4.0		<4.7	<2.0
T4CW	17	02030	06/27/86	14:01	<0.130			<9.31		
T4CC	6	02035	06/25/86	09:02		<15	<4.0		<4.7	<2.0
T4CW	20	02035	06/25/86	09:02	<0.130			<9.31		
T4CC	7	02037	06/23/86	11:26		<15	<4.0		<4.7	<2.0
T4CW	22	02037	06/23/86	11:26	<0.130			<9.31		
T4CC	8	02038	06/23/86	15:55		<15	<4.0		<4.7	<2.0
T4CW	23	02038	06/23/86	15:55	<0.130			<9.31		
T4CC	9	02039	06/24/86	10:05		<15	<4.0		<4.7	<2.0
T4CW	24	02039	06/24/86	10:05	<0.130			<9.31		
T4CC	11	22021	06/12/86	09:37		<15	<4.0		<4.7	<2.0
T4CW	26	22021	06/12/86	09:37	<0.130			<9.31		
T4CC	12	22024	06/12/86	07:28		<15	<4.0		<4.7	<2.0
T4CW	27	22024	06/12/86	07:28	<0.130			<9.31		
T4CC	13	23142	06/26/86	08:47		<15	<4.0		<4.7	<2.0
T4CW	34	23142	06/26/86	08:47	<0.130			<9.31		
T4CC	15	23177	06/12/86	15:00		<15	<4.0		<4.7	<2.0
T4CW	36	23177	06/12/86	15:00	<0.130			<9.31		
T4CC	16	23179	06/12/86	09:42		<15	<4.0		810	530
T4CW	37	23179	06/12/86	09:42	0.953			736		
T4CC	17	23185	06/19/86	10:03		<15	<4.0		<4.7	<2.0
T4CW	41	23185	06/19/86	10:03	<0.130			<9.31		
T4CC	18	23188	06/19/86	11:46		<15	<4.0		42	15
T4CW	44	23188	06/19/86	11:46	<0.130			16.8		
T4CC	19	23190	06/19/86	12:41		<15	<4.0		<4.7	<2.0
T4CW	45	23190	06/19/86	12:41	<0.130			<9.31		
T4BW	16	24150	05/29/86	09:00	<0.130			<9.31		
T4BWC	3	24150	05/29/86	09:00		*<15	<4.0		*<4.7	<2.0
T4CC	20	24178	06/19/86	14:22		<15	9.5		24	35
T4CW	50	24178	06/19/86	14:22	7.25			34.2		
T4CC	21	25023	06/25/86	08:36		<15	<4.0		<4.7	<2.0
T4CW	59	25023	06/25/86	08:36	<0.130			<9.31		
T4CC	23	26041	06/27/86	10:28		<15	<4.0		89	83
T4CW	65	26041	06/27/86	10:28	<0.130			40.5		
T4CC	22	26066	06/25/86	09:25		<15	<4.0		<4.7	<2.0
T4CW	64	26066	06/25/86	09:25	<0.130			<9.31		
T4CC	24	26073	06/26/86	09:52		<15	<4.0		<4.7	<2.0
T4CW	66	26073	06/26/86	09:52	<0.130			<9.31		
T4CC	25	26083	06/23/86	14:52		<15	<4.0		<4.7	<2.0
T4CW	68	26083	06/23/86	14:52	<0.130			<9.31		
T4CC	26	26084	06/23/86	13:57		<15	<4.0		<4.7	<2.0
T4CW	69	26084	06/23/86	13:57	<0.130			<9.31		
T4CC	27	26085	06/26/86	14:20		<15	<4.0		<4.7	<2.0
T4CW	70	26085	06/26/86	14:20	0.239			<9.31		

SAMPLE LIST T4C

STORET CODE:				98551	34386	39330	39430	39320	39380	39390	39300	81580	98564	98563	98562	81512	98561
METHOD CODE:				B88	S8	S8	S8	S8	S8	S8	S8	U8	U8	U8	U8	U8	U8
PARAMETER:				DIMP	HCCPD	ALDRIN	ISODRIN	P,P'-DDE	DIELDRIN	ENDRIN	P,P'-DDT	DMDS	1,4-OXAT	1,4-DITH	CPMS	BTZ	CPMSO
UNITS:				UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L
FLD.GRP.	#	SAMPLE ID	DATE TIME														
T4CC	28	26086	06/24/86 13:55	170	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
T4CW	71	26086	06/24/86 13:55	210	<0.070	<0.070	<0.060	<0.053	0.620	0.142	<0.070	<1.80	<2.00	13.6	<1.30		<4.20
T4CC	29	26127	06/26/86 12:58	1900	<11.0	5.20	<5.90	<4.70	12.7	<7.60	<10.0	<3.00	<6.10	74.8	<14.0		<17.0
T4CW	72	26127	06/26/86 12:58	1900	<0.070	0.667	<0.300	<0.053	1.49	0.391	<0.070	<1.80	5.35	59.6	<1.30		<4.20
T4CC	30	26128	06/24/86 13:34	1000	<11.0	5.64	<5.90	<4.70	56.9	7.64	<10.0	<3.00	<6.10	42.3	<14.0		<17.0
T4CW	73	26128	06/24/86 13:34	1700	<0.700	1.00	<0.600	<0.530	6.41	1.34	<0.700	<1.80	7.02	72.4	2.62		<4.20
T4CC	31	26133	06/27/86 09:06	690	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<300	26.5	69.1	527		<17.0
T4CW	74	26133	06/27/86 09:06	950	<0.700	<0.700	<0.600	<0.530	<0.600	<0.520	<0.700	<1.80	15.4	59.7	612		14.6
T4CC	32	26140	06/24/86 08:52	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
T4CW	75	26140	06/24/86 08:52	<11	<0.070	<0.070	<0.060	<0.053	0.537	0.103	<0.070	<1.80	<2.00	<1.10	<1.30		<4.20
T4CC	33	27040	06/19/86 09:15	36	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
T4CW	80	27040	06/19/86 09:15	44	<0.700	<0.700	<0.600	<0.530	<0.600	<0.520	<0.700	<1.80	<2.00	<1.10	<1.30		<4.20
T4CC	34	27062	06/12/86 10:52	27	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
T4CW	87	27062	06/12/86 10:52	29	<0.070	<0.070	<0.060	<0.053	0.119	<0.052	<0.070	<1.80	<2.00	<1.10	<1.30		<4.20
T4CC	35	28025	06/19/86 14:35	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
T4CW	89	28025	06/19/86 14:35	<11	<0.070	<0.070	<0.060	<0.053	<0.060	<0.052	<0.070	<1.80	<2.00	<1.10	<1.30		<4.20
T4WC	6	28027	06/04/86 07:44	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
T4WW	35	28027	06/04/86 07:44		<0.070	<0.070	<0.060	<0.053	<0.060	<0.052	<0.070						
T4CC	10	03005	06/11/86 11:50	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
T4CW	25	03005	06/11/86 11:50	<11	<0.070	<0.070	<0.060	<0.053	<0.060	<0.052	<0.070	<1.80	<2.00	<1.10	<1.30		<4.20
T4WC	7	33060	06/04/86 08:56	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
T4WW	26	33060	06/04/86 08:56		<0.070	<0.070	<0.060	<0.053	<0.060	<0.052	<0.070						
T4CC	36	35012	06/11/86 16:18	3500	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	28.7	192	<14.0		<17.0
T4CW	94	35012	06/11/86 16:18	10000	<0.070	0.988	<0.060	<0.053	0.220	<0.052	<0.070	<1.80	37.4	345	<1.30		<4.20
T4CC	37	35013	06/12/86 14:21	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
T4CW	95	35013	06/12/86 14:21	<11	<0.070	<0.070	<0.060	<0.053	<0.060	<0.052	<0.070	<1.80	<2.00	<1.10	<1.30		<4.20
T4CC	38	35052	06/25/86 12:01	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
T4CW	100	35052	06/25/86 12:01	<11	<0.070	<0.070	<0.060	<0.053	<0.060	<0.052	<0.070	<1.80	<2.00	<1.10	<1.30		<4.20
T4CC	39	35065	06/30/86 09:48	2500	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<30.0	23.7	134	<14.0		<17.0
T4CW	106	35065	06/30/86 09:48	1900	<0.070	<0.070	<0.060	<0.053	<0.060	<0.052	<0.070	<1.80	9.44	86.7	<1.30		10.2
T4WC	1	03523	06/04/86 13:47	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
T4WW	1	03523	06/04/86 13:47		<0.070	<0.070	<0.060	<0.053	<0.060	<0.052	<0.070						
T4CC	40	36001	06/23/86 14:09	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	8.00	<10.0	129	<6.10	<11.0	69.5		<17.0
T4CW	109	36001	06/23/86 14:09	<11	<0.700	<0.700	<0.600	<0.530	0.659	5.66	<0.700	22.6	<2.00	<1.10	59.6		<4.20
T4CC	41	36076	06/25/86 14:24	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3000	27.9	28.2	<14.0		<17.0
T4CW	113	36076	06/25/86 14:24	<11	<1.40	<1.40	<1.20	<1.06	<1.20	<1.04	<1.40	<1.80	32.6	42.8	14.4		19.9
T4CC	42	36082	06/27/86 10:02	490	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<300	179	972	<14.0		<17.0
T4CW	114	36082	06/27/86 10:02	590	<0.700	4.87	<0.600	<0.530	<0.600	<0.520	<0.700	<1.80	133	679	4.51		<4.20
T4CC	43	36112	06/30/86 08:52	1000	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	76.8	450	<14.0		<17.0
T4CW	117	36112	06/30/86 08:52	1500	<0.070	<0.070	0.149	<0.053	<0.060	<0.052	<0.070	<1.80	73.3	541	2.59		<4.20
OPGW2	2	37307	06/18/86 11:41	41	<0.070	<0.070	<0.060	<0.053	<0.060	<0.052	<0.070	<1.80	<2.00	<1.10	<1.30		<4.20
OPGW2C	2	37307	06/18/86 11:41	35	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
OPGW2	3	37308	06/16/86 15:17	330	<0.070	<0.070	<0.060	<0.053	0.521	<0.052	<0.070	<1.80	<2.00	<1.10	<1.30		81.8
OPGW2C	3	37308	06/16/86 15:17	270	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		49.2
OPGW2	5	37312	06/17/86 11:13	22	<0.070	<0.070	<0.120	<0.053	1.42	1.11	<0.140	<1.80	<2.00	<1.10	<1.30		<4.20
OPGW2C	1	37312	06/17/86 11:13	14	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
OPGW2	12	37332	06/16/86 11:58	<11	<0.070	<0.070	<0.060	<0.053	0.363	<0.052	<0.070	<1.80	<2.00	<1.10	<1.30		<4.20
OPGW2C	5	37332	06/16/86 11:58	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
OPGW2	21	37343	06/13/86 08:34	1100	<0.070	<0.070	<0.060	<0.053	<0.060	<0.052	<0.070	<1.80	<2.00	<1.10	<1.30		<4.20
OPGW2C	6	37343	06/13/86 08:39	36	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0

SAMPLE LIST T4C

STORET CODE:				81596	34030	34010	34371	98553	98554	34423	34501	34496	34546	32106	34531	34506	32102
METHOD CODE:				R8	W8	W8	W8	W8	W8	Y8	Y8	Y8	Y8	Y8	Y8	Y8	Y8
PARAMETER:				MIBK	BENZENE	TOLUEN	ETHYLBENZ	M-XYL	O&P-XYL	METHYLCL	11DCE	11DCLE	T12DCE	CHCL3	12DCLE	111TCE	CCL4
UNITS:				UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L
FLD.GRP.	#	SAMPLE ID	DATE TIME														
T4CC	28	26086	06/24/86 13:55	<2.00	1.95	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	<1.00	<1.00	<1.00	<2.00
T4CW	71	26086	06/24/86 13:55	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	<0.610	<1.70	<2.40
T4CC	29	26127	06/26/86 12:58	<2.00	<1.00	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	<1.00	<1.00	<1.00	<2.00
T4CW	72	26127	06/26/86 12:58	<12.9	<1.34	2.47	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	<0.610	<1.70	<2.40
T4CC	30	26128	06/24/86 13:34	<2.00	<1.00	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	<1.00	<1.00	<1.00	<2.00
T4CW	73	26128	06/24/86 13:34	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	<0.610	<1.70	<2.40
T4CC	31	26133	06/27/86 09:06	462	605	270	<100	<100	<200	1710		<200	<200	68000	<100	<100	<200
T4CW	74	26133	06/27/86 09:06	<258	645	356	7.77	8.49	58.7	640	<1.10	8.34	<1.20	19200	<0.610	<1.70	<2.40
T4CC	32	26140	06/24/86 08:52	<2.00	<1.00	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	36.0	<1.00	<1.00	<2.00
T4CW	75	26140	06/24/86 08:52	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	27.9	<0.610	<1.70	<2.40
T4CC	33	27040	06/19/86 09:15	<2.00	<1.00	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	<1.00	3.77	<1.00	<2.00
T4CW	80	27040	06/19/86 09:15	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	1.81	2.74	<1.70	<2.40
T4CC	34	27062	06/12/86 10:52	<2.00	<1.00	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	33.9	<1.00	<1.00	<2.00
T4CW	87	27062	06/12/86 10:52	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	12.5	<0.610	<1.70	<2.40
T4CC	35	28025	06/19/86 14:35	<2.00	<1.00	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	<1.00	<1.00	<1.00	<2.00
T4CW	89	28025	06/19/86 14:35	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	<0.610	<1.70	<2.40
T4WC	6	28027	06/04/86 07:44	<2.00	<1.00	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	<1.00	<1.00	2.25	<2.00
T4WW	35	28027	06/04/86 07:44		1.48	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	<0.610	1.95	<2.40
T4CC	10	03005	06/11/86 11:50	<2.00	<1.00	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	1.49	<1.00	<1.00	<2.00
T4CW	25	03005	06/11/86 11:50	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	<0.610	<1.70	<2.40
T4WC	7	33060	06/04/86 08:56	<2.00	<1.00	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	<1.00	<1.00	<1.00	<2.00
T4WW	26	33060	06/04/86 08:56		1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	<0.610	<1.70	<2.40
T4CC	36	35012	06/11/86 16:18	<2.00	40.9	1.33	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	<1.00	<1.00	<1.00	<2.00
T4CW	94	35012	06/11/86 16:18	<12.9	39.6	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	<0.610	<1.70	<2.40
T4CC	37	35013	06/12/86 14:21	<2.00	1.78	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	14.6	<1.00	<1.00	64.1
T4CW	95	35013	06/12/86 14:21	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	5.18	<1.20	<1.20	11.3	<0.610	<1.70	56.0
T4CC	38	35052	06/25/86 12:01	<2.00	5.78	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	2.32	<1.00	<1.00	<2.00
T4CW	100	35052	06/25/86 12:01	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	1.62	<1.40	<0.610	<1.70	<2.40
T4CC	39	35065	06/30/86 09:48	<20.0	<10.0	<10.0	<10.0	<10.0	<20.0	<50.0		<20.0	<20.0	<10.0	<10.0	<10.0	<20.0
T4CW	106	35065	06/30/86 09:48	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	1.35	<1.20	<1.40	<0.610	<1.70	<2.40
T4WC	1	03523	06/04/86 13:47	<2.00	3.88	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	12.4	<1.00	<1.00	<2.00
T4WW	1	03523	06/04/86 13:47		9.04	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	8.97	<0.610	<1.70	<2.40
T4CC	40	36001	06/23/86 14:09	5670	16700	401	572	588	728	125			108	5100	3.49		273
T4CW	109	36001	06/23/86 14:09	3740	27300	582	714	860	1850	RE	7.86	<1.20	<1.20	4780	<0.610	<1.70	282
T4CC	41	36076	06/25/86 14:24	<2000	<1000	<1000	<1000	<1000	<2000	30100		<2000	<2000	14900	<1000	<1000	<2000
T4CW	113	36076	06/25/86 14:24	24.0	490	9.12	<1.28	<1.35	<2.47	3830	1.21	6.43	<1.20	6700	<0.610	<1.70	<2.40
T4CC	42	36082	06/27/86 10:02	<200	104	<100	<100	<100	<200	<500		<200	<200	<100	<100	<100	<200
T4CW	114	36082	06/27/86 10:02	<12.9	4.05	<1.21	<1.28	2.11	<2.47	<5.00	<1.10	<1.20	<1.20	4.15	8.91	<1.70	<2.40
T4CC	43	36112	06/30/86 08:52	<2.00	2.65	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	<1.00	<1.00	<1.00	<2.00
T4CW	117	36112	06/30/86 08:52	<12.9	3.65	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	28.9	<0.610	<1.70	<2.40
OPGW2	2	37307	06/18/86 11:41	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	<0.610	<1.70	<2.40
OPGW2C	2	37307	06/18/86 11:41	<2.00	<1.00	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	<1.00	<1.00	<1.00	<2.00
OPGW2	3	37308	06/16/86 15:17	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	2.00	2.82	<1.70	<2.40
OPGW2C	3	37308	06/16/86 15:17	<2.00	<1.00	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	7.12	3.20	<1.00	<2.00
OPGW2	5	37312	06/17/86 11:13	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	<0.610	<1.70	<2.40
OPGW2C	1	37312	06/17/86 11:13	<2.00	<1.00	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	2.28	<1.00	<1.00	<2.00
OPGW2	12	37332	06/16/86 11:58	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	4.47	<0.610	<1.70	<2.40
OPGW2C	5	37332	06/16/86 11:58	<2.00	<1.00	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	6.04	<1.00	<1.00	<2.00
OPGW2	21	37343	06/13/86 08:34	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	<0.610	<1.70	<2.40
OPGW2C	6	37343	06/13/86 08:39	<2.00	<1.00	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	<1.00	<1.00	<1.00	<2.00

SAMPLE LIST T4C

STORET CODE:				34511	34475	34301
METHOD CODE:				Y8	Y8	Y8
PARAMETER:				112TCE	TCLEE	CLC6H5
UNITS:				UG/L	UG/L	UG/L
FLD.GRP.	#	SAMPLE ID	DATE TIME			
T4CC	28	26086	06/24/86 13:55	<1.00	<1.00	<2.00
T4CW	71	26086	06/24/86 13:55	<1.00	<1.30	<0.580
T4CC	29	26127	06/26/86 12:58	<1.00	<1.00	2.37
T4CW	72	26127	06/26/86 12:58	<1.00	<1.30	<0.580
T4CC	30	26128	06/24/86 13:34	<1.00	<1.00	2.39
T4CW	73	26128	06/24/86 13:34	<1.00	<1.30	2.63
T4CC	31	26133	06/27/86 09:06	<100	495	<200
T4CW	74	26133	06/27/86 09:06	<1.00	510	5.25
T4CC	32	26140	06/24/86 08:52	<1.00	<1.00	<2.00
T4CW	75	26140	06/24/86 08:52	<1.00	<1.30	<0.580
T4CC	33	27040	06/19/86 09:15	<1.00	<1.00	<2.00
T4CW	80	27040	06/19/86 09:15	<1.00	<1.30	<0.580
T4CC	34	27062	06/12/86 10:52	<1.00	<1.00	<2.00
T4CW	87	27062	06/12/86 10:52	<1.00	<1.30	<0.580
T4CC	35	28025	06/19/86 14:35	<1.00	<1.00	<2.00
T4CW	89	28025	06/19/86 14:35	<5.00	<1.30	<0.580
T4WC	6	28027	06/04/86 07:44	<1.00	<1.00	<2.00
T4WW	35	28027	06/04/86 07:44	<1.00	<1.30	<0.580
T4CC	10	03005	06/11/86 11:50	<1.00	<1.00	<2.00
T4CW	25	03005	06/11/86 11:50	<1.00	<1.30	<0.580
T4WC	7	33060	06/04/86 08:56	<1.00	<1.00	<2.00
T4WW	26	33060	06/04/86 08:56	<1.00	<1.30	<0.580
T4CC	36	35012	06/11/86 16:18	<1.00	<1.00	80.0
T4CW	94	35012	06/11/86 16:18	<1.00	<1.30	58.3
T4CC	37	35013	06/12/86 14:21	<1.00	4.03	<2.00
T4CW	95	35013	06/12/86 14:21	<1.00	4.31	<0.580
T4CC	38	35052	06/25/86 12:01	<1.00	<1.00	18.3
T4CW	100	35052	06/25/86 12:01	<1.00	<1.30	<0.580
T4CC	39	35065	06/30/86 09:48	<10.0	19.7	<20.0
T4CW	106	35065	06/30/86 09:48	<1.00	15.4	5.76
T4WC	1	03523	06/04/86 13:47	<1.00	<1.00	<2.00
T4WW	1	03523	06/04/86 13:47	<1.00	<1.30	<0.580
T4CC	40	36001	06/23/86 14:09		227	28200
T4CW	109	36001	06/23/86 14:09	<1.00	164	38000
T4CC	41	36076	06/25/86 14:24	<1000	<1000	16500
T4CW	113	36076	06/25/86 14:24	3.08	8.27	6380
T4CC	42	36082	06/27/86 10:02	<100	<100	413
T4CW	114	36082	06/27/86 10:02	<1.00	<1.30	1.98
T4CC	43	36112	06/30/86 08:52	<1.00	<1.00	<2.00
T4CW	117	36112	06/30/86 08:52	<1.00	1.88	<0.580
OPGW2	2	37307	06/18/86 11:41	<1.00	<1.30	<0.580
OPGW2C	2	37307	06/18/86 11:41	<1.00	<1.00	<2.00
OPGW2	3	37308	06/16/86 15:17	<1.00	40.5	<0.580
OPGW2C	3	37308	06/16/86 15:17	<1.00	36.3	<2.00
OPGW2	5	37312	06/17/86 11:13	<1.00	<1.30	<0.580
OPGW2C	1	37312	06/17/86 11:13	<1.00	<1.00	<2.00
OPGW2	12	37332	06/16/86 11:58	<1.00	<1.30	<0.580
OPGW2C	5	37332	06/16/86 11:58	<1.00	<1.00	<2.00
OPGW2	21	37343	06/13/86 08:34	<1.00	<1.30	<0.580
OPGW2C	6	37343	06/13/86 08:39	<1.00	<1.00	<2.00

SAMPLE LIST T4C

STORET CODE:					98551	34386	39330	39430	39320	39380	39390	39300	81580	98564	98563	98562	81512	98561
METHOD CODE:					BB8	S8	S8	S8	S8	S8	S8	S8	U8	U8	U8	U8	U8	U8
PARAMETER:					DIMP	HCCPD	ALDRIN	ISODRIN	P,P'-DDE	DIELDRIN	ENDRIN	P,P'-DDT	DMDS	1,4-OXAT	1,4-DITH	CPMS	BTZ	CPMSO
UNITS:					UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L
FLD.GRP.	#	SAMPLE ID	DATE	TIME														
OPGW2	31	37353	06/12/86	11:32	210	<0.070	<0.070	<0.060	<0.053	<0.060	<0.052	<0.070	<1.80	<2.00	<1.10	<1.30		<4.20
OPGW2C	8	37353	06/12/86	11:32	140	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
OPGW2	32	37354	06/11/86	10:06	<11	<0.070	<0.070	<0.060	<0.053	<0.060	<0.052	<0.070	<1.80	<2.00	<1.10	<1.30		<4.20
OPGW2C	4	37354	06/11/86	10:06	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
T4WC	2	04007	06/04/86	14:13	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
T4WW	2	04007	06/04/86	14:13		<0.070	<0.070	<0.060	<0.053	<0.060	<0.052	<0.070						
T4WC	3	04030	06/04/86	08:24	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	35.0	<6.10	<11.0	<14.0		<17.0
T4WW	10	04030	06/04/86	08:24		<0.070	<0.070	<0.060	<0.053	<0.060	<0.052	<0.070						
T4WC	4	04033	06/04/86	09:01	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
T4WW	13	04033	06/04/86	09:01		<0.070	<0.070	<0.060	<0.053	<0.060	<0.052	<0.070						
T4BW	4	06005	06/04/86	11:37	<11	<0.070	<0.070	<0.060	<0.053	<0.060	<0.052	<0.070	<1.80	<2.00	<1.10	<1.30		<4.20
T4BWC	4	6005	06/04/86	11:37	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
T4BW	5	07001	05/29/86	11:26	<11	<0.070	<0.070	<0.060	<0.053	<0.060	<0.052	<0.070	<1.80	<2.00	<1.10	<1.30		<4.20
T4BWC	1	07001	05/29/86	11:26	*<5.7	*<11.0	*<4.70	*<5.90	*<4.70	*<4.70	*<7.60	*<10.0	<3.00	*<6.10	*<11.0	*<14.0		*<17.0
T4WC	5	09005	06/05/86	11:05	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
T4WW	15	09005	06/05/86	11:05		<0.070	<0.070	<0.060	<0.053	<0.060	<0.052	<0.070						
OPGW2	8	BOLLER	07/01/86	09:32	120	<0.070	<0.070	<0.060	<0.053	<0.060	<0.052	<0.070	<1.80	<2.00	<1.10	<1.30		8.40
OPGW2C	7	BOLLER	07/01/86	09:32	120	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
T4CC	1	01012	06/25/86	12:50	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
T4CW	1	01012	06/25/86	12:50	<11	<0.070	<0.070	<0.060	<0.053	<0.060	<0.052	<0.070	<1.80	<2.00	<1.10	<1.30		<4.20
T4CC	2	01014	07/01/86	08:36	<29	<55.0	<23.5	<29.5	<23.5	<23.5	<38.0	<50.0	<300	<30.5	<55.0	<70.0		<85.0
T4CW	2	01014	07/01/86	08:36	<11	<0.700	<0.700	<0.600	<0.530	<0.600	<0.520	<0.700	<1.80	4.31	<1.10	<1.30		<4.20

SAMPLE LIST T4C

STORET CODE:					81596	34030	34010	34371	98553	98554	34423	34501	34496	34546	32106	34531	34506	32102
METHOD CODE:					R8	W8	W8	W8	W8	W8	Y8	Y8	Y8	Y8	Y8	Y8	Y8	Y8
PARAMETER:					MIBK	BENZENE	TOLUEN	ETHYLBENZ	M-XYL	O&P-XYL	METHYLCL	11DCE	11DCLE	T12DCE	CHCL3	12DCLE	111TCE	CCL4
UNITS:					UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L
FLD.GRP.	#	SAMPLE ID	DATE	TIME														
OPGW2	31	37353	06/12/86	11:32	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	<0.610	<1.70	<2.40
OPGW2C	8	37353	06/12/86	11:32	4.01	<1.00	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	<1.00	<1.00	<1.00	<2.00
OPGW2	32	37354	06/11/86	10:06	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	<0.610	<1.70	<2.40
OPGW2C	4	37354	06/11/86	10:06	<2.00	<1.00	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	2.21	<1.00	<1.00	<2.00
T4WC	2	04007	06/04/86	14:13	<2.00	<1.00	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	7.38	<1.00	<1.00	<1.00	<2.00
T4WW	2	04007	06/04/86	14:13		<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	8.64	<1.40	<0.610	<1.70	<2.40
T4WC	3	04030	06/04/86	08:24	<2.00	3.31	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	4.21	4.40	<1.00	<1.00	<2.00
T4WW	10	04030	06/04/86	08:24		2.96	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	2.54	3.29	<0.610	<1.70	<2.40
T4WC	4	04033	06/04/86	09:01	<2.00	36.6	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	<1.00	<1.00	<1.00	<2.00
T4WW	13	04033	06/04/86	09:01		266	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	<0.610	<1.70	<2.40
T4BW	4	06005	06/04/86	11:37	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	<0.610	<1.70	<2.40
T4BWC	4	6005	06/04/86	11:37	<2.00	12.1	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	<1.00	<1.00	<1.00	<2.00
T4BW	5	07001	05/29/86	11:26	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	<0.610	<1.70	<2.40
T4BWC	1	07001	05/29/86	11:26	<2.00	<1.00	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	<1.00	<1.00	<1.00	<2.00
T4WC	5	09005	06/05/86	11:05	<2.00	<1.00	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	10.9	<1.00	<1.00	<1.00	<2.00
T4WW	15	09005	06/05/86	11:05		<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	7.29	<1.40	<0.610	<1.70	<2.40
OPGW2	8	BOLLER	07/01/86	09:32	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	27.3	<0.610	<1.70	<2.40
OPGW2C	7	BOLLER	07/01/86	09:32	<2.00	<1.00	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	39.7	<1.00	<1.00	<2.00
T4CC	1	01012	06/25/86	12:50	2.58	<1.00	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	3.87	2.86	<1.00	<1.00	<2.00
T4CW	1	01012	06/25/86	12:50	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	1.75	3.62	1.95	<0.610	<1.70	<2.40
T4CC	2	01014	07/01/86	08:36	<200	185000	1090	441	1090	846	<500		<200	<200	<100	<100	<100	<200
T4CW	2	01014	07/01/86	08:36	<12.9	212000	832	273	696	1740	<5.00	<1.10	<1.20	<1.20	<1.40	8.00	<1.70	<2.40

SAMPLE LIST T4C

STORET CODE:				34511	34475	34301
METHOD CODE:				Y8	Y8	Y8
PARAMETER:				112TCE	TCLEE	CLC6H5
UNITS:				UG/L	UG/L	UG/L
FLD.GRP.	#	SAMPLE ID	DATE TIME			
OPGW2	31	37353	06/12/86 11:32	<1.00	<1.30	<0.580
OPGW2C	8	37353	06/12/86 11:32	<1.00	<1.00	<2.00
OPGW2	32	37354	06/11/86 10:06	<1.00	<1.30	<0.580
OPGW2C	4	37354	06/11/86 10:06	<1.00	<1.00	<2.00
T4WC	2	04007	06/04/86 14:13	<1.00	1.83	<2.00
T4WW	2	04007	06/04/86 14:13	<1.00	2.11	<0.580
T4WC	3	04030	06/04/86 08:24	<1.00	<1.00	<2.00
T4WW	10	04030	06/04/86 08:24	<1.00	<1.30	<0.580
T4WC	4	04033	06/04/86 09:01	<1.00	<1.00	<2.00
T4WW	13	04033	06/04/86 09:01	<1.00	<1.30	<0.580
T4BW	4	06005	06/04/86 11:37	<1.00	<1.30	<0.580
T4BWC	4	6005	06/04/86 11:37	<1.00	<1.00	<2.00
T4BW	5	07001	05/29/86 11:26	<1.00	<1.30	<0.580
T4BWC	1	07001	05/29/86 11:26	<1.00	<1.00	<2.00
T4WC	5	09005	06/05/86 11:05	<1.00	2.01	<2.00
T4WW	15	09005	06/05/86 11:05	<1.00	1.84	<0.580
OPGW2	8	BOLLER	07/01/86 09:32	<1.00	6.56	<0.580
OPGW2C	7	BOLLER	07/01/86 09:32	<1.00	5.90	<2.00
T4CC	1	01012	06/25/86 12:50	<1.00	15.8	<2.00
T4CW	1	01012	06/25/86 12:50	<1.00	10.8	<0.580
T4CC	2	01014	07/01/86 08:36	<100	<100	<200
T4CW	2	01014	07/01/86 08:36	<1.00	<1.30	<0.580

SAMPLE LIST T4C

STORET CODE:				99133	99133	99133	77985	77985	77985
METHOD CODE:				Q8	BB8	M8	R8	BB8	M8
PARAMETER:				DBCP	DBCP	DBCP	DCPD	DCPD	DCPD
UNITS:				UG/L	UG/L	UG/L	UG/L	UG/L	UG/L
FLD.GRP.	#	SAMPLE ID	DATE TIME						
T4CC	28	26086	06/24/86 13:55		<15	<4.0		<4.7	<2.0
T4CW	71	26086	06/24/86 13:55	<0.130			<9.31		
T4CC	29	26127	06/26/86 12:58		<15	<4.0		<4.7	<2.0
T4CW	72	26127	06/26/86 12:58	<0.130			<9.31		
T4CC	30	26128	06/24/86 13:34		<15	<4.0		<4.7	<2.0
T4CW	73	26128	06/24/86 13:34	<0.130			<9.31		
T4CC	31	26133	06/27/86 09:06		39	<400		1100	1000
T4CW	74	26133	06/27/86 09:06	26.4			935		
T4CC	32	26140	06/24/86 08:52		<15	<4.0		<4.7	<2.0
T4CW	75	26140	06/24/86 08:52	<0.130			<9.31		
T4CC	33	27040	06/19/86 09:15		<15	<4.0		<4.7	<2.0
T4CW	80	27040	06/19/86 09:15	0.433			<9.31		
T4CC	34	27062	06/12/86 10:52		<15	<4.0		<4.7	<2.0
T4CW	87	27062	06/12/86 10:52	0.330			<9.31		
T4CC	35	28025	06/19/86 14:35		<15	<4.0		<4.7	<2.0
T4CW	89	28025	06/19/86 14:35	<0.130			<9.31		
T4WC	6	28027	06/04/86 07:44		<15	<4.0		<4.7	<2.0
T4WW	35	28027	06/04/86 07:44	<0.130					
T4CC	10	03005	06/11/86 11:50		<15	<4.0		<4.7	6.2
T4CW	25	03005	06/11/86 11:50	<0.130			<9.31		
T4WC	7	33060	06/04/86 08:56		<15	<4.0		<4.7	<2.0
T4WW	26	33060	06/04/86 08:56	<0.130					
T4CC	36	35012	06/11/86 16:18		<15	<4.0		<4.7	<2.0
T4CW	94	35012	06/11/86 16:18	<0.130			<9.31		
T4CC	37	35013	06/12/86 14:21		<15	<4.0		<4.7	<2.0
T4CW	95	35013	06/12/86 14:21	<0.130			<9.31		
T4CC	38	35052	06/25/86 12:01		<15	<4.0		<4.7	<2.0
T4CW	100	35052	06/25/86 12:01	<0.130			<9.31		
T4CC	39	35065	06/30/86 09:48		<15	<40		70	<20
T4CW	106	35065	06/30/86 09:48	<0.130			33.9		
T4WC	1	03523	06/04/86 13:47		53	56		<4.7	<2.0
T4WW	1	03523	06/04/86 13:47	40.9					
T4CC	40	36001	06/23/86 14:09		200	140		73	53
T4CW	109	36001	06/23/86 14:09	141			34.2		
T4CC	41	36076	06/25/86 14:24		<15	<4000		<4.7	<2000
T4CW	113	36076	06/25/86 14:24	0.644			<9.31		
T4CC	42	36082	06/27/86 10:02		<15	<400		28	<200
T4CW	114	36082	06/27/86 10:02	<0.130			17.9		
T4CC	43	36112	06/30/86 08:52		<15	<4.0		<4.7	<2.0
T4CW	117	36112	06/30/86 08:52	<0.130			<9.31		
OPGW2	2	37307	06/18/86 11:41	<0.130			<9.31		
OPGW2C	2	37307	06/18/86 11:41		<15	<4.0		<4.7	<2.0
OPGW2	3	37308	06/16/86 15:17	0.876			111		
OPGW2C	3	37308	06/16/86 15:17		<15	<4.0		150	120
OPGW2	5	37312	06/17/86 11:13	<0.130			<9.31		
OPGW2C	1	37312	06/17/86 11:13		<15	<4.0		<4.7	<2.0
OPGW2	12	37332	06/16/86 11:58	<0.130			<9.31		
OPGW2C	5	37332	06/16/86 11:58		<15	<4.0		<4.7	<2.0
OPGW2	21	37343	06/13/86 08:34	<0.130			<9.31		
OPGW2C	6	37343	06/13/86 08:39		<15	<4.0		<4.7	8.4

SAMPLE LIST T4C

STORET CODE:				99133	99133	99133	77985	77985	77985
METHOD CODE:				Q8	BB8	M8	R8	BB8	M8
PARAMETER:				DBCP	DBCP	DBCP	DCPD	DCPD	DCPD
UNITS:				UG/L	UG/L	UG/L	UG/L	UG/L	UG/L
FLD.GRP.	#	SAMPLE ID	DATE TIME						
OPGW2	31	37353	06/12/86 11:32	<0.130			<9.31		
OPGW2C	8	37353	06/12/86 11:32		<15	<4.0		<4.7	<2.0
OPGW2	32	37354	06/11/86 10:06	<0.130			<9.31		
OPGW2C	4	37354	06/11/86 10:06		<15	<4.0		<4.7	<2.0
T4WC	2	04007	06/04/86 14:13		<15	<4.0		<4.7	<2.0
T4WW	2	04007	06/04/86 14:13	<0.130					
T4WC	3	04030	06/04/86 08:24		<15	<4.0		<4.7	<2.0
T4WW	10	04030	06/04/86 08:24	<0.130					
T4WC	4	04033	06/04/86 09:01		<15	<4.0		<4.7	<2.0
T4WW	13	04033	06/04/86 09:01	<0.130					
T4BW	4	06005	06/04/86 11:37	<0.130			<9.31		
T4BWC	4	6005	06/04/86 11:37		<15	<4.0		<4.7	<2.0
T4BW	5	07001	05/29/86 11:26	<0.130			<9.31		
T4BWC	1	07001	05/29/86 11:26		*<15	<4.0		*<4.7	<2.0
T4WC	5	09005	06/05/86 11:05		<15	<4.0		<4.7	<2.0
T4WW	15	09005	06/05/86 11:05	<0.130					
OPGW2	8	BOLLER	07/01/86 09:32	0.332			<9.31		
OPGW2C	7	BOLLER	07/01/86 09:32		<15	<4.0		<4.7	<2.0
T4CC	1	01012	06/25/86 12:50		<15	<4.0		<4.7	<2.0
T4CW	1	01012	06/25/86 12:50	0.244			<9.31		
T4CC	2	01014	07/01/86 08:36		<75	<400		72000	3700
T4CW	2	01014	07/01/86 08:36	<0.130			3360		

4TH QUARTER FY 1986 TASK 4 GC/MS CONFIRMATION DATA

FIELD GROUP NUMBERS T4CC2, T4WC2, AND OPG3C ARE GC/MS RESULTS

SAMPLE LIST T4C3

STORET CODE:				98551	34386	39330	39430	39320	39380	39390	39300	81580	98564	98563	98562	81512	98561
METHOD CODE:				B88	S8	S8	S8	S8	S8	S8	S8	U8	U8	U8	U8	U8	U8
PARAMETER:				DIMP	HCCPD	ALDRIN	ISODRIN	P,P'-DDE	DIELDRIN	ENDRIN	P,P'-DDT	DMDS	1,4-OXAT	1,4-DITH	CPMS	BTZ	CPMSO
UNITS:				UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L
FLD.GRP.	#	SAMPLE ID	DATE TIME														
T4C2	4	01021	09/18/86 14:22	<11	<0.070	<0.070	<0.060	<0.053	<0.060	<0.052	<0.070	<1.80	<2.00	<1.10	<1.30		<4.20
T4CC2	1	01021	09/18/86 07:00	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
T4C2	6	01023	09/18/86 11:09	<11	<0.070	<0.070	<0.060	<0.053	<0.060	<0.052	<0.070	<1.80	<2.00	<1.10	<1.30		<4.20
T4CC2	2	01023	09/18/86 11:09	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
T4C2	16	02020	09/17/86 11:16	<11	<0.070	<0.070	<0.060	<0.053	0.430	<0.052	<0.070	<1.80	<2.00	<1.10	<1.30		<4.20
T4CC2	4	02020	09/17/86 11:16	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
T4C2	19	02034	09/05/86 13:57	<11	<0.070	<0.070	<0.060	<0.053	<0.060	<0.052	<0.070	<1.80	<2.00	<1.10	<1.30		<4.20
T4CC2	5	02034	09/05/86 13:57	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
T4C2	20	02035	09/05/86 15:00	<11	<0.070	<0.070	<0.060	<0.053	<0.060	<0.052	<0.070	<1.80	<2.00	<1.10	<1.30		<4.20
T4CC2	6	02035	09/05/86 15:00	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
T4C2	28	22059	09/03/86 10:24	<11	<0.070	<0.070	<0.060	<0.053	0.127	<0.052	<0.070	<1.80	<2.00	<1.10	<1.30		<4.20
T4CC2	7	22059	09/03/86 10:24	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
T4C2	29	22060	09/03/86 08:05	<11	<0.070	<0.070	<0.060	<0.053	0.396	<0.052	<0.070	<1.80	<2.00	<1.10	<1.30		<4.20
T4CC2	8	22060	09/03/86 08:05	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
T4C2	31	23095	09/03/86 12:31	1100	<0.700	<0.700	<0.600	<0.530	<0.600	<0.520	<0.700	<1.80	10.8	91.0	<1.30		<4.20
T4CC2	9	23095	09/03/86 12:31	600	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	4.33	10.1	67.7	<14.0		<17.0
T4C2	33	23125	09/25/86 15:24	19	<0.070	<0.070	<0.060	<0.053	<0.060	<0.052	<0.070	<1.80	<2.00	<1.10	<1.30		<4.20
T4CC2	10	23125	09/25/86 15:24	10	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
T4C2	37	23179	09/02/86 09:57	780	2.29	<1.40	<1.20	<1.06	<1.20	<1.04	<1.40	<1.80	17.9	73.0	73.4		13.6
T4CC2	12	23179	09/02/86 09:57	540	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	55.0	115		<17.0
T4C2	39	23182	09/04/86 10:12	<11	<0.070	<0.070	<0.060	<0.053	<0.060	<0.052	<0.070	<1.80	<2.00	<1.10	<1.30		<4.20
T4CC2	14	23182	09/04/86 10:12	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
T4C2	40	23183	09/04/86 14:07	<11	<0.070	<0.070	<0.060	<0.053	<0.060	<0.052	<0.070	<1.80	<2.00	<1.10	<1.30		<4.20
T4CC2	15	23183	09/04/86 14:07	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
T4C2	50	24178	09/22/86 14:50	300	0.207	<0.070	<0.060	<0.053	3.35	2.22	<0.070	<1.80	<2.00	<1.10	13.5		95.9
T4CC2	18	24178	09/22/86 14:50	>280	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		70.3
T4C2	51	24185	09/23/86 08:50	<11	<0.070	<0.070	<0.060	<0.053	0.396	0.080	<0.070	<1.80	<2.00	<1.10	<1.30		<4.20
T4CC2	19	24185	09/23/86 08:50	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
T4C2	57	25016	09/05/86 11:06	<11	<0.070	<0.070	<0.060	<0.053	<0.060	<0.052	0.133	<1.80	<2.00	<1.10	<1.30		<4.20
T4CC2	20	25016	09/05/86 11:06	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
T4C2	60	26011	09/19/86 08:54	19	<0.070	0.109	<0.060	<0.053	0.164	<0.052	<0.070	<1.80	<2.00	1.99	<1.30		<4.20
T4CC2	21	26011	09/19/86 08:54	15	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
T4C2	61	26015	09/22/86 09:10	590	<0.070	<0.070	<0.060	<0.053	0.112	<0.052	<0.070	<1.80	2.46	11.7	<1.30		<4.20
T4CC2	22	26015	09/22/86 09:10	410	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
T4C2	62	26017	09/22/86 10:53	130	<0.070	<0.070	<0.060	<0.053	0.103	<0.052	<0.070	<1.80	<2.00	5.27	<1.30		<4.20
T4CC2	23	26017	09/22/86 10:53	61	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
T4C2	63	26020	09/23/86 08:45	920	<0.070	<0.070	<0.060	<0.053	0.201	<0.052	<0.070	<1.80	<2.00	2.93	<1.30		<4.20
T4CC2	24	26020	09/23/86 08:45									<3.00					
T4C2	65	26041	09/23/86 07:10	3300	<0.700	<0.700	<0.600	<0.530	<0.600	<0.520	<0.700	10.0	8.46	54.5	48.8		<42.0
T4CC2	25	26041	09/23/86 07:10	2500	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	42.3	<6.10	62.1	<14.0		<17.0
T4C2	72	26127	09/29/86 10:20	1700	<0.070	<0.070	<0.060	<0.053	2.42	0.366	1.14	<1.80	4.42	34.3	<1.30		<4.20
T4CC2	26	26127	09/29/86 10:20	1300	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	40.1	<14.0		<17.0
T4C2	74	26133	09/19/86 12:07	950	<1.40	<1.40	<0.060	<1.06	2.24	<1.04	<1.40	<1.80	11.4	31.7	360		31.4
T4CC2	27	26133	09/19/86 12:07	470	<11.0	<4.70	<5.90	<4.70	7.84	<7.60	<10.0	<300	13.0	35.3	408		18.6
T4C2	76	26142	09/24/86 07:48	<11	<0.070	<0.700	<0.060	<0.053	2.52	<0.520	<0.070	<1.80	<2.00	<1.10	<1.30		<4.20
T4CC2	28	26142	09/24/86 07:48	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
T4C2	122	27016	09/26/86 08:22	14	<0.070	<0.070	<0.060	<0.053	0.246	<0.052	<0.070	<1.80	<2.00	<1.10	<1.30		<4.20
T4CC2	29	27016	09/26/86 08:22	6.6	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
T4C2	81	27053	09/19/86 08:52	<11	<0.070	<0.070	<0.060	<0.053	<0.060	<0.052	<0.070	<1.80	<2.00	<1.10	<1.30		<4.20
T4CC2	30	27053	09/19/86 08:52	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0

SAMPLE LIST T4C3

STORET CODE:				81596	34030	34010	34371	98553	98554	34423	34501	34496	34546	32106	34531	34506	32102
METHOD CODE:				R8	W8	W8	W8	W8	W8	Y8	Y8	Y8	Y8	Y8	Y8	Y8	Y8
PARAMETER:				MIBK	BENZENE	TOLUEN	ETHYLBENZ	M-XYL	O&P-XYL	METHYLCL	11DCE	11DCLE	T12DCE	CHCL3	12DCLE	111TCE	CCL4
UNITS:				UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L
FLD.GRP.	#	SAMPLE ID	DATE TIME														
T4C2	4	01021	09/18/86 14:22	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	<0.610	<1.70	<2.40
T4CC2	1	01021	09/18/86 07:00	<2.00	<1.00	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	<1.00	<1.00	<1.00	<2.00
T4C2	6	01023	09/18/86 11:09	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	<0.610	<1.70	<2.40
T4CC2	2	01023	09/18/86 11:09	<2.00	<1.00	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	<1.00	<1.00	<1.00	<2.00
T4C2	16	02020	09/17/86 11:16	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	2.50	<1.20	31.9	<0.610	<1.70	<2.40
T4CC2	4	02020	09/17/86 11:16	<2.00	<1.00	<1.00	<1.00	<1.00	<2.00	<5.00		2.82	<2.00	36.0	<1.00	<1.00	<2.00
T4C2	19	02034	09/05/86 13:57	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	4.29	<1.20	13.3	<0.610	<1.70	<2.40
T4CC2	5	02034	09/05/86 13:57	<2.00	<1.00	<1.00	<1.00	<1.00	<2.00	<5.00		4.61	<2.00	14.6	<1.00	<1.00	<2.00
T4C2	20	02035	09/05/86 15:00	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	6.74	<1.20	162	<0.610	<1.70	13.5
T4CC2	6	02035	09/05/86 15:00	<2.00	<1.00	<1.00	<1.00	<1.00	<2.00	<5.00		10.0	<2.00	>166	<1.00	<1.00	16.7
T4C2	28	22059	09/03/86 10:24	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	14.1	<0.610	<1.70	<2.40
T4CC2	7	22059	09/03/86 10:24	<2.00	<1.00	<1.00	<1.00	<1.00	<2.00	17.9		<2.00	<2.00	9.09	<1.00	<1.00	<2.00
T4C2	29	22060	09/03/86 08:05	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	<0.610	<1.70	<2.40
T4CC2	8	22060	09/03/86 08:05	<2.00	<1.00	<1.00	<1.00	<1.00	<2.00	>160		<2.00	<2.00	<1.00	<1.00	<1.00	<2.00
T4C2	31	23095	09/03/86 12:31	<12.9	22.0	6.40	2.85	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	1420	<0.610	<1.70	<2.40
T4CC2	9	23095	09/03/86 12:31	6.22	23.7	<1.00	<1.00	<1.00	2.25	<5.00		<2.00	<2.00	3860	43.1	<1.00	<2.00
T4C2	33	23125	09/25/86 15:24	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	1.71	<0.610	<1.70	<2.40
T4CC2	10	23125	09/25/86 15:24	<2.00	<1.00	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	2.24	<1.00	<1.00	<2.00
T4C2	37	23179	09/02/86 09:57	<12.9	32.8	460	<1.28	<1.35	<2.47	128	<1.10	<1.20	<1.20	26900	<0.610	<1.70	<2.40
T4CC2	12	23179	09/02/86 09:57	<2.00	31.5	<1.00	<1.00	<1.00	2.85	150		3.35	<2.00	>16600	122	<1.00	<2.00
T4C2	39	23182	09/04/86 10:12	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	<0.610	<1.70	<2.40
T4CC2	14	23182	09/04/86 10:12	<2.00	<1.00	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	<1.00	<1.00	<1.00	<2.00
T4C2	40	23183	09/04/86 14:07	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	<0.610	<1.70	<2.40
T4CC2	15	23183	09/04/86 14:07	<2.00	<1.00	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	<1.00	<1.00	<1.00	<2.00
T4C2	50	24178	09/22/86 14:50	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	124	<0.610	<1.70	2.66
T4CC2	18	24178	09/22/86 14:50	<2.00	1.14	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	163	1.39	<1.00	2.73
T4C2	51	24185	09/23/86 08:50	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	<0.610	<1.70	<2.40
T4CC2	19	24185	09/23/86 08:50	<2.00	<1.10	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	<1.00	<1.00	<1.00	<2.00
T4C2	57	25016	09/05/86 11:06	<12.9	15.4	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	<0.610	<1.70	<2.40
T4CC2	20	25016	09/05/86 11:06	<2.00	5.62	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	<1.00	<1.00	<1.00	<2.00
T4C2	60	26011	09/19/86 08:54	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	<0.610	<1.70	<2.40
T4CC2	21	26011	09/19/86 08:54	<2.00	<1.00	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	<1.00	<1.00	<1.00	<2.00
T4C2	61	26015	09/22/86 09:10	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	<0.610	<1.70	<2.40
T4CC2	22	26015	09/22/86 09:10	<2.00	<1.10	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	<1.00	<1.00	<1.00	<2.00
T4C2	62	26017	09/22/86 10:53	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	<0.610	<1.70	<2.40
T4CC2	23	26017	09/22/86 10:53	<2.00	<1.10	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	<1.00	<1.00	<1.00	<2.00
T4C2	63	26020	09/23/86 08:45	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	<0.610	<1.70	<2.40
T4CC2	24	26020	09/23/86 08:45	<2.00	<1.10	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	<1.00	<1.00	<1.00	<2.00
T4C2	65	26041	09/23/86 07:10	<12.9	48.4	729	2.22	<1.35	2.59	<100	<22.0	<24.0	<24.0	<28.0	19.9	<34.0	<48.0
T4CC2	25	26041	09/23/86 07:10	25.1	<27.5	<25.0	<5.00	<5.00	<10.0	<25.0		<10.0	<10.0	<5.00	<25.0	<5.00	<10.0
T4C2	72	26127	09/29/86 10:20	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	<0.610	<1.70	<2.40
T4CC2	26	26127	09/29/86 10:20	<2.00	<1.00	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	<1.00	<1.00	<1.00	<2.00
T4C2	74	26133	09/19/86 12:07	<323	562	195	8.41	8.52	55.0	<25.0	<1.10	<6.00	<600	48000	<61.0	<170	<240
T4CC2	27	26133	09/19/86 12:07	<200	536	199	<100	<100	<200	814		<200	<200	68300	<100	<100	<200
T4C2	76	26142	09/24/86 07:48	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	<0.610	<1.70	<2.40
T4CC2	28	26142	09/24/86 07:48	<2.00	<1.10	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	<1.00	<1.00	<1.00	<2.00
T4C2	122	27016	09/26/86 08:22	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	<0.610	<1.70	<2.40
T4CC2	29	27016	09/26/86 08:22	<2.00	<1.00	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	<1.00	<1.00	<1.00	<2.00
T4C2	81	27053	09/19/86 08:52	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	<0.610	<1.70	<2.40
T4CC2	30	27053	09/19/86 08:52	<2.00	<1.00	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	<1.00	<1.00	<1.00	<2.00

SAMPLE LIST T4C3

STORET CODE:				34511	34475	34301
METHOD CODE:				Y8	Y8	Y8
PARAMETER:				112TCE	TCLEE	CLC6H5
UNITS:				UG/L	UG/L	UG/L
FLD.GRP.	#	SAMPLE ID	DATE TIME			
T4C2	4	01021	09/18/86 14:22	<1.00	<1.30	<0.580
T4CC2	1	01021	09/18/86 07:00	<1.00	<1.00	<2.00
T4C2	6	01023	09/18/86 11:09	<1.00	<1.30	<0.580
T4CC2	2	01023	09/18/86 11:09	<1.00	<1.00	<2.00
T4C2	16	02020	09/17/86 11:16	<1.00	<1.30	<0.580
T4CC2	4	02020	09/17/86 11:16	<1.00	<1.00	<2.00
T4C2	19	02034	09/05/86 13:57	<1.00	1.36	<0.580
T4CC2	5	02034	09/05/86 13:57	<1.00	<1.00	<2.00
T4C2	20	02035	09/05/86 15:00	<1.00	2.98	<0.580
T4CC2	6	02035	09/05/86 15:00	<1.00	3.59	<2.00
T4C2	28	22059	09/03/86 10:24	<1.00	<1.30	<0.580
T4CC2	7	22059	09/03/86 10:24	<1.00	<1.00	<2.00
T4C2	29	22060	09/03/86 08:05	<1.00	<1.30	<0.580
T4CC2	8	22060	09/03/86 08:05	<1.00	<1.00	<2.00
T4C2	31	23095	09/03/86 12:31	<1.00	31.5	<0.580
T4CC2	9	23095	09/03/86 12:31	<1.00	34.3	<2.00
T4C2	33	23125	09/25/86 15:24	<1.00	<1.30	<0.580
T4CC2	10	23125	09/25/86 15:24	<1.00	<1.00	<2.00
T4C2	37	23179	09/02/86 09:57	<1.00	67.7	<0.580
T4CC2	12	23179	09/02/86 09:57	<1.00	59.0	<2.00
T4C2	39	23182	09/04/86 10:12	<1.00	<1.30	<0.580
T4CC2	14	23182	09/04/86 10:12	<1.00	<1.00	<2.00
T4C2	40	23183	09/04/86 14:07	<1.00	<1.30	<0.580
T4CC2	15	23183	09/04/86 14:07	<1.00	<1.00	<2.00
T4C2	50	24178	09/22/86 14:50	<1.00	48.2	<0.580
T4CC2	18	24178	09/22/86 14:50	<1.00	55.7	<2.00
T4C2	51	24185	09/23/86 08:50	<1.00	<1.30	<0.580
T4CC2	19	24185	09/23/86 08:50	<1.00	<1.00	<2.00
T4C2	57	25016	09/05/86 11:06	<1.00	<1.30	<0.580
T4CC2	20	25016	09/05/86 11:06	<1.00	<1.00	<2.00
T4C2	60	26011	09/19/86 08:54	<1.00	<1.30	<0.580
T4CC2	21	26011	09/19/86 08:54	<1.00	<1.00	<2.00
T4C2	61	26015	09/22/86 09:10	<1.00	<1.30	<0.580
T4CC2	22	26015	09/22/86 09:10	<1.00	<1.00	<2.00
T4C2	62	26017	09/22/86 10:53	<1.00	<1.30	<0.580
T4CC2	23	26017	09/22/86 10:53	<1.00	<1.00	<2.00
T4C2	63	26020	09/23/86 08:45	<1.00	<1.30	<0.580
T4CC2	24	26020	09/23/86 08:45	<1.00	<1.00	<2.00
T4C2	65	26041	09/23/86 07:10	<20.0	<26.0	<11.6
T4CC2	25	26041	09/23/86 07:10	<5.00	<5.00	<10.0
T4C2	72	26127	09/29/86 10:20	<1.00	<1.30	<0.580
T4CC2	26	26127	09/29/86 10:20	<1.00	<1.00	3.52
T4C2	74	26133	09/19/86 12:07	<5.00	<6.50	<2.90
T4CC2	27	26133	09/19/86 12:07	<100	437	<200
T4C2	76	26142	09/24/86 07:48	<1.00	<1.30	<0.580
T4CC2	28	26142	09/24/86 07:48	<1.00	<1.00	<2.00
T4C2	122	27016	09/26/86 08:22	<1.00	<1.30	<0.580
T4CC2	29	27016	09/26/86 08:22	<1.00	<1.00	<2.00
T4C2	81	27053	09/19/86 08:52	<1.00	<1.30	<0.580
T4CC2	30	27053	09/19/86 08:52	<1.00	<1.00	<2.00

SAMPLE LIST T4C3

STORET CODE:				99133	99133	99133	77985	77985	77985
METHOD CODE:				Q8	BB8	M8	R8	BB8	M8
PARAMETER:				DBCP	DBCP	DBCP	DCPD	DCPD	DCPD
UNITS:				UG/L	UG/L	UG/L	UG/L	UG/L	UG/L
FLD.GRP.	#	SAMPLE ID	DATE TIME						
T4C2	4	01021	09/18/86 14:22	<0.130			<9.31		
T4CC2	1	01021	09/18/86 07:00		<15	<4.0		<4.7	<2.0
T4C2	6	01023	09/18/86 11:09	<0.130			<9.31		
T4CC2	2	01023	09/18/86 11:09		<15	<4.0		<4.7	<2.0
T4C2	16	02020	09/17/86 11:16	<0.130			<9.31		
T4CC2	4	02020	09/17/86 11:16		<15	<4.0		<4.7	<2.0
T4C2	19	02034	09/05/86 13:57	<0.130			<9.31		
T4CC2	5	02034	09/05/86 13:57		<15	<4.0		<4.7	<2.0
T4C2	20	02035	09/05/86 15:00	<0.130			<9.31		
T4CC2	6	02035	09/05/86 15:00		<15	<4.0		<4.7	<2.0
T4C2	28	22059	09/03/86 10:24	0.149			<9.31		
T4CC2	7	22059	09/03/86 10:24		<15	<4.0		<4.7	<2.0
T4C2	29	22060	09/03/86 08:05	<0.130			<9.31		
T4CC2	8	22060	09/03/86 08:05		<15	<4.0		<4.7	<2.0
T4C2	31	23095	09/03/86 12:31	<0.130			674		
T4CC2	9	23095	09/03/86 12:31		<15	<4.0		900	680
T4C2	33	23125	09/25/86 15:24	<0.130			<9.31		
T4CC2	10	23125	09/25/86 15:24		<15	<4.0		<4.7	<2.0
T4C2	37	23179	09/02/86 09:57	1.82			626		
T4CC2	12	23179	09/02/86 09:57		<15	<4.0		870	790
T4C2	39	23182	09/04/86 10:12	<0.130			<9.31		
T4CC2	14	23182	09/04/86 10:12		<15	<4.0		<4.7	<2.0
T4C2	40	23183	09/04/86 14:07	<0.130			<9.31		
T4CC2	15	23183	09/04/86 14:07		<15	<4.0		<4.7	<2.0
T4C2	50	24178	09/22/86 14:50	5.50			31.9		
T4CC2	18	24178	09/22/86 14:50		<15	5.1		56	47
T4C2	51	24185	09/23/86 08:50	<0.130			<9.31		
T4CC2	19	24185	09/23/86 08:50		<15	<4.0		<4.7	<2.0
T4C2	57	25016	09/05/86 11:06	<0.130			<9.31		
T4CC2	20	25016	09/05/86 11:06		<15	<4.0		<4.7	<2.0
T4C2	60	26011	09/19/86 08:54	<0.130			<9.31		
T4CC2	21	26011	09/19/86 08:54		<15	<4.0		<4.7	<2.0
T4C2	61	26015	09/22/86 09:10	<0.130			<9.31		
T4CC2	22	26015	09/22/86 09:10		<15	<4.0		<4.7	<2.0
T4C2	62	26017	09/22/86 10:53	<0.130			<9.31		
T4CC2	23	26017	09/22/86 10:53		<15	<4.0		<4.7	<2.0
T4C2	63	26020	09/23/86 08:45	<0.130			<9.31		
T4CC2	24	26020	09/23/86 08:45			<4.0			<2.0
T4C2	65	26041	09/23/86 07:10	<0.130			23.5		
T4CC2	25	26041	09/23/86 07:10		<15	<20		73	47
T4C2	72	26127	09/29/86 10:20	<0.130			<9.31		
T4CC2	26	26127	09/29/86 10:20		<15	<4.0		<4.7	<2.0
T4C2	74	26133	09/19/86 12:07	25.0			736		
T4CC2	27	26133	09/19/86 12:07		30	<400		770	850
T4C2	76	26142	09/24/86 07:48	<0.130			<9.31		
T4CC2	28	26142	09/24/86 07:48		<15	<4.0		<4.7	<2.0
T4C2	122	27016	09/26/86 08:22	<0.130			<9.31		
T4CC2	29	27016	09/26/86 08:22		<15	<4.0		<4.7	<2.0
T4C2	81	27053	09/19/86 08:52	<0.130			<9.31		
T4CC2	30	27053	09/19/86 08:52		<15	<4.0		<4.7	<2.0

SAMPLE LIST T4C3

STORET CODE:					98551	34386	39330	39430	39320	39380	39390	39300	81580	98564	98563	98562	81512	98561
METHOD CODE:					BB8	S8	S8	S8	S8	S8	S8	S8	U8	U8	U8	U8	U8	U8
PARAMETER:					DIMP	HCCPD	ALDRIN	ISODRIN	P,P'-DDE	DIELDRIN	ENDRIN	P,P'-DDT	DMDS	1,4-OXAT	1,4-DITH	CPMS	BTZ	CPMSO
UNITS:					UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L
FLD.GRP.	#	SAMPLE ID	DATE	TIME														
T4W2	19	33024	09/03/86	10:50	<11	<0.070	<0.070	<0.060	<0.053	<0.060	<0.052	<0.070						
T4WC2	1	33024	09/03/86	10:50	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
T4W2	21	33026	08/28/86	13:53	<11	<0.070	<0.070	<0.060	<0.053	<0.060	<0.052	<0.070						
T4WC2	2	33026	08/28/86	13:53	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
T4W2	23	33030	09/04/86	09:40		<0.070	<0.070	<0.060	<0.053	<0.060	<0.052	<0.070						
T4WC2	3	33030	09/04/86	09:40	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
T4W2	25	33034	09/04/86	11:37		<0.070	<0.070	<0.060	<0.053	<0.060	<0.052	<0.070						
T4WC2	4	33034	09/04/86	11:37	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
T4C2	97	35037	09/05/86	12:30	<11	<0.070	<0.070	<0.060	<0.053	3.64	<0.052	<0.070	<1.80	<2.00	<1.10	<1.30		<4.20
T4CC2	32	35037	09/05/86	12:30	<5.7	<11.0	<4.70	<5.90	<4.70	8.04	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
T4C2	98	35038	09/05/86	13:31	<11	<0.070	<0.070	<0.060	<0.053	<0.060	<0.052	<0.070	<1.80	<2.00	<1.10	<1.30		<4.20
T4CC2	33	35038	09/05/86	13:31	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
T4C2	101	35058	09/08/86	10:18	<11	<0.070	<0.070	<0.060	<0.053	1.44	<0.052	<0.070	<1.80	<2.00	<1.10	<1.30		<4.20
T4CC2	34	35058	09/08/86	10:18	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
T4C2	105	35063	09/15/86	11:37	<11	<0.070	<0.070	<0.060	<0.053	<0.060	<0.052	<0.070	<1.80	<2.00	<1.10	<1.30		<4.20
T4CC2	35	35063	09/15/86	11:37	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
T4C2	106	35065	09/08/86	11:17	2500	<0.700	<0.700	<0.600	<0.530	<0.600	<0.520	<0.700	<1.80	14.2	113	<1.30		<4.20
T4CC2	36	35065	09/08/86	11:17	1500	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	104	<14.0		<17.0
T4C2	110	36065	09/26/86	11:44	43	<0.070	<0.070	<0.060	<0.053	<0.060	<0.052	<0.070	<1.80	<2.00	<1.10	<1.30		<4.20
T4CC2	37	36065	09/26/86	11:41	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
T4C2	114	36082	09/26/86	10:45	580	<0.700	<0.700	<0.600	<0.530	<0.600	<0.520	<0.700	<1.80	126	896	6.35		<4.20
T4CC2	39	36082	09/26/86	10:45	480	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	197	1220	<14.0		<17.0
T4C2	120	36121	09/26/86	13:40	<11	<0.070	<0.070	<0.060	<0.053	<0.060	<0.052	<0.070	<1.80	<2.00	<1.10	<1.30		<4.20
T4CC2	38	36121	09/26/86	13:40	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
OPG3	1	37305	08/26/86	14:56	1700	<0.070	<0.070	<0.060	<0.053	<0.060	<0.052	<0.070	<1.80	<2.00	<1.10	<1.30		<4.20
OPG3C	1	37305	08/26/86	14:56	1000	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
OPG3	6	37313	08/26/86	10:15	3900	<0.350	<0.350	<0.300	<0.265	<0.300	<0.260	<0.350	<1.80	4.15	9.45	<1.30		<4.20
OPG3C	2	37313	08/26/86	10:15	3700	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
OPG3	7	37320	09/22/86	12:06	19	<0.070	<0.070	<0.060	<0.053	0.065	<0.052	<0.070	<1.80	<2.00	<1.10	<1.30		<4.20
OPG3C	3	37320	09/22/86	12:06	13	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
OPG3	25	37347	08/25/86	10:13	<11	<0.070	<0.070	<0.060	<0.053	<0.060	<0.052	<0.070	<1.80	<2.00	<1.10	<1.30		<4.20
OPG3C	5	37347	08/25/86	00:00	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
OPG3	27	37349	09/11/86	07:53	42	<0.070	<0.070	<0.060	<0.053	<0.060	<0.052	<0.070	<1.80	<2.00	<1.10	<1.30		<4.20
OPG3C	6	37349	09/11/86	07:53	31	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	NA	<6.10	<11.0	<14.0		<17.0
OPG3	31	37353	09/12/86	07:38	660	<0.070	<0.070	<0.060	<0.053	<0.060	<0.052	<0.070	<1.80	<2.00	<1.10	<1.30		<4.20
OPG3C	4	37353	09/12/86	07:38	>94	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	NA	<6.10	<11.0	<14.0		<17.0
OPG3	34	37356	09/08/86	10:43	180	<0.070	<0.070	<0.060	<0.053	<0.060	<0.052	<0.070	<1.80	<2.00	<1.10	<1.30		<4.20
OPG3C	7	37356	09/08/86	10:43	150	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
OPG3	35	37357	09/11/86	10:47	22	<0.070	<0.070	<0.060	<0.053	<0.060	<0.052	<0.070	<1.80	<2.00	<1.10	<1.30		<4.20
OPG3C	8	37357	09/11/86	10:47	10	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	NA	<6.10	<11.0	<14.0		<17.0
T4W2	4	04014	08/26/86	08:04	<11	<0.070	<0.070	<0.060	<0.053	<0.060	<0.052	<0.070						
T4WC2	5	04014	08/26/86	08:04	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
T4W2	6	04021	08/25/86	10:18	<11	<0.070	<0.070	<0.060	<0.053	<0.060	<0.052	<0.070						
T4WC2	6	04021	08/25/86	10:18	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	5.64	<6.10	<11.0	<14.0		<17.0
T4W2	8	04027	08/26/86	11:59	<11	<0.070	<0.070	<0.060	<0.053	<0.060	<0.052	<0.070						
T4WC2	7	04027	08/26/86	11:59	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0

SAMPLE LIST T4C3

STORET CODE:				81596	34030	34010	34371	98553	98554	34423	34501	34496	34546	32106	34531	34506	32102
METHOD CODE:				R8	W8	W8	W8	W8	W8	Y8	Y8	Y8	Y8	Y8	Y8	Y8	Y8
PARAMETER:				MIBK	BENZENE	TOLUEN	ETHYLBENZ	M-XYL	O&P-XYL	METHYLCL	11DCE	11DCLE	T12DCE	CHCL3	12DCLE	111TCE	CCL4
UNITS:				UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L
FLD.GRP.	#	SAMPLE ID	DATE TIME														
T4W2	19	33024	09/03/86 10:50		3.68	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	<0.610	<1.70	<2.40
T4WC2	1	33024	09/03/86 10:50	<2.00	<1.00	<1.00	<1.00	<1.00	<2.00	47.3		<2.00	<2.00	<1.00	<1.00	<1.00	<2.00
T4W2	21	33026	08/28/86 13:53		<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	<0.610	<1.70	<2.40
T4WC2	2	33026	08/28/86 13:53	<2.00	<1.00	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	<1.00	<1.00	<1.00	<2.00
T4W2	23	33030	09/04/86 09:40		<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	1.78	<0.610	<1.70	<2.40
T4WC2	3	33030	09/04/86 09:40	<2.00	<1.00	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	2.53	<1.00	<1.00	<2.00
T4W2	25	33034	09/04/86 11:37		<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	<0.610	<1.70	<2.40
T4WC2	4	33034	09/04/86 11:37	<2.00	<1.00	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	1.91	<1.00	<1.00	<2.00
T4C2	97	35037	09/05/86 12:30	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	24.6	<0.610	<1.70	<2.40
T4CC2	32	35037	09/05/86 12:30	<2.00	<1.00	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	33.0	<1.00	<1.00	<2.00
T4C2	98	35038	09/05/86 13:31	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	<0.610	<1.70	<2.40
T4CC2	33	35038	09/05/86 13:31	<2.00	<1.00	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	<1.00	<1.00	<1.00	<2.00
T4C2	101	35058	09/08/86 10:18	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	7.83	<0.610	<1.70	<2.40
T4CC2	34	35058	09/08/86 10:18	<2.00	<1.00	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	9.40	<1.00	<1.00	<2.00
T4C2	105	35063	09/15/86 11:37	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	<0.610	<8.50	<9.60
T4CC2	35	35063	09/15/86 11:37	<2.00	<1.00	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	<1.00	<1.00	<1.00	<2.00
T4C2	106	35065	09/08/86 11:17	<12.9	<1.34	>8.55	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	4.92	0.776	<1.70	<2.40
T4CC2	36	35065	09/08/86 11:17	<2.00	<1.00	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	<1.00	<1.00	<1.00	<2.00
T4C2	110	36065	09/26/86 11:44	<12.9	4.09	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	43.9	<0.610	<1.70	11.5
T4CC2	37	36065	09/26/86 11:41	<2.00	7.73	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	73.5	<1.00	<1.00	17.8
T4C2	114	36082	09/26/86 10:45	<12.9	<1.34	<1.21	<1.28	2.69	3.43	<5.00	<1.10	<1.20	<1.20	4.28	<0.610	<1.70	<2.40
T4CC2	39	36082	09/26/86 10:45	<2.00	<1.00	<1.00	<1.00	2.10	<2.00	<5.00		<2.00	<2.00	3.43	15.6	<1.00	<2.00
T4C2	120	36121	09/26/86 13:40	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	<0.610	<1.70	<2.40
T4CC2	38	36121	09/26/86 13:40	<2.00	<1.00	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	<1.00	<1.00	<1.00	<2.00
OPG3	1	37305	08/26/86 14:56	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	<0.610	<1.70	<2.40
OPG3C	1	37305	08/26/86 14:56	<2.00	<1.00	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	<1.00	<1.00	<1.00	<2.00
OPG3	6	37313	08/26/86 10:15	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	0.617	<1.70	<2.40
OPG3C	2	37313	08/26/86 10:15	<2.00	<1.00	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	<1.00	<1.00	<1.00	<2.00
OPG3	7	37320	09/22/86 12:06	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	<0.610	<1.70	<2.40
OPG3C	3	37320	09/22/86 12:06	<2.00	<1.10	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	1.87	<1.00	<1.00	<2.00
OPG3	25	37347	08/25/86 10:13	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	<0.610	<1.70	<2.40
OPG3C	5	37347	08/25/86 00:00	<2.00	<1.00	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	<1.00	<1.00	<1.00	<2.00
OPG3	27	37349	09/11/86 07:53	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	<0.610	<1.70	<2.40
OPG3C	6	37349	09/11/86 07:53	NA	NA	NA	NA	NA	NA	NA		NA	NA	NA	NA	NA	NA
OPG3	31	37353	09/12/86 07:38	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	<0.610	<1.70	<2.40
OPG3C	4	37353	09/12/86 07:38	NA	NA	NA	NA	NA	NA	NA		NA	NA	NA	NA	NA	NA
OPG3	34	37356	09/08/86 10:43	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	<0.610	<1.70	<2.40
OPG3C	7	37356	09/08/86 10:43	<2.00	<1.00	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	<1.00	<1.00	<1.00	<2.00
OPG3	35	37357	09/11/86 10:47	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	11.0	<0.610	<1.70	<2.40
OPG3C	8	37357	09/11/86 10:47	NA	NA	NA	NA	NA	NA	NA		NA	NA	NA	NA	NA	NA
T4W2	4	04014	08/26/86 08:04		<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	<0.610	<1.70	<2.40
T4WC2	5	04014	08/26/86 08:04	<2.00	<1.00	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	<1.00	<1.00	<1.00	<2.00
T4W2	6	04021	08/25/86 10:18		<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	<0.610	<1.70	<2.40
T4WC2	6	04021	08/25/86 10:18	<2.00	<1.00	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	1.84	<1.00	<1.00	<2.00
T4W2	8	04027	08/26/86 11:59		<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	<0.610	<1.70	<2.40
T4WC2	7	04027	08/26/86 11:59	<2.00	<1.00	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	<1.00	<1.00	<1.00	<2.00

SAMPLE LIST T4C3

STORET CODE:				34511	34475	34301
METHOD CODE:				Y8	Y8	Y8
PARAMETER:				112TCE	TCLEE	CLC6H5
UNITS:				UG/L	UG/L	UG/L
FLD.GRP.	#	SAMPLE ID	DATE TIME			
T4W2	19	33024	09/03/86 10:50	<1.00	<1.30	<0.580
T4WC2	1	33024	09/03/86 10:50	<1.00	<1.00	<2.00
T4W2	21	33026	08/28/86 13:53	<1.00	<1.30	<0.580
T4WC2	2	33026	08/28/86 13:53	<1.00	<1.00	<2.00
T4W2	23	33030	09/04/86 09:40	<1.00	<1.30	<0.580
T4WC2	3	33030	09/04/86 09:40	<1.00	<1.00	<2.00
T4W2	25	33034	09/04/86 11:37	<1.00	<1.30	<0.580
T4WC2	4	33034	09/04/86 11:37	<1.00	<1.00	<2.00
T4C2	97	35037	09/05/86 12:30	<1.00	<1.30	<0.580
T4CC2	32	35037	09/05/86 12:30	<1.00	<1.00	<2.00
T4C2	98	35038	09/05/86 13:31	<1.00	<1.30	<0.580
T4CC2	33	35038	09/05/86 13:31	<1.00	<1.00	<2.00
T4C2	101	35058	09/08/86 10:18	<1.00	<1.30	<0.580
T4CC2	34	35058	09/08/86 10:18	<1.00	<1.00	<2.00
T4C2	105	35063	09/15/86 11:37	<5.00	<1.30	<0.580
T4CC2	35	35063	09/15/86 11:37	<1.00	<1.00	<2.00
T4C2	106	35065	09/08/86 11:17	<1.00	11.0	5.77
T4CC2	36	35065	09/08/86 11:17	<1.00	10.7	4.44
T4C2	110	36065	09/26/86 11:44	<1.00	<1.30	1.78
T4CC2	37	36065	09/26/86 11:41	<1.00	<1.00	2.87
T4C2	114	36082	09/26/86 10:45	<1.00	1.55	<0.580
T4CC2	39	36082	09/26/86 10:45	<1.00	1.09	2.16
T4C2	120	36121	09/26/86 13:40	<1.00	<1.30	<0.580
T4CC2	38	36121	09/26/86 13:40	<1.00	<1.00	<2.00
OPG3	1	37305	08/26/86 14:56	<1.00	<1.30	<0.580
OPG3C	1	37305	08/26/86 14:56	<1.00	<1.00	<2.00
OPG3	6	37313	08/26/86 10:15	<1.00	<1.30	<0.580
OPG3C	2	37313	08/26/86 10:15	<1.00	<1.00	<2.00
OPG3	7	37320	09/22/86 12:06	<1.00	<1.30	<0.580
OPG3C	3	37320	09/22/86 12:06	<1.00	<1.00	<2.00
OPG3	25	37347	08/25/86 10:13	<1.00	<1.30	<0.580
OPG3C	5	37347	08/25/86 00:00	<1.00	<1.00	<2.00
OPG3	27	37349	09/11/86 07:53	<1.00	<1.30	<0.580
OPG3C	6	37349	09/11/86 07:53	NA	NA	NA
OPG3	31	37353	09/12/86 07:38	<1.00	<1.30	<0.580
OPG3C	4	37353	09/12/86 07:38	NA	NA	NA
OPG3	34	37356	09/08/86 10:43	<1.00	<1.30	<0.580
OPG3C	7	37356	09/08/86 10:43	<1.00	<1.00	<2.00
OPG3	35	37357	09/11/86 10:47	<1.00	2.24	<0.580
OPG3C	8	37357	09/11/86 10:47	NA	NA	NA
T4W2	4	04014	08/26/86 08:04	<1.00	<1.30	<0.580
T4WC2	5	04014	08/26/86 08:04	<1.00	<1.00	<2.00
T4W2	6	04021	08/25/86 10:18	<1.00	<1.30	<0.580
T4WC2	6	04021	08/25/86 10:18	<1.00	<1.00	<2.00
T4W2	8	04027	08/26/86 11:59	<1.00	<1.30	<0.580
T4WC2	7	04027	08/26/86 11:59	<1.00	<1.00	<2.00

SAMPLE LIST T4C3

STORET CODE:				99133	99133	99133	77985	77985	77985
METHOD CODE:				Q8	BB8	M8	R8	BB8	M8
PARAMETER:				DBCP	DBCP	DBCP	DCPD	DCPD	DCPD
UNITS:				UG/L	UG/L	UG/L	UG/L	UG/L	UG/L
FLD.GRP.	#	SAMPLE ID	DATE TIME						
T4W2	19	33024	09/03/86 10:50	<0.130					
T4WC2	1	33024	09/03/86 10:50		<15	<4.0		<4.7	<2.0
T4W2	21	33026	08/28/86 13:53	<0.130					
T4WC2	2	33026	08/28/86 13:53		<15	<4.0		<4.7	<2.0
T4W2	23	33030	09/04/86 09:40	5.46					
T4WC2	3	33030	09/04/86 09:40		<15	4.9		<4.7	<2.0
T4W2	25	33034	09/04/86 11:37	<0.130					
T4WC2	4	33034	09/04/86 11:37		<15	<4.0		<4.7	<2.0
T4C2	97	35037	09/05/86 12:30	<0.130			<9.31		
T4CC2	32	35037	09/05/86 12:30		<15	<4.0		<4.7	<2.0
T4C2	98	35038	09/05/86 13:31	<0.130			<9.31		
T4CC2	33	35038	09/05/86 13:31		<15	<4.0		<4.7	<2.0
T4C2	101	35058	09/08/86 10:18	<0.130			<9.31		
T4CC2	34	35058	09/08/86 10:18		<15	<4.0		<4.7	<2.0
T4C2	105	35063	09/15/86 11:37	<0.130			<9.31		
T4CC2	35	35063	09/15/86 11:37		<15	<4.0		<4.7	<2.0
T4C2	106	35065	09/08/86 11:17	<0.130			24.0		
T4CC2	36	35065	09/08/86 11:17		<15	<4.0		42	27
T4C2	110	36065	09/26/86 11:44	1.07			<9.31		
T4CC2	37	36065	09/26/86 11:41		<15	<4.0		<4.7	<2.0
T4C2	114	36082	09/26/86 10:45	0.191			24.3		
T4CC2	39	36082	09/26/86 10:45		<15	<4.0		31	30
T4C2	120	36121	09/26/86 13:40	<0.130			<9.31		
T4CC2	38	36121	09/26/86 13:40		<15	<4.0		<4.7	<2.0
OPG3	1	37305	08/26/86 14:56	<0.130			<9.31		
OPG3C	1	37305	08/26/86 14:56		<15	<4.0		<4.7	<2.0
OPG3	6	37313	08/26/86 10:15	<0.130			<9.31		
OPG3C	2	37313	08/26/86 10:15		<15	<4.0		<4.7	<2.0
OPG3	7	37320	09/22/86 12:06	<0.130			<9.31		
OPG3C	3	37320	09/22/86 12:06		<15	<4.0		<4.7	<2.0
OPG3	25	37347	08/25/86 10:13	<0.130			<9.31		
OPG3C	5	37347	08/25/86 00:00		<15	<4.0		<4.7	<2.0
OPG3	27	37349	09/11/86 07:53	<0.130			<9.31		
OPG3C	6	37349	09/11/86 07:53		<15	NA		<4.7	NA
OPG3	31	37353	09/12/86 07:38	<0.130			<9.31		
OPG3C	4	37353	09/12/86 07:38		<15	NA		<4.7	NA
OPG3	34	37356	09/08/86 10:43	<0.130			<9.31		
OPG3C	7	37356	09/08/86 10:43		<15	<4.0		<4.7	<2.0
OPG3	35	37357	09/11/86 10:47	<0.130			<9.31		
OPG3C	8	37357	09/11/86 10:47		<15	NA		<4.7	NA
T4W2	4	04014	08/26/86 08:04	11.5					
T4WC2	5	04014	08/26/86 08:04		<15	9.1		<4.7	<2.0
T4W2	6	04021	08/25/86 10:18	<0.130					
T4WC2	6	04021	08/25/86 10:18		<15	<4.0		<4.7	<2.0
T4W2	8	04027	08/26/86 11:59	38.8					
T4WC2	7	04027	08/26/86 11:59		43	<4.0		<4.7	<2.0

TASK 44 GC/MS CONFIRMATION DATA

FIELD GROUP NUMBER T44GM53 IS GC/MS RESULTS

SAMPLE LIST T4PAUL

STORET CODE:				98551	34386	39330	39430	39320	39380	39390	39300	81580	98564	98563	98562	81512	98561
METHOD CODE:				BB8	S8	S8	S8	S8	S8	S8	S8	U8	U8	U8	U8	U8	U8
PARAMETER:				DIMP	HCCPD	ALDRIN	ISODRIN	P,P'-DDE	DIELDRIN	ENDRIN	P,P'-DDT	DMDS	1,4-OXAT	1,4-DITH	CPMS	BTZ	CPMSO
UNITS:				UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L
FLD.GRP.	#	SAMPLE ID	DATE TIME														
T44GMS3	1	01008	05/05/87 10:13	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
T44IS3	1	01008	05/05/87 10:13	<11	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
T44RR3	1	01008	06/02/87 08:51	<11	<0.083	<0.083	<0.056	<0.046	0.154	<0.060	<0.059	<1.16	<1.35	<1.59	<1.08	<1.14	<1.98
T44CW3	7	02008	05/05/87 13:19	<11	<0.083	<0.083	<0.056	<0.046	0.069	<0.060	<0.059	<1.16	<1.35	<1.59	<1.08	<1.14	<1.98
T44GMS3	2	02008	05/05/87 13:19	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
T44RR3	3	02008	06/02/87 08:58	<11	<0.083	<0.083	<0.056	<0.046	0.080	<0.060	<0.059	<1.16	<1.35	<1.59	<1.08	<1.14	<1.98
T44GMS3	3	04009	05/06/87 07:36	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
T44WW3	9	04009	05/06/87 07:36	<11	<0.083	<0.083	<0.056	<0.046	<0.055	<0.060	<0.059	<1.16	<1.35	<1.59	<1.08	1.50	<1.98
T44GMS3	4	09002	05/05/87 14:16	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
T44RR3	12	09002	06/03/87 09:55	<11	<0.083	<0.083	<0.056	<0.046	<0.055	<0.060	<0.059	<1.16	<1.35	<1.59	<1.08	<1.14	<1.98
T44WW3	106	09002	05/05/87 14:16	<11	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
T44GMS3	5	22051	05/13/87 07:52	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<2.50	<6.10	<11.0	<14.0		<17.0
T4425-3	5	23004	05/13/87 10:08	1600	<0.415	<0.415	<0.280	<0.230	3.48	0.512	<0.295	<1.16	2.92	10.8	<1.08	<1.14	<1.98
T44GMS3	6	23004	05/13/87 10:08	930	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<2.50	9.08	48.2	24.6		<17.0
T4425-3	6	23029	05/13/87 11:44	420	<0.083	<0.083	<0.056	<0.046	0.670	0.421	<0.059	8.47	13.1	55.0	30.1	1.41	12.7
T44GMS3	7	23029	05/13/87 11:44	230	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	NA	<6.10	<11.0	<14.0		<17.0
T4425-3	11	23189	05/14/87 08:36	<11	<0.083	<0.083	<0.056	<0.046	<0.055	<0.060	<0.059	<1.16	<1.35	<1.59	<1.08	<1.14	<1.98
T44GMS3	8	23189	05/14/87 08:36	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<2.50	<6.10	<11.0	<14.0		<17.0
T44GMS3	9	23193	05/14/87 08:28	NA	NA	NA	NA	NA	NA	NA	NA	27.5	NA	NA	NA		NA
T44IS3	9	23193	05/14/87 08:28	<11	<0.083	<0.083	<0.056	<0.046	<0.055	<0.060	<0.059	<1.16	<1.35	1.68	<1.08	<1.14	<1.98
T4425-3	15	24092	05/18/87 08:42	30	<0.083	<0.083	<0.056	<0.046	<0.055	<0.060	<0.059	<1.16	<1.35	<1.59	<1.08	<1.14	<1.98
T44GMS3	10	24092	05/18/87 08:42	25	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<2.50	<6.10	<11.0	<14.0		<17.0
T4425-3	16	24106	05/18/87 13:35	<11	<0.083	<0.083	<0.056	<0.046	<0.055	<0.060	<0.059	<1.16	<1.35	<1.59	<1.08	<1.14	<1.98
T44GMS3	11	24106	05/18/87 13:35	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<2.50	<6.10	<11.0	<14.0		<17.0
T4425-3	18	24111	05/14/87 13:55	220	<0.083	<0.083	<0.056	<0.046	<0.055	<0.060	<0.059	<1.16	<1.35	<1.59	<1.08	<1.14	<1.98
T44GMS3	12	24111	05/14/87 13:55	120	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<2.50	<6.10	<11.0	<14.0		<17.0
T4425-3	19	24113	05/18/87 10:46	13	<0.083	<0.083	<0.056	<0.046	<0.055	<0.060	<0.059	<1.16	<1.35	<1.59	<1.08	<1.14	<1.98
T44GMS3	13	24113	05/18/87 10:46	8.4	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<2.50	<6.10	<11.0	<14.0		<17.0
T4425-3	20	24120	05/19/87 13:43	<11	<0.083	<0.083	<0.056	<0.046	0.125	<0.060	<0.059	<1.16	<1.35	<1.59	<1.08	<1.14	<1.98
T44GMS3	14	24120	05/19/87 13:43	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<2.50	<6.10	<11.0	<14.0		<17.0
T4425-3	22	24127	05/12/87 14:33	680	<0.083	<0.083	<0.056	<0.046	1.14	0.819	>0.066	<1.16	2.09	6.45	22.9	<1.14	92.6
T44GMS3	15	24127	05/12/87 14:43	310	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<2.50	<6.10	<11.0	22.3		49.5
T4425-3	24	27049	05/12/87 15:12	<11	<0.083	<0.083	<0.056	<0.046	0.136	<0.060	<0.059	<1.16	<1.35	<1.59	<1.08	<1.14	<1.98
T44GMS3	17	27049	05/12/87 15:12	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<2.50	<6.10	<11.0	<14.0		<17.0
T44CW3	64	27055	05/08/87 09:15	<11	<0.083	<0.083	<0.056	<0.046	<0.055	<0.060	<0.059	<1.16	<1.35	<1.59	<1.08	<1.14	<1.98
T44GMS3	19	27055	05/08/87 09:15	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<2.50	<6.10	<11.0	<14.0		<17.0
T4425-3	25	27074	05/13/87 09:47	<11	<0.083	<0.083	<0.056	<0.046	0.180	<0.060	<0.059	<1.16	<1.35	<1.59	<1.08	<1.14	<1.98
T44GMS3	20	27074	05/13/87 09:47	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	NA	<6.10	<11.0	<14.0		<17.0
T44GMS3	21	33002	05/05/87 08:21	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
T44RR3	17	33002	06/02/87 14:41	<11	<0.083	<0.083	<0.056	<0.046	<0.055	<0.060	<0.059	<1.16	<1.35	<1.59	<1.08	<1.14	<1.98
T44WW3	108	33002	05/05/87 08:21	<11	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
T44GMS3	22	33063	05/06/87 14:24	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	<6.10	<11.0	<14.0		<17.0
T44WW3	32	33063	05/06/87 14:24	<11	<0.083	<0.083	<0.056	<0.046	<0.055	<0.060	<0.059	<1.16	<1.35	<1.59	<1.08	<1.14	<1.98
T44GMS3	23	35016	05/06/87 15:16	3600	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	14.7	160	<14.0		<17.0
T44IS3	23	35016	05/06/87 15:16	5400	<0.083	<0.083	<0.056	<0.046	<0.055	<0.060	<0.059	<1.16	16.9	183	1.25	3.56	<1.98
T44GMS3	25	35066	05/12/87 07:47	1400	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<2.50	<6.10	<11.0	<14.0		<17.0
T44GMS3	26	36084	05/12/87 10:20	5400	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<2.50	44.6	346	<14.0		<17.0
T44IS3	30	36084	05/12/87 10:20	12000	<2.08	<2.08	<1.40	<1.15	<1.38	<1.50	<1.48	<1.16	68.6	498	<1.08	5.27	<1.98
T44GMS3	27	36090	05/06/87 13:51	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<3.00	1230	1060	<14.0		<17.0
T44IS3	31	36090	05/06/87 13:51	13	<0.083	<0.083	<0.056	<0.046	<0.055	<0.060	<0.059	<1.16	1170	1110	8.46	14.6	<1.98

SAMPLE LIST T4PAUL

STORET CODE:				81596	34030	34010	34371	98553	98554	34423	34501	34496	34546	32106	34531	34506	32102
METHOD CODE:				R8	W8	W8	W8	W8	W8	Y8	Y8	Y8	Y8	Y8	Y8	Y8	Y8
PARAMETER:				MIBK	BENZENE	TOLUEN	ETHYLBENZ	M-XYL	O&P-XYL	METHYLCL	11DCE	11DCLE	T12DCE	CHCL3	12DCLE	111TCE	CCL4
UNITS:				UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L
FLD.GRP.	#	SAMPLE ID	DATE TIME														
T44GMS3	1	01008	05/05/87 10:13	<2.00	<1.00	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	6.57	<1.00	<1.00	<2.00
T441S3	1	01008	05/05/87 10:13	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	4.29	<0.610	<1.70	<2.40
T44RR3	1	01008	06/02/87 08:51	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	6.93	<0.610	<1.70	<2.40
T44CW3	7	02008	05/05/87 13:19	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	<0.610	<1.70	<2.40
T44GMS3	2	02008	05/05/87 13:19	<2.00	<1.00	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	<1.00	<1.00	<1.00	<2.00
T44RR3	3	02008	06/02/87 08:58	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	<0.610	<1.70	<2.40
T44GMS3	3	04009	05/06/87 07:36	<2.00	3.40	7.23	20.6	62.3	67.4	<5.00		<2.00	<2.00	<1.00	<1.00	<1.00	<2.00
T44WW3	9	04009	05/06/87 07:36	<12.9	3.05	5.20	13.7	45.1	53.4	<5.00	<1.10	<1.20	<1.20	<1.40	<0.610	<1.70	<2.40
T44GMS3	4	09002	05/05/87 14:16	<2.00	<1.00	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	<1.00	<1.00	<1.00	<2.00
T44RR3	12	09002	06/03/87 09:55	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	<0.610	<1.70	<2.40
T44WW3	106	09002	05/05/87 14:16	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	<0.610	<1.70	<2.40
T44GMS3	5	22051	05/13/87 07:52	<2.00	<1.10	<1.00	<1.00	<1.00	<2.00	<4.80		<2.00	<1.20	1.66	<1.00	<1.00	<1.50
T4425-3	5	23004	05/13/87 10:08	<12.9	<134	<121	<128	<135	<247	<500	<110	<120	<120	7330	<61.0	<170	<240
T44GMS3	6	23004	05/13/87 10:08	<2.00	10.3	<1.00	<1.00	<1.00	<2.00	34.0		<2.00	<1.20	>160	54.3	<1.00	<1.50
T4425-3	6	23029	05/13/87 11:44	<12.9	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
T44GMS3	7	23029	05/13/87 11:44	NA	NA	NA	NA	NA	NA	NA		NA	NA	NA	NA	NA	NA
T4425-3	11	23189	05/14/87 08:36	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	<0.610	<1.70	<2.40
T44GMS3	8	23189	05/14/87 08:36	<2.00	<1.10	<1.00	<1.00	<1.00	<2.00	<4.80		<2.00	<1.20	1.11	<1.00	<1.00	<1.50
T44GMS3	9	23193	05/14/87 08:28	<2.00	3.36	<1.00	<1.00	<1.00	2.50	<4.80		<2.00	<1.20	<1.00	<1.00	<1.00	<1.50
T441S3	9	23193	05/14/87 08:28	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	<0.610	<1.70	<2.40
T4425-3	15	24092	05/18/87 08:42	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	<0.610	<1.70	<2.40
T44GMS3	10	24092	05/18/87 08:42	<2.00	<1.10	<1.00	<1.00	<1.00	<2.00	<4.80		<2.00	<1.20	<1.00	<1.00	<1.00	<1.50
T4425-3	16	24106	05/18/87 13:35	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	<0.610	<1.70	<2.40
T44GMS3	11	24106	05/18/87 13:35	<2.00	<1.10	<1.00	<1.00	<1.00	<2.00	<4.80		<2.00	<1.20	<1.00	<1.00	<1.00	<1.50
T4425-3	18	24111	05/14/87 13:55	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	1.58	<0.610	<1.70	<2.40
T44GMS3	12	24111	05/14/87 13:55	<2.00	<1.10	<1.00	<1.00	<1.00	<2.00	<4.80		<2.00	<1.20	1.21	<1.00	<1.00	<1.50
T4425-3	19	24113	05/18/87 10:46	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	<0.610	<1.70	<2.40
T44GMS3	13	24113	05/18/87 10:46	<2.00	<1.10	<1.00	<1.00	<1.00	<2.00	<4.80		<2.00	<1.20	<1.00	<1.00	<1.00	<1.50
T4425-3	20	24120	05/19/87 13:43	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	<0.610	<1.70	<2.40
T44GMS3	14	24120	05/19/87 13:43	<2.00	<1.10	<1.00	<1.00	<1.00	<2.00	<4.80		<2.00	<1.20	<1.00	<1.00	<1.00	<1.50
T4425-3	22	24127	05/12/87 14:33	<12.9	2.15	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	104	4.25	<1.70	<2.40
T44GMS3	15	24127	05/12/87 14:43	<2.00	2.89	<1.00	<1.00	<1.00	<2.00	7.23		<2.00	<1.20	139	8.12	<1.00	<1.50
T4425-3	24	27049	05/12/87 15:12	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	19.4	<0.610	<1.70	<2.40
T44GMS3	17	27049	05/12/87 15:12	<2.00	1.13	<1.00	<1.00	<1.00	<2.00	<4.80		<2.00	<1.20	26.3	<1.00	<1.00	<1.50
T44CW3	64	27055	05/08/87 09:15	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	<0.610	<1.70	<2.40
T44GMS3	19	27055	05/08/87 09:15	<2.00	<1.10	<1.00	<1.00	<1.00	<2.00	<4.80		<2.00	<1.20	<1.00	<1.00	<1.00	<1.50
T4425-3	25	27074	05/13/87 09:47	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	27.0	<0.610	<1.70	<2.40
T44GMS3	20	27074	05/13/87 09:47	NA	NA	NA	NA	NA	NA	NA		NA	NA	NA	NA	NA	NA
T44GMS3	21	33002	05/05/87 08:21	<2.00	<1.00	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	<1.00	<1.00	<1.00	<2.00
T44RR3	17	33002	06/02/87 14:41	<12.9	8.23	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	<0.610	<1.70	<2.40
T44WW3	108	33002	05/05/87 08:21	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	<0.610	<1.70	<2.40
T44GMS3	22	33063	05/06/87 14:24	<2.00	<1.00	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	1.38	<1.00	<1.00	<2.00
T44WW3	32	33063	05/06/87 14:24	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	<0.610	<1.70	<2.40
T44GMS3	23	35016	05/06/87 15:16	<2.00	<1.00	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	<2.00	<1.00	<1.00	<1.00	<2.00
T441S3	23	35016	05/06/87 15:16	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	<0.610	<1.70	<2.40
T44GMS3	25	35066	05/12/87 07:47	<2.00	2.80	<1.00	<1.00	<1.00	<2.00	<4.80		<2.00	<1.20	2.34	<1.00	<1.00	<1.50
T44GMS3	26	36084	05/12/87 10:20	<2.00	7.68	<1.00	<1.00	<1.00	<2.00	<4.80		<2.00	74.5	37.1	19.1	<1.00	<1.50
T441S3	30	36084	05/12/87 10:20	<12.9	8.47	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	56.7	34.5	11.9	<1.70	<2.40
T44GMS3	27	36090	05/06/87 13:51	<2.00	<1.00	<1.00	<1.00	<1.00	<2.00	<5.00		<2.00	13.6	4.56	>158	<1.00	<2.00
T441S3	31	36090	05/06/87 13:51	<12.9	<1.34	<1.21	2.84	<1.35	<2.47	<5.00	<1.10	<1.20	14.9	3.99	265	<1.70	<2.40

SAMPLE LIST T4PAUL

STORET CODE:				34511	34475	34301
METHOD CODE:				Y8	Y8	Y8
PARAMETER:				112TCE	TCLEE	CLC6H5
UNITS:				UG/L	UG/L	UG/L
FLD.GRP.	#	SAMPLE ID	DATE TIME			
T44GMS3	1	01008	05/05/87 10:13	<1.00	<1.00	<2.00
T44IS3	1	01008	05/05/87 10:13	<1.00	<1.30	<0.580
T44RR3	1	01008	06/02/87 08:51	<1.00	<1.30	<0.580
T44CW3	7	02008	05/05/87 13:19	<1.00	<1.30	<0.580
T44GMS3	2	02008	05/05/87 13:19	<1.00	<1.00	<2.00
T44RR3	3	02008	06/02/87 08:58	<1.00	<1.30	<0.580
T44GMS3	3	04009	05/06/87 07:36	<1.00	<1.00	<2.00
T44WW3	9	04009	05/06/87 07:36	<1.00	<1.30	<0.580
T44GMS3	4	09002	05/05/87 14:16	<1.00	1.65	<2.00
T44RR3	12	09002	06/03/87 09:55	<1.00	1.59	<0.580
T44WW3	106	09002	05/05/87 14:16	<1.00	1.93	<0.580
T44GMS3	5	22051	05/13/87 07:52	<1.00	<1.00	<2.10
T4425-3	5	23004	05/13/87 10:08	<100	<130	<58.0
T44GMS3	6	23004	05/13/87 10:08	<1.00	36.9	<2.10
T4425-3	6	23029	05/13/87 11:44	NA	NA	NA
T44GMS3	7	23029	05/13/87 11:44	NA	NA	NA
T4425-3	11	23189	05/14/87 08:36	<1.00	<1.30	<0.580
T44GMS3	8	23189	05/14/87 08:36	<1.00	<1.00	<2.10
T44GMS3	9	23193	05/14/87 08:28	<1.00	<1.00	<2.10
T44IS3	9	23193	05/14/87 08:28	<1.00	<1.30	<0.580
T4425-3	15	24092	05/18/87 08:42	<1.00	<1.30	<0.580
T44GMS3	10	24092	05/18/87 08:42	<1.00	<1.00	<2.10
T4425-3	16	24106	05/18/87 13:35	<1.00	<1.30	<0.580
T44GMS3	11	24106	05/18/87 13:35	<1.00	<1.00	<2.10
T4425-3	18	24111	05/14/87 13:55	<1.00	<1.30	<0.580
T44GMS3	12	24111	05/14/87 13:55	<1.00	<1.00	<2.10
T4425-3	19	24113	05/18/87 10:46	<1.00	<1.30	<0.580
T44GMS3	13	24113	05/18/87 10:46	<1.00	<1.00	<2.10
T4425-3	20	24120	05/19/87 13:43	<1.00	<1.30	<0.580
T44GMS3	14	24120	05/19/87 13:43	<1.00	<1.00	<2.10
T4425-3	22	24127	05/12/87 14:33	<1.00	70.1	<0.580
T44GMS3	15	24127	05/12/87 14:43	<1.00	84.6	<2.10
T4425-3	24	27049	05/12/87 15:12	<1.00	<1.30	<0.580
T44GMS3	17	27049	05/12/87 15:12	<1.00	<1.00	<2.10
T44CW3	64	27055	05/08/87 09:15	<1.00	<1.30	<0.580
T44GMS3	19	27055	05/08/87 09:15	<1.00	<1.00	<2.10
T4425-3	25	27074	05/13/87 09:47	<1.00	<1.30	<0.580
T44GMS3	20	27074	05/13/87 09:47	NA	NA	NA
T44GMS3	21	33002	05/05/87 08:21	<1.00	<1.00	<2.00
T44RR3	17	33002	06/02/87 14:41	<1.00	<1.30	32.7
T44WW3	108	33002	05/05/87 08:21	<1.00	<1.30	<0.580
T44GMS3	22	33063	05/06/87 14:24	<1.00	<1.00	<2.00
T44WW3	32	33063	05/06/87 14:24	<1.00	<1.30	<0.580
T44GMS3	23	35016	05/06/87 15:16	<1.00	<1.00	6.00
T44IS3	23	35016	05/06/87 15:16	<1.00	<1.30	19.5
T44GMS3	25	35066	05/12/87 07:47	<1.00	<1.00	<2.10
T44GMS3	26	36084	05/12/87 10:20	21.0	7.51	5.30
T44IS3	30	36084	05/12/87 10:20	36.8	8.76	4.71
T44GMS3	27	36090	05/06/87 13:51	2.43	18.9	39.5
T44IS3	31	36090	05/06/87 13:51	4.47	23.6	55.9

SAMPLE LIST T4PAUL

STORET CODE:				99133	99133	99133	77985	77985	77985
METHOD CODE:				Q8	BB8	M8	R8	BB8	M8
PARAMETER:				DBCP	DBCP	DBCP	DCPD	DCPD	DCPD
UNITS:				UG/L	UG/L	UG/L	UG/L	UG/L	UG/L
FLD.GRP.	#	SAMPLE ID	DATE TIME						
T44GMS3	1	01008	05/05/87 10:13		<15	<4.0		<4.7	<2.0
T441S3	1	01008	05/05/87 10:13	<0.130			<9.31		
T44RR3	1	01008	06/02/87 08:51	<0.130			<9.31		
T44CW3	7	02008	05/05/87 13:19	<0.130			<9.31		
T44GMS3	2	02008	05/05/87 13:19		<15	<4.0		<4.7	<2.0
T44RR3	3	02008	06/02/87 08:58	<0.130			<9.31		
T44GMS3	3	04009	05/06/87 07:36		<15	<4.0		<4.7	<2.0
T44WW3	9	04009	05/06/87 07:36	<0.130			<9.31		
T44GMS3	4	09002	05/05/87 14:16		<15	<4.0		<4.7	<2.0
T44RR3	12	09002	06/03/87 09:55	<0.130			<9.31		
T44WW3	106	09002	05/05/87 14:16	<0.130			<9.31		
T44GMS3	5	22051	05/13/87 07:52		<15	<3.8		<4.7	<1.1
T4425-3	5	23004	05/13/87 10:08	1.42			414		
T44GMS3	6	23004	05/13/87 10:08		<15	<3.8		720	>170
T4425-3	6	23029	05/13/87 11:44	<0.130			<9.31		
T44GMS3	7	23029	05/13/87 11:44		<15	NA		<4.7	NA
T4425-3	11	23189	05/14/87 08:36	<0.130			<9.31		
T44GMS3	8	23189	05/14/87 08:36		<15	<3.8		<4.7	2.0
T44GMS3	9	23193	05/14/87 08:28		NA	<3.8		NA	<1.1
T441S3	9	23193	05/14/87 08:28	<0.130			<9.31		
T4425-3	15	24092	05/18/87 08:42	<0.130			<9.31		
T44GMS3	10	24092	05/18/87 08:42		<15	<3.8		<4.7	<1.1
T4425-3	16	24106	05/18/87 13:35	<0.130			<9.31		
T44GMS3	11	24106	05/18/87 13:35		<15	<3.8		<4.7	<1.1
T4425-3	18	24111	05/14/87 13:55	<0.130			<9.31		
T44GMS3	12	24111	05/14/87 13:55		<15	<3.8		<4.7	<1.1
T4425-3	19	24113	05/18/87 10:46	<0.130			<9.31		
T44GMS3	13	24113	05/18/87 10:46		<15	<3.8		<4.7	<1.1
T4425-3	20	24120	05/19/87 13:43	<0.130			<21.6		
T44GMS3	14	24120	05/19/87 13:43		<15	<3.8		<4.7	<1.1
T4425-3	22	24127	05/12/87 14:33	3.64			169		
T44GMS3	15	24127	05/12/87 14:43		<15	<3.8		190	>170
T4425-3	24	27049	05/12/87 15:12	<0.130			<9.31		
T44GMS3	17	27049	05/12/87 15:12		<15	<3.8		<4.7	1.2
T44CW3	64	27055	05/08/87 09:15	<0.130			<9.31		
T44GMS3	19	27055	05/08/87 09:15		<15	<3.8		<4.7	<1.1
T4425-3	25	27074	05/13/87 09:47	<0.130			<9.31		
T44GMS3	20	27074	05/13/87 09:47		<15	NA		<4.7	NA
T44GMS3	21	33002	05/05/87 08:21		<15	<4.0		<4.7	<2.0
T44RR3	17	33002	06/02/87 14:41	<0.130			<9.31		
T44WW3	108	33002	05/05/87 08:21	<0.130			<9.31		
T44GMS3	22	33063	05/06/87 14:24		<15	<4.0		<4.7	<2.0
T44WW3	32	33063	05/06/87 14:24	3.21			<9.31		
T44GMS3	23	35016	05/06/87 15:16		<15	<4.0		<4.7	<2.0
T441S3	23	35016	05/06/87 15:16	<0.130			<9.31		
T44GMS3	25	35066	05/12/87 07:47		<15	<3.8		<4.7	<1.1
T44GMS3	26	36084	05/12/87 10:20		<15	<3.8		<4.7	<1.1
T441S3	30	36084	05/12/87 10:20	<0.130			<9.31		
T44GMS3	27	36090	05/06/87 13:51		<15	<4.0		<4.7	<2.0
T441S3	31	36090	05/06/87 13:51	<0.130			<9.31		

SAMPLE LIST T4PAUL

STORET CODE:				98551	34386	39330	39430	39320	39380	39390	39300	81580	98564	98563	98562	81512	98561
METHOD CODE:				BB8	S8	S8	S8	S8	S8	S8	S8	U8	U8	U8	U8	U8	U8
PARAMETER:				DIMP	HCCPD	ALDRIN	ISODRIN	P,P'-DDE	DIELDRIN	ENDRIN	P,P'-DDT	DMDS	1,4-OXAT	1,4-DITH	CPMS	BTZ	CPMSO
UNITS:				UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L
FLD.GRP.	#	SAMPLE ID	DATE TIME														
T44CW3	92	36110	05/11/87 15:42	<11	<0.083	<0.083	<0.056	<0.046	>0.050	<0.060	<0.059	<1.16	<1.35	<1.59	<1.08	<1.14	<1.98
T44GMS3	28	36110	05/11/87 15:42	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<2.50	<6.10	<11.0	<14.0		<17.0
T44CW3	97	36139	05/11/87 14:39	420	<0.415	<0.415	<0.280	<0.230	<0.275	<0.300	<0.295	<1.16	58.9	302	3.79	6.79	<1.98
T44GMS3	29	36139	05/11/87 14:39	170	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<2.50	44.9	241	<14.0		<17.0
T44GMS3	41	37309	07/08/87 08:56	500	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<2.50	<6.10	<11.0	<14.0		15.7
T44OP3	4	37309	06/16/87 09:45	830	<0.700	<0.700	<0.600	<0.530	<0.600	<0.520	<0.700	<1.80	<2.00	6.48	<1.30	<2.00	27.1
T44GMS3	42	37332	07/08/87 08:05	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<2.50	<6.10	<11.0	<14.0		<17.0
T44OP3	9	37332	06/18/87 08:29	<11	<0.070	<0.070	<0.060	<0.053	0.711	<0.052	<0.070	<1.80	<2.00	<1.10	<1.30	<2.00	<4.20
T44GMS3	43	37333	07/09/87 07:20	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<2.50	<6.10	<11.0	<14.0		<17.0
T44OP3	10	37333	06/18/87 09:39	<11	<0.070	<0.070	<0.060	<0.053	0.205	<0.052	<0.070	<1.80	<2.00	<1.10	<1.30	<2.00	<4.20
T44GMS3	44	37344	07/08/87 11:15	560	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<2.50	<6.10	<11.0	<14.0		53.8
T44GMS3	45	37359	07/08/87 09:45	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<2.50	<6.10	<11.0	<14.0		<17.0
T44OP3	33	37359	06/17/87 10:25	<11	<0.070	<0.070	<0.060	<0.053	<0.060	<0.052	<0.070	<1.80	<2.00	<1.10	<1.30	<2.00	<4.20
T44GMS3	46	C111	07/08/87 09:55	<5.7	<11.0	<4.70	<5.90	<4.70	<4.70	<7.60	<10.0	<2.50	<6.10	<11.0	<14.0		<17.0

SAMPLE LIST T4PAUL

STORET CODE:				81596	34030	34010	34371	98553	98554	34423	34501	34496	34546	32106	34531	34506	32102
METHOD CODE:				R8	W8	W8	W8	W8	W8	Y8	Y8	Y8	Y8	Y8	Y8	Y8	Y8
PARAMETER:				MIBK	BENZENE	TOLUEN	ETHYLBENZ	M-XYL	O&P-XYL	METHYLCL	11DCE	11DCLE	T12DCE	CHCL3	12DCLE	111TCE	CCL4
UNITS:				UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L
FLD.GRP.	#	SAMPLE ID	DATE TIME														
T44CW3	92	36110	05/11/87 15:42	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	91.6	2.61	<1.70	<2.40
T44GMS3	28	36110	05/11/87 15:42	<2.00	<1.10	<1.00	<1.00	<1.00	<2.00	<4.80		<2.00	<1.20	<1.00	<1.00	<1.00	<1.50
T44CW3	97	36139	05/11/87 14:39	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	25.4	20.4	<1.70	<2.40
T44GMS3	29	36139	05/11/87 14:39	<2.00	<1.10	<1.00	<1.00	<1.00	<2.00	<4.80		<2.00	<1.20	4.28	27.6	<1.00	<1.50
T44GMS3	41	37309	07/08/87 08:56	<2.00	<1.10	<1.00	<1.00	<1.00	<2.00	<4.80		<2.00	<1.20	<1.00	6.25	<1.00	<1.50
T44OP3	4	37309	06/16/87 09:45	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	6.27	<1.70	<2.40
T44GMS3	42	37332	07/08/87 08:05	<2.00	1.75	<1.00	<1.00	<1.00	<2.00	<4.80		<2.00	<1.20	2.78	<1.00	<1.00	<1.50
T44OP3	9	37332	06/18/87 08:29	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	<1.40	<0.610	<1.70	<2.40
T44GMS3	43	37333	07/09/87 07:20	<2.00	48.0	<1.00	<1.00	<1.00	<2.00	<4.80		<2.00	<1.20	16.7	<1.00	<1.00	<1.50
T44OP3	10	37333	06/18/87 09:39	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	<1.20	<1.20	13.5	<0.610	<1.70	<2.40
T44GMS3	44	37344	07/08/87 11:15	<2.00	<1.10	<1.00	<1.00	<1.00	<2.00	<4.80		<2.00	<1.20	>160	3.93	<1.00	9.30
T44GMS3	45	37359	07/08/87 09:45	<2.00	2.89	<1.00	<1.00	<1.00	<2.00	<4.80		2.58	<1.20	<1.00	<1.00	2.86	<1.50
T44OP3	33	37359	06/17/87 10:25	<12.9	<1.34	<1.21	<1.28	<1.35	<2.47	<5.00	<1.10	2.31	1.26	<1.40	<0.610	3.70	<2.40
T44GMS3	46	C111	07/08/87 09:55	<2.00	<1.10	<1.00	<1.00	<1.00	<2.00	<4.80		<2.00	<1.20	<1.00	<1.00	1.08	<1.50

SAMPLE LIST T4PAUL

STORET CODE:				34511	34475	34301
METHOD CODE:				Y8	Y8	Y8
PARAMETER:				112TCE	TCLEE	CLC6H5
UNITS:				UG/L	UG/L	UG/L
FLD.GRP.	#	SAMPLE ID	DATE TIME			
T44CW3	92	36110	05/11/87 15:42	<1.00	<1.30	<0.580
T44GMS3	28	36110	05/11/87 15:42	<1.00	<1.00	<2.10
T44CW3	97	36139	05/11/87 14:39	<1.00	<1.30	<0.580
T44GMS3	29	36139	05/11/87 14:39	<1.00	<1.00	<2.10
T44GMS3	41	37309	07/08/87 08:56	<1.00	73.5	<2.10
T44OP3	4	37309	06/16/87 09:45	<1.00	45.4	<0.580
T44GMS3	42	37332	07/08/87 08:05	<1.00	<1.00	6.64
T44OP3	9	37332	06/18/87 08:29	<1.00	<1.30	<0.580
T44GMS3	43	37333	07/09/87 07:20	<1.00	<1.00	<2.10
T44OP3	10	37333	06/18/87 09:39	<1.00	<1.30	<0.580
T44GMS3	44	37344	07/08/87 11:15	<1.00	116	3.89
T44GMS3	45	37359	07/08/87 09:45	<1.00	3.17	10.8
T44OP3	33	37359	06/17/87 10:25	<1.00	3.95	<0.580
T44GMS3	46	C111	07/08/87 09:55	<1.00	1.74	<2.10

SAMPLE LIST T4PAUL

STORET CODE:				99133	99133	99133	77985	77985	77985
METHOD CODE:				Q8	BB8	M8	R8	BB8	M8
PARAMETER:				DBCP	DBCP	DBCP	DCPD	DCPD	DCPD
UNITS:				UG/L	UG/L	UG/L	UG/L	UG/L	UG/L
FLD.GRP.	#	SAMPLE ID	DATE TIME						
T44CW3	92	36110	05/11/87 15:42	<0.130			<9.31		
T44GMS3	28	36110	05/11/87 15:42		<15	<3.8		<4.7	<1.1
T44CW3	97	36139	05/11/87 14:39	<0.130			<9.31		
T44GMS3	29	36139	05/11/87 14:39		<15	<3.8		<4.7	<1.1
T44GMS3	41	37309	07/08/87 08:56		<15	<3.8		840	>170
T44OP3	4	37309	06/16/87 09:45	0.176			475		
T44GMS3	42	37332	07/08/87 08:05		<15	<3.8		<4.7	<1.1
T44OP3	9	37332	06/18/87 08:29	<0.130			<9.31		
T44GMS3	43	37333	07/09/87 07:20		<15	<3.8		<4.7	<1.1
T44OP3	10	37333	06/18/87 09:39	<0.130			<9.31		
T44GMS3	44	37344	07/08/87 11:15		<15	12		<4.7	43
T44GMS3	45	37359	07/08/87 09:45		<15	<3.8		<4.7	1.8
T44OP3	33	37359	06/17/87 10:25	<0.130			<9.31		
T44GMS3	46	C111	07/08/87 09:55		<15	<3.8		<4.7	<1.1

TASK 4

ANALYTICAL RESULTS FOR NONTARGET COMPOUNDS IDENTIFIED BY GC/MS ANALYSIS

ENVIRONMENTAL SCIENCE & ENGINEERING 01/06/88

RESULTS FOR NON-TARGET COMPOUNDS AT STATION 37309

ESE SAMPLE * SEQUENCE NUMBER: T44GMS3 41

COLLECTION DATE: 07/08/87
COLLECTION TIME: 08:56

UASATHAMA TEST NAME		ESE STORET	CONC.	IDENTIFICATION
UNK563		91563	21.9	UNKNOWN, ALICYCLIC CMPD.
	UG/L	0		
UNK566		91566	72.7	UNKNOWN, ALICYCLIC CMPD.
	UG/L	0		
UNK569		91569	18.1	UNKNOWN
	UG/L	0		
UNK573		91573	9.11	UNKNOWN, ALICYCLIC CMPD.
	UG/L	0		
UNK577		91577	13.3	UNKNOWN
	UG/L	0		
UNK582		91582	16.9	UNKNOWN
	UG/L	0		
UNK587		91587	16.5	UNKNOWN
	UG/L	0		
UNK589		91589	28.2	UNKNOWN
	UG/L	0		
UNK595		91595	13.7	UNKNOWN
	UG/L	0		
UNK625		91625	13.8	UNKNOWN
	UG/L	0		
UNK575		91575	16.1	UNKNOWN
	UG/L	0		
UNK579		91579	79.0	UNKNOWN
	UG/L	0		
UNK580		91580	20	UNKNOWN
	UG/L	0		
UNK581		91581	10.4	UNKNOWN
	UG/L	0		
UNK583		91583	30.0	UNKNOWN
	UG/L	0		
UNK585		91585	80	UNKNOWN, ALICYCLIC CMPD.
	UG/L	0		
UNK586		91586	54.4	UNKNOWN
	UG/L	0		
UNK593		91593	24.5	UNKNOWN
	UG/L	0		
UNK594		91594	31.5	UNKNOWN
	UG/L	0		
UNK623		91623	7.90	c12h9cl5o
	UG/L	0		2,5,7-METHENO-3H-CYCLOPENTA-[A]PENTALEN-3-ONE
UNK633		91633	40.4	PENTACHLORO CMPD, POSS.M.WT.360
	UG/L	0		
UNK519		91519	23.1	TETRACHLOROETHENE

UNK543	UG/L	0		
	UG/L	91543	11.2	DCPD ISOMER
		0		

ENVIRONMENTAL SCIENCE & ENGINEERING 01/06/88

RESULTS FOR NON-TARGET COMPOUNDS AT STATION 37332

ESE SAMPLE * SEQUENCE NUMBER T44GMS3 42

COLLECTION DATE: 07/08/87
COLLECTION TIME: 08:05

UASATHAMA TEST NAME		ESE STORET	CONC.	IDENTIFICATION
UNK523	UG/L	91523 0	8.80	CHLOROBENZENE
UNK582	UG/L	91582 0	10.3	UNKNOWN

ENVIRONMENTAL SCIENCE & ENGINEERING 01/06/88

RESULTS FOR NON-TARGET COMPOUNDS AT STATION 37333

ESE SAMPLE * SEQUENCE NUMBER: T44GMS3 43

COLLECTION DATE: 07/09/87
COLLECTION TIME: 07:20

UASATHAMA TEST NAME		ESE STORET	CONC.	IDENTIFICATION
UNK642	UG/L	91642 0	37.8	UNKNOWN

ENVIRONMENTAL SCIENCE & ENGINEERING 01/06/88

RESULTS FOR NON-TARGET COMPOUNDS AT STATION 37344

ESE SAMPLE * SEQUENCE NUMBER: T44GMS3 44

COLLECTION DATE: 07/08/87
COLLECTION TIME: 11:15

UASATHAMA TEST NAME		ESE STORET	CONC.	IDENTIFICATION
UNK523	UG/L	91523 0	2.90	CHLOROBENZENE
UNK582	UG/L	91582 0	8.12	UNKNOWN
UNK589	UG/L	91589 0	79.2	UNKNOWN
UNK585	UG/L	91585 0	7	UNKNOWN
UNK593	UG/L	91593 0	13.7	UNKNOWN
UNK519	UG/L	91519 0	39.5	TETRACHLOROETHENE

ENVIRONMENTAL SCIENCE & ENGINEERING 01/06/88

RESULTS FOR NON-TARGET COMPOUNDS AT STATION 37359

ESE SAMPLE * SEQUENCE NUMBER: T44GMS3 45

COLLECTION DATE: 07/08/87
COLLECTION TIME: 09:45

UASATHAMA TEST NAME		ESE STORET	CONC.	IDENTIFICATION
UNK523		91523	5.50	CHLOROBENZENE
	UG/L	0		
UNK543		91543	2.48	DICHLOROBENZENE
	UG/L	0		

TASK 44

ANALYTICAL RESULTS FOR NONTARGET COMPOUNDS IDENTIFIED BY GC/MS ANALYSIS

PARAMETERS	STORET #	37305 OPG3C	ID
UNITS	METHOD	1	
DATE		08/26/86	
TIME		14:56	
UNK563	91563	28.8	UNK
UNK565	91565	154	CAPROLACTAM
UNK582	91582	20.4	UNK
UNK586	91586	8.78	UNK

PARAMETERS UNITS	STORET # METHOD	37307 OPGW2C 2	ID
DATE		06/18/86	
TIME		11:41	
UNK594	91594	26.4	N-HEPTADECANE; 2,10,6,4-TETRA-METHYLPENTADECANE
UNK600	91600	7.48	N-OCTADECANE
UNK605	91605	13.0	N-NONADECANE
UNK610	91610	7.40	N-EICOSANE

PARAMETERS	STORET #	37308 OPGW2C	ID
UNITS	METHOD	3	
DATE		06/16/86	
TIME		15:17	
UNK519	91519	20.9	TETRACHLOROETHENE
UNK563	91563	7.43	CYCLOPENTADIENE DERIVATIVE c11h16
UNK566	91566	18.9	c10h10o, CYCLPENTADIENE
UNK579	91579	33.6	UNK
UNK582	91582	6.61	UNK
UNK583	91583	7.54	UNK
UNK585	91585	27.9	UNK
UNK586	91586	18.7	UNK
UNK589	91589	30.5	UNK
UNK593	91593	14.4	UNK
UNK594	91594	6.78	UNK
UNK595	91595	6.42	UNK
UNK633	91633	8.52	TETRACHLORINATED COMPOUND

PARAMETERS	STORET #	37312	ID
UNITS	METHOD	OPGW2C 1	
DATE		06/17/86	
TIME		11:13	
UNK579	91579	6.57	UNK

PARAMETERS	STORET #	37313 OPG3C 2	ID
UNITS	METHOD		
DATE		08/26/86	
TIME		10:15	
UNK560	91560	7.49	UNK
UNK563	91563	29.0	UNK
UNK565	91565	339	CAPROLACTAM
UNK579	91579	14.4	2-(4-METHYL-2-FURYL)-2-CYCLOPENTEN-1-ONE
UNK582	91582	27.5	UNK
UNK585	91585	11.8	UNK
UNK586	91586	14.6	UNK
UNK588	91588	38.7	PROPANOIC ACID, 2-METHYL-1-(1,1-DIMETHYL ETHYL)-2-METHYL-1,3-PROPANEDIEL ESTER
UNK599	91599	7.87	UNK
UNK642	91642	96.6	UNK
UNK654	91654	911	UNK
UNK671	91671	752	UNK
UNK693	91693	571	UNK

PARAMETERS	STORET #	37320 OPG3C 3	ID
UNITS	METHOD		
DATE		09/22/86	
TIME		12:06	
UNK529	91529	14.1	2-METHYLCYCLOPENTANONE
UNK648	91648	11.3	UNK
UNK652	91652	236	UNK

PARAMETERS	UNITS	STORET # METHOD	37332 OPGW2C 5	ID
DATE			06/16/86	
TIME			11:58	
UNK040		91040	7.50	UNK
UNK582		91582	6.41	UNK

PARAMETERS		STORET #	37343	
	UNITS	METHOD	OPGW2C	ID
			6	
DATE			06/13/86	
TIME			08:39	
UNK594		91594	14.3	N-HEPTADECANE, 2,6,10,14-TETRAMETHYLPENTADECANE

PARAMETERS	STORET #	37343 OPGW2C 6	ID
UNITS	METHOD		
DATE		06/13/86	
TIME		08:39	
UNK600	91600	5.51	2,6,10,14-TETRAMETHYLPENTADECANE
UNK605	91605	7.49	N-NONADECANE
UNK667	91667	175	UNK

PARAMETERS		STORET #	37347	
	UNITS	METHOD	OPG3C	ID
			5	
DATE			08/25/86	
TIME			00:00	

PARAMETERS		STORET #	37349 OPG3C	ID
	UNITS	METHOD	6	
DATE			09/11/86	
TIME			07:53	

PARAMETERS	STORET #	37353 OPGW2C	ID
UNITS	METHOD	8	
DATE		06/12/86	
TIME		11:32	
UNK523	91523	10.8	A NONANE
UNK524	91524	13.0	4-HYDROXYL-4-METHYL-2-PENTANONE
UNK526	91526	20.9	A NONANE
UNK526	91526	20.9	A NONANE
UNK527	91527	32.3	METHYLOCTANE

PARAMETERS	STORET #	37353 OPGW2C	ID
UNITS	METHOD	8	
DATE		06/12/86	
TIME		11:32	
UNK649	91649	120	UNK
UNK657	91657	67.7	UNK

		37353	
PARAMETERS	STORET #	OPG3C	ID
UNITS	METHOD	4	
DATE		09/12/86	
TIME		07:38	

PARAMETERS		STORET #	37354 OPGW2C	ID
	UNITS	METHOD	4	
DATE			06/11/86	
TIME			10:06	
UNK635		91635	2.83	BIS(2-ETHYLHEXYL)PHTHALATE

PARAMETERS		STORET #	37356	
	UNITS	METHOD	OPG3C 7	ID
DATE			09/08/86	
TIME			10:43	
UNK652		91652	127	UNK

PARAMETERS	STORET #	37357 OPG3C	ID
UNITS	METHOD	8	
DATE		09/11/86	
TIME		10:47	

PARAMETERS	STORET #	BOLLER OPGW2C	ID
UNITS	METHOD	7	
DATE		07/01/86	
TIME		09:32	
UNK588	91588	11.4	UNK
UNK635	91635	18.4	PHTHALATE, BIS(2-ETHYLHEXYL)-PHTHALATE
UNK640	91640	5.79	PHTHALATE
UNK649	91649	7.08	PHTHALATE
UNK654	91654	6.42	PHTHALATE
UNK656	91656	112	UNK
UNK669	91669	5.87	PHTHALATE

APPENDIX G
CONTAMINANT TRANSPORT MODEL RESULTS

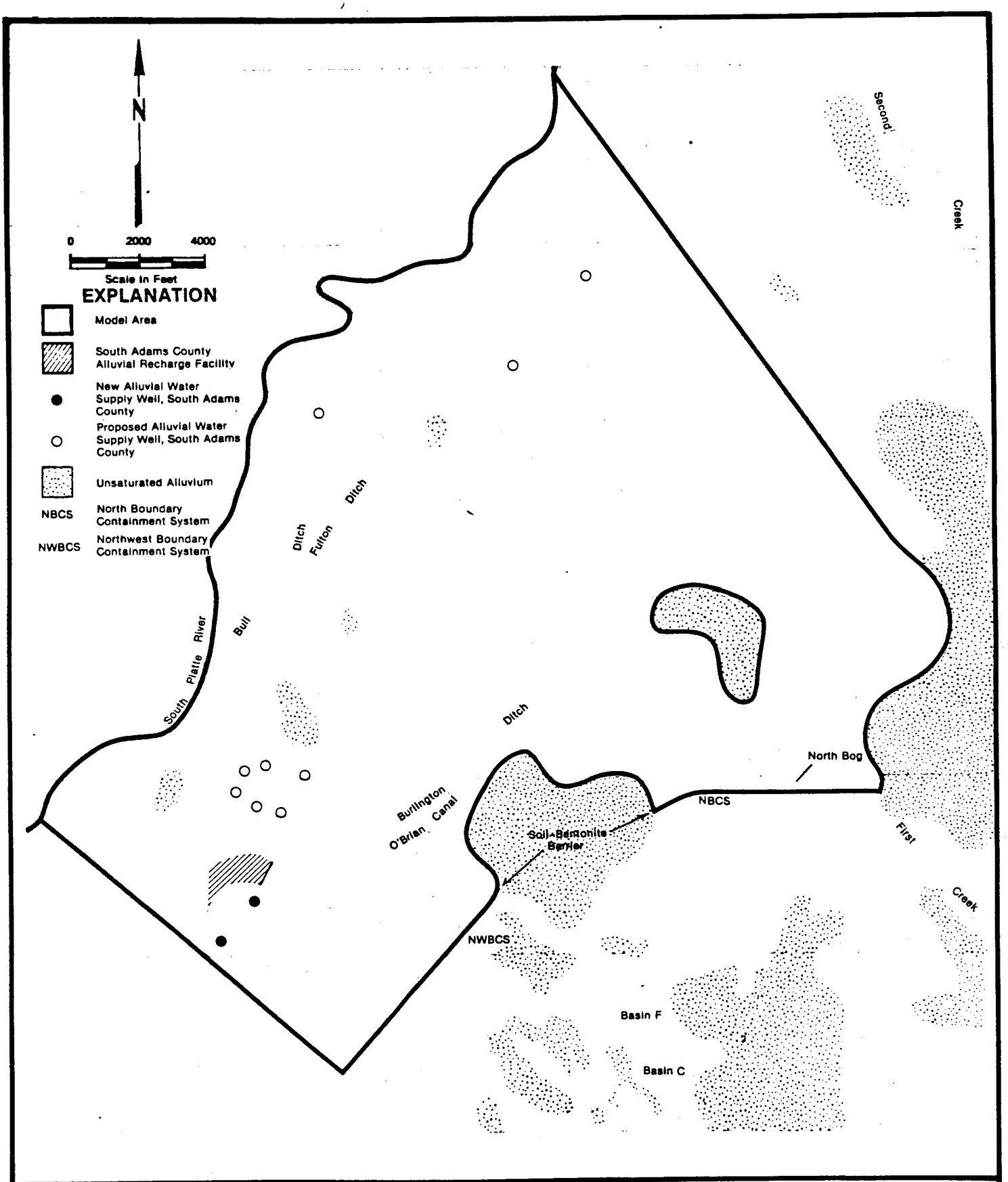


Figure G-1
MODEL AREA IN THE OFFPOST OPERABLE UNIT, ROCKY MOUNTAIN ARSENAL

SOURCE: WARNER, 1988

Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

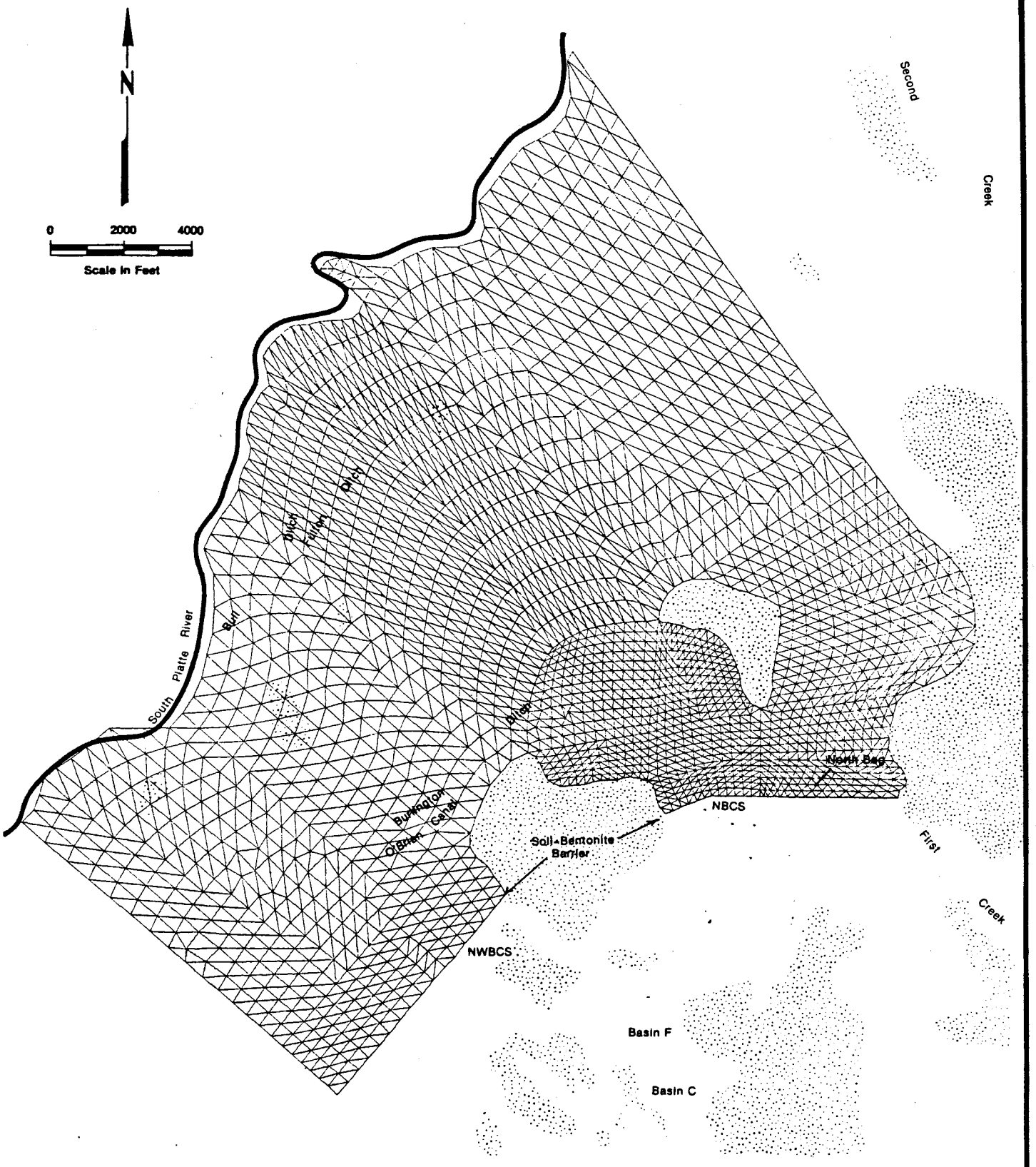


Figure G-2

FINITE ELEMENT MESH

SOURCE: WARNER, 1988

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

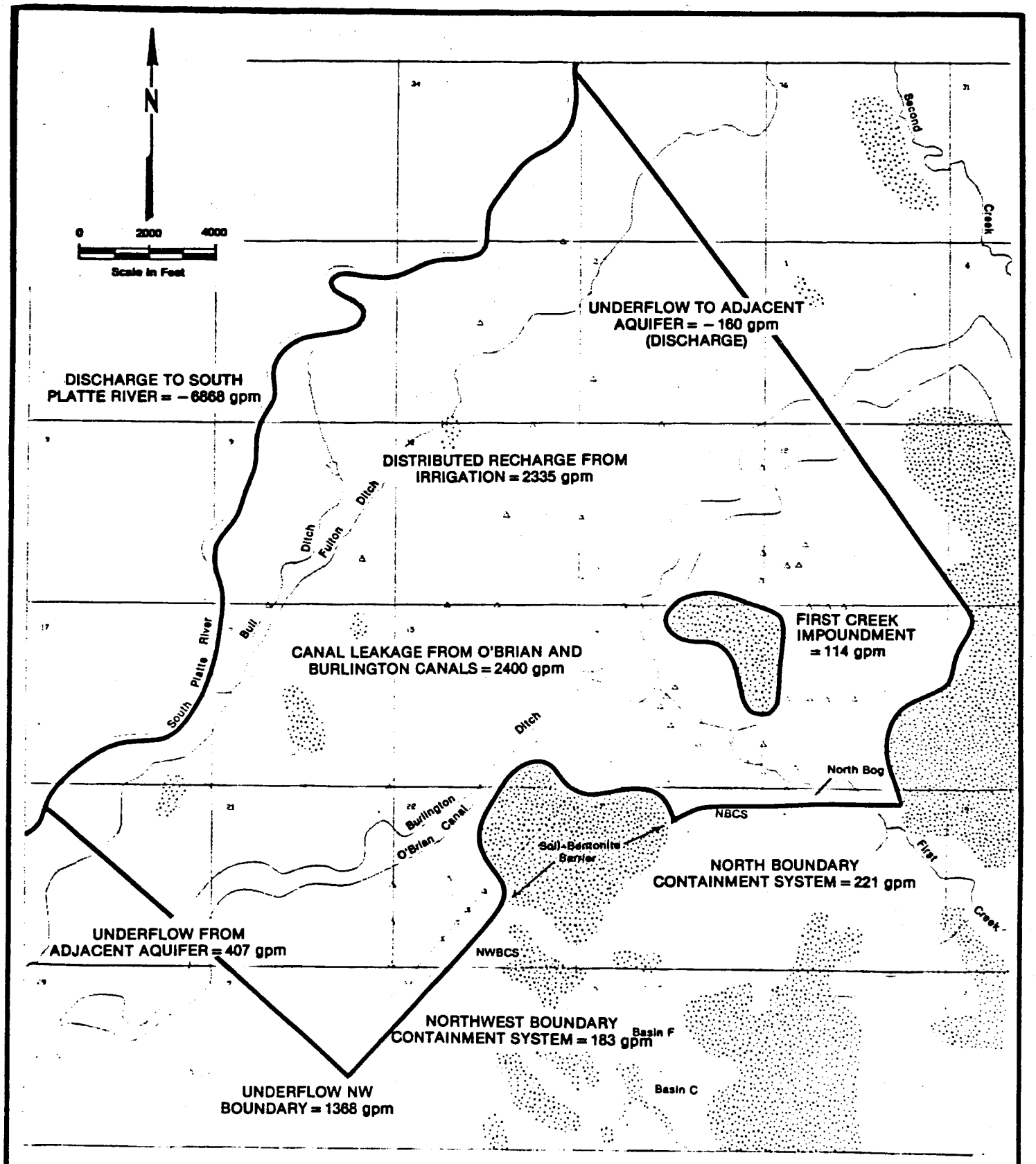


Figure G-3
WATER BALANCE OF MODEL AREA

SOURCE: WARNER, 1988

Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

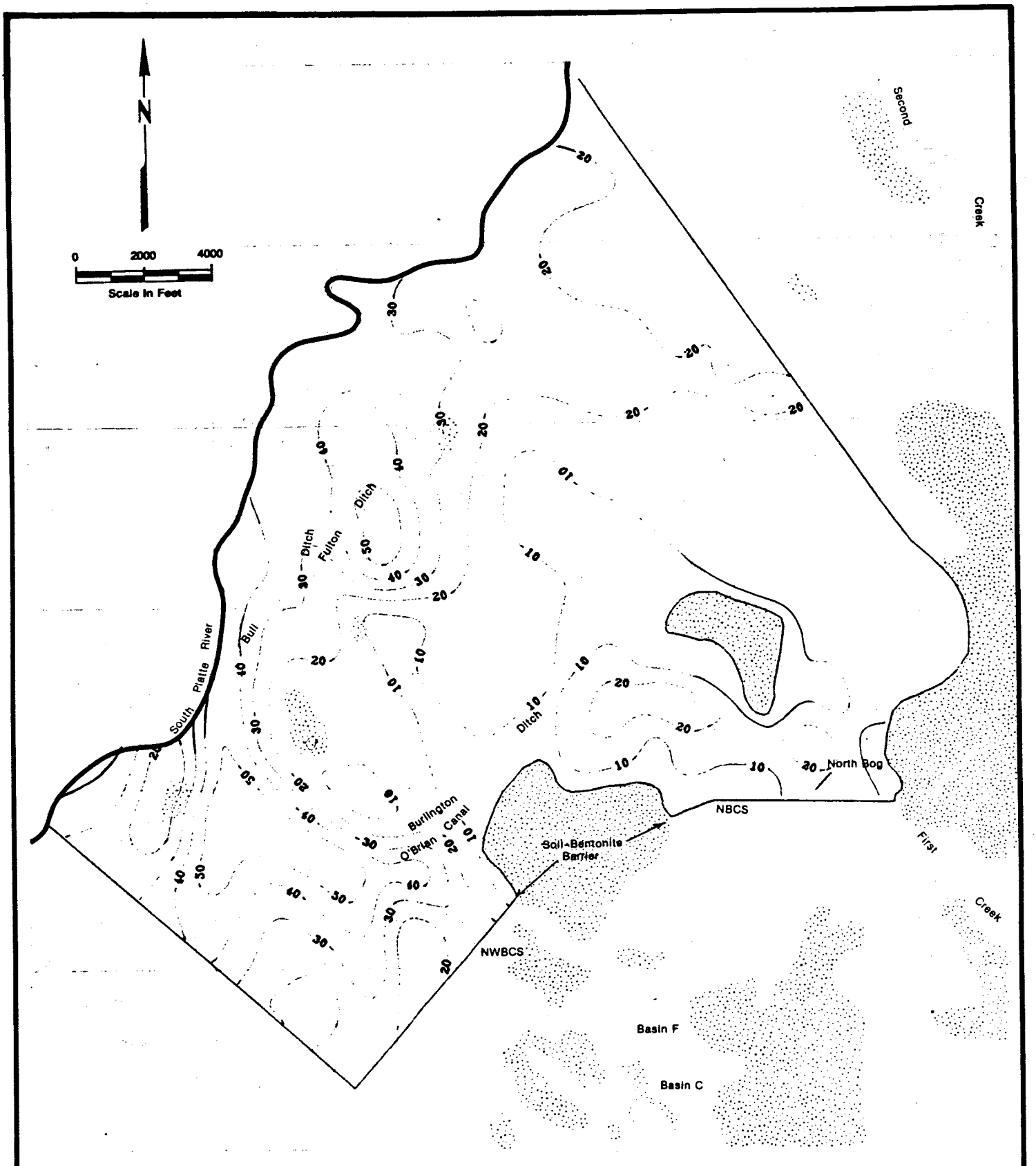


Figure G-4

AQUIFER THICKNESS MAP (FEET)

SOURCE: WARNER, 1988

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

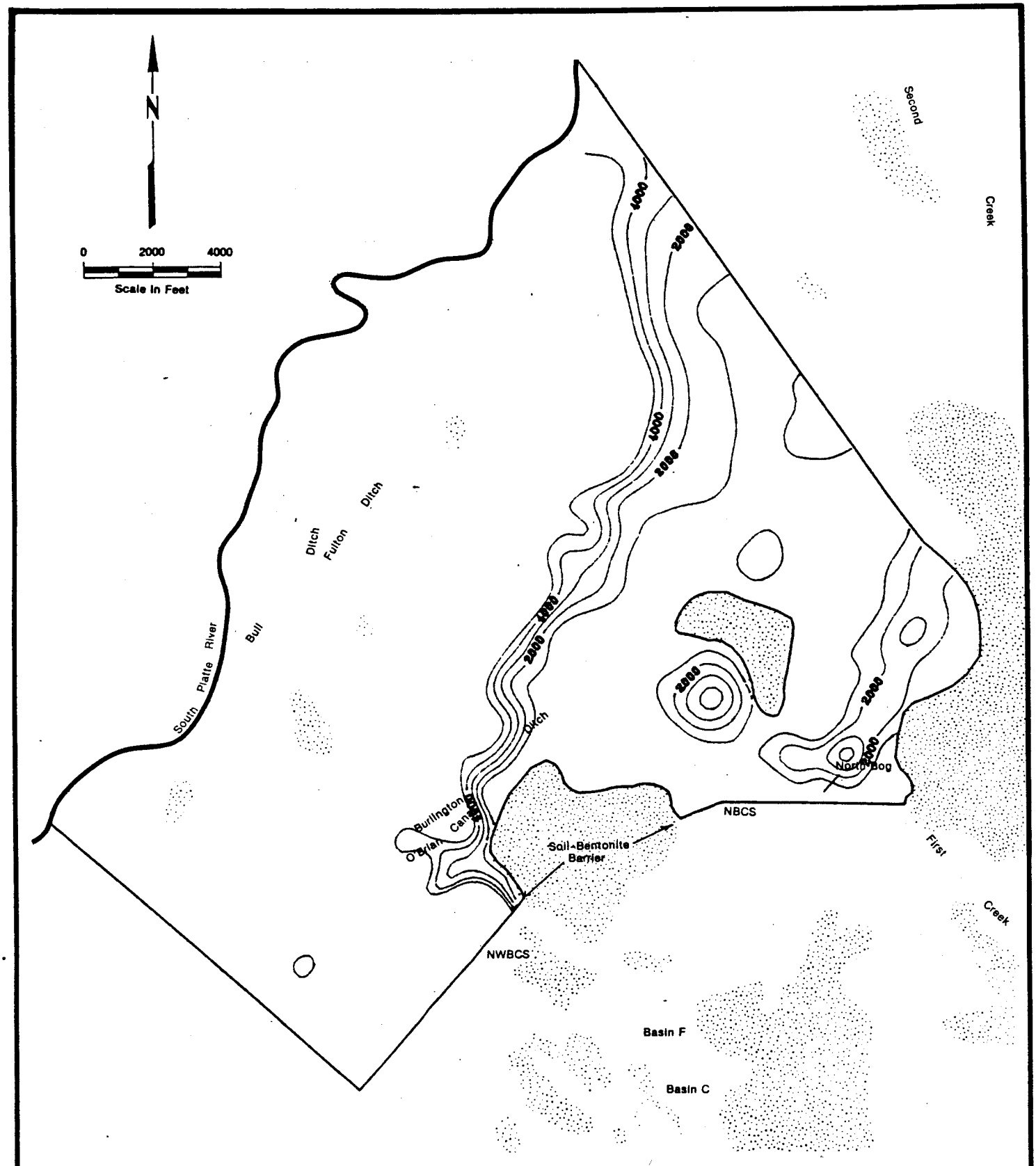


Figure G-5a
TRANSMISSIVITY MAP,
CONTOUR INTERVAL (1,000-5,000 ft²/day)
SOURCE: WARNER, 1988

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

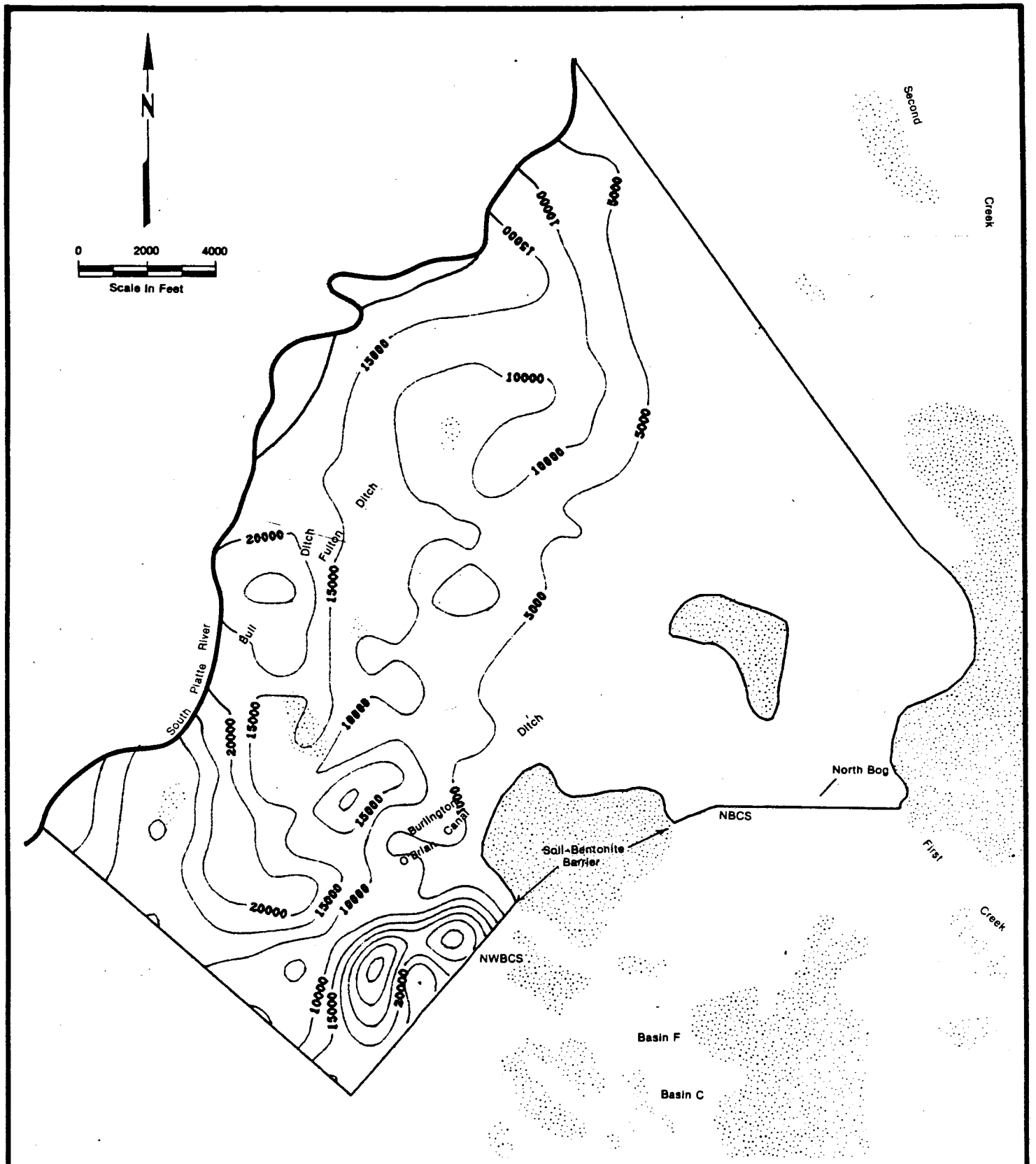


Figure G-5b
TRANSMISSIVITY MAP,
CONTOUR INTERVAL (5,000-25,000 ft²/day)
SOURCE: WARNER, 1988

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

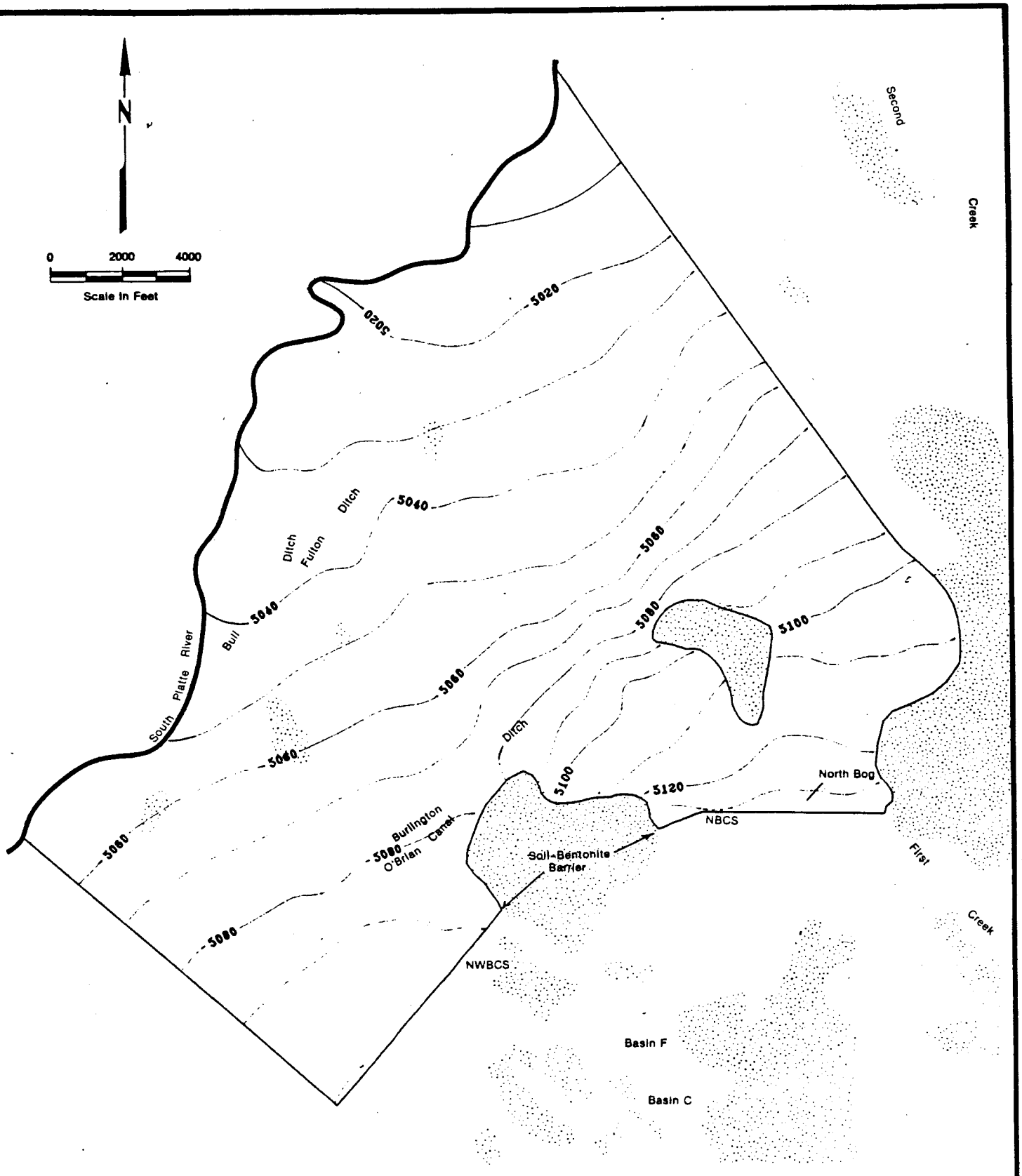


Figure G-6
WATER TABLE ELEVATION MAP, SPRING 1987, CONTOURS IN FEET ABOVE MSL
SOURCE: WARNER, 1988

Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

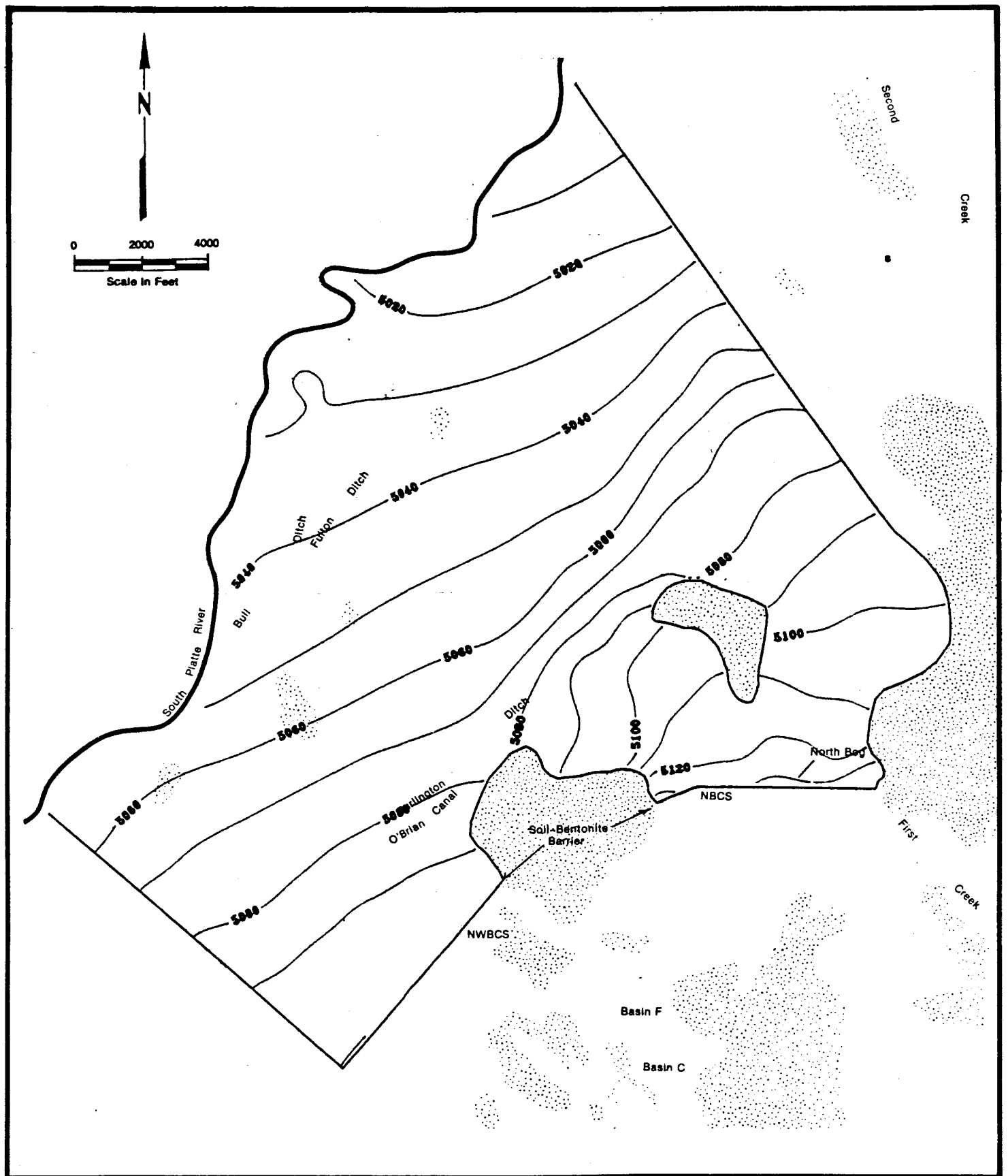


Figure G-7
MODEL CALCULATED STEADY STATE, WATER TABLE ELEVATION MAP, CONTOURS IN FEET ABOVE MSL
SOURCE: WARNER, 1988

Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

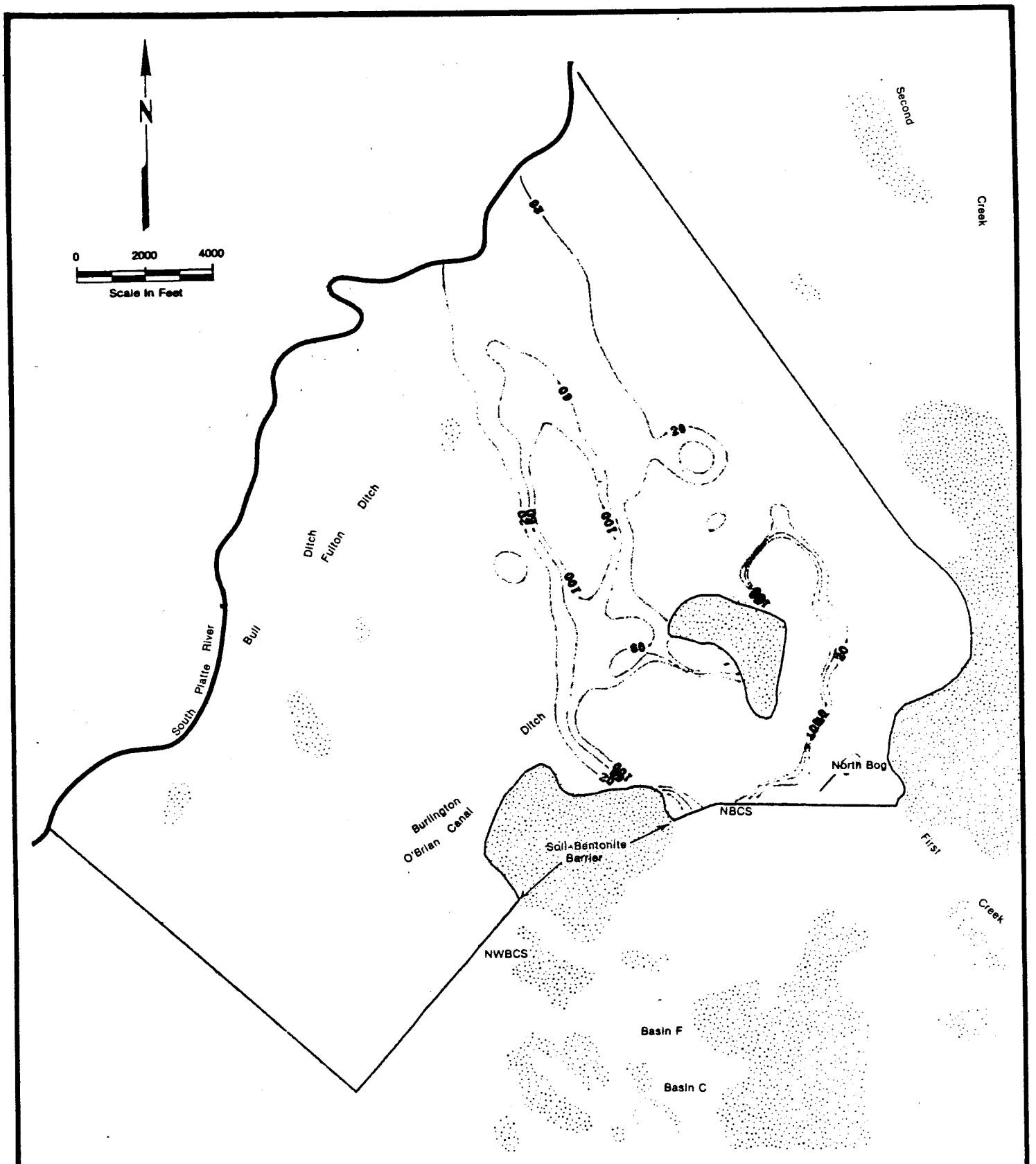


Figure G-8a
DIMP CONCENTRATION DISTRIBUTION, 1987,
ALLUVIAL AQUIFER, CONTOUR INTERVAL
(20-100 ug/l)
SOURCE: WARNER, 1988

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

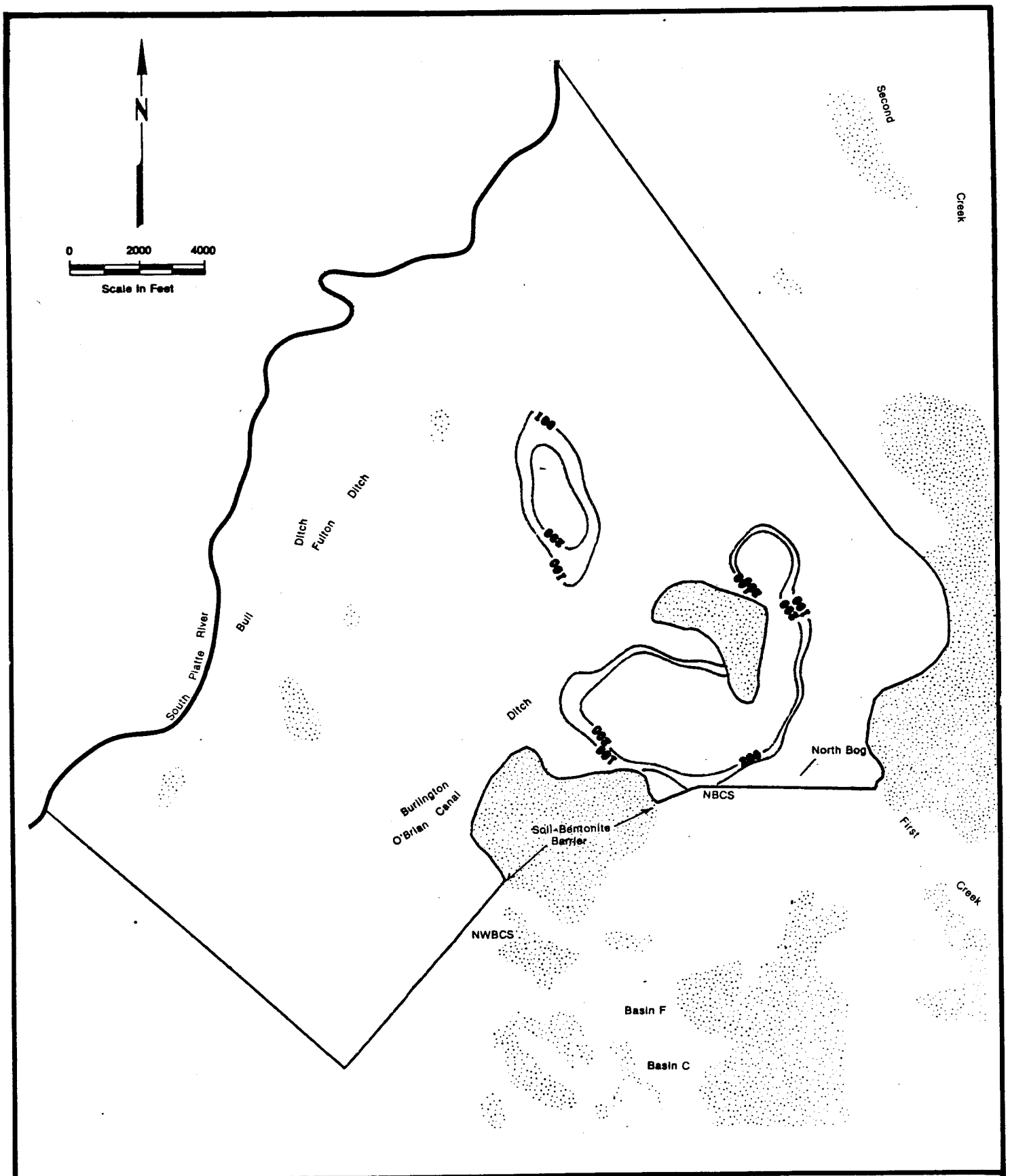


Figure G-8b
DIMP CONCENTRATION DISTRIBUTION, 1987,
ALLUVIAL AQUIFER, CONTOUR INTERVAL
(100-200 ug/l)
SOURCE: WARNER, 1988

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

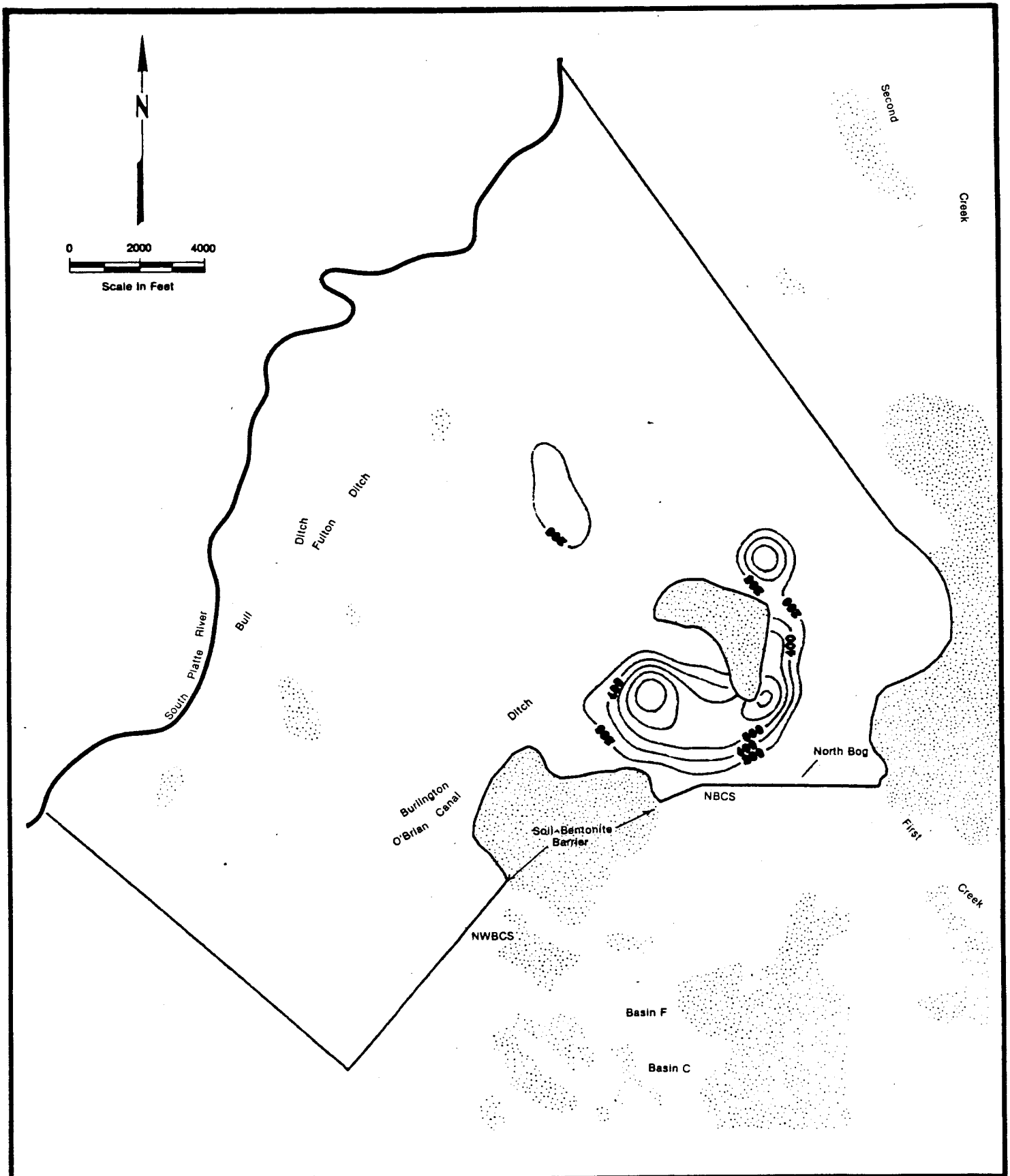


Figure G-8c
DIMP CONCENTRATION DISTRIBUTION, 1987, ALLUVIAL AQUIFER, CONTOUR INTERVAL (200-1000 ug/l)
SOURCE: WARNER, 1988

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

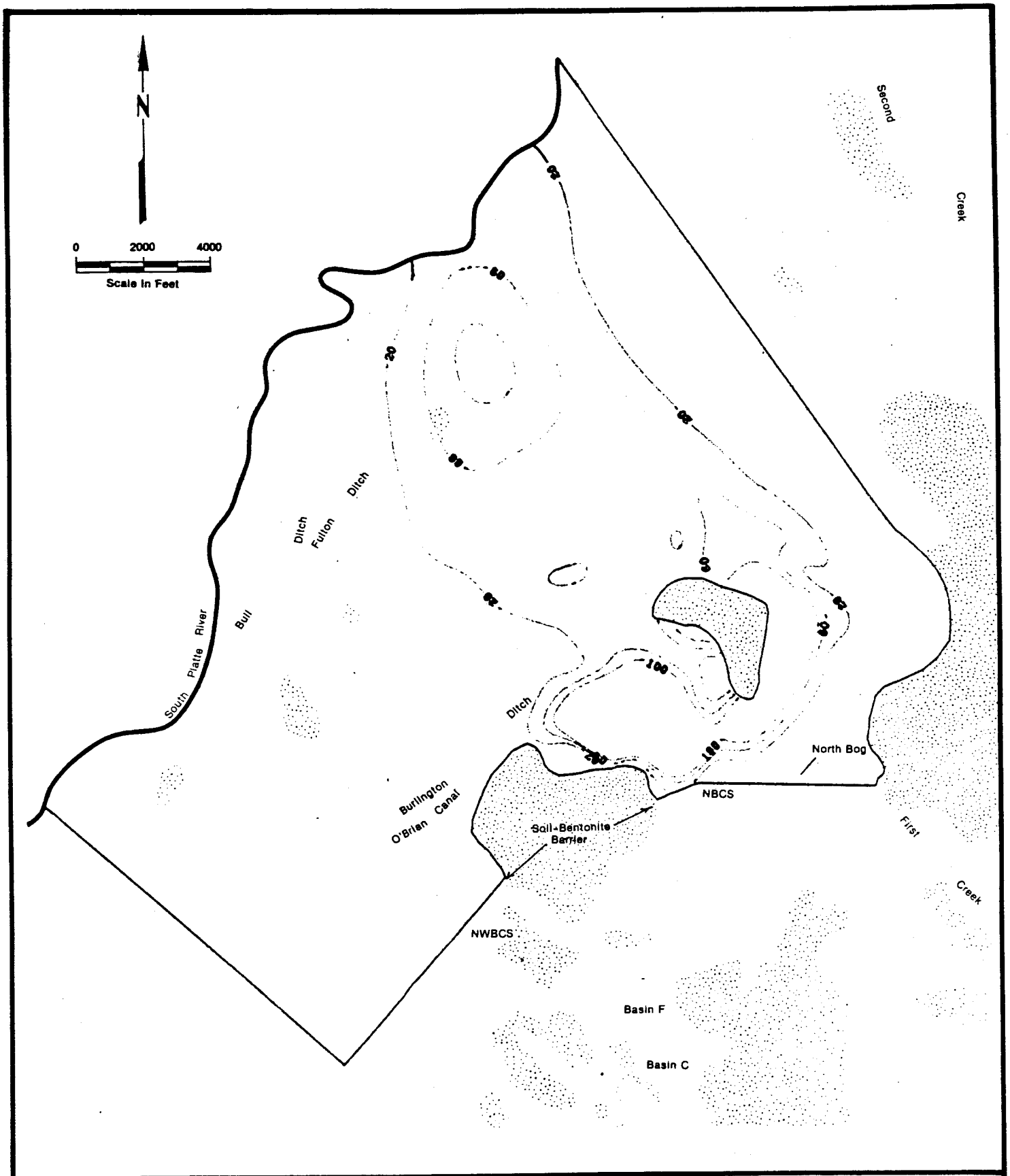


Figure G-9a
DIMP CONCENTRATION DISTRIBUTION IN 1992 (5 YEARS) WITH EXISTING NORTH BOUNDARY RECHARGE OPERATIONS, ALLUVIAL AQUIFER, CONTOUR INTERVAL (20-100 ug/l)
SOURCE: WARNER, 1988

Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

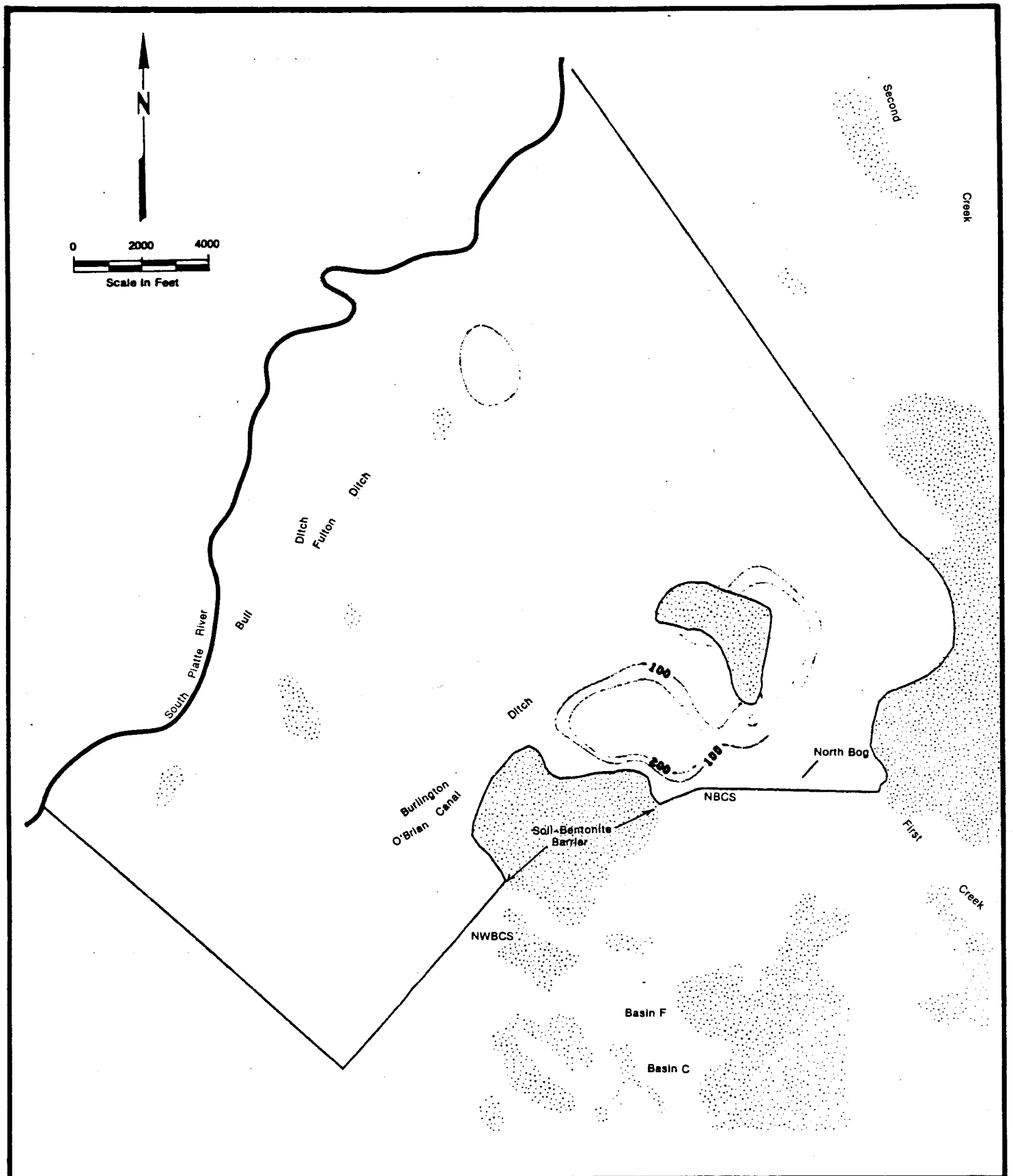


Figure G-9b
DIMP CONCENTRATION DISTRIBUTION IN 1992 (5 YEARS) WITH EXISTING NORTH BOUNDARY RECHARGE OPERATIONS, ALLUVIAL AQUIFER, CONTOUR INTERVAL (100-200 ug/l)
SOURCE: WARNER, 1988

Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

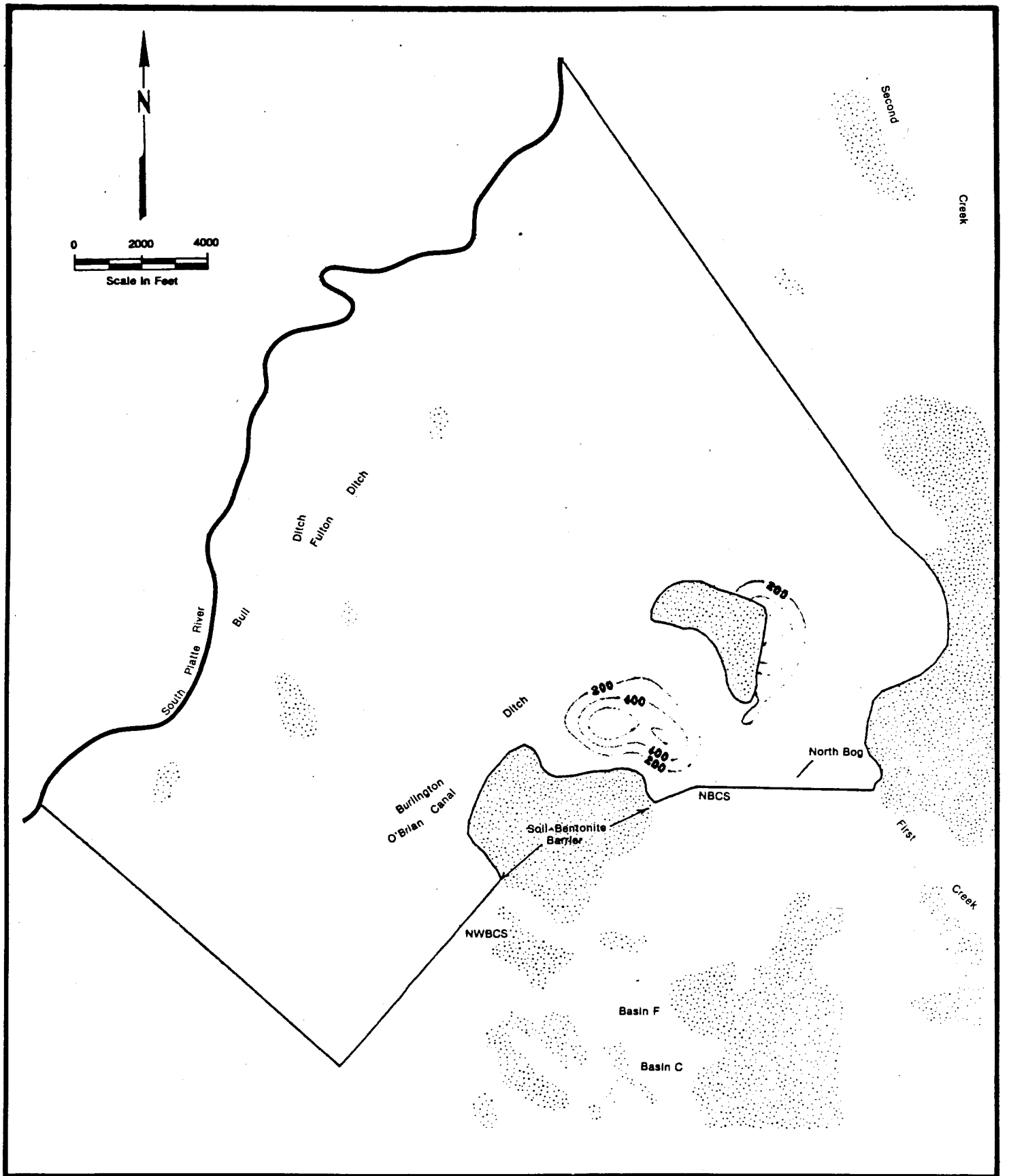


Figure G-9c
DIMP CONCENTRATION DISTRIBUTION IN 1992 (5 YEARS) WITH EXISTING NORTH BOUNDARY RECHARGE OPERATIONS, ALLUVIAL AQUIFER, CONTOUR INTERVAL (200-800 ug/l)
SOURCE: WARNER, 1988

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

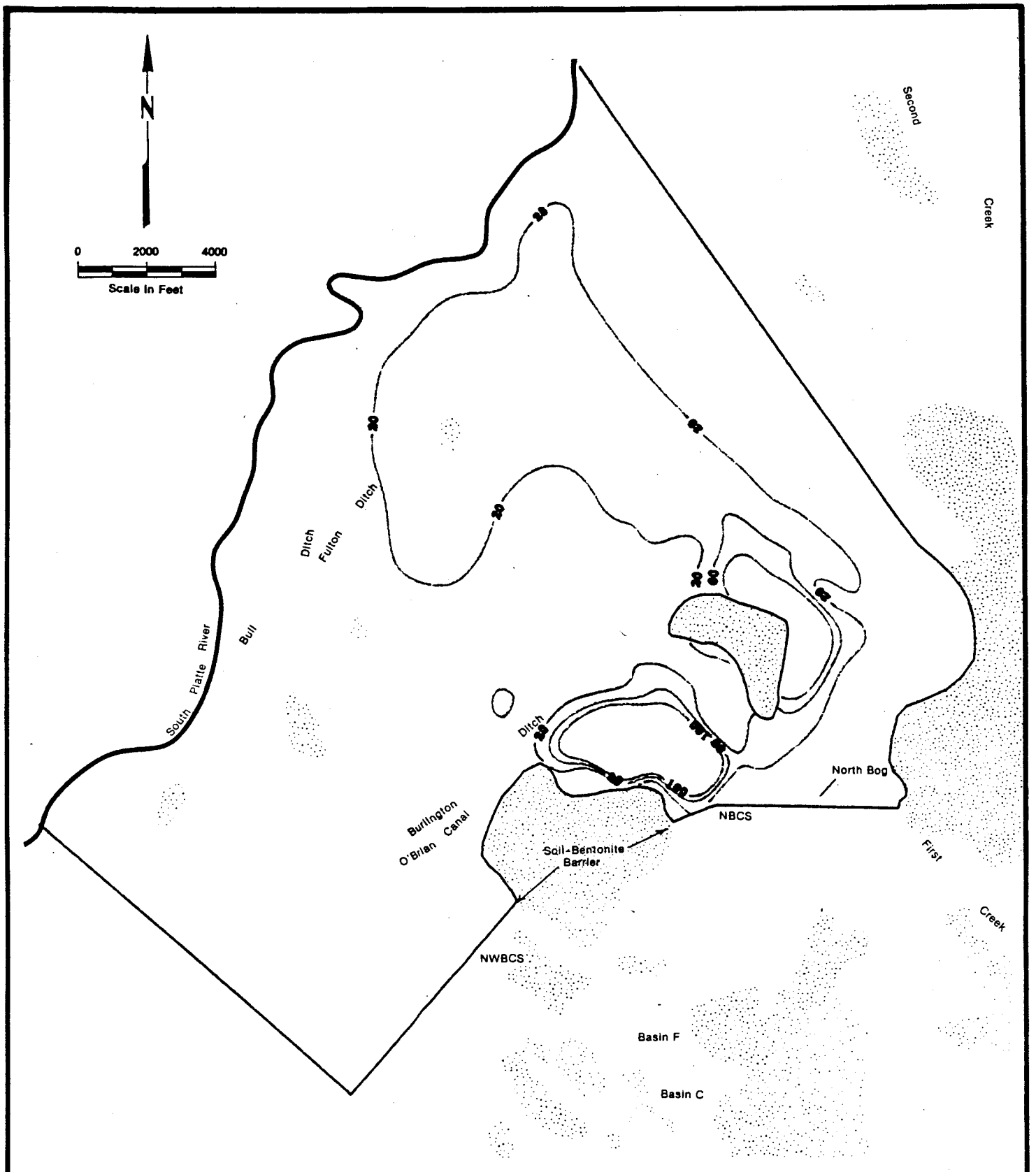


Figure G-10a
DIMP CONCENTRATION DISTRIBUTION IN 1997 (10 YEARS) WITH EXISTING NORTH BOUNDARY RECHARGE OPERATIONS, ALLUVIAL AQUIFER, CONTOUR INTERVAL (20-100 ug/l)
SOURCE: WARNER, 1988

Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

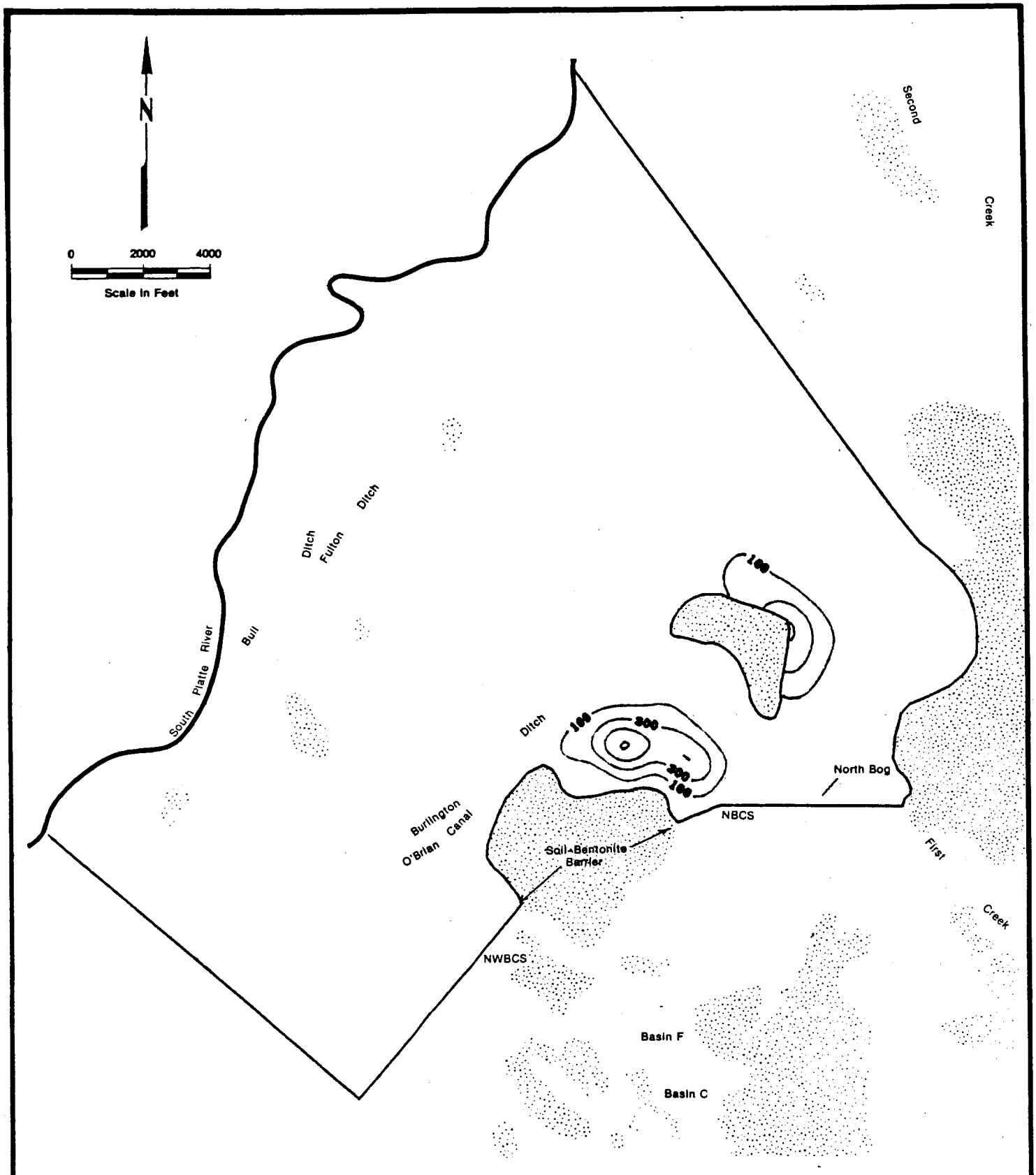


Figure G-10b
DIMP CONCENTRATION DISTRIBUTION IN 1997 (10 YEARS) WITH EXISTING NORTH BOUNDARY RECHARGE OPERATIONS, ALLUVIAL AQUIFER, CONTOUR INTERVAL (100-500 ug/l)
SOURCE: WARNER, 1988

Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

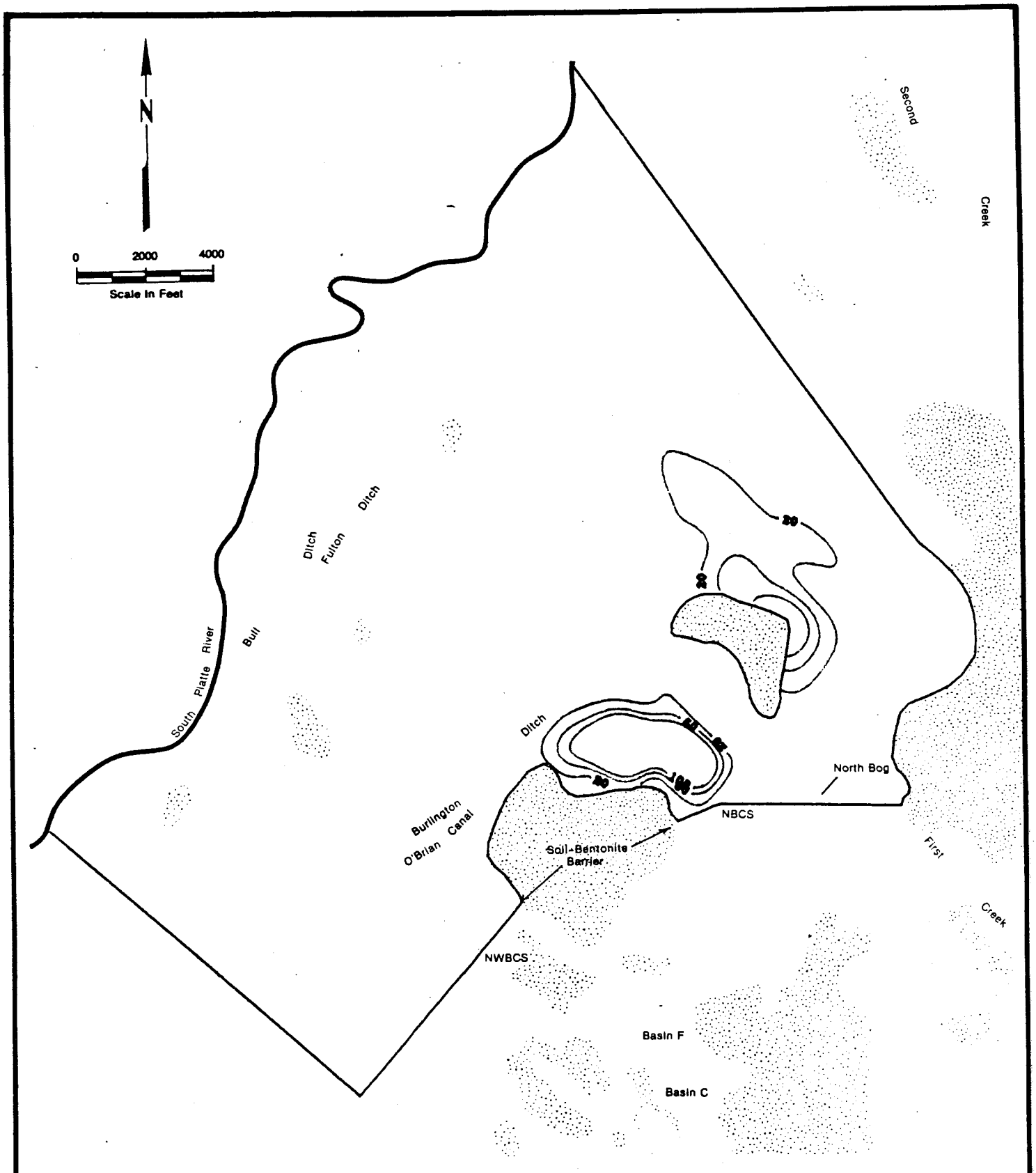


Figure G-11a
DIMP CONCENTRATION DISTRIBUTION IN 2007 (20 YEARS) WITH EXISTING NORTH BOUNDARY RECHARGE OPERATIONS, ALLUVIAL AQUIFER, CONTOUR INTERVAL (20-100 ug/l)
SOURCE: WARNER, 1988

Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

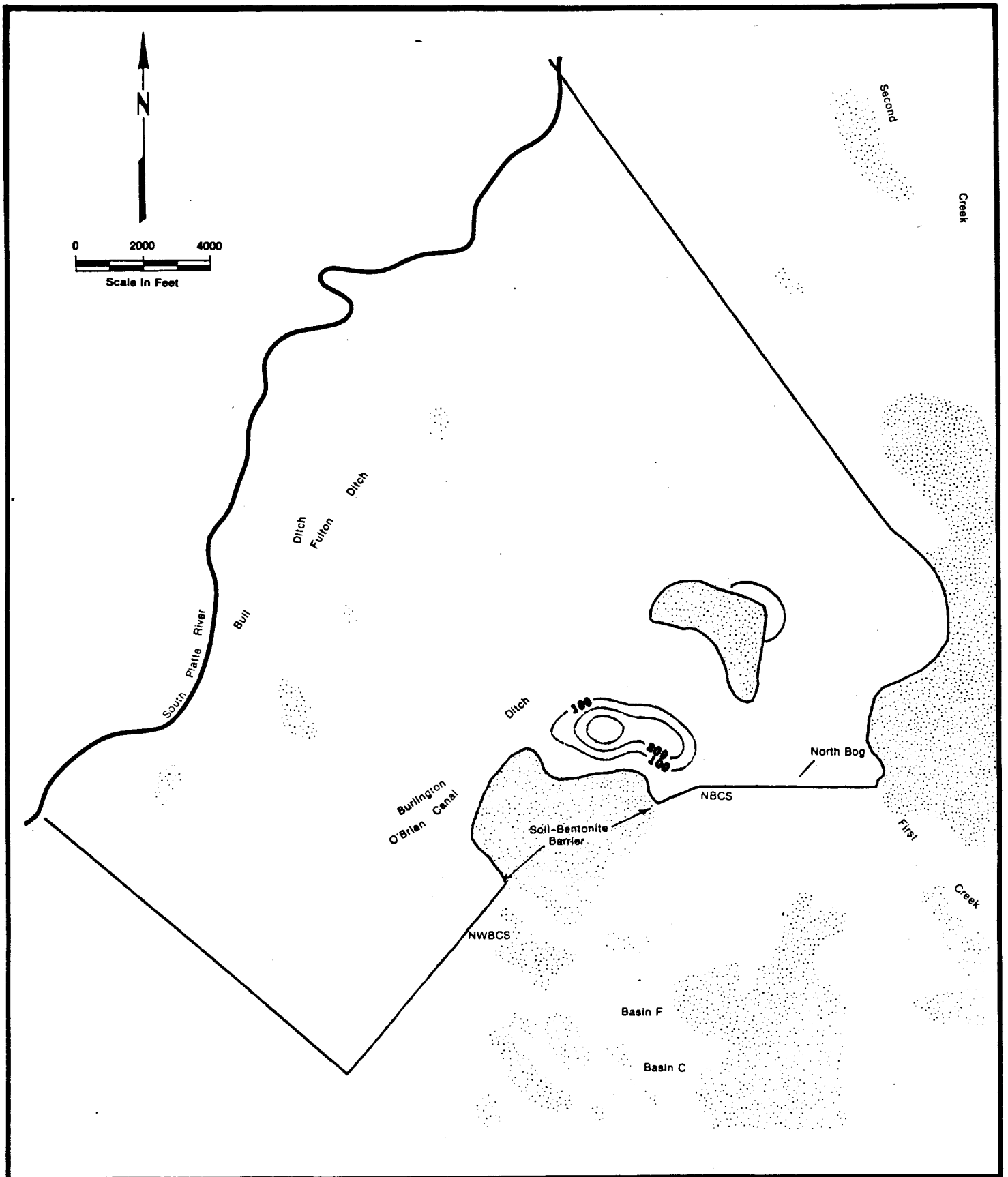


Figure G-11b
DIMP CONCENTRATION DISTRIBUTION IN 2007 (20 YEARS) WITH EXISTING NORTH BOUNDARY RECHARGE OPERATIONS, ALLUVIAL AQUIFER, CONTOUR INTERVAL (100-300 ug/l)
SOURCE: WARNER, 1988

Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

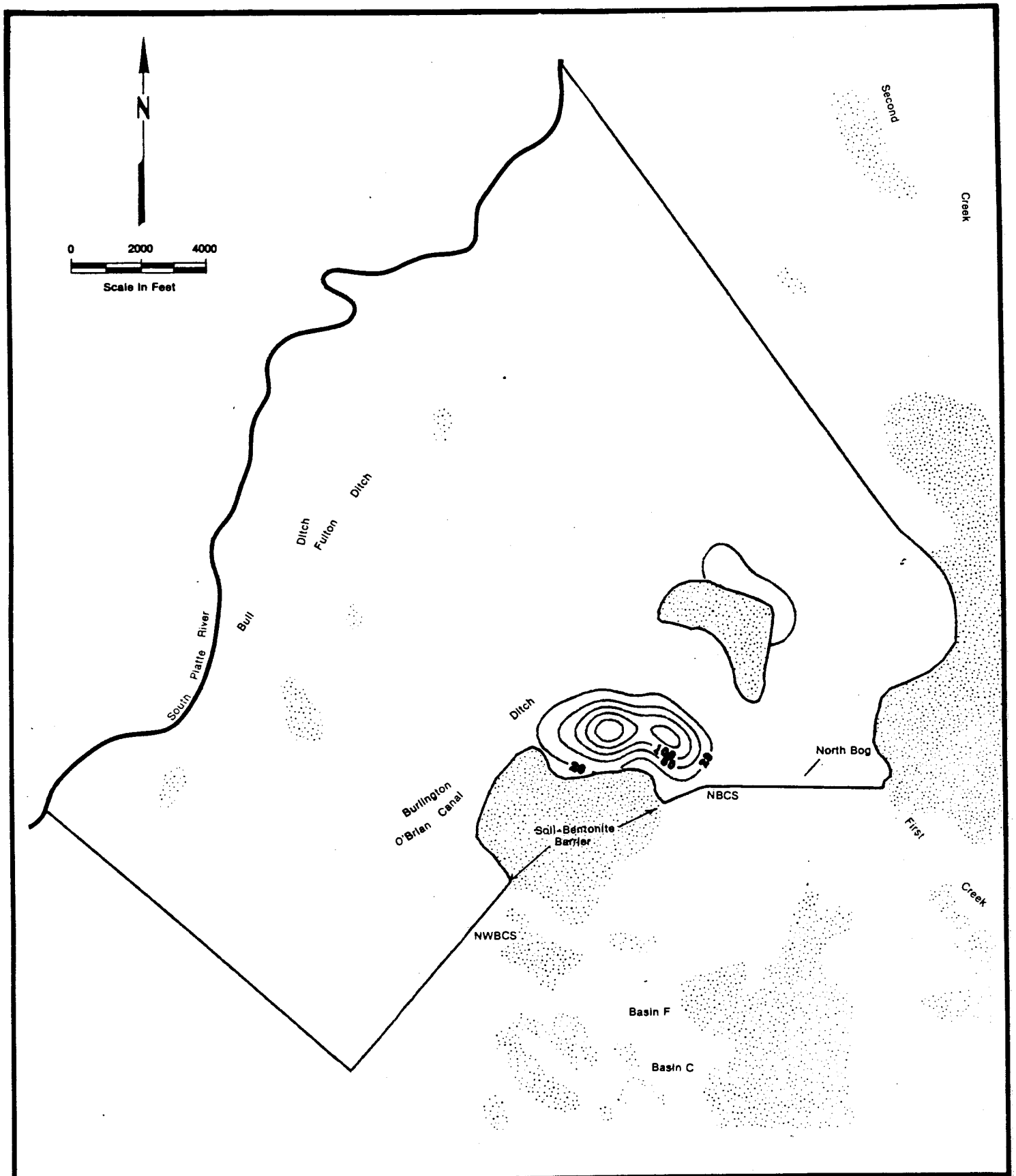


Figure G-12
DIMP CONCENTRATION DISTRIBUTION IN 2017 (30 YEARS) WITH EXISTING NORTH BOUNDARY RECHARGE OPERATIONS, ALLUVIAL AQUIFER, CONTOUR INTERVAL (20-180 ug/l)
SOURCE: WARNER, 1988

Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

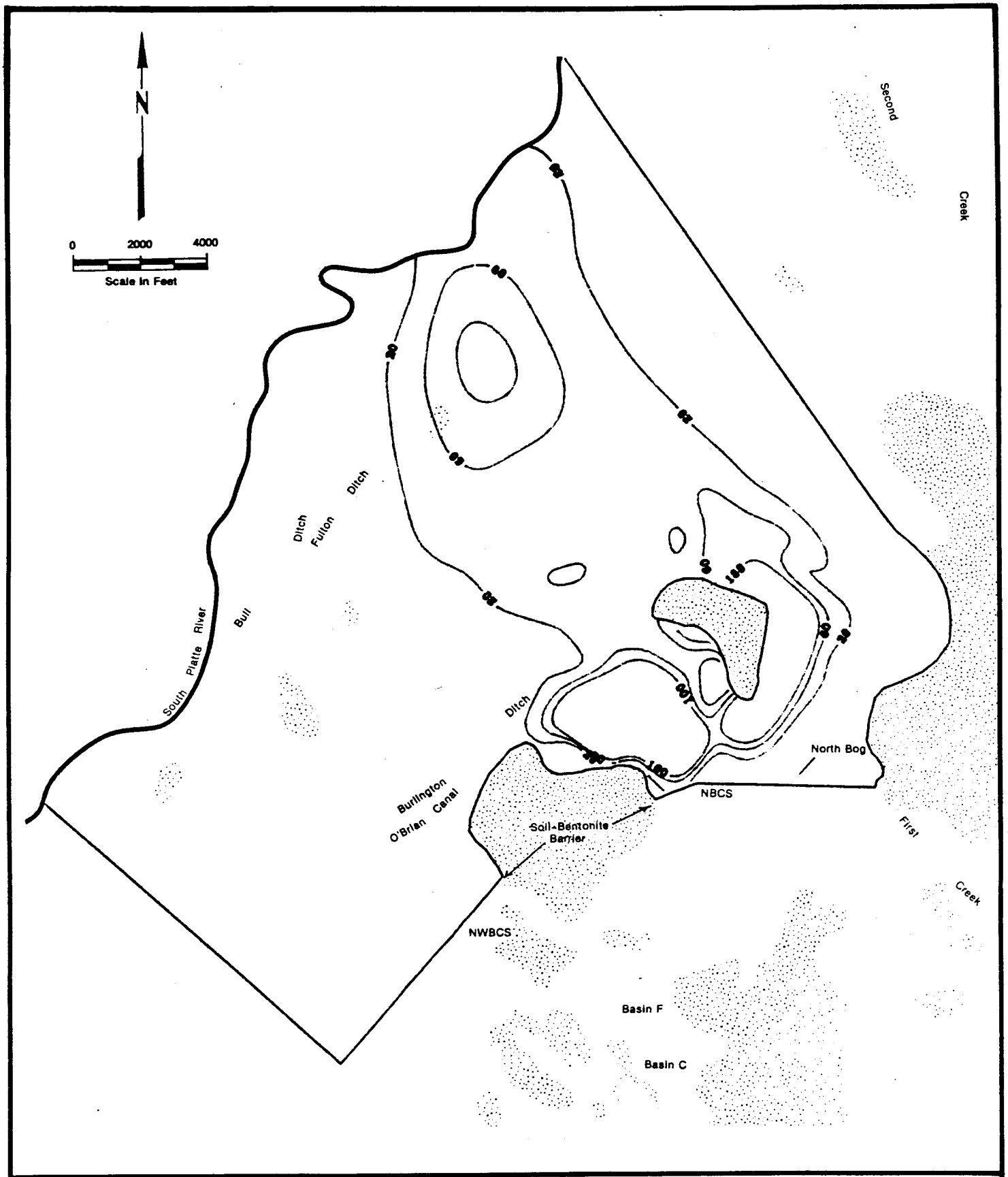


Figure G-13a
DIMP CONCENTRATION DISTRIBUTION IN 1992 (5 YEARS) WITH NORTH BOUNDARY RECHARGE OPERATION FOR NATURAL FLOW CONDITIONS, ALLUVIAL AQUIFER, CONTOUR INTERVAL (20-100 ug/l)
SOURCE: WARNER, 1988

Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

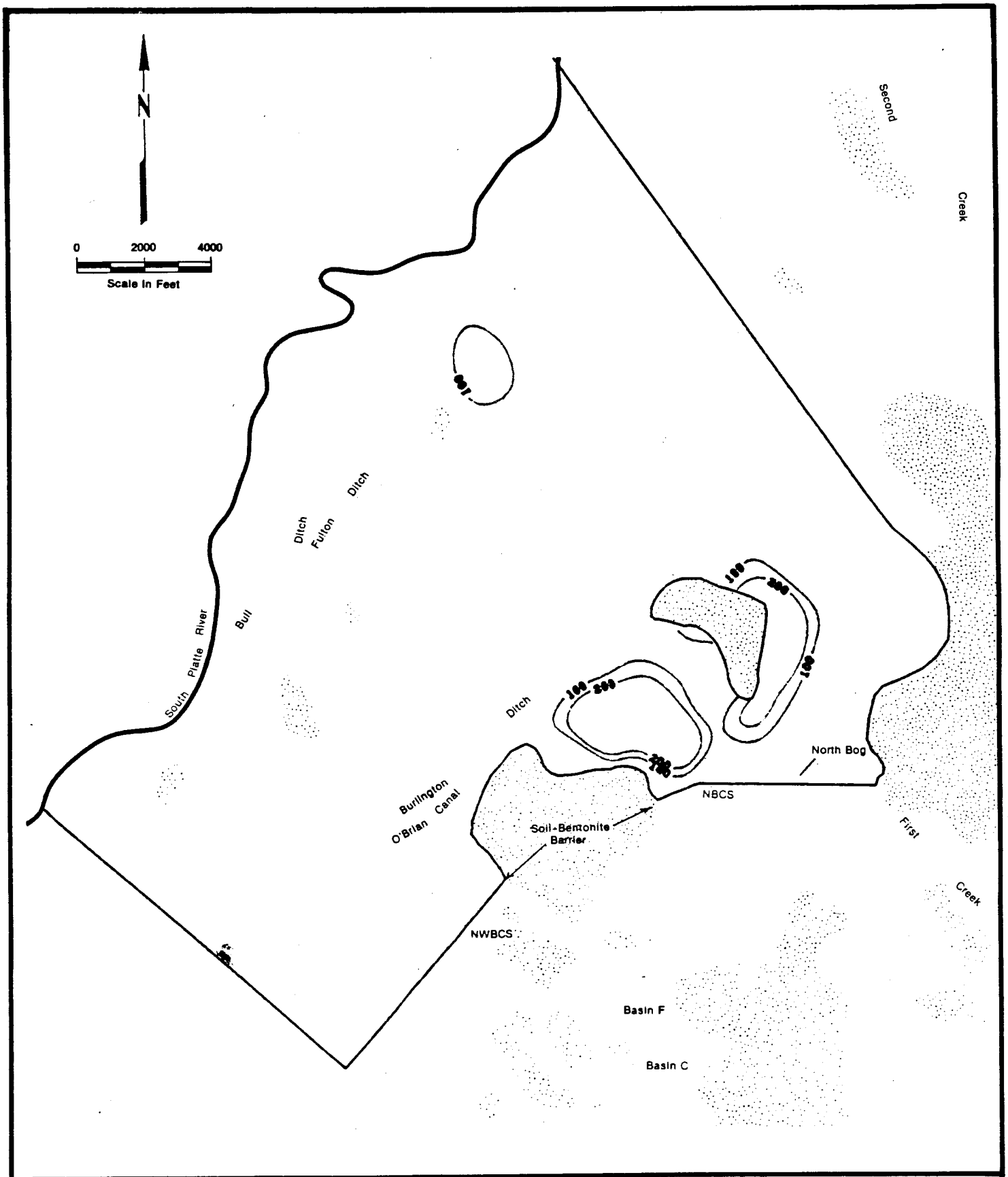


Figure G-13b
DIMP CONCENTRATION DISTRIBUTION IN 1992 (5 YEARS) WITH NORTH BOUNDARY RECHARGE OPERATION FOR NATURAL FLOW CONDITIONS, ALLUVIAL AQUIFER, CONTOUR INTERVAL (100-200 ug/l)
SOURCE: WARNER, 1988

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

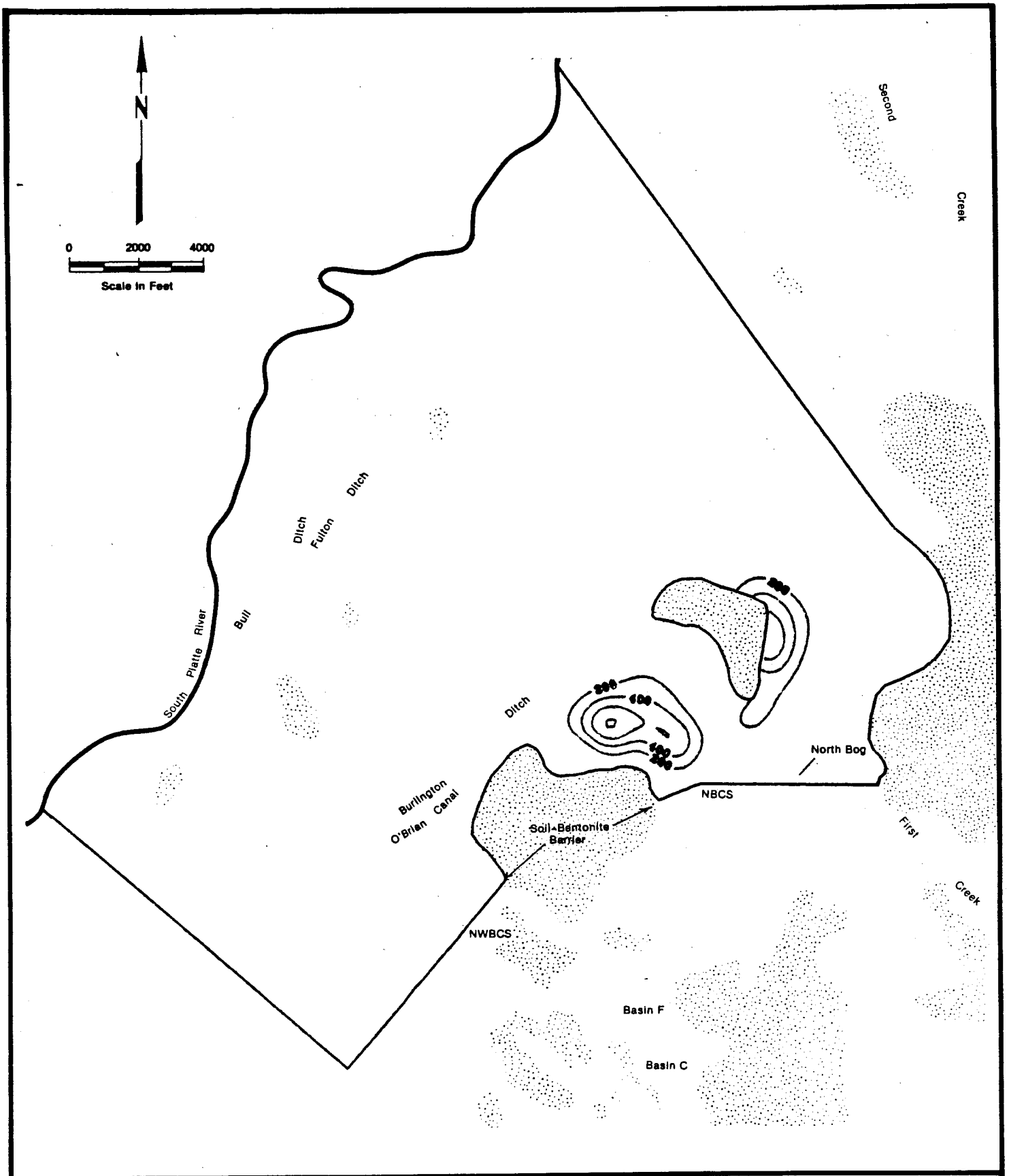


Figure G-13c
DIMP CONCENTRATION DISTRIBUTION IN 1992 (5 YEARS) WITH NORTH BOUNDARY RECHARGE OPERATION FOR NATURAL FLOW CONDITIONS, ALLUVIAL AQUIFER, CONTOUR INTERVAL (200-800 ug/l)
SOURCE: WARNER, 1988

Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

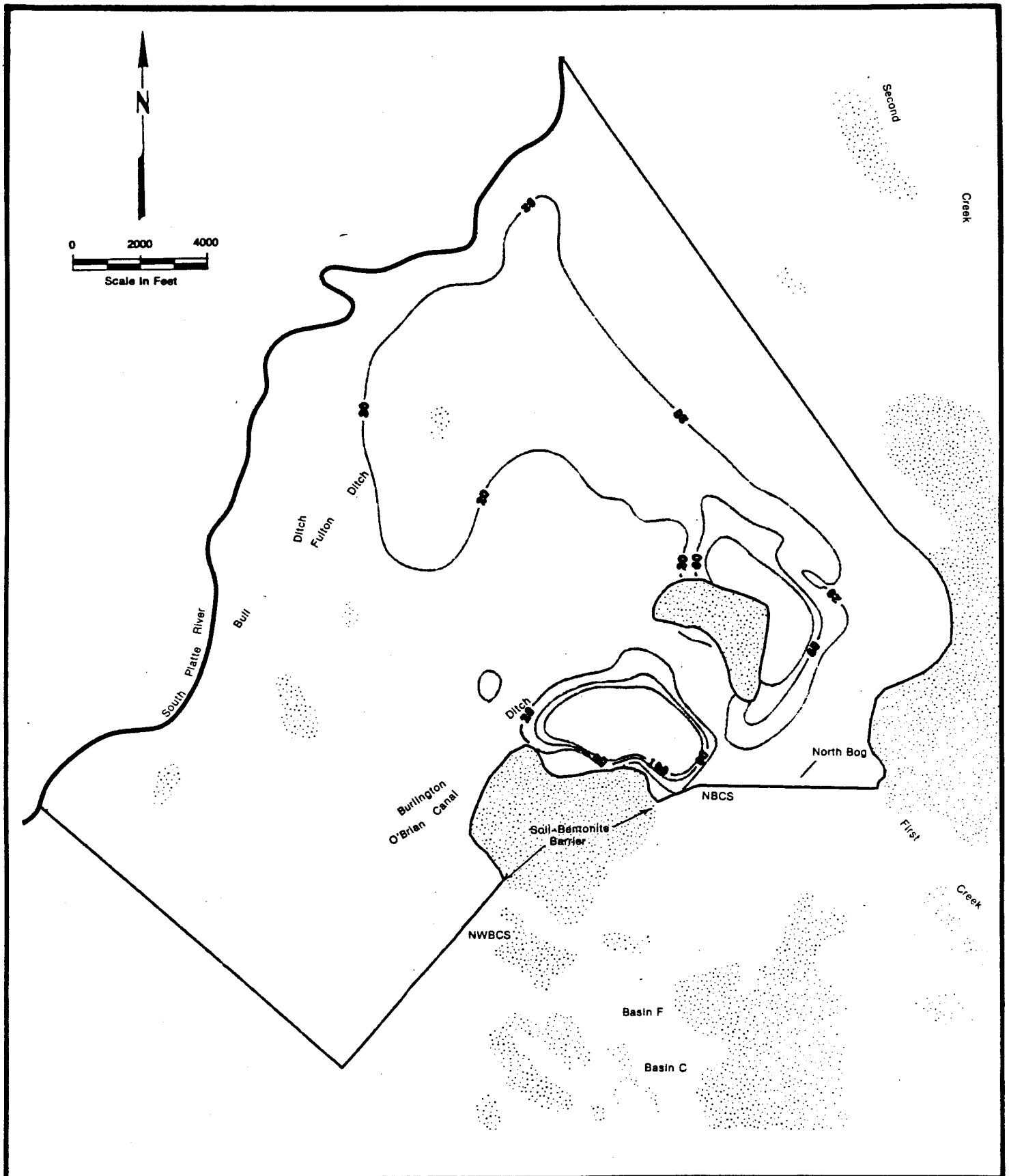


Figure G-14a
DIMP CONCENTRATION DISTRIBUTION IN 1997 (10 YEARS) WITH NORTH BOUNDARY RECHARGE OPERATION FOR NATURAL FLOW CONDITIONS, ALLUVIAL AQUIFER, CONTOUR INTERVAL (20-100 ug/l)
SOURCE: WARNER, 1988

Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

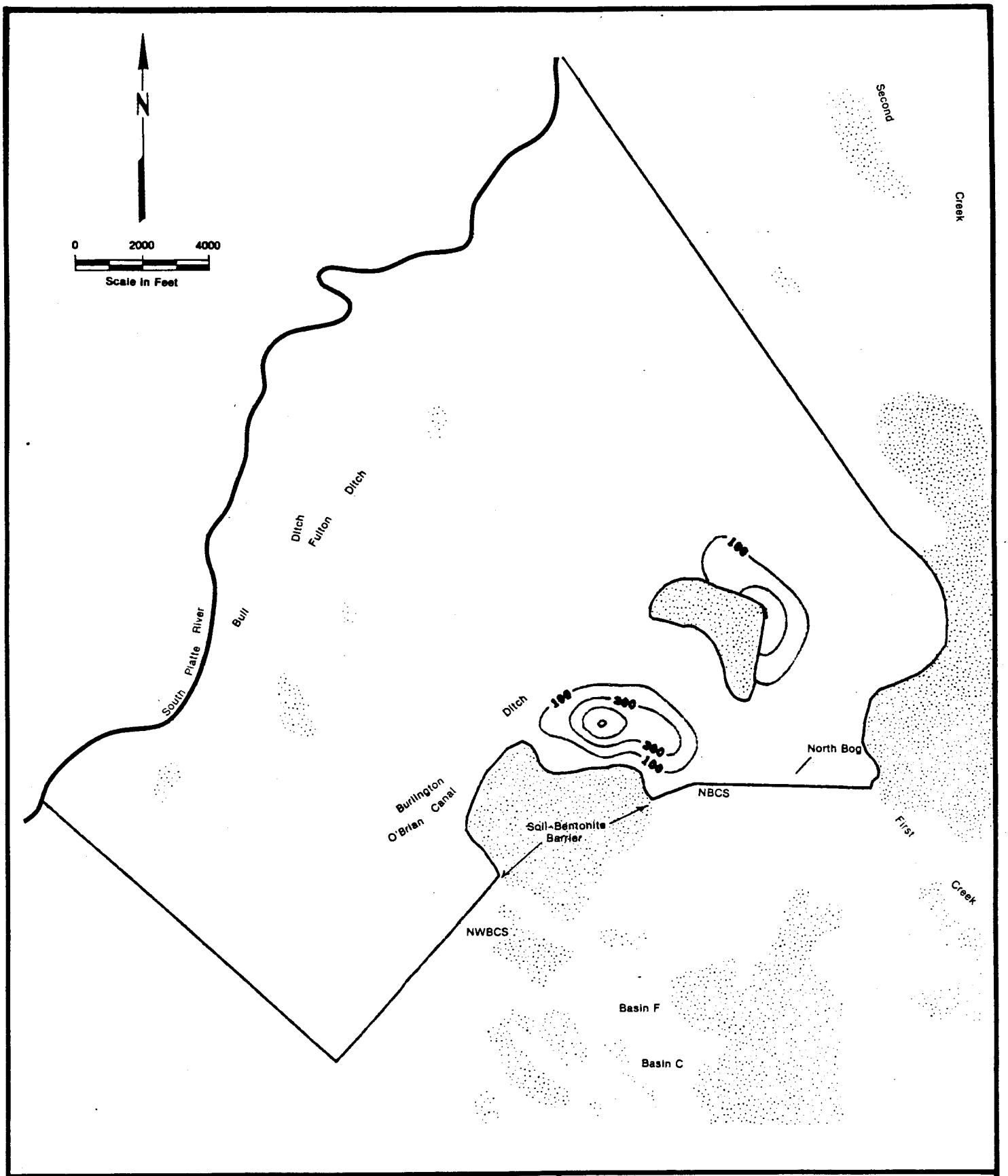


Figure G-14b
DIMP CONCENTRATION DISTRIBUTION IN 1997 (10 YEARS) WITH NORTH BOUNDARY RECHARGE OPERATION FOR NATURAL FLOW CONDITIONS, ALLUVIAL AQUIFER, CONTOUR INTERVAL (100-700 ug/l)
SOURCE: WARNER, 1988

Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

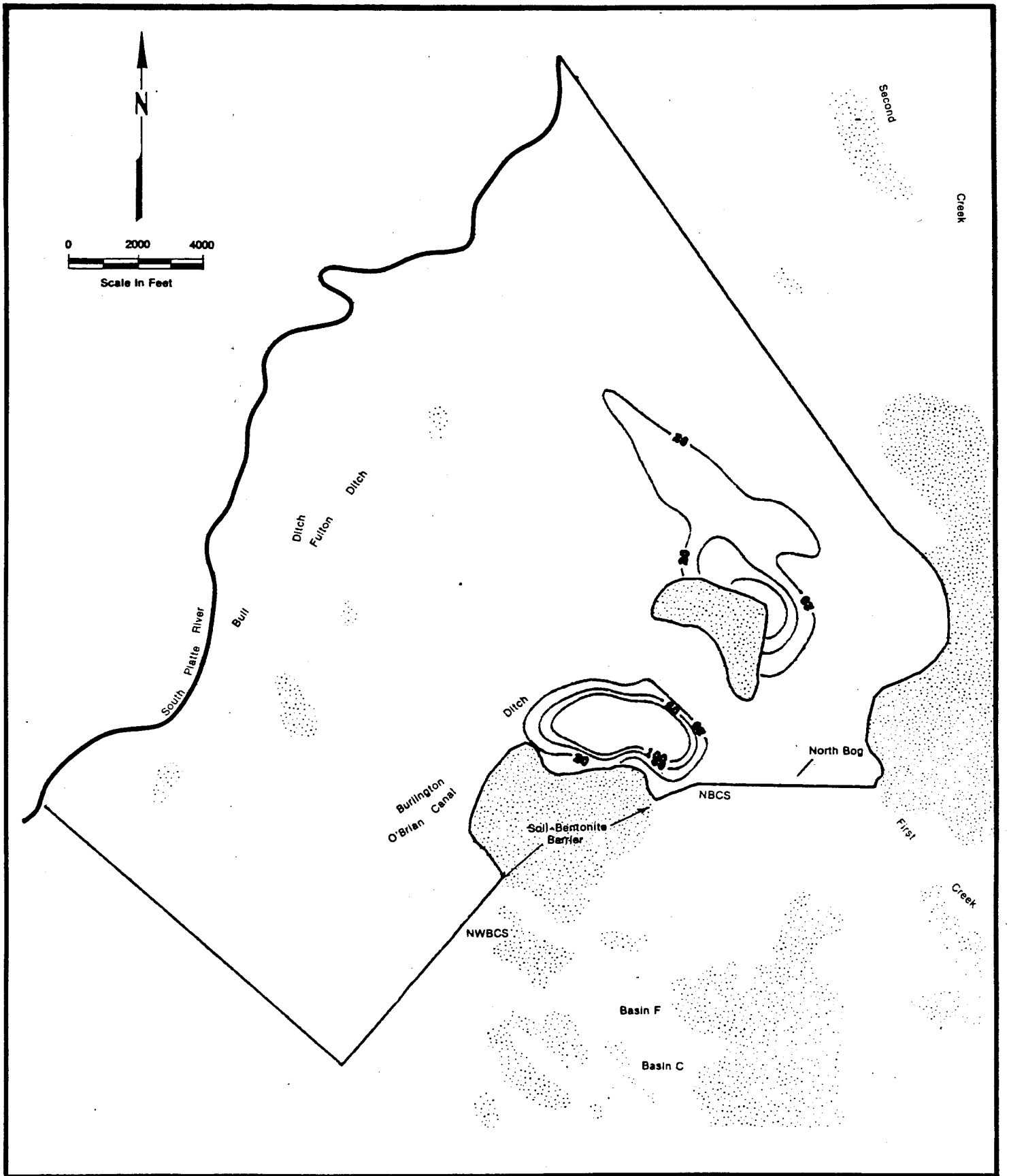


Figure G-15a
DIMP CONCENTRATION DISTRIBUTION IN 2007 (20 YEARS) WITH NORTH BOUNDARY RECHARGE OPERATION FOR NATURAL FLOW CONDITIONS, ALLUVIAL AQUIFER, CONTOUR INTERVAL (20-100 ug/l)
SOURCE: WARNER, 1988

Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

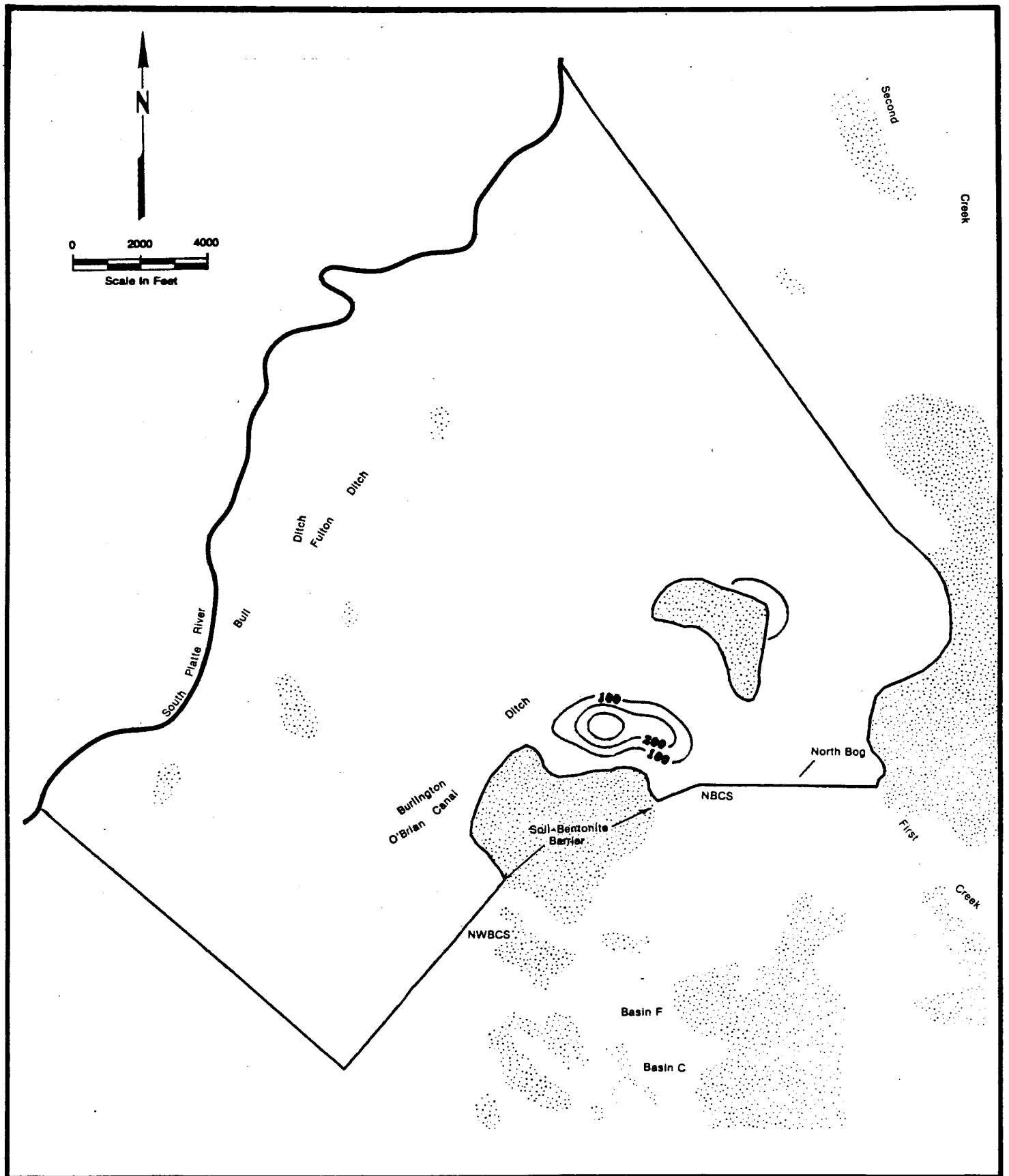


Figure G-15b
DIMP CONCENTRATION DISTRIBUTION IN 2007 (20 YEARS) WITH NORTH BOUNDARY RECHARGE OPERATION FOR NATURAL FLOW CONDITIONS, ALLUVIAL AQUIFER, CONTOUR INTERVAL (100-300 ug/l)
SOURCE: WARNER, 1988

Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

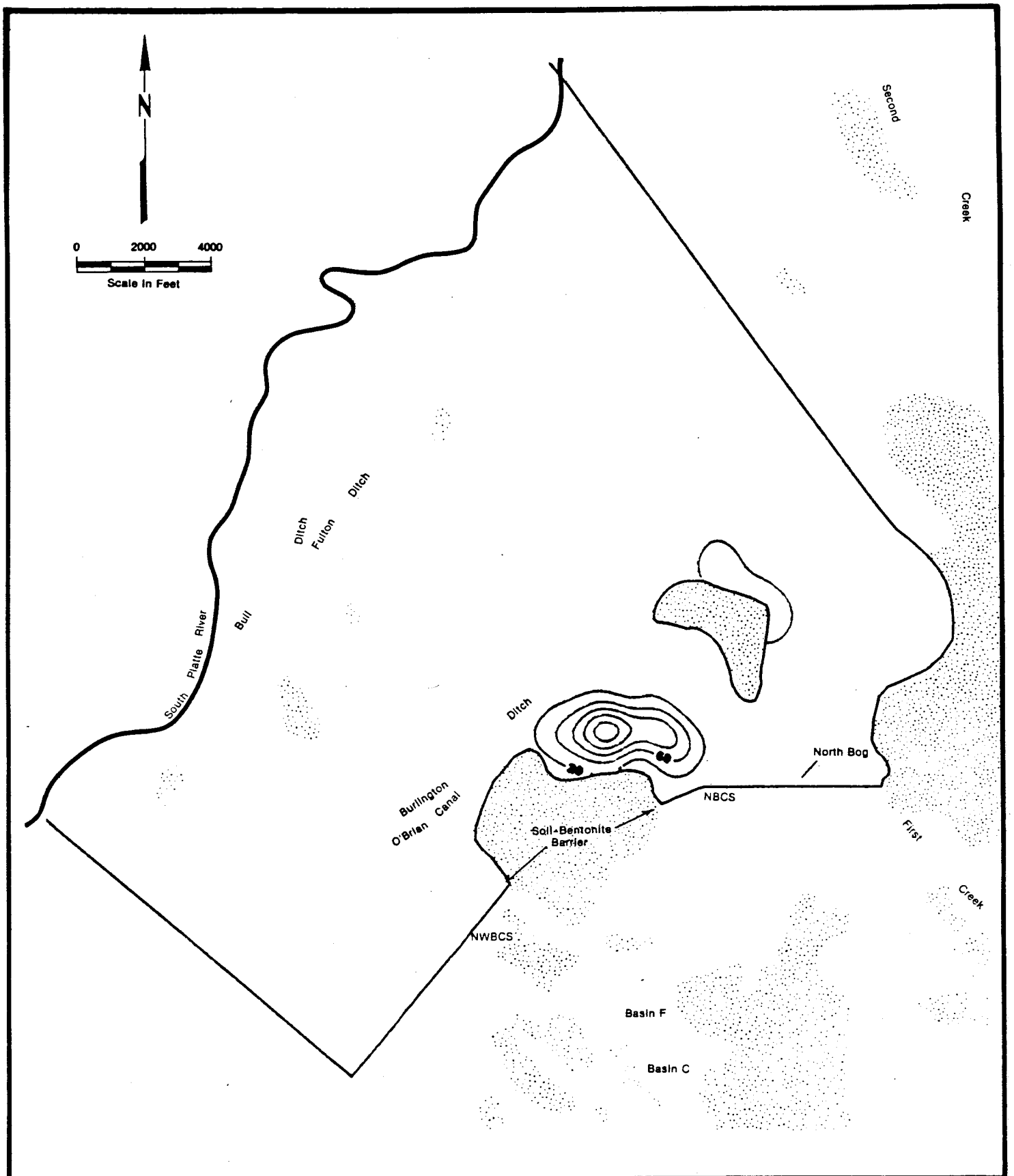
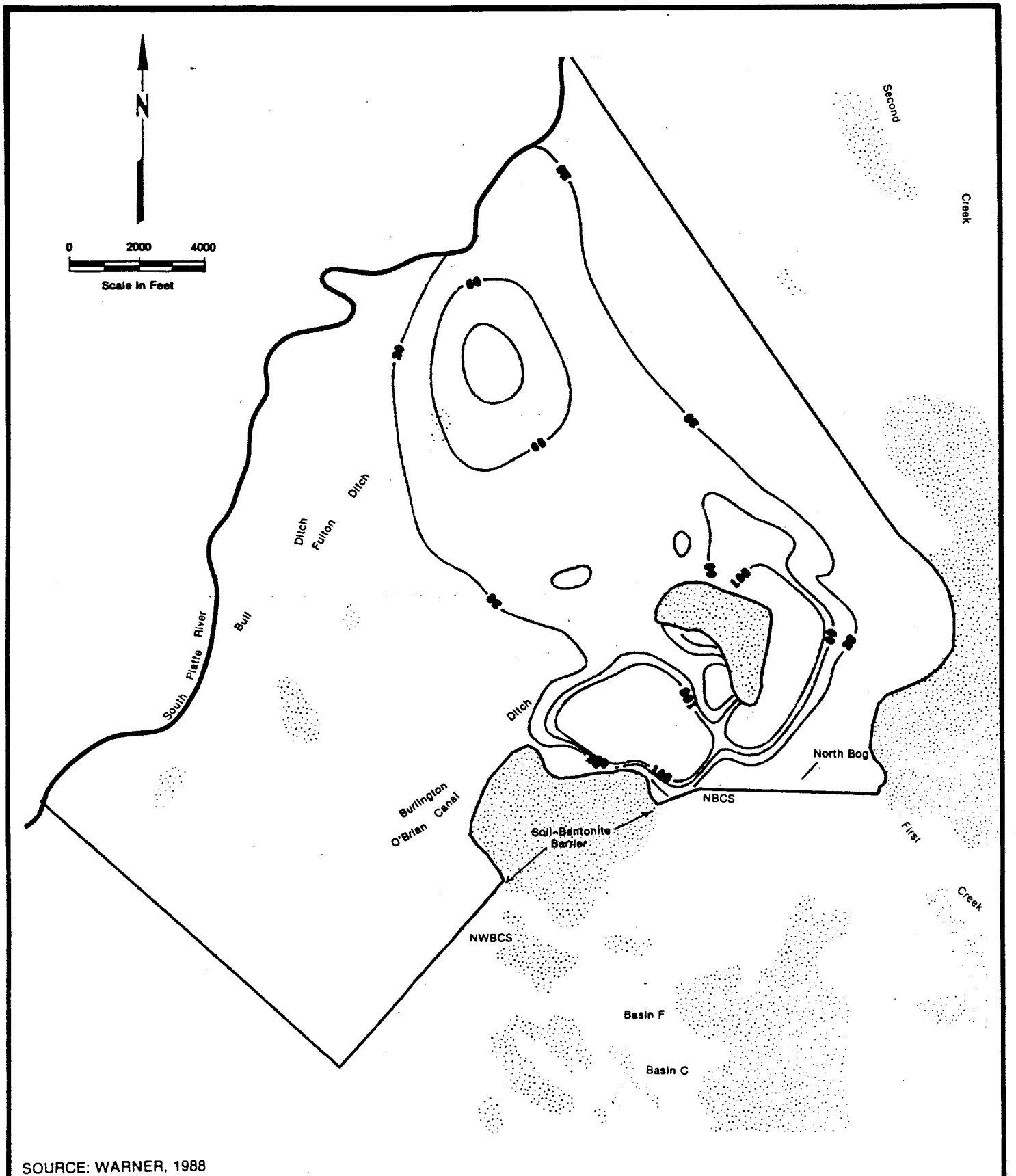


Figure G-16
DIMP CONCENTRATION DISTRIBUTION IN 2017 (30 YEARS) WITH NORTH BOUNDARY RECHARGE OPERATION FOR NATURAL FLOW CONDITIONS, ALLUVIAL AQUIFER, CONTOUR INTERVAL (20-180 ug/l)
SOURCE: WARNER, 1988

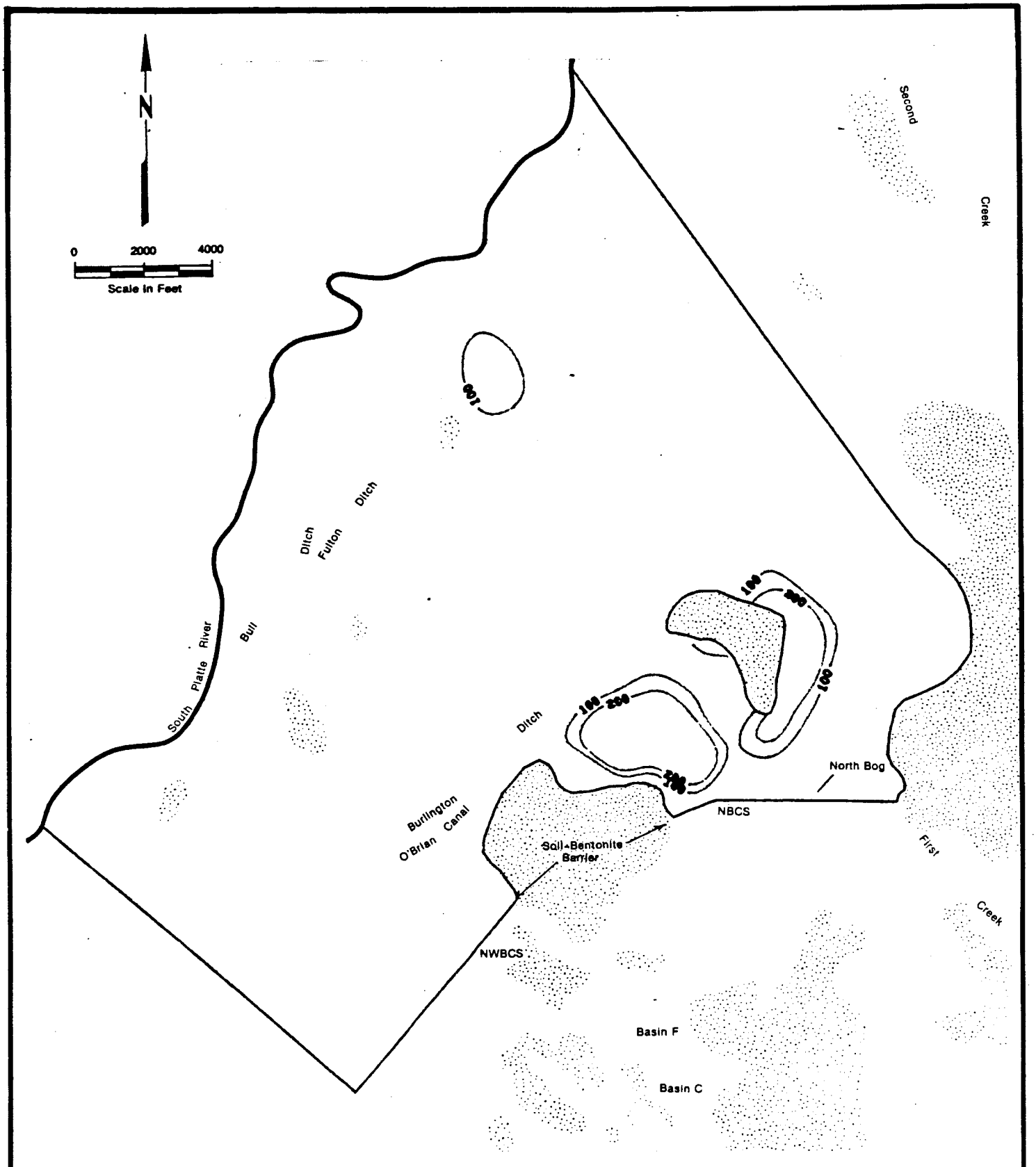
Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland



SOURCE: WARNER, 1988

Figure G-17a
DIMP CONCENTRATION DISTRIBUTION IN 1992 (5 YEARS) WITH EXISTING NEW SOUTH ADAMS COUNTY WELL FIELD, ALLUVIAL AQUIFER, CONTOUR INTERVAL (20-100 ug/l)

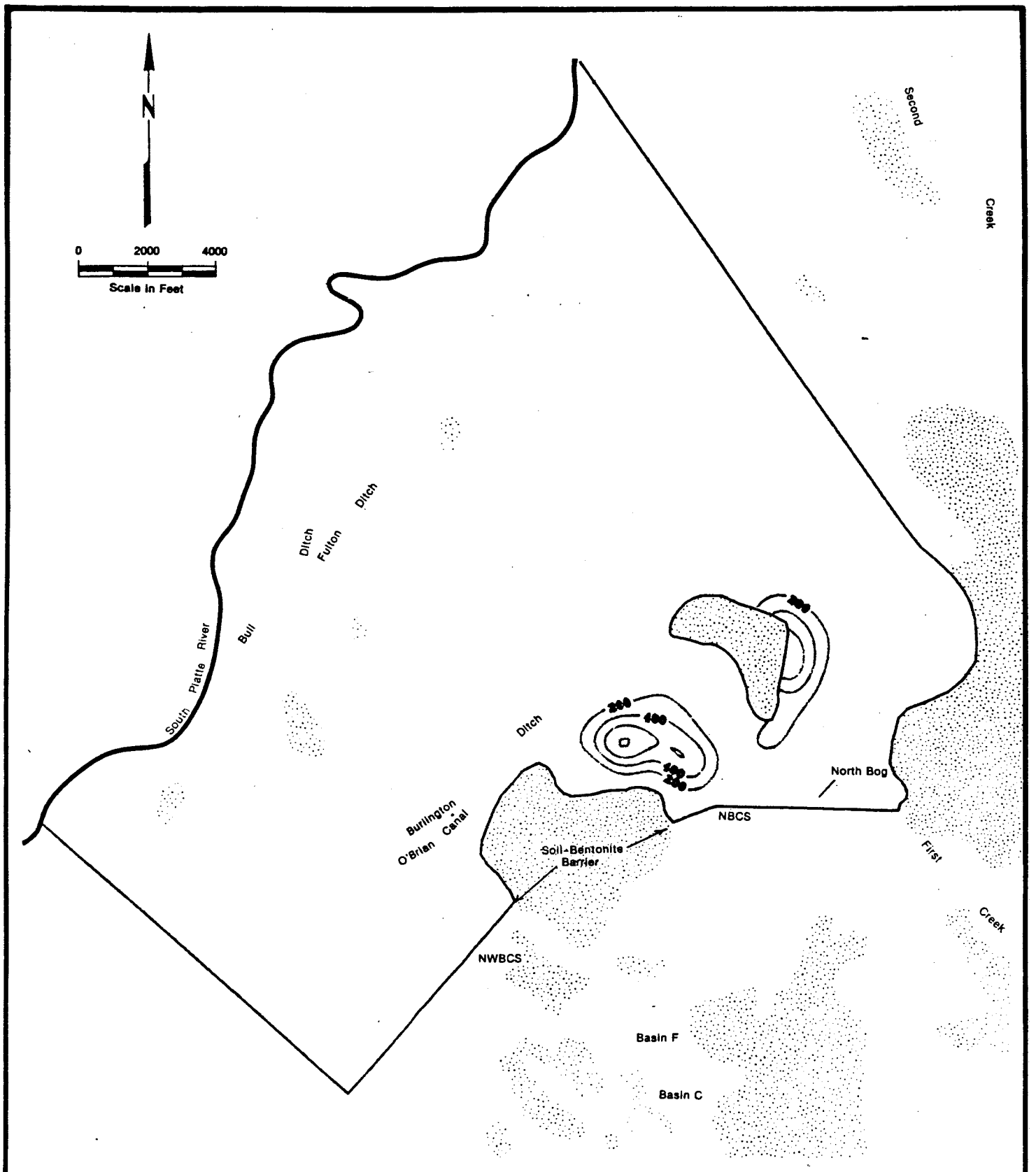
Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland



SOURCE: WARNER, 1988

Figure G-17b
DIMP CONCENTRATION DISTRIBUTION IN 1992 (5 YEARS) WITH EXISTING NEW SOUTH ADAMS COUNTY WELL FIELD, ALLUVIAL AQUIFER, CONTOUR INTERVAL (100-200 ug/l)

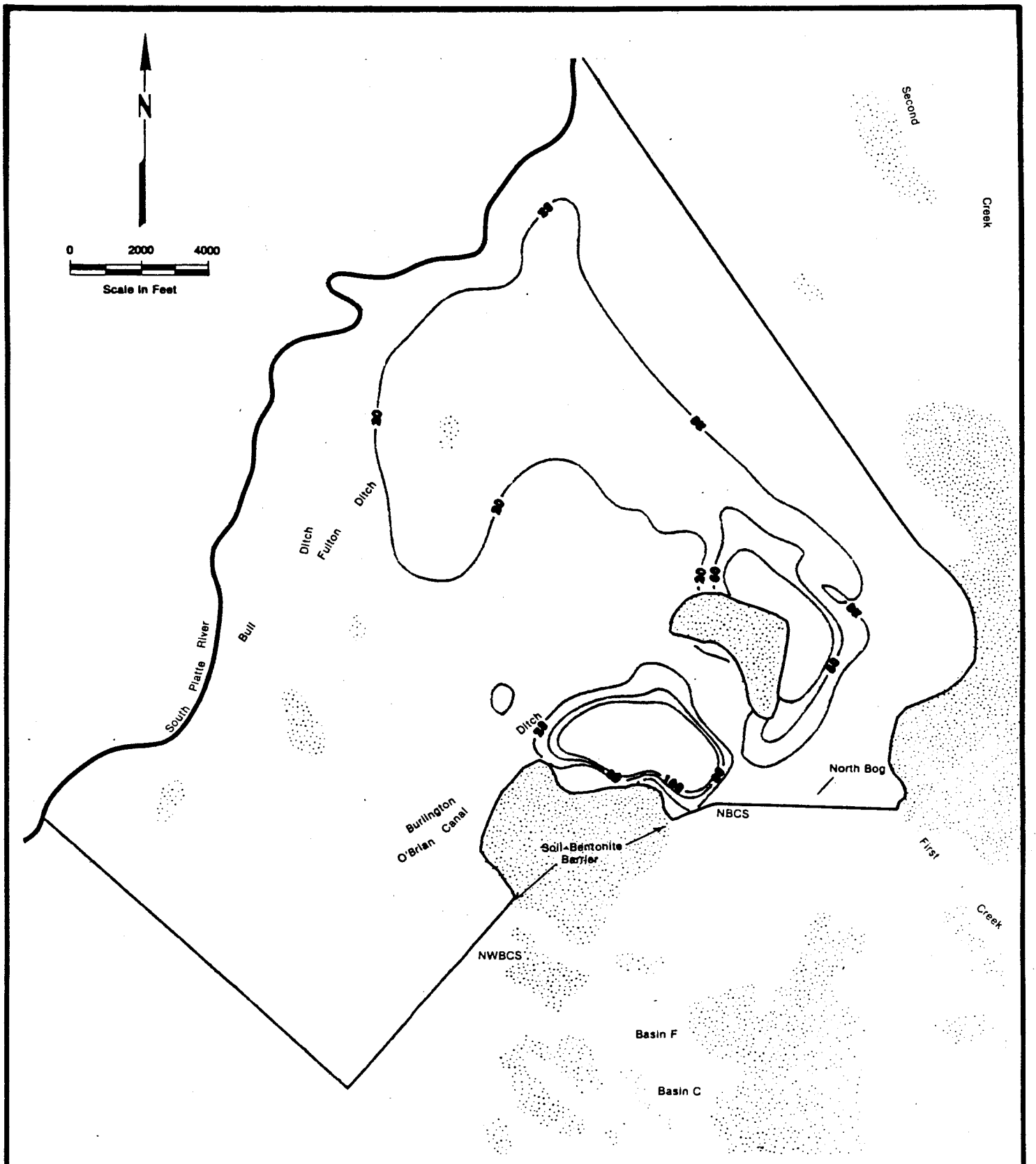
Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland



SOURCE: WARNER, 1988

Figure G-17c
DIMP CONCENTRATION DISTRIBUTION IN 1992 (5 YEARS) WITH EXISTING NEW SOUTH ADAMS COUNTY WELL FIELD, ALLUVIAL AQUIFER, CONTOUR INTERVAL (200-800 ug/l)

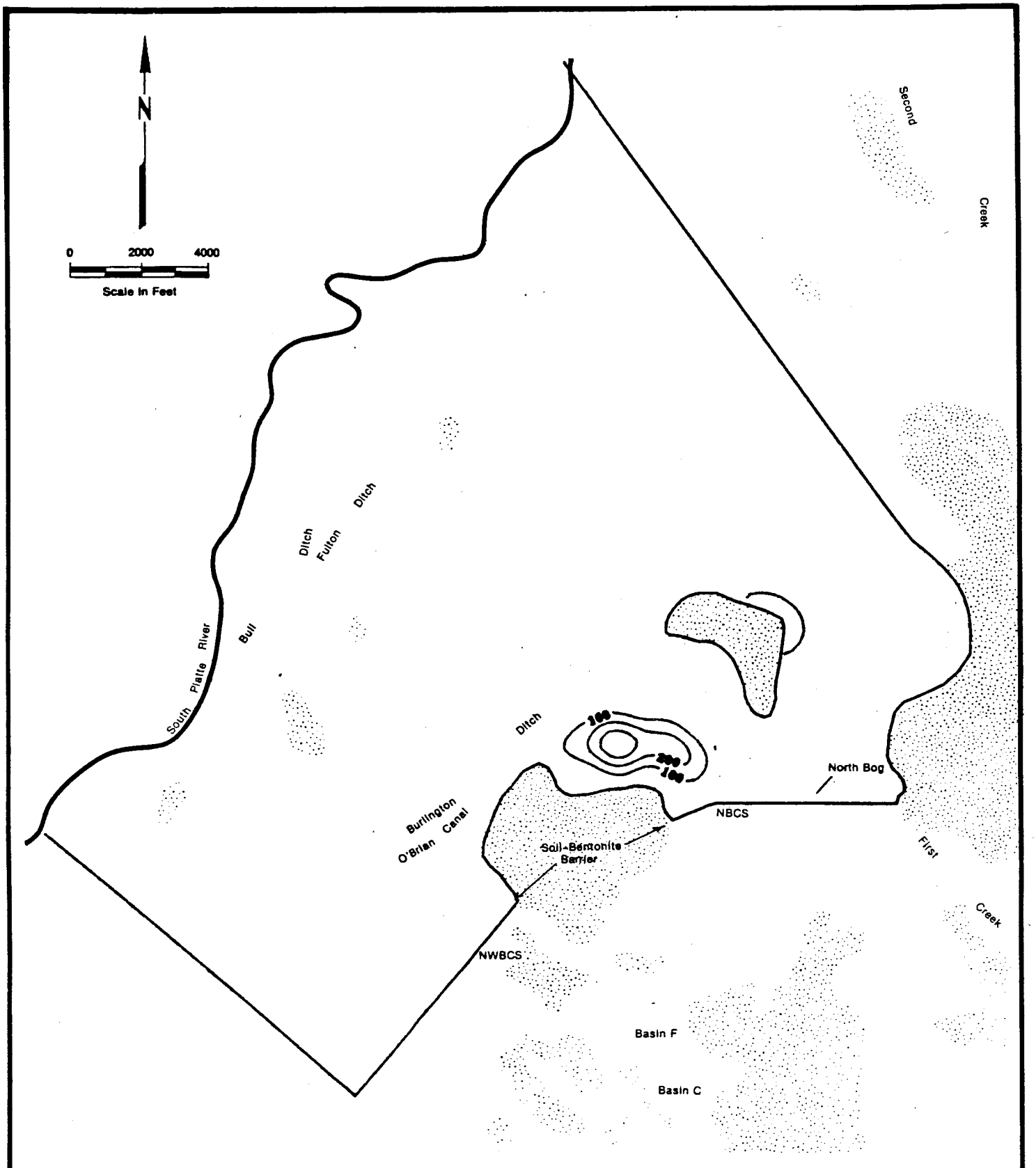
Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland



SOURCE: WARNER, 1988

Figure G-18a
DIMP CONCENTRATION DISTRIBUTION IN 1997 (10 YEARS) WITH EXISTING NEW SOUTH ADAMS COUNTY WELL FIELD, ALLUVIAL AQUIFER, CONTOUR INTERVAL (20-100 ug/l)

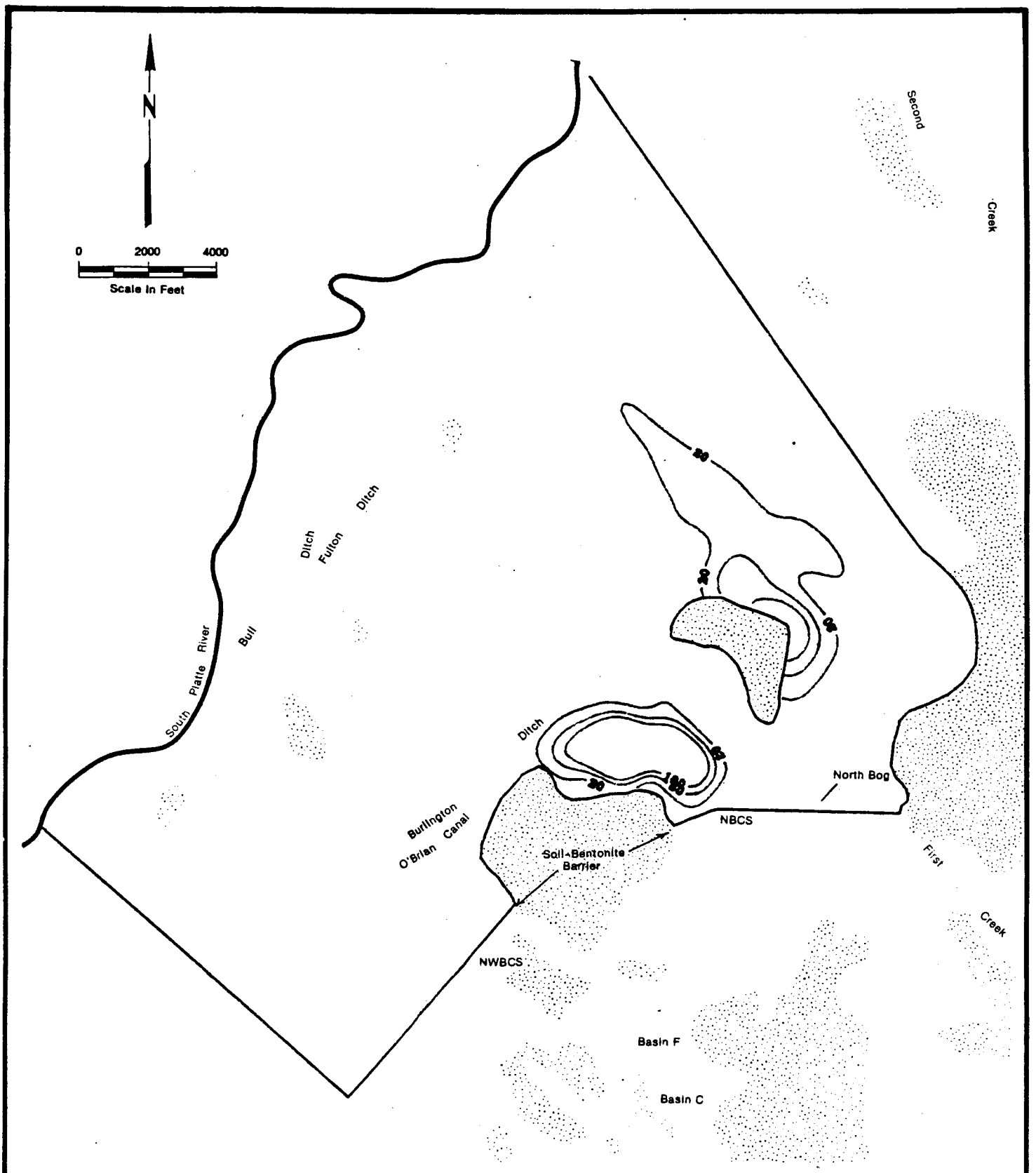
Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland



SOURCE: WARNER, 1988

Figure G-18b
DIMP CONCENTRATION DISTRIBUTION IN 1997 (10 YEARS) WITH EXISTING NEW SOUTH ADAMS COUNTY WELL FIELD, ALLUVIAL AQUIFER, CONTOUR INTERVAL (100-700 ug/l)

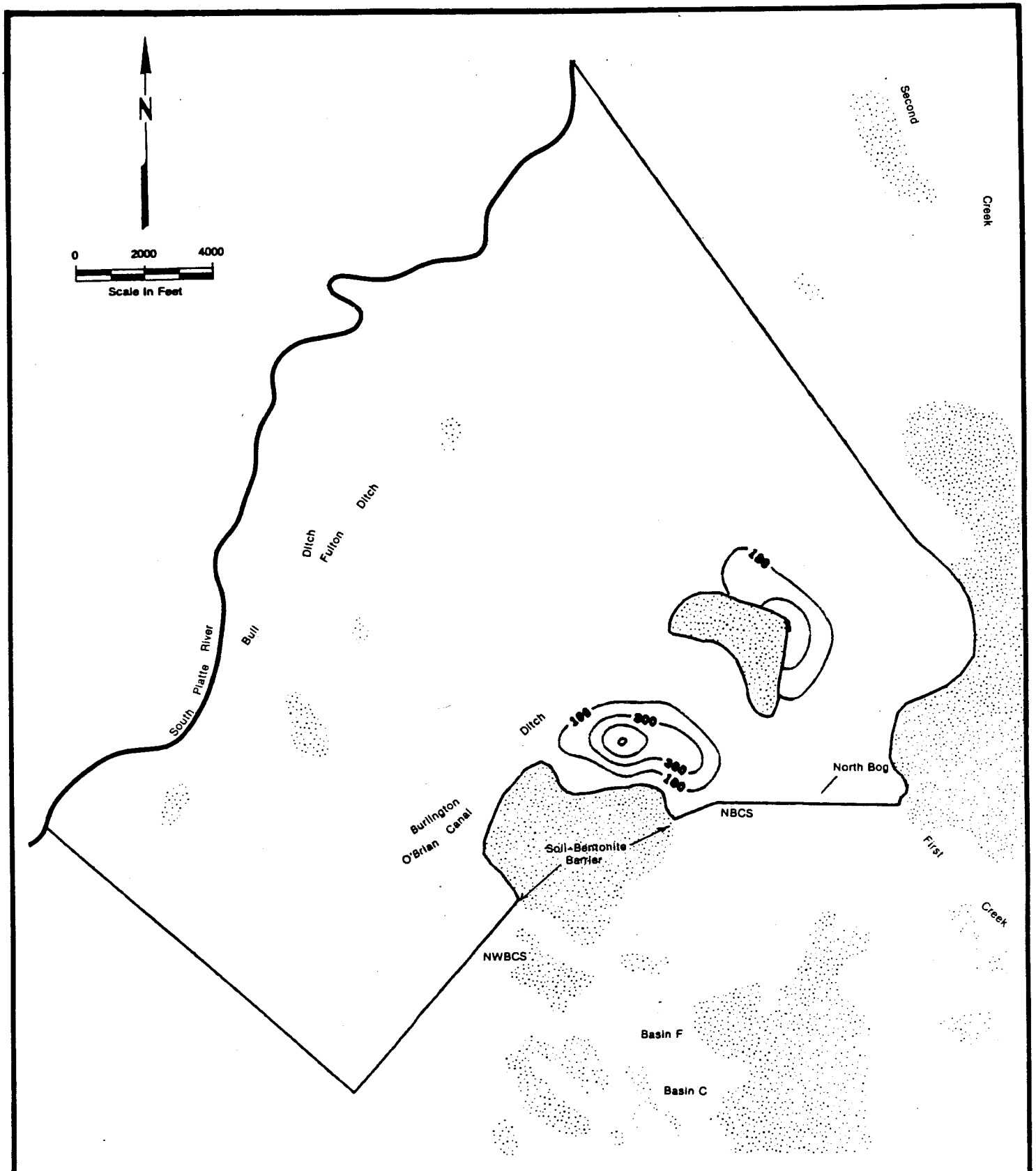
Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland



SOURCE: WARNER, 1988

Figure G-19a
DIMP CONCENTRATION DISTRIBUTION IN 2007 (20 YEARS) WITH EXISTING NEW SOUTH ADAMS COUNTY WELL FIELD, ALLUVIAL AQUIFER, CONTOUR INTERVAL (20-100 ug/l)

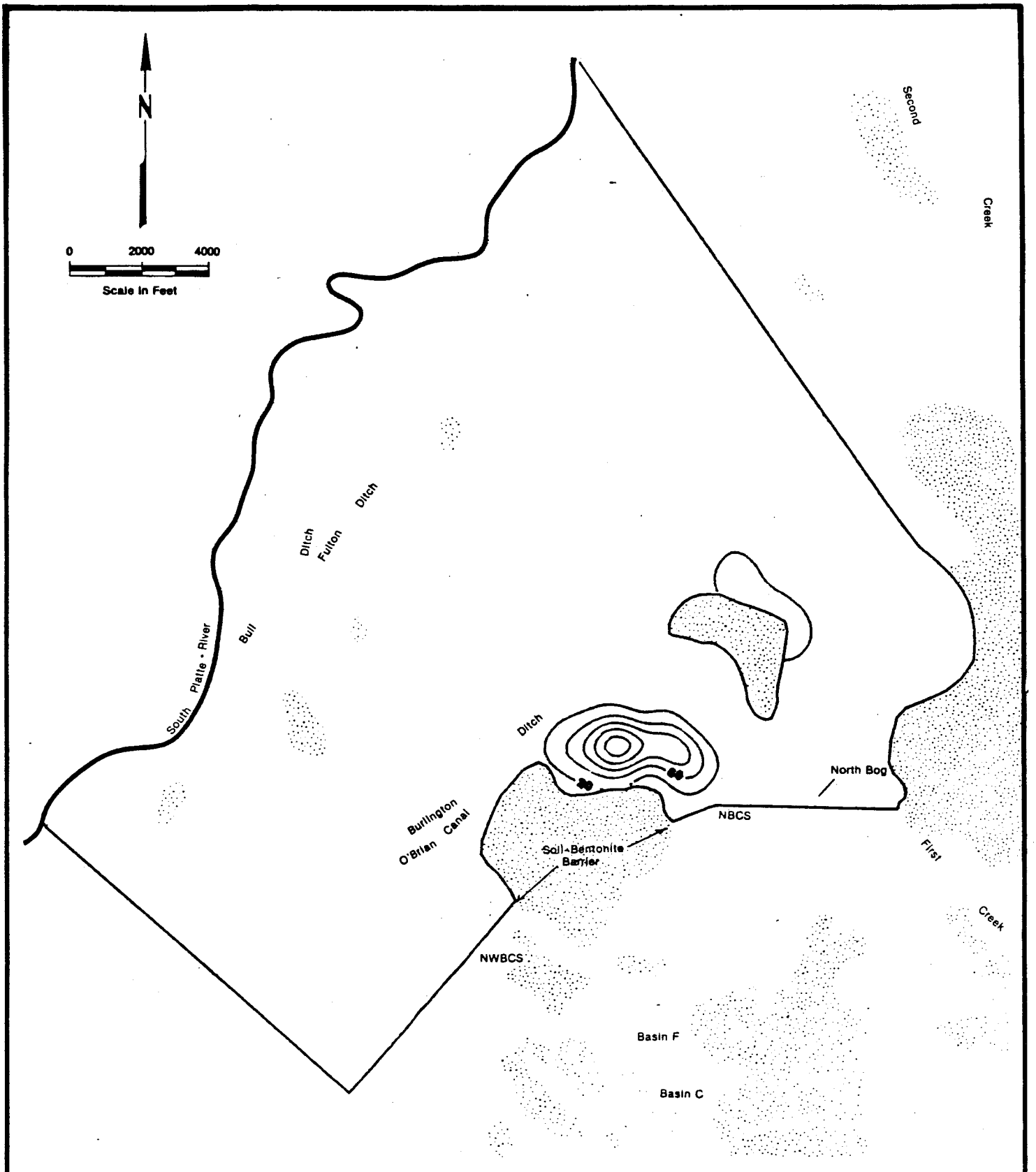
Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland



SOURCE: WARNER, 1988

Figure G-19b
DIMP CONCENTRATION DISTRIBUTION IN 2007 (20 YEARS) WITH EXISTING NEW SOUTH ADAMS COUNTY WELL FIELD, ALLUVIAL AQUIFER, CONTOUR INTERVAL (20-100 ug/l)

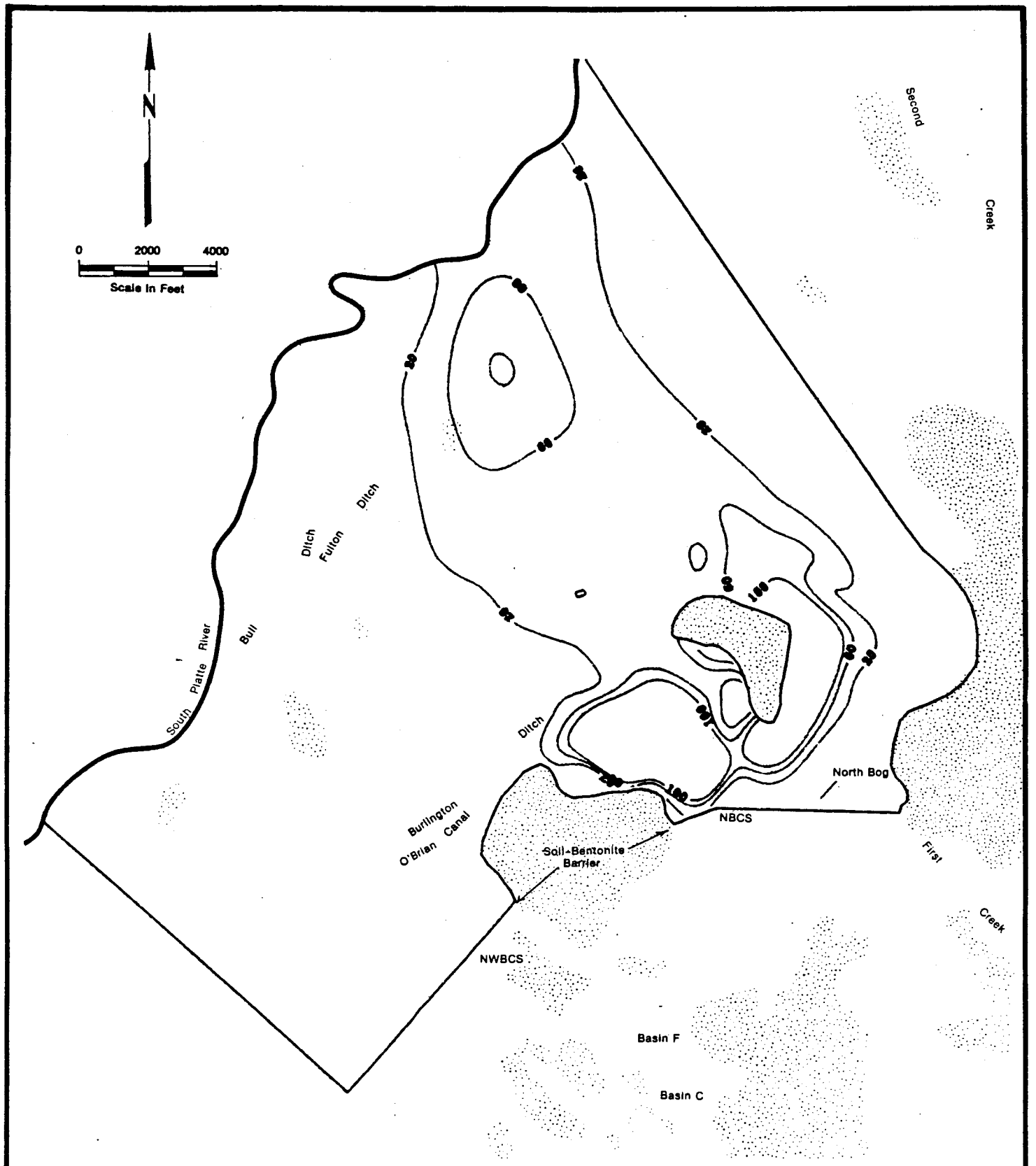
Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland



SOURCE: WARNER, 1988

Figure G-20
DIMP CONCENTRATION DISTRIBUTION IN 2017 (30 YEARS) WITH EXISTING NEW SOUTH ADAMS COUNTY WELL FIELD, ALLUVIAL AQUIFER, CONTOUR INTERVAL (20-180 ug/l)

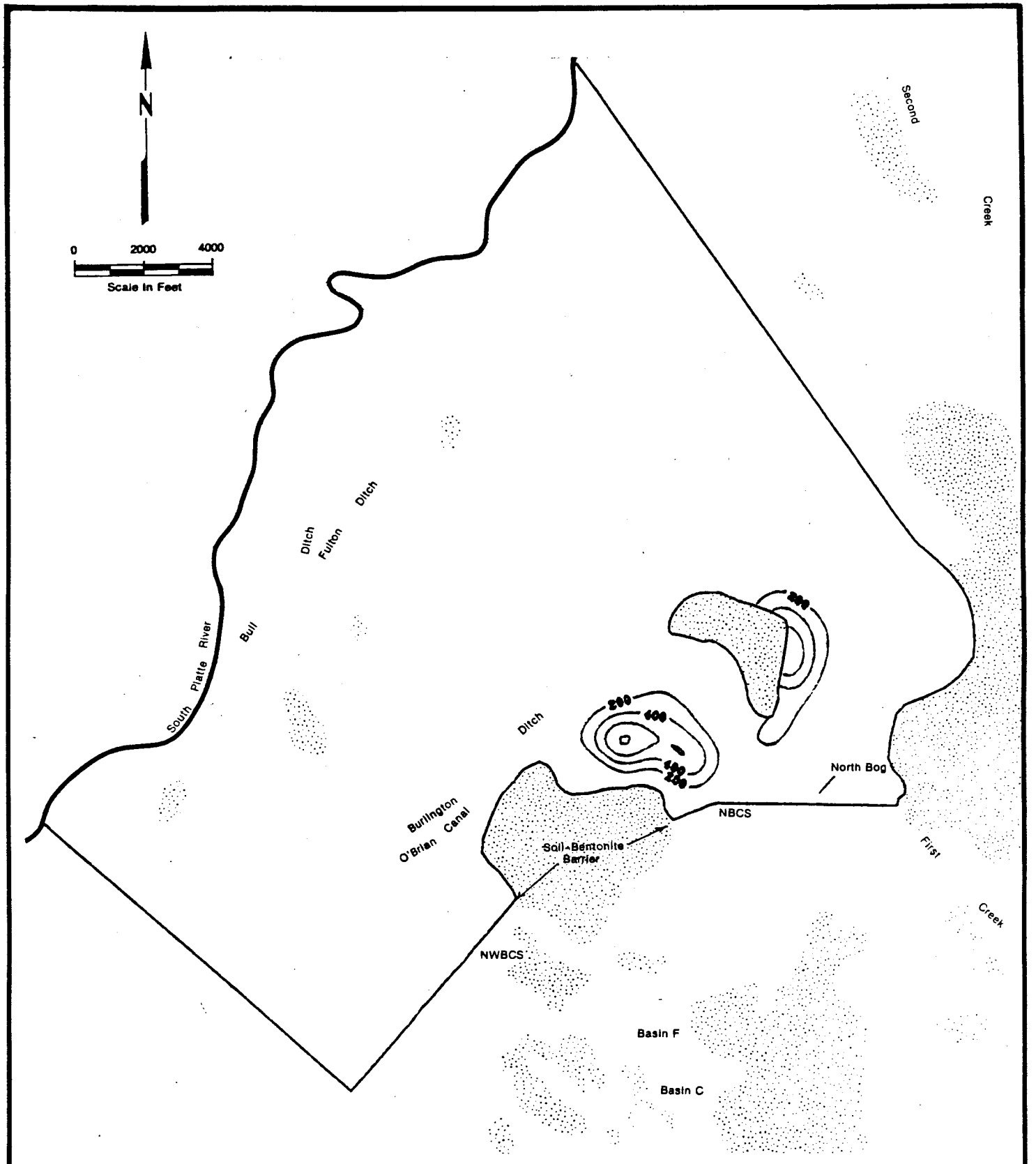
Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland



SOURCE: WARNER, 1988

Figure G-21a
DIMP CONCENTRATION DISTRIBUTION IN 1992 (5 YEARS) FOR PROPOSED SOUTH ADAMS COUNTY WELL FIELD, ALLUVIAL AQUIFER; CONTOUR INTERVAL (20–100 ug/l)

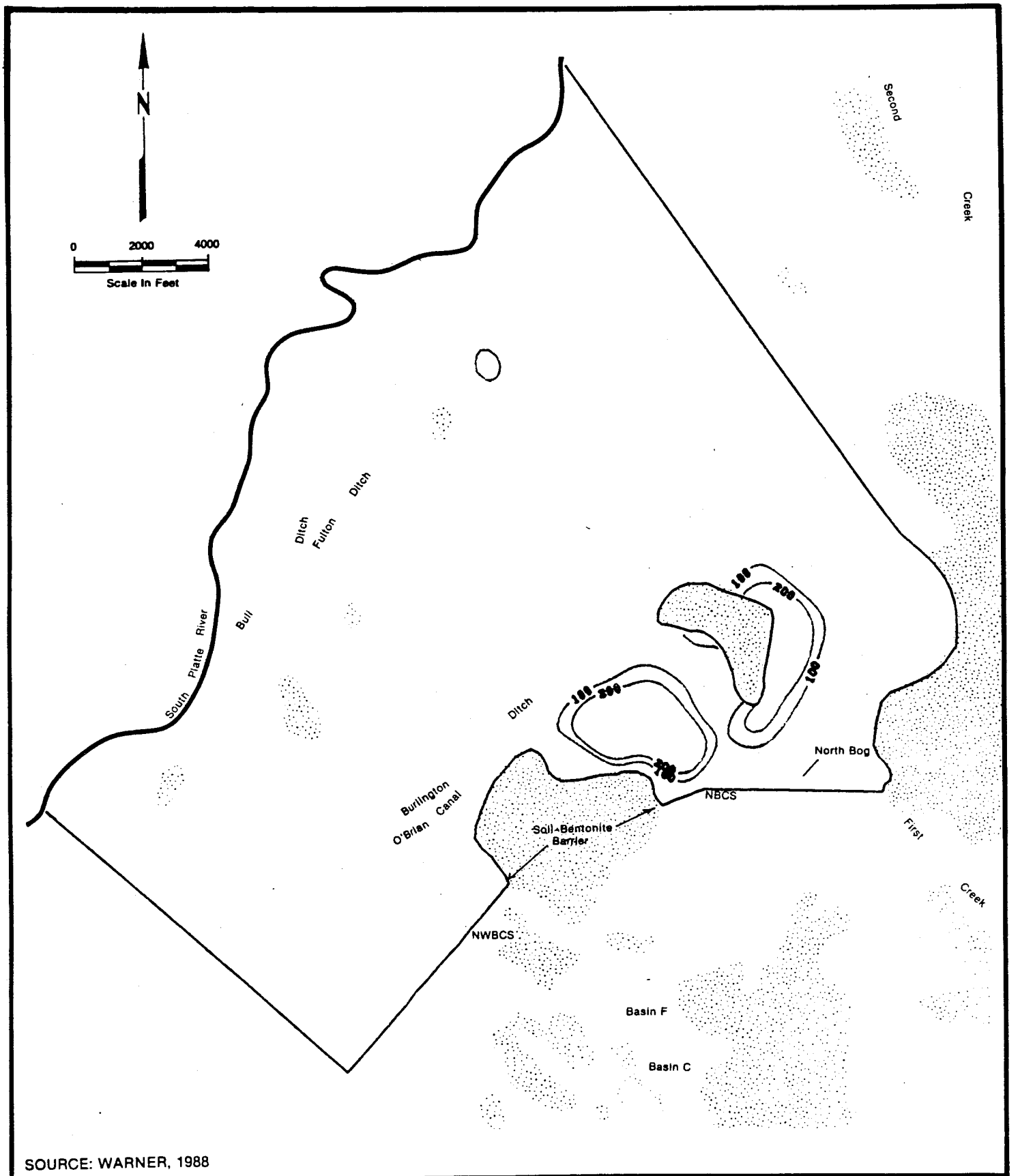
Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland



SOURCE: WARNER, 1988

Figure G-21b
DIMP CONCENTRATION DISTRIBUTION IN 1992 (5 YEARS) FOR PROPOSED SOUTH ADAMS COUNTY WELL FIELD, ALLUVIAL AQUIFER, CONTOUR INTERVAL (200-800 ug/l)

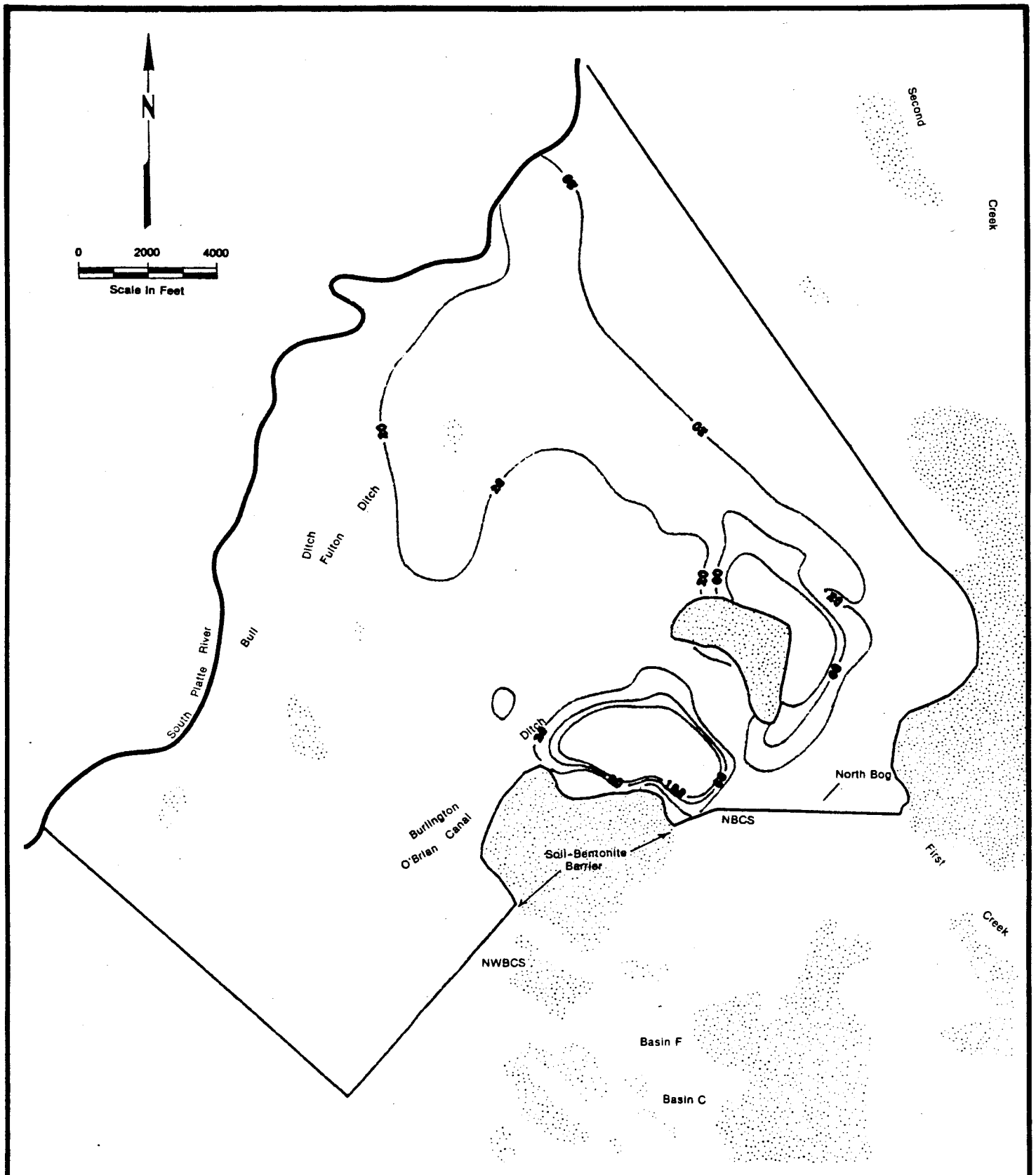
Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland



SOURCE: WARNER, 1988

Figure G-21c
DIMP CONCENTRATION DISTRIBUTION IN 1992 (5 YEARS) FOR PROPOSED SOUTH ADAMS COUNTY WELL FIELD, ALLUVIAL AQUIFER, CONTOUR INTERVAL (100-200 ug/l)

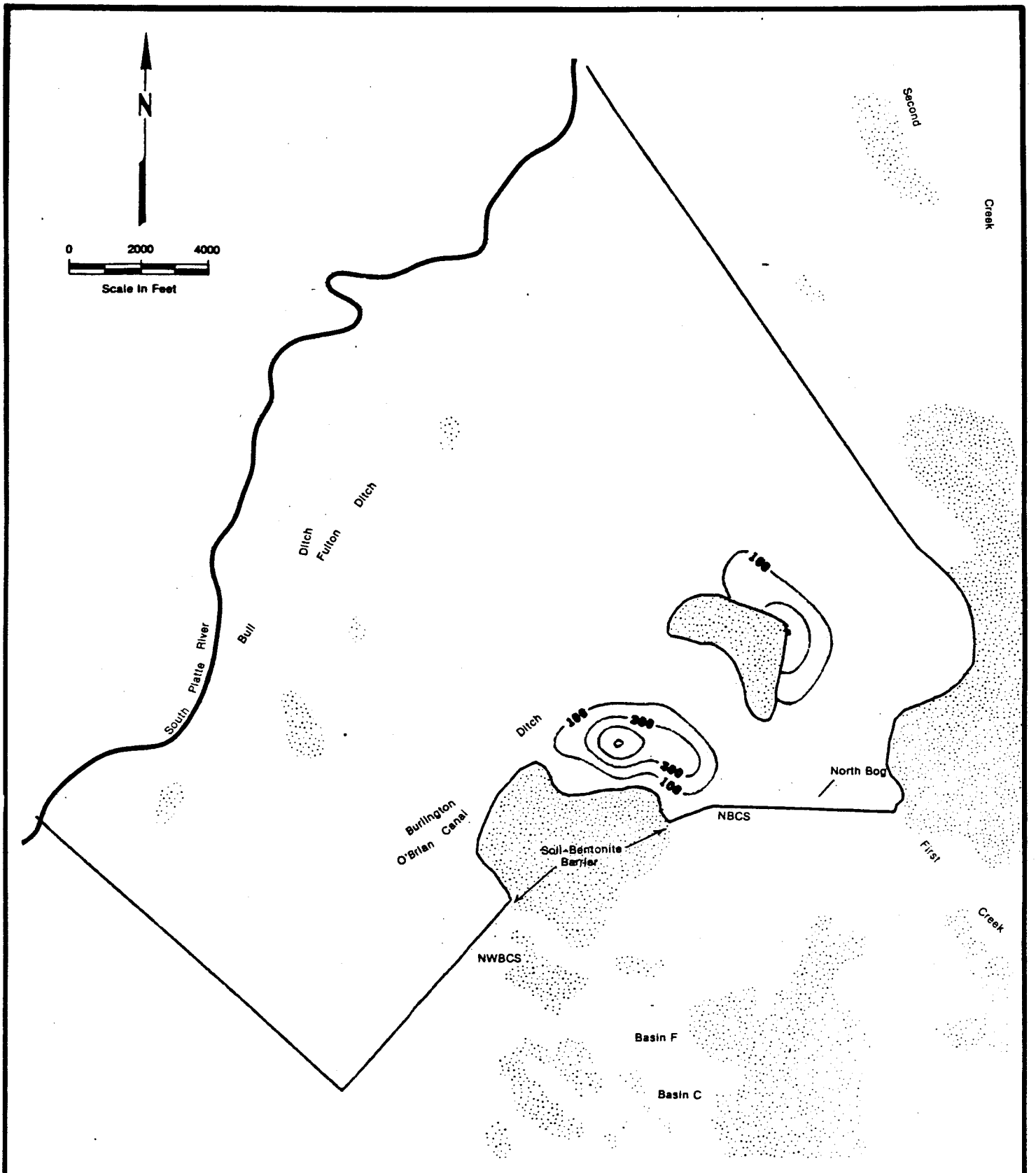
Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland



SOURCE: WARNER, 1988

Figure G-22a
DIMP CONCENTRATION DISTRIBUTION IN 1997 (10 YEARS) FOR PROPOSED SOUTH ADAMS COUNTY WELL FIELD, ALLUVIAL AQUIFER, CONTOUR INTERVAL (20-100 ug/l)

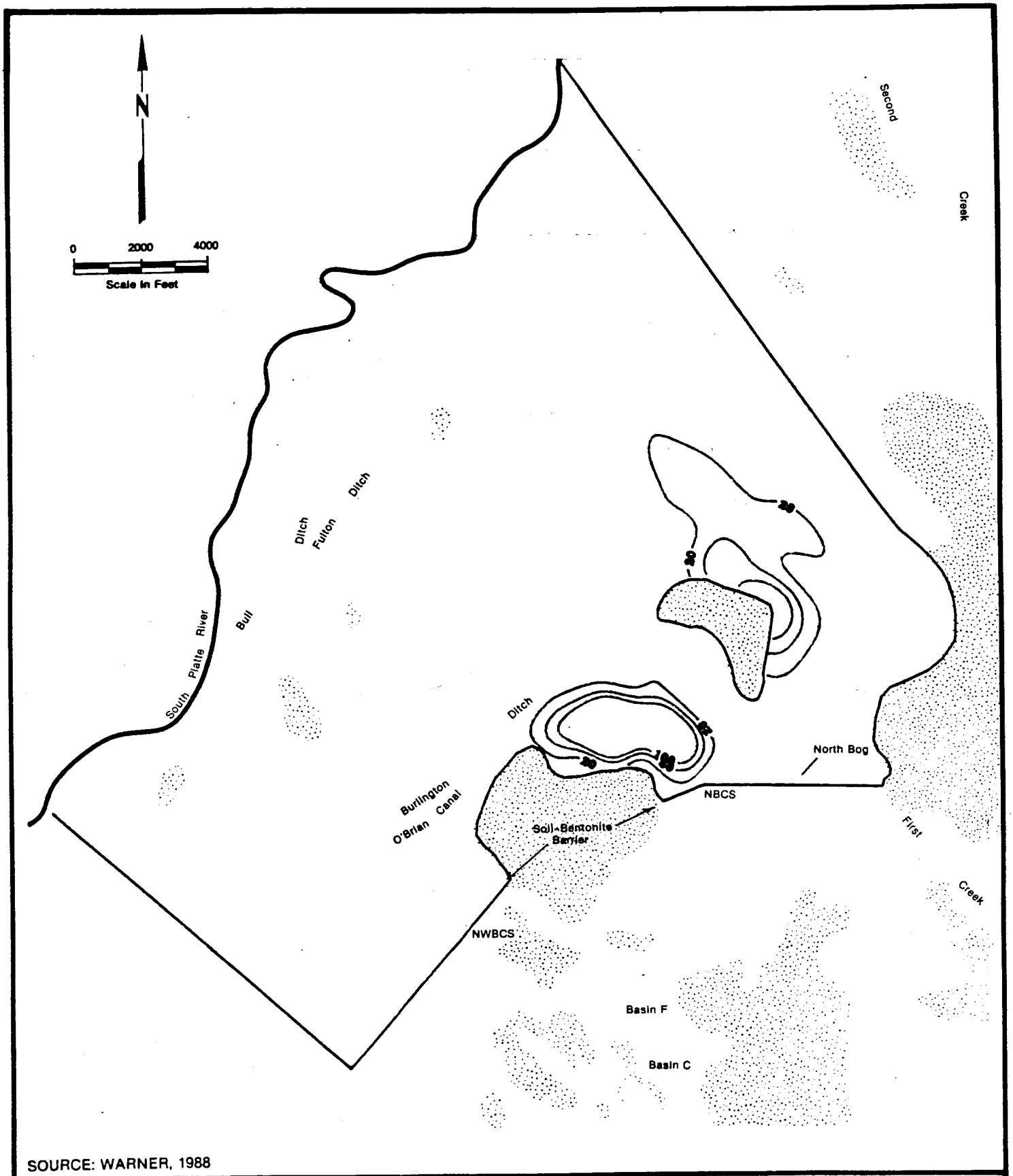
Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland



SOURCE: WARNER, 1988

Figure G-22b
DIMP CONCENTRATION DISTRIBUTION IN 1997 (10 YEARS) FOR PROPOSED SOUTH ADAMS COUNTY WELL FIELD, ALLUVIAL AQUIFER, CONTOUR INTERVAL (100-700 ug/l)

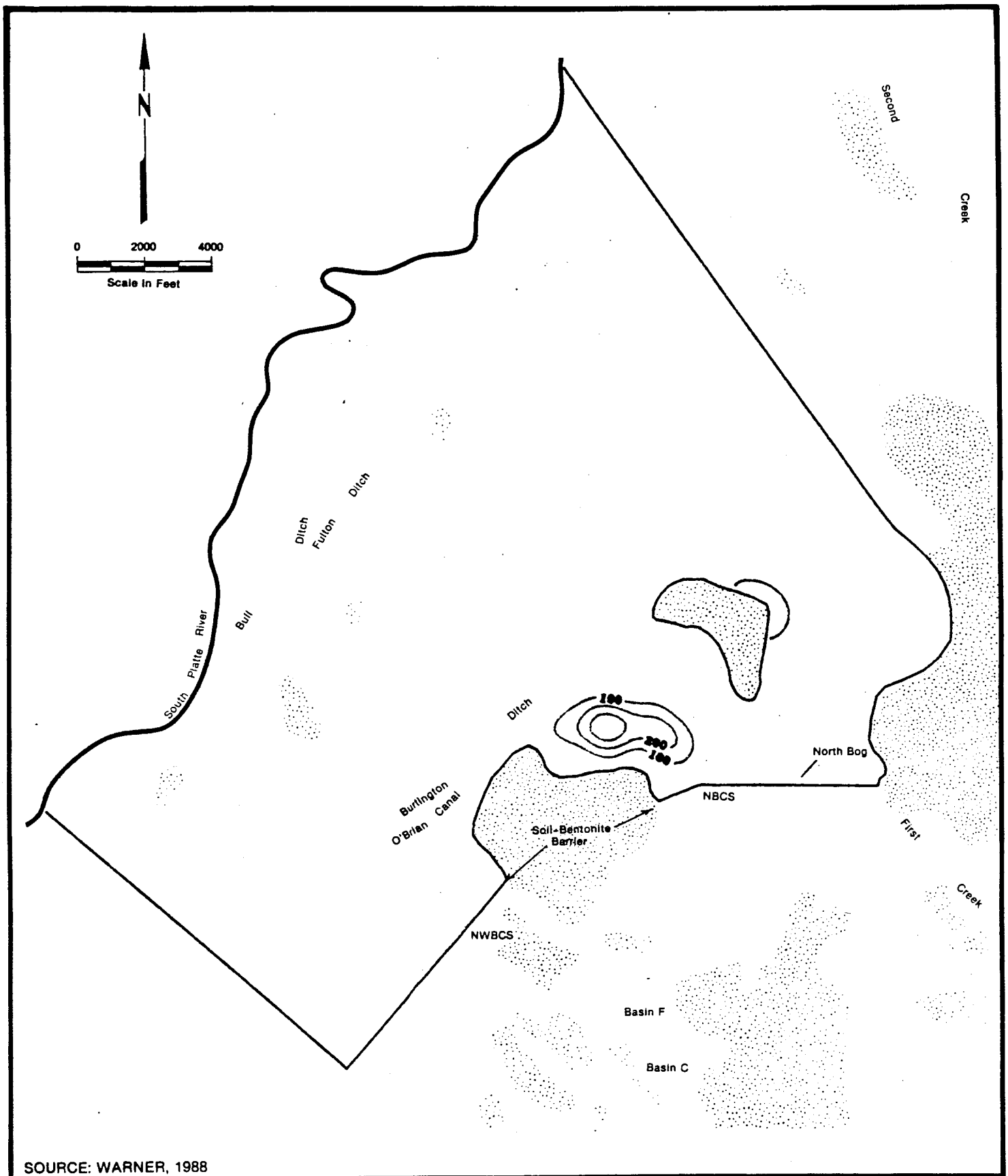
Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland



SOURCE: WARNER, 1988

Figure G-23a
DIMP CONCENTRATION DISTRIBUTION IN 2007 (20 YEARS) FOR PROPOSED SOUTH ADAMS COUNTY WELL FIELD, ALLUVIAL AQUIFER, CONTOUR INTERVAL (20-100 ug/l)

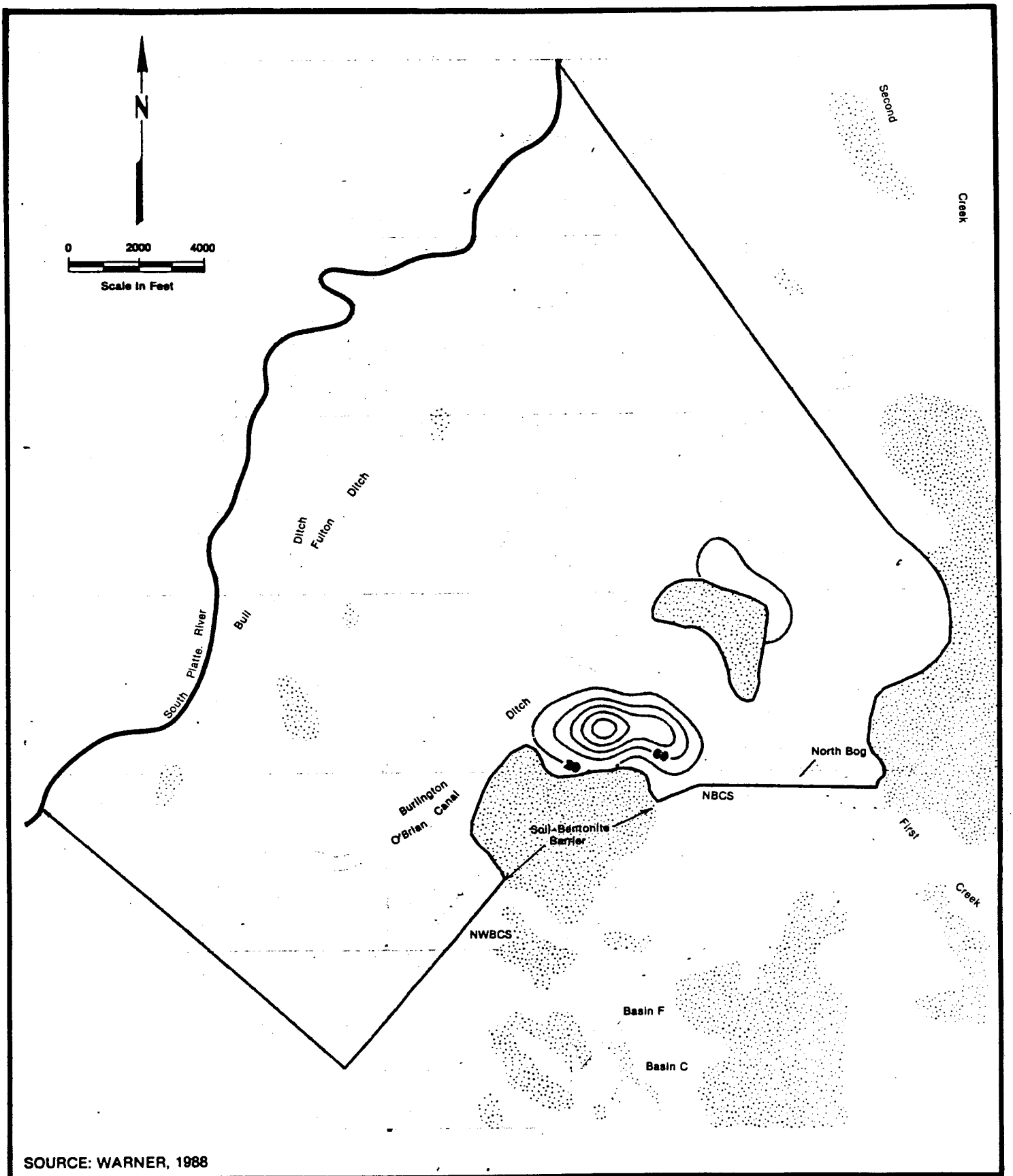
Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland



SOURCE: WARNER, 1988

Figure G-23b
DIMP CONCENTRATION DISTRIBUTION IN 2007 (20 YEARS) FOR PROPOSED SOUTH ADAMS COUNTY WELL FIELD, ALLUVIAL AQUIFER, CONTOUR INTERVAL (100-300 ug/l)

Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland



SOURCE: WARNER, 1988

Figure G-24
DIMP CONCENTRATION DISTRIBUTION IN 2017 (30 YEARS) FOR PROPOSED SOUTH ADAMS COUNTY WELL FIELD, ALLUVIAL AQUIFER, CONTOUR INTERVAL (20-180 ug/l)

Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

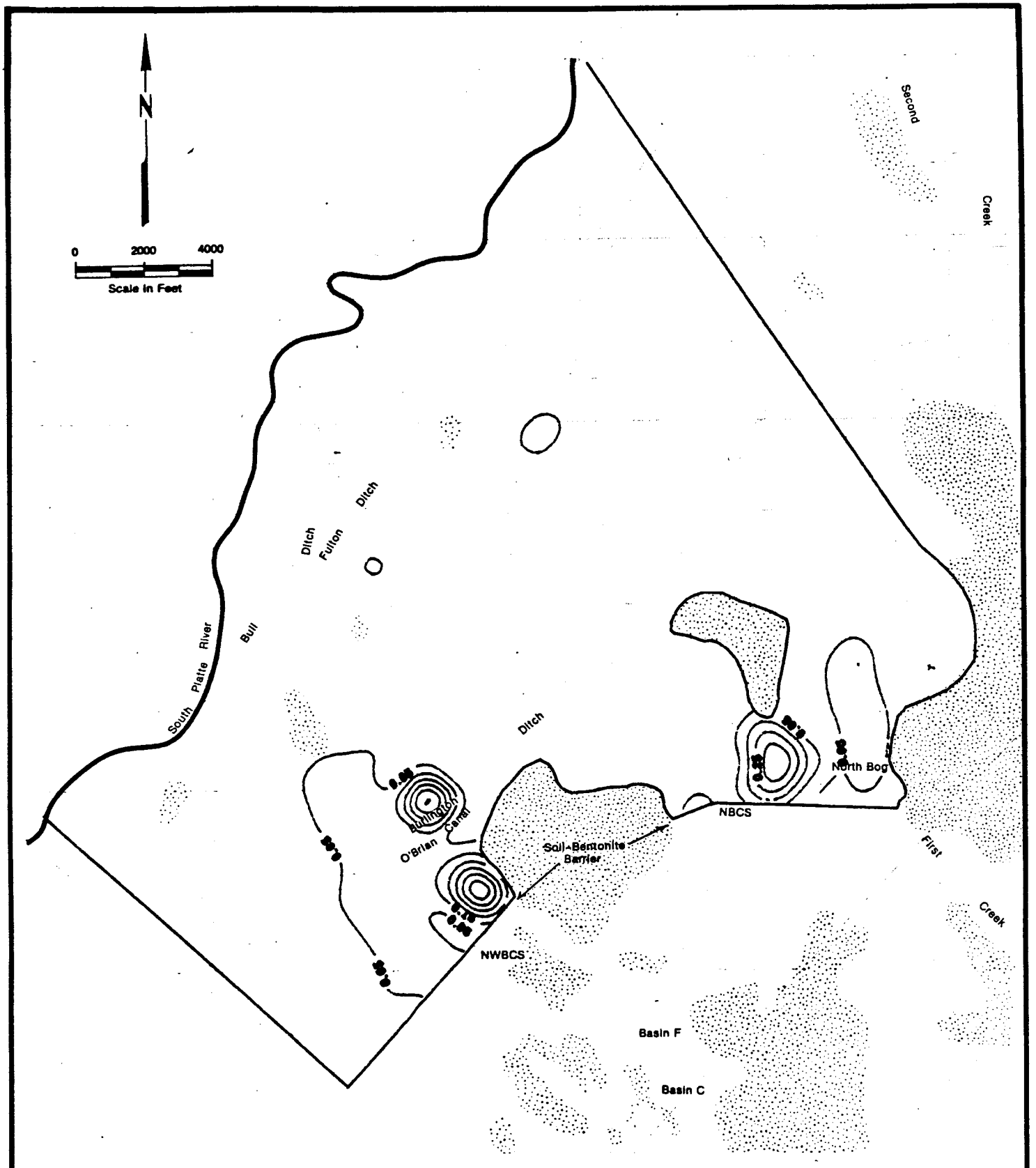
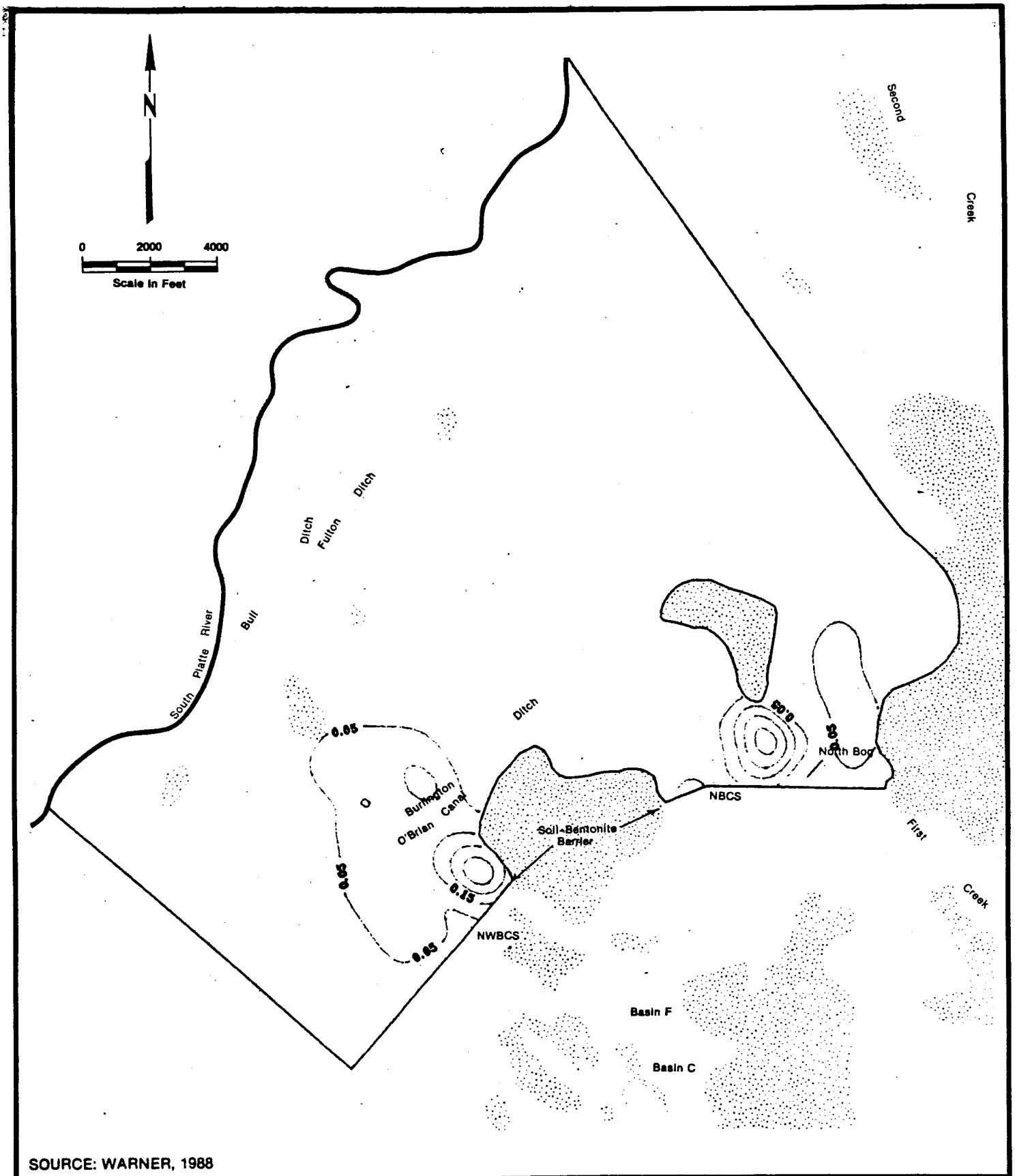


Figure G-25

DIELDRIN CONCENTRATION DISTRIBUTION (ug/l), 1987, ALLUVIAL AQUIFER

SOURCE: WARNER, 1988

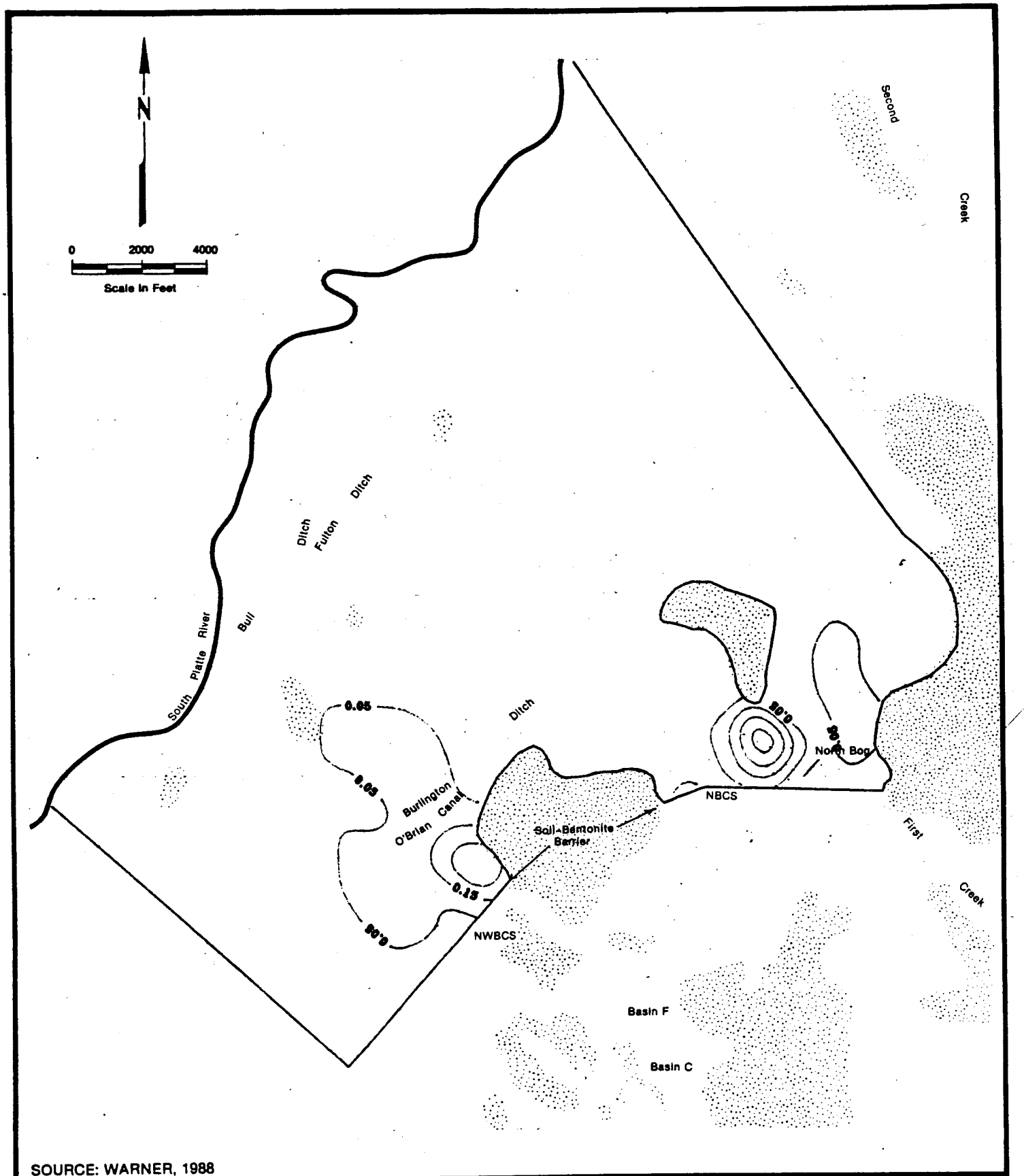
Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland



SOURCE: WARNER, 1988

Figure G-26
DIELDRIN CONCENTRATION DISTRIBUTION (ug/l) IN 1992 (5 YEARS) WITH EXISTING NORTH BOUNDARY RECHARGE OPERATIONS, ALLUVIAL AQUIFER

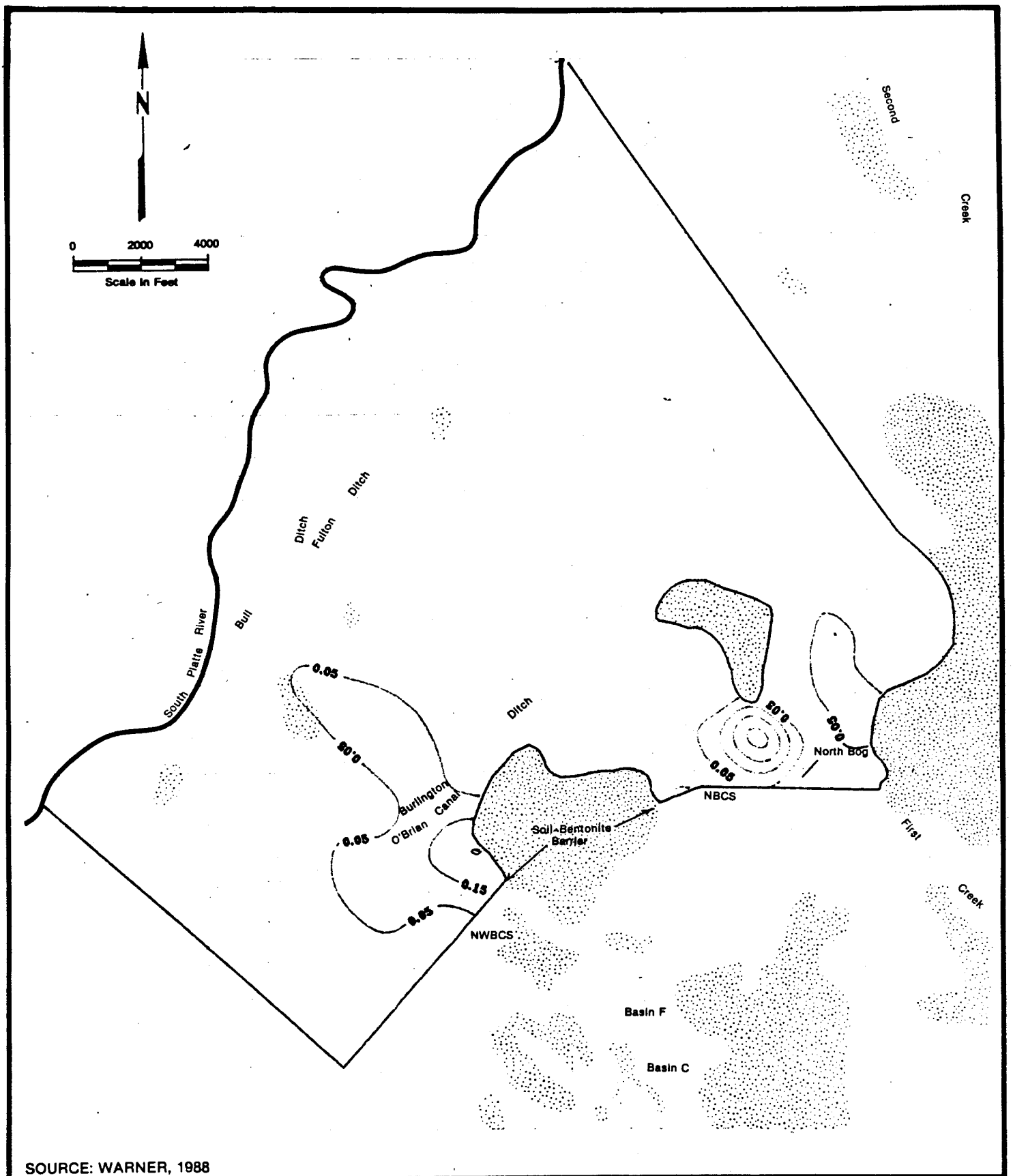
Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland



SOURCE: WARNER, 1988

Figure G-27
DIELDRIN CONCENTRATION DISTRIBUTION (ug/l) IN 1997 (10 YEARS) WITH EXISTING NORTH BOUNDARY RECHARGE OPERATIONS, ALLUVIAL AQUIFER

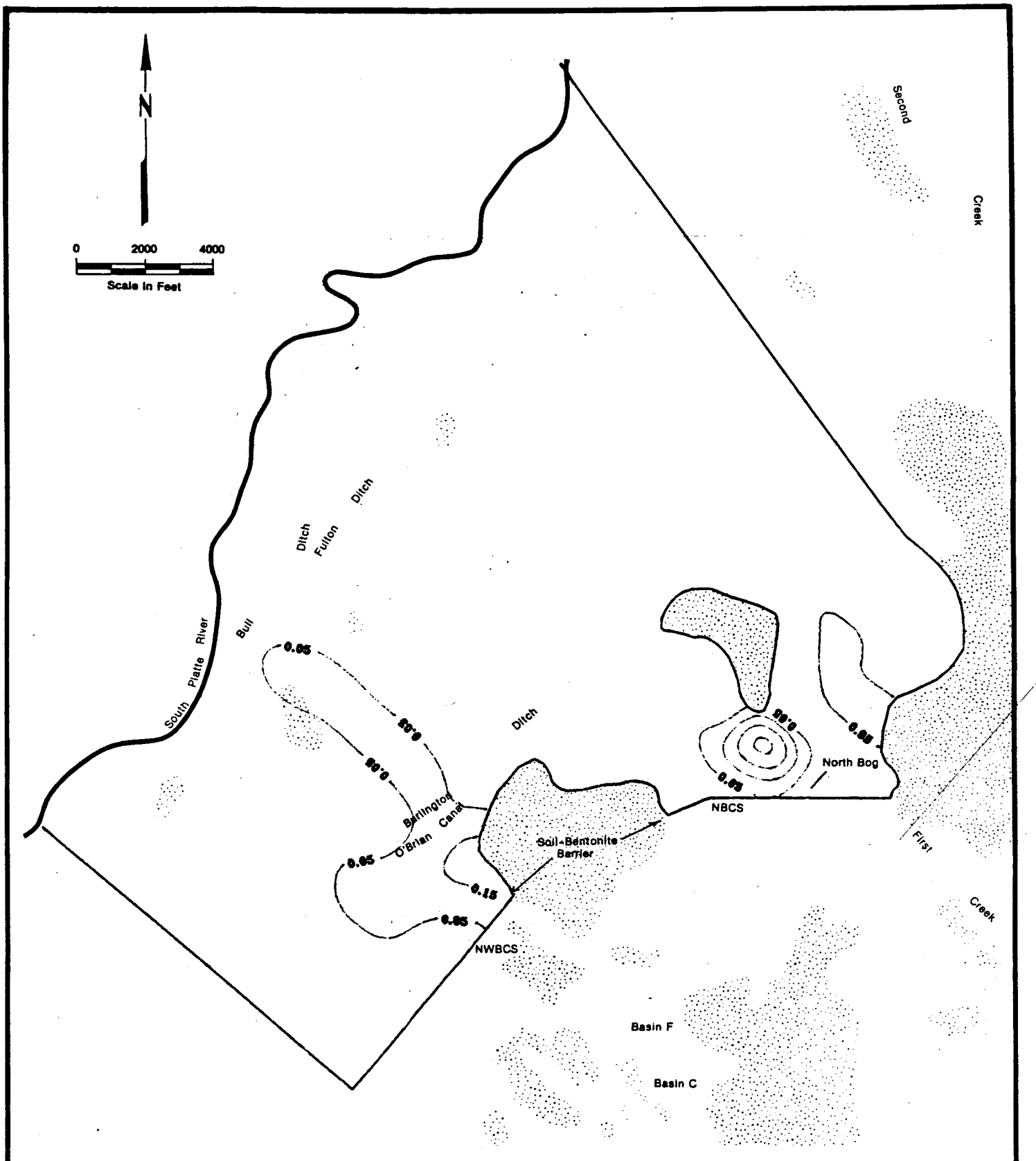
Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland



SOURCE: WARNER, 1988

Figure G-28
DIELDRIN CONCENTRATION DISTRIBUTION (ug/l) IN 2007 (20 YEARS) WITH EXISTING NORTH BOUNDARY RECHARGE OPERATIONS, ALLUVIAL AQUIFER

Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland



SOURCE: WARNER, 1988

Figure G-29
DIELDRIN CONCENTRATION DISTRIBUTION (ug/l) IN 2017 (30 YEARS) WITH EXISTING NORTH BOUNDARY RECHARGE OPERATIONS, ALLUVIAL AQUIFER

Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

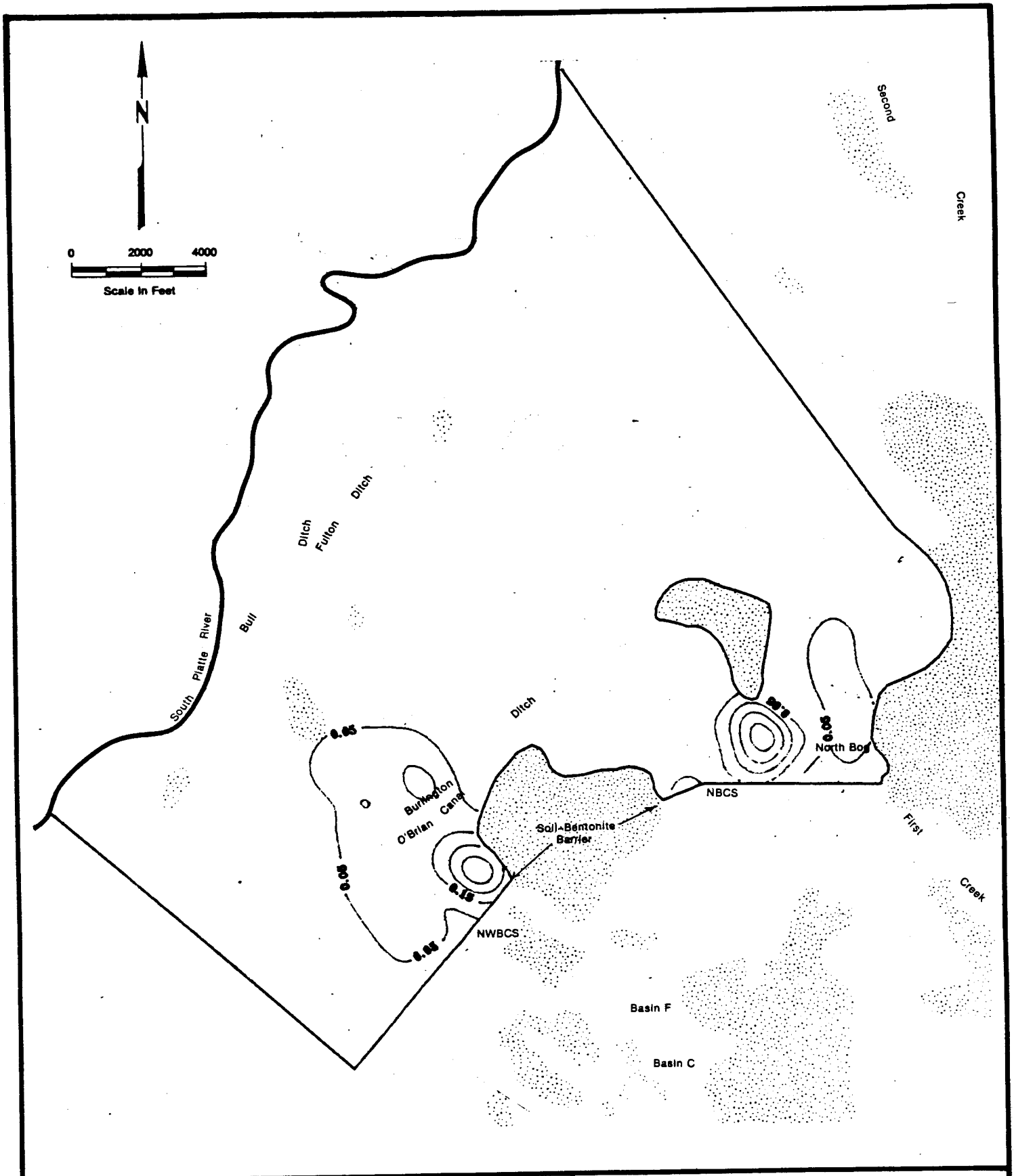
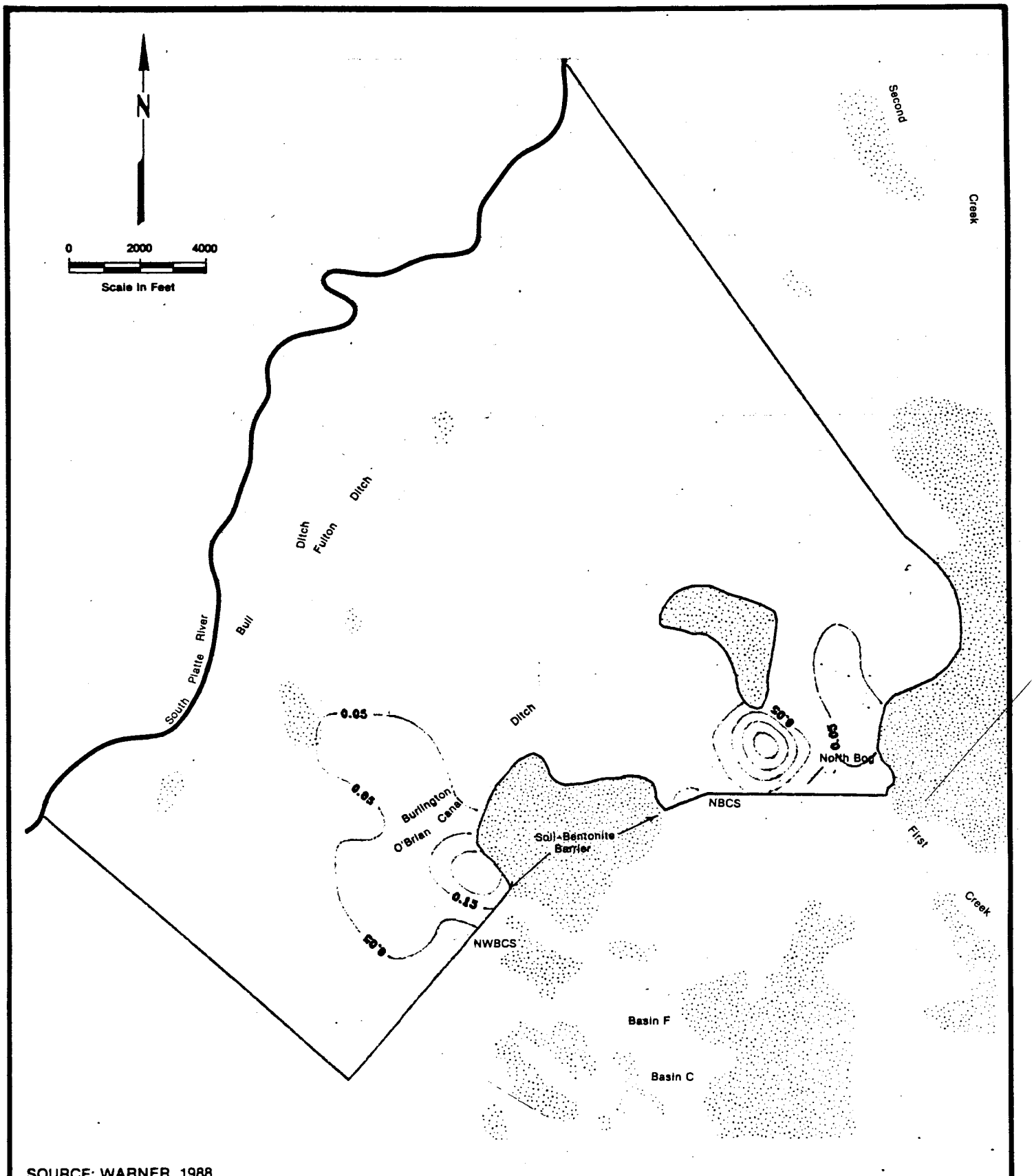


Figure G-30
DIELDRIN CONCENTRATION DISTRIBUTION (ug/l) IN 1992 (5 YEARS) WITH EXISTING NORTH BOUNDARY RECHARGE OPERATION FOR NATURAL FLOW CONDITIONS, ALLUVIAL AQUIFER
SOURCE: WARNER, 1988

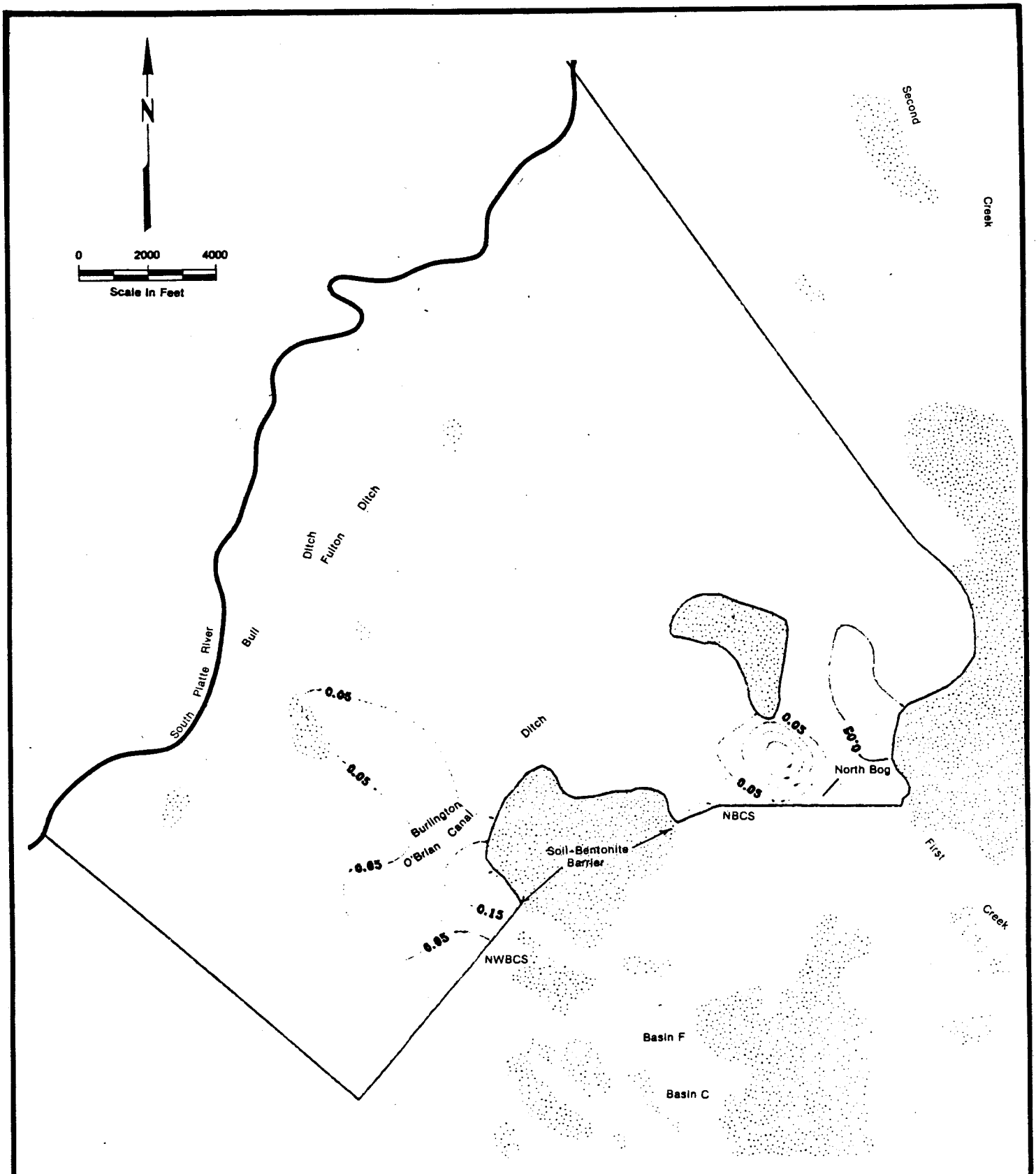
Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland



SOURCE: WARNER, 1988

Figure G-31
DIELDRIN CONCENTRATION DISTRIBUTION (ug/l) IN 1997 (10 YEARS) WITH NORTH BOUNDARY RECHARGE OPERATION FOR NATURAL FLOW CONDITIONS, ALLUVIAL AQUIFER

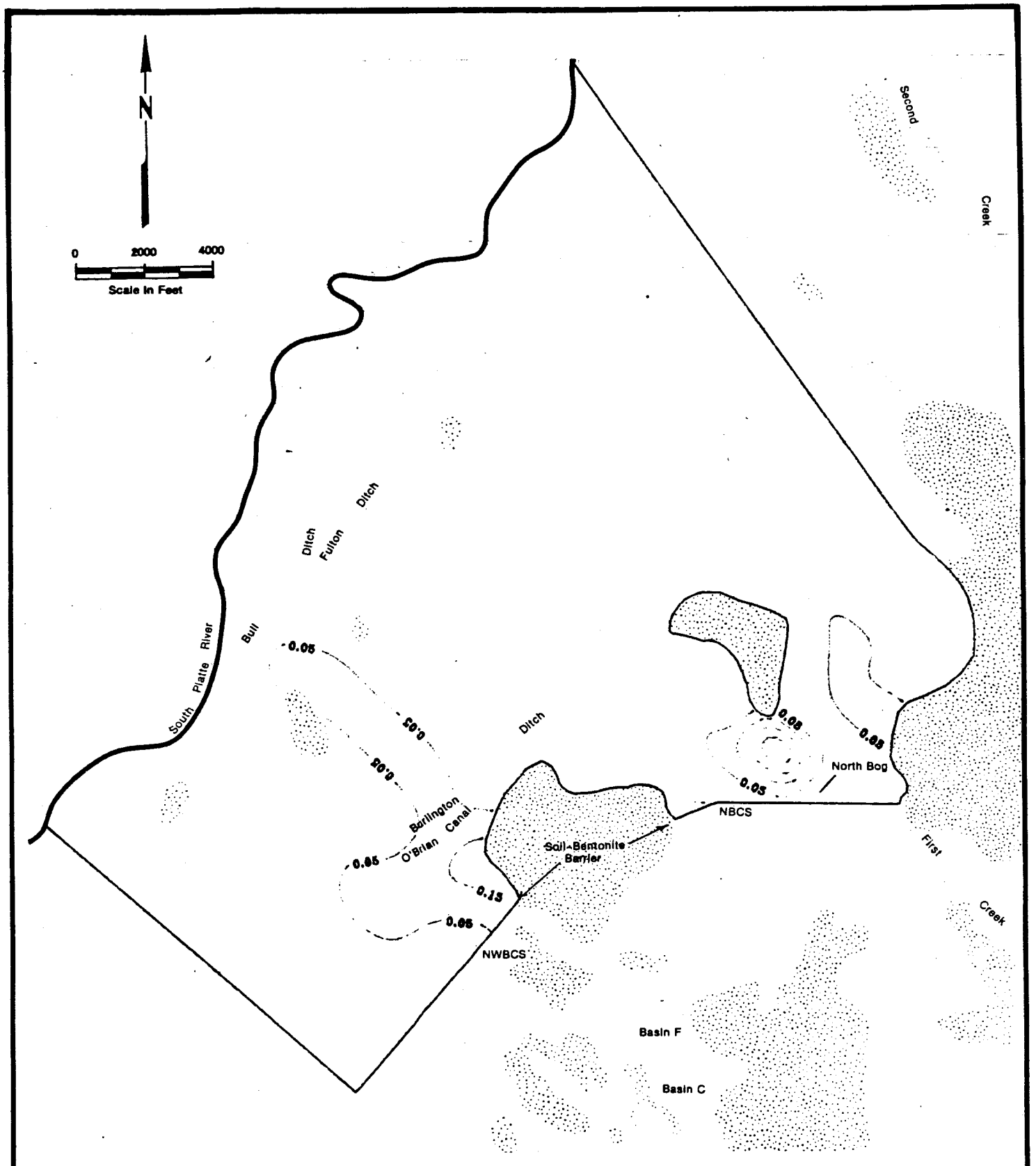
Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland



SOURCE: WARNER, 1988

Figure G-32
DIELDRIN CONCENTRATION DISTRIBUTION (ug/l) IN 2007 (20 YEARS) WITH NORTH BOUNDARY RECHARGE OPERATION FOR NATURAL FLOW CONDITIONS, ALLUVIAL AQUIFER

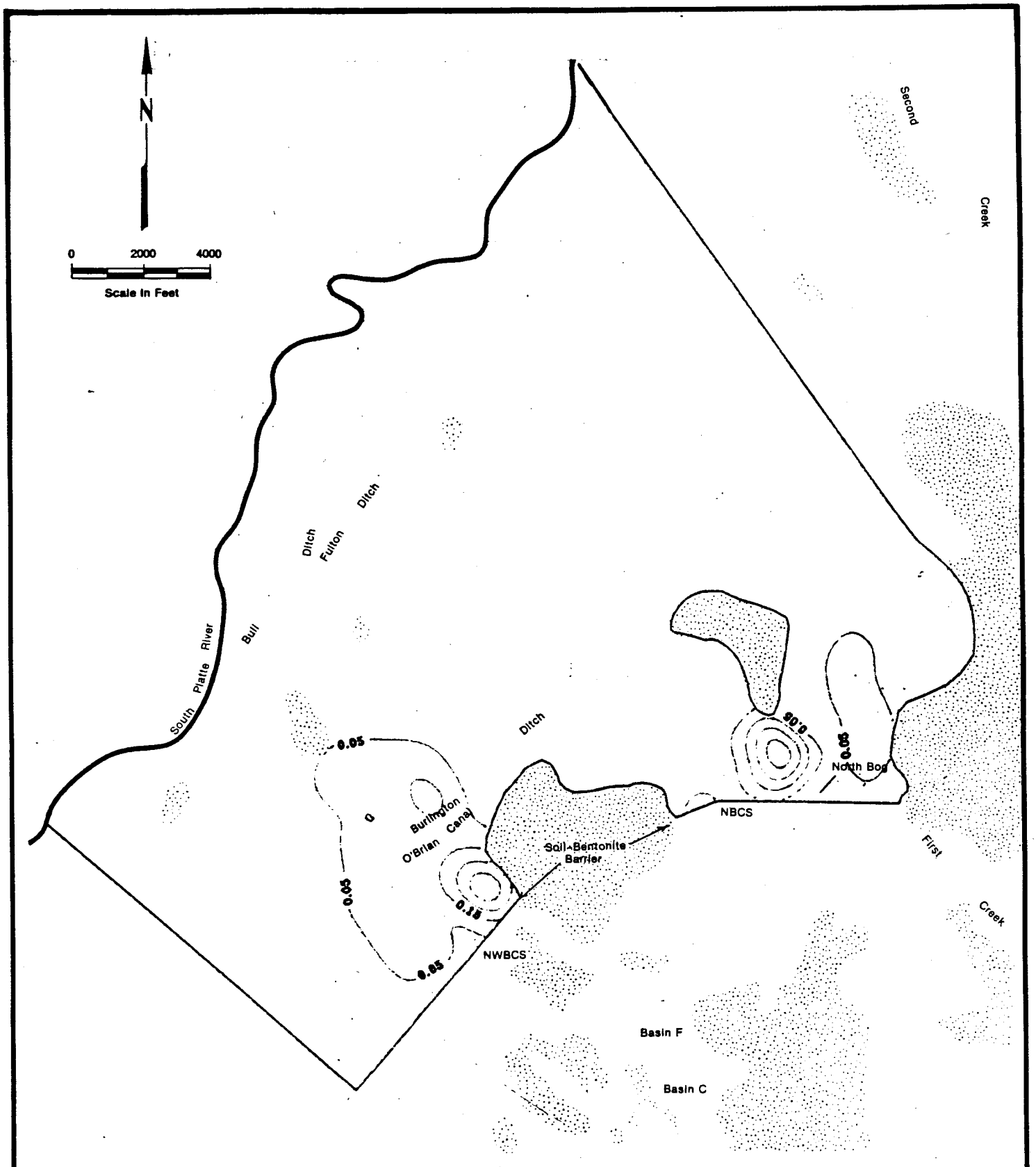
Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland



SOURCE: WARNER, 1988

Figure G-33
DIELDRIN CONCENTRATION DISTRIBUTION (ug/l) IN 2017 (30 YEARS) WITH NORTH BOUNDARY RECHARGE OPERATION FOR NATURAL FLOW CONDITIONS, ALLUVIAL AQUIFER

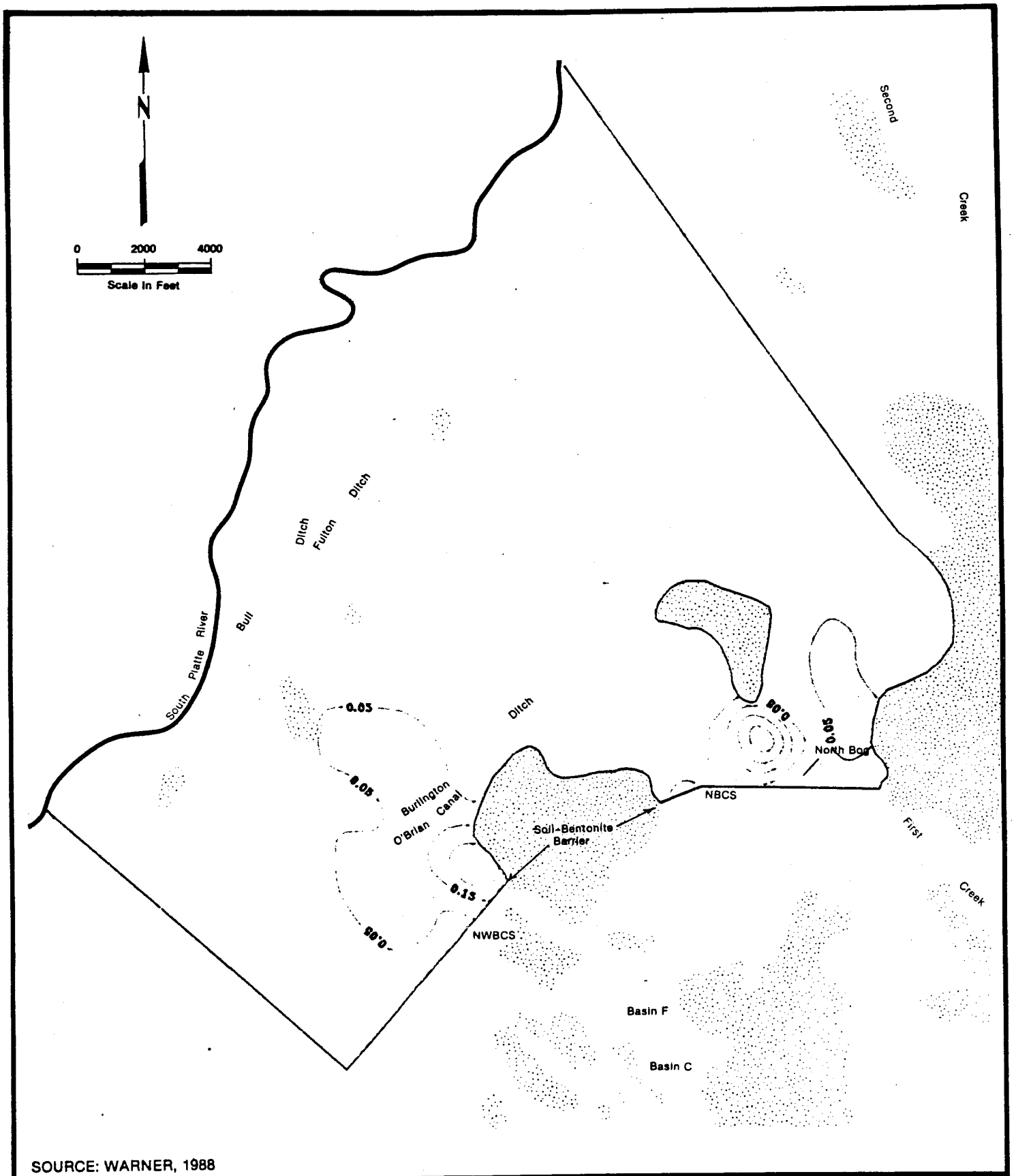
Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland



SOURCE: WARNER, 1988

Figure G-34
DIELDRIN CONCENTRATION DISTRIBUTION (ug/l) IN 1992 (5 YEARS) WITH EXISTING NEW SOUTH ADAMS COUNTY WELL FIELD, ALLUVIAL AQUIFER

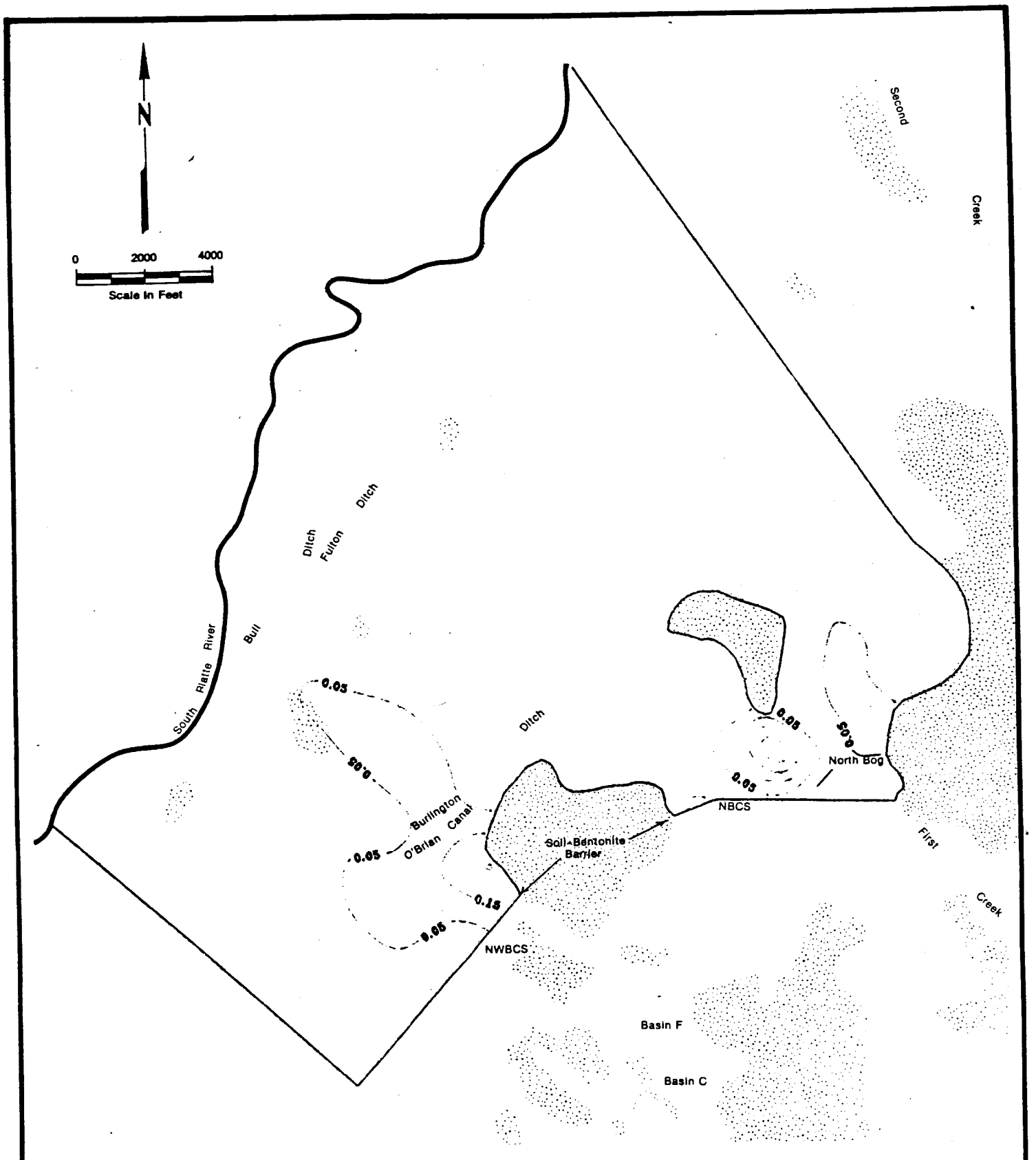
Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland



SOURCE: WARNER, 1988

Figure G-35
DIELDRIN CONCENTRATION DISTRIBUTION (ug/l) IN 1997 (10 YEARS) WITH EXISTING NEW SOUTH ADAMS COUNTY WELL FIELD, ALLUVIAL AQUIFER

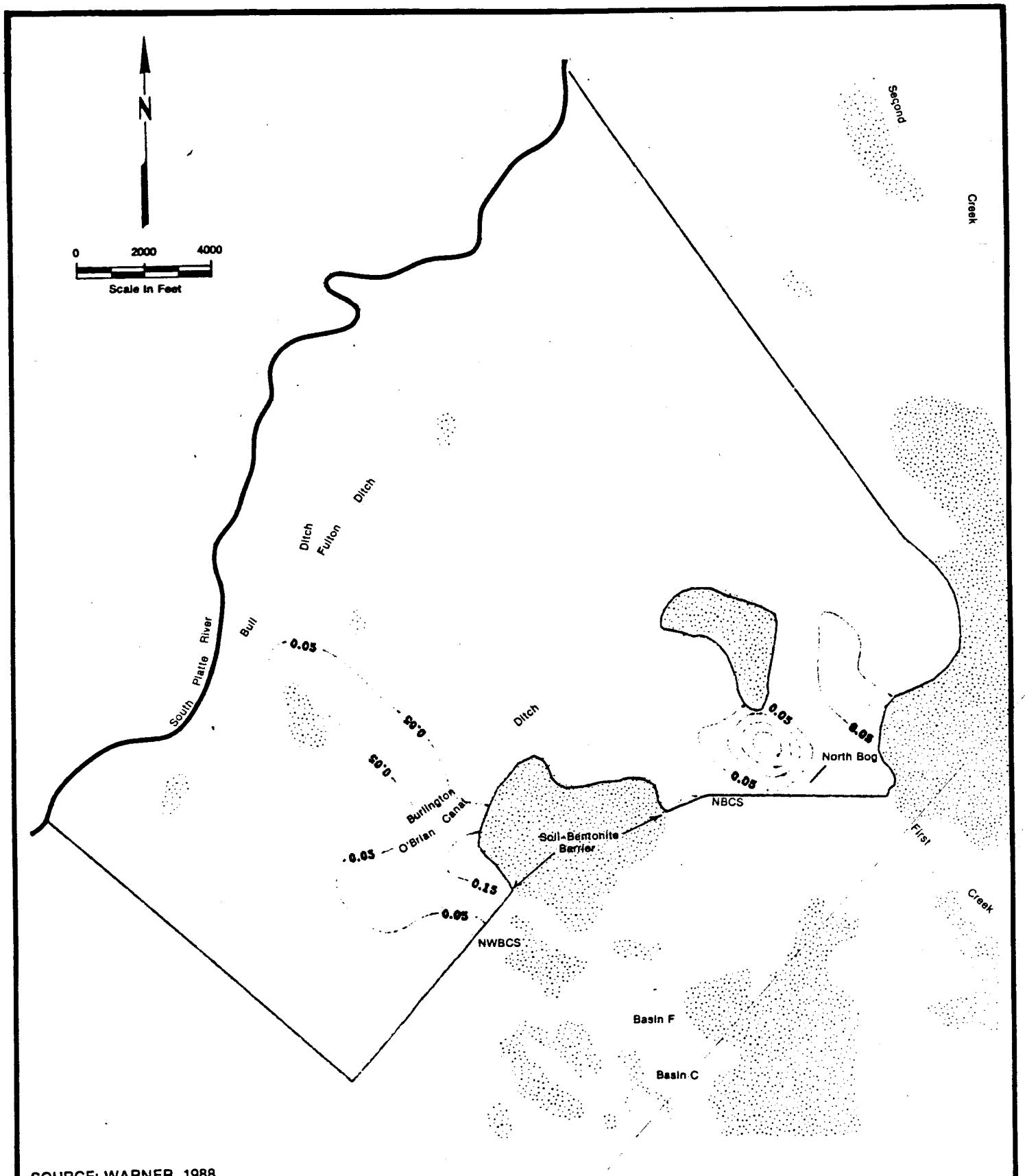
Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland



SOURCE: WARNER, 1988

Figure G-36
DIELDRIN CONCENTRATION DISTRIBUTION (ug/l) IN 2007 (20 YEARS) WITH EXISTING NEW SOUTH ADAMS COUNTY WELL FIELD, ALLUVIAL AQUIFER

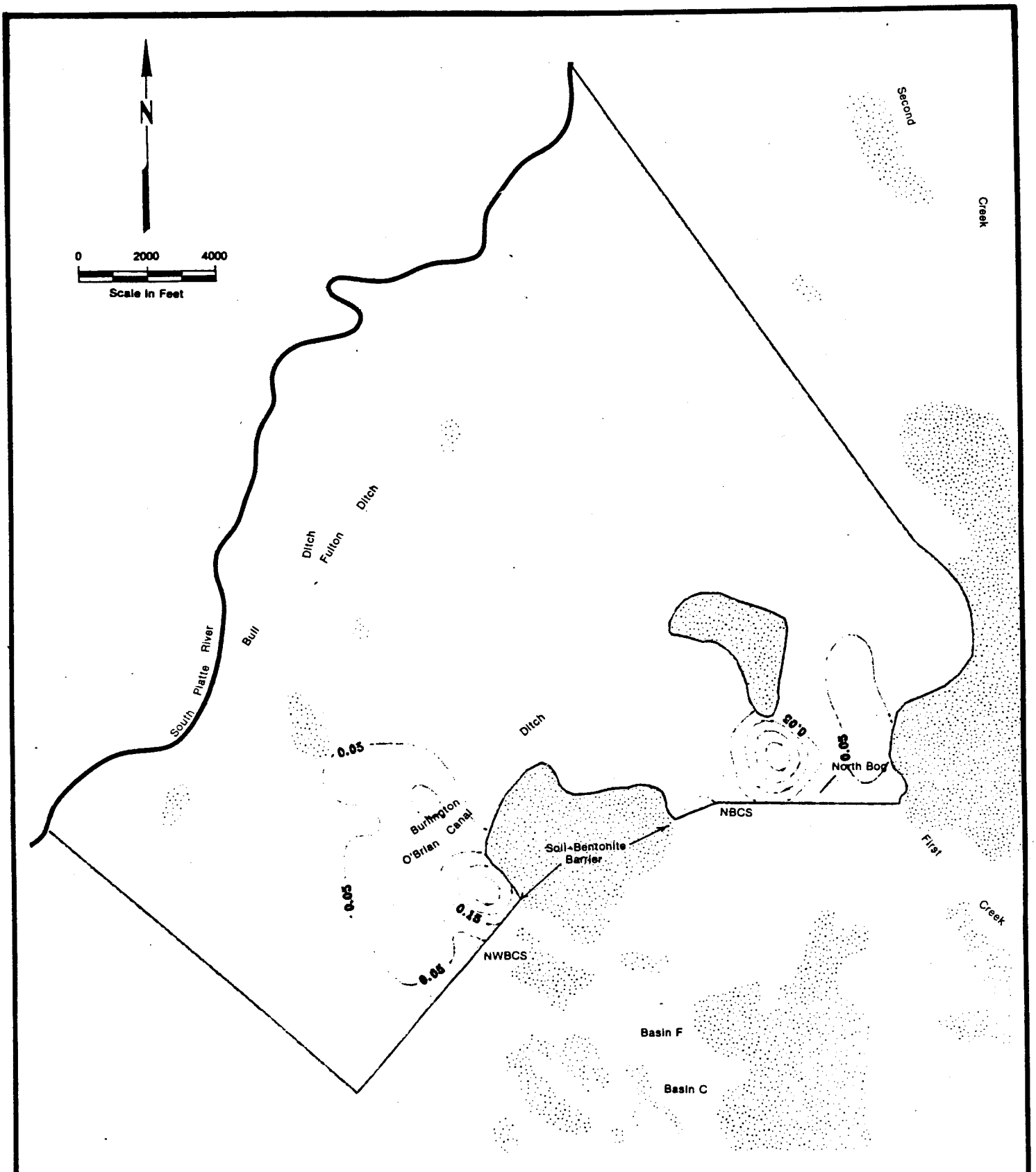
Prepared for:
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Aberdeen Proving Ground, Maryland



SOURCE: WARNER, 1988

Figure G-37
DIELDRIN CONCENTRATION DISTRIBUTION (ug/l) IN 2017 (30 YEARS) WITH EXISTING NEW SOUTH ADAMS COUNTY WELL FIELD, ALLUVIAL AQUIFER

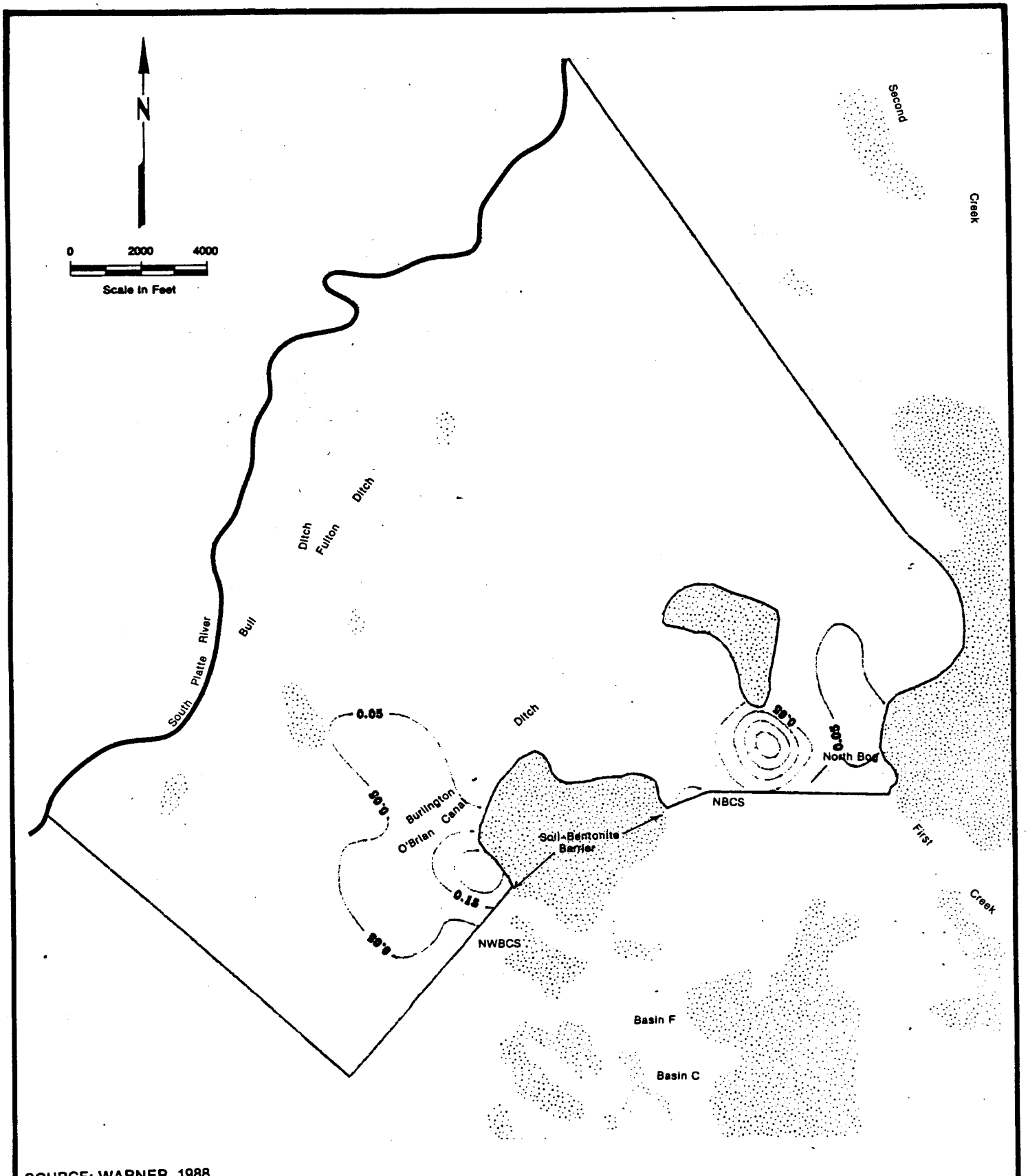
Prepared for:
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SOURCE: WARNER, 1988

Figure G-38
DIELDRIN CONCENTRATION DISTRIBUTION (ug/l) IN 1992 (5 YEARS) FOR PROPOSED SOUTH ADAMS COUNTY WELL FIELD, ALLUVIAL AQUIFER

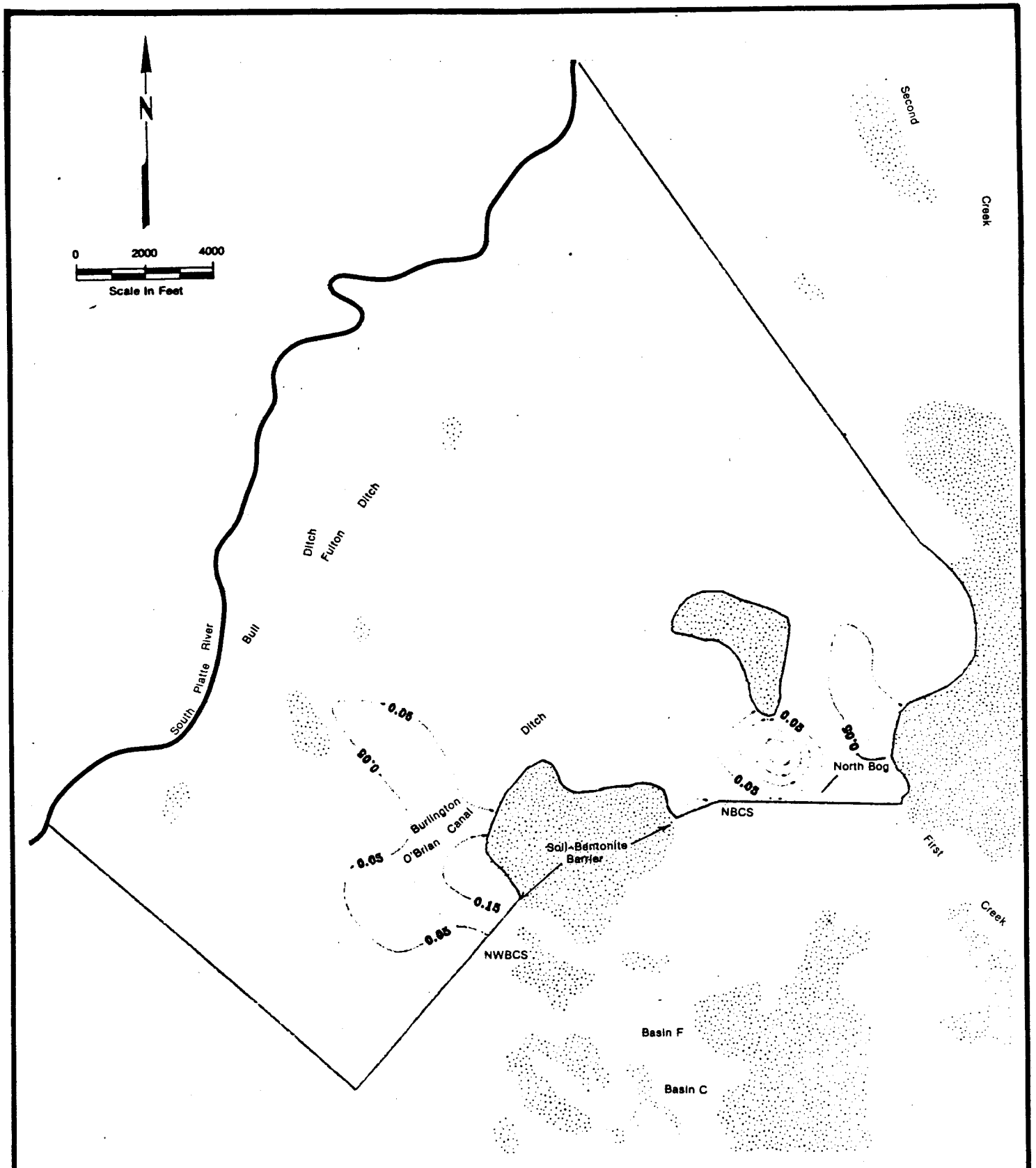
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SOURCE: WARNER, 1988

Figure G-39
DIELDRIN CONCENTRATION DISTRIBUTION (ug/l) IN 1997 (10 YEARS) FOR PROPOSED SOUTH ADAMS COUNTY WELL FIELD, ALLUVIAL AQUIFER

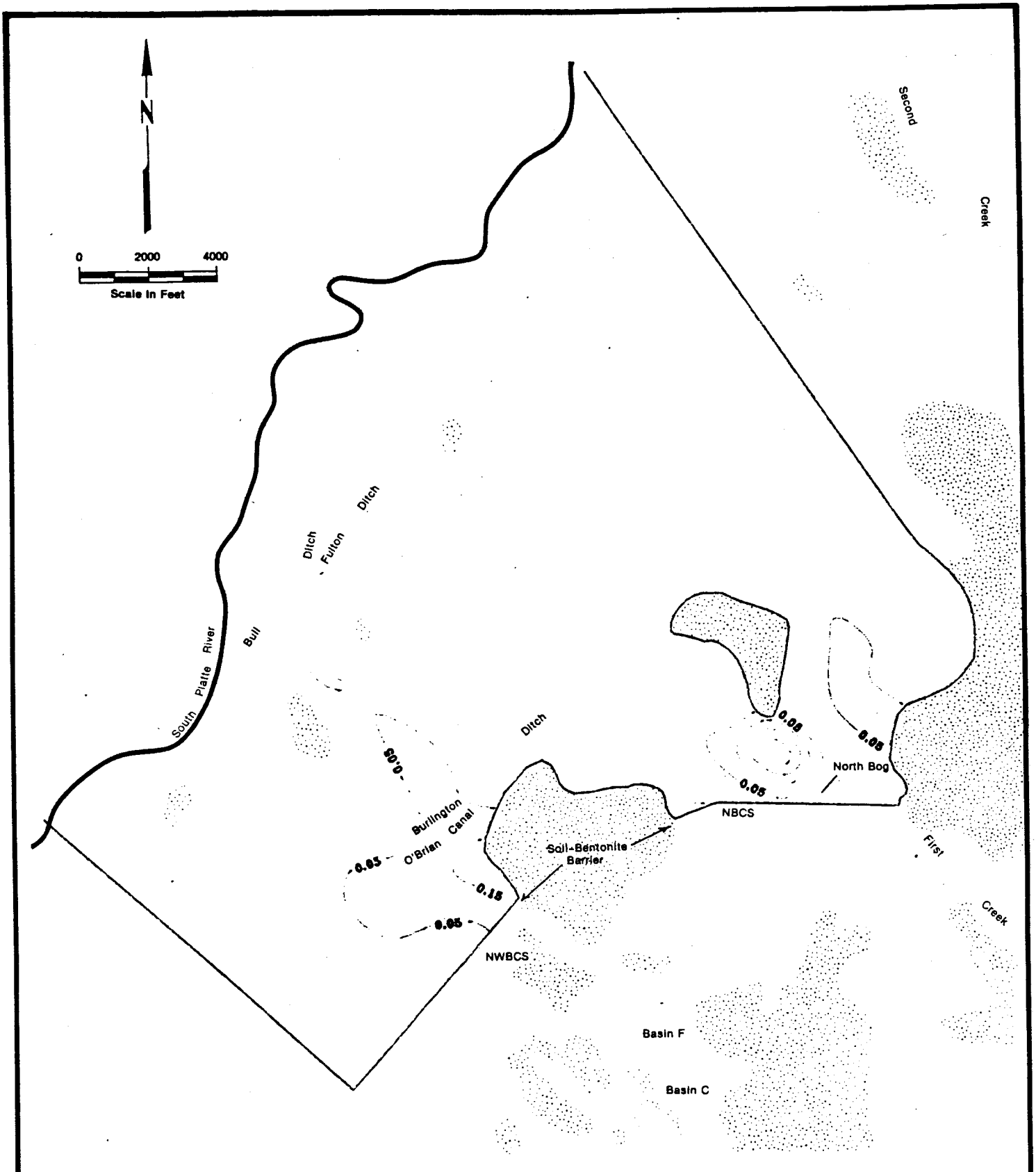
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SOURCE: WARNER, 1988

Figure G-40
DIELDRIN CONCENTRATION DISTRIBUTION (ug/l) IN 2007 (20 YEARS) FOR PROPOSED SOUTH ADAMS COUNTY WELL FIELD, ALLUVIAL AQUIFER

Prepared for:
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Aberdeen Proving Ground, Maryland



SOURCE: WARNER, 1988

Figure G-41
DIELDRIN CONCENTRATION DISTRIBUTION (ug/l) IN 2017 (30 YEARS) FOR PROPOSED SOUTH ADAMS COUNTY WELL FIELD, ALLUVIAL AQUIFER

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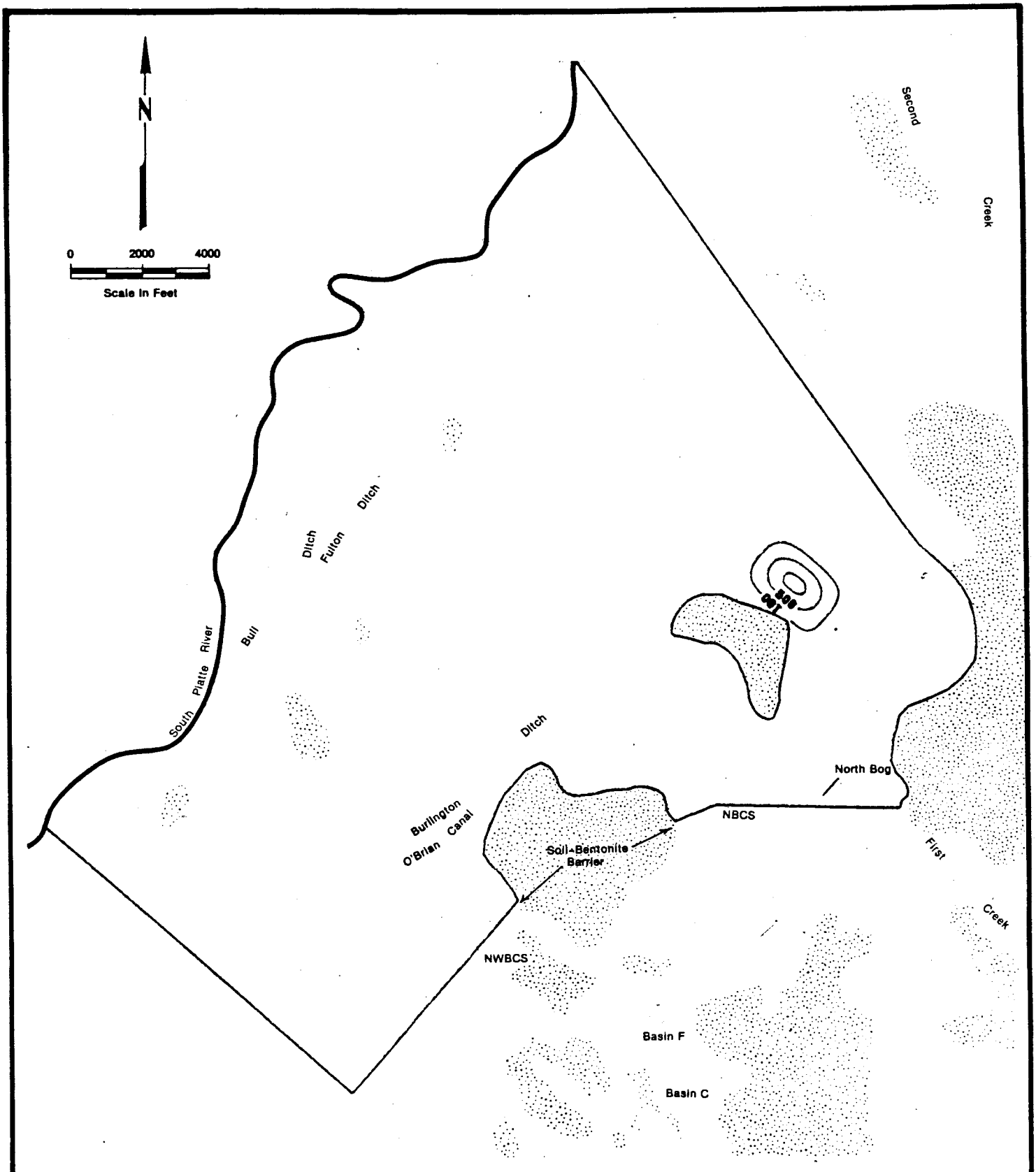
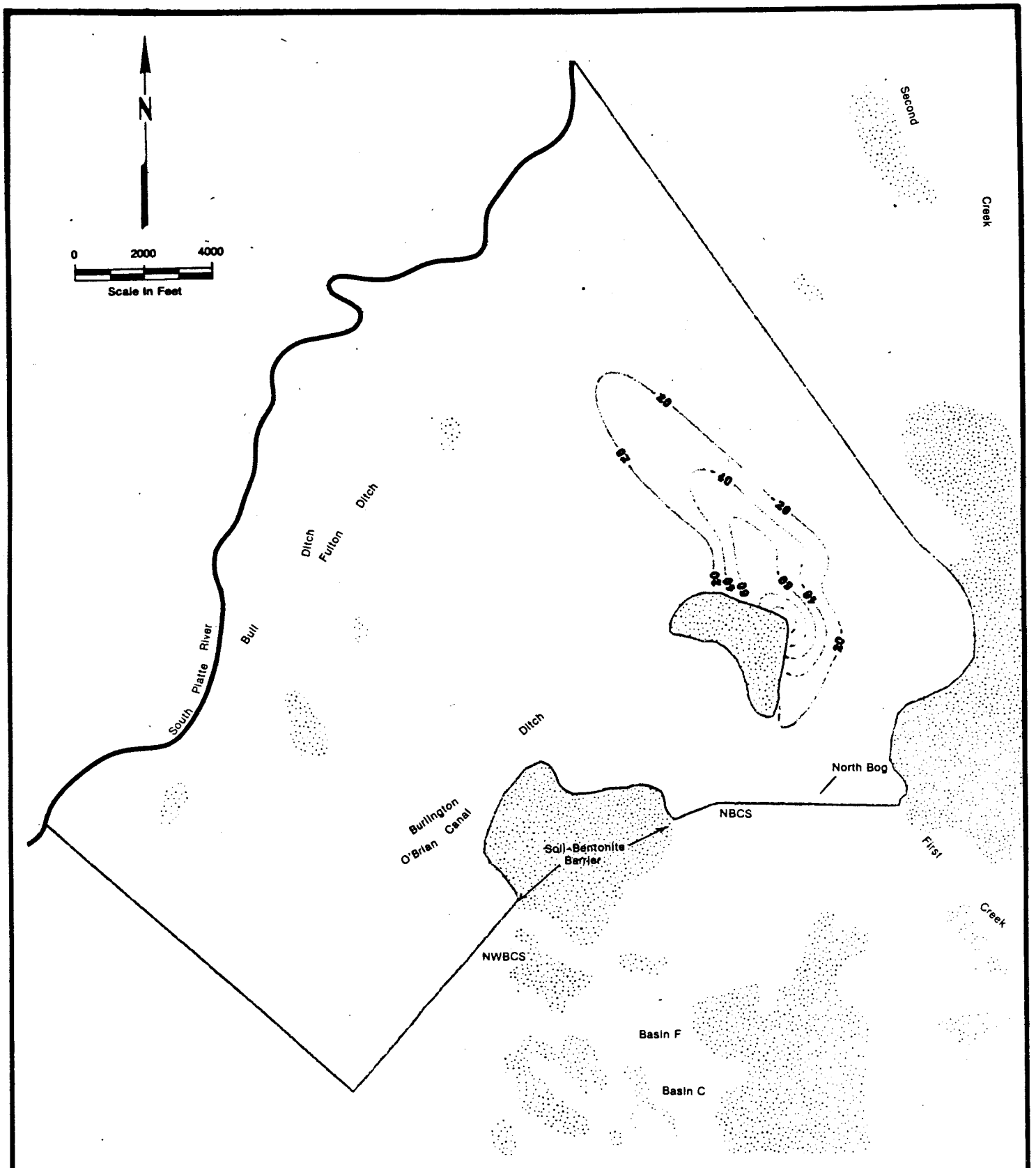


Figure G-42
CHLOROFORM CONCENTRATION DISTRIBUTION (ug/l) 1987 ALLUVIAL AQUIFER
SOURCE: WARNER, 1988

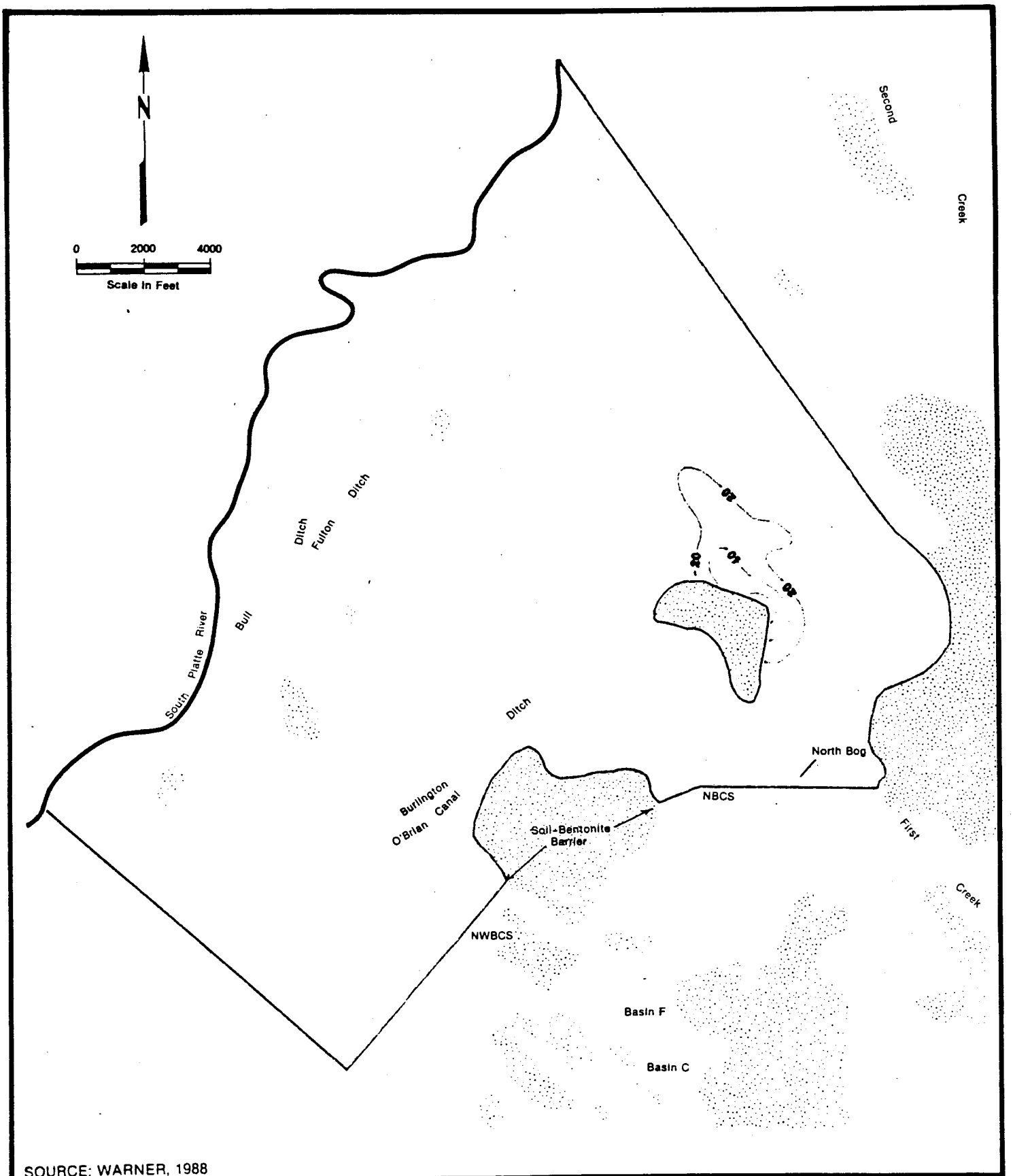
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SOURCE: WARNER, 1988

Figure G-43
CHLOROFORM CONCENTRATION DISTRIBUTION (ug/l) IN 1992 (5 YEARS) WITH EXISTING NEW SOUTH ADAMS COUNTY WELL FIELD, ALLUVIAL AQUIFER

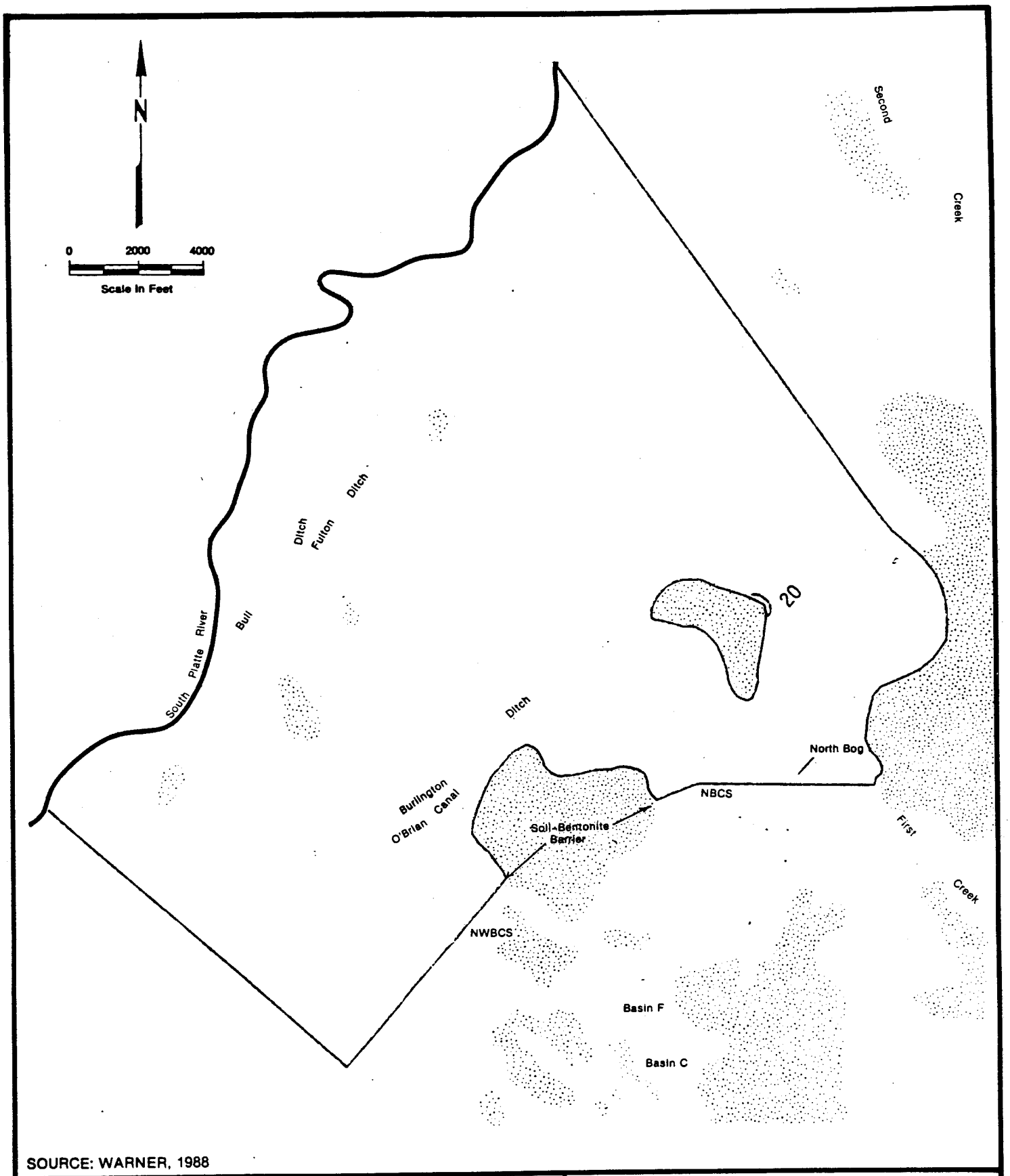
Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland



SOURCE: WARNER, 1988

Figure G-44
CHOLORFORM CONCENTRATION DISTRIBUTION (ug/l) IN 1997 (10 YEARS) WITH EXISTING NEW SOUTH ADAMS COUNTY WELL FIELD, ALLUVIAL AQUIFER

Prepared for:
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SOURCE: WARNER, 1988

Figure G-45
CHOLROFORM CONCENTRATION DISTRIBUTION (ug/l) IN 2007 (20 YEARS) WITH EXISTING NEW SOUTH ADAMS COUNTY WELL FIELD, ALLUVIAL AQUIFER

Prepared for:
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Aberdeen Proving Ground, Maryland

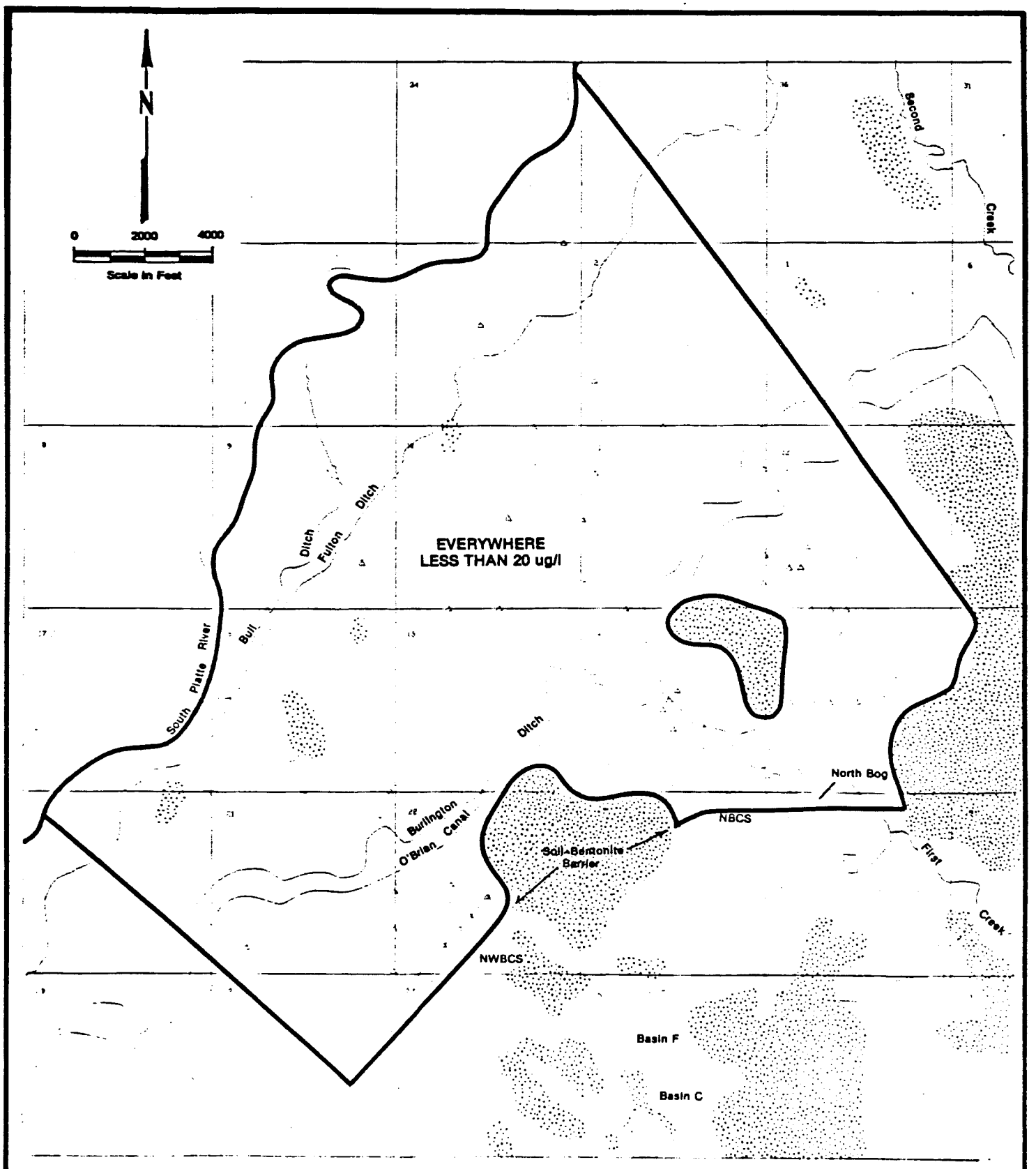


Figure G-46
CHLOROFORM CONCENTRATION DISTRIBUTION (ug/l) IN 2017 (30 YEARS) WITH EXISTING NEW SOUTH ADAMS COUNTY WELL FIELD, ALLUVIAL AQUIFER
SOURCE: WARNER, 1988

Prepared for:
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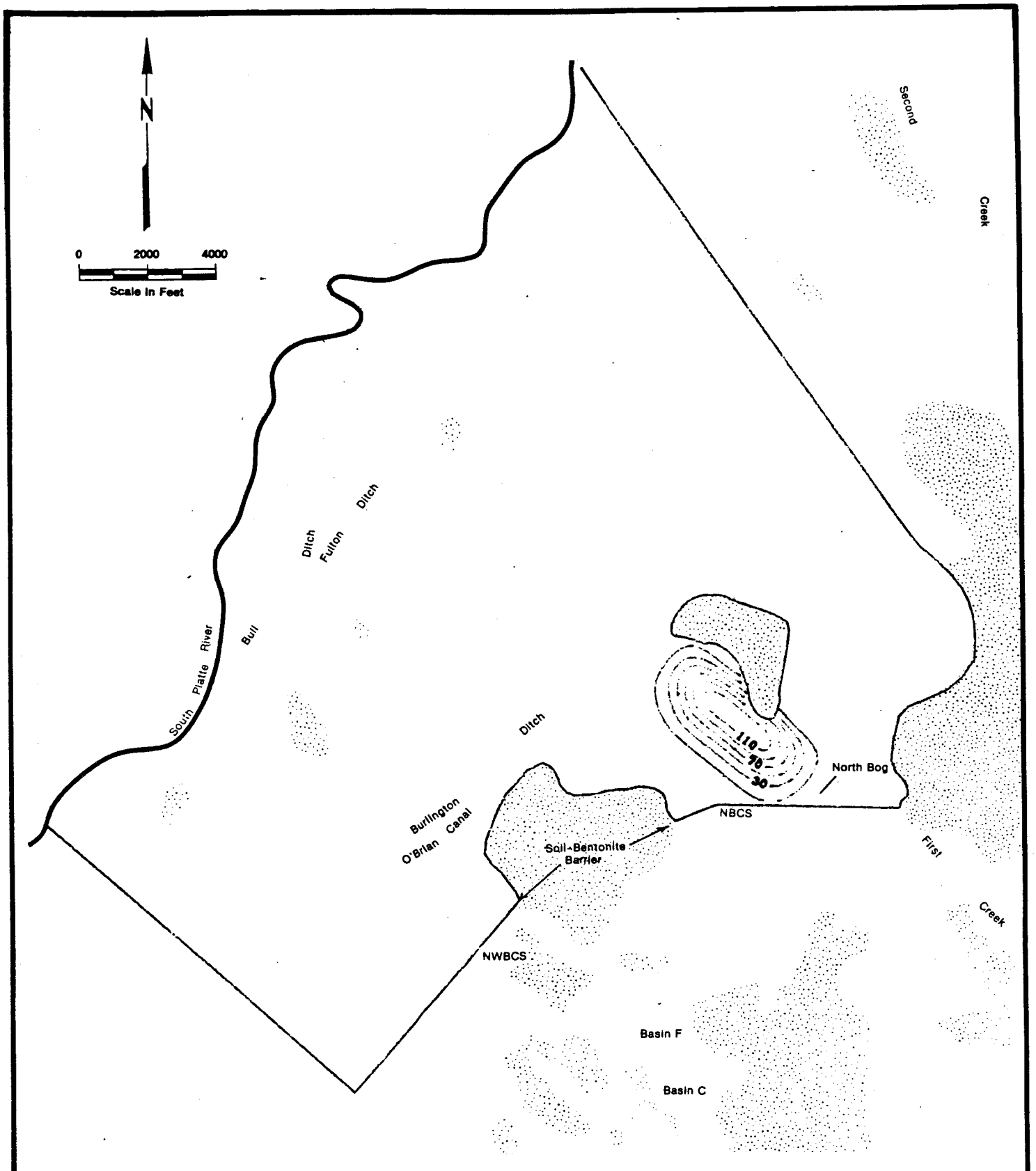
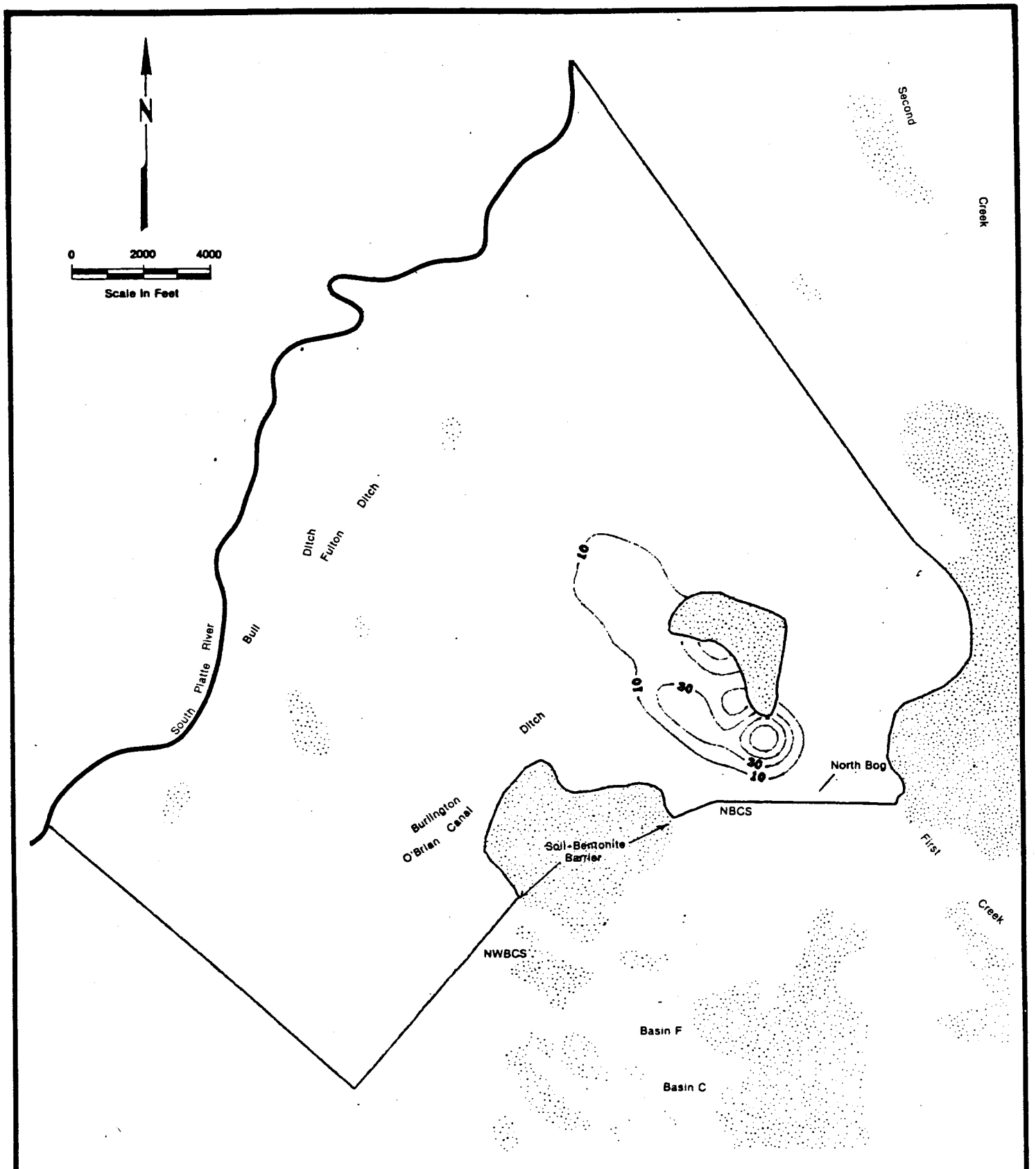


Figure G-47
DCPD CONCENTRATION DISTRIBUTION (ug/l)
1987, ALLUVIAL AQUIFER
SOURCE: WARNER, 1988

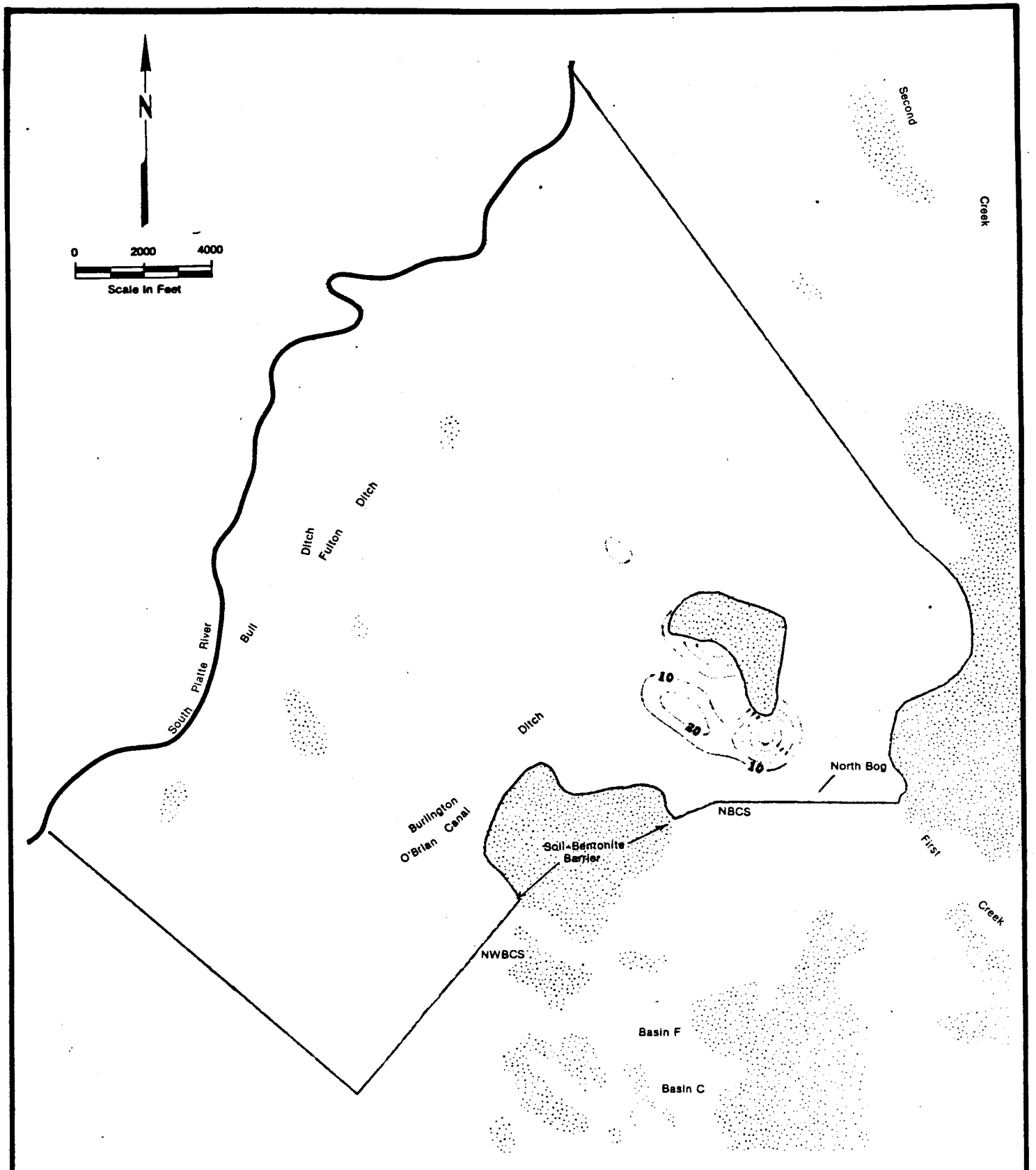
Prepared for:
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SOURCE: WARNER, 1988

Figure G-48
DCPD CONCENTRATION DISTRIBUTION (ug/l)
IN 1992 (5 YEARS) WITH EXISTING NEW
SOUTH ADAMS COUNTY WELL FIELD,
ALLUVIAL AQUIFER

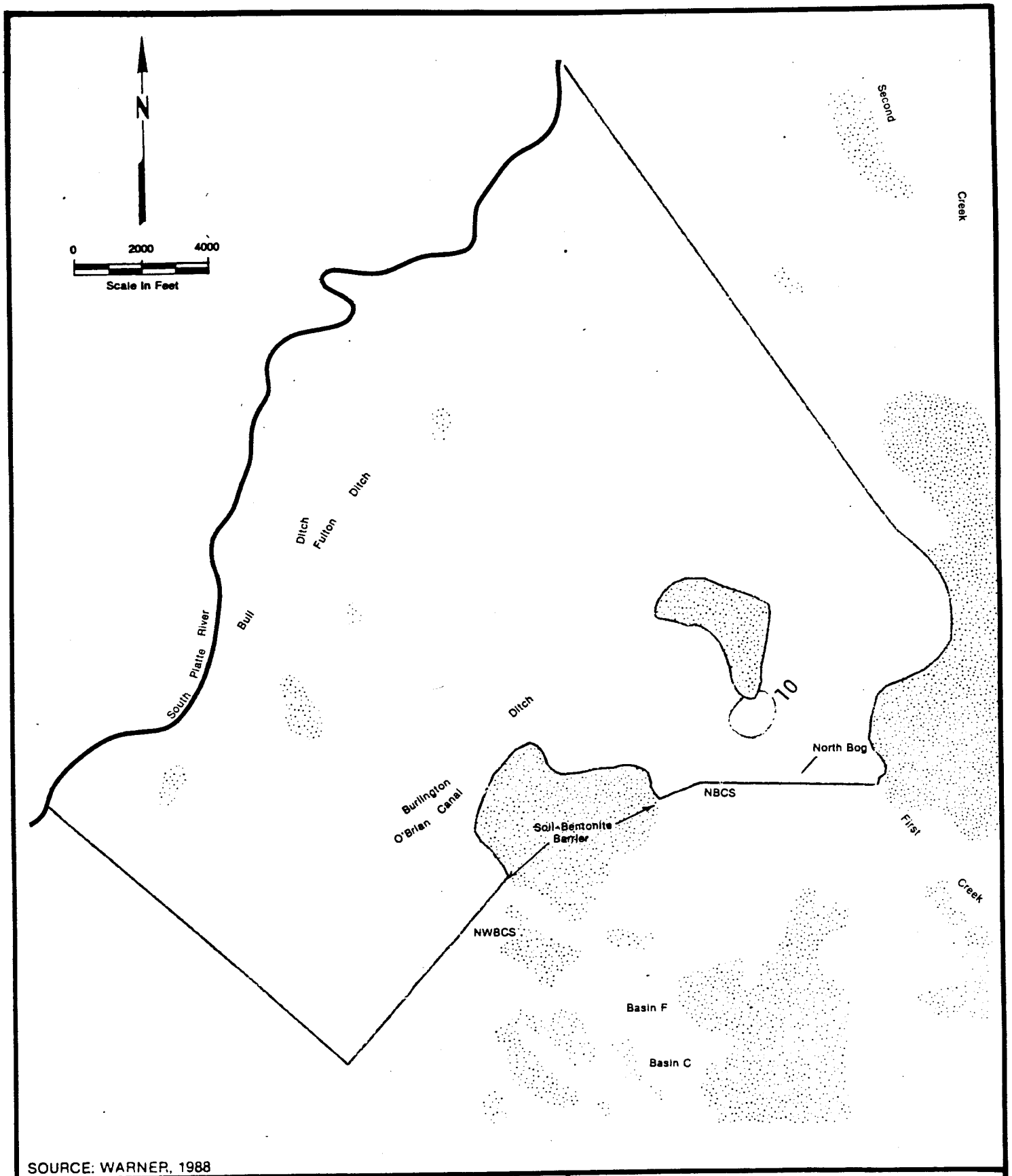
Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland



SOURCE: WARNER, 1988

Figure G-49
DCPD CONCENTRATION DISTRIBUTION (ug/l) IN 1997 (10 YEARS) WITH EXISTING NEW SOUTH ADAMS COUNTY WELL FIELD, ALLUVIAL AQUIFER

Prepared for:
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Aberdeen Proving Ground, Maryland



SOURCE: WARNER, 1988

Figure G-50
DCPD CONCENTRATION DISTRIBUTION (ug/l)
IN 2017 (20 YEARS) WITH EXISTING NEW
SOUTH ADAMS COUNTY WELL FIELD,
ALLUVIAL AQUIFER

Prepared for:
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For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

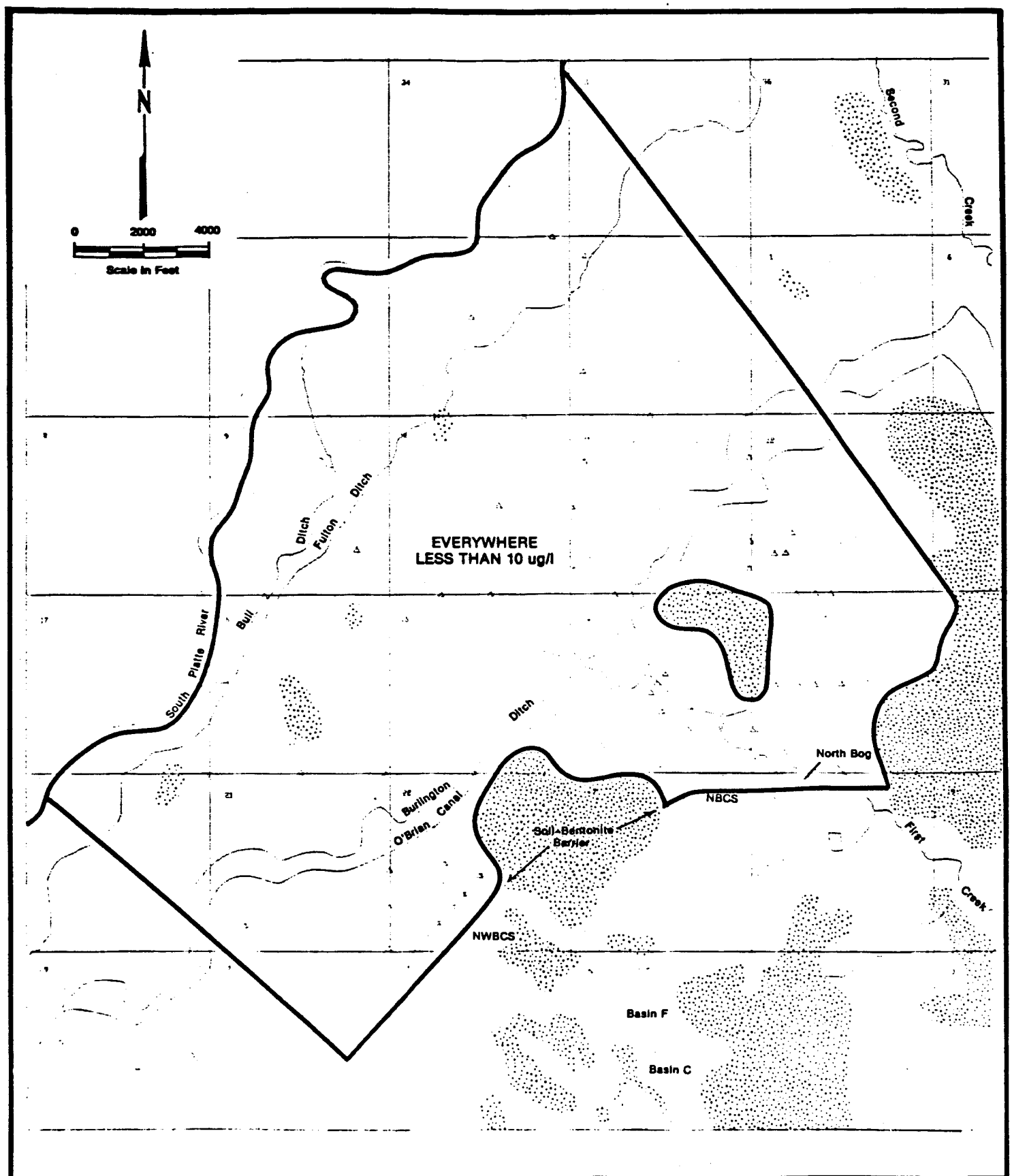


Figure G-51
DCPD CONCENTRATION DISTRIBUTION (ug/l) IN 2017 (30 YEARS) WITH EXISTING NEW SOUTH ADAMS COUNTY WELL FIELD, ALLUVIAL AQUIFER
SOURCE: WARNER, 1988

Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

APPENDIX H

POTENTIAL CHEMICAL-SPECIFIC ARARs FOR THE ENDANGERMENT ASSESSMENT FOR THE OFF-POST OPERABLE UNIT, RMA

TABLE OF CONTENTS FOR APPENDIX H

Page

INTRODUCTION iii
- A. Contents of Appendix iii
- B. Process for Selecting Chemical-Specific ARARs iv
- C. Potential Air ARARs v
- D. Potential Ground Water ARARs vi
- E. Potential Soil ARARs vii
- F. Potential Surface Water ARARs vii
- G. Potential Biota ARARs vii
- H. Potential State ARARs viii
- I. Exclusion of Worker Protection Regulations from Volume ix

POTENTIAL CHEMICAL-SPECIFIC ARARs FOR ON-POST OPERABLE UNIT, RMA

1. Acetone 1
2. Aldrin 1
3. Arsenic 2
4. Arsenic chloride 3
5. Arsenic trioxide 4
6. Benzene 5
7. Cadmium 6
8. Calcium 6
9. Calcium bromate 7
10. Calcium carbide 7
11. Calcium chloride 7
12. Carbon tetrachloride (Perchloromethane, Tetrachloromethane) 8
13. Chloride 8
14. Chlorinated phenol 9
15. Chlorobenzene (Monochlorobenzene) 10
16. Chloroform (Trichloromethane) 11
17. p-Chlorophenyl methyl sulfide (CPMS, PCPMS) 12
18. p-Chlorophenyl methyl sulfone ($CPMSO_2$, $PCPMSO_2$) 12
19. p-Chlorophenyl methyl sulfoxide (CPMSO, PCPMSO) 13
20. Chromium 13
21. Chromium III 14
22. Chromium VI 14
23. Copper 15
24. Copper sulfate 16
25. DDE (p, p'-Dichlorodiphenylethene) 17
26. DDT (p,p'-Dichlorodiphenyltrichloroethane) 17

27. 1,2-Dibromo-3-chloropropane (DBCP, Nemagon, Dibromochloropropane) 18
28. p-Dichlorobenzene (1,4-Dichlorobenzene) 19
29. 1,1-Dichloroethane 20
30. 1,2-Dichloroethane 20
31. 1,1-Dichloroethylene 21
32. 1,2-Dichloroethylene 22
33. Dicyclopentadiene (DCPD) 22
34. Dieldrin 23
35. Diisopropyl methyl phosphonate (DIMP) 24
36. 1,4-Dithiane (DITH) 24
37. Endrin 25
38. Ethyl benzene 26
39. Fluoride 26
40. Isodrin 27
41. Lead 27
42. Magnesium 28
43. Magnesium hydroxide 28
44. Mercuric chloride 29
45. Mercury 30
46. Nitrate 31
47. Nitrite 31
48. 1,4-Oxathiane (P-Thiozane) 31
49. Sodium 32
50. Sodium bicarbonate, 1:1 32
51. Sodium bromate 32
52. Sodium carbonate, 2:1 33
53. Sodium methylate, alcohol mixture 33
54. Sodium nitrite 33
55. Sodium silicate 34
56. Sodium sulfite, 2:1 34
57. Sodium sulfonate 34
58. Sodium thiosulfate (Hypo) 35
59. Sulfate 35
60. Sulfonic acid 35
61. p,p'-TDE 36
62. Tetrachlorobenzene (1,2,4,5-Tetrachlorobenzene) 36
63. 1,1,2,2-Tetrachloroethane 36
64. 1,1,2,2-Tetrachloroethylene (Perchloroethylene, PCE) 37
65. Toluene 37
66. 1,1,1-Trichloroethane 38
67. Trichloroethylene (Trichloroethene, TCE) 38
68. Xylene 39
69. Zinc 39
70. Zinc oxide 40

INTRODUCTION

A. Contents of Appendix

This Appendix sets forth the potential applicable or relevant and appropriate standards, requirements, criteria or limitations (ARARs) for air, ground water, soil, surface water or biota for use in the Endangerment Assessment for the Off-Post Operable Unit, as well as specifies whether: (i) the designated chemicals constitute CERCLA Hazardous Substances; (ii) are ranked as a potential human health risk on the priority-order list prepared by the U.S. Environmental Protection Agency (EPA) and the Agency for Toxic Substances and Disease Registry (ATSDR), 52 Fed. Reg. 12866 (1987); (iii) are air analytes; (iv) are ground water remedial investigation (RI) analytes; (v) are soil RI analytes; (vi) are soil EA analytes; (vii) are surface water RI analytes; or (viii) are biota RI analytes. (A separate but similar volume has been issued earlier to identify the potential chemical-specific ARARs for the On-Post Operable Unit.)

Where potential duly promulgated ARARs exist at this time for the designated chemicals, these are identified in this volume by citation to both the controlling regulatory provision and the relevant ARAR limit, standard or criterion derived from that regulation. For these purposes, all pertinent statutes and regulations of the EPA, U.S. Food and Drug Administration (FDA), and the State of Colorado (State) available through December 30, 1988, were reviewed to determine their suitability for inclusion in this document as potential ARARs.

B. Process for Selecting Chemical-Specific ARARs

By issuing this list of potential ARARs, the Army does not purport to determine which of these regulations are applicable and which are relevant and appropriate, or even to represent that all of these regulations warrant selection as some form of ARARs for the Off-Post Operable Unit. Rather, this appendix of potential ARARs is prepared solely to ensure that decisionmaking with respect to the Off-Post Endangerment Assessment will be fully informed with respect to all existing regulations that merit consideration as ARARs.

It should be noted that the accompanying list of chemical-specific ARARs will be up-dated in the context of the Off-Post RMA Feasibility Study/Endangerment Assessment Report to reflect any Federal or pertinent State chemical-specific regulations promulgated prior to the issuance of the proposed final version of that report in the Spring of 1989.

The actual selection of ARARs for this portion of the RI/FS will occur in the context of the Off-Post RMA Feasibility Study/Endangerment Assessment Report in accordance with the terms of CERCLA Section 121(d)(2), 42 U.S.C. § 9621(d), the National Contingency Plan (NCP), EPA guidance that is not inconsistent with CERCLA and the NCP, and the proposed Consent Decree (including the RI/FS Process document).

The first step in this process will be to determine the chemicals for which an ARAR determination is warranted since 42 U.S.C. § 9621(d) provides that ARARs are to be selected only for hazardous substances, pollutants, or contaminants. Second, it will be necessary for the Army to determine whether ARARs exist for the designated

hazardous substances, pollutants or contaminants. Third, the Army will determine the ARARs to be attained for purposes of remedial action on the Off-Post Operable Unit and whether any ARARs should be waived in accordance with CERCLA's provisions. (Where either there is no existing ARAR or no ARAR is selected for a particular chemical compound, the Endangerment Assessment will set levels or standards of control through the risk assessment process that are to be protective of human health and the environment.) The Off-Post chemical-specific ARARs selected by the Army will be set forth in the Endangerment Assessment Report.

C. Potential Air ARARs

For the potential air ARARs for RMA contaminants in the Off-Post Operable Unit, all generally pertinent National Ambient Air Quality Standards (NAAQS) and Natural Emission Standards for Hazardous Air Pollutants (NESHAP) are identified.

No air ARARs have been expressly designated for the Off-Post Operable Unit for particulate matter because such particulate standards are not chemical-specific. Nevertheless, for purposes of clean-up of the RMA Off-Post Operable Unit, it should be noted that the provisions of 40 C.F.R. § 50.6 will be a potential ARAR: There will be no particulate matter (of whatever chemical) transported from RMA by air that is in excess of 75 micrograms per cubic meter--annual geometric mean and that 260 micrograms per cubic meter--maximum 24-hour concentration will not be exceeded more than once a year.

D. Potential Ground Water ARARs

Potential ground water ARARs for RMA contaminants in the Off-Post Operable Unit include Maximum Contaminant Levels (MCL) and non-zero Maximum Contaminant Level Goals (MCLG) from the National Primary Drinking Water Regulations (NPDW), 40 C.F.R. Part 141, the Clean Water Act's Toxic Pollutant Effluent Standards (TPES), 40 C.F.R. Part 129, the ground water protection standards of the Resource Conservation and Recovery Act, 40 C.F.R. Part 264 regulations (RCRA), non-zero human health protection provisions of the Ambient Water Quality Criteria (AWQC), 45 Fed. Reg. 79318 (1980)[1], and FDA's Tolerances for Pesticides in Food Administered by EPA (TPF).

E. Potential Soil ARARs

No potential chemical-specific ARARs were identified that might pertain to the RMA chemicals in the soils in the Army's Off-Post Operable Unit.

F. Potential Surface Water ARARs

Potential surface water ARARs for RMA contaminants in the lakes and streams of the Off-Post Operable Unit are similar to those for potential ground water (including

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[1]It should be noted that whether the AWQC values designated herein as potential ground water ARARs are appropriate for utilization as ARARs is a matter that warrants serious consideration during the course of Endangerment Assessment decisionmaking. Since the indicated AWQC values are predicated on human consumption both of water and aquatic organisms in that water, and ground water does not contain aquatic life, use of alternative values (such as the adjusted AWQC found in the 1986 Superfund Public Health Evaluation Manual) may well be more appropriate in connection with ground water.

the NPDW, the TPES, RCRA, the non-zero human protection provisions of the AWQC and the TPFA), as well as the non-zero fresh water aquatic life protection provisions of AWQC.

G. Potential Biota ARARs

While there are no chemical-specific ARARs for RMA contaminants that pertain to the wild flora and fauna found in the Army's Off-Post Operable Unit (except for the aquatic life AWQC set for surface water), the levels that EPA and FDA have set for domesticated crops and animals with respect to pesticides found on or in such raw farm commodities will be a useful aid to ARAR-decisionmaking for such domestic acriculture in the Endangerment Assessment (and may also have utility with respect to wild flora and fauna on a case-by-case basis). Accordingly, EPA's Tolerances for Pesticide Chemicals On or In Raw Agricultural Commodities (TPCRAC), 40 C.F.R. Part 180, and the FDA's TPFA have been identified. It should be noted that the designated pesticide tolerances are not the same as action levels. As EPA has previously explained, "[t]here are major differences between tolerances and action levels. A tolerance is set before the fact to cover residues which will result from legal and purposeful use of the pesticide. An action level is a more appropriate mechanism for situations involving residues which persist in the environment after the once-legal use of that pesticide has been halted." 51 Fed. Reg. 46666 (1986). Thus, while EPA's pesticide tolerance level information is provided here (along with FDA action levels) to aid ARAR

decisionmaking, it is only during the course of ARAR selection that the relevance, if any, of these tolerance levels to the RMA cleanup will be determined.[2]

H. Potential State ARARs

In accordance with CERCLA Section 121, State statutes and regulations warrant consideration as potential ARARs only where they meet the three-part test of being: (i) promulgated; (ii) more stringent than any Federal ARAR; and (iii) could not effectively result in the statewide prohibition of land disposal (where the State standard is not of general applicability or adopted on the basis of hydrologic, geologic or other relevant considerations). To date the State has not identified any chemical-specific ARARs pertinent to the Off-Post Operable Unit that satisfy the three elements of this test, and the Army has been unable to identify any existing State regulations that satisfy this CERCLA criteria. Thus, no State chemical-specific ARARs are cited in the current edition of this appendix as potential ARARs.

I. Exclusion of Worker Protection Regulations from Appendix

It should be noted that worker protection regulations are not treated as chemical-specific ARARs for purposes of this appendix. These will be separately addressed for

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[2]With respect to certain of the chemicals that do not have designated tolerance levels, it should be noted that EPA has revoked the pesticide tolerances for which related registered uses have been cancelled, EPA has recommended action levels to FDA to replace the existing tolerances and EPA has made recommendations to the FDA and the U.S. Department of Agriculture regarding existing action levels for commodities bearing residues for which tolerances have not been established. Among the pesticides for which EPA has revoked tolerances are: (i) DDT (51 Fed. Reg. 46658 (1986)); (ii) TDE (id.); (iii) DDE (id.); (iv) Aldrin (51 Fed. Reg. 46662 (1986); (v) Dieldrin (id.); and (vi) Chlordane (51 Fed. Reg. 46665 (1986).)

purposes of the final response action for the RMA Off-Post Operable Unit in accordance with the EPA regulations adopted pursuant to 42 U.S.C. § 9651(f) (which provides that the NCP is to be amended by December 11, 1988, to provide procedures for the protection of the health and safety of employees involved in response actions) and the provisions of the OSHA interim final rule at Fed. Reg. 45654 (1986) (as this may be subsequently finalized).

December 1988

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POTENTIAL CHEMICAL-SPECIFIC ARARs FOR

THE ENDANGERMENT ASSESSMENT FOR THE

OFF-POST OPERABLE UNIT, RMA

POTENTIAL
CHEMICAL-SPECIFIC ARARS FOR
THE ENDANGERMENT ASSESSMENT FOR THE
OFF-POST OPERABLE UNIT
ROCKY MOUNTAIN ARSENAL

1. PRIMARY NAME: Acetone (Dimethyl ketone)
CERCLA Hazardous Substance: Yes
Ranking on ATSDR Priority List: No
Air Analyte: No
Potential Air ARAR: No
Ground Water RI Analyte: No
Potential Ground Water ARAR: No
Soil RI Analyte: No
Soil EA Analyte: No
Potential Soil ARAR: No
Surface Water RI Analyte: No
Potential Surface Water ARAR: No
Biota RI Analyte: No
Potential Biota ARAR: No

2. PRIMARY NAME: Aldrin
CERCLA Hazardous Substance: Yes
Ranking on ATSDR Priority List: Priority Group 1
Air Analyte: Yes
Potential Air ARAR: No
Ground Water RI Analyte: Yes
Potential Ground Water ARAR:
(a) 40 C.F.R. § 129.100(a)(3) (TPES) -- 0.003 µg/l;
(b) 45 Fed. Reg. 79325 (1980) (AWQC) -- 0.74 ng/l (10^{-5}), 0.074 ng/l (10^{-6}), 0.0074 ng/l (10^{-7}) (Human Health).

Soil RI Analyte: Yes
Soil EA Analyte: Yes
Potential Soil ARAR: No
Surface Water RI Analyte: Yes
Potential Surface Water ARAR:
(a) 40 C.F.R. § 129.100(a)(3) (TPES) -- 0.003 µg/l;
(b) 45 Fed. Reg. 79325 (1980) (AWQC) -- 0.74 ng/l (10^{-5}), 0.074 ng/l (10^{-6}), 0.0074 ng/l (10^{-7}) (Human Health);
(c) 45 Fed. Reg. 79325 (1980) (AWQC) -- 3 µg/l (Aquatic Life).

Biota RI Analyte: Yes
Potential Biota ARAR: No

3. PRIMARY NAME: Arsenic
CERCLA Hazardous Substance: Yes
Ranking on ATSDR Priority List: Priority Group 1
Air Analyte: Yes
Potential Air ARAR: (a) 40 C.F.R. § 61.162(a)(1) (NESHAP) -- uncontrolled total arsenic emissions from existing glass melting furnaces shall be less than 2.5 Mg per year;
(b) 40 C.F.R. § 61.162(b)(1) (NESHAP) -- uncontrolled total arsenic emissions from new or modified glass melting furnaces shall be less than 0.4 Mg per year.

Ground Water RI Analyte: Yes
Potential Ground Water ARAR: (a) 40 C.F.R. § 141.11(b) (NPDW -- MCL) -- 50 µg/l;
(b) 40 C.F.R. § 264.94(a)(2) (RCRA) -- 50 µg/l;
(c) 45 Fed. Reg. 79325-79326 (1980) (AWQC) -- 22 ng/l (10^{-5}), 2.2 ng/l (10^{-6}), 0.22 ng/l (10^{-7}) (Human Health).

Soil RI Analyte: Yes
Soil EA Analyte: Yes
Potential Soil ARAR: No
Surface Water RI Analyte: Yes
Potential Surface Water ARAR: (a) 40 C.F.R. § 141.11(b) (NPDW -- MCL) -- 50 µg/l;
(b) 40 C.F.R. § 264.94(a)(2) (RCRA) -- 50 µg/l;
(c) 45 Fed. Reg. 79325-79326 (1980) (AWQC) -- 22 ng/l (10^{-5}), 2.2 ng/l (10^{-6}), 0.22 ng/l (10^{-7}) (Human Health);
(d) 45 Fed. Reg. 79325 (1980) (AWQC) -- 440 µg/l (Aquatic Life).

Biota RI Analyte: Yes
Potential Biota ARAR: No

4. PRIMARY NAME: Arsenic chloride (AT)
CERCLA Hazardous Substance: Yes
Ranking on ATSDR Priority List: No
Air Analyte: Yes (Arsenic)
Potential Air ARAR: (a) 40 C.F.R. § 61.162(a)(1) (NESHAP) (Arsenic) -- uncontrolled total arsenic emissions from existing glass melting furnaces shall be less than 2.5 Mg per year;
(b) 40 C.F.R. § 61.162(b)(1) (NESHAP) (Arsenic) -- uncontrolled total arsenic emissions from new or modified glass melting furnaces shall be less than 0.4 Mg per year.

Ground Water RI Analyte: Yes (Arsenic)
Potential Ground Water ARAR: (a) (Arsenic) 40 C.F.R. § 141.11(b) (NPDW -- MCL) -- 50 µg/l;
(b) (Arsenic) 40 C.F.R. § 264.94(a)(2) (RCRA) -- 50 µg/l;
(c) (Arsenic) 45 Fed. Reg. 79325-79326 (1980) (AWQC) -- 22 ng/l (10^{-5}), 2.2 ng/l (10^{-6}), 0.22 ng/l (10^{-7}) (Human Health).

Soil RI Analyte: Yes (Arsenic)
Soil EA Analyte: Yes (Arsenic)
Potential Soil ARAR: No
Surface Water RI Analyte: Yes (Arsenic)
Potential Surface Water ARAR: (a) (Arsenic) 40 C.F.R. § 141.11(b) (NPDW --MCL) -- 50 µg/l;
(b) (Arsenic) 40 C.F.R. § 264.94(a)(2) (RCRA) -- 50 µg/l;
(c) (Arsenic) 45 Fed. Reg. 79325-79326 (1980) (AWQC) -- 22 ng/l (10^{-5}), 2.2 ng/l (10^{-6}), 0.22 ng/l (10^{-7}) (Human Health);
(d) (Arsenic) 45 Fed. Reg. 79325 (1980) (AWQC) -- 440 µg/l (Aquatic Life).

Biota RI Analyte: No
Potential Biota ARAR: No

5. PRIMARY NAME: Arsenic trioxide (ATO)
CERCLA Hazardous Substance: Yes
Ranking on ATSDR Priority List: No
Air Analyte: Yes (Arsenic)
Potential Air ARAR: (a) (Arsenic) 40 C.F.R. § 61.162(a)(1) (NESHAP) -- uncontrolled total arsenic emissions from existing glass melting furnaces shall be less than 2.5 Mg per year;
(b) (Arsenic) 40 C.F.R. § 61.162(b)(1) (NESHAP) -- uncontrolled total arsenic emissions from new or modified glass melting furnaces shall be less than 0.4 Mg per year.

Ground Water RI Analyte: Yes (Arsenic)
Potential Ground Water ARAR: (a) (Arsenic) 40 C.F.R. § 141.11(b) (NPDW -- MCL) -- 50 µg/l;
(b) (Arsenic) 40 C.F.R. § 264.94(a)(2) (RCRA) -- 50 µg/l;
(c) (Arsenic) 45 Fed. Reg. 79325-79326 (1980) (AWQC) -- 22 ng/l (10^{-5}), 2.2 ng/l (10^{-6}), 0.22 ng/l (10^{-7}) (Human Health);

Soil RI Analyte: Yes (Arsenic)
Soil EA Analyte: Yes (Arsenic)
Potential Soil ARAR: No
Surface Water RI Analyte: Yes (Arsenic)
Potential Surface Water ARAR: (a) (Arsenic) 40 C.F.R. § 141.11(b) (NPDW -- MCL) -- 50 µg/l;
(b) (Arsenic) 40 C.F.R. § 264.94(a)(2) (RCRA) -- 50 µg/l;
(c) (Arsenic) 45 Fed. Reg. 79325-79326 (1980) (AWQC) -- 22 ng/l (10^{-5}), 2.2 ng/l (10^{-6}), 0.22 ng/l (10^{-7}) (Human Health);
(d) (Arsenic) 45 Fed. Reg. 79325 (1980) (AWQC) -- 440 µg/l (Aquatic Life).

Biota RI Analyte: No
Potential Biota ARAR: No

6. PRIMARY NAME: Benzene
CERCLA Hazardous Substance: Yes
Ranking on ATSDR Priority List: Priority Group 1
Air Analyte: Yes
Potential Air ARAR: No
Ground Water RI Analyte: No
Potential Ground Water ARAR:
(a) 40 C.F.R. § 141.61(a), 52 Fed. Reg. 25716 (1987) (effective Jan. 9, 1989) (NPDW -- MCL) -- 5 µg/l;
(b) 45 Fed. Reg. 79326 (1980) (AWQC) -- 6.6 µg/l (10^{-5}), 0.66 (10^{-6}), 0.066 (10^{-7}) (Human Health).

Soil RI Analyte: Yes
Soil EA Analyte: Yes
Potential Soil ARAR: No
Surface Water RI Analyte: Yes
Potential Surface Water ARAR:
(a) 40 C.F.R. §141.61(a); 52 Fed. Reg. 25716 (1987) (effective Jan. 9, 1989) (NPDW -- MCL) -- 5 µg/l;
(b) 45 Fed. Reg. 79326 (1980) (AWQC) -- 6.6 µg/l (10^{-5}), 0.66 (10^{-6}), 0.066 (10^{-7}) (Human Health);
(c) 45 Fed. Reg. 79326 (1980) -- 5,300 µg/l (Aquatic Life).

Biota RI Analyte: No
Potential Biota ARAR: No

7. PRIMARY NAME: Cadmium
CERCLA Hazardous Substance: Yes
Ranking on ATSDR Priority List: Priority Group 1
Air Analyte: Yes
Potential Air ARAR: No
Ground Water RI Analyte: Yes
Potential Ground Water ARAR:
(a) 40 C.F.R. § 141.11(b) (NPDW -- MCL) -- 10 µg/l;
(b) 40 C.F.R. § 264.94(a)(2) (RCRA) -- 10 µg/l;
(c) 45 Fed. Reg. 79327 (1980) (AWQC) -- 10 µg/l (Human Health).

Soil RI Analyte: Yes
Soil EA Analyte: Yes
Potential Soil ARAR: No
Surface Water RI Analyte: Yes
Potential Surface Water ARAR:
(a) 40 C.F.R. § 141.11(b) (NPDW -- MCL) -- 10 µg/l;
(b) 40 C.F.R. § 264.94(a)(2) (RCRA) -- 10 µg/l;
(c) 45 Fed. Reg. 79327 (1980) (AWQC) -- 10 µg/l (Human Health);
(d) 45 Fed. Reg. 79326-79327 (1980) (AWQC) -- 24 hour average to be determined by e (1.05 [In(hardness)]-8.73), but not to exceed value of e (1.05 [In(hardness)]-3.73) at any one time (Aquatic Life).

Biota RI Analyte: No
Potential Biota ARAR: No

8. PRIMARY NAME: Calcium
CERCLA Hazardous Substance: No
Ranking on ATSDR Priority List: No
Air Analyte: No
Potential Air ARAR: No
Ground Water RI Analyte: Yes
Potential Ground Water ARAR: No
Soil RI Analyte: No
Soil EA Analyte: No
Potential Soil ARAR: No
Surface Water RI Analyte: Yes
Potential Surface Water ARAR: No
Biota RI Analyte: No
Potential Biota ARAR: No

9. PRIMARY NAME: Calcium bromate (Bromic acid, calcium salt)
CERCLA Hazardous Substance: No
Ranking on ATSDR Priority List: No
Air Analyte: No
Potential Air ARAR: No
Ground Water RI Analyte: Yes (Calcium)
Potential Ground Water ARAR: No
Soil RI Analyte: No
Soil EA Analyte: No
Potential Soil ARAR: No
Surface Water RI Analyte: Yes (Calcium)
Potential Surface Water ARAR: No
Biota RI Analyte: No
Potential Biota ARAR: No

10. PRIMARY NAME: Calcium carbide
CERCLA Hazardous Substance: Yes
Ranking on ATSDR Priority List: No
Air Analyte: No
Potential Air ARAR: No
Ground Water RI Analyte: Yes (Calcium)
Potential Ground Water ARAR: No
Soil RI Analyte: No
Soil EA Analyte: No
Potential Soil ARAR: No
Surface Water RI Analyte: Yes (Calcium)
Potential Surface Water ARAR: No
Biota RI Analyte: No
Potential Biota ARAR: No

11. PRIMARY NAME: Calcium chloride
CERCLA Hazardous Substance: No
Ranking on ATSDR Priority List: No
Air Analyte: No
Potential Air ARAR: No
Ground Water RI Analyte: Yes (Calcium)
Potential Ground Water ARAR: No
Soil RI Analyte: No
Soil EA Analyte: No
Potential Soil ARAR: No
Surface Water RI Analyte: Yes (Calcium)
Potential Surface Water ARAR: No
Biota RI Analyte: No
Potential Biota ARAR: No

12. PRIMARY NAME: Carbon tetrachloride (Perchloromethane, Tetrachloromethane)
CERCLA Hazardous Substance: Yes
Ranking on ATSDR Priority List: Priority Group 2
Air Analyte: Yes
Potential Air ARAR: No
Ground Water RI Analyte: Yes
Potential Ground Water ARAR: (a) 40 C.F.R. § 141.61(a), 42 Fed. Reg. 25716 (1987) (effective Jan. 9, 1989) (NPDW -- MCL) -- 5 µg/l;
(b) 45 Fed. Reg. 79327 (1980) (AWQC) -- 4.0 µg/l (10^{-5}), 0.40 µg/l (10^{-6}), 0.04 µg/l (10^{-7}) (Human Health).
Soil RI Analyte: Yes
Soil EA Analyte: Yes
Potential Soil ARAR: No
Surface Water RI Analyte: Yes
Potential Surface Water ARAR: (a) 40 C.F.R. § 141.61(a), 42 Fed. Reg. 25716 (1987) (effective Jan. 9, 1989) (NPDW -- MCL) -- 5 µg/l;
(b) 45 Fed. Reg. 79327 (1980) (AWQC) -- 4.0 µg/l (10^{-5}), 0.40 µg/l (10^{-6}), 0.04 (10^{-7}) (Human Health);
(c) 45 Fed. Reg. 79327 (1980) (AWQC) -- 35,200 µg/l (Aquatic Life).
Biota RI Analyte: No
Potential Biota ARAR: No

13. PRIMARY NAME: Chloride
CERCLA Hazardous Substance: No
Ranking on ATSDR Priority List: No
Air Analyte: No
Potential Air ARAR: No
Ground Water RI Analyte: Yes
Potential Ground Water ARAR: No
Soil RI Analyte: Yes
Soil EA Analyte: Yes
Potential Soil ARAR: No
Surface Water RI Analyte: Yes
Potential Surface Water ARAR: No
Biota RI Analyte: No
Potential Biota ARAR: No

14. PRIMARY NAME: Chlorinated phenol
CERCLA Hazardous Substance: Yes
Ranking on ATSDR Priority List: Priority Group 4 (2,4,6-Trichlorophenol and 2,4-Dichlorophenol)

Air Analyte: No
Potential Air ARAR: No
Ground Water RI Analyte: No
Potential Ground Water ARAR:

(a) 2,4,5-trichlorophenol -- 45 Fed. Reg. 79329 (1980) (AWQC) -- 2600 µg/l (Human Health);

(b) 2,4,6-trichlorophenol -- 45 Fed. Reg. 79329 (1980) (AWQC) -- 12 µg/l (10^{-5}), 1.2 µg/l (10^{-6}), 0.12 µg/l (10^{-7}) (Human Health);

(c) Sufficient data was not available to derive AWQC toxicity levels for other compounds that would be protective of human health, 45 Fed. Reg. 79329 (1980).

Soil RI Analyte: No
Soil EA Analyte: No
Potential Soil ARAR: No
Surface Water RI Analyte: No
Potential Surface Water ARAR:

(a) 2,4,5-trichlorophenol -- 45 Fed. Reg. 79329 (1980) (AWQC) -- 2600 µg/l (Human Health);

(b) 2,4,6-trichlorophenol -- 45 Fed. Reg. 79329 (1980) (AWQC) -- 12 µg/l (10^{-5}), 1.2 µg/l (10^{-6}), 0.12 µg/l (10^{-7}) (Human Health);

(c) Sufficient data was not available to derive AWQC toxicity levels for other compounds that would be protective of human health, 45 Fed. Reg. 79329 (1980);

(d) 4-chloro-3-methyphenol, 45 Fed. Reg. 79329 (1980) (AWQC) -- 30 µg/l (Aquatic Life);

(e) 2,4,6-trichlorophenol, 45 Fed. Reg. 79329 (1980) (AWQC) -- 970 µg/l (Aquatic Life);

(f) Other chlorinated phenols, 45 Fed. Reg. 79329 (1980) (AWQC) -- 500,000 µg/l (Aquatic Life).

Biota RI Analyte: No
Potential Biota ARAR: No

15. PRIMARY NAME: Chlorobenzene (Monochlorobenzene)
CERCLA Hazardous Substance: Yes
Ranking on ATSDR Priority List: Priority Group 3
Air Analyte: Yes
Potential Air ARAR: No
Ground Water RI Analyte: Yes
Potential Ground Water ARAR: 45 Fed. Reg. 79327-79328 (1980) (AWQC-Monochlorobenzene) -- 488 µg/l (Human Health)
Soil RI Analyte: Yes (Benzene)
Soil EA Analyte: Yes (Benzene)
Potential Soil ARAR: No
Surface Water RI Analyte: Yes (Benzene)
Potential Surface Water ARAR: (a) 45 Fed. Reg. 79327-79328 (1980) (AWQC-Monochlorobenzene) -- 488 µg/l (Human Health);
(b) 45 Fed. Reg. 79327 (1980) (AWQC) -- 50 µg/l (7.5 days exposure) (Aquatic Life).
Biota RI Analyte: No
Potential Biota ARAR: No

16. PRIMARY NAME: Chloroform (Trichloromethane)
CERCLA Hazardous Substance: Yes
Ranking on ATSDR Priority List: Priority Group 1
Air Analyte: Yes
Potential Air ARAR: No
Ground Water RI Analyte: Yes
Potential Ground Water ARAR:
(a) 40 C.F.R. § 141.12 (NPDW -- MCL) -- 100 µg/l (Note this is the total combined limit for this and all other trihalomethanes);
(b) 45 Fed. Reg. 79330 (1980) (AWQC) -- 1.9 µg/l (10^{-5}), 0.19 µg/l (10^{-6}), 0.019 µg/l (10^{-7}) (Human Health).

Soil RI Analyte: Yes
Soil EA Analyte: Yes
Potential Soil ARAR: No
Surface Water RI Analyte: Yes
Potential Surface Water ARAR:
(a) 40 C.F.R. § 141.12 (NPDW -- MCL) -- 100 µg/l (Note this is the total combined limit for this and all other trihalomethanes);
(b) 45 Fed. Reg. 79330 (1980) (AWQC) -- 1.9 µg/l (10^{-5}), 0.19 µg/l (10^{-6}), 0.019 µg/l (10^{-7}) (Human Health);
(c) 45 Fed. Reg. 79330 (1980) (AWQC) -- 1240 µg/l (Aquatic Life).

Biota RI Analyte: No
Potential Biota ARAR: No

17. PRIMARY NAME: p-Chlorophenyl methyl sulfide (CPMS, PCPMS)
CERCLA Hazardous Substance: No
Ranking on ATSDR Priority List: No
Air Analyte: Yes
Potential Air ARAR: No
Ground Water RI Analyte: Yes
Potential Ground Water ARAR: No
Soil RI Analyte: Yes
Soil EA Analyte: Yes
Potential Soil ARAR: No
Surface Water RI Analyte: Yes
Potential Surface Water ARAR: (2-Chlorophenol) 45 Fed. Reg. 79330 (1980) (AWQC) -- 4380 µg/l (Aquatic Life).

Biota RI Analyte: No
Potential Biota ARAR: No

18. PRIMARY NAME: p-Chlorophenyl methyl sulfone ($CPMSO_2$, $PCPMSO_2$)
CERCLA Hazardous Substance: No
Ranking on ATSDR Priority List: No
Air Analyte: Yes
Potential Air ARAR: No
Ground Water RI Analyte: Yes
Potential Ground Water ARAR: No
Soil RI Analyte: Yes
Soil EA Analyte: Yes
Potential Soil ARAR: No
Surface Water RI Analyte: Yes
Potential Surface Water ARAR: (2-Chlorophenol) 45 Fed. Reg. 79330 (1980) (AWQC) -- 4380 µg/l (Aquatic Life).

Biota RI Analyte: No
Potential Biota ARAR: No

19. PRIMARY NAME: p-Chlorophenyl methyl sulfoxide (CPMSO, PCPMSO)
CERCLA Hazardous Substance: No
Ranking on ATSDR Priority List: No
Air Analyte: Yes
Potential Air ARAR: No
Ground Water RI Analyte: Yes
Potential Ground Water ARAR: No
Soil RI Analyte: Yes
Soil EA Analyte: Yes
Potential Soil ARAR: No
Surface Water RI Analyte: Yes
Potential Surface Water ARAR: (2-Chlorophenol) 45 Fed. Reg. 79330 (1980) (AWQC) -- 4380 µg/l (Aquatic Life).

Biota RI Analyte: No
Potential Biota ARAR: No

20. PRIMARY NAME: Chromium
CERCLA Hazardous Substance: Yes
Ranking on ATSDR Priority List: Priority Group 1
Air Analyte: Yes
Potential Air ARAR: No
Ground Water RI Analyte: Yes
Potential Ground Water ARAR: (a) 40 C.F.R. § 141.11(b) (NPDW -- MCL) -- 50 µg/l;
(b) 40 C.F.R. § 264.94(a)(2) (RCRA) -- 50 µg/l.

Soil RI Analyte: Yes
Soil EA Analyte: Yes
Potential Soil ARAR: No
Surface Water RI Analyte: Yes
Potential Surface Water ARAR: (a) 40 C.F.R. § 141.11(b) (NPDW -- MCL) -- 50 µg/l;
(b) 40 C.F.R. § 264.94(a)(2) (RCRA) -- 50 µg/l.

Biota RI Analyte: No
Potential Biota ARAR: No

21. PRIMARY NAME: Chromium III
CERCLA Hazardous Substance: Yes
Ranking on ATSDR Priority List: No
Air Analyte: Yes (Chromium)
Potential Air ARAR: No
Ground Water RI Analyte: Yes (Chromium)
Potential Ground Water ARAR: 45 Fed. Reg. 79331 (1980) (AWQC) -- 0.170 µg/l (Human Health)
Soil RI Analyte: Yes (Chromium)
Soil EA Analyte: Yes (Chromium)
Potential Soil ARAR: No
Surface Water RI Analyte: Yes (Chromium)
Potential Surface Water ARAR: (a) 45 Fed. Reg. 79331 (1980) (AWQC) -- 0.170 µg/l (Human Health);
(b) 45 Fed. Reg. 79331 (1980) (AWQC) -- to be determined by e (1.08 [In(hard - ness)] + 3.48) (Aquatic Life.
Biota RI Analyte: No
Potential Biota ARAR: No

22. PRIMARY NAME: Chromium VI
CERCLA Hazardous Substance: Yes
Ranking on ATSDR Priority List: No
Air Analyte: Yes (Chromium)
Potential Air ARAR: No
Ground Water RI Analyte: Yes (Chromium)
Potential Ground Water ARAR: 45 Fed. Reg. 79331 (1980) (AWQC) -- 50 µg/l (Human Health)
Soil RI Analyte: Yes (Chromium)
Soil EA Analyte: Yes (Chromium)
Potential Soil ARAR: No
Surface Water RI Analyte: Yes (Chromium)
Potential Surface Water ARAR: (a) 45 Fed. Reg. 79331 (1980) (AWQC) -- 50 µg/l (Human Health);
(b) 45 Fed. Reg. 79331 (1980) (AWQC) -- 24 hour average to be determined by e (1.08 [In(hard - ness)] + 3.48) (Aquatic Life.
Biota RI Analyte: No
Potential Biota ARAR: No

23. PRIMARY NAME: Copper
CERCLA Hazardous Substance: Yes
Ranking on ATSDR Priority List: Priority Group 3
Air Analyte: Yes
Potential Air ARAR: No
Ground Water RI Analyte: Yes
Potential Ground Water ARAR: 21 C.F.R. § 193.90 (TPFA) -- tolerance of 1 part per million for potable water for residues of copper resulting from the use as algicides or herbicides of basic copper carbonate (molachite), copper sulfate (see below), copper monoethandime, and copper to control aquatic plants in reservoirs, lakes, ponds, irrigation ditches and other potential sources of potable water.

Soil RI Analyte: Yes
Soil EA Analyte: Yes
Potential Soil ARAR: No
Surface Water RI Analyte: Yes
Potential Surface Water ARAR: (a) 21 C.F.R. § 193.90 (TPFA) -- tolerance of 1 part per million for potable water for residues of copper resulting from the use as algicides or herbicides of basic copper sulfate (and the other copper compounds cited in "Potential Ground Water ARAR" above) to control aquatic plants in reservoirs, lakes, ponds, irrigation ditches and other potential sources of potable water;

(b) 45 Fed. Reg. 79331 (1980) (AWQC) -- 24 hour average is 5.6 μg/l and concentration at any one time should not exceed e (0.94 [In(hardness)]- 1.23) (Aquatic Life).

Biota RI Analyte: No
Potential Biota ARAR: No

24. PRIMARY NAME: Copper sulfate
CERCLA Hazardous Substance: Yes
Ranking on ATSDR Priority List: No
Air Analyte: Yes (Copper)
Potential Air ARAR: No
Ground Water RI Analyte: Yes (Copper)
Potential Ground Water ARAR: 21 C.F.R. § 193.90 (TPFA) -- tolerance of 1 part per million for potable water for residues of copper resulting from the use as algicides or herbicides of basic copper carbonate (molachite), copper sulfate (see below), copper monoethandime, and copper to control aquatic plants in reservoirs, lakes, ponds, irrigation ditches and other potential sources of potable water.

Soil RI Analyte: Yes (Copper)
Soil EA Analyte: Yes (Copper)
Potential Soil ARAR: No
Surface Water RI Analyte: Yes
Potential Surface Water ARAR: (a) 21 C.F.R. § 193.90 (TPFA) -- tolerance of 1 part per million for potable water for residues of copper resulting from the use as algicides or herbicides of basic copper sulfate (and the other copper compounds cited in "Potential Ground Water ARAR" above) to control aquatic plants in reservoirs, lakes, ponds, irrigation ditches and other potential sources of potable water;

(b) 45 Fed. Reg. 79331 (1980) (AWQC) -- 24 hour average is 5.6 µg/l and concentration at any one time should not exceed e (0.94 [In(hardness)]-1.23) (Aquatic Life).

Biota RI Analyte: No
Potential Biota ARAR: No

25. PRIMARY NAME: DDE (p, p'-Dichlorodiphenylethene)
CERCLA Hazardous Substance: Yes
Ranking on ATSDR Priority List: Priority Group 2
Air Analyte: Yes
Potential Air ARAR: No
Ground Water RI Analyte: Yes
Potential Ground Water ARAR: 40 C.F.R. § 129.101(a)(3) (TPES) -- 0.001 µg/l

Soil RI Analyte: Yes
Soil EA Analyte: Yes
Potential Soil ARAR: No
Surface Water RI Analyte: Yes
Potential Surface Water ARAR:
(a) 40 C.F.R. § 129.101(a)(3) (TPES) -- 0.001 µg/l;
(b) 45 Fed. Reg. 79331 (1980) (AWQC) -- 1,050 µg/l (Aquatic Life).

Biota RI Analyte: Yes
Potential Biota ARAR: No

26. PRIMARY NAME: DDT (p,p'-Dichlorodipenyltrichloroethane)
CERCLA Hazardous Substance: Yes
Ranking on ATSDR Priority List: Priority Group 2
Air Analyte: Yes
Potential Air ARAR: No
Ground Water RI Analyte: Yes
Potential Ground Water ARAR:
(a) 40 C.F.R. § 129.101(a)(3) (TPES) -- 10 µg/l;
(b) 45 Fed. Reg. 79332 (1980) (AWQC) -- 0.24 ng/l (10^{-5}), 0.024 ng/l (10^{-6}), 0.0024 ng/l (10^{-7}) (Human Health).

Soil RI Analyte: Yes
Soil EA Analyte: Yes
Potential Soil ARAR: No
Surface Water RI Analyte: Yes
Potential Surface Water ARAR:
(a) 40 C.F.R. § 129.101(a)(3) (TPES) -- 10 µg/l;
(b) 45 Fed. Reg. 79332 (1980) (AWQC) -- 0.24 ng/l (10^{-5}), 0.024 ng/l (10^{-6}), 0.0024 ng/l (10^{-7}) (Human Health);
(c) 45 Fed. Reg. 79331 (1980) (AWQC) -- 24 hour average is 0.0010 µg/l and 1.1 µg/l at any one time (Aquatic Life).

Biota RI Analyte: Yes
Potential Biota ARAR: No

27. PRIMARY NAME: 1,2-Dibromo-3-chloropropane (DBCP, Nemagon, Dibromochloropropane)
CERCLA Hazardous Substance: Yes
Ranking on ATSDR Priority List: No
Air Analyte: Yes
Potential Air ARAR: No
Ground Water RI Analyte: Yes
Potential Ground Water ARAR: No
Soil RI Analyte: Yes
Soil EA Analyte: Yes
Potential Soil ARAR: No
Surface Water RI Analyte: Yes
Potential Surface Water ARAR: No
Biota RI Analyte: No
Potential Biota ARAR: 21 C.F.R. § 193.250(a) (TPFA) -- When food additive is present as a result of fumigation in addition to the authorized use of this nematocide, the total residues of inorganic bromides shall not exceed the following: (i) 400 parts per million in or on dried eggs and processed herbs and spices;...(iii) 250 parts per million in or on concentrated tomato products and dried figs; and (iv) 125 parts per million in or on processed foods other than those listed above.

28. PRIMARY NAME: p-Dichlorobenzene (1,4-Dichlorobenzene)
CERCLA Hazardous Substance: Yes
Ranking on ATSDR Priority List: Priority Group 1
Air Analyte: No
Potential Air ARAR: No
Ground Water RI Analyte: No
Potential Ground Water ARAR:
(a) 40 C.F.R. § 141.50(b) (NPDW -- MCLG) -- 750 µg/l;
(b) 45 Fed. Reg. 79332 (1980) (AWQC) -- 400 µg/l (Human Health)

Soil RI Analyte: No
Soil EA Analyte: No
Potential Soil ARAR: No
Surface Water RI Analyte: No
Potential Surface Water ARAR:
(a) 40 C.F.R. § 141.50(b) (NPDW -- MCLG) -- 750 µg/l;
(b) 45 Fed. Reg. 79332 (1980) (AWQC) -- 400 µg/l (Human Health);
(c) 45 Fed. Reg. 79332 (1980) (AWQC) -- 763 µg/l (Aquatic Life).

Biota RI Analyte: No
Potential Biota ARAR: No

29. PRIMARY NAME: 1,1-Dichloroethane
CERCLA Hazardous Substance: Yes
Ranking on ATSDR Priority List: Priority Group 3
Air Analyte: Yes
Potential Air ARAR: No
Ground Water RI Analyte: Yes
Potential Ground Water ARAR: No
Soil RI Analyte: Yes
Soil EA Analyte: Yes
Potential Soil ARAR: No
Surface Water RI Analyte: Yes
Potential Surface Water ARAR: No
Biota RI Analyte: No
Potential Biota ARAR: No

30. PRIMARY NAME: 1,2-Dichloroethane
CERCLA Hazardous Substance: Yes
Ranking on ATSDR Priority List: Priority Group 2
Air Analyte: Yes
Potential Air ARAR: No
Ground Water RI Analyte: Yes
Potential Ground Water ARAR: 40 C.F.R. § 141.61(a) (NPDW -- MCL); 52 Fed. Reg. 25716 (1987) (effective Jan. 9, 1989) -- 5 µg/l
Soil RI Analyte: Yes
Soil EA Analyte: Yes
Potential Soil ARAR: No
Surface Water RI Analyte: Yes
Potential Surface Water ARAR: 40 C.F.R. § 141.61(a); 52 Fed. Reg. 25716 (1987) (effective Jan 9, 1989) -- 5 µg/l
Biota RI Analyte: No
Potential Biota ARAR: No

31. PRIMARY NAME: 1,1-Dichloroethylene
CERCLA Hazardous Substance: Yes
Ranking on ATSDR Priority List: No
Air Analyte: No
Potential Air ARAR: No
Ground Water RI Analyte: Yes
Potential Ground Water ARAR:
(a) 40 C.F.R. § 141.61(a), 52 Fed. Reg. 25716 (1987) (effective Jan. 9, 1989) (NPDW -- MCL) -- 7 µg/l;
(b) 40 C.F.R. § 141.50(b) (NPDW -- MCLG) -- 7 µg/l;
(c) 45 Fed. Reg. 79332 (1980) (AWQC) -- 0.33 µg/l (10^{-5}), 0.033 µg/l (10^{-6}), 0.0033 µg/l (10^{-7}) (Human Health).

Soil RI Analyte: Yes
Soil EA Analyte: Yes
Potential Soil ARAR: No
Surface Water RI Analyte: No
Potential Surface Water ARAR:
(a) 40 C.F.R. § 141.61(a), 52 Fed. Reg. 25716 (1987) (effective Jan 9, 1989) (NPDW -- MCL) -- 7 µg/l;
(b) 40 C.F.R. § 141.50(b) (NPDW -- MCLG) -- 7 µg/l;
(c) 45 Fed. Reg. 79332 (1980) (AWQC) -- 0.33 µg/l (10^{-5}), 0.033 µg/l (10^{-6}), 0.0033 µg/l (10^{-7}) (Human Health);
(d) 45 Fed. Reg. 79332 (1980) (AWQC) -- 11,600 µg/l (Aquatic Life).

Biota RI Analyte: No
Potential Biota ARAR: No

32. PRIMARY NAME: 1,2-Dichloroethylene
CERCLA Hazardous Substance: No
Ranking on ATSDR Priority List: No
Air Analyte: Yes
Potential Air ARAR: No
Ground Water RI Analyte: Yes
Potential Ground Water ARAR: (a) 40 C.F.R. § 141.61(a), 52 Fed. Reg. 25716 (1987) (effective Jan 9, 1989) (NPDW -- MCL) -- 7 μg/l;
(b) 45 Fed. Reg. 79332 (1980) (AWQC) -- 0.33 μg/l (10^{-5}), 0.033 μg/l (10^{-6}), 0.0033 μg/l (10^{-7}) (Human Health);

Soil RI Analyte: Yes
Soil EA Analyte: Yes
Potential Soil ARAR: No
Surface Water RI Analyte: No
Potential Surface Water ARAR: (a) 40 C.F.R. § 141.61(a), 52 Fed. Reg. 25716 (1987) (effective Jan 9, 1989) (NPDW -- MCL) -- 7 μg/l;
(b) 45 Fed. Reg. 79332 (1980) (AWQC) -- 0.33 μg/l (10^{-5}), 0.033 μg/l (10^{-6}), 0.0033 μg/l (10^{-7}) (Human Health);
(c) 45 Fed. Reg. 79332 (1980) (AWQC) -- 11,600 μg/l (Aquatic Life).

Biota RI Analyte: No
Potential Biota ARAR: No

33. PRIMARY NAME: Dicyclopentadiene (DCPD)
CERCLA Hazardous Substance: No
Ranking on ATSDR Priority List: No
Air Analyte: Yes
Potential Air ARAR: No
Ground Water RI Analyte: Yes
Potential Ground Water ARAR: No
Soil RI Analyte: Yes
Soil EA Analyte: Yes
Potential Soil ARAR: No
Surface Water RI Analyte: Yes
Potential Surface Water ARAR: No
Biota RI Analyte: No
Potential Biota ARAR: No

34. PRIMARY NAME: Dieldrin
CERCLA Hazardous Substance: Yes
Ranking on ATSDR Priority List: Priority Group 1
Air Analyte: Yes
Potential Air ARAR: No
Ground Water RI Analyte: Yes
Potential Ground Water ARAR:
(a) 40 C.F.R. § 129.100(a)(3) (TPES) -- 0.12 µg/l;
(b) 45 Fed. Reg. 79325 (1980) (AWQC) -- 0.71 ng/l (10^{-5}), 0.071 ng/l (10^{-6}), 0.0071 ng/l (10^{-7}) (Human Health).

Soil RI Analyte: Yes
Soil EA Analyte: Yes
Potential Soil ARAR: No
Surface Water RI Analyte: Yes
Potential Surface Water ARAR:
(a) 40 C.F.R. § 129.100(a)(3) (TPES) -- 0.12 µg/l;
(b) 45 Fed. Reg. 79325 (1980) (AWQC) -- 0.71 ng/l (10^{-5}), 0.071 ng/l (10^{-6}), 0.0071 ng/l (10^{-7}) (Human Health);
(c) 45 Fed. Reg. 79325 (1980) (AWQC) -- 24 hour average 0.0019 µg/l and concentration of 2.5 µg/l at any one time (Aquatic Life).

Biota RI Analyte: Yes
Potential Biota ARAR: No

35. PRIMARY NAME: Diisopropyl methyl phosphonate (DIMP, Diisopropylmethylphosphonate)
CERCLA Hazardous Substance: No
Ranking on ATSDR Priority List: No
Air Analyte: Yes
Potential Air ARAR: No
Ground Water RI Analyte: Yes
Potential Ground Water ARAR: No
Soil RI Analyte: Yes
Soil EA Analyte: Yes
Potential Soil ARAR: No
Surface Water RI Analyte: Yes
Potential Surface Water ARAR: No
Biota RI Analyte: No
Potential Biota ARAR: No

36. PRIMARY NAME: 1,4-Dithiane (DITH)
CERCLA Hazardous Substance: No
Ranking on ATSDR Priority List: No
Air Analyte: Yes
Potential Air ARAR: No
Ground Water RI Analyte: Yes
Potential Ground Water ARAR: No
Soil RI Analyte: Yes
Soil EA Analyte: Yes
Potential Soil ARAR: No
Surface Water RI Analyte: Yes
Potential Surface Water ARAR: No
Biota RI Analyte: No
Potential Biota ARAR: No

37. PRIMARY NAME: Endrin
CERCLA Hazardous Substance: Yes
Ranking on ATSDR Priority List: Priority Group 3
Air Analyte: Yes
Potential Air ARAR: No
Ground Water RI Analyte: Yes
Potential Ground Water ARAR:
(a) 40 C.F.R. § 141.12 (NPDW -- MCL) -- 0.2 µg/l;
(b) 40 C.F.R. § 264.94(a)(2) (RCRA) -- 0.2 µg/l;
(c) 45 Fed. Reg. 79334 (1980) (AWQC) -- 1 µg/l (Human Health).

Soil RI Analyte: Yes
Soil EA Analyte: Yes
Potential Soil ARAR: No
Surface Water RI Analyte: Yes
Potential Surface Water ARAR:
(a) 40 C.F.R. § 141.12 (NPDW -- MCL) -- 0.2 µg/l;
(b) 40 C.F.R. § 264.94(a)(2) (RCRA) -- 0.2 µg/l;
(c) 45 Fed. Reg. 79334 (1980) (AWQC) -- 1 µg/l (Human Health);
(d) 45 Fed. Reg. 79334 (1980) (AWQC) -- 24 hour average 0.0023 µg/l and concentration not to exceed 0.18 µg/l at any time (Aquatic Life).

Biota RI Analyte: Yes
Potential Biota ARAR: 40 C.F.R. § 180.131 (TPCRAC) -- zero parts per million tolerances for residues in sugarbeets, sugarbeet tops, broccoli, brussels sprouts, cabbage, cauliflower, cottonseed, cucumbers, eggplant, peppers, potatoes, summer squash and tomatoes.

38. PRIMARY NAME: Ethyl benzene (Ethylbenzene)
CERCLA Hazardous Substance: Yes
Ranking on ATSDR Priority List: Priority Group 4
Air Analyte: Yes
Potential Air ARAR: No
Ground Water RI Analyte: Yes
Potential Ground Water ARAR: 45 Fed. Reg. 79334 (1980) (AWQC) -- 1400 µg/l

Soil RI Analyte: Yes
Soil EA Analyte: Yes
Potential Soil ARAR: No
Surface Water RI Analyte: Yes
Potential Surface Water ARAR:
(a) 45 Fed. Reg. 79334 (1980) (AWQC) -- 1400 µg/l;
(b) 45 Fed. Reg. 79334 (1980) (AWQC) -- 32,000 µg/l (Aquatic Life).

Biota RI Analyte: No
Potential Biota ARAR: No

39. PRIMARY NAME: Fluoride
CERCLA Hazardous Substance: No
Ranking on ATSDR Priority List: No
Air Analyte: No
Potential Air ARAR: No
Ground Water RI Analyte: Yes
Potential Ground Water ARAR:
(a) 40 C.F.R. § 141.11(c) (NPDW -- MCL) -- 4000 µg/l;
(b) 40 C.F.R. § 141.62(b) (NPDW -- MCL) -- 4000 µg/l;
(c) 40 C.F.R. § 141.50(b) (NPDW -- MCLG) -- 4000 µg/l.

Soil RI Analyte: Yes
Soil EA Analyte: Yes
Potential Soil ARAR: No
Surface Water RI Analyte: No
Potential Surface Water ARAR:
(a) 40 C.F.R. § 141.11(c) (NPDW -- MCL) -- 4000 µg/l;
(b) 40 C.F.R. § 141.62(b) (NPDW -- MCL) -- 4000 µg/l;
(c) 40 C.F.R. § 141.50(b) (NPDW -- MCLG) -- 4000 µg/l.

Biota RI Analyte: No
Potential Biota ARAR: No

40. PRIMARY NAME: Isodrin
CERCLA Hazardous Substance: No
Ranking on ATSDR Priority List: No
Air Analyte: Yes
Potential Air ARAR: No
Ground Water RI Analyte: Yes
Potential Ground Water ARAR: No
Soil RI Analyte: Yes
Soil EA Analyte: Yes
Potential Soil ARAR: No
Surface Water RI Analyte: Yes
Potential Surface Water ARAR: No
Biota RI Analyte: No
Potential Biota ARAR: No

41. PRIMARY NAME: Lead
CERCLA Hazardous Substance: Yes
Ranking on ATSDR Priority List: Priority Group 1
Air Analyte: Yes
Potential Air ARAR: 40 C.F.R. § 50.12 (NAAQS) -- 1.5 micrograms per cubic meter, maximum arithmetic mean averaged over a calendar quarter
Ground Water RI Analyte: Yes
Potential Ground Water ARAR:
(a) 40 C.F.R. § 141.11(b) (NPDW -- MCL) -- 50 µg/l;
(b) 40 C.F.R. § 264.94(a)(2) (RCRA) -- 50 µg/l;
(c) 45 Fed. Reg. 79336 (1980) (AWQC) -- 50 µg/l (Human Health).

Soil RI Analyte: Yes
Soil EA Analyte: Yes
Potential Soil ARAR: No
Surface Water RI Analyte: Yes
Potential Surface Water ARAR:
(a) 40 C.F.R. § 141.11(b) (NPDW -- MCL) -- 50 µg/l;
(b) 40 C.F.R. § 264.94(a)(2) (RCRA) -- 50 µg/l;
(c) 45 Fed. Reg. 79336 (1980) (AWQC) -- 50 µg/l (Human Health);
(d) 45 Fed. Reg. 79336 (1980) (AWQC) -- 24 hour limit to not exceed e (2.35 [In(hardness)] - 9.48) and concentration at any one time to not exceed e (1.22 [In(hardness)] - 0.47] (Aquatic Life).

Biota RI Analyte: No
Potential Biota ARAR: No

42. PRIMARY NAME: Magnesium
CERCLA Hazardous Substance: No
Ranking on ATSDR Priority List: No
Air Analyte: No
Potential Air ARAR: No
Ground Water RI Analyte: Yes
Potential Ground Water ARAR: No
Soil RI Analyte: No
Soil EA Analyte: No
Potential Soil ARAR: No
Surface Water RI Analyte: No
Potential Surface Water ARAR: No
Biota RI Analyte: No
Potential Biota ARAR: No

43. PRIMARY NAME: Magnesium hydroxide
CERCLA Hazardous Substance: No
Ranking on ATSDR Priority List: No
Air Analyte: No
Potential Air ARAR: No
Ground Water RI Analyte: Yes (Magnesium)
Potential Ground Water ARAR: No
Soil RI Analyte: No
Soil EA Analyte: No
Potential Soil ARAR: No
Surface Water RI Analyte: No
Potential Surface Water ARAR: No
Biota RI Analyte: No
Potential Biota ARAR: No

44. PRIMARY NAME: Mercuric chloride
CERCLA Hazardous Substance: Yes
Ranking on ATSDR Priority List: No
Air Analyte: Yes (Mercury)
Potential Air ARAR: No
Ground Water RI Analyte: Yes (Mercury)
Potential Ground Water ARAR:
(a) (Mercury) 40 C.F.R. § 141.11(b) (NPDW -- MCL) -- 2 µg/l;
(b) (Mercury) 45 Fed. Reg. 79336-79337 (1980) (AWQC) -- 144 ng/l (Human Health).

Soil RI Analyte: Yes (Mercury)
Soil EA Analyte: Yes (Mercury)
Potential Soil ARAR: No
Surface Water RI Analyte: Yes (Mercury)
Potential Surface Water ARAR:
(a) (Mercury) 40 C.F.R. § 141.11(b) (NPDW -- MCL) -- 2 µg/l;
(b) (Mercury) 45 Fed. Reg. 79336-79337 (1980) (AWQC) -- 144 ng/l (Human Health);
(c) (Mercury) 45 Fed. Reg. 79336 (1980) (AWQC) -- 0.00057 µg/l (as a 24-hour average and the concentration should not exceed 0.0017 µg/l at any one time) (Aquatic Life).

Biota RI Analyte: No
Potential Biota ARAR: No

45. PRIMARY NAME: Mercury
CERCLA Hazardous Substance: Yes
Ranking on ATSDR Priority List: Priority Group 2
Air Analyte: Yes
Potential Air ARAR: (a) 40 C.F.R. § 61.52(a) (NESHAP) -- emissions to atmosphere from mercury ore processing facilities not to exceed 2300 grams per 24-hour period;
(b) 40 C.F.R. § 61.52(b) (NESHAP) -- emissions to atmosphere from sludge incineration or drying plants not to exceed 3200 grams per 24-hour period.

Ground Water RI Analyte: Yes
Potential Ground Water ARAR: (a) 40 C.F.R. § 141.11(b) (NPDW -- MCL) -- 2 µg/l;
(b) 40 C.F.R. § 264.94(a)(2) (RCRA) -- 2 µg/l;
(c) 45 Fed. Reg. 79336-79337 (1980) (AWQC) -- 144 ng/l (Human Health).

Soil RI Analyte: Yes
Soil EA Analyte: Yes
Potential Soil ARAR: No

Surface Water RI Analyte: Yes
Potential Surface Water ARAR: (a) 40 C.F.R. § 141.11(b) (NPDW -- MCL) -- 2 µg/l;
(b) 40 C.F.R. § 264.94(a)(2) (RCRA) -- 2 µg/l;
(c) 45 Fed. Reg. 79336-79337 (1980) (AWQC) -- 144 ng/l (Human Health);
(d) 45 Fed. Reg. 79336-79337 (1980) (AWQC) -- 24 hour average 0.00057 µg/l and concentration not to exceed 0.0017 µg/l at any one time (Aquatic Life).

Biota RI Analyte: No
Potential Biota ARAR: No

46. PRIMARY NAME: Nitrate
CERCLA Hazardous Substance: No
Ranking on ATSDR Priority List: No
Air Analyte: No
Potential Air ARAR: No
Ground Water RI Analyte: Yes
Potential Ground Water ARAR: 40 C.F.R. § 141.11(b) (NPDW--MCL) -- 10,000 µg/l

Soil RI Analyte: No
Soil EA Analyte: No
Potential Soil ARAR: No
Surface Water RI Analyte: No
Potential Surface Water ARAR: 40 C.F.R. § 141.11(b) (NPDW--MCL) -- 10,000 µg/l

Biota RI Analyte: No
Potential Biota ARAR: No

47. PRIMARY NAME: Nitrite
CERCLA Hazardous Substance: No
Ranking on ATSDR Priority List: No
Air Analyte: No
Potential Air ARAR: No
Ground Water RI Analyte: No
Potential Ground Water ARAR: No
Soil RI Analyte: No
Soil EA Analyte: No
Potential Soil ARAR: No
Surface Water RI Analyte: No
Potential Surface Water ARAR: No
Biota RI Analyte: No
Potential Biota ARAR: No

48. PRIMARY NAME: 1,4-Oxathiane (p-Thiozane)
CERCLA Hazardous Substance: No
Ranking on ATSDR Priority List: No
Air Analyte: Yes
Potential Air ARAR: No
Ground Water RI Analyte: Yes
Potential Ground Water ARAR: No
Soil RI Analyte: Yes
Soil EA Analyte: Yes
Potential Soil ARAR: No
Surface Water RI Analyte: Yes
Potential Surface Water ARAR: No
Biota RI Analyte: No
Potential Biota ARAR: No

49. PRIMARY NAME: Sodium
CERCLA Hazardous Substance: Yes
Ranking on ATSDR Priority List: No
Air Analyte: No
Potential Air ARAR: No
Ground Water RI Analyte: Yes
Potential Ground Water ARAR: No
Soil RI Analyte: No
Soil EA Analyte: No
Potential Soil ARAR: No
Surface Water RI Analyte: No
Potential Surface Water ARAR: No
Biota RI Analyte: No
Potential Biota ARAR: No

50. PRIMARY NAME: Sodium bicarbonate, 1:1
CERCLA Hazardous Substance: No
Ranking on ATSDR Priority List: No
Air Analyte: No
Potential Air ARAR: No
Ground Water RI Analyte: Yes (Sodium)
Potential Ground Water ARAR: No
Soil RI Analyte: No
Soil EA Analyte: No
Potential Soil ARAR: No
Surface Water RI Analyte: No
Potential Surface Water ARAR: No
Biota RI Analyte: No
Potential Biota ARAR: No

51. PRIMARY NAME: Sodium bromate
CERCLA Hazardous Substance: No
Ranking on ATSDR Priority List: No
Air Analyte: No
Potential Air ARAR: No
Ground Water RI Analyte: Yes (Sodium)
Potential Ground Water ARAR: No
Soil RI Analyte: No
Soil EA Analyte: No
Potential Soil ARAR: No
Surface Water RI Analyte: No
Potential Surface Water ARAR: No
Biota RI Analyte: No
Potential Biota ARAR: No

52. PRIMARY NAME: Sodium carbonate, 2:1
CERCLA Hazardous Substance: No
Ranking on ATSDR Priority List: No
Air Analyte: No
Potential Air ARAR: No
Ground Water RI Analyte: Yes (Sodium)
Potential Ground Water ARAR: No
Soil RI Analyte: No
Soil EA Analyte: No
Potential Soil ARAR: No
Surface Water RI Analyte: No
Potential Surface Water ARAR: No
Biota RI Analyte: No
Potential Biota ARAR: No

53. PRIMARY NAME: Sodium methylate, alcohol mixture
CERCLA Hazardous Substance: Yes
Ranking on ATSDR Priority List: No
Air Analyte: No
Potential Air ARAR: No
Ground Water RI Analyte: Yes (Sodium)
Potential Ground Water ARAR: No
Soil RI Analyte: No
Soil EA Analyte: No
Potential Soil ARAR: No
Surface Water RI Analyte: No
Potential Surface Water ARAR: No
Biota RI Analyte: No
Potential Biota ARAR: No

54. PRIMARY NAME: Sodium nitrite
CERCLA Hazardous Substance: Yes
Ranking on ATSDR Priority List: No
Air Analyte: No
Potential Air ARAR: No
Ground Water RI Analyte: Yes (Sodium)
Potential Ground Water ARAR: No
Soil RI Analyte: No
Soil EA Analyte: No
Potential Soil ARAR: No
Surface Water RI Analyte: No
Potential Surface Water ARAR: No
Biota RI Analyte: No
Potential Biota ARAR: No

55. PRIMARY NAME: Sodium silicate
CERCLA Hazardous Substance: No
Ranking on ATSDR Priority List: No
Air Analyte: No
Potential Air ARAR: No
Ground Water RI Analyte: Yes (Sodium)
Potential Ground Water ARAR: No
Soil RI Analyte: No
Soil EA Analyte: No
Potential Soil ARAR: No
Surface Water RI Analyte: No
Potential Surface Water ARAR: No
Biota RI Analyte: No
Potential Biota ARAR: No

56. PRIMARY NAME: Sodium sulfite, 2:1
CERCLA Hazardous Substance: No
Ranking on ATSDR Priority List: No
Air Analyte: No
Potential Air ARAR: No
Ground Water RI Analyte: Yes (Sodium)
Potential Ground Water ARAR: No
Soil RI Analyte: No
Soil EA Analyte: No
Potential Soil ARAR: No
Surface Water RI Analyte: No
Potential Surface Water ARAR: No
Biota RI Analyte: No
Potential Biota ARAR: No

57. PRIMARY NAME: Sodium sulfonate
CERCLA Hazardous Substance: No
Ranking on ATSDR Priority List: No
Air Analyte: No
Potential Air ARAR: No
Ground Water RI Analyte: Yes (Sodium)
Potential Ground Water ARAR: No
Soil RI Analyte: No
Soil EA Analyte: No
Potential Soil ARAR: No
Surface Water RI Analyte: No
Potential Surface Water ARAR: No
Biota RI Analyte: No
Potential Biota ARAR: No

58. PRIMARY NAME: Sodium thiosulfate (Hypo)
CERCLA Hazardous Substance: No
Ranking on ATSDR Priority List: No
Air Analyte: No
Potential Air ARAR: No
Ground Water RI Analyte: Yes (Sodium)
Potential Ground Water ARAR: No
Soil RI Analyte: No
Soil EA Analyte: No
Potential Soil ARAR: No
Surface Water RI Analyte: No
Potential Surface Water ARAR: No
Biota RI Analyte: No
Potential Biota ARAR: No

59. PRIMARY NAME: Sulfate
CERCLA Hazardous Substance: No
Ranking on ATSDR Priority List: No
Air Analyte: No
Potential Air ARAR: No
Ground Water RI Analyte: Yes
Potential Ground Water ARAR: No
Soil RI Analyte: Yes
Soil EA Analyte: No
Potential Soil ARAR: No
Surface Water RI Analyte: Yes
Potential Surface Water ARAR: No
Biota RI Analyte: No
Potential Biota ARAR: No

60. PRIMARY NAME: Sulfonic acid
CERCLA Hazardous Substance: No
Ranking on ATSDR Priority List: No
Air Analyte: No
Potential Air ARAR: No
Ground Water RI Analyte: No
Potential Ground Water ARAR: No
Soil RI Analyte: No
Soil EA Analyte: No
Potential Soil ARAR: No
Surface Water RI Analyte: No
Potential Surface Water ARAR: No
Biota RI Analyte: No
Potential Biota ARAR: No

61. PRIMARY NAME: p,p'-TDE
CERCLA Hazardous Substance: Yes
Ranking on ATSDR Priority List: No
Air Analyte: No
Potential Air ARAR: No
Ground Water RI Analyte: No
Potential Ground Water ARAR: No
Soil RI Analyte: No
Soil EA Analyte: No
Potential Soil ARAR: No
Surface Water RI Analyte: No
Potential Surface Water ARAR: 45 Fed. Reg. 79331 (1980) (AWQC) -- 0.6 µg/l (Aquatic Life).
Biota RI Analyte: No
Potential Biota ARAR: No

62. PRIMARY NAME: Tetrachlorobenzene (1,2,4,5-Tetrachlorobenzene)
CERCLA Hazardous Substance: Yes
Ranking on ATSDR Priority List: No
Air Analyte: No
Potential Air ARAR: No
Ground Water RI Analyte: No
Potential Ground Water ARAR: 45 Fed. Reg. 79327 (1980) (AWQC) -- 38 µg/l (Human Health)
Soil RI Analyte: No
Soil EA Analyte: No
Potential Soil ARAR: No
Surface Water RI Analyte: No
Potential Surface Water ARAR: (a) 45 Fed. Reg. 79327 (1980) (AWQC) -- 38 ug/l (Human Health);
(b) 45 Fed. Reg. 79327 (1980) (AWQC) -- 250 ug/l (Aquatic Life).
Biota RI Analyte: No
Potential Biota ARAR: No

63. PRIMARY NAME: 1,1,2,2-Tetrachloroethane
CERCLA Hazardous Substance: Yes
Ranking on ATSDR Priority List: No
Air Analyte: No
Potential Air ARAR: No
Ground Water RI Analyte: No
Potential Ground Water ARAR: No
Soil RI Analyte: No
Soil EA Analyte: No
Potential Soil ARAR: No
Surface Water RI Analyte: No
Potential Surface Water ARAR: No
Biota RI Analyte: No
Potential Biota ARAR: No

64. PRIMARY NAME: 1,1,2,2-Tetrachloroethylene (Perchloroethylene, PCE)
CERCLA Hazardous Substance: Yes
Ranking on ATSDR Priority List: No
Air Analyte: Yes
Potential Air ARAR: No
Ground Water RI Analyte: Yes
Potential Ground Water ARAR: 45 Fed. Reg. 79341 (1980) (AWQC) -- 8 $\mu g/l$ (10^{-5}), 0.8 $\mu g/l$ (10^{-6}), 0.08 $\mu g/l$ (10^{-7}) (Human Health)

Soil RI Analyte: Yes
Soil EA Analyte: Yes
Potential Soil ARAR: No
Surface Water RI Analyte: Yes
Potential Surface Water ARAR: (a) 45 Fed. Reg. 79341 (1980) (AWQC) -- 8 $\mu g/l$ (10^{-5}), 0.8 $\mu g/l$ (10^{-6}), 0.08 $\mu g/l$ (10^{-7}) (Human Health);
(b) 45 Fed. Reg. 79341 (1980) (AWQC) - 840 $\mu g/l$ (Aquatic Life).

Biota RI Analyte: No
Potential Biota ARAR: No

65. PRIMARY NAME: Toluene
CERCLA Hazardous Substance: Yes
Ranking on ATSDR Priority List: Priority Group 2
Air Analyte: Yes
Potential Air ARAR: 45 Fed. Reg. 79340 (1980) (AWQC) -- 14,300 $\mu g/l$ (Human Health)
Ground Water RI Analyte: Yes
Potential Ground Water ARAR: No
Soil RI Analyte: Yes
Soil EA Analyte: Yes
Potential Soil ARAR: No
Surface Water RI Analyte: Yes
Potential Surface Water ARAR: (a) 45 Fed. Reg. 79340 (1980) (AWQC) -- 14,300 $\mu g/l$ (Human Health);
(b) 45 Fed. Reg. 79340 (1980) (AWQC) -- 17,500 $\mu g/l$ (Aquatic Life).

Biota RI Analyte: No
Potential Biota ARAR: No

66. PRIMARY NAME: 1,1,1-Trichloroethane
CERCLA Hazardous Substance: Yes
Ranking on ATSDR Priority List: Priority Group 3
Air Analyte: Yes
Potential Air ARAR: No
Ground Water RI Analyte: Yes
Potential Ground Water ARAR: (a) 40 C.F.R. § 141.50 (NPDW -- MCLG) -- 200 µg/l;
(b) 40 C.F.R. § 141.61(a); 52 Fed. Reg. 25716 (1987) (effective Jan. 9, 1989) (NPDW -- MCL) -- 200 µg/l.

Soil RI Analyte: Yes
Soil EA Analyte: Yes
Potential Soil ARAR: No
Surface Water RI Analyte: Yes
Potential Surface Water ARAR: (a) 40 C.F.R. § 141.50 (NPDW -- MCLG) -- 200 µg/l;
(b) 40 C.F.R. § 141.61(a); 52 Fed. Reg. 25716 (1987) (effective Jan. 9, 1989) (NPDW -- MCL) -- 200 µg/l.

Biota RI Analyte: No
Potential Biota ARAR: No

67. PRIMARY NAME: Trichloroethylene (Trichloroethene, TCE)
CERCLA Hazardous Substance: Yes
Ranking on ATSDR Priority List: Priority Group 1
Air Analyte: Yes
Potential Air ARAR: No
Ground Water RI Analyte: Yes
Potential Ground Water ARAR: (a) 40 C.F.R. § 141.61(a); 52 Fed. Reg. 25716 (1987) (effective Jan. 9, 1989) (NPDW -- MCL) -- 5 µg/l;
(b) 45 Fed. Reg. 79341 (1980) (AWQC) -- 27 µg/l (10^{-5}), 2.7 µg/l (10^{-6}), 0.27 µg/l (10^{-7}) (Human Health).

Soil RI Analyte: Yes
Soil EA Analyte: Yes
Potential Soil ARAR: No
Surface Water RI Analyte: Yes
Potential Surface Water ARAR: (a) 45 Fed. Reg. 79341 (1980) (AWQC) -- 27 µg/l (10^{-5}), 2.7 µg/l (10^{-6}), 0.27 µg/l (10^{-7}) (Human Health);
(b) 45 Fed. Reg. 79341 (1980) (AWQC) -- 45,000 µg/l (Aquatic Life).

Biota RI Analyte: No
Potential Biota ARAR: No

68. PRIMARY NAME: Xylene (includes m,o, p-Xylene)
CERCLA Hazardous Substance: Yes
Ranking on ATSDR Priority List: Priority Group 3
Air Analyte: Yes
Potential Air ARAR: No
Ground Water RI Analyte: Yes
Potential Ground Water ARAR: 40 C.F.R. § 180.1025(c) (TPCRAC) -- Xylene is not to be applied to irrigation conveyances where there is any likelihood that the irrigation water will be used as a source of potable water, or that return flows to rivers and streams could contain residues of Xylene in excess of 10 parts per million.
Soil RI Analyte: Yes
Soil EA Analyte: Yes
Potential Soil ARAR: No
Surface Water RI Analyte: Yes
Potential Surface Water ARAR: 40 C.F.R. § 180.1025(c) (TPCRAC) -- Xylene is not to be applied to irrigation conveyances where there is any likelihood that the irrigation water will be used as a source of potable water, or that return flows to rivers and streams could contain residues of Xylene in excess of 10 parts per million.
Biota RI Analyte: No
Potential Biota ARAR: No

69. PRIMARY NAME: Zinc
CERCLA Hazardous Substance: Yes
Ranking on ATSDR Priority List: Priority Group 2
Air Analyte: Yes
Potential Air ARAR: No
Ground Water RI Analyte: Yes
Potential Ground Water ARAR: No
Soil RI Analyte: Yes
Soil EA Analyte: Yes
Potential Soil ARAR: No
Surface Water RI Analyte: Yes
Potential Surface Water ARAR: 45 Fed. Reg. 79341 (1980) (AWQC) -- 24 hour average is 47 µg/l and should not exceed e (0.83[In(hardness)] + 1.95) at any one time (Aquatic Life).
Biota RI Analyte: No
Potential Biota ARAR: No

70. PRIMARY NAME: Zinc oxide
CERCLA Hazardous Substance: Yes
Ranking on ATSDR Priority List: No
Air Analyte: Yes (Zinc)
Potential Air ARAR: No
Ground Water RI Analyte: Yes (Zinc)
Potential Ground Water ARAR: No
Soil RI Analyte: Yes (Zinc)
Soil EA Analyte: Yes (Zinc)
Potential Soil ARAR: No
Surface Water RI Analyte: Yes (Zinc)
Potential Surface Water ARAR: 45 Fed. Reg. 79341 (1980) (AWQC-Zinc) -- 24 hour average is 47 μg/l and should not exceed e (0.83 [In(hardness)] + 1.95) at any one time (Aquatic Life).

Biota RI Analyte: No
Potential Biota ARAR: No

RESPONSES TO COMMENTS ON

CHEMICAL-SPECIFIC ARARs

FOR THE OFF-POST OPERABLE UNIT

RESPONSES TO COMMENTS ON CHEMICAL SPECIFIC ARARs FOR THE OFF-POST OPERABLE UNIT

1. SHELL COMMENTS ON THE PROPOSED ARARs FOR THE OFF-POST OPERABLE UNIT

A. SHELL GENERAL COMMENTS:

Shell's comments on the potential chemical-specific ARARs may be categorized into the following general issues:

1. The use of standards based upon EPA Carcinogen Assessment Group (CAG) methodologies;
2. The use of MCLs;
3. The use of MCLGs;
4. The use of Ambient Water Quality Criteria (AWQC);
5. The use of RCRA permit conditions;
6. The use of National Emission Standards for Hazardous Air Pollutants (NESHAPS);
7. The use of EPA and FDA action levels and tolerances for agricultural commodities;
8. The application points for ARARs.

Comments which have been submitted to the Army on previous occasions regarding these issues are summarized below.

Shell General Comments on the Use of Standards Based on EPA CAG Methodologies:

As expressed to the Army on numerous occasions, CAG methodology is premised on invalid assumptions. EPA has stated that performing a quantitative assessment should never appear to remove the underlying uncertainty in the quality of evidence. The displayed "upper-limit risk" therefore should be accompanied, where appropriate, with explicit acknowledgment that the agent may not be a human carcinogen at all, and that there may be zero risk of cancer to humans due to exposure. Moreover, it should be made clear to the reader that there is currently no way to decide whether the upper-bound value for risk is more or less likely to be the true risk than the lower-bound value (zero). See letter for Edward J. McGrath to Donald L. Campbell, May 12, 1988.

The linearized multistage model used by the CAG leads to a plausible upper limit to the risk that is consistent with some proposed mechanism of carcinogenesis. Such an estimate, however, does not necessarily give a realistic prediction of the risk. The value of the risk is unknown, and may be as low as zero. 51 Fed. Reg. 33997-33998 (September 24, 1986).

The choice of which low-dose extrapolation model to use and the animal data set to utilize in the model to derive estimates of upper-bounds of risk are not matters currently settled by science. EPA recognizes that "risks at low exposure levels cannot be measured directly by either animal experiments or mathematical models . . . a number of mathematical models have been developed to extrapolate from high to low dose." No single mathematical procedure is recognized as the most appropriate for low-dose extrapolation in carcinogenesis. 51 Fed. Reg. 33992-34003, (September 24, 1986). For several reasons, the unit cancer risk estimate based on animal bioassays is only an approximate indication of the absolute risk in populations exposed to carcinogens. See EPA, The Endangerment Assessment Handbook, August 1985. Different extrapolation models and data sets may lead to large differences in estimates of upper-bound risk at low doses and, even if one accepts the data as a basis for modeling, such modeling generates a widely diverse range of risk estimates depending on the model used. CAG selects data sets and models so as to derive unnecessarily conservative estimates of the upper-bound of risk. See letter from Edward J. McGrath to Donald L. Campbell, May 12, 1988.

Response to Shell General Comments on the Use of Standards Based on EPA CAG Methodologies:

While the Army recognizes that Shell is dissatisfied with the regulations, standards, criteria or limitations that have been set, in whole or in part, pursuant to the CAG methodology, it is the Army's position that this is not the appropriate context to debate the merits of the CAG methodology that produced such regulations, standards, criteria or limitations. Shell has already had an opportunity to raise its CAG methodological concerns with EPA's Cancer Assessment Group. If EPA hereafter determines to modify the CAG methodology prior to the issuance of the Off-Post RMA ROD, such modification(s) will be applied in each pertinent instance to the substances identified herein for the Off-Post RMA Operable Unit. Until such time, the Army will not look behind or question the CAG methodology that produced any of the chemical-specific regulations, standards, criteria or limitations identified as potential ARARs in this appendix.

Shell General Comments on the Use of MCLGs:

Shell does not believe that it is necessary for MCLGs to be considered as potential ARARs. Only MCLs, not MCLGs, are required to be met at the point of human consumption for drinking water. It is our understanding that the use of MCLGs as potential ARARs is undergoing internal review by EPA. At some future time when

EPA reports a decision on this matter, Shell may submit additional comments regarding the use of MCLGs as the basis of potential ARARs.

Furthermore, MCLGs for carcinogens are usually set at zero based on EPA CAG methodologies. The current CAG methodology uses potency measures, such as unit risk and relative risks, which are based on upper bounds and not on fitted model values. These measurements do not differentiate between carcinogens on the basis of available experimental data about the shapes of the dose-response relationship. The inability to differentiate between risks is a serious deficiency in CAG methodology. Therefore, the use of MCLGs as potential ARARs is generally inappropriate.

Response to Shell General Comments on the Use of MCLGs:

Non-zero MCLGs are identified as potential ARARs for purposes of this appendix in order to ensure that the decisionmaking process for the Off-Post Operable Unit will take into account all regulations, standards, criteria or limitations that bear a clean-up relationship to the chemicals found off-post from RMA, irrespective of whether such regulations, standards, criteria or limitations are ultimately selected as ARARs. If EPA hereafter determines to issue new guidance on the use of MCLGs prior to the issuance of the Off-Post RMA ROD, such guidance will be applied accordingly in each pertinent instance to the substances identified for the Off-Post RMA Operable Unit.

Shell's CAG-related concerns are addresses in the preceding comment.

Shell General Comments on the Use of Ambient Water Quality Criteria:

Shell has previously rejected Army proposals for groundwater ARARs based on Ambient Water Quality Criteria (AWQC). See letter from Edward J. McGrath to Charles Scharmann, June 21, 1988, commenting on IRA North of RMA. Shell has also submitted comments to the Army stating that the aquatic life values are merely published as guidance, and do not constitute an Ambient Water Quality Criterion. See letter of Edward J. McGrath to Donald L. Campbell, June 17, 1988. In many instances, the values cited by the Army as the basis of proposed ARARs are based upon the assumption of factors for the human consumption of drinking water and aquatic life. Naturally, fish are not collected from groundwater. Therefore, aquatic life values cannot be potential ARARs for groundwater on the RMA. See also Colorado Basic Standards and Methodologies at 5 CCR 1002-8.

Shell appreciates the consideration being given to these difficult issues by the Army, as reflected in the following footnote:

> It should be noted that whether the AWQC values designated herein as potential groundwater ARARs are appropriate for utilization as ARARs is a matter that warrants serious consideration during the course of Endangerment Assessment decisionmaking. Since the indicated AWQC values are predicated on human consumption both of water and aquatic

organisms in that water, and groundwater does not contain aquatic life, use of alternative values (such as the adjusted AWQC found in the 1986 Superfund Public Health Evaluation Manual) may well be more appropriate in connection with groundwater.

Volume III, Appendix H at vi.

Response to Shell General Comments on the Use of Ambient Water Quality Criteria:

The Army's position remains as set forth in Footnote No. 1 of the appendix.

Non-zero Ambient Water Quality Criteria are identified as potential ARARs for purposes of this appendix in order to ensure that they will be taken into account for possible future use in setting cleanup levels, irrespective of whether such Ambient Water Quality Criteria are ultimately selected as ARARs for use in the Off-Post RMA Operable Unit.

Shell General Comments on the Use of RCRA Permit Conditions:

Shell has commented previously on the Army proposal of chemical-specific ARARs based on 40 CFR § 264.94(a)(2). These standards in this section are the same as the MCLs. Shell has previously set forth its position on the use of MCLs at the Arsenal boundaries. The levels in 40 CFR § 264.94(a)(2) are intended to trigger corrective action at RCRA TSD facilities. Since the Arsenal is being remediated pursuant to CERCLA, we do not believe that Section 264.94(a)(2) can be a potential ARAR. See letter from Edward J. McGrath to Donald L. Campbell, August 30, 1988.

Response to Shell General Comments on the Use of RCRA Permit Conditions:

While the On-Post and Off-Post RMA Operable Units are being remediated pursuant to CERCLA, it is nevertheless proper to consider as potential CERCLA cleanup standards all regulations, standards, criteria or limitations that bear a relationship to the identified chemicals, including those found in the RCRA regulations. Thus, RCRA regulations are identified as potential ARARs for purposes of this appendix in order to ensure that they will be taken into account for possible future use in setting cleanup levels, irrespective of whether such regulations are ultimately selected as ARARs for use in the Off-Post Operable Unit.

Shell General Comments on the Use of National Emission Standards for Hazardous Air Pollutants (NESHAPS):

NESHAPS are source-specific and chemical-specific air emission standards which have been promulgated under the Clean Air Act. The standards are intended to be applied to emissions from a "stationary source" such as a stack in a particular industry. It is therefore clearly inappropriate to use NESHAPS as the basis of ARARs at RMA.

Chemical-specific ARARs have been listed in Appendix H for any compound believed to be present in the air, surface water, groundwater, or soil. Potential ARARs are listed, however, for compounds for which there is unquestionable proof of their presence. For example, in the case of endrin the following statement is made:

> [A]t all other wells, duplicate samples consistently reproduced concentrations less than CRLs.
>
> Volume I at 3-101.

A similar argument could be made for tetrachloroethylene and trichloroethylene. See Volume I at 3-81.

Response to Shell Comments on the Use of the National Emission Standards for Hazardous Air Pollutants:

NESHAP's regulations are identified in this context in order to ensure full consideration as possible CERCLA cleanup standards all regulations, standards, criteria or limitations that bear a relationship to the identified chemicals, including those found in the NESHAP's regulations. Thus, NESHAP's regulations are identified as potential ARARs for purposes of this appendix irrespective of whether such regulations are well-suited or ultimately selected as ARARs for use in the Off-Post Operable Unit.

ARARs will be selected for all chemicals from RMA found in the recent past in Off-Post air, surface water, groundwater, soil or biota.

B. Shell Chemical-Specific Comments On Appendix H

Shell Comments on Aldrin:

Proposed Groundwater ARAR:

Shell disagrees with the Army proposal of 0.003 μg/l as an ARAR, which is the ambient water criterion for aldrin/dieldrin in navigable waters based on an FDA tolerance level of 0.3 ppm for fish times an application factor of 0.01. 40 C.F.R. § 129.100 (a)(3).

Shell also disagrees with an assumption underlying this criterion. That assumption is that "there is no demonstrated 'no effect level'." See 41 Fed. Reg. 23,584 (1976). As Shell has previously explained in comments, developments in modelling , such as those by Sielken, indicate that this assumption is invalid. In addition, a water quality criterion designed to provide for protection of aquatic life is not relevant and appropriate. The criterion was intended to address the impact of bioaccumulation in fish and their food sources on the biological transport of aldrin/dieldrin to birds and to mammals, including man. 41 Fed. Reg. 23,584 (1976).

Furthermore, aldrin and dieldrin are considered by the EPA CAG to be an animal carcinogen and a suspected human carcinogen. As stated in previous comments, numerous carcinogenicity tests in a variety of animals indicate that aldrin and dieldrin promote only liver tumors and the tumors develop only in mice. On the basis of this species-specific effect, aldrin and dieldrin are improperly categorized by the EPA as animal carcinogens.

PROPOSED SURFACE WATER ARAR:

Shell disagrees with the Army proposal of 3.0 μg/l as an ARAR. The aquatic life value published at 45 Fed. Reg. 79325 is merely guidance, and does not constitute an ambient Water Quality Criterion. See 45 Fed. Reg. at 79,322 ("The aquatic life criteria specify both maximum and 24-hour average values. In those cases where there were insufficient data to allow the derivation of a criterion, narrative descriptions of apparent threshold levels for acute and/or chronic effects based on the available data are presented. These descriptions are intended to convey a sense of the degree of toxicity of the pollutant in the absence of a criterion recommendation.").

Shell questions why the Army did not consider the State surface water standard for Aldrin (.003 μg/l) promulgated pursuant to the Colorado Water Quality Control Act as a potential ARAR. See 5 Colo. Code Reg. 1002-8 3.8.5(2) hereinafter referred to as "South Platte Organics Standards" (1987).

Response to Shell Comments on Aldrin:

In this appendix, the Army has only designated potential ARARs for Aldrin. Whether these potential ARARs merit selection as ARARs will be determined in the context of the Feasibility Study/Endangerment Assessment Report for the Off-Post Operable Unit.

While the Army understands Shell's CAG-related concerns, as explained in the Army's response to Shell's general comments, reassessment of the merits of the CAG methodology is a national EPA issue that must be resolved by EPA in the first instance. If EPA determines to modify the CAG methodology during the course of the Off-Post RMA RI/FS, such modification(s) will be applied in each pertinent instance to the substances identified herein.

The Army did not consider the South Platte Organics Standards for Aldrin because the State standard is not more stringent than the designated potential Federal ARARs and the Army is unable to determine from presently available information whether the standard was properly promulgated or could effectively result in the statewide prohibition of land disposal (where the standard is not of general applicibility or adopted on the basis of hydrologic, geologic or other relevant considerations).

Shell Comments on (3) Arsenic and (4) Arsenic trioxide:

AIR ARAR:

Shell disagrees with the Army proposal of arsenic concentrations in air of 2.5 mg/year and less than 0.4 mg per year based on 40 CFR Section 61.162(b)(1) and 40 CFR § 61.162(b)(1), respectively.

Shell disagrees with the Army proposal of uncontrolled arsenic emissions of 2.5 mg per year as an ARAR. The National Emission Standard for Inorganic Arsenic Emissions from Glass Manufacturing Plants is neither applicable nor relevant and appropriate. See 40 CFR § 61.160-162(a)(j). Shell disagrees with the Army proposal of 0.4 mg per year of uncontrolled arsenic emissions from new or modified glass melting furnaces as an ARAR, because the National Emission Standard for Inorganic Arsenic Emissions from Glass Manufacturing Plants is neither applicable nor relevant and appropriate because commercial arsenic is not used in any remediation processes. See 40 CFR § 61.160-162(b)(1). In addition to other difficulties in using such standards as ARARs, the theoretical arsenic emissions factor is expressed as the amount of arsenic, expressed in grams per kilogram of glass produced, as determined on a material balance.

PROPOSED GROUNDWATER ARAR:

Shell agrees with the Army proposal of the MCL of 50 μg/l as an ARAR. The National Academy of Sciences Drinking Water Committee, NAS, and the World Health Organization, WHO, have prepared recommendations and guidelines, respectively, for inorganic contaminant in drinking water, based upon non-carcinogenic, no observed adverse effects levels in humans with considerations for a margin of safety. The MCL is based upon guidance from these organizations and upon reasonable scientific studies and peer reviews of these studies.

The State Human Health standard is the same as the MCL, and is therefore not more stringent than the Federal standard.

Shell disagrees with the Army proposal of 50 μg/l as an ARAR based on 40 CFR § 264.94(a)(2) for the reasons set forth above.

Shell disagrees with the Army proposal of 22 μg/l as an ARAR. The aquatic life value published at 45 Fed. Reg. 79325 is merely guidance, and does not constitute an AWQC.

PROPOSED SURFACE WATER ARAR:

Shell disagrees with the proposed ARARs for the reasons stated above regarding our concerns with the CAG methodology.

Response to Shell Comment on (3) Arsenic and (4) Arsenic trioxide:

In this appendix, the Army has only designated potential ARARs for Arsenic and Arsenic trioxide. Whether these potential ARARs merit selection as ARARs will be determined in the context of the Feasibility Study/Endangerment Assessment Report for the Off-Post Operable Unit.

The Army has designated the NESHAP's standard for arsenic as a potential ARAR for Arsenic and Arsenic trioxide because it warrants consideration as a possible guideline for use in controlling Arsenic emissions during the course of remediation. Whether this standard has any practical application in the context of the cleanup will be determined in the Feasibility Study/Endangerment Assessment for the Off-Post RMA Operable Unit.

The designation of 50 μg/l (40 C.F.R. § 264.94(a)(2)) as a potential ARAR for a CERCLA cleanup is warranted because such a criterion is not inconsistent with CERCLA, the NCP and EPA guidance that is not inconsistent with CERCLA and the NCP.

As discussed above, Shell's concerns with CAG methodology do not properly arise in this context.

The balance of Shell's comment concerns the areas of its agreement with the Army's initial determination and thus requires no further discussion in this context.

6. Shell Comments on Benzene:

Potential Groundwater ARAR:

Shell disagrees with the Army proposal of the MCL of 5 μg/l as an ARAR. The benzene MCL is based on CAG methodology and is therefore unacceptable for the reasons outlined above in the general comments.

Shell disagrees with the Army proposal of the AWQC of 6.6 μg/1 as an ARAR. The aquatic life value published in 45 Fed. Reg 79326 is merely guidance, and does not constitute an AWQC. Furthermore, this guidance is based upon CAG methodologies, and therefore unacceptable for the reasons outlined above in the General Comments.

Proposed Surface Water ARAR:

Shell disagrees with the Army proposal of 5,300 μg/l as an ARAR. The Aquatic Life value published at 45 Fed. Reg. 79326 is merely guidance, and does not constitute an ambient Water Quality Criterion.

Response to Shell Comments on Benzene:

In this appendix, the Army has only designated potential ARARs for Benzene. Whether these potential ARARs merit selection as ARARs will be determined in the context of the Feasibility Study/Endangerment Assessment Report for the Off-Post Operable Unit.

While the Army understands Shell's CAG-related concerns, as explained in the Army's response to Shell's general comments, reassessment of the merits of the CAG methodology is a national EPA issue that must be resolved by EPA in the first instance. If EPA determines to modify the CAG methodology during the course of the Off-Post RMA RI/FS, such modification(s) will be applied in each relevant instance to the substances identified herein.

7. Shell Comments on Cadmium:

PROPOSED GROUNDWATER ARAR:

Shell agrees with the Army proposal of 10 μg/l as an ARAR for the reasons outlined in the arsenic comment.

The State Human Health standard is the same as and is based on the MCL, and is therefore not an ARAR.

Shell disagrees with the Army proposal of 50 μg/l as an ARAR based upon 40 C.F.R. 264.94(a)(2) for the reasons stated above in the discussion of RCRA permit conditions.

PROPOSED SURFACE WATER ARAR:

Shell tentatively accepts the Army proposal of the AWQC (Aquatic Life) standard (max: e (l.05 [In hardness)] -3.73) as a potential ARAR. Shell questions why the Army did not consider the State surface water standard for cadmium (0.001 μg/l) as a potential ARAR. See discussion of Ambient Water Quality Criteria.

For reasons stated above in the discussion of RCRA permit conditions, Shell disagrees with 40 CFR § 264.94(a)(2).

Response to Shell Comments on Cadmium:

In this appendix, the Army has only designated potential ARARs for Cadmium. Whether these potential ARARs merit selection as ARARs will be determined in the context of the Feasibility Study/Endangerment Assessment for the Off-Post Operable Unit.

Shell's first, second and fourth comments concern its tentative agreement with the Army's initial determination for Cadmium and thus requires no further discussion in this context.

The Army's designation of 50 μg/l (40 C.F.R. § 264.94(a)(2)) as a potential ARAR for a CERCLA cleanup is warranted because such a criterion is not inconsistent with CERCLA, the NCP and EPA guidance that is not inconsistent with CERCLA and the NCP.

The Army did not consider the State surface water standard for Cadmium to be a potential ARAR because the Army is unable to determine from presently available information whether the State standard was properly promulgated or could effectively result in the statewide prohibition of land disposal (where the standard is not of general applicability or adopted on the basis of hydrologic, geologic or other relevant considerations).

12. Shell Comments on Carbon Tetrachloride:

Proposed Groundwater ARAR:

Shell disagrees with the Army proposal of the MCL of 5 μg/l as an ARAR. The carbon tetrachloride MCL is based on CAG methodology and is therefore unacceptable for the reasons set forth above.

Shell also disagrees with the use of the AWQC of 4 μg/l as an ARAR for carbon tetrachloride, because this value is based on CAG methodology, and is therefore unacceptable for the reasons set forth above.

Proposed Surface Water ARAR:

Shell disagrees with the Army proposal of the MCL of 5 μg/l as an ARAR. The carbon tetrachloride MCL is based on CAG methodology, and is therefore unacceptable for the reasons set forth above.

Shell disagrees with the Army proposal of 32,200 μg/l as an ARAR. The aquatic life value published at 45 Fed. Reg. 79327 is merely guidance, and does not constitute an ambient Water Quality Criterion.

Response to Shell Comments on Carbon Tetrachloride:

In this appendix, the Army has only designated potential ARARs for Carbon Tetrachloride. Whether these potential ARARs merit selection as ARARs will be determined in the context of the Feasibility Study/Endangerment Assessment Report for the Off-Post Operable Unit.

While the Army understands Shell's CAG-related concerns, as explained in the Army's response to Shell's general comments, reassessment of the merits of the CAG methodology is a national EPA issue that must be resolved by EPA in the first instance. If EPA determines to modify the CAG methodology during the course of the Off-Post RMA RI/FS, such modification(s) will be applied in each pertinent instance to the substances identified herein.

14. Shell Comments on Chlorinated phenol:

PROPOSED SURFACE WATER ARAR:

Shell disagrees with the Army proposal of 500,000 μg/l as an ARAR. The aquatic life value published at 45 Fed. Reg. 79329 is merely guidance, and does not constitute an ambient Water Quality Criterion.

Response to Shell Comments on Chlorinated phenol:

In this appendix, the Army has only designated potential ARARs for Chlorinated phenol. Whether these potential ARARs merit selection as ARARs will be determined in the context of the Feasibility Study/Endangerment Assessment Report for the Off-Post Operable Unit.

The use of AWQC as potential ARARs is warranted because such a criterion is not inconsistent with CERCLA, the NCP and EPA guidance not inconsistent with CERCLA and the NCP.

15. Shell Comments on Chlorobenzene:

PROPOSED GROUNDWATER ARAR:

The value cited by the Army is incorrect. The human health AWQC for chlorobenzene, as reported at 45 Fed. Reg. 79327-28, is 488 μg/l. This value has been derived from non-referenced sources for the protection of human health. The references do not advise the reader on the toxicological endpoints considered or the assumptions incorporated in performing the calculations for values protective of human health. Furthermore, the standard attempts to protect biota in surface water, which may not be appropriate for groundwater. We therefore disagree with the proposed ARAR of 448 μg/l.

PROPOSED SURFACE WATER ARAR:

Shell disagrees with the Army proposal of 250 μg/l as an ARAR. The aquatic life value published at 45 Fed. Reg. 79237 is merely guidance, and does not constitute an ambient Water Quality Criterion.

Response to Shell Comments on Chlorobenzene:

In this appendix, the Army has only designated potential ARARs for Chlorobenzene. Whether these potential ARARs merit selection as ARARs will be determined in the context of the Feasibility Study/Endangerment Assessment Report for the Off-Post Operable Unit.

The human health AWQC for groundwater (488 μg/l) was correct and thus no change was necessary to this appendix.

The use of the AWQC as potential ARARs is warranted because such a criterion is not inconsistent with CERCLA, the NCP and EPA guidance not inconsistent with CERCLA and the NCP.

16. Shell Comments on Chloroform:

PROPOSED GROUNDWATER ARAR:

Shell tentatively accepts the MCL of 100 μg/l as the proposed MCL. The MCL is based upon the median range of chloroform concentrations in U.S. drinking water pursuant to an EPA study.

Shell disagrees with the Army proposal of 1.9 μg/l (10^{-5}) as an ARAR. The aquatic life value published at 45 Fed. Reg. 79330 is merely guidance, and does not constitute an AWQC. Furthermore, the AWQC is based on the underlying assumption that there is no threshold level and is premised on CAG methodology.

Response to Shell Comments on Chloroform:

In this appendix, the Army has only designated potential ARARs for Chloroform. Whether these potential ARARs merit selection as ARARs will be determined in the context of the Feasibility Study/Endangerment Assessment Report for the Off-Post Operable Unit.

Shell's initial comment concerns its tentative agreement with the Army's initial determination for Chloroform and thus requires no further discussion in this context.

Shell's second comment concerns the appropriateness of the AWQC aquatic life value as a potential ARAR. Use of such guidance as a potential ARAR is not inconsistent with CERCLA, the NCP and EPA guidance not inconsistent with CERCLA and the NCP.

As discussed above, Shell's concerns with CAG methodology do not properly arise in this context.

17. p-Chlorophenyl methyl sulfide

18. p-Chlorophenyl methyl sulfone

19. p-Chlorophenyl methyl sulfoxide

PROPOSED SURFACE WATER ARAR:

Shell tentatively accepts the Army proposal of the AWQC standard of 4,380 ng/1 as potential ARAR for these three compounds.

Response to Shell Comments on p-Chlorophenyl methyl sulfide, p-Chlorophenyl sulfone and p-Chlorophenyl methyl sulfoxide:

In this appendix, the Army has only designated potential ARARs for p-Chlorophenyl methyl sulfide, p-Chlorophenyl sulfone and p-Chlorophenyl methyl sulfoxide. Whether these potential ARARs merit selection as ARARs will be determined in the context of the Feasibility Study/Endangerment Assessment Report for the Off-Post Operable Unit.

Shell's comment concerning its tentative acceptance of the Army's initial determination for these three compounds requires no further discussion in this context.

20. Shell Comments on Chromium:

PROPOSED GROUNDWATER ARAR:

Shell agrees with the Army proposal of the MCL of 50 μg/l as an ARAR for the reasons outlined in the arsenic comment. The State Human Health standard is the same as and is based on the MCL, and is therefore not an ARAR.

Shell disagrees with the Army proposal of 50 μg/1 as an ARAR based upon 40 CFR § 264.94(a)(2) for the reasons set forth above for the reasons stated in the discussion of RCRA permit conditions.

PROPOSED SURFACE WATER ARAR:

Shell tentatively accepts the Army proposal of the AWQC (Aquatic Life) standard as a potential ARAR. Shell questions why the Army did not consider the State surface water standards for Cr III (50 μg/l) and Cr VI (25 μg/l) as potential ARARs. See discussion of Ambient Water Quality Criteria.

Shell disagrees with the Army proposal 50 μg/l as an ARAR based upon 40 CFR § 294.94(a)(2) for the reasons set forth above for the reasons stated in the discussion of RCRA permit condition.

Response to Shell Comments on Chromium:

In this appendix, the Army has only designated potential ARARs for Chromium. Whether these potential ARARs merit selection as ARARs will be determined in the context of the Feasibility Study/Endangerment Assessment Report for the Off-Post Operable Unit.

Shell's comments concern it agreement with and tentative acceptance of the Army's initial determination for Chromium and thus requires no further discussion in this context.

The Army did not consider the State surface water standard for Chromium III to be a potential ARAR because it is not more stringent than the designated potential Federal ARARs and because the Army is unable to determine from presently available information whether the standard was properly promulgated or could effectively result in the statewide prohibition of land disposal (where the standard is not of general applicability or adopted on the basis of hydrologic, geologic or other relevant considerations). The State surface water standard for Chromium VI was not determined to be a potential ARAR because the Army is unable to determine from presently available information whether the standard was properly promulgated or could effectively result in the statewide prohibition of land disposal (where the standard is not of general applicability or adopted on the basis of hydrologic, geologic or other relevant considerations).

The designation of 50 μg/l (40 C.F.R. § 264.94(a)(2)) as a potential ARAR for a CERCLA cleanup is not inconsistent with CERCLA, the NCP and EPA guidance that is not inconsistent with CERCLA and the NCP.

21. Shell Comments on Chromium III:

PROPOSED GROUNDWATER ARAR:

Shell disagrees with the Army proposal of the AWQC of 0.170 μg/1 as an ARAR based upon the AWQC. The aquatic life value published at 45 Fed. Reg. 79331 is merely guidance and does not constitute an AWQC.

PROPOSED SURFACE WATER ARAR:

Shell does agree with the Army's proposed ARARs for surface water.

Response to Shell Comments on Chromium III:

In this appendix, the Army has only designated potential ARARs for Chromium III. Whether these potential ARARs merit selection as ARARs will be determined in the context of the Feasibility Study/Endangerment Assessment Report for the Off-Post Operable Unit.

Shell's initial comment concerns the appropriateness of the AWQC aquatic life value as a potential ARAR for Chromium III. Use of such guidance is warranted because such a criterion is not inconsistent with CERCLA, the NCP and EPA guidance not inconsistent with CERCLA and the NCP.

Shell's second comment concerns its agreement with the Army's proposed ARARs for surface water and thus requires no further discussion in this context.

22. Shell Comments on Chromium VI:

PROPOSED GROUNDWATER ARAR:

Shell disagrees with the Army proposal of the AWQC of 50 μg/l as an ARAR for the reasons set forth above. Shell does agree with the MCL as a groundwater ARAR/surface groundwater ARAR: Shell also agrees with the Army's proposed ARARs for surface water for chromium VI for the reasons set forth above. See discussion of AWQC.

Response to Shell Comments on Chromium VI:

In this appendix, the Army has only designated potential ARARs for Chromium VI. Whether these potential ARARs merit selection as ARARs will be determined in the context of the Feasibility Study/Endangerment Assessment Report for the Off-Post Operable Unit.

Shell's initial comment expresses disagreement with the appropriateness of the AWQC aquatic life value as a potential ARAR for Chromium VI. Use of such guidance to designate a potential ARAR is warranted because such a criterion is not inconsistent with CERCLA, the NCP and EPA guidance not inconsistent with CERCLA and the NCP.

The remainder of Shell's comments concern its agreement with the Army's other designated potential ARARs and thus requires no further discussion in this context.

Shell Comments on (23) Copper and (24) Copper Sulfate

PROPOSED SURFACE WATER ARAR:

Shell disagrees with the Army proposal of 1 ppm for potable water for residues of copper based upon 21 CFR § 193.90 for the reasons set forth above. See discussion of TPFA.

PROPOSED GROUNDWATER ARAR:

Shell agrees with the Army in not selecting the State Water Quality Standards for Secondary Drinking Water (1 mg/l) and Agricultural (.2 mg/l) uses as potential ARARs. The secondary drinking water standard is premised on the AWQC for human health (1 mg/l) which is based upon organoleptic data. Organoleptic concerns do not relate to protection of public health and environment and the agricultural value is not based on human health concerns.

PROPOSED SURFACE WATER ARAR:

Shell tentatively agrees with the Army proposal of the AWQC (Aquatic Life) standard as a potential ARAR. Shell questions why the Army did not consider the State surface water standard for Copper (25 μg/l) as a potential ARAR. See discussion of Ambient Water Quality Criteria.

Response to Shell Comments on (23) Copper and (24) Copper sulfate:

In this appendix, the Army has only designated potential ARARs for Copper and Copper sulfate. Whether these potential ARARs merit selection as ARARs will be determined in the context of the Feasibility Study/Endangerment Assessment Report for the Off-Post Operable Unit.

The Army's use of the standard for residues of Copper (21 C.F.R. § 193.90) as a potential ARAR is warranted because such a criterion is not inconsistent with CERCLA, the NCP and EPA guidance not inconsistent with CERCLA and the NCP. Whether such standard has any practical utility in this context will be determined in the Feasibility Study/Endangerment Assessment Report for the Off-Post Operable Unit.

The balance of Shell's comments concern its agreement and tentative agreement with the Army's initial determination for Copper and Copper sulfate and thus requires no further discussion in this context.

The State surface water standard for Copper was not determined to be a potential ARAR because it is not more stringent than the designated potential Federal ARARs and because the Army is unable to determine from presently available information whether the standard was properly promulgated or could effectively result in the statewide prohibition of land disposal (where the standard is not of general applicability or adopted on the basis of hydrologic, geologic or other relevant considerations).

25. Shell Comments on DDE:

PROPOSED GROUNDWATER ARAR:

Shell disagrees that the AWQC of 0.001 μg/l should be selected as an ARAR based on 40 CFR 120.101(a)(3) for the reasons set forth above in the discussion of AWQC.

PROPOSED SURFACE WATER ARAR:

Shell disagrees with the Army proposal of 1,050 μg/l as an ARAR. The aquatic life value published at 45 Fed. Reg. 79331 is merely guidance, and does not constitute an ambient water quality criterion. Shell questions why the Army did not consider the State surface water standard for DDE (.001 μg/l) as a potential ARAR. See South Platte Organics Standards.

Response to Shell Comments on DDE:

In this appendix, the Army has only designated potential ARARs for DDE. Whether these potential ARARs merit selection as ARARs will be determined in the context of the Feasibility Study/Endangerment Assessment Report for the Off-Post Operable Unit.

Shell's comments concern its disagreement with the use of AWQC for DDE as potential ARARs. Such use is warranted because these criteria are not inconsistent with CERCLA, the NCP and EPA guidance that is not inconsistent with CERCLA and the NCP.

The Army did not consider the South Platte Organics Standard for DDE to be a potential ARAR because the State standard is not more stringent than the designated potential Federal ARARs and because the Army is unable to determine from presently available information whether the standard was properly promulgated or could effectively result in the statewide prohibition of land disposal (where the standard is not of general applicability or adopted on the basis of hydrologic, geologic or other relevant considerations).

26. Shell Comments on DDT:

PROPOSED GROUNDWATER ARAR:

For the reasons set forth above, Shell disagrees that the AWQC of 0.0024 μg/l should be selected as an ARAR based on 40 CFR § 129.101(a)(3).

PROPOSED SURFACE WATER ARAR:

Shell tentatively accepts the Army proposal of the AWQC (Aquatic Life) standard (24 hr: 0.0010 μg/l and 1.1 μg/l at any one time) as a potential ARAR.

Response to Shell Comments on DDT:

In this appendix, the Army has only designated potential ARARs for DDT. Whether these potential ARARs merit selection as ARARs will be determined in the context of the Feasibility Study/Endangerment Assessment Report for the Off-Post Operable Unit.

While Shell disagrees with the use of AWQC for DDT as a potential ARAR, such use is warranted because such criteria are not inconsistent with CERCLA, the NCP or EPA guidance that is not inconsistent with CERCLA and the NCP.

Shell's comment expressing its tentative acceptance of the Army's initial determination with respect to surface water requires no further discussion in this context.

27. Shell Comments on 1,2-Dibromo-3-chloropropane:

BIOTA ARAR:

Shell disagrees with the use standards for food products under the Food and Drug Administration regulations because the standards are neither applicable nor relevant and appropriate to the remediation of RMA.

Response to Shell Comments on 1,2-Dibromo-3-chloropropane:

The use of FDA standards as an aid to determining cleanup levels is warranted because such limitations are not inconsistent with CERCLA, the NCP and EPA guidance not inconsistent with CERCLA and the NCP. Whether such standards have any practical utility in this context will be determined in the Feasibility Study/Endangerment Assessment Report for the Off-Post Operable Unit.

28. Shell Comments on p-Dichlorobenzene:

PROPOSED GROUNDWATER ARAR:

Shell disagrees with the use of MCLGs as the basis of potential ARARs for the reasons set forth above.

Shell disagrees with the Army proposal of 400 μg/1 as an ARAR. The AWQC is not adjusted for consumption of drinking water only, but includes consumption of aquatic organisms as well.

PROPOSED SURFACE WATER ARAR:

Shell disagrees with the use of MCLGs as the basis of potential ARARs for the reasons set forth above.

Shell disagrees with the Army proposal 763 μg/l as an ARAR. The Aquatic Life value published at 45 Fed. Reg. 79332 is merely guidance, and does not constitute an AWQC.

Response to Shell Comments on p-Dichlorobenzene:

In this appendix, the Army has only designated potential ARARs for p-Dichlorobenzene. Whether these potential ARARs merit selection as ARARs will be determined in the context of the Feasibility Study/Endangerment Assessment Report for the Off-Post Operable Unit.

The use of MCLGs or AWQC as potential ARARs is warranted because such criteria are not inconsistent with CERCLA, the NCP and EPA guidance not inconsistent with CERCLA and the NCP.

18. Shell Comments on 1,2-Dichloroethane:

PROPOSED GROUNDWATER ARAR:

Shell disagrees with the Army proposal of the MCL of 5 μg/l as an ARAR. This MCL is driven by CAG methodology, and therefore, for the reasons set forth above, is unacceptable to Shell.

PROPOSED SURFACE WATER ARAR:

Shell rejects the Army proposal of 0.5 μg/1 based on 40 CFR 141.61(a) for the reasons set forth above.

Response to Shell Comments on 1,2-Dichloroethane:

In this appendix, the Army has only designated potential ARARs for 1,2-Dichloroethane. Whether these potential ARARs merit selection as ARARs will be determined in the context of the Feasibility Study/Endangerment Assessment Report.

While the Army understands Shell's CAG-related concerns, as explained in the Army's response to Shell's general comments, reassessment of the merits of the CAG methodology is a national EPA issue that must be resolved by EPA in the first instance. If EPA determines to modify the CAG methodology during the course of the Off-Post RMA RI/FS, such modification(s) will be applied in each pertinent instance to the substances identified herein.

31. Shell Comments on 1,1-Dichloroethylene:

PROPOSED GROUNDWATER ARAR:

Shell disagrees with the Army proposal of the MCL of 7 μg/l as an ARAR. This MCL is driven by CAG methodology and is therefore, for the reasons set forth above, unacceptable to Shell. Shell disagrees with the use of values based on MCLGs and AWQC as potential ARARs.

PROPOSED SURFACE WATER ARAR:

Shell disagrees with the Army proposal of 11,600 μg/l as an ARAR. The aquatic life value published at 45 Fed. Reg. 79332 is merely guidance, and does not constitute an AWQC. Shell disagrees with the use of values based on MCLGs as potential surface water ARARs for the reasons set forth above.

Response to Shell Comments on 1,1-Dichloroethylene:

In this appendix, the Army has only designated potential ARARs for 1,1-Dichloroethylene. Whether these potential ARARs merit selection as ARARs will be determined in the context of the Feasibility Study/Endangerment Assessment Report for the Off-Post Operable Unit.

While the Army understands Shell's CAG-related concerns, as explained in the Army's response to Shell's general comments, reassessment of the merits of the CAG methodology is a national EPA issue that must be resolved by EPA in the first instance. If EPA determines to modify the CAG methodology during the course of the Off-Post RMA RI/FS, such modification(s) will be applied in each pertinent instance to the substances identified herein.

The use of the AWQC aquatic life value as a potential ARAR is warranted because such a criterion is not inconsistent with CERCLA, the NCP and EPA guidance not inconsistent with CERCLA and the NCP.

32. Shell Comments on 1,2-Dichloroethylene:

PROPOSED GROUNDWATER ARAR:

Shell disagrees with the Army proposal of 7 μg/1 as a potential ARAR based upon the MCL. Shell disagrees with the Army proposal of the AWQC of 0.3 μg/l based upon AWQC. The basis for this rejection is that this value is based upon CAG methodology, and the value is therefore unacceptable for the reasons set forth above.

PROPOSED SURFACE WATER ARAR:

For the reasons stated above in the discussion of AWQC, Shell disagrees with the Army proposal of 7 μg/l based on 52 Fed. Reg. 25716 (1987) as a potential ARAR.

For the reasons stated above in the discussion of CAG, Shell also disagrees with the Army proposal as 17 mg/l and 0.33 μg/l at (10^{-5}) risk level as potential ARARs.

Shell disagrees with the Army proposal of 11,600 μg/1 as an ARAR. The aquatic life value published at 45 Fed. Reg. 79332 is merely guidance, and does not constitute an AWQC.

Response to Shell Comments on 1,2-Dichloroethylene:

In this appendix, the Army has only designated potential ARARs for 1,2-Dichloroethylene. Whether these potential ARARs merit selection as ARARs will be determined in the context of the Feasibility Study/Endangerment Assessment Report for the Off-Post Operable Unit.

As discussed above, Shell's concerns with the CAG methodology do not properly arise in this context.

The use of AWQC as potential ARARs is warranted because such criteria are not inconsistent with CERCLA, the NCP and EPA guidance not inconsistent with CERCLA and the NCP.

34. Shell Comments on Dieldrin:

PROPOSED GROUNDWATER ARAR:

Shell disagrees with the Army proposal of 0.12 μg/l based on 40 CFR § 129.100(a)(3) as an ARAR for reasons set forth above in the comments on aldrin. Shell also disagrees with the Army proposal of the AWQC of 0.17 ng/l at (10^{-5}) risk level as a potential ARAR for reasons set forth above in the discussion of CAG.

PROPOSED SURFACE WATER ARAR:

Shell tentatively accepts the Army proposals of 0.0019 μg/l for a 24-hour average and 2.5 μg/l at any one time based on AWQC (Aquatic Life) standard as a potential ARAR.

Shell disagrees with the Army proposal of 0.71 μg/1 at 10^{-5} risk level based on AWQC for the consumption of drinking water and aquatic life for the reasons set forth above. See discussion of EPA CAG methodology.

Response to Shell Comments on Dieldrin:

In this appendix, the Army has only designated potential ARARs for Dieldrin. Whether these potential ARARs merit selection as ARARs will be determined in the context of the Feasibility Study/Endangerment Assessment Report for the Off-Post Operable Unit.

The Army disagrees with Shell's comments on the use of 40 C.F.R. § 129.100(a)(3) as a potential ARAR for the same reasons set forth above in the response to Shell's comments on aldrin.

As discussed above, Shell's concerns about the CAG methodology do not properly arise in this context.

Shell's comment expressing its tentative acceptance of the Army's initial determination with respect to surface water requires no further discussion in this context.

37. Shell Comments on Endrin:

Proposed Groundwater ARAR:

Shell agrees with the Army proposal of 0.2 μg/l as an ARAR based on 40 CFR § 141.12.

Shell disagrees with the Army proposal of 0.2 μg/1 as an ARAR based on 40 CFR § 264.94(a)(2) for the reasons set forth in the discussion of RCRA permit conditions.

Shell disagrees with the Army proposal of 1 μg/l based on AWQC for reasons set forth above for the reasons set forth in the discussion of AWQC.

Proposed Surface Water ARAR:

Shell tentatively accepts the Army proposal of the AWQC (Aquatic Life) standard (24 hr: .0023 μg/l; max: .037 μg/l) as a potential ARAR. Shell agrees with the Army in not including the State surface water standard for endrin (.004 μg/l) as a potential ARAR because it is not more stringent than the AWQC. See discussion of Ambient Water Quality Criteria.

Biota ARAR:

Shell rejects the Army proposal of zero tolerance for residues of endrin in agricultural products for the reasons set forth in the discussion of EPA and FDA action level tolerances.

Response to Shell Comments on Endrin:

In this appendix, the Army has only designated potential ARARs for Endrin. Whether these potential ARARs merit selection as ARARs will be determined in the context of the Feasibility Study/Endangerment Assessment Report for the Off-Post Operable Unit.

While the Army understands Shell's CAG-related concerns, as explained in the Army's response to Shell's general comments, reassessment of the merits of the CAG methodology is a national EPA issue that must be resolved by EPA in the first instance. If EPA determines to modify the CAG methodology during the course of the Off-Post RMA RI/FS, such modification(s) will be applied in each pertinent instance to the substances identified herein.

Shell's disagreements with the use of RCRA regulations and AWQC as potential ARARs are addressed respectively in the responses to Shell's general comments on RCRA permit conditions and AWQC.

Shell's comments expressing its tentative acceptance of the Army's initial determination of C.F.R. § 141.12 and the aquatic life standard as potential ARARs require no further discussion in this context.

38. Shell Comments on Ethylbenzene:

Proposed Groundwater ARAR:

Shell disagrees with the Army proposal of 1,400 μg/l as an ARAR. This value has been derived from non-referenced sources for the protection of human health. The references do not advise the reader on the toxicological endpoints considered or the assumptions incorporated in performing the calculations for values protective of human health. Furthermore, considerations which are protective of biota in surface.

Proposed Surface Water ARAR:

Shell disagrees with the Army proposals of 1,400 μg/l 32,000 μg/l based on AWQC as an ARAR for reasons set forth above.

Response to Shell Comments on Ethylbenzene:

In this appendix, the Army has only designated potential ARARs for Ethylbenzene. Whether these potential ARARs merit selection as ARARs will be determined in the context of the Feasibility Study/Endangerment Assessment Report for the Off-Post Operable Unit.

While the Army understands Shell's CAG-related concerns, as explained in the Army's response to Shell's general comments, reassessment of the merits of the CAG

methodology is a national EPA issue that must be resolved by EPA in the first instance. If EPA determines to modify the CAG methodology during the course of the Off-Post RMA RI/FS, such modification(s) will be applied in each pertinent instance to the substances identified herein.

39. Shell Comments on Fluoride:

PROPOSED GROUNDWATER ARAR:

Shell tentatively agrees with the Army proposal of the MCL of 4,000 μg/l as an ARAR.

Shell rejects the Army proposal of 4,000 μg/l based on 40 CFR 141.50(b) as a potential ARAR for the reasons set forth above in the discussion of MCLGS.

PROPOSED SURFACE WATER ARAR:

Shell rejects the Army proposal of 4,000 μg/l based on 40 CFR § 141.50(b) as a potential ARAR for the reasons set forth above in the discussion of AWQC.

Response to Shell Comments on Fluoride:

In this appendix, the Army has only designated potential ARARs for Fluoride. Whether these potential ARARs merit selection as ARARs will be determined in the context of the Feasibility Study/Endangerment Assessment Report for the Off-Post Operable Unit.

Shell's comments expressing its tentative agreement with the Army's initial determination for Fluoride requires no further discussion in this context.

41. Shell Comments on Lead:

AIR ARAR:

Shell questions why the Army did not consider the State regulations for the control of Hazardous Air Pollutants regarding lead as a potential ARAR. See 5 Colo. Code Reg. 1001-10 p. 52.

PROPOSED GROUNDWATER ARAR:

Shell tentatively supports the MCL of 50 μg/l as a potential ARAR for the reasons outlined in the arsenic comment.

Shell disagrees with the Army proposal of 50 μg/l as an ARAR based upon 40 CFR § 264.94(a)(2) as an ARAR for the reasons set forth above in the RCRA discussion. Shell also disagrees with the Army proposal of the AWQC of 50 μg/l as an

ARAR. The Aquatic Life Value published at 45 Fed. Reg. 79336 is merely guidance, and does not constitute an AWQC. Furthermore, this guidance is more stringent than the MCL.

PROPOSED SURFACE WATER ARAR:

Shell tentatively accepts the Army proposal of the AWQC (Aquatic Life) standard (24 hr: e(2.35 [In (hardness)] -9.48]; max: e(1.22 [In hardness)] -0.47) as an ARAR.

Shell disagrees with the Army proposal of 50 μg/l based on 40 CFR 264.94(a)(2) as an ARAR for the reasons set forth above in the RCRA discussion.

Response to Shell Comments on Lead:

In this appendix, the Army has only designated potential ARARs for Lead. Whether these potential ARARs merit selection as ARARs will be determined in the context of the Feasibility Study/Endangerment Assessment Report for the Off-Post Operable Unit.

The Army did not consider the lead standard in the CDH regulations for the Control of Hazardous Air Pollutants because this standard is not more stringent than the potential Federal ARARs.

The Army disagrees with Shell's position on the designation of RCRA requirements as potential ARARs for the reasons set forth above in response to Shell's general comment on RCRA permit conditions.

The use of the AWQC as potential ARARs is warranted because such criteria are not inconsistent with CERCLA, the NCP and EPA guidance not inconsistent with CERCLA and the NCP.

Shell's comments expressing its tentative acceptance of the Army's initial groundwater and surface water determinations requires no further discussion in this context.

Shell Comments on (44) Mercuric chloride and (45) Mercury:

AIR ARAR:

Shell disagrees with the Army proposal of emissions values based on 40 CFR 61.52 and (b) as ARARs for the reasons set forth above in the discussion of NESHAPs.

PROPOSED GROUNDWATER ARAR:

Shell agrees with the Army proposal of the MCL of 2 μg/l as an ARAR for the reasons outlined in the arsenic comments.

Shell disagrees with the Army proposal of 144 ng/l based on 45 Fed. Reg. 79336-79337 as an ARAR for the reasons set forth in the discussion of AWQC.

PROPOSED SURFACE WATER ARAR:

Shell tentatively accepts the Army proposal of the AWQC (Aquatic Life) standard (24 hr: .00057 μg/1; max .0017 μg/1) as an ARAR.

Shell disagrees with the Army proposal of 144 ng/l based on 45 Fed. Reg. 79336-79337 as an ARAR for the reasons set forth above in the AWQC discussion.

Shell disagrees with the Army proposal of 2 μg/l based on 40 CFR § 264.94(a)(2) as an ARAR for the reasons set forth above in the RCRA discussion.

Response to Shell Comments on (44) Mercuric chloride and (45) Mercury:

In this appendix, the Army has only designated potential ARARs for Mercuric chloride and Mercury. Whether these potential ARARs merit selection as ARARs will be determined in the context of the Feasibility Study/Endangerment Assessment Report for the Off-Post Operable Unit.

The Army declines to adopt Shell's opposition to the use of emissions values as potential ARARs for the reasons set forth above in response to Shell's general comments on NESHAPs.

The Army declines to adopt Shell's opposition to the use of 144 ng/l (45 Fed. Reg. 79336-79337) as a potential ARAR for the reasons set forth above in response to Shell's general comments on AWQC.

The Army declines to adopt Shell's opposition to the use of 2 μg/l (40 C.F.R. § 264.94(a)(2)) as a potential ARAR for the reasons set forth above in response to Shell's general comments on RCRA permit conditions.

The balance of Shell's comments concern its agreement or tentative acceptance of the Army's designation of potential ARARs and thus requires no further discussion in this context.

46. Shell Comments on Nitrate:

PROPOSED GROUNDWATER ARAR:

Shell tentatively agrees that the MCL (10,000 μg/l) for this chemical based on 40 C.F.R. § 141.11(b) should be treated as an ARAR.

SURFACE WATER ARAR:

Shell agrees with the Army in not selecting the State surface water standard for nitrates (10,000 ng/1) as a potential ARAR because it is the same as the corresponding Federal AWQC (1976) and therefore is not more stringent. See discussion of Ambient Water Quality Criteria.

Response to Shell Comments on Nitrate:

In this appendix, the Army has only designated potential ARARs for Nitrate. Whether these potential ARARs merit selection as ARARs will be determined in the context of the Feasibility Study/Endangerment Assessment Report for the Off-Post Operable Unit.

Shell's comments expressing tentative agreement and agreement with the Army's initial groundwater and surface water determinations requires no further discussion in this context.

61. Shell Comments on p, p-TDE:

PROPOSED SURFACE WATER ARAR:

Shell disagrees with the Army proposal of 0.6 μg/l, based on 45 Fed. Reg. 79331, as an ARAR for the reasons set forth above in the discussion of AWQC.

Response to Shell Comments on p, p-TDE:

In this appendix, the Army has only designated potential ARARs for p, p-TDE. Whether these potential ARARs merit selection as ARARs will be determined in the context of the Feasibility Study/Endangerment Assessment Report for the Off-Post Operable Unit.

The Army declines to adopt Shell's opposition to the use of 0.6 μg/l (45 Fed. Reg. 79331) as a potential ARAR for the reasons set forth above in response to Shell's general comments on AWQC.

62. Shell Comments on Tetrachlorobenzene:

PROPOSED GROUNDWATER ARAR:

Shell disagrees with the Army proposal of 38 μg/l based on 45 Fed. Reg. 79327 as an ARAR for the reasons set forth above in the discussion of AWQC.

PROPOSED SURFACE WATER ARAR:

Shell disagrees with the Army proposals of 38 μg/1 and 250 μg/l based on 45 Fed. Reg. 79327 as ARARs for the reasons set forth above.

Response to Shell Comments on Tetrachlorobenzene:

In this appendix, the Army has only designated potential ARARs for Tetrachlorobenzene. Whether these potential ARARs merit selection as ARARs will be determined in the context of the Feasibility Study/Endangerment Assessment Report for the Off-Post Operable Unit.

The Army declines to adopt Shell's opposition to the use of 38 μg/l or 250μg/l (45 Fed. Reg. 79327) as potential ARARs for the reasons set forth in response to Shell's general comments on AWQC.

64. 1,1,2,2-Tetrachloroethylene:

PROPOSED GROUNDWATER ARAR:

Shell disagrees with the Army proposal of 8 μg/1 (10^{-5}) based on 45 Fed. Reg. 79341 as an ARAR for the reasons set forth above.

PROPOSED SURFACE WATER ARAR:

Shell disagrees with the Army proposals of 8 μg/1 (10^{-5}) based on 45 Fed. Reg. 79341 as an ARAR for the reasons set forth above.

Response to Shell Comments on 1,1,2,2-Tetrachloroethylene:

In this appendix, the Army has only designated potential ARARs for 1,1,2,2-Tetrachloroethylene. Whether these potential ARARs merit selection as ARARs will be determined in the context of the Feasibility Study/Endangerment Assessment Report for the Off-Post Operable Unit.

The Army declines to adopt Shell's opposition to the use of 8 μg/l (45 Fed. Reg. 79341) as potential ARARs for the reasons set forth above in response to Shell's general comments on AWQC.

65. Shell Comments on Toluene:

PROPOSED GROUNDWATER ARAR:

Shell disagrees with the Army proposal of 14,300 μg/l based on 45 Fed. Reg. 79340 (1980) as an ARAR for the reasons set forth above in the discussion of AWQCs.

PROPOSED SURFACE WATER ARAR:

Shell disagrees with the Army proposals of 14,300 μg/l and 17,500 μg/l as ARARs based on 45 Fed. Reg. 79340 (1980) for the reasons set forth above in the discussion of AWQC.

Response to Shell Comments on Toluene:

In this appendix, the Army has only designated potential ARARs for Toluene. Whether these potential ARARs merit selection as ARARs will be determined in the context of the Feasibility Study/Endangerment Assessment Report for the Off-Post Operable Unit.

The Army declines to adopt Shell's opposition to the use of 14,300 and 17,500 μg/l (45 Fed. Reg. 79340) as potential ARARs for the reasons set forth above in response to Shell's general comments on AWQC.

66. Shell Comments on 1,1,1-Trichloroethane:

PROPOSED GROUNDWATER ARAR:

Shell disagrees with the Army proposal of 200 μg/l based on 40 CFR § 141.50 as an ARAR for the reasons set forth above in the discussion of MCLGs.

PROPOSED SURFACE WATER ARAR:

Shell disagrees that the MCL for this chemical should be selected as an ARAR because it is driven by CAG methodology.

Response to Shell Comments on 1,1,1-Trichloroethane:

In this appendix, the Army has only designated potential ARARs for 1,1,1-Trichloroethane. Whether these potential ARARs merit selection as ARARs will be determined in the context of the Feasibility Study/Endangerment Assessment Report for the Off-Post Operable Unit.

The Army declines to adopt Shell's opposition to 200 μg/l (40 C.F.R. § 141.50) as a potential ARAR for the reasons set forth above in response to Shell's general comments on MCLGs.

While the Army understands Shell's CAG-related concerns, as explained in the Army's response to Shell's general comments, reassessment of the merits of the CAG methodology is a national EPA issue that must be resolved by EPA in the first instance. If EPA determines to modify the CAG methodology during the course of the Off-Post RMA RI/FS, such modification(s) will be applied in each pertinent instance to the substances identified herein.

67. Shell Comments on Trichloroethylene:

PROPOSED GROUNDWATER ARAR:

Shell disagrees with the Army proposal of 5 μg/l based on 40 CFR § 141.61(a) as an ARAR for the reasons set forth above in the discussions of CAG methodology and proposed standards.

Shell disagrees with the Army proposal of 27 μg/l (10^{-5}) based on 45 Fed. Reg. 79341 as an ARAR for the reasons set forth above in the discussion of CAG.

PROPOSED SURFACE WATER ARAR:

Shell disagrees with the Army proposals or 45,000 μg/l and 27 μg/l (10^{-5}) based on 45 Fed. Reg. 79341 as ARARs for the reasons set forth above in the discussion of CAG.

Response to Shell Comments on Trichloroethylene:

In this appendix, the Army has only designated potential ARARs for Trichloroethylene. Whether these potential ARARs merit selection as ARARs will be determined in the context of the Feasibility Study/Endangerment Assessment Report for the Off-Post Operable Unit.

While the Army understands Shell's CAG-related concerns, as explained in the Army's response to Shell's general comments, reassessment of the merits of the CAG methodology is a national EPA issue that must be resolved by EPA in the first instance. If EPA determines to modify the CAG methodology during the course of the Off-Post RMA RI/FS, such modification(s) will be applied in each pertinent instance to the substances identified herein.

68. Shell Comments on Xylene

PROPOSED GROUNDWATER ARAR:

Shell disagrees with the Army proposal of a narrative standard based 40 CFR § 180.1025(c) as a potential ARAR for the reasons set forth above in the discussion of TPCRAC.

PROPOSED SURFACE WATER ARAR:

Shell disagrees with Army proposal of a narrative standard based on 40 CFR § 180.1025(c) as a potential ARAR for the reasons set forth above in the discussion of TPCRAC.

Response to Shell Comments on Xylene:

In this appendix, the Army has only designated potential ARARs for Xylene. Whether these potential ARARs merit selection as ARARs will be determined in the context of the Feasibility Study/Endangerment Assessment Report for the Off-Post Operable Unit.

The Army declines to adopt Shell's position because the designation of 40 C.F.R. § 180.1025(c) as a potential ARAR is not inconsistent with CERCLA, the NCP and EPA guidance not inconsistent with CERCLA and the NCP.

Shell Comments on (69) Zinc and (70) Zinc Oxide:

PROPOSED SURFACE WATER ARAR:

Shell tentatively agrees with the Army proposal of the AWQC (Aquatic Life) standard (24 hr: 47 μg/l; max: e(0.83 [In hardness)] -1.90) as a potential ARAR.

Response to Shell Comments on (69) Zinc and (70) Zinc Oxide:

In this appendix, the Army has only designated potential ARARs for Zinc and Zinc Oxide. Whether these potential ARARs merit selection as ARARs will be determined in the context of the Feasibility Study/Endangerment Assessment Report for the Off-Post Operable Unit.

Shell's comments expressing tentative agreement with the Army's initial determination of potential ARARs for Zinc and Zinc Oxide in surface water requires no further discussion in this context.

C. Shell Miscellaneous Comments on Appendix H

Shell Miscellaneous Comment No. 1:

Appendix H, page iii, second paragraph - Change "criterium" in the fourth line to "criterion."

Response to Shell's Miscellaneous Comment No. 1:

The requested change has been made.

Shell Miscellaneous Comment No. 2:

Appendix H, page iv, second paragraph - Is the reference to "this volume" in the second sentence an error?

Response to Shell's Miscellaneous Comment No. 2:

The reference has been changed to "this appendix" for greater clarity.

Shell Miscellaneous Comment No. 3:

Appendix H, page iv, fourth paragraph - The last line should be corrected to refer to Section 121(d) of CERCLA, 42 U.S.C. § 9621(d), since the selection process may include waiver under Section 121(d)(4). See, for example, the last sentence in paragraph 16.59 of the RI/FS Process Document.

Response to Shell's Miscellaneous Comment No. 3:

The requested change has been made for greater clarity.

Shell Miscellaneous Comment No. 4:

Appendix H, page viii - the first word should be "levels," not "limits."

Response to Shell's Miscellaneous Comment No. 4:

The requested change has been made.

Shell Miscellaneous Comment No. 5:

Appendix H, page iii, second paragraph - Change "CDH" in the fifth line to "the State," since it is the State that is to identify State ARARs under Section 121(d)(2)(A)(ii) of CERCLA.

Response to Shell's Miscellaneous Comment No. 5:

The requested change has been made.

Shell Miscellaneous Comment No. 6:

Appendix H, page ix, second paragraph - Change "work" in the first line to "worker."

Response to Shell's Miscellaneous Comment No. 6:

The requested change has been made.

Shell Miscellaneous Comment No. 7:

Shell supports the Army's decision to address worker protection standards separately from the ARAR selection process. As we have commented in the past, Shell supports the application of worker protection standards, but believes that those standards should not be confused with ARARs.

Response to Shell's Miscellaneous Comment No. 7:

Shell's agreement with the Army on this matter requires no further discussion in this context.

COLORADO ARAR COMMENTS

Colorado Comment No. 26:

Appendix H, page vi. The text should include 5 CCR 1001-2 through 5 CCR 1001-10 as potential air ARARs.

Response to Colorado Comment No. 26:

The Army is unable to determine from presently available information whether any of these standards were properly promulgated and generally applicable and thus none of the referenced regulations have been identified at this time as potential State ARARs. In order for the Army to determine whether the referenced standards qualify as potential ARARs, the State is requested to provide to counsel for the Army:

(a) Specific citations to the generally referenced State air standards;

(b) Proof of promulgation of the referenced State air standards (including opportunity for notice and comment by the public) with a brief description of the promulgation process followed by the State;

(c) Copies of pertinent rulemakings or preambles to the regulations;

(d) Copies of all relevant Colorado Attorney General Opinions interpreting these regulations and any relevant Colorado Department of Health guidance documents;

(e) Copies of any relevant judicial or administrative determinations;

(f) A description of all relevant circumstances for each instance where the State has similarly construed or applied these air regulations for sites in Colorado; and

(g) Any other documents that the State believes support its position that the referenced State air regulations qualify as State ARARs for the CERCLA cleanup of the Off-Post RMA Operable Unit because these regulations constitute promulgated, generally applicable State standards, requirements, criteria or limitations under a State environmental or facility siting law that is more stringent than any federal standards, requirements, criteria or limitations.

Colorado Comment No. 27:

Appendix H. page vi. The text should include the following potential groundwater ARARs:

- Colorado Basic Standards for Groundwater, 5 CCR 1002-8, Section 3.11.0 et seq. (in particular Tables 1, 2, and 3).

- Colorado Basic Standards and Methodologies, 5 CCR 1002-8, Section 3.1.0 et seq. (in particular Section 3.1.11).

Response to Colorado Comment No. 27:

The Army is unable to determine from presently available information whether any of these standards were properly promulgated or could effectively result in the statewide prohibition of land disposal of hazardous substances, pollutants or contaminants (where the State standards are not of general applicability or adopted by formal means, or where the State standards were not adopted on the basis of hydrologic, geologic or other relevant considerations). In order for the Army to determine whether the referenced standards qualify as potential State ARARs, the State is requested to provide to counsel for the Army:

(a) Specific citations to the generally referenced groundwater standards;

(b) Proof of promulgation of the referenced State groundwater standards (including opportunity for notice and comment by the public) with a brief description of the promulgation process followed by the State;

(c) Copies of pertinent rulemakings or preambles to the regulations;

(d) Copies of all relevant Colorado Attorney General Opinions interpreting these regulations and any relevant Colorado Department of Health guidance documents;

(e) Copies of any relevant judicial or administrative determinations;

(f) A description of all relevant circumstances for each instance where the State has similarly construed or applied these groundwater regulations for sites in Colorado; and

(g) Any other documents that the State believes support its position that the referenced State groundwater regulations qualify as State ARARs for the CERCLA cleanup of the Off-Post RMA Operable Unit because the regulations constitute promulgated, generally applicable State standards, requirements, criteria or limitations under a State environmental or facility siting law that is more stringent than any federal standards, requirements, criteria or limitations.

Colorado Comment No. 28:

Appendix H, page viii. Contrary to the statement in the text, the State has identified promulgated chemical-specific ARARs for RMA on several occasions. In particular, the State identified ARARs on January 6, 1987, March 7, 1987, and most recently on July 18, 1988. The Army has consistently ignored all promulgated State statutes and regulations. This practice is inconsistent with U.S. EPA actions at Colorado CERCLA sites and is not consistent with Section 121(d) of CERCLA. To the extent the State promulgated standards are more stringent than the federal standards, the State standards must be met. Attachment I contains State identified chemical-specific standards (ARARs).

Response to Colorado Comment No. 28:

Although the State has identified on each of the referenced occasions standards that it characterizes as State ARARs, the State has failed, to date, to meet its burden under 42 U.S.C. § 9621(d)(2)(A)(ii) and (C) to show that these standards warrant treatment as potential State ARARs. The Army is unable to determine from presently available information whether these standards were properly promulgated or could effectively result in the statewide prohibition of land disposal (where the standard is not of general applicability or adopted on the basis of hydrologic, geologic or other relevant considerations).

Until such time as the State provides to counsel for the Army sufficient information to establish that the State standards merit consideration as potential ARARs, the Army will not treat them as such.

COLORADO ATTACHMENT 1

STATE IDENTIFICATION OF ADDITIONAL CHEMICAL-SPECIFIC ARARs FOR OFF-POST OPERABLE UNIT AT RMA

REFERENCE

(1) Colorado Basic Standards for Groundwater, 5 CCR 1002-8, Section 3.11.0--3.11.9 (in particular Tables 1, 2, and 3).

(2) Colorado Basic Standards and Methodologies, 5 CCR 1002-8, Section 3.1.0--3.1.20 (in particular Section 3.1.11).

(3) Federal Safe Drinking Water Act (in particular Maximum Contaminant Level Goals--MCLGs).

(4) Federal Safe Drinking Water Act (in particular Maximum contaminant Levels--MCLs).

(5) Federal Clean Water Act (in particular Water Quality Criteria for Protection of Human Health).

Chemical	Abbreviation	Water Quality Standard (Reference) all values in µg/l
Aldrin	ALDRN	0(2) 0.000074(5)
Arsenic	AS	50(1) 50(4)
Benzene	C6H6	0(3) 5(4)
Carbon tetrachloride	CCL4	0(3) 5(4)
Chloride	CL	250,000(1)
Chlorobenzene	CLC6H5	0(2)
Chloroform	CHCL3	.19(5)
Chlorophenylmethyl sulfide	CPMS	0(2)
Chlorophenylmethyl sulfone	CPMSO2	0(2)
Chlorophenylmethyl sulfoxide	CPMSO	0(2)

Chemical	Abbreviation	Water Quality Standard (Reference) all values in µg/l
Chromium	CR	50(1) 1.2(3)* 50(4)
Copper	CU	200(1) 1300(3)*
Dibromochloropropane	DBCP	0(2) 0(3)
Dichlorobenzenes	CL2BZ	75(3) 74(4)
Dichlorodiphenylethane	PPDDE	0(2)
Dichlorodiphenyltrichloroethane	PPDDT	0(2)
1,1-Dichloroethane	11DCLE	0(2)
1,2-Dichloroethane	12DCLE	0(3) 5(4)
1,2-Dichloroethylene	12DCE	0(2)
2,4-Dichlorophenoxyacetic acid	24D	7(3) 100(4)
Dicyclopentadiene	DCPD	0(2)
Dieldrin	DLDRN	0(2) 0.000071(5)
Diisopropylmethyl phosphonate	DIMP	0(2)
Dimethylmethylphosphate	DMMP	0(2)
Dithiane	DITH	0(2)
Endrin	ENDRN	0.2(1) 0.2(4)
Ethylbenzene	ETC6H5	0(2) 680(3)*
Fluoride	F	4000(1) 4000(4)
Iron	FE	300(1)
Isodrin	ISODR	0(2)
Lead	PB	50(1) 20(3)* 50(4)
Mercury	HG	2(1) 2(4)
Methylene chloride	CH2CL2	0(2)
Nitrite	NIT	1000(1)
Nitrate		10,000(1) 10,000(4)
Oxathiane	OXAT	0(2)
pH	PH	6.5--8.5(1)
Sulfate	SO4	250,000(1)

Chemical	Abbreviation	Water Quality Standard (Reference) all values in µg/l
Tetrachloroethylene	TCLEE	0(2) 0(3)*
Toluene	MEC6H5	0(2) 2000(3)*
Trichloroethylene	TRCLE	0(3) 5(4)
All Unknowns	UNK---	0(2)
All Other Organic Compounds		0(2)
Xylenes	XYLEN	0(2)
Zinc	ZN	500(1)

* Proposed Maximum Contaminant Level Goals

Response to Colorado Attachment 1:

The State should be aware that the information provided in Colorado Attachment I is not helpful in aiding the Army to determine the existence of any potential State ARARs.

The Army is unable to determine from presently available information whether any of these State standards were properly promulgated or could effectively result in the statewide prohibition of land disposal of hazardous substances, pollutants or contaminants (where the State standards are not of general applicability or adopted by formal means, or where the State standards were not adopted on the basis of hydrologic, geologic or other relevant considerations). In order for the Army to determine whether the referenced standards qualify as potential State ARARs, the State is requested to provide to counsel for the Army:

(a) Specific citations to the generally referenced groundwater standards;

(b) Proof of promulgation of the referenced State groundwater standards (including opportunity for notice and comment by the public) with a brief description of the promulgation process followed by the State;

(c) Copies of pertinent rulemakings or preambles to the regulations;

(d) Copies of all relevant Colorado Attorney General Opinions interpreting these regulations and any relevant Colorado Department of Health guidance documents;

(e) Copies of any relevant judicial or administrative determinations;

(f) A description of all relevant circumstances for each instance where the State has similarly construed or applied these groundwater regulations for sites in Colorado; and

(g) Any other documents that the State believes support its position that the referenced State groundwater regulations qualify as State ARARs for the CERCLA cleanup of the Off-Post RMA Operable Unit because the regulations constitute promulgated, generally applicable State standards, requirements, criteria or limitations under a State environmental or facility siting law that is more stringent than any federal standards, requirements, criteria or limitations.

APPENDIX I
ANALYTICAL RESULTS OF OFFPOST CONTAMINATION ASSESSMENT REPORTS, DISTRIBUTION MAPS

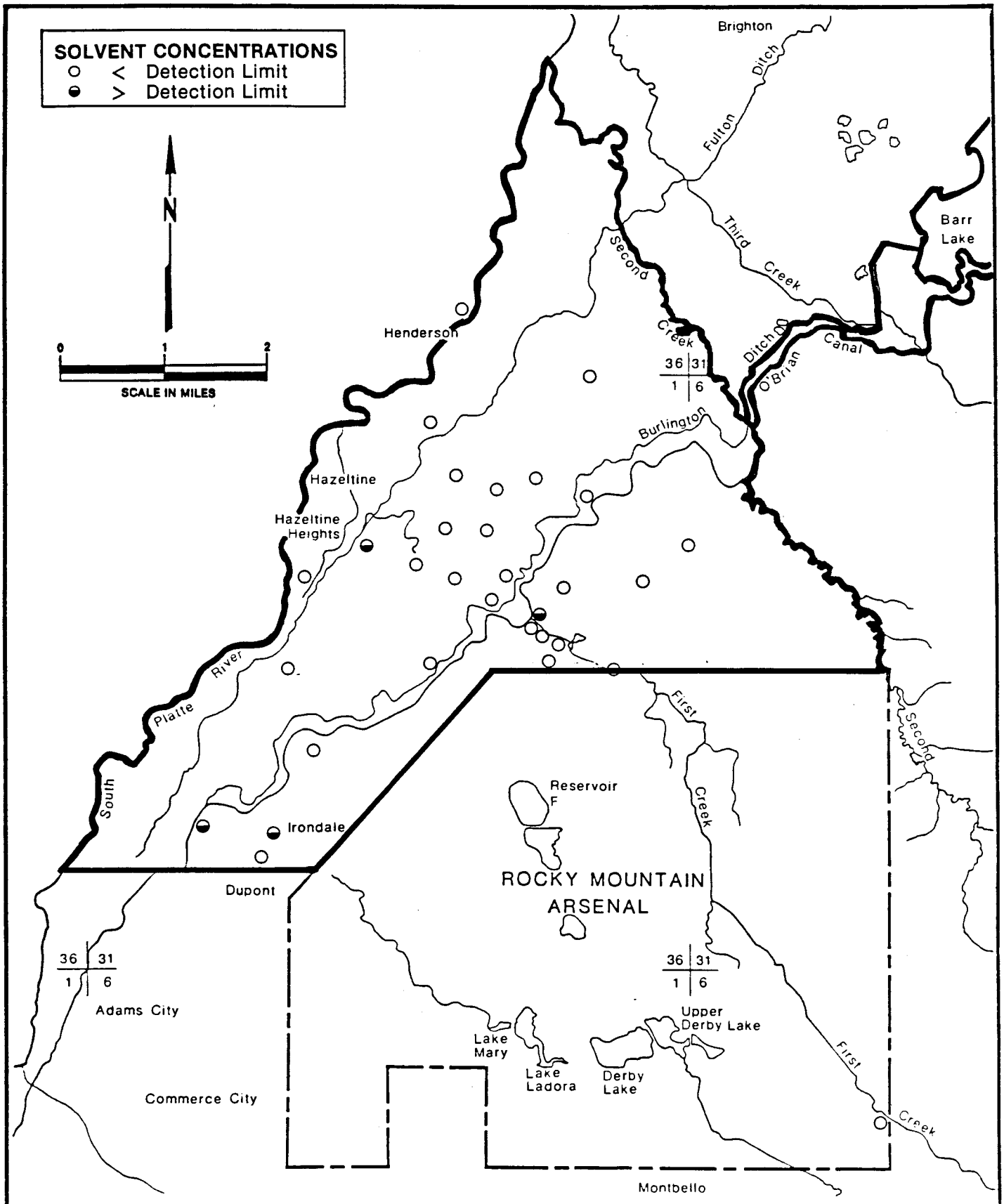


Figure I-1
AROMATIC AND HALOGENATED ALIPHATIC SOLVENT ASSESSMENT RMA OFFPOST FIRST QUARTER SAMPLING OF WELLS
SOURCE: ESE, 1987

Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

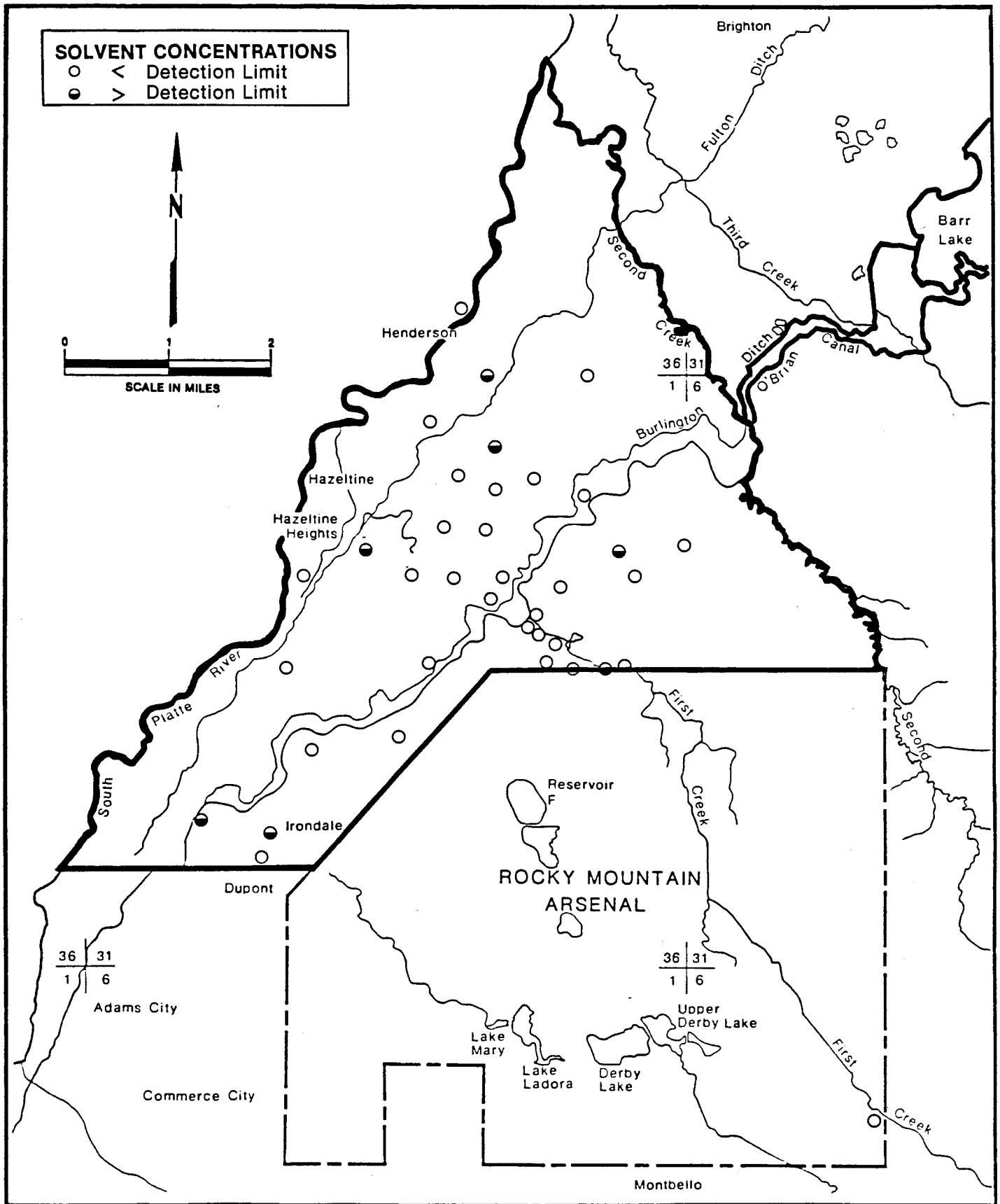


Figure I-2
AROMATIC AND HALOGENATED ALIPHATIC SOLVENT ASSESSMENT RMA OFFPOST SECOND QUARTER SAMPLING OF WELLS
SOURCE: ESE, 1987

Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

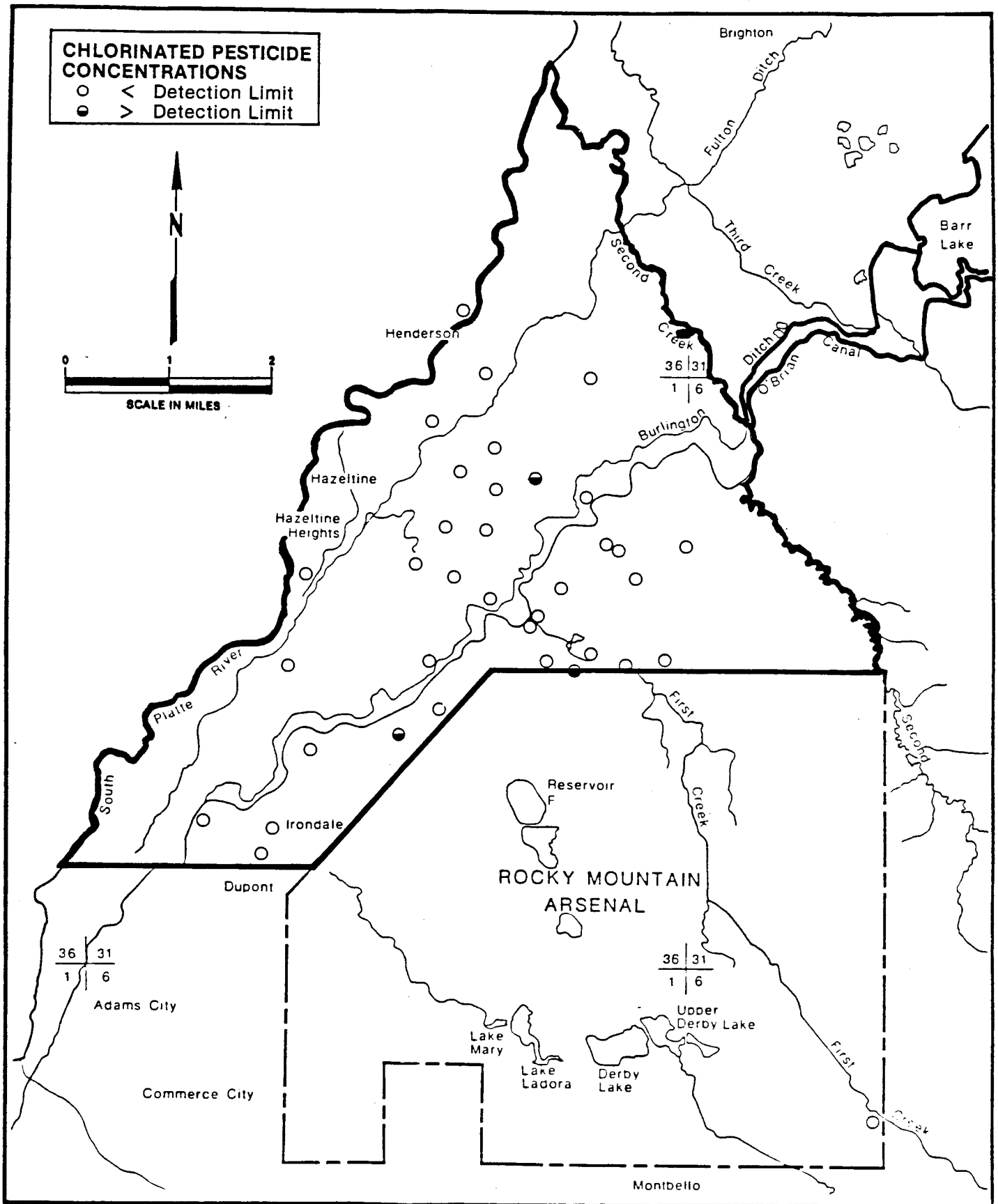


Figure I-3
CHLORINATED PESTICIDE ASSESSMENT
RMA OFFPOST FIRST QUARTER SAMPLING OF WELLS
SOURCE: ESE, 1987

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

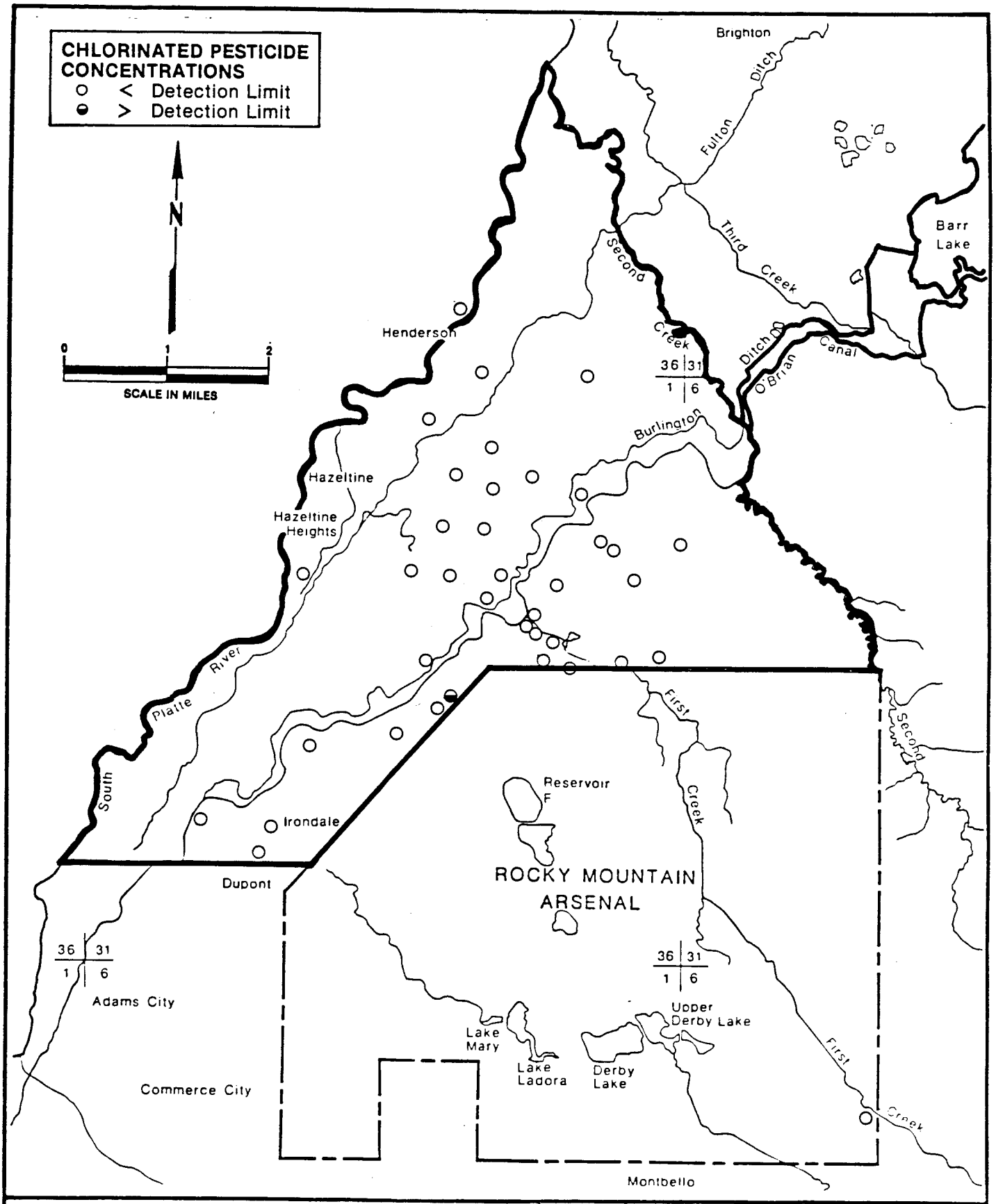


Figure I-4
CHLORINATED PESTICIDE ASSESSMENT
RMA OFFPOST SECOND QUARTER
SAMPLING OF WELLS
SOURCE: ESE, 1987

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

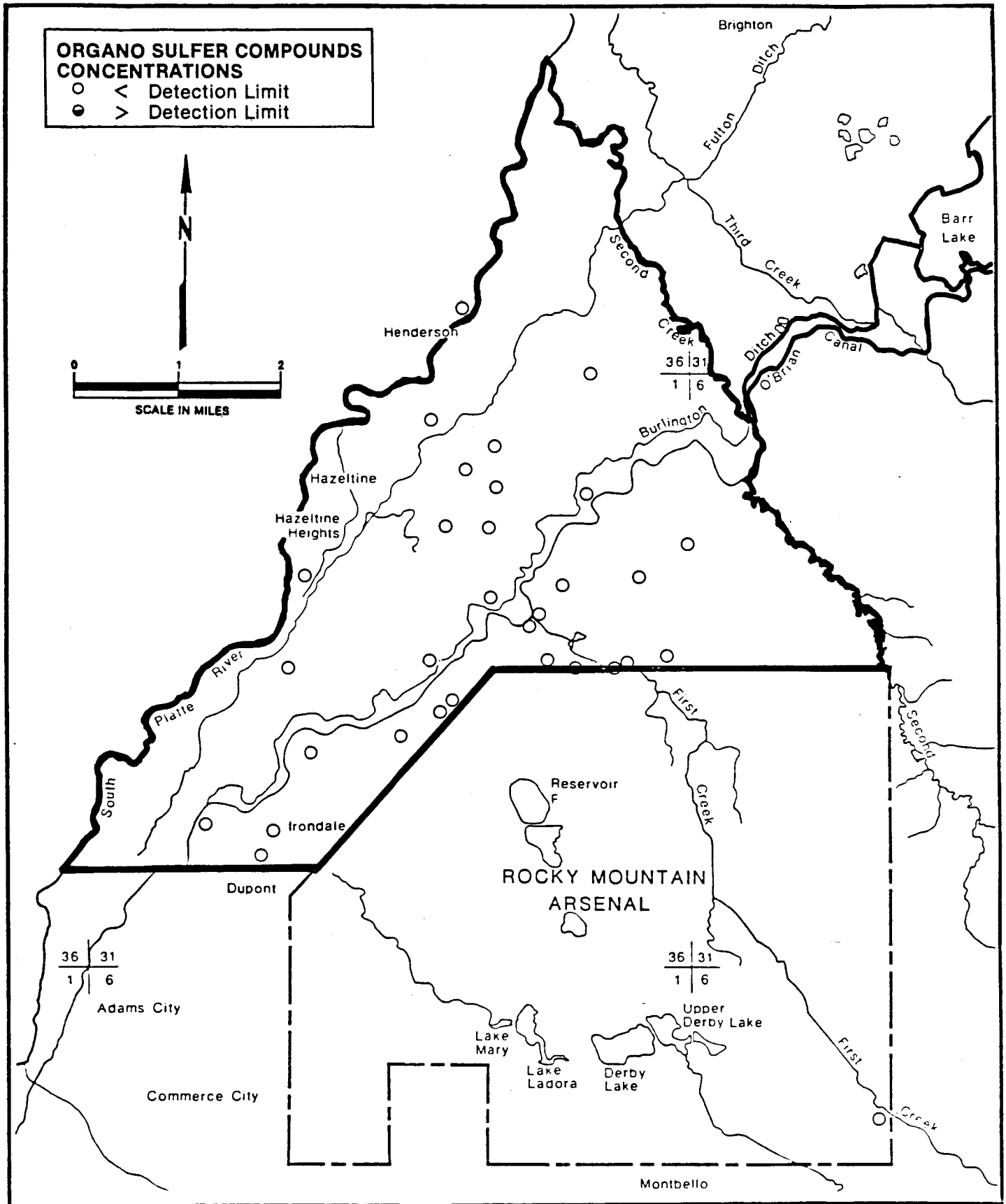


Figure I-5

ORGANOSULFUR COMPOUNDS ASSESSMENT RMA OFFPOST FIRST QUARTER SAMPLING OF WELLS

SOURCE: ESE, 1987

Prepared for:

U.S. Army Program Manager's Office For Rocky Mountain Arsenal

Aberdeen Proving Ground, Maryland

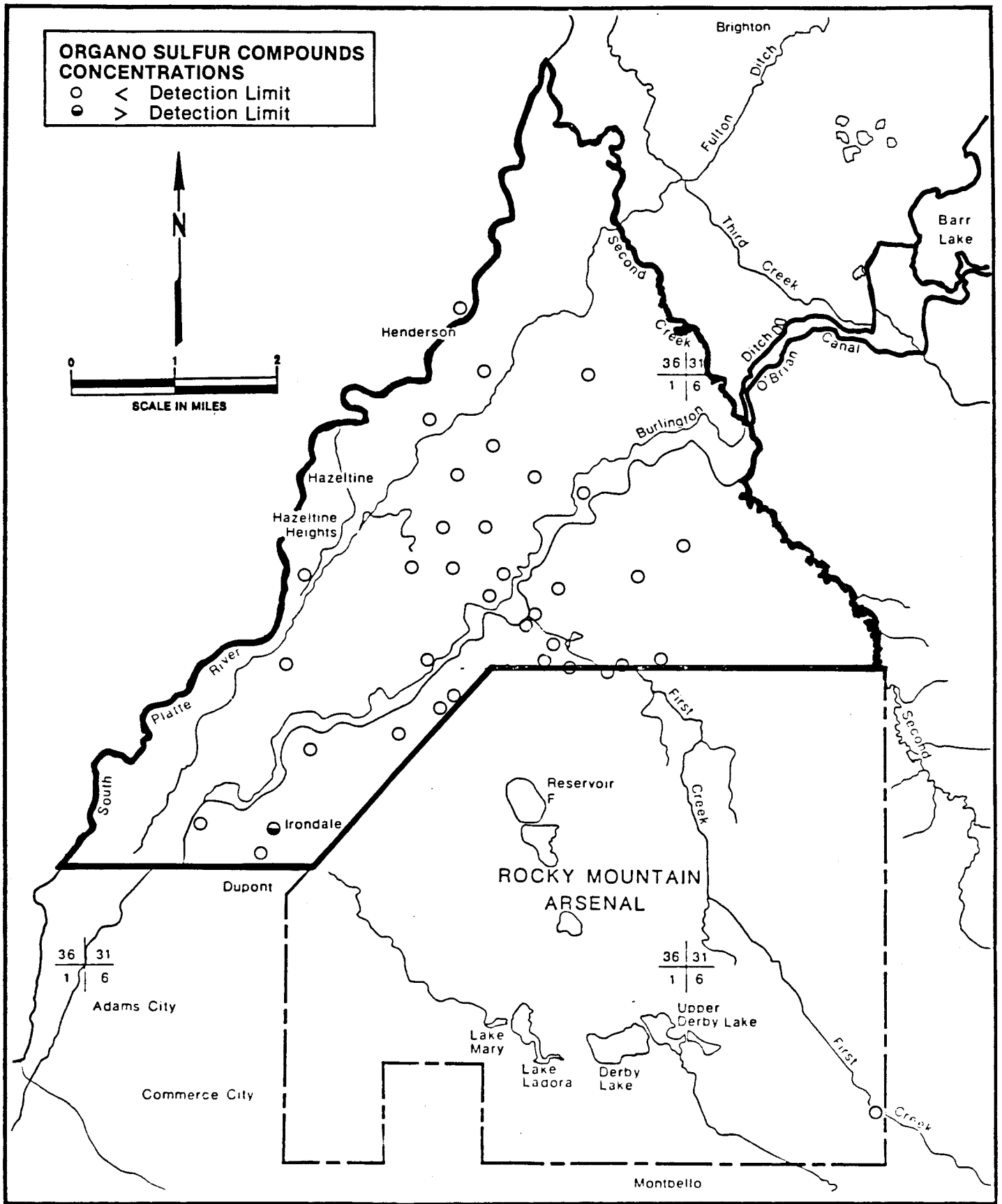


Figure I-6
ORGANOSULFUR COMPOUNDS ASSESSMENT RMA
OFFPOST SECOND QUARTER SAMPLING OF WELLS
SOURCE: ESE, 1987

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

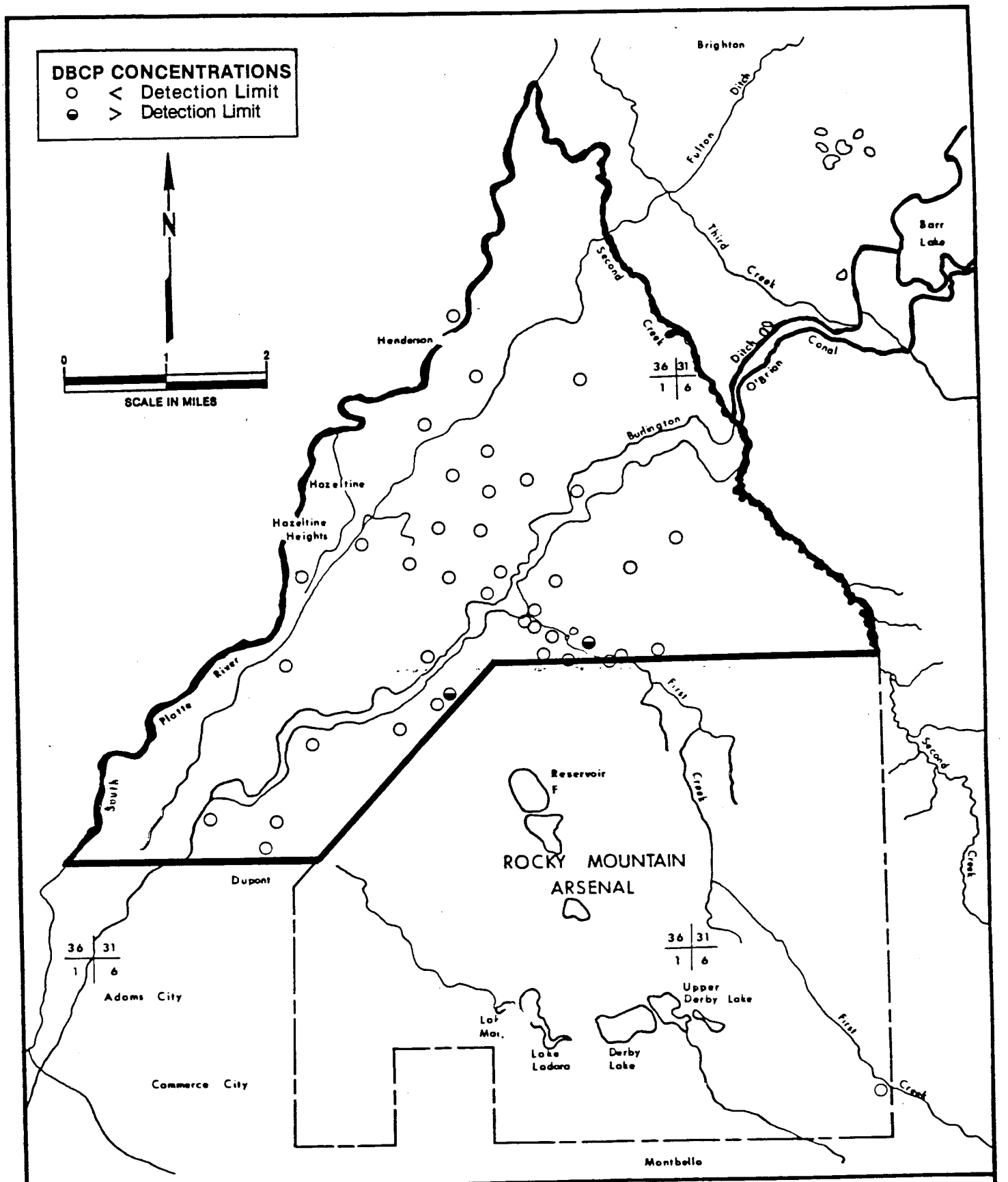


Figure I-7
DBCP ASSESSMENT RMA OFFPOST FIRST QUARTER SAMPLING OF WELLS
SOURCE: ESE, 1987

Prepared for:
U.S. Army Program Manager's Office For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

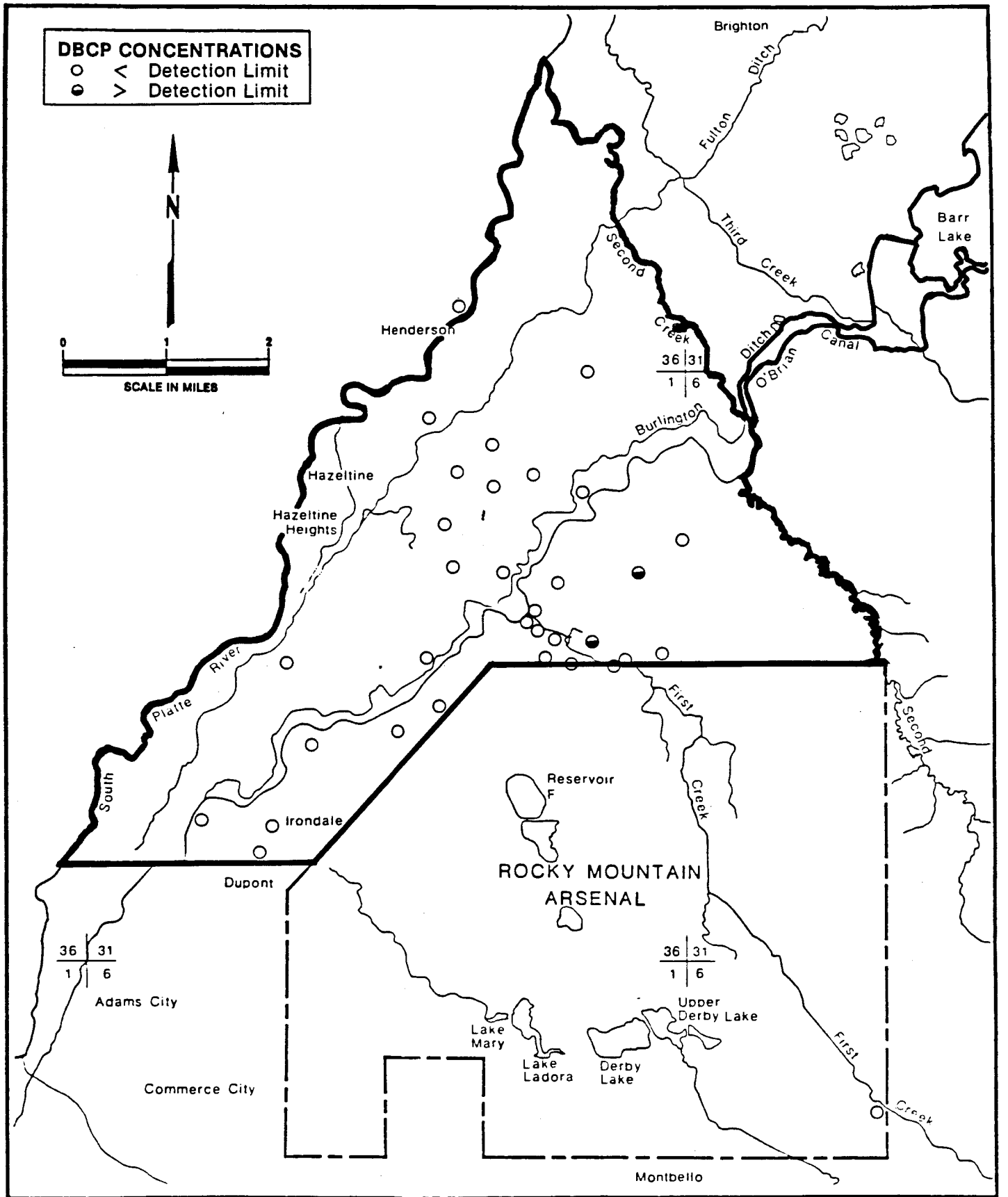


Figure I-8
DBCP ASSESSMENT RMA OFFPOST
SECOND QUARTER SAMPLING OF WELLS
SOURCE: ESE, 1987

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

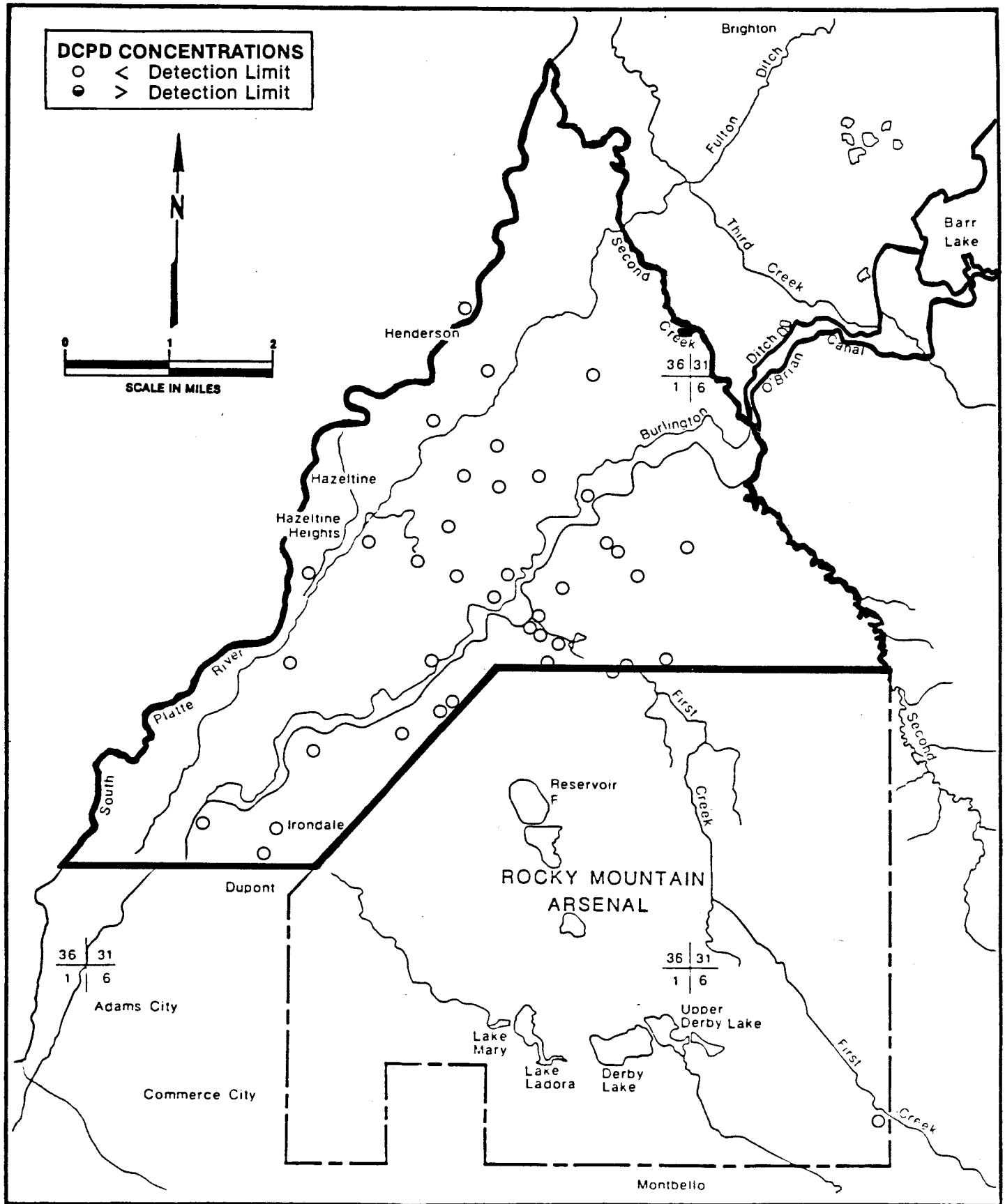


Figure I-9
DCPD ASSESSMENT RMA OFFPOST FIRST QUARTER SAMPLING OF WELLS
SOURCE: ESE, 1987

Prepared for:
U.S. Army Program Manager's Office
For Rocky Mountain Arsenal
Aberdeen Proving Ground, Maryland

APPENDIX J

COMMENTS AND RESPONSES TO THE OFFPOST OPERABLE UNIT REMEDIAL INVESTIGATION AND CHEMICAL SPECIFIC APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS, DRAFT FINAL REPORT (VERSION 2.1), AUGUST 1988

The Task 39 Offpost Operable Unit Remedial Investigation and Chemical Specific Applicable or Relevant and Appropriate Requirements Draft Final Report was distributed on September 30, 1988 to all Organizations and the State (OAS). Comments were received from the Colorado Department of Health on November 3, 1988; the U.S. Environmental Protection Agency on November 14, 1988; Shell Oil Company on November 14, 1988; Holme, Roberts & Owen on November 14, 1988; and the U.S. Fish and Wildlife Service on November 14, 1988. All written comments and formal responses are incorporated in the following appendix.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION VIII
999 18th STREET - SUITE 500
DENVER, COLORADO 80202-2405

Ref: 8HWM-SR

NOV 14 1988

Mr. Donald L. Campbell,
Deputy Program Manager
Office of the Program Manager
Rocky Mountain Arsenal
ATTN: AMXRM-TO
Commerce City, Colorado 80022-2180

Re: Rocky Mountain Arsenal, (RMA), Offpost Operable Unit Remedial Investigation and Chemical Specific Applicable or Relevant and Appropriate Requirements Draft Final Report, August, 1988.

Dear Mr. Campbell:

We have reviewed the above referenced report and have the enclosed comments. Please contact me at (303) 293-1528, if there are questions on this matter.

Sincerely yours,

Connally Mears
EPA Coordinator
for Rocky Mountain Arsenal Cleanup

Enclosure

cc: Thomas P. Looby, CDH
David Shelton, CDH
Patricia Bohm, CAGO
Lt. Col. Scott P. Isaacson
Chris Hahn, Shell Oil Company
R. D. Lundahl, Shell Oil Company
David Anderson, Department of Justice

RESPONSES TO EPA COMMENTS ON
REMEDIAL INVESTIGATION FOR OFFPOST OPERABLE UNIT

December 13, 1988

COMMENT

1. Page 3-56, Aldrin and isodrin, observed at concentrations exceeding CRLs, were not addressed here, but were addressed in the endangerment assessment. Why?

RESPONSE

Aldrin and isodrin were not detected offpost in the Spring and Summer 1987 sampling quarters. The remedial investigation (RI) focused on these two quarters because they were by far the most comprehensive sampling events conducted at the time the report was prepared. However, aldrin was detected sporadically at low levels (generally near the certified reporting limit (CRL)) in samples collected from offpost wells during 1985, 1986, and the winter of 1987. Thus, we believe the endangerment assessment (EA) must address aldrin even though the most recent sampling events do not indicate aldrin's presence at detectable levels offpost. Offpost data from previous sampling episodes is provided in the Contamination Assessment Report (CAR), and the Draft Final Water Remedial Investigation which will be released in January.

With respect to isodrin, the text is in error. Isodrin has not been detected in offpost wells since the Revision III-360° Program began monitoring in December of 1985. Thus, isodrin will be deleted from the Offpost Remedial Investigation (RI) text and will not be discussed in the EA.

COMMENT

2. Page 3-67, Section 3.3.1.9, third sentence, insert "were" for "ere".

RESPONSE

The text will be changed to correct this typographical error.

COMMENT

3. Page 3-114, For chloroform, DIMP, CPMSO, and $CPMSO_2$, "systematic deviations" between GC and GC/MS results were noted. It is stated that "these deviations could result in unforeseen problems associated with remedial actions". Text should be revised to describe more fully this systematic difference in concentration between GC and GC/MS methods.

RESPONSE

The "systematic differences" for chloroform, DIMP, CPMSO, and $CPMSO_2$ are described on the last paragraph of page 3-109. The relationship between GC and GC/MS results was not evaluated statistically because the number of samples in which these compounds were detected were relatively small and the concentrations were low (generally in the range of 10 to 20 %g/l).

COMMENT

4. Page 3-132, First paragraph, last sentence, the second "in" should be "is".

RESPONSE

The text will be changed to correct this error.

COMMENT

5. Page 3-143, First sentence, first paragraph, delete the "8".

RESPONSE

The text will be revised to make this correction.

COMMENT

6. Page 3-148, Are projected quantities used in scenario development consistent with South Adams County Water and Sanitation District projections?

RESPONSE

Yes. Each of the two alluvial wells is to pump approximately 400 acre-feet/year (ac- ft/yr) and the recharge is to be 1000 ac-ft/yr. So far in 1988, South Adams County has recharged approximately 800 ac-ft. Also, South Adams County only proposes to add two new production wells in the near future. The text will be revised to reflect these facts.

COMMENT

7. Page 3-149, Section 3.5.4.1, last paragraph, first sentence, replace "area" with "are".

RESPONSE

The text will be revised to make this correction.

COMMENT

8. Page 3-151, Section 3.5.4.3, first paragraph, last sentence, is the value, 29 ug/l, correct?

RESPONSE

No, this value should be 20 %g/l. The text will be revised to make this correction.

COMMENT

9. Page 4-20, Third paragraph, the potential exists for overland flow near First Creek in which backwater could (or could have) accumulate and overtop 96th Avenue contributing to offpost surface water and soil contamination from contaminated areas such as the Toxic Storage Yard or ditches leading from the North Plants or the Sewage Treatment Plant. Recent citizen accounts have indicated that such events may well have occurred. The RI should address the potential for past flood events depositing contaminated sediment outside of stream channels along the First Creek, and other potential pathways. The same type of concern exists regarding dieldrin detections in the O'Brian Canal (see page 5-14). Further, the flow of contaminated groundwater in that area could have lead, or now be leading, to soil contamination, as could the use of groundwater for irrigation (see comment regarding page 1-7, below). It is essential that such possibilities be fully evaluated.

RESPONSE

The Army has also become aware of citizen accounts which indicate that flooding events have created backwater at 96th Avenue and that surface water flow may have overtopped 96th Avenue. Although monitoring of First Creek at the RMA North Boundary indicates this surface water is generally uncontaminated, storm event sampling has not been initiated until recently. Thus, the Army recognizes the importance of evaluating the potential for soil contamination outside the First Creek stream channel and has initiated soil sampling and analysis to help investigate this potential pathway. The Army will be glad to discuss this supplemental program with the EPA at your request and recommendations you may have for further sampling. This data will be provided in an addendum to the RI Report and will be evaluated in an addendum to the EA/FS if unacceptable contaminant exposures as a result of this pathway are indicated.

There are several different issues raised by the other potential pathways mentioned in this comment. First, the detection of dieldrin in O'Brian Canal upgradient of First Creek does not appear related to ground water contamination. The bottom of O'Brian Canal is approximately 20 ft above the water table in the area this sample was collected.

The statement, "The same type of concern exists regarding dieldrin detections in the O'Brian Canal" is interpreted to refer to overland flow from the RMA Northwest Boundary as a potential pathway. As discussed on pages 4-19 and 4-20, there is a potential for overland flow at the RMA Northwest Boundary during severe storm events. However, modeling conducted by the Corps of Engineers (COE) indicates that during a 100-year storm the Basin F drainage basin would not overflow. Since this drainage basin

contains the source areas closest to the RMA Northwest Boundary, erosion of contaminated soils to O'Brian Canal via this pathway appears unlikely. However, the Army will be willing to discuss specific recommendations for soil sampling downgradient of the RMA Northwest Boundary if the EPA believes this is or has been a viable contaminant pathway to O'Brian Canal.

Soil contamination, as a result of the use of ground water for irrigation, has been evaluated as a potential pathway in the EA.

COMMENT

10. Pages 5-11 and 9-4, Reference is made to past disposal of Denver wastewater sludge in Barr Lake. When did this occur? What quantities were disposed and what was the source? Are there records of the chemical composition of the wastewater sludge that support your assertion that the sludges are the source of the heavy metals detected in the sediments?

RESPONSE

The disposal of sludge by Denver Metro occurred in the 1950s and early 1960s. The sludge was placed directly into O'Brian Canal. We were not able to find documentation of what quantities were disposed. We do not feel it is necessary to have documentation of the chemical composition of the wastewater sludge. The presence of heavy metals in wastewater sludge is well documented in the literature. Ms. Carol Leafure with Barr Lake State Park was the source of much of our information.

COMMENT

11. Page 1-4, The area between 80th Avenue and areas downgradient of the Northwest Boundary Control System (NWBCS) have been excluded from the off-post RI. Historic information indicates that the DBCP plume currently intercepted by the Irondale Boundary Control System extended into the off-post area. This same area is downgradient of the TCE plume that originates on-post in the West Tier area of RMA. The effects of operating the Irondale system on both the TCE and DBCP plumes should be addressed in a manner similar to the other two boundary control systems.

RESPONSE

The statement that the "area between 80th Avenue and areas downgradient of the Northwest Boundary Control System (NWBCS) have been excluded from the offpost RI" is misleading. The Army has presented extensive monitoring data in this area from the Consumptive Use Phase I and III Programs and continues to monitor dedicated monitoring wells in this area on a routine basis. Full size chemical distribution maps that incorporate this part of the Offpost Operable Unit are available upon request.

These maps were not in the RI report because general contaminants were not detected outside the areas shown on the maps in the RI report.

None of the recent monitoring programs mentioned above have indicated that DBCP, a compound solely related to RMA, continues to persist in this area. However, trichloroethylene (TRCLE) has been sporadically detected. Because there are documented sources of TRCLE to the south of 80th Avenue that are not associated with RMA, the contamination downgradient of the Irondale System can not be traced to a specific source. Because multiple sources are indicated, the EPA should be the lead agency for this area in accordance with Executive Order No. 12580, 52 CFR 2923 (1987). Thus, discussions of the operational effects of the Irondale System on these contamination plumes need not be as detailed as those provided on the North Boundary Containment System (NBCS) and Northwest Boundary Containment System (NWBCS). However, additional discussion will be provided in Section 3.0 of the RI report where the effects of the other two systems are discussed.

COMMENT

12. Page 1-7, The potential for contamination of soil by application of contaminated irrigation water at present or in the past should be addressed by identifying all potential irrigation wells that lie within plume areas. If historic application of ground water contaminated with persistent compounds appears likely, then examination of the potential for soil contamination should be conducted and presented for use in the off-post endangerment assessment.

RESPONSE

The potential for soil contamination via this pathway is being considered by the EA. Irrigation wells that lie within present or historic plumes were identified as a part of the Consumptive Use Programs. The majority of these wells lie downgradient of O'Brian Canal and Burlington Ditch where ground water contaminant concentrations are greatly diminished relative to concentrations closer to the RMA boundary. Nonetheless, the relevant data on irrigation wells is presented again in the EA and this pathway is being evaluated in the exposure assessment.

COMMENT

13. Page 3-48, Two wells were identified with casing in poor condition that may lead to mixing of alluvial and bedrock water. The potential for wells of this type to provide a pathway for migration of contaminated ground water to Denver Formation or Arapahoe Formation aquifers should be addressed.

RESPONSE

The Army agrees that the potential for this pathway needs to be addressed. Currently, the only two Consumptive Use bedrock wells that have shown contamination were the two wells identified in the RI report. The Army believes that the best method of detecting potential cross-contamination problems between aquifers is to monitor bedrock wells on a regular basis. When poorly constructed bedrock wells are identified in areas where alluvial water is contaminated above remedial action levels, the wells will be

abandoned and replaced as necessary. Both monitoring and abandonment/ replacement of bedrock wells will be a part of alternatives developed in the FS.

It should be noted that the highest density of bedrock wells are located just north of the RMA North Boundary. During the Consumptive Use Phase I program, analyses of samples collected from these wells did not exhibit any concentrations of target analytes above Certified Reporting Limits (CRLs).

COMMENT

14. Page 3-49, The off-post impact of at least the DBCP plume and potentially the RMA-related TCE plume from the West Tier should be addressed. We need to discuss this issue further.

RESPONSE

As discussed in our response to Comment #11, the most recent monitoring (Consumptive User Phase III) in the offpost area downgradient of the Irondale System did not indicate the presence of DBCP. Data from the Consumptive Use Phase III Report will be discussed in the RI report to support this position. We agree that this issue requires further discussion.

COMMENT

15. Page 3-59, The historic DBCP plume that led to construction of the Irondale System should be addressed.

RESPONSE

We agree that discussion of the historic DBCP plume and the rationale for construction of the Irondale System are appropriate in this section of the report. An appropriate discussion will be added to the text.

COMMENT

16. Page 3-63, The concentration of dieldrin identified as anomalous lies in an area of sparse well control and is along a potential flow path downgradient of elevated dieldrin concentrations on-post. Recharge from the O'Brian Canal and Burlington Ditch have probably diluted the concentrations in the plume.

RESPONSE

The text does not refer to the dieldrin concentrations observed in samples from Wells 37353 and 37355 as anomalous. The text states that the detection of dieldrin do not correlate well with upgradient detections. In the case of both Wells 37353 and 37355, there are at least a half dozen upgradient wells which do not exhibit detectable levels of dieldrin. In neither case however, are we ruling out that this contamination could be attributable to

RMA. We are in agreement that these detections are in areas of sparse well control and downgradient of dieldrin contamination near the RMA boundaries. Thus, monitoring will continue in these areas under the Comprehensive Monitoring Program (CMP) and the need for additional wells upgradient of these areas will be evaluated to help assess the origins of these detections.

COMMENT

17. Page 3-147, At least a rudimentary calibration attempt for contaminants of concern for the future scenario simulations should be conducted to validate the future predictions. In particular, the extreme variation in Kd should be validated by calibration since this parameter is a major control on future contaminant concentration distribution.

RESPONSE

We agree that the variability in Kd values has a major influence on the results of the "no action" simulations, particularly for the relatively immobile compounds such as dieldrin. However, even a rudimentary calibration for the contaminants of concern offpost is difficult because historical offpost data is much less comprehensive than presented in the RI report. As a result, we are not able to reconstruct offpost contaminant distributions with any certainty. As an alternative, we propose to perform "no action" simulations for different Kd values to evaluate the sensitivity of the results of this variable. Our preliminary results suggest that the "no action" simulations are not very sensitive to different Kd values for the extremely mobile compounds such as chloroform and DIMP. A "best estimate" Kd will be determined for dieldrin based upon travel times from onpost source areas. Then, two additional Kd values will be chosen for modeling. One of these values will be selected less than the "best estimate" Kd and one will be selected greater than this value. The purpose of these simulations will be to bracket the actual movement of dieldrin by providing a reasonable range of contaminant migration scenarios. The results of these additional simulations will be provided in the EA/FS Report.

Volume III

COMMENT

1. ARARs were not identified for the following compounds detected in the offpost sampling: chlordane, hexachlorocyclopentadiene, and 1,1,2-trichloroethane.

RESPONSE

These contaminants were not detected offpost in 1987. We do not have any indication that chlordane has ever been detected offpost. Hexachlorocyclopentadiene and 1,1,2-trichloroethane have been detected once and twice respectively since monitoring began for these contaminants offpost. All three of these detections were just above the respective CRL.

We will however identify potential ARARs for these two compounds in the event that they are detected offpost in the future. (Will require DOJ concurrence.)

COMMENT

2. Although we normally think it most appropriate for the State of Colorado to comment on potential State ARARs, in light of recent RMA experience with State air pollution regulations we would point out that State odor regulations, and perhaps others, should be considered as potential ARARs.

RESPONSE

State odor regulations are not environmental regulations that constitute standards, requirements, criteria or limitations pertinent to hazardous substances, pollutants or contaminants. Therefore, these regulations have not been designated as potential ARARs within the meaning of 42 U.S.C. Section 9621(d)(2).

COMMENT

3. We have not had the opportunity to make a full compound-specific comparison with potential ARARs. We may supplement our comments on that matter at a later time.

RESPONSE

The organizations are urged to make any supplemental comments on the designated potnetial ARARs no later than January 20, 1989 so that any such additional comments on ARARs may be considered by the Army prior to the issuance of the Offpost Operable Unit EA/FS.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
COLORADO FIELD OFFICE
730 SIMMS STREET
ROOM 292
GOLDEN, COLORADO 80401

IN REPLY REFER TO:

(FWE)

November 11, 1988



Deputy Program Manager
Rocky Mountain Arsenal
ATTN: AMXRM-PM (Donald L. Campbell)
Building 111 Rocky Mountain Arsenal
Commerce City, Colorado 80022

Dear Mr. Campbell:

We have reviewed Volumes I, II and III of the Offpost Operable Unit RI and Chemical Specific ARARs Draft Final Report (version 2.1) for Task Number 39. Please refer to the specific comments below.

Vol. I, Sec. 4.3 (p. 4-10). Two contaminant pathways to offpost surface water are listed: surface water runoff and erosion plus contaminated ground water discharges to surface channels. Soil and surface erosion by wind action is not mentioned. This is surprising because of the IRA that addressed supression of wind erosion problems in section 36. Is it not possible that surface/contaminant-borne soil and other particles have blown offpost and been deposited within the watersheds that feed back onto or away from the Arsenal? This could be examined with near-surface soil-core samples and testing for surface-borne analytes offpost. However, offpost soil studies conducted so far may have used a core depth great enough to swamp out detection of shallow/surface contamination. It is our contention that airborne surface erosion should be considered and examined at a level of detail which would render it an insignificant factor or a significant factor. If it is shown to be significant, then a description of the process and its past, present and future impacts on surface water contamination should be included in this section. The issue raised here could explain why aldrin and DIMP concentrations were detected in surface waters of First Creek at the southeastern-most edge of RNA (sec. 4.2.1 p. 4-4, Table 4.2-1 and Fig. 4.2-1 for sample location 08ADD). Figure 4.3-2 would suggest that this contamination occurred via a recharge phenomenon; does the ground water move in this direction? We request that you consider whether or not surface air-borne contaminants may have moved to some degree offpost (i.e., down wind). For this reason, we would be interested in any contaminant data you may have pertaining to offpost biota to the east, southeast and south of RMA (i.e., downwind) to help us judge this issue in relation to the contamination of fish and wildlife in the total offpost area.

Vol I, Sec 5.0. The data presented in Tables 5.1-2, 5.2-1 and 5.3-1 are confusing. The latter table specifies the basis of expression is ug metal/gm dry sediment. The former two tables do not indicate the basis of expression, i.e., whether it is on a dry, wet or other basis. The methodology section

pertaining to these results (sec. 2.3, p. 2-24) specifies that the sediment samples were centrifuged to remove excess water prior to extraction and analysis. Please provide us with an explanation for the basis of expression for all data in Sec. 5.0. Without this we have no valid way to assess the relevance of contaminant concentrations in offpost sediments.

Vol I, Sec. 7.0. Our concerns about studies of biota for this operable unit center around the general approach and the specific investigation, as well. First, there is no indication of studies of contaminants in biota that reside in the offpost operable unit. Rather, the studies focused entirely on movement of animals from onpost to offpost and the possible 'export' of contaminants in this manner. The movement studies indicated that pheasants, to a limited extent, and no cottontail rabbits could be expected to move back and forth across the RMA north boundary. We are concerned with the possibility that offpost contamination has resulted in contamination in offpost biota that never comes onto RMA. Please provide some explanatory response to this concern.

The ramainder of our comments about sec. 7.0 pertains to the movement studies.

Vol I, Sec. 7.1. The title is misleading. Because no summer movements and wintertime movements of only one bird were monitored, the title should read Results of Fall Movements. Home range implies year-round monitoring which was not done.

Vol I, Sec. 7.1.1. On p. 7-1, how was death from natural causes determined for pheasants found dismembered with the transmitter found nearby? Also, were any of the animal carcasses found intact with accompanying transmitters analyzed for contaminant concentrations? Transmitter effect on the natural movement of experimental birds is never mentioned. Was there a period of adjustment to the stress caused by handling/radio-fitting afforded each animal before data were collected from it? We are aware of some studies in which transmitter effects on the animals totally negated the valididty of movement data. Who placed a reward band on the pheasant recovered 7.5 miles from the Arsenal? More details are needed on this. What does the term radio-collar mean? We are not familiar with collars used on birds. Usually a harness or tail clip type of radio attachment is used on birds. Sex should be indicated in Table 7.1-1. Why was 20 locations used as the cutoff for valid (?) movement data (top p. 7-3)? There was an admitted relationship between number of locations and activity range, i.e., more locations yielded a larger range. Perhaps pheasants with smaller ranges exhibited a radio effect. If a radio effect existed, at what point in time after radio-fitting did it cease to be a factor? Radio effect needs to be brought in the discussion in this section. In para. 3, p, 7-3, references sould be given and casual observations should be expounded upon. In para. 4, p. 7-3, the first and last sentences are contradictory. Seasonal movement patterns could not be compared because only one pheasant was monitored during winter.

Vol I, Sec. 7.2, 5th para, p. 7.4. The statement about "the data obtained provide an objective and quantitative basis for evaluating potential pathways offpost" seems to hang out there in the face of admitted problems with the study. And, as mentioned above, contamination in resident biota offpost is not presented. Lack of evaluating or considering a potential radio effect surely weakens the results. Some studies have found aberrant behavior and

restrictive movements exhibited by radio-fitted animnals. The interpretation at least warrants this consideration. The pheasant that moved 7.5 miles offpost was apparently not radio-fitted but it was reward-banded. Perhaps this bird is more representative than were the radio-fitted birds. If so, a reward-banding study could have been more enlightening. Also, the population of lost transmitters may have included animals that moved offpost. In para 2, p. 7-12, the draft Biota RI (ESE, 1988) should not be cited as a reference. It is not listed in the references and probably has not been released for our review yet.

In summary of Section 7.0, the discussion of findings in 7.2 asppears to present a fair and objective assessment of the limitations and findings of the radio-tracking studies. A stronger opinion about the strengths of the study is what is transmitted prior to this point, however. Lastly, the Evaluation of Biota Contaminant Pathways given in sec. 7.3 does not include mention of existing offpost contamination and its potential to contaminate offpost plants or animals.

Volume II. No comments.

Volume III. In Appendix H, p. vii, we would like to see listed in this section the tolerances and action levels on or in raw agricultural commodities that were indentified in para. G. These data could be shown in the section on Potential Chemical-Specific ARARS for the EA for the Offpost Operable Unit, RMA.

Thank you for the opportunity to review the subject documents. For any questions pertaining to our comments, please contact Rod DeWeese of this office at 303-236-2675 or FTS 776-2675.

Sincerely,

LeRoy W. Carlson
Acting State Supervisor

RESPONSES TO FISH AND WILDLIFE SERVICE COMMENTS
ON REMEDIAL INVESTIGATION FOR THE OFFPOST OPERABLE UNIT

December 13, 1988

COMMENT

Vol. 1, Sec. 4.3 (p. 4-10). Two contaminant pathways to offpost surface water are listed: surface water runoff and erosion plus contaminated ground water discharges to surface channels. Soil and surface erosion by wind action is not mentioned. This is surprising because of the IRA that addressed suppression of wind erosion problems in section 36. Is it not possible that surface/contaminant-borne soil and other particles have blown offpost and been deposited within the watersheds that feed back onto or away from the Arsenal? This could be examined with near-surface soil-core samples and testing for surface-borne analytes offpost. However, offpost soil studies conducted so far may have used a core depth great enough to swamp out detection of shallow/surface contamination. It is our contention that airborne surface erosion should be considered and examined at a level of detail which would render it an insignificant factor or a significant factor. If it is shown to be significant, then a description of the process and its past, present and future impacts on surface water contamination should be included in this section. The issue raised here could explain why aldrin and DIMP concentrations were detected in surface waters of First Creek at the southeastern-most edge of RMA (sec. 4.2.1 p. 4-4, Table 4.2-1 and Fig. 4.2-1 for sample location 08ADD). Figure 4.3-2 would suggest that this contamination occurred via a recharge phenomenon; does not ground water move in this direction? We request that you consider whether or not surface airborne contaminants may have moved to some degree offpost (i.e., downwind). For this reason, we would be interested in any contaminant data you may have pertaining to offpost biota to the east, southeast and south of RMA (i.e., downwind) to help us judge this issue in relation to the contamination of fish and wildlife in the total offpost area.

RESPONSE

Based upon a preliminary review of this pathway, the Army does not believe that the windblown pathway is a significant exposure route in the Offpost Operable Unit. To address your concern over this potential pathway the Army would first like to discuss the plausibility of the pathway by evaluating the potential for it to occur. For example, an evaluation could be effectively accomplished by performing long-term air dispersion and deposition modeling. If the results of this assessment indicate the potential for substantial migration of contaminants via this pathway, then sampling could be performed using the modeling results as a guide. Again, we are willing to discuss your recommendations but would also like to explore other approaches to the evaluation of this potential pathway.

COMMENT

Vol. I, Sec. 5.0. The data presented in Tables 5.1-2, 5.2-1 and 5.3-1 are confusing. The latter tables specifies the basis of expression is ug metal/gm dry sediment. The former two tables do not indicate the basis of expression, i.e., whether it is on a dry, wet or other basis. The methodology section pertaining to these results (Sec. 2.3, p. 2-24) specifies that the sediment samples were centrifuged to remove excess water prior to extraction and analysis. Please provide us with an explanation for the basis of expression for all data in Sec. 5.0. Without this we have no valid way to assess the relevance of contaminant concentrations in offpost sediments.

RESPONSE

All concentrations are expressed in terms of dry sediment. The text will be revised to clarify this.

COMMENT

Vol. I, Sec. 7.0. Our concerns about studies of biota for this operable unit center around the general approach and the specific investigation, as well. First, there is no indication of studies of contaminants in biota that reside in the Offpost Operable Unit. Rather, the studies focused entirely on movement of animals from onpost to offpost and the possible 'export' of contaminants in this manner. The movement studies indicated that pheasants, to a limited extent, and no cottontail rabbits could be expected to move back and forth across the RMA north boundary. We are concerned with the possibility that offpost contamination has resulted in contamination in offpost biota that never comes onto RMA. Please provide some explanatory response to this concern.

RESPONSE

Offpost studies of other media (e.g., surface water, ground water) were being conducted simultaneously with the investigation of animals movements. No investigations of contamination in offpost biota were conducted because potential offpost sites of contamination (e.g., contaminated surface waters or sediments) had not been identified at the time of the study. The assessment of hazards to offpost biota are being addressed in the Offpost Endangerment Assessment (EA) that is currently being prepared.

Pheasant and cottontail studies were initiated to address the specific concern regarding the potential of human exposure offpost via wildlife that were potentially contaminated on RMA. The study design involved capturing animals within RMA along boundaries where the animals might be expected to move offpost, be hunted, and subsequently consumed by humans. Tracking studies followed these animals to determine if the size of the home ranges through the seasons of dispersal and hunting would permit individuals to move from sites of contamination onpost to the Offpost Operable Unit. For a

variety of reasons already discussed in the text sample sizes were small, yet the study did produce results that indicated movement of pheasants from onpost areas to the adjacent offpost areas. More quantification may have been useful, but the study did achieve its objectives and is sufficient for the conduct of an EA/FS on this potential pathway.

COMMENT

Vol. I, Sec. 7.1. The title is misleading. Because no summer movements and wintertime movements of only one bird were monitored, the title should read Results of Fall Movements. Home range implies year-round monitoring which was not done.

RESPONSE

Most of the pheasants monitored during the study were monitored from August through November, therefore more than fall movements were monitored. Pheasants were deliberately monitored during August before they would be expected to disperse from the Rocky Mountain Arsenal (RMA) and change their seasonal use locations between summer and fall seasons. Depending on the animal group addressed, the term home range may imply year-round range, seasonal range, or lifetime range. Because most pheasants were monitored for more than one season, we believe that home range is a more appropriate term than fall movements for the title of this section.

COMMENT

Vol. I, Sec. 7.1.1. On p. 7-1, how was death from natural causes determined for pheasants found dismembered with the transmitter found nearby? Also, were any of the animal carcasses found intact with accompanying transmitters analyzed for contaminant concentrations? Transmitter effect on the natural movement of experimental birds is never mentioned. Was there a period of adjustment to the stress caused by handling/radio-fitting afforded each animal before data were collected from it? We are aware of some studies in which transmitter effects on the animals totally negated the validity of movement data. Who placed a reward band on the pheasant recovered 7.5 miles from the Arsenal? More details are needed on this. What does the term radio-collar mean? We are not familiar with collars used on birds. Usually a harness or tail clip type of radio attachment is used on birds. Sex should be indicated in Table 7.1-1. Why was 20 locations used as the cutoff for valid (?) movement data (top p. 7-3)? There was an admitted relationship between number of locations and activity range, i.e., more locations yielded a larger range. Perhaps pheasants with smaller ranges exhibited a radio effect. If a radio effect existed, at what point in time after radio-fitting did it cease to be a factor? Radio effect needs to brought in the discussion in this section. In para. 3, p. 7-3, references should be given and casual observations should be expounded upon. In para. 4, p. 7-3, the first and last sentences are contradictory. Seasonal movement patterns could not be compared because only one pheasant was monitored during winter.

RESPONSE

Death from natural causes was assumed if the transmitter was found mangled (e.g., the insulation on the antennae was chewed) as if the pheasant had been killed by a predator and/or if the animal's recent movements indicated that the animal was active and apparently healthy prior to its discovery as a deceased individual.

Tissue analyses of pheasants found dead on RMA were beyond the scope of this investigation. A RMA-wide study of contamination and contaminant effects in pheasants was conducted as part of the overall RMA Biota Assessment Task and is included in the Biota RI document scheduled for review in early 1989.

Pheasants were captured during the late evening hours and were tracked starting on the following day. None of the pheasants tracked made any significant change in habitat during the period following their initial capture. Most stayed in the same general habitat as when captured. Released pheasants flew readily and with no apparent difficulty. Dunke and Pils (1973) reported that pheasants adjusted to transmitters within 1 to 2 days. Hanson and Progulske (1973) found that pheasants in their study that had been equipped with radiotransmitters did not show signs of physical hindrance. The pheasants tracked in the RMA study were tracked for extended periods of time, thus any reduction in movements that may have occurred during the first two days of movement should not have significantly affected overall results. One study (Hessler et al., 1970) suggested that radiotransmitters lowered survival of pheasants, but the birds used in this investigation were raised in captivity and released into a foreign environment. These factors are known to reduce the survivorship of released animals.

Biologists from ESE placed the reward bands on all pheasants released with transmitters as a supplemental means of obtaining data, not as a separate study.

The term radio collar is equivalent to a bib transmitter. Both bib and harness transmitters were tested during a pilot study. The bib collar was selected because it was less easily lost by active birds than was the harness. The bib collar we used consisted of a single piece of material that was cut to fit (like a collar) over the head of each pheasant. The sex of the pheasants will be added to Table 7.1-1.

In the calculation of home ranges, increase in calculated home range size levels off after a sufficient number of captures has been reached. The cutoff point of 20 sightings was selected for the estimation of minimum home ranges based on past studies (Rose, 1982; Jennrich and Turner, 1969, and others) that have shown this to be a sufficiently large number to estimate the minimum home range of most species. The study design attempted to locate pheasants at different times of day and at different seasons to account for daily and seasonal shifts in movement between different use areas.

The objective of the RMA pheasant study was to determine if minimum home ranges were large enough to permit individuals exposed to sites of contamination on RMA to move offpost, and not to simply estimate the home range of pheasants. The study accomplished this objective in spite of the loss of pheasants throughout the investigation. Pheasants with smaller home ranges may have exhibited a radio effect, but this does not alter finding that some RMA pheasants did move offpost.

COMMENT

Vol. I, Sec. 7.2, 5th para., p. 7-4. The statement about "the data obtained provide an objective and quantitative basis for evaluating potential pathways offpost" seems to hang out there in the face of admitted problems with the study. And, as mentioned above, contamination in resident biota offpost is not presented. Lack of evaluating or considering a potential radio effect surely weakens the results. Some studies have found aberrant behavior and restrictive movements exhibited by radio-fitted animals. The interpretation at least warrants this consideration. The pheasant that moved 7.5 miles offpost was apparently not radio-fitted but it was reward-banded. Perhaps this bird is more representative than were the radio-fitted birds. If so, a reward-banding study could have been more enlightening. Also, the population of lost transmitters may have included animals that moved offpost. In para. 2, p. 7-12, the draft Biota RI (ESE, 1988) should not be cited as a reference. It is not listed in the references and probably has not been released for our review yet.

In summary of Section 7.0, the discussion of findings in 7.2 appears to present a fair and objective assessment of the limitations and findings of the radio-tracking studies. A stronger opinion about the strengths of the study is what is transmitted prior to this point, however. Lastly, the Evaluation of Biota Contaminant Pathways given in Sec. 7.3 does not include mention of existing offpost contamination and its potential to contaminant offpost plants or animals.

RESPONSE

Shortcomings and problems that weakened the data were presented earlier in the section, and in the first part of the sentence. We agree that the results were less quantitative than would have been possible with larger sample sizes and less disturbance, nevertheless the investigation results were objective and quantitative to the extent possible under the circumstances. Therefore, the additional effort and expense was not considered justified.

Contamination in resident biota are addressed in the Biota RI document which will be released early in 1989. The assessment of risk offpost from pheasants contaminated onpost is being addressed as part of the Offpost Endangerment Assessment that is also currently being prepared. Comments on the effect of radio transmitters were addressed in the previous response.

The pheasant that moved 7.5 miles offpost had been equipped with a radio transmitter, but the device had been lost. A reward banding study might have been more enlightening, but would have involved substantially more effort that the current study with no guarantee of a proportional increase in pertinent information. The study did demonstrate that RMA pheasants do move offpost, and that pheasants from RMA are obtained by hunters. The quantification of risks as a result of these movements is addressed as part of the Offpost Endangerment Assessment document that is currently being prepared.

No biological sampling was conducted in the offpost study area because of limited extent of offpost contamination from RMA that was detected. Contaminants of concern to biota were detected in sediments and surface waters at low levels. Biota sampling under these circumstances was not considered appropriate or necessary because hits above detection limits for contaminants in these media were at low levels, were sporadic, and for some contaminants (e.g., organochlorine pesticides) the source could not be attributed exclusively to RMA. The hazard to offpost biota as a result of this contaminant is addressed in the Offpost Endangerment Assessment that is currently being prepared.

COMMENT

Volume III. In Appendix H, p. vii, we would like to see listed in this section the tolerances and action levels on or in raw agriculture commodities that were identified in para. G. These data could be shown in the section on Potential Chemical-Specific ARARs for the EA for the Offpost Operable Unit, RMA.

RESPONSE

The tolerances and action levels on or in raw agricultural commodities will be provided in conjunction with the section on designated (no longer potential) chemical-specific ARARs in the Offpost Operable Unit EA/FS.

HOLME ROBERTS & OWEN

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EDWARD J. McGRATH

November 11, 1988

Mr. Donald Campbell
Office of the Program Manager
for Rocky Mountain Arsenal
Attn: AMXRM-PM/Mr. Donald Campbell
Rocky Mountain Arsenal, Building 111
Commerce City, Colorado 80022-2180

Re: Shell Comments on Offpost Remedial Investigation Potential ARARs

Dear Mr. Campbell:

Shell Oil Company submits the attached comments on Appendix H of the draft final report on the Offpost Remedial Investigation.

Very truly yours,

T. F. Cope

for Edward J. McGrath

EJM:TFC:cg
Enclosures
cc: Office of the Program Manager for Rocky Mountain Arsenal
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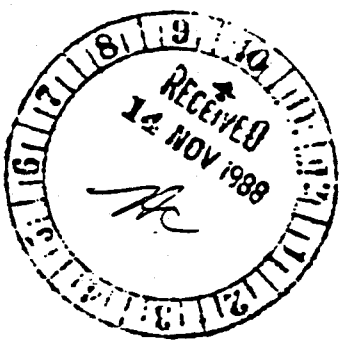
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Mr. Thomas P. Looby
Assistant Director
Colorado Department of Health
4210 East 11th Avenue
Denver, CO 80220

Shell Oil Company

One Shell Plaza
P.O. Box 4320
Houston, Texas 77210

November 11, 1988



Office of the Program Manager for Rocky Mountain Arsenal
ATTN: AMXRM-PM: Mr. Donald L. Campbell
Rocky Mountain Arsenal, Building 111
Commerce City, Colorado 80022-2180

Dear Mr. Campbell:

Enclosed herewith are a portion of Shell Oil's comments on the Draft Final Report entitled "Offpost Remedial Investigation and Endangerment Assessment and Applicable or Relevant and Appropriate Requirements". Comments on potential chemical-specific ARARs will be sent under separate cover.

Sincerely,

W. E. Echols
for
C. K. Hahn
Manager
Denver Site Project

WEA:ajg

Enclosure

cc: (w/enclosure)
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RESPONSES TO SHELL OIL (SHELL) COMMENTS
ON REMEDIAL INVESTIGATION FOR OFFPOST OPERABLE UNIT

December 13, 1988

General Comments

Presently, there are only 36 monitoring wells in the four-square mile area (Sections 11 to 14) located directly north of the North Boundary Containment system. Basis the limited contaminant data that was obtained from these wells, it would be difficult to infer continuous plumes with clean-cut contours as presented in the report. Thus, the data base and its interpretation may be inadequate to support any future feasibility studies.

Besides incomplete definitions of contaminant distributions, the geologic and lithologic characteristics of the off-post alluvial channels are not well defined. For example, there are only 80 boreholes/monitoring wells in Section 12, 13, and 14. Thus, it is difficult to define channels through which soluble contaminants may migrate.

More data are necessary before the need for remediation can be determined. The lithology of the area, the contaminant pathways, and ground water flows must be further evaluated. Several monitoring wells or cone penetrometer holes should be installed in key locations to collect additional water quality data to better define and monitor the distribution and fate of these contaminants. These key locations include the Boller Well area, the area between Wells 391, 377, 392, 378, and the area between Boller Well and Well 377.

RESPONSE

There are several different aspects of this general comment which need to be addressed. First, the Army realizes that refinements to the offpost ground water monitoring network will be needed for remedial design. Currently, the Army is formulating plans to collect additional ground water data offpost. We suggest that a working session be held with Shell to discuss specific recommendations so that they can be evaluated for inclusion into further offpost data collection efforts.

Although the Army recognizes that additional ground water quality data will be required at the remediation design stage, we believe that the existing conceptualization of the nature and extent of contamination in the offpost areas described in your comments is sufficient to conduct a Feasibility Study (FS).

We are in agreement that the isoconcentration lines are, in some instances, interpolated over significant distances, particularly in the area between Wells 37391 and 37367 as identified in your comments. The Army is willing to supplement its monitoring network in this area to support remedial design and will incorporate your comments.

Although additional geologic and lithologic data will help to refine offpost paleochannels in Sections 12, 13, and 14, the two paleochannels which exert a strong influence on offpost alluvial contaminant migration (i.e., the First Creek and Northern Pathways) have been characterized sufficiently to identify them as primary pathways. We believe the hydrogeologic and geochemical data is sufficient to support a FS.

We are not in agreement that more data is needed before the need for remediation can be determined. The nature of offpost contamination has been reasonably determined. Although the extent of alluvial contamination will have to be refined for design of remediation systems, we believe the characterization is sufficient to determine whether unacceptable risks are posed by offpost contamination. Thus, the need for remediation can be evaluated.

SPECIFIC COMMENTS

COMMENT

1. Page 1-1, second paragraph.

   If examples are to be listed, arsenic and mercury should be included.

RESPONSE

The list of contaminants presented on page 1-1 was not intended to be all-inclusive. Emphasis was placed on listing contaminants which have migrated to offpost areas. Arsenic has migrated to offpost areas at levels just above the detection limits and will be listed. However, mercury was detected only once in the Spring and Summer 1987 quarterly sampling event conducted offpost. The addition of mercury to this introductory list is not appropriate.

COMMENT

2. Page 1-3, last paragraph.

   Given the Army's new policy on access to the RIC, shouldn't the Task 39 Technical Plan and supporting documents be in the JARDF?

RESPONSE

All materials relevant to the Offpost Operable Unit will be included in the administrative record in the JARDF at the time of issuance for comment to the Offpost Operable Unit Endangerment Assessment EA/FS.

COMMENT

3. Page 1-3, last line.

   Trichloroethene is referred to, yet throughout page 1-4 references are made to trichloroethylene. The authors should be consistent with their nomenclature.

RESPONSE

The text will be revised to consistently refer to this compound as trichloroethylene.

COMMENT

4. Page 1-4, second paragraph.

Is the last sentence true? The area between 80th and 88th Avenues would be in the Off-Post Area. Under paragraph 8.1 of the RI/FS Process Document, the Army is Lead Agency. How can EPA have jurisdiction over TCE "as per previous agreements with the Army"?

RESPONSE

An Executive Order No. 12580, 52 CFR 2923 (1987) established that the EPA would be the lead agency in areas where multiple sources are suspected. Because documented sources of trichloroethylene and other volatile organohalogens exist to the south and upgradient of the area in question, it is the Army's position that the EPA will have jurisdiction over the cleanup in this area.

COMMENT

5. Page 1-5, paragraph 1.2.1.

Shouldn't the description of the North Boundary System also mention the recharge trenches?

RESPONSE

Construction of the recharge trenches was just beginning at the time this Draft Final Report was being prepared. The text will be revised to reflect the addition of the recharge trenches.

COMMENT

6. Page 1-6, second paragraph.

CERCLA should be defined as the Comprehensive Environmental Response, Compensation and Liability Act, as amended by the Superfund Amendments and Reauthorization Act. We never refer to SARA separately in the Consent Decree or the RI/FS Process Document; it is a part of CERCLA.

RESPONSE

There is no disagreement that CERCLA was simply amended by SARA. The fact that SARA was listed separately is only intended to indicate that the RI is not inconsistent with CERCLA and the SARA amendments. In the future, the Army will simply refer to CERCLA.

COMMENT

7. Page 1-8, last paragraph.

The Army should clarify that its preliminary evaluation of ARARs is a preliminary evaluation of potential ARARs.

RESPONSE

The text will be revised to clarify that only an identification of potential chemical specific ARARs have been identified in the RI report.

COMMENT

8. Page 1-10, Figure 1.0-2 should be corrected to include the surface waters of the O'Brian Canal and the Burlington Ditch from their confluence with Second Creek to Barr Lake. It might also help to avoid misunderstandings if the figure made clear that only the surface waters of Barr Lake are included.

RESPONSE

This figure will be revised to include the O'Brian Canal and Burlington Ditch from their confluence with Second Creek to Barr Lake. The figure will also be revised to make clear it is the only lake being examined in the RI.

COMMENT

9. Page 3-19, Section 3.2.1, second paragraph.

This paragraph implies that the alluvium and Upper Denver are functionally equivalent. While it is hard to disagree that these two formations are in contact, it may still be premature to say that hydrologically these two formations function as one unit.

RESPONSE

The text states that in areas of subcropping Denver Fm sandstones, the alluvium and Denver Fm are considered hydraulically connected and can act as one hydrogeologic unit. This statement implies that flow within the upper Denver Fm under these circumstances can occur under unconfined conditions because of the relatively high hydraulic conductivity (K) of the Denver sandstones and minimal contrast in K values between the Denver Fm and alluvium in these areas.

The explanation of this localized phenomenon will be expanded in the text to avoid any misinterpretations.

COMMENT

10. Page 3-50, Section 3.3.1.1.

This section should, but does not, provide a statistical treatment of the analytical data. See EPA "Guidance on Remedial Investigations Under CERCLA," at 3-4, and 8-11 to 8-12 (June 1985).

RESPONSE

There is no discussion of the need for statistical treatment of data in the more recent EPA Guidance Document of March 1988.

The cited references would seem to deal more with data validity. A discussion of the QA/QC data is provided in Section 3.3.3, however, we do not believe that there is enough QA/QC data to warrant a rigorous statistical treatment. Because the intent of your comment is not clear, we are willing to discuss it with you if we have not addressed your concern.

COMMENT

11. Pages 3-50 - 3-54.

The data presented in Tables 3.3-1 and 3.3-2 provides a listing of the frequency of detection and range of concentrations for target analytes for samples collected from the alluvial aquifer. It is assumed that the detection limits, i.e., CRLs, are derived by USATHAMA protocols and that the detection limits are laboratory-specific and method-specific. If this is the case, the report should reflect this information in this section.

Also, the tables should identify the analytical methods, i.e., GC/MS, GC/electron capture detector, ICP, etc., for each compound listed. In many cases more than one analytical method is available, and it is not clear from Table 3.3-1 whether the number of concentration exceeding CRLs represents data from one method or several analytical methods.

RESPONSE

The information requested is provided in Table 2.1.-4, on pages 2-14 and 2-15. The assumption that CRLs are derived by USATHAMA protocols and are laboratory- and method-specific is correct. The data provided in Table 3.3-1 represent only one analytical method for all the analytes but two. Mercury and arsenic were analyzed by different methods in the Denver and Gainesville laboratories as specified in Table 3.3-1.

COMMENT

12. Pages 3-56 - 3-57, paragraphs 2 and 3.

The report states that aldrin and isodrin were not observed at concentrations exceeding CRLs in samples from wells in the Offpost Operable Unit. The report continues, however, with the following statements:

"Aldrin and isodrin were observed at concentrations exceeding CRLs in analyses from previous sampling episodes. Although these analyses will not be discussed further here, they will be addressed in the endangerment assessment."

The endangerment assessment should be based upon information presented in the RI. Historical information from previous sampling campaigns, and possibly of questionable quality, should not be incorporated in the endangerment assessment.

RESPONSE

The Offpost Endangerment Assessment (EA) has evaluated data from one additional sampling quarter, Winter 1987 (March, April 1987) or from all data collected in 1987 (i.e., the RI only presents data from the Spring and Summer 1987 Quarter) and was also detected sporadically offpost during 1985 and 1986 sampling events. Because aldrin was detected in the Winter 1987 sampling quarter and detected sporadically offpost during 1985 and 1986, it has been evaluated by the EA. Isodrin has not been detected in the Offpost Operable Unit since the Revision III-360° Program began monitoring in December of 1985 and will not be evaluated by the EA. The text will be revised to reflect these facts.

The Winter 1987 data were not included in the RI because the most recently installed offpost alluvial wells (23 wells) were not available for sampling during the Winter 1987 quarter. Thus, the limited number of analyses obtained during the Winter 1987 quarter would have provided little if any additional information which had not already been presented in the Contamination Assessment Report (CAR) (ESE, 1987). For this reason, data from the Winter 1987 quarter were not presented in the RI report. However, data from the Winter 1987 quarter were used in the EA to provide a larger data base with which to evaluate the variability in contaminant concentrations from critical wells (i.e., 37344, Boller, etc.). Chemical data obtained from offpost wells during the Winter 1987 quarter will be provided in the Draft Final version of the RMA Water Remedial Investigation.

COMMENT

13. Page 3-109, Section 3.3.4.4.

It should be noted that, in particular, the confirmation of dieldrin or endrin in offpost ground water by GC/MS has not been possible in any of the analyses.

RESPONSE

Confirmation of dieldrin and endrin in offpost ground water by GC/MS would not be expected because the GC/MS Method Detection Limits are approximately three to four times higher than the highest offpost concentrations detected by the GC method. The substantial differences between organochlorine pesticide detection limits for the GC and GC/MS methods are discussed in Section 3.3.4.4.

COMMENT

14. Page 9-1 through 9-3.

A discussion of the Irondale Groundwater Contaminant System should be included here with the other systems since the downgradient groundwater is within the Offpost Operable Unit.

RESPONSE

We will provide a brief discussion of the Irondale ground water containment system here even though the areas downgradient of the system fall under the jurisdiction of the EPA.

NOTE: Comments from Shell on potential ARARs are addressed separately.

STATE OF COLORADO

COLORADO DEPARTMENT OF HEALTH

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Roy Romer
Governor

Thomas M. Vernon, M
Executive Director

November 16, 1988

Mr. Donald Campbell
Office of the Program Manager for
Rocky Mountain Arsenal
Attn: AMXRM-PM, Building 111
Commerce City, CO 80022-2180

RE: The Offpost Operable Unit Remedial Investigation and Chemical Specific Applicable or Relevant and Appropriate Requirements Draft Final Report

Dear Mr. Campbell:

Enclosed are the State's comments on the Offpost Operable Unit Remedial Investigation and Chemical Specific Applicable or Relevant and Appropriate Requirements Draft Final Report. The report presents a more rigorous discussion of groundwater contamination than the Army has presented in the past. Nonetheless, there are numerous areas of concern that have not been addressed. Those areas are discussed in detail in the enclosed comments.

As the report is or will be available to the public, we suggest that it not be finalized due to the recognized need to collect further data and because further data collection may change conclusions that appear in the text. If the report is finalized, the Executive Summary should include a statement acknowledging that additional information is being collected and may alter the conclusions. Such a statement is important so that the public is not misled with respect to the nature and extent of contamination affecting offpost areas.

As you know, the report contains a vast amount of information. The State reviewed these data as extensively as possible in the comment period provided. The State will continue its review and will provide additional comments as necessary.

The Final Task 39 Technical Plan indicates that a number of issues would be addressed in the Offpost Remedial Investigation Report. However, it does not appear that all of those issues have been addressed in the RI report. Therefore, the State has

included several comments which relate to statements made in the Task 39 Technical Plan.

If you have any questions regarding the comments, please contact Mr. Greg Brand with this Division.

Sincerely,

David C. Shelton
Director, Hazardous Material and Waste
Management Division

PB/rw

pc: Michael R. Hope
David L. Anderson
Chris Hahn
Edward J. McGrath
Connally Mears
Mike Gaydosh
Lt. Col. Scott Isaacson
Tony Truschel

enclosure

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RESPONSE TO COMMENTS
FROM COLORADO DEPARTMENT OF HEALTH

December 13, 1988

GENERAL COMMENTS

COMMENT 1

1. Throughout the Offpost Operable Unit Remedial Investigation and Chemical Specific Applicable or Relevant and Appropriate Requirements Draft Final Report, the Army acknowledges that the data collected to date suggest that additional information is needed to fully define the nature and extent of off-post contamination. The State agrees that additional data should be collected. Therefore, the report should not be finalized until sufficient information has been collected, or in the event the report is finalized, a statement should be included in the Executive Summary indicating that data collection is ongoing and that the conclusions set forth in the report may change.

RESPONSE

It is the Army's position that the nature and extent of offpost ground water and surface water contamination have been sufficiently described for conducting an Endangerment Assessment/Feasibility Study (EA/FS). We do recognize the need to collect additional data to support remedial design. However, we believe it would be inappropriate to delay the cleanup of ground water in the offpost area to collect data which will not have an impact on the EA/FS.

The Army has also recognized the need to collect additional data pertaining to other media, such as sediments and soils, in the Offpost Operable Unit. Although the data available suggest that these media have been largely unaffected by contamination from RMA, we are currently collecting additional data relative to these media to supplement the data presented in the Remedial Investigation (RI). If these data suggest that these media will require eventual remediation, they will be addressed in an addendum to the RI and EA/FS reports.

NOTE: Assume 2nd Comment #1 is Comment #2.

COMMENT 2a

2. Substantial available sources of relevant data have not been utilized or incorporated in the offpost remedial investigation. The failure to include all available information in the interpretations presented in the offpost remedial investigation may result in an incomplete characterization of the offpost contamination and result in an underestimate of the areas potentially affected by contamination migrating from RMA. The draft report should be redrafted to include currently available data from the following sources:

a. Historical data from the domestic ("DOM") and other ("OTH") series wells. (By failing to include this information in the offpost remedial investigation, a substantially smaller zone of shallow groundwater contamination is depicted in the report than that documented historically. See general comment number 4.)

RESPONSE

Domestic wells have not been constructed to meet specifications for water quality monitoring wells. Thus, water chemistry data from these wells may be of questionable quality. The "DOM" and "OTH" series wells have not been monitored in 1987 and it is not appropriate to include historic data from these wells when constructing chemical distribution maps for 1987.

The chemical distributions obtained from the consumptive use programs were compared to those prepared in the RI and are in general agreement. Permanent monitoring wells were sited to encompass those areas indicating contamination as a result of the consumptive use monitoring. We agree that additional wells will be needed for remedial design downgradient of the irrigation canals where the plumes emanating from RMA are significantly diluted by virtue of recharge from the canals. We will incorporate specific recommendations you may have for selecting locations for additional monitoring wells downgradient of the canals.

COMMENT 2b

b. Historical shallow aquifer contamination data north of 112th Avenue and west of Havana Street documented in the 1987 Offpost CAR and various Army consumptive use program reports. (Without prior knowledge of the Rocky Mountain Arsenal, the public (or any other reader) will not have any concept of the historical extent of contamination. Furthermore, the failure to include this information is misleading in that contamination migration calculations will be based on the present interpretation of the extent of a plume rather than on the historical extent of a plume.)

RESPONSE

A clearer summary of the results of the Offpost CAR (ESE, 1987) and the Consumptive Use Reports will be included in the RI. Much of this background data was included in the Technical Plan and distribution plots from these programs will be included in the Final RI Report.

This comment suggests that contaminant concentrations and distributions in the Offpost Operable Unit have remained relatively unchanged since the Consumptive Use programs were conducted. However, contaminant concentrations have fallen steadily offpost as evidenced by chemical results for samples from monitoring wells downgradient of the RMA north boundary. The Army is willing to address specific data gaps where low levels of RMA contaminants, particularly DIMP, have been detected in the Offpost Operable Unit. But, the Army does not believe that the data collected several years

ago from domestic wells necessarily represents the present extent of contamination. Also, full size drawings showing the distribution of DIMP and other target analytes are available to CDH upon request as indicated in our response to Specific Comment #12.

COMMENT 2c

c. Data collected pursuant to the EPA RMA Offpost RI/FS.

RESPONSE

Data from the EPA RMA Offpost RI/FS are only included to the extent that they impact conclusions reached for areas under the jurisdiction of the Army. It is neither logical nor cost-effective to present data which is relevant only to areas under the jurisdiction of the EPA and has no bearing on the areas being addressed by the Army. However, a summary of potential sources in the EPA study area, resulting plumes that may be impacting the area north of 80th Avenue and a general discussion of the nature and extent of contamination in the Irondale area will be added to the Final RI Report.

COMMENT 3a

3. Data from the following sources should be included in the offpost remedial investigation as soon as it becomes available:

   a. Results from the Tri-County Health Department door-to-door survey in the offpost operable unit area. The survey will better define the location of wells, well depth, how the well water is used, and how long people have lived or worked on the property. The findings of this survey will likely increase the number of known wells which are or have the potential to be contaminated from the Rocky Mountain Arsenal. The Army should be prepared to initiate a comprehensive sampling program for new wells to assess public exposure to RMA contaminants. The results of this sampling program may effect the definition of the extent of contamination in the offpost remedial investigation study area.

RESPONSE

The Army has conducted mail and door-to-door surveys in the Offpost Operable Unit from December 1984 to October 1986 and is confident we have identified most users of alluvial ground water. However, the Army has already stated their willingness to initiate a comprehensive sampling program for new wells identified by Tri-County Health Department. Because the door-to-door survey is just beginning, it is doubtful that analytical data from a future Consumptive Use Program would be available within the next several months. We do not believe that results from additional private well samples will alter the definition of the extent of offpost ground water contamination. Thus, the postponing of remedial actions offpost to wait for additional Consumptive Use data is not warranted.

COMMENT_3b

b. Data from the recently discovered seeps occurring at residences immediately north of the North Boundary Containment System. The State and the Army sampled one of the seeps on November 11, 1988. State data from these samples will be provided to the Army as soon as they are available. If the seep contains contamination associated with the Rocky Mountain Arsenal, these occurrences will need to be investigated further.

RESPONSE

The Army has initiated a program to sample several seeps noted along First Creek just north of the North Boundary Containment System (NBCS). The Army is prepared to conduct a thorough investigation of this potential pathway if preliminary data indicate these seeps are contaminated. Although this information will not be presented in the RI/EA/FS, these data will be evaluated to determine if unacceptable risks are present. If unacceptable risks are identified, remedial action(s) will be implemented as soon as possible to mitigate them. However, we do not believe that remediation of the source of these seeps (i.e., alluvial ground water) should be postponed to wait for the results of this sampling program. This data will be provided in an addendum to the RI and EA/FS reports.

COMMENT

4. As the State's Task 39 and Offpost CAR comments indicate, it is inappropriate to arbitrarily limit the boundaries of the offpost remedial investigation study area. As stated in general comment number 1 above, the historical data base demonstrates that the contaminant distribution from RMA extends beyond the Army's study area. It makes little sense to design and implement an offpost remedy without evaluating all available data. Using a subset of the available data may result in the implementation of an incomplete remedy.

   In addition, the north and northeast boundaries of the study area appear to be inhibiting a full definition of the extent of contamination. The limits of the offpost remedial investigation study area must be defined by the extent of contamination adjacent to and migrating from the RMA, not by pre-selected boundaries.

   Similarly, it is inappropriate to propose to limit the definition of the extent of contamination hoping that elevated health-based action levels will somehow eliminate the need to define the distal extent of the low level contamination. The NCP requires that the nature and extent of contamination be fully defined as part of the remedial investigation/feasibility study. Furthermore, future toxicological studies may indicate that chronic exposures to low concentrations of RMA contaminants may have adverse public health effects. Therefore, efforts must be made to define the full extent of offpost contamination within the limits of current technology during the offpost remedial investigation.

RESPONSE

The historical data presented in the Consumptive Use Phase I Report (CU Phase I) do not support CDH's comment (ESE, 1985). As presented in this report, the three wells which lie to the north and northeast of the Offpost Operable Unit northern and northeast boundary, did not exhibit detectable levels of any RMA contaminants (DIMP, DBCP, DCPD, chlorinated pesticides, volatile aromatic or volatile organohalogens). Furthermore, as stated previously, the Army contends that the extent of contamination as depicted by the CU Phase I Report and the Offpost CAR are consistent with that presented in the RI.

The second and third paragraph of this comment suggest that the boundaries of the Offpost Operable Unit were set without any consideration of preliminary chemistry and hydrogeologic data. This is not the case since monitoring has been conducted to the north and northeast of the Offpost Operable Unit boundaries. The boundaries have been established based upon preliminary monitoring data and ground water and surface water flow patterns. We believe that the boundaries have been appropriately set incorporating monitoring data and using sound scientific judgement.

COMMENT 5

5. There are an insufficient number of alluvial aquifer monitoring wells northwest of the Northwest Boundary Containment System to define the extent of shallow groundwater contamination. It is impossible to detect contaminants northwest of the Burlington Ditch with the present monitoring system. Sections 15 and 16 only contain monitoring wells at coarse density along their north and south section lines. Additional monitoring wells are needed in Sections 15 and 16 to correct this problem.

   Contaminants such as chloroform and DIMP have been detected historically in the area northwest of the Northwest Boundary Containment System (offpost sections 9 and 10) with the aid of consumptive use wells. A chloroform plume has been preliminarily delineated in this area (Figure F-23), but too few wells exist to define the extent of the contamination. The 1977 Konikow groundwater modeling investigation showed this area to be a significant past contaminant pathway. The northwest plume is a significant pathway that must be fully defined. A plan to fully investigate the northwest plume should be drafted and provided to the MOA parties for review and comment.

RESPONSE

We are in agreement that more monitoring wells will be needed in Sections 15 and 16 for remedial design. The Army is willing to discuss CDH's specific recommendations for additional monitoring in this area. However, CDH should realize that well siting in this area will be more difficult because of lack of access to private land.

The Army believes that the nature and extent of contamination downgradient of the Northwest Boundary Containment System (NWBCS) is reasonably well understood. However, the extent of contaminants which persist in this area (i.e., primarily chloroform, and dieldrin) need further definition for remedial design. A plan for a supplemental technical investigation (STI) will be formulated as a part of alternatives developed in the FS. The results of this monitoring will be provided in the remedial design document for this area.

COMMENT 6

6. There are an insufficient number of upper Denver Formation groundwater monitoring wells up and downgradient of the Northwest Boundary Containment System to determine the extent of upper Denver contamination in this area. The limited monitoring wells upgradient of the Northwest Boundary Containment System indicate the presence of Denver Formation contamination (e.g., aldrin and dieldrin). Therefore, additional monitoring wells up and downgradient of the containment system must be installed to determine the full extent of Denver Formation contamination.

RESPONSE

Substantial monitoring of the Denver Fm downgradient of the North Boundary Containment System (NBCS) has been conducted. The primary contaminant pathway to the Denver Formation (Fm) downgradient of the NBCS was identified in the RI as vertical migration from the alluvial aquifer. Average linear velocities within the most permeable zones of the Denver Fm do not support the potential for extensive lateral migration through the Denver Fm. As such, the potential for Denver Fm contamination downgradient of the NWBCS is expected to be directly related to the level of contamination in the overlying alluvium. Because alluvial aquifer contaminant concentrations downgradient of the NWBCS are generally orders of magnitude less than those observed downgradient of the NBCS, a corresponding decrease in contaminant concentrations in the upper Denver Fm downgradient of the NWBCS is expected. However, the Army realizes the need to evaluate the potential for Denver Fm contamination downgradient of the NWBCS with actual monitoring data. The Army is willing to discuss your specific recommendations for monitoring of the Denver Fm downgradient of the NWBCS and incorporate them into a plan for the STI discussed in our response to Comment #5.

COMMENT 7a

7. While progress has been made in mapping and correlating Denver Formation sand units upgradient and downgradient of the North Boundary Containment System ("NBCS") (including an enhanced understanding of contaminant movement in the Denver Formation along the north boundary, the distribution of contaminants immediately downgradient from the boundary, and the estimation of vertical gradients) two issues must be resolved prior to evaluating remedial alternatives. Those issues are:

a. Contaminated Denver Formation monitoring wells that could not be correlated with sandstone units identified onpost or at the NBCS need to be assessed to determine how the wells became contaminated (i.e., what was and currently is the transport mechanism); and

RESPONSE

We believe that these wells became contaminated primarily as a result of vertical migration from the alluvial aquifer. In the few instances where contamination of the Denver Fm extends beneath the upper sand units at a cluster site, the most probable pathway is migration down poorly constructed Denver Fm wells just upgradient of the detections. For example, a poorly constructed consumptive use well completed in the Denver Fm was abandoned near 96th Avenue and Peoria Street several years ago. The examination of travel times in the Denver Fm, presented on page 3-118, does not support a theory of lateral migration over significant distances through the Denver Fm. We do not believe that the contamination is the result of lateral migration from near source areas through the Denver Fm. For the majority of organic contaminants, this explanation was reinforced by the absence of contamination in stratigraphically equivalent units upgradient and onpost. Thus, even though several offpost Denver Fm wells could not be correlated with onpost units, we believe that the transport pathways are understood reasonably well.

COMMENT 7b

b. The hydrology and contaminant distribution should be further evaluated to determine if contaminants observed in the Denver Formation are due to lateral movement in sandstone units across the north boundary or by downward movement from the alluvial aquifer to the Denver formation (as evidenced by observed vertical gradients downgradient of the north boundary). The State suspects that both scenarios result in Denver Formation contamination.

RESPONSE

As stated in our response to comment 7a, we believe that the contamination present offpost in the Denver Fm is primarily a result of vertical migration from the alluvial aquifer offpost (either by natural migration or migration down poorly constructed wells). However, we agree that for some compounds, most notably chlorobenzene and benzene, migration pathways are not clear. An evaluation of transport pathways is complicated by large numbers of Denver Fm wells onpost near the north boundary and offpost (for example, bedrock wells have been abandoned onpost near 96th Avenue and just north of RMA) that may have acted or are currently acting as preferred pathways to the Denver Fm. Thus, transport mechanisms to the Denver Fm are complex. Despite this, the travel times within the Denver Fm discussed on page 3-118 do not support the scenario of vertical migration upgradient of the NBCS and then lateral migration to offpost Denver Fm monitoring wells. Additional discussion of pathways to the Denver Fm is provided in the forthcoming Regional Ground Water Flow Modeling at RMA report.

COMMENT_8

8. While progress has been made in identifying nontarget compounds detected in groundwater, efforts must continue to identify additional semi-volatile unknowns, such as UNK 582, UNK 586, UNK 589, UNK 652, and UNK 657. The State agrees that caprolactum, dichlorobenzene and Bis-phthalate should be added to the offpost target analyte list. The State also agrees that additional GC/MS analyses on the acid fraction for semi-volatile organics is necessary. The State further recommends that samples from new monitoring wells constructed under the Composite Well Program be GC/MS screened, particularly wells which will be constructed in the northwest plume area.

RESPONSE

HLA to respond.

COMMENT_9a

9. The State concurs with the need to model the offpost groundwater system to simulate future contaminant concentrations in the alluvial aquifer. However, numerous issues and questions need to be resolved before the findings and conclusions drawn from the modeling effort can be accepted.

   a. Harding Lawson Associates ("HLA") has assembled a large data base of aquifer properties and water level information. The offpost modeling effort should utilize the information from the HLA database.

RESPONSE

The ground water flow/transport modeling effort in the RMA Offpost Operable Unit, included all the available information in this area. These data contain all information from previous studies in the area (Konikow, 1975, 1977; Robson, 1976, Warner, 1979; MKE, 1987; Ebasco, 1987; and SACWSD, 1987) as well as data from Tasks 25, 36, and 39 and the most recent information published by ESE (1988). This includes the data from the Water Remedial Investigation Report (WRIR).

COMMENT_9b

   b. Kriging was used to estimate aquifer properties and water table elevations (pg. 3-145) yet no details are provided in the report. Similarly, a storage coefficient of .05 to .25 was assigned in the model, but no distribution was provided. This information should be included in the report.

RESPONSE

Details of the Kriging, including semi-variograms, are on file and available upon request, but we do not feel this information is appropriate or necessary for the RI report. The Kriging was used to make a first estimate of aquifer properties used in the model. These data were then adjusted during the model calibration procedure to achieve a best fit between the model calculated water table elevation and the observed water table elevation. The Kriging aided in the calibration of the model by minimizing the number of calibration simulations needed to achieve acceptable agreement with water table data.

In the vicinity of the NBCS to the O'Brian Canal a storage coefficient of .05 was used. Elsewhere in the model area a storage coefficient of .25 was used. A discussion of the distribution of storage coefficient values used in the model will be included in the report.

COMMENT 9c

c. A no-flow boundary was used for the contact between the alluvial aquifer and the Denver Formation. A sensitivity analysis should have been performed on the boundary condition to verify the validity of the no-flow boundary assumption. (Leakage from the Denver Formation could be very important to scenarios 3 and 4.)

RESPONSE

Model simulations were conducted to study the impact of leakage from the Denver Formation on flow in the alluvial aquifer. Leakage from subcrops of the Denver Formation as well as upward leakage from the underlying Denver Formation were modeled. This leakage had negligible effect on flow in the alluvial aquifer. With regard to scenarios 3 and 4 (South Adams County Wellfield pumping), the major recharge sources to the alluvial aquifer between the O'Brian Canal and Burlington Ditch and the South Platte River were canal leakage (2400 gpm) and infiltration of irrigation water (2335 gpm). Leakage from the Denver Formation is several orders of magnitude less than this. Thus, the fraction of total flow from the Denver Fm is very small and would have negligible affect on the results of simulations 3 and 4.

COMMENT 9d

d. Similarly, sensitivity analyses should be performed on the northeast and southwest boundaries. Based on the water table map (Figure G-6), these boundaries could be approximated by flow lines (i.e., no-flow boundary.) How were the underflows of these boundaries determined?

RESPONSE

In the calibration simulations the northeast and southwest boundaries were specified head. The calibrated model was then used to calculate the flow across these model boundaries. The model calculated flow quantities across the southwest model boundary were compared with MKE modeling efforts in the nearby area and found to be in reasonable agreement. Note that the aquifer thickness is fairly large along the Southwest boundary which results in significant underflow across this boundary. The aquifer thickness along the northeast boundary is less and the resulting underflow is smaller.

COMMENT 9e

e. It does not appear that a mass balance was computed for the model. Was it? The percent errors for various simulations should be presented in the report.

RESPONSE

Mass balance error for flow and contaminant mass were calculated by the model. This is an internal check in the model. Mass balance errors were less than one percent for flow and less than 2.5 percent for contaminant mass in the model simulations. These overall mass balance results will be added to the text of the RI. Mass balance details are on file and are available upon request.

COMMENT 9f

f. A sensitivity analysis must be completed for the recharge estimates assigned to the Burlington Ditch and the O'Brian Canal. These canals appear to have an important impact on contaminant plumes. If the leakage is overestimated, the steady-state history match will overestimate hydraulic conductivity and result in a model that underestimates flushing times to clean up the aquifer.

RESPONSE

Recharge quantities for canal leakage and percolation of irrigation water were obtained from the MKE recharge study (MKE, 1987). The MKE recharge data were analyzed on a cell by cell basis and used in the current model. No significant changes in the MKE recharge data were made. Minor changes made in the MKE recharge estimates include a reduction in recharge from irrigation in the vicinity of the Fulton Canal, and redistribution of canal leakage to better match water levels during the calibration process It is important to note that total canal leakage was kept constant.

COMMENT 9g

g. The report should indicate how First Creek leakage was treated. Depending upon the location and the time of year, First Creek can be either gaining or losing.

RESPONSE

On average, First Creek loses water to the alluvial aquifer as described in Section 4.0. The average annual leakage from First Creek was determined from flow data obtained at the gages at the North Boundary of RMA and at Highway 2. This recharge to the aquifer was assumed to be constant. Because the bottom of the impoundment along First Creek is always above the water table, while other reaches of First Creek may gain or lose water, the total recharge was assumed to be from the impoundment. A description of how recharge from First Creek was treated will be added to the text.

COMMENT 10

10. The surface water and sediment sampling performed in First Creek are insufficient. As the State's Offpost Contamination Assessment Report comments indicate, the sediment sampling program is insufficient to fully characterize the presence of contaminated sediment in the First Creek/O'Brian Canal drainage system. The offpost remedial investigation merely resampled the two First Creek sample points. Therefore, a more intensive sediment sampling program must be implemented focusing on First Creek, the First Creek impoundment, and the area downstream from the confluence of First Creek and the O'Brian Canal. The samples should be collected at a maximum of 1,000 foot intervals, with at least two samples collected at every location to evaluate local concentration variability.

RESPONSE

The premise of this comment is that the offpost CAR sampling locations were merely resampled. This is not correct. The reviewer is referred to Figure 2.3-1 which shows the latest sampling locations. In particular, it should be noted that two samples were collected and analyzed from the First Creek impoundment. No organic contaminants were detected in these samples. This is a significant finding because the impoundment would be expected to act as a sink for the accumulation of contaminated sediments from First Creek.

The sampling locations along O'Brian Canal and Barr Lake are also different from those in the Offpost CAR. The Army recognizes however, the need to collect additional sediment samples along First Creek and is willing to discuss your specific recommendations. The results of additional sediment sampling and analyses will be provided in an addendum to the RI.

COMMENT 11

11. The State has recently proposed a surficial soils sampling program to assess windblown contamination in non-source areas onpost. The offpost area may also be a receptor of windblown contaminants and should be investigated in a similar fashion. The State proposes that a meeting be scheduled to discuss specific sampling locations.

RESPONSE

Based upon a preliminary review of this pathway the Army does not believe that the windblown pathway is a significant exposure route in the Offpost Operable Unit. The Army is willing to discuss your specific recommendations for sampling locations but would also like to discuss the plausibility of this pathway by evaluating the potential for it to occur. For example, this evaluation could be most effectively accomplished by performing long-term air dispersion and deposition modeling. If the results of this assessment indicate substantial migration of contaminants via this pathway, then sampling could be performed using the model results as a guide. Again, we are willing to discuss your recommendations but would also like to explore other approaches for evaluating this potential pathway with CDH.

COMMENT_12

12. It is evident that remedial actions which will be conducted at RMA are likely to cause significant air emissions which will impact residents offsite. For example, the recent air and odor emissions associated with the closure of Basin F indicate that an offpost air quality monitoring program must be included in the Comprehensive Monitoring Program and operated continuously. Actually, observed data should be used in the offpost endangerment assessment rather than predictive data. The actual monitoring data should also be used to verify the predictive results. Every available means to control air emissions must be employed and incorporated into all remedial actions.

RESPONSE

The Army is committed to taking every precaution to control air emissions that result from remedial actions onpost. However, we feel it is important to recognize that current results from offpost air monitoring stations do not represent baseline offpost conditions and only constitute a temporary condition. Thus, the use of this data to evaluate long-term exposures is not appropriate. Interim responses to control emissions will be conducted during all remedial actions to minimize airborne emissions.

COMMENT_13a

13. The Final Task 39 Technical Plan indicates that certain data would be collected for use in the Offpost Endangerment Assessment. Those data are not presented in the draft report and it does not appear that the information was collected as part of the offpost investigation. A separate section on offpost land-use and demography should be included in the final offpost remedial investigation. Information which should be defined, to the extent possible, and factored into the report includes:

    a. Current land-use, water use, biota population, and characterization of human populations (i.e., identification of potentially sensitive subpopulations such as children, pregnant women, infants, and the chronically ill).

RESPONSE

Much of this data was gathered as part of the offpost assessment and is more appropriately included in the Offpost Endangerment Assessment (EA). The specifics of this comment will be addressed in responses to comments on the EA report.

COMMENT 13b

b. Future land-use and water use based on future development of areas east, northeast, north, and northwest of the Rocky Mountain Arsenal. For example, the proposed 96th Street Highway, the proposal to construct E-470, and the proposal to construct a new airport east of RMA will impact on the growth patterns around the RMA. Similarly, the South Adams County Water and Sanitation District ("SACWSD") plans for water needs and water use north, northeast, and northwest of the RMA must be incorporated into the report.

This information is essential in estimating the human populations which will likely be exposed to RMA contamination.

RESPONSE

We agree these factors need to be considered and they have been examined in the EA.

COMMENT 14

14. The Final Task 39 Technical Plan indicates that the Offpost Endangerment Assessment would be available at the same time as the offpost RI report. During the October, 1988, MOA meeting, the Army indicated that the Endangerment Assessment would not be available until the Feasibility Study report is released. The Endangerment Assessment must be made available prior to the Feasibility Study if any party is to have a meaningful opportunity to review and comment on the report.

RESPONSE

The referenced meeting was not an MOA meeting but rather a meeting of the RMA committee pursuant to the RI/FS process document.

Consistent with the Technical Program Plan and the Army's comments at the October 1988 meeting, the EA will be released for comment in conjunction with the FS.

COMMENT 15

15. The Final Task 39 Technical Plan states at page 9-3, section 9.1 that, "industrial or commercial facilities that routinely use solvents will be identified in specific portions of the study area where anomalous contaminant levels have been observed." It is unclear where this data

was or is to be reported. However, the data are not included in the offpost remedial investigation report.

RESPONSE

Several facilities have been identified in the EPA study area that may have impacted the water quality in the southern portion of the Offpost Operable Unit where solvents have been sporadically detected. A summary of these data will be provided as indicated in our response to comment #2c.

SPECIFIC_COMMENTS

COMMENT

1. Pg. 1-3. The text should include a summary of findings from EPA's RMA Offpost RI/FS for the area south of 80th Avenue and west of RMA.

RESPONSE

See response to comment #2c.

COMMENT

2. Pg. 1-4. The offpost operable unit is not conservative and fails to include the western boundary, an area known to be impacted by contamination migrating off the Arsenal. All identified groundwater contaminant flowpaths from RMA should be included in this report. Therefore, this report should include an evaluation of the contamination migrating off the western boundary of RMA.

RESPONSE

Multiple sources have been documented in the area to the west of RMA and are currently under investigation in connection with the EPA's Second Offpost Operable Unit. As per an Executive Order No. 12580, 52 CFR 2923 (1987), the area is under the jurisdiction of the EPA.

COMMENT

3. Pp. 1-5 and 1-6. The text should include a summary of the problems associated with the boundary systems and a summary of findings from Tasks 25 and 36.

RESPONSE

An introductory statement will be included to discuss the boundary system(s), a reference to Tasks 25 and 36, and a brief summary of the relevant findings. The specific findings of these tasks are provided in the Task 25 and Task 36 reports.

COMMENT

4. Pg. 2-6. Tables 2.1-1 lists monitoring wells 37310, 37319, 37323 and 37365 as alluvial aquifer wells. Figure 2.1-4 states that the same wells are Denver Formation wells. Please modify the report to properly characterize the aquifer monitored by the wells.

RESPONSE

The text will be modified to correct this inconsistency.

COMMENT

5. Pg. 2-16. The analytical data used in this investigation will not be used solely for the RI/FS engineering efforts, as stated. These data also will be used in support of the endangerment assessment. Given the toxicity of certain RMA contaminants, the lowest detection levels should be attained. Therefore, it is inappropriate to use CRLs. The risk of reporting false negatives is the same for the CRL and MDL methodologies (approximately 50%). The analytical methodologies are also of similar difficulty and cost. Therefore, MDL methodology must be used to achieve the lowest detection levels and to assure that the detection levels are lower than the action levels.

RESPONSE

The Army believes that the concentrations below the CRL lie within a range where the uncertainties are too large to justify quantification. Although these highly uncertain results are not sent to the RMA data management system, they are available as raw data to supplement reported results where there may be ambiguities or contradictory results. We believe that the CRL estimates from the USATHAMA procedure are better representations of what will be achieved in long-term programs conducted by contractor laboratories. A more comprehensive discussion of the rationale for using the CRL methodology is provided in the "Development and Evaluation of Analytical Methodologies Used in RMA Soil Investigations" (Ebasco, April 1988).

COMMENT

6. Pg. 2-27. Table 2.4.1 indicates that hydrochloric acid was monitored in a previous air quality monitoring program. The results should be included in the report.

RESPONSE

The intent of Table 2.4-1 was to provide a general understanding of previous air quality monitoring programs that had occurred during a variety of activities at the RMA. As in the case of hydrochloric acid monitoring, air quality samples were collected in 1969 during demilitarization activities. Reporting hydrochloric acid data here does not seem appropriate as activities suspected of generating hydrochloric acid have ceased.

COMMENT

7. Pp. 3-6, 3-17, and 3-46. The Army needs to confirm the existence of the 50 to 100 foot clayshale "buffer zone" which apparently provides hydraulic separation between the Arapahoe and Denver formation aquifer systems. This determination can be made by constructing groundwater monitoring wells into the Arapahoe formation. These wells should be used to monitor the potentiometric surface and water quality of the Arapahoe aquifer.

RESPONSE

The Army does not agree that monitoring wells should be constructed into the Arapahoe Formation to "confirm" the buffer zone. The presence of the buffer zone is well documented and merely confirming its presence does not justify the risk of cross-contamination caused by extensive drilling into the Arapahoe Formation. The Army will continue to monitor existing Arapahoe wells in the Offpost Operable Unit to assess the water quality of this aquifer.

COMMENT

8. Pg. 3-33. Konikow's 180 gpm/mile groundwater recharge estimate from the Burlington Ditch and O'Brian Canal leakage appears to be low. A 1988 field investigation conducted by MKE (the results of which the State has not received) and groundwater modeling work by Harding Lawson Associates, provide more comprehensive and more recent estimates of groundwater flow than the Konikow estimate. The most recent estimates should be used in the offpost remedial investigation.

RESPONSE

We are in agreement with this comment. The Konikow estimate was only used as an approximation early in this section of the report to demonstrate that recharge from the canal is substantial. Morrison-Knudsen's recharge estimates were used for numerical modeling (MKE, 1987). A consistency check has been performed by HLA to address any differences between the RMA regional model in the Offpost Operable Unit and the offpost RI model. This check revealed that the recharge estimates for the irrigation canals used in both models were similar.

COMMENT

9. Pg. 3-39. Denver formation aquifer pumping tests, similar to those conducted at the north boundary, should be conducted along the northwest boundary due to the variability of the hydraulic properties of the Denver formation.

RESPONSE

A substantial data base for the hydraulic properties of the Denver Fm exists at RMA. Although we agree that the hydraulic properties vary substantially across RMA, we believe that the existing data base should be examined before additional pumping tests are conducted. Much of these data are presented in Task 25. If hydraulic test data are available for Denver Fm units onpost that are similar to units encountered along the RMA northwest boundary, then reasonable estimates of hydraulic properties may be attainable from existing data. Also, the water quality of Denver Fm units downgradient of the northwest boundary should be established before extensive hydrologic testing can be justified.

COMMENT

10. Pg. 3-47. The Arapahoe formation is an important source of municipal water supplies for the metro area, yet no Arapahoe observation/monitoring wells exist at RMA. A potentiometric surface map for the Arapahoe formation should be part of this remedial investigation.

RESPONSE

As pointed out in our response to your comments on the Task 39 Technical Plan, we believe the most prudent method of investigating the bedrock aquifers at RMA is to monitor the uppermost aquifers (those most likely to be affected) and proceed downward to adjacent units which do not indicate contamination. We do not believe that arbitrarily installing wells at depths corresponding to the Arapahoe is an effective approach to defining the vertical extent of contamination nor is it warranted given the risk of cross-contamination associated with drilling into the Arapahoe Fm.

COMMENT

11. Pg. 3-48. The report infers that the contamination detected in the Arapahoe formation is due to poorly constructed domestic wells. While this inference may be true, there are insufficient data to conclude that these wells are the only contaminated Arapahoe formation wells or that poor well construction is the only cause of Arapahoe formation contamination. The Arapahoe formation needs to be further investigated to identify all pathways of contamination and to fully define the extent of contamination in this aquifer.

RESPONSE

The Army will continue to monitor private Arapahoe Formation wells in the Offpost Operable Unit. We do believe that the poorly constructed wells mentioned are responsible for the contamination detected in the Arapahoe

Formation. We do not believe that the low levels of DIMP detected warrant the risk of cross-contamination caused by extensive drilling into the Arapahoe Formation. A program to abandon poorly constructed Arapahoe wells in the Offpost Operable Unit will be evaluated as a part of alternatives examined in the FS.

COMMENT

12. Pg. 3-55 and Appendix F. Please explain why the chemical distribution maps for the alluvial aquifer extend only two miles north of the northern RMA boundary. Known contamination for chloride, chlorobenzene, chloroform, DIMP, fluoride, and sulfate extends beyond this limitation. For example, the consumptive use investigation conducted by ESE in December 1984 and January 1985 showed RMA specific contamination extending into sections 1, 2, 35, 36, and 26. While all of these sections are in the study area, they are not included in the chemical distribution maps. All chemical distribution maps must define the full lateral extent of contamination.

RESPONSE

Full size chemical distribution maps that incorporate the entire Offpost Operable Unit, have been prepared but were too bulky to incorporate in the RI report. With the exception of DIMP, the maps in the report do show the extent of offpost ground water contamination. To facilitate your review of offpost data, chemical distribution maps which incorporate the entire Offpost Operable Unit are available to CDH upon request.

COMMENT

13. Pg. 3-55 and Appendix F. The chemical distribution maps for chloride and sulfate do not adequately represent the contamination which has migrated off RMA. Page 3-69 provides a background concentration range for chloride of 34-102 mg/l, however the isoconcentration lines on Figures F-38 and F-39 begin at 250 mg/l. Similarly, Page 3-69 provides a background concentration range for sulfate of 43-220 mg/l, however the isoconcentration lines on Figures F-44 and F-45 begin at 250 mg/l. All four of these figures must be replotted using a minimum contour of at least 50 mg/l.

RESPONSE

We are in agreement with the intent of this comment. However, a minimum contour interval of 50 milligrams/liter (mg/l) is not appropriate for sulfate because downgradient concentrations are never less than 50 mg/l. The chemical distribution map for sulfate will be redrafted with a minimum contour interval of 150 mg/l. We believe a minimum contour interval of 50 mg/l will be appropriate for chloride and distribution maps for this analyte will be redrafted accordingly.

COMMENT

14. Pg. 3-59. DIMP has been detected in the area downgradient of the Northwest Boundary Containment System (offpost sections 9 and 10). The historical presence of DIMP has not been discussed in the report. As noted in the general comments, the monitoring well network in the area northwest of the RMA must be improved to better define the northwest plume, including the distribution of DIMP.

RESPONSE

Please see our response to general comment #5.

COMMENT

15. Pg. 3-113. Although the section is entitled "Distribution of Nontarget Analytes", very little information is presented on the location and distribution of nontarget analytes (e.g., caprolactum) and the frequently occurring TICs. For the State to verify the reported objectives and conclusions in this section, the original data base had to be searched because of the vague discussion in the text. A more complete evaluation and analysis should be included in the report. Summary maps and tables should also be presented.

RESPONSE

A summary of frequency of detection for TICS will be added to the text. The TICS were not detected frequently enough offpost to justify distribution mapping. However, the wells from which samples exhibited TICS and the concentration ranges will be included in the frequency of detection table to facilitate evaluation of the data.

COMMENT

16. Pg. 3-126. Please clarify whether the last sentence of the first full paragraph with respect to the extent of DCPD contamination downgradient of the NBCS indicates that additional wells are needed in the downgradient area along 96th Avenue.

RESPONSE

This interpretation is correct. Task 36 identified the need for more alluvial water quality monitoring wells in this area to fully assess the effects of the NBCS on the DCPD plume.

COMMENT

17. Pp. 4-3 and 4-7. The text needs to explain in further detail the DIMP detected in First Creek at station 08ADD and in the South Platte River at station 01CDD given that these stations are located upstream of known RMA contamination sources and that RMA is the sole source of DIMP.

RESPONSE

The pathways for these detections of DIMP are not known. Because both detections are just above the CRL, have not been repeated in subsequent samplings, and were only detected in the first surface water sampling event (12/85), we believe the detections are the result of errors in the field and/or in the laboratory. The Army will continue to monitor these stations to verify that they are anomalous results.

COMMENT

18. Pp. 4-20 and 4-21. It is concluded that groundwater discharges to First Creek during periods of low flow is the primary contaminant pathway to offpost surface water. The State concurs with this finding. However, a more extensive surface water/groundwater monitoring and sampling program is needed to determine the spatial and temporal interaction of groundwater and surface water along First Creek. For example, additional surface water sampling stations should be located between stations 13DCC and 14BDD. The additional stations should be sampled during periods of low flow. Continuous groundwater level recorders should also be installed in wells along First Creek to better define the interaction between groundwater and surface water.

RESPONSE

We are in agreement that additional data are needed along First Creek to more fully characterize ground water/surface water interactions in this area. The Army has recently collected additional surface water samples along First Creek and between the upstream and downstream gages. We are going to conduct additional monitoring under the Comprehensive Monitoring Program (CMP) and are willing to discuss your specific recommendations for this work.

COMMENT

19. Pg. 5-1. (See general comment number 10.)

RESPONSE

See our response to General Comment #10.

COMMENT

20. Pg. 6-1 to 6-10. Offsite monitoring for airborne pollutants must be performed. As the lead agency, the Army has the responsibility to define the extent of contamination in all media, including air. The report should explain why actual offsite monitoring for airborne pollutants has not been performed to date.

RESPONSE

Offsite air monitoring was not conducted during the RI because onsite air monitoring near sources showed low-levels of contaminants. There were no remedial actions at Basin F at the time that the RI was underway and onsite air quality levels at the basin were considered worst-case. Now that remedial actions are underway, emissions are somewhat elevated but we stress that it is important to recognize that these levels are temporary and do not represent a long-term exposure.

COMMENT

21. Pp. 6-1 to 6-10. The specific results of the predictive offpost toxic airborne analysis (i.e., predictive concentrations at the boundaries and the data used for input parameters, such as stability, diffusion and wind speed) must be presented in the report. The conservative assumptions that were made regarding the input parameters should also be documented in the report. The findings of the predictive offpost airborne analysis cannot be accepted in the absence of these data.

RESPONSE

The predictive toxic airborne analysis utilized gaussian dispersion method equations under conservative conditions. Specifically, we assumed that emissions evolved from Basin F migrated to the nearest boundary to the northwest. Under slightly stable conditions, winds at 3 miles per hour were moving from southeast to northwest across Basin F. We assumed no volatilization of airborne contaminants during dispersion. A discussion of the input parameters and assumptions used in dispersion calculations will be added to the RI report.

COMMENT

22. Pg. 6-3. The report states that semi-volatile compounds identified near the boundary of Basin F comprise "low concentrations". The State disagrees. Dieldrin and CMPS02 have been detected at maximum concentrations of 1.6 ug/m^3 and 1.7 ug/m^3, respectively. These concentrations are relatively high and may present a significant health risk. Even if the conclusion that offpost concentrations are an order of magnitude lower (a conclusion that cannot be substantiated given the lack of documentation), these toxics are impacting offpost air quality.

RESPONSE

The source of these airborne contaminants is currently being remediated by the interim action being conducted at Basin F. We believe that this is the most effective means of mitigating exposure to these airborne contaminants.

COMMENT

23. Pg. 6-3. The results from the Task 18 onpost air investigations have been used to predict the offpost air concentrations. Previously identified problems with the Task 18 investigation affect the onpost results, and therefore the off-post predictions. The two major problems are:

    a. The limited suite of compounds included in the analytic program. Many compounds could have migrated offpost but were not detected because of the limited analyte suite.

    b. Hi-vol monitors were not located in the direction of predominant high wind events. The worst case scenario of wind transport has not been evaluated in the offpost remedial investigation.

RESPONSE

The Task 18 monitoring program addressed these concerns in the "Air Remedial Investigation Final Report." Relative to the various potential airborne contaminants, there were several volatile and semivolatile organics for which certified methods were used to monitor airborne contaminant concentrations. Additionally, if unknown compounds were detected during sampling, attempts were mae to identify these compounds. We do not feel that many compounds could have migrated offpost and not been detected during Task 18 monitoring. During the upcoming CMP, additional air quality monitoring will be conducted at the basins and at the boundaries. If contaminants are identified that had not been observed previously, their impacts to offpost air quality will be evaluated.

Because the intent was to determine the average ambient TSP levels, we did not focus the TSP sampling specifically on downwind conditions. However, TSP samples were collected at all of the RMA boundaries including in the predominant high wind event direction.

COMMENT

24. Pg. 6-10. Without an offpost air monitoring program, it is impossible to conclude that RMA is not a source of airborne contamination for particulates and ozone.

RESPONSE

Particulate levels at RMA were less at the interior of the Arsenal and greater at the boundaries. Sampling results indicate that offpost of RMA contains more significant sources of particulates than sources onpost. As an example, TSP concentrations at the western boundary are higher than concentrations at the interior of the site, especially during the winter when Quebec Street is sanded.

Offpost sampling for ozone will not provide a direct correlation of ozone levels to the Arsenal. Because ozone is related to widespread point and non-point sources, including hydrocarbons and nitrogen oxides from automobile exhaust, gasoline, and oil storage and transfer facilities and industrial paints, solvents, degreasing agents, cleaning fluids, ink, and incompletely burned wood or coal, it would be difficult to draw direct correlation between the RMA and offpost ozone sources.

COMMENT

25. Appendix H, Pg. v. The text is unclear with respect to the relationship between chemical-specific ARARs and the Endangerment Assessment process. The Endangerment Assessment process cannot be used to unilaterally establish action levels where chemical specific ARARs exist. Please clarify.

RESPONSE

The EA will not unilaterally establish action levels irrespective of ARARs. The process set forth in Figure 2-3 of the Technical Program Plan (and the related text) will be followed in order to integrate ARARs into the EA process.

COMMENT

26. Appendix H, Pg. vi. The text should include 5 CCR 1001-2 through 5 CCR 1001-10 as potential air ARARs.

RESPONSE

The State's suggested potential ARARs will be addressed separately.

COMMENT

27. Appendix H, Pg. vi. The text should include the following potential groundwater ARARs:

- Colorado Basic Standards for Groundwater, 5 CCR 1002-8, Section 3.11.0 et seq. (in particular Tables 1, 2, and 3).

- Colorado Basic Standards and Methodologies, 5 CCR 1002-8, Section 3.1.0 et seq. (in particular Section 3.1.11).

RESPONSE

The State's suggested potential ARARs will be addressed separately.

COMMENT

28. Appendix H, Pg. viii. Contrary to the statement in the text, the State has identified promulgated chemical-specific ARARs for RMA on several occasions. In particular, the State identified ARARs on January 6, 1987, March 7, 1987, and most recently on July 18, 1988. The Army has consistently ignored all promulgated State statutes and regulations. This practice is inconsistent with U.S. EPA actions at Colorado CERCLA sites and is not consistent with Section 121(d) of CERCLA. To the extent the State promulgated standards are more stringent than the federal standards, the State standards must be met. Attachment I contains State identified chemical-specific standards (ARARs).

RESPONSE

The State's position concerning potential state ARAR's will be addressed separately.