DOE/RL-94-32
Revision 0

UC-630,721

State Waste Discharge Permit Application

Electrical Resistance Tomography Testing

Date Published
April 1994

United States
Department of Energy
P.O. Box 550
Richland, Washington 99352

Approved for Public Release

MASTER

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FOREWORD

This permit application documentation is for a State Waste Discharge Permit issued in accordance with requirements of *Washington Administrative Code* 173-216. The activity being permitted is a technology test using electrical resistance tomography.

The electrical resistance tomography technology was developed at Lawrence Livermore National Laboratory and has been used at other waste sites to track underground contamination plumes. The electrical resistance tomography technology measures soil electrical resistance between two electrodes. If a fluid contaminated with electrolytes is introduced into the soil, the soil resistance is expected to drop. By using an array of measurement electrodes in several boreholes, the areal extent of contamination can be estimated.

At the Hanford Site, the purpose of the testing is to determine if the electrical resistance tomography technology can be used in the vicinity of large underground metal tanks without the metal tank interfering with the test. It is anticipated that the electrical resistance tomography technology will provide a method for accurately detecting leaks from the bottom of underground tanks, such as the Hanford Site single-shell tanks.

The electrical resistance tomography testing will take place in the 200 East Area, northwest of the inactive Semi-Works. The testing will use a partially constructed metal tank known as tank 105A. The tank will be fitted with a simulated bottom and backfilled to function as a mock-up of an underground tank. A number of boreholes containing electrode arrays will be placed around the tank mock-up. The test will be performed in two phases. The electrical resistance tomography testing will inject a maximum of 6,000 gallons of water with a tracer of 0.1 molar sodium chloride. This concentration is equivalent to approximately 7,000 milligrams per liter of sodium chloride. Vadose zone modeling indicated that the chlorine concentration will be below the groundwater quality criteria in *Washington Administrative Code* 173-200-040 by the time the plume reaches the groundwater. In addition to the tracer solution, Hanford Site raw water may be used to simulate rainfall events during the second phase of testing. The simulated rainfall testing will include the application of up to a maximum of 25,000 gallons of raw water to the soil surface. The raw water is not included in the waste stream information in the permit application. Testing could include mockups of underground piping and cathodic protection systems. The purpose of the additional components would be to test for possible interference with the electrical resistance tomography measurements.

Melodie Selby of the Washington State Department of Ecology was briefed on the electrical resistance tomography testing and subsequently requested that a state waste discharge permit application be submitted for this testing program. *Washington Administrative Code* 173-216 does not allow for waivers for small, one time discharges. In addition, submission of a permit application is consistent with requirements the plan and schedule for the disposition of Hanford Site miscellaneous streams submitted to the Washington State Department of Ecology in January 1994.

CONTENTS

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GLOSSARY

cm	centimeter
DOE	U.S. Department of Energy
DOE/RL	U.S. Department of Energy, Richland Operations Office
gal	gallons
gpm	gallon per minute
Ecology	Washington State Department of Ecology
ERT	electrical resistance tomography
L	liter
MCL	maximum contaminant level
mg	milligram
NaCl	sodium chloride
ppm	parts per million
USGS	U.S. Geological Survey
WAC	Washington Administrative Code
yr	year

METRIC CONVERSION CHART

INTO METRIC		
If you know	Multiply by	To get
Length		
inches	2.54	centimeters
feet	30.48	centimeters
Volume		
gallons	3.786	liters
cubic feet	0.02832	cubic meters
Temperature		
Fahrenheit	Subtract 32 then multiply by 5/9ths	Celsius
Pressure		
inches water	1.87	mm Hg
inches water	249	pascal (Pa)
OUT OF METRIC		
Length		
centimeters	0.3937	inches
meters	3.28	feet
Volume		
milliliters	1.247×10^{-3}	cubic feet
liters	0.264	gallons
cubic meters	35.31	cubic feet
Temperature		
Celsius	Multiply by 9/5ths, then add 32	Fahrenheit
Pressure		
mm Hg	0.5353	inches water
pascal (Pa)	4.02×10^{-3}	inches water

1.0 INTRODUCTION

1.1 ORGANIZATION

The State Waste Discharge Permit Application (SWDP) for Discharges to Land consists of Form ECY 040-179 (Revision 4/93) developed by the Washington State Department of Ecology (Ecology). The 12 page form requires the applicant to supply the information requested in the appropriate space on the form or on an attached sheet. Information that either will not fit the space provided, or is requested to be submitted on a attached form, is included in an appendix to the permit application.

Each appendix will state which specific sections of the permit application are being addressed in that appendix.

1.2 STATE WASTE PERMIT APPLICATION FORM

The following pages contain the SWDP application for the electrical resistance tomography testing.

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WASHINGTON STATE DEPARTMENT OF ECOLOGY

STATE WASTE DISCHARGE PERMIT APPLICATION FOR INDUSTRIAL DISCHARGES TO LAND

FOR STATE USE ONLY

Date Application Received		Date Fee Paid		Application/ Permit No.	
Date Application Accepted				Facility No.	
Temporary Permit Effective Date				Temporary Permit Expiration Date	

This application is for a waste discharge permit as required in accordance with provisions of Chapter 90.48 RCW and Chapter 173-216 WAC. Additional information may be required. Information previously submitted and applicable to this application should be referenced in the appropriate section.

SECTION A. GENERAL INFORMATION

1. Company Name: U.S. Department of Energy, Richland Operations Office

2. Unified Business Identification Number (UBI#): DOE-RL Tax Exempt # 91-0565159

3. Mailing Address: P.O. Box 550
Street
Richland, Washington 99352
City/State Zip

4. Facility Location: 200 East Area - Hanford Site
Street or Other Description
Refer to map in Appendix A
City/State Zip

5. Person to contact who is familiar with the information contained in this application:
James E. Rassmussen U.S. DOE, Regulatory Permits, Branch Chief (509) 376-2247
Name Title Telephone

6. Check One: ☐ Permit Renewal ☐ Existing Unpermitted Discharge
☒ Proposed Discharge
Anticipated date of discharge: June 1994

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of a fine and/or imprisonment for knowing violations.

John D. Wagoner 4/19/94 Manager, DOE, Richland Operations Office
Signature* Date Title

John D. Wagoner
Printed Name

*Applications must be signed as follows: Corporation, by a principal executive officer of at least the level of vice-president; partnership, by a general partner; sole proprietorship, by the proprietor.

SECTION B. PRODUCT INFORMATION

1. Briefly describe all manufacturing processes and products, and/or commercial activities. Provide the applicable Standard Industrial Classification (SIC) Code(s) for each activity. (See *Standard Industrial Classification Manual*, 1987 ed.)

   SIC No(s): **9999**

   Description: **Refer to Appendix B, Section 1.0**

2. Include a production schematic flow diagram of the process and service activities described above on a separate sheet.

   This is an research and development activity. No process or service activities are planned.

3. List raw materials and products:

Type — RAW MATERIALS	Quanity
Sanitary water (potable)	6,000 gallons maximum
Sodium chloride (NaCl)	360 pounds (0.1 Molar solution NaCl)
Type — PRODUCTS	**Quanity**
Potable water with 0.1 Molar NaCl	6,000 gallons maximum

SECTION C. PLANT OPERATIONAL CHARACTERISTICS

1. Identify the waste stream for each of the production processes or activities described in Section B.1. Assign each waste stream an identification number--use this number in subsequent questions.

Process	Waste Stream Name	Batch or Continuous Process	Waste Stream ID #
ERT Testing	**ERT Testing Wastewater**	**B**	**1**

2. On a separate sheet, describe in detail the treatment and disposal of all wastewaters as described above. Include a schematic flow diagram for all wastewater treatment and disposal systems.
Refer to Appendix B, Section 2.0.
3. Indicate treatment provided to each waste stream identified in C.1. above.
Refer to Appendix B, Section 2.0.

Waste Stream(s) ID #	Treatment	Waste Stream(s) ID #	Treatment
	Air flotation		pH correction
	Centrifuge		Ozonation
	Chemical precipitation		Reverse osmosis
	Chlorination		Screen
	Cyclone		Sedimentation
	Filtration		Septic tank
	Flow equalization		Solvent separation
	Grease or oil separation		Biological treatment, type:
	Grease trap		Rainwater diversion or storage
	Grit removal		Other chemical treatment type:
	Ion exchange		Other physical treatment type:

4. Describe any planned wastewater treatment improvements or changes in wastewater disposal methods and when they will occur *(use additional sheets, if necessary)*.

None.

5. If production processes are subject to seasonal variations, provide the following information. List discharge for each waste stream in gallons per day (GPD). The combined value for each month should equal the estimated total monthly flow.

Waste Stream ID #	MONTHS											
	J	F	M	A	M	J	J	A	S	O	N	D
The production process is not subject to seasonal variations												
Estimated Total Monthly Flow (GPD)												

6. Shift Information:
   a. Number of shifts per work day: **1**
   b. Number of work days per week: **7**
   c. Average number of work days per year: **250**
   d. Maximum number of work days per year: **365**
   e. Number of employees per shift:

Number of employees per shift		Shift start times	
1st	**10**	1st	**07:00**
2nd		2nd	
3rd		3rd	

7. List all incidental materials like oil, paint, grease, solvents, soaps, cleaners, that are used or stored on-site. (Use additional sheets, if necessary.)

Material/Quantity Stored **Sodium chloride / <400 pounds**

Poly vinyl choride (PVC) glue / <1 gallon

PVC surface preparation / <1 gallon

8. Describe any water recycling or material reclaiming processes:

There are no water recycling or material reclaiming processes.

9. Does this facility have:
   a. Spill Prevention, Control, and Countermeasure Plan (per 40 CFR 112)? ☐ Yes ☒ No
   b. Emergency Response Plan (per WAC 173-303-350)? ☐ Yes ☒ No
   c. Runoff, spillage, or leak control plan (per WAC 173-216-110(f))? ☐ Yes ☒ No
   d. Does your current waste discharge permit require a spill plan? ☐ Yes ☒ No
      If yes, submit an update with your application. Not Applicable.
   e. Solid Waste Management Plan? ☐ Yes ☒ No

SECTION D. WATER CONSUMPTION AND WATER LOSS

1. Water Source(s):

   ☐ Public System (Specify) ____________

   ☐ Private Well ☒ Surface Water

   a. Water Right Permit Number: **Not Applicable.**

   b. Legal Description:

   SW 1/4S, **SW** 1/4S, **2** Section, **13N** TWN, **25E** R

2. a. Indicate total water use: Gallons per day (average) **Phase I: 200-400/II: 40**

   Gallons per day (Maximum) **400 gpd**

   b. Is water metered? ☐ Yes ☒ No

3. Attach a line drawing showing the water flow through the facility. Indicate source of intake water, operations contributing wastewater to the effluent, and treatment units labeled to correspond to the more detailed descriptions in Item C. Construct a water balance on the line drawing by showing average flows between intakes, operations, treatment units, and outfalls. If a water balance cannot be determined (*e.g., for certain mining activities*), provide a pictorial description of the nature and amount of any sources of water and any collection or treatment measures.
   Refer to Appendix B, Section 3.0.

SECTION E. WASTEWATER INFORMATION

1. Provide measurements for treated wastewater prior to land application for the parameters listed below, unless waived by the permitting authority. All analytical methods used to meet these requirements shall, unless approved otherwise in writing by Ecology, conform to the Guidelines Establishing Test Procedures for the Analysis of Pollutants Contained in 40 CFR Part 136.
Refer to Appendix B, Section 2.0.

Parameter	Concentrations Measured	Analytical Method	Detection Limit
pH			
Conductivity			
Total Dissolved Solids			
Total Suspended Solids			
BOD (5 day)			
COD			
Ammonia-N			
TKN-N			
Nitrate-N			
Ortho-phosphate-P			
Total-phosphate-P			
Total Oil & Grease			
Calcium			
Magnesium			
Sodium			
Potassium			
Chloride			
Sulfate			
Fluoride			
Cadmium (total)			
Chromium (total)			
Lead (total)			
Mercury			
Selenium (total)			
Silver (total)			
Copper (total)			
Iron (total)			
Manganese (total)			
Zinc (total)			
Barium (total)			
Total Coliform			

2. Wastewater characteristics for toxic pollutants.

The intent of this question is to determine which chemicals are or might be present in the process water or wastewater. For each chemical listed below:

a. Use the letter **A** in the **Absent** column if the chemical is not likely to be present because it is not used in the production process or used on site.

b. Use the letter **S** in the **Absent** column if the chemical may be present because it is used on site, but the chemical is not used in the production process.

c. Use the letter **P** in the **Present** column if the chemical is likely to be present because it is used in the production process, but the effluent has not been tested.

d. Use the letter **K** in the **Present** column if the effluent has been tested and the chemical was found to be present. Attach the analytical results.
Attach the analytical results

Analytical Results
Wastewater Characterization for Toxic Pollutants

Absent	Present	Constituent/CAS No.	Absent	Present	Constituent/CAS No.
A		Acrylamide/79-06-1	A		1,2 Dichloropropane/78-87-5
A		Acrylonitrile/107-13-1	A		1,3 Dichloropropene/542-75-6
A		Aldrin/309-00-2	A		Dichlorvos/62-73-7
A		Aniline/62-53-3	A		Dieldrin/60-57-1
A		Aramite/140-57-8	A		3,3' Dimethoxybenzidine/119-90-4
A		Arsenic/7440-38-2	A		3,3 Dimethylbenzidine/119-93-7
A		Azobenzene/103-33-3	A		1,2 Dimethylhydrazine/540-73-8
A		Benzene/71-43-2	A		2,4 Dinitrotoluene/121-14-2
A		Benzidine/92-87-5	A		2,6 Dinitrotoluene/606-20-2
A		Benzo(a)pyrene/50-32-8	A		1,4 Dioxane/123-91-1
A		Benzotrichloride/98-07-7	A		1,2 Diphenylhydrazine/122-66-7
A		Benzyl chloride/100-44-7	A		Endrin/72-20-8
A		Bis(chloroethyl)ether/111-44-4	A		Epichlorohydrin/106-89-8
A		Bis(chloromethyl)ether/542-88-1	A		Ethyl acrylate/140-88-5
A		Bis(2-ethylhexyl)phthalate/ 117-81-7	A		Ethylene dibromide/106-93-4
A		Bromodichloromethane/75-27-4	A		Ethylene thioureae/96-45-7
A		Bromoform/75-25-2	A		Folpet/133-07-3
A		Carbazole/86-74-8	A		Furmecyclox/60568-05-0
A		Carbon tetrachloride/56-23-5	A		Heptachlor/76-44-8
A		Chlordane/57-74-9	A		Heptachlor epoxide/1024-57-3
A		Chlorodibromomethane/124-48-1	A		Hexachlorobenzene/118-74-1

Absent / Present	Constituent/CAS No.	Absent / Present	Constituent/CAS No.
A	Chloroform/67-66-3	A	Hexachlorocyclohexane (alpha)/ 319-84-6
A	Chlorthalonil/1897-45-6	A	Hexachlorocyclohexane (tech.)/ 608-73-1
A	2,4-D/94-75-7	A	Hexachlorodibenzo-p-dioxin, mix/ 19408-74-3
A	DDT/50-29-3	A	Hydrazine/hydrazine sulfate/ 302-01-2
A	Diallate/2303-16-4	A	Lindane/58-89-9
A	1,2 Dibromoethane/106-93-4	A	2 Methylaniline/100-61-8
A	1,4 Dichlorobenzene/106-46-7	A	2 Methylaniline hydrochloride/ 636-21-5
A	3,3' Dichlorobenzidine/91-94-1	A	4,4' Methylene bis(N,N-dimethyl)aniline/101-61-1
A	1,1 Dichloroethane/75-34-3	A	Methylene chloride (dichloromethane)/75-09-2
A	1,2 Dichloroethane/107-06-2	A	Mirex/2385-85-5
A	Nitrofurazone/59-87-0	A	O-phenylenediamine/106-50-3
A	N-nitrosodiethanolamine/ 1116-54-7	A	Propylene oxide/75-56-9
A	N-nitrosodiethylamine/55-18-5	A	2,3,7,8-Tetrachlorodibenzo-p-dioxin/ 1746-01-6
A	N-nitrosodimethylamine/62-75-9	A	Tetrachloroethylene/127-18-4
A	N-nitrosodiphenylamine/86-30-6	A	2,4 Toluenediamine/95-80-7
A	N-nitroso-di-n-propylamine/ 621-64-7	A	o-Toluidine/95-53-4
A	N-nitrosopyrrolidine/930-55-2	A	Toxaphene/8001-35-2
A	N-nitroso-di-n-butylamine/ 924-16-3	A	Trichloroethylene/79-01-6
A	N-nitroso-n-methylethylamine/ 10595-95-6	A	2,4,6-Trichlorophenol/88-06-2
A	PAH/NA	A	Trimethyl phosphate/512-56-1
A	PBBs/NA	A	Vinyl chloride/75-01-4
A	PCBs/1336-36-3		

SECTION F. STORMWATER

1. Do you have a Washington State Storm Water Baseline General Permit? ☐ Yes ☒ No

   If yes, please list the permit number here ______________

2. Have you applied for a Washington State Storm Water Baseline General Permit? ☐ Yes ☒ No

3. Do you have any storm water quality or quantity data? ☐ Yes ☒ No

Note: If you answered "yes" to questions 1 or 2 above, skip questions 4 through 8.

4. Describe the size of the storm water collection area.

   a. Unpaved Area ____0____ sq. ft.

   b. Paved Area ____0____ sq. ft.

   c. Other Collection Areas (Roofs) ____0____ sq. ft.

5. Does your facility's storm water discharge to: *(check all that apply)*

   ☐ Storm sewer systems; name of storm sewer system *(operator)*:

   ☐ Directly to surface waters or Washington State *(e.g., river, lake, creek, estuary, ocean)*.

   ☐ Indirectly to surface waters of Washington State *(i.e., flows over adjacent properties first)*.

   ☐ Directly to ground waters of Washington State: ☐ dry well ☐ drainfield ☐ Other

6. Areas with industrial activities at facility: *(check all that apply)* None.

   ☐ Manufacturing Building

   ☐ Material Handling

   ☐ Material Storage

   ☐ Hazardous Waste Treatment, Storage, or Disposal *(Refers to RCRA, Subtitle C Facilities Only)*

   ☐ Waste Treatment, Storage, or Disposal

   ☐ Application or Disposal of Wastewaters

   ☐ Storage and Maintenance of Material Handling Equipment

   ☐ Vehicle Maintenance

   ☐ Areas Where Significant Materials Remain

   ☐ Access Roads and Rail Lines for Shipping and Receiving

   ☒ Other **Research and development testing**

7. Material handling/management practices.

a. Types of materials handled and/or stored outdoors: *(check all that apply)*

- [ ] Solvents
- [ ] Hazardous Wastes
- [ ] Scrap Metal
- [ ] Acids or Alkalies
- [ ] Petroleum or Petrochemical Products
- [ ] Paints/Coatings
- [ ] Plating Products
- [ ] Woodtreating Products
- [ ] Pesticides
- [x] Other (Please list) **Sodium chloride**

b. Identify existing management practices employed to reduce pollutants in industrial storm water discharges: *(check all that apply)*

- [ ] Oil/Water Separator
- [ ] Detention Facilities
- [ ] Containment
- [ ] Infiltration Basins
- [ ] Spill Prevention
- [ ] Operational BMPs
- [ ] Surface Leachate Collection
- [ ] Vegetation Management
- [ ] Overhead Coverage
- [ ] Other (Please list) ____________

8. Attach a map showing storm water drainage/collection areas, disposal areas and discharge points. **No drainage or collection areas.**

SECTION G. OTHER INFORMATION

1. Describe liquid wastes or sludges being generated that are not disposed of in the waste stream(s) and how they are disposed of. For each type of waste, provide type of waste, name, address, and phone number of hauler.
No liquid wastes or sludges are being generated.

2. Describe storage areas for raw materials, products, and wastes.
The sanitary water (potable) will be stored in portable tanks.
Other materials will be stored in portable storage units at the site.

3. Have you designated your wastes according to the procedures of Dangerous Waste Regulations, Chapter 173-303-WAC? [x] Yes [ ] No

SECTION H. SITE ASSESSMENT

1. Give the legal description of the land treatment site(s). Give the acreage of each land treatment site(s). Attach a copy of the contract(s) authorizing use of land for treatment.
The ERT testing does not include land treatment. The ERT site is located in the NW 1/4, NW 1/4, Section 2, T12N, R26E, Benton County, Washington

2. List all environmental control permits or approvals needed for this project; for example, septic tank permits, sludge application permits, or air emissions permits.
The ERT test qualifies for a National Environmental Policy Act (NEPA) Categorical Exclusion (CX). The CX is currently under preparation and will be submitted May 1994.
A State Environmental Policy Act Checklist is currently under preparation and will be submitted May 1994.

3. Attach a United States Geological Survey (USGS) a topographic map. Show the following on this map:
Refer to Appendix A.
   a. Location and name of internal and adjacent streets
   b. Surface water drainage systems within 1/4 mile of the site
   c. All wells within 1 mile of the site
   d. Chemical and product handling and storage facilities
   e. Infiltration sources, such as drainfields and lagoons within 1/4 mile of the site
   f. Wastewater and cooling water discharge points with waste stream ID numbers (See Section C.1)
   g. Other activities and land uses within 1/4 mile of the site

4. Attach well logs and well I.D.# when available for all wells within 500 feet and any available water quality data.
Refer to Appendix C, Section 1.0.

5. Describe soils on the site using information from local soil survey reports. (Submit on separate sheet.)

   Refer to Appendix C, Section 2.0.

6. Describe the regional geology and hydrogeology within one mile of the site. (Submit on separate sheet.)

   Refer to Appendix C, Section 3.0.

7. List the names and addresses of contractors or consultants who provided information and cite sources of information by title and author.

   Information for this permit application was obtained from the references listed in section 2.0 (References), and from interviews with cognizant personnel for the Electrical Resistance Tomography Testing project. The permit application was compiled by:

Westinghouse Hanford Company
Air & Water Permits Function
P.O. Box 1970
Richland, WA 99352

2.0 REFERENCES

Baker, V.R., B.N. Bjornstad, A.J. Busacca, K.R. Fecht, E.P. Kiver, U.L. Moddy, J.G. Rigby, D.F. Stradling, and A.M. Tallman, 1991, "Quaternary Geology of the Columbia Plateau", in *Quaternary Nonglacial Geology; Conterminous U.S.*, R.B. Morrison, Editor, Geology of North America, Geological Society of America, vol. K-2, Boulder, Colorado.

Delaney, C.D., K.A. Lindsey, and S.P. Reidel, 1991, *Geology and Hydrology of the Hanford Site: A Standardized Text for Use in Westinghouse Hanford Company Documents and Reports*, WHC-SD-ER-TI-003, Westinghouse Hanford Company, Richland, Washington.

DOE, 1988, *Site Characterization Plan, Reference Repository Location, Hanford Site, Washington*; Consultation Draft, 9 Vols., DOE/RW-0164, U.S. Department of Energy, Office of Civilian Radioactive Waste Management, Washington, D.C.

DOE-RL, 1993, *200 East Groundwater Aggregate Area Management Study Report*, DOE/RL-92-9, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

Fecht, R.E., S.P. Reidel, and A.M. Tallman, 1987, *Paleodrainage of the Columbia River System on the Columbia Plateau of Washington: A Summary*, RHO-BW-SA-318P, Rockwell Hanford Operations, Richland, Washington.

Gaylord, D.R., and E.P. Poeter, 1991, *Geology and Hydrology of the 300 Area and Vicinity, Hanford Site, South-Central Washington*, WHC-EP-0500, Westinghouse Hanford Company, Richland, Washington.

Gephart, R.E., R.C. Arnett, R.C. Baca, L.S. Leonhart, and F.A. Spane Jr., 1979, *Hydrologic Studies Within the Columbia Plateau, Washington: An Integration of Current Knowledge*, RHO-BWI-ST-5, Rockwell Hanford Operations, Richland, Washington.

Hajek, B.F., 1966, *Soil Survey: Hanford Project in Benton County, Washington*, BWNL-243, Pacific Northwest Laboratory, Richland, Washington.

Hoffman, K.M., S.J. Trent, K.A. Lindsey, and B.N. Bjornstad, 1992, *Summary of the Geology of the 200-BP-1 Operable Unit*, WHC-SD-EN-TI-037, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Kasza, G.L., M.J. Hartman, W.A. Jordan, D.C. Weekes, 1994, *Groundwater Map of the Hanford Site, June 1993*, Westinghouse Hanford Company, Richland, Washington.

Last, G.V., B.N. Bjornstad, M.P. Bergeron, D.W. Wallace, D.R. Newcomer, J.A. Schramke, M.A. Chamness, C.S. Cline, S.P. Airhart, and J.S. Wilbur, 1989, *Hydrology of the 200 Areas Low-Level Burial Grounds an Interim Report*, PNL-6820, Pacific Northwest Laboratory, Richland, Washington.

Lindsey, K.A., 1991, *Revised Stratigraphy for the Ringold Formation, Hanford Site, South Central Washington*, WHC-SD-EN-EE-004, Westinghouse Hanford Company, Richland, Washington.

Lindsey, K.A., M.P. Connelly, and B.N. Bjornstad, 1991, *Geologic Setting of the 200 West Area: An Update*, WHC-SD-EN-TI-008, Westinghouse Hanford Company, Richland, Washington.

Lindsey, K.A., B.N. Bjornstad, J.W. Lindberg, and K.M. Hoffman, 1992, *Geologic Setting of the 200 East Area: An Update*, WHC-SD-EN-TI-012, Westinghouse Hanford Company, Richland, Washington.

PSPL, 1982, *Skagit/Hanford Nuclear Project, Preliminary Safety Analysis Report*, Volume 4, Appendix 20, Amendment 23, Puget Sound Power and Light Company, Bellevue, Washington.

Reidel, S.P. and K.R. Fecht, 1981, "Wanapum and Saddle Mountain Basalt in the Cold Creek Syncline Area", in *Subsurface Geology of the Cold Creek Syncline*, RHO-BWI-ST-14, Rockwell Hanford Operations, Richland, Washington.

Runchal, A.K. and B. Sager, 1992, *PORFLOW: A Model for Fluid Flow, Heat and Mass Transport in Multifluid, Multiphase Fractured or Porous Media, Users Manual, Version 2.4*, ACRi/106/Rev. G, Analytic and Computational Research, Inc., Los Angeles, California.

Smith, G.A., B.N. Bjornstad, and K.R. Fecht, 1989, "Neogene Terrestrial Sedimentation On and Adjacent To the Columbia Plateau", in *Volcanism and Tectonism in the Columbia River Flood-Basalt Province*, Special Paper 239, S.P. Reidel and P.R. Hopper, editors, Geological Society of America, Boulder, Colorado, pp. 187-198.

Tallman, A.M., K.R. Fecht, M.C. Marratt, and G.V. Last, 1979, *Geology of the Separations Areas, Hanford Site, South Central Washington*, RHO-ST-23, Rockwell Hanford Operations, Richland, Washington.

WHC, 1993, *Characterization Report for the Table 4 Miscellaneous Streams in Consent Order No. DE 91NM-177*, WHC-EN-EV-020, Westinghouse Hanford Company, Richland, Washington.

APPENDICES

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APPENDIX A

LOCATION MAPS

CONTENTS

TOPOGRAPHIC MAPS

SECTION H., SITE ASSESSMENT, ITEM 3: ATTACH A UNITED STATES GEOLOGICAL SURVEY (USGS) TOPOGRAPHIC MAP. SHOW THE FOLLOWING ON THIS MAP:

a. LOCATION AND NAME OF INTERNAL AND ADJACENT STREETS
b. SURFACE WATER DRAINAGE SYSTEMS WITHIN 1/4 MILE OF THE SITE
c. ALL WELLS WITHIN 1 MILE OF THE SITE
d. CHEMICAL AND PRODUCT HANDLING AND STORAGE FACILITIES
e. INFILTRATION SOURCES, SUCH AS DRAINFIELDS AND LAGOONS WITHIN 1/4 MILE OF THE SITE
f. WASTEWATER AND COOLING WATER DISCHARGE POINTS WITH WASTE STREAM ID NUMBERS (SEE SECTION C.1)
g. OTHER ACTIVITIES AND LAND USES WITHIN 1/4 MILE OF THE SITE.

A topographic map is included in Appendix A. The map is not a USGS topographic map, but is derived from the Hanford Site topographic map database. The Hanford Site database provides more detail and better accuracy than the USGS topographic map. There are no known, active disposal areas within on quarter mile of the ERT test site.

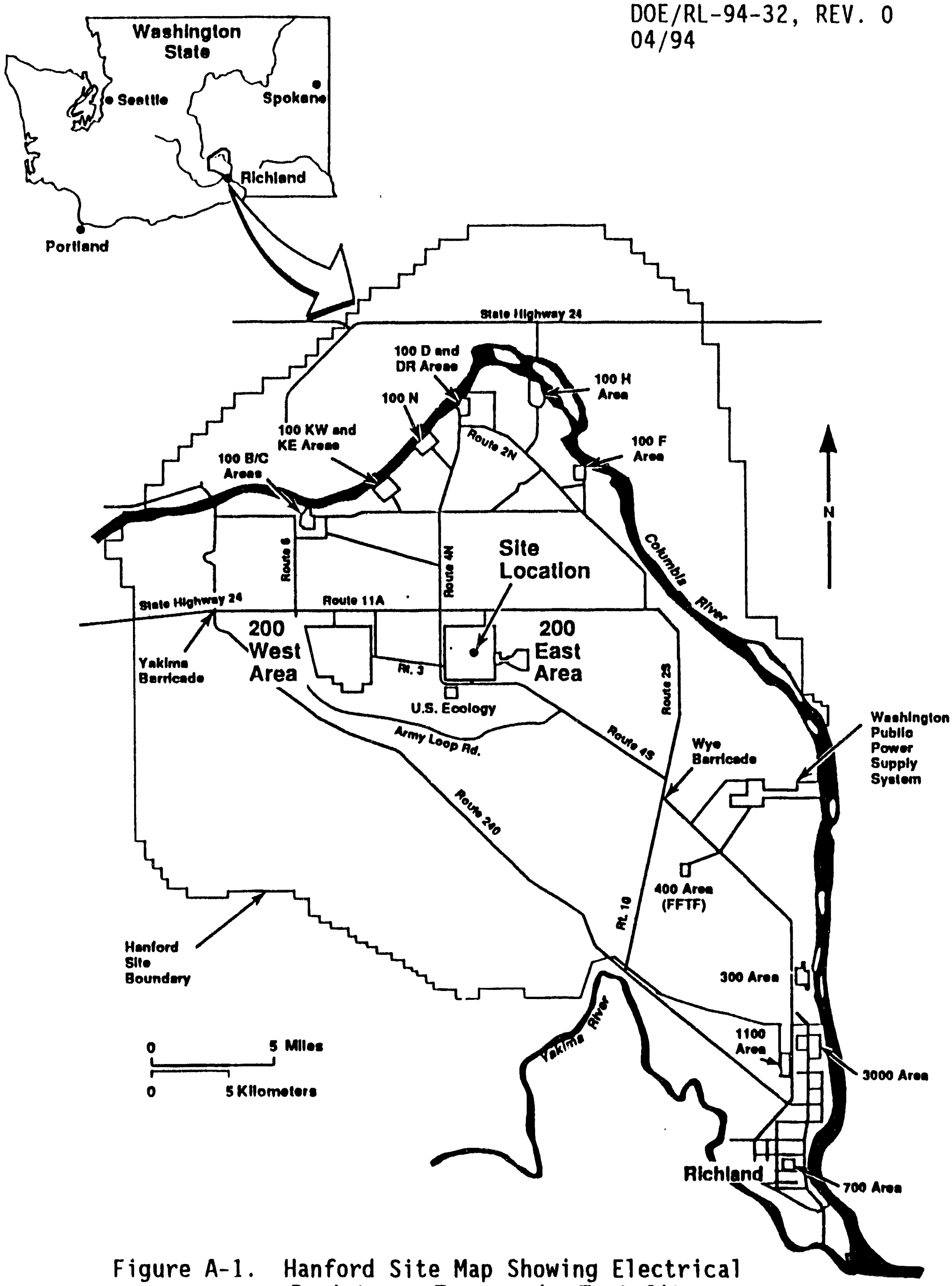


Figure A-1. Hanford Site Map Showing Electrical Resistance Tomography Test Site.

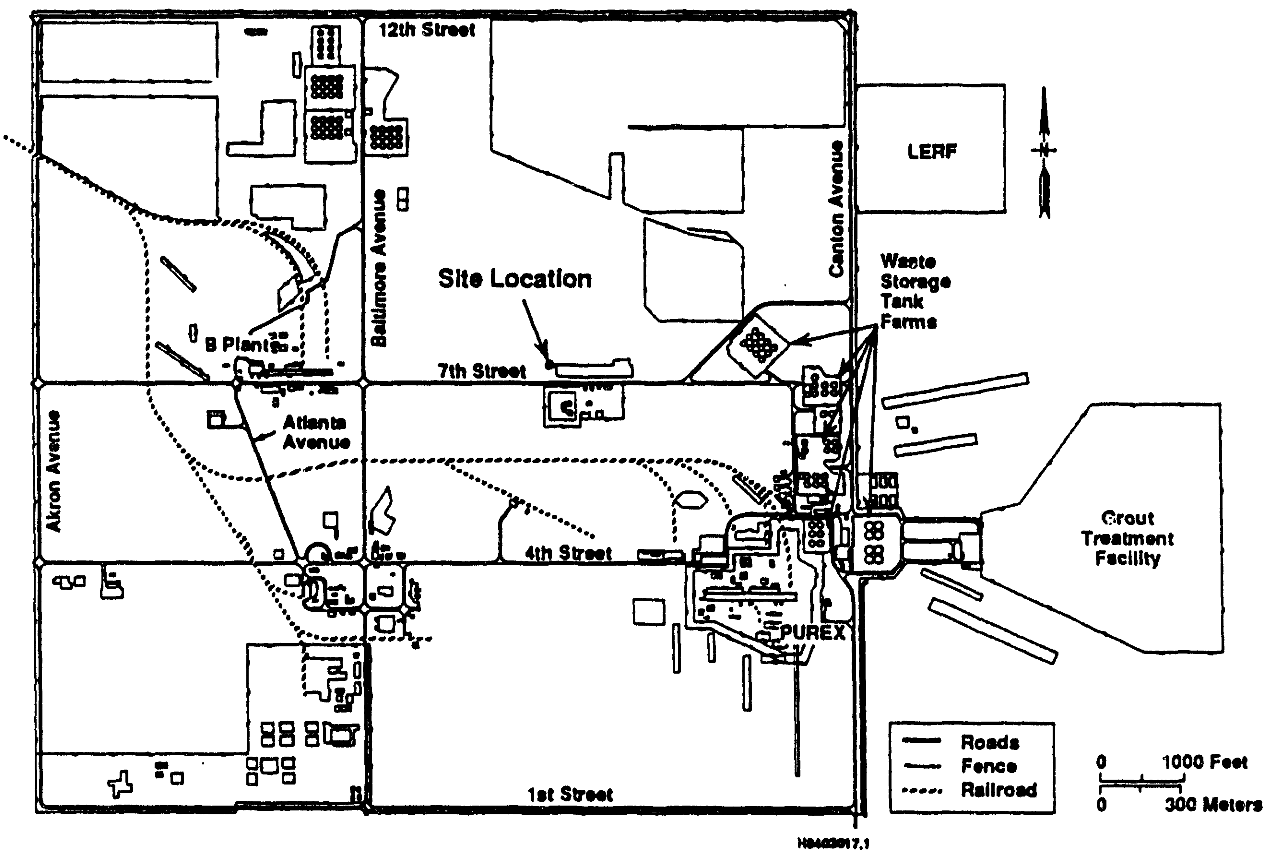
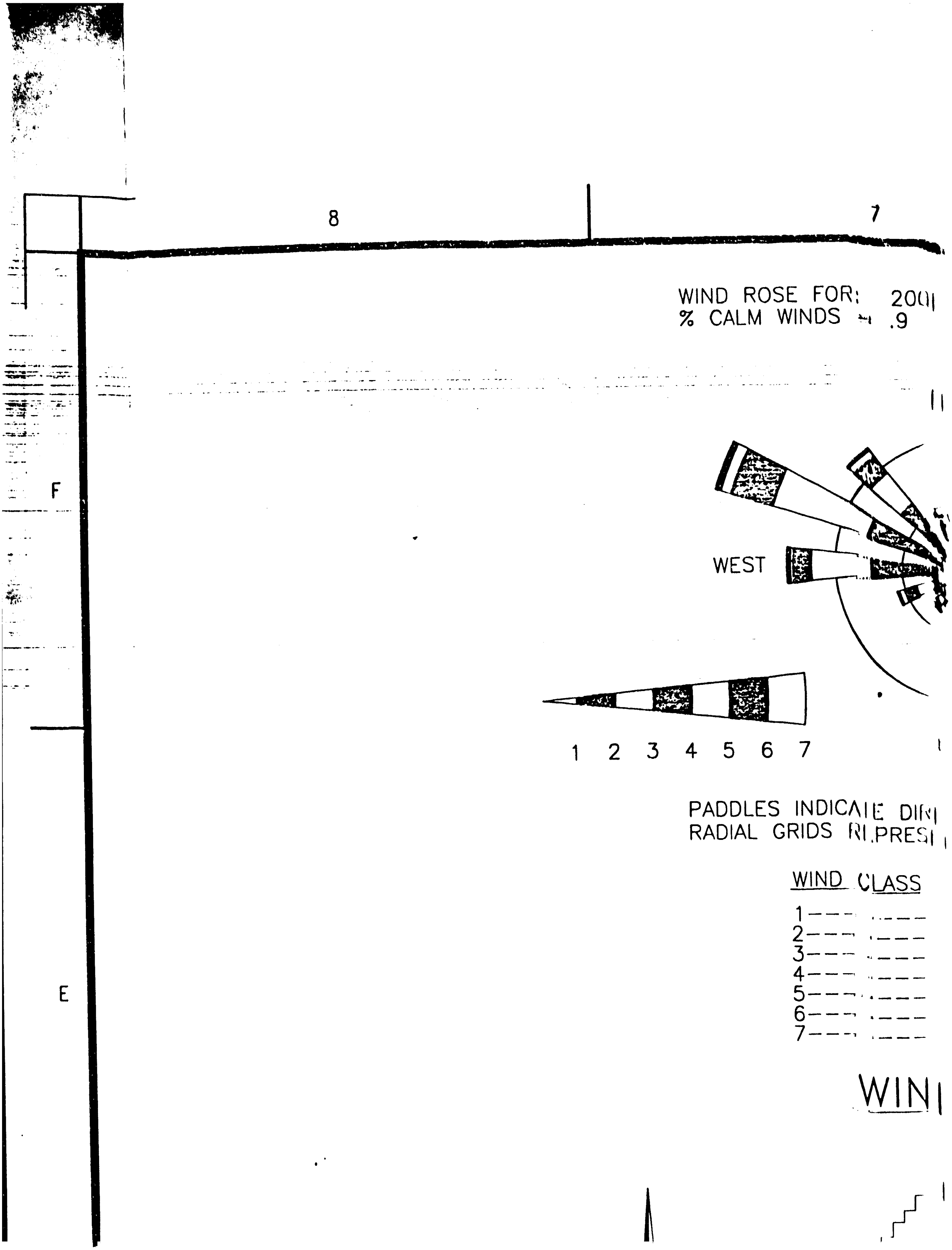


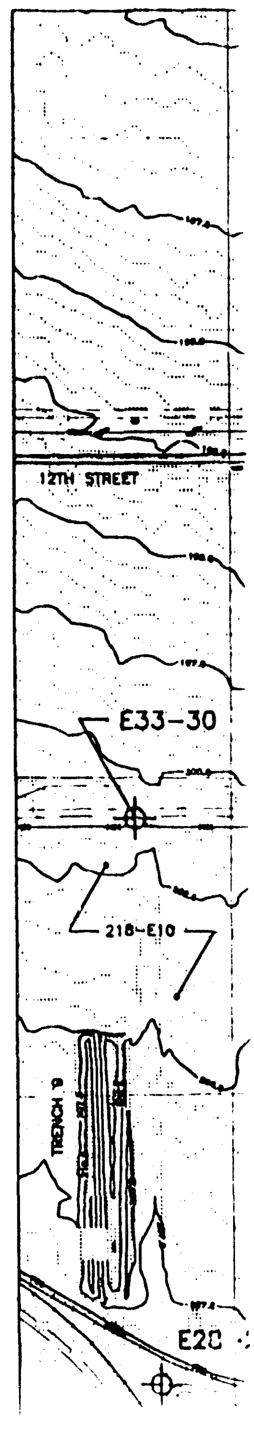
Figure A-2. 200 East Area Map Showing Electrical Resistance Tomography Test Site.


8
7
F
E
WIND ROSE FOR: 200
% CALM WINDS .9
WEST
1 2 3 4 5 6 7
PADDLES INDICATE DI
RADIAL GRIDS REPRES
WIND CLASS
1
2
3
4
5
6
7
WIN

6 | 5

PERIOD COVERED
12/01/85 – 12/31/87
STATION NO. 6

E.573,000

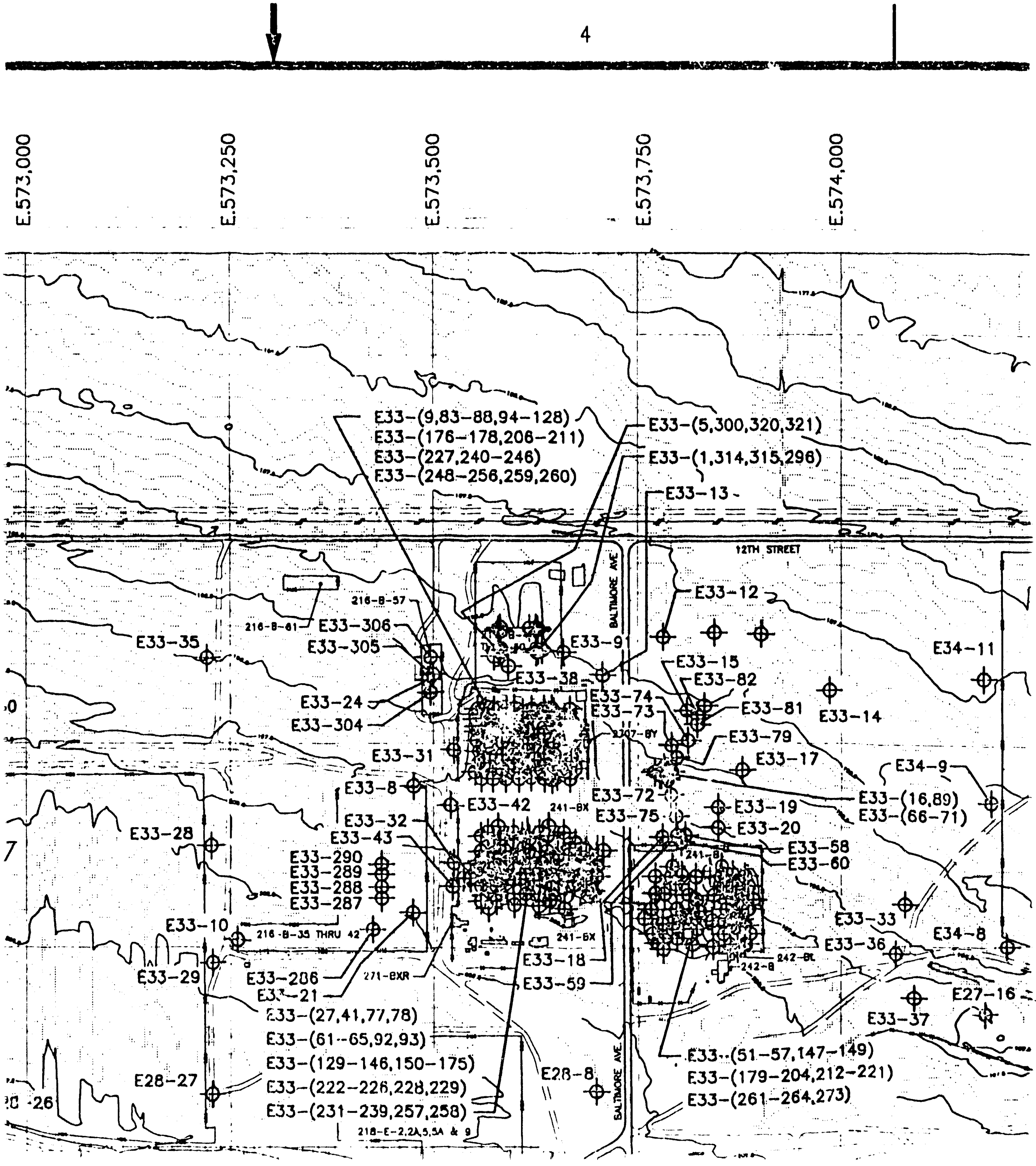


EAST

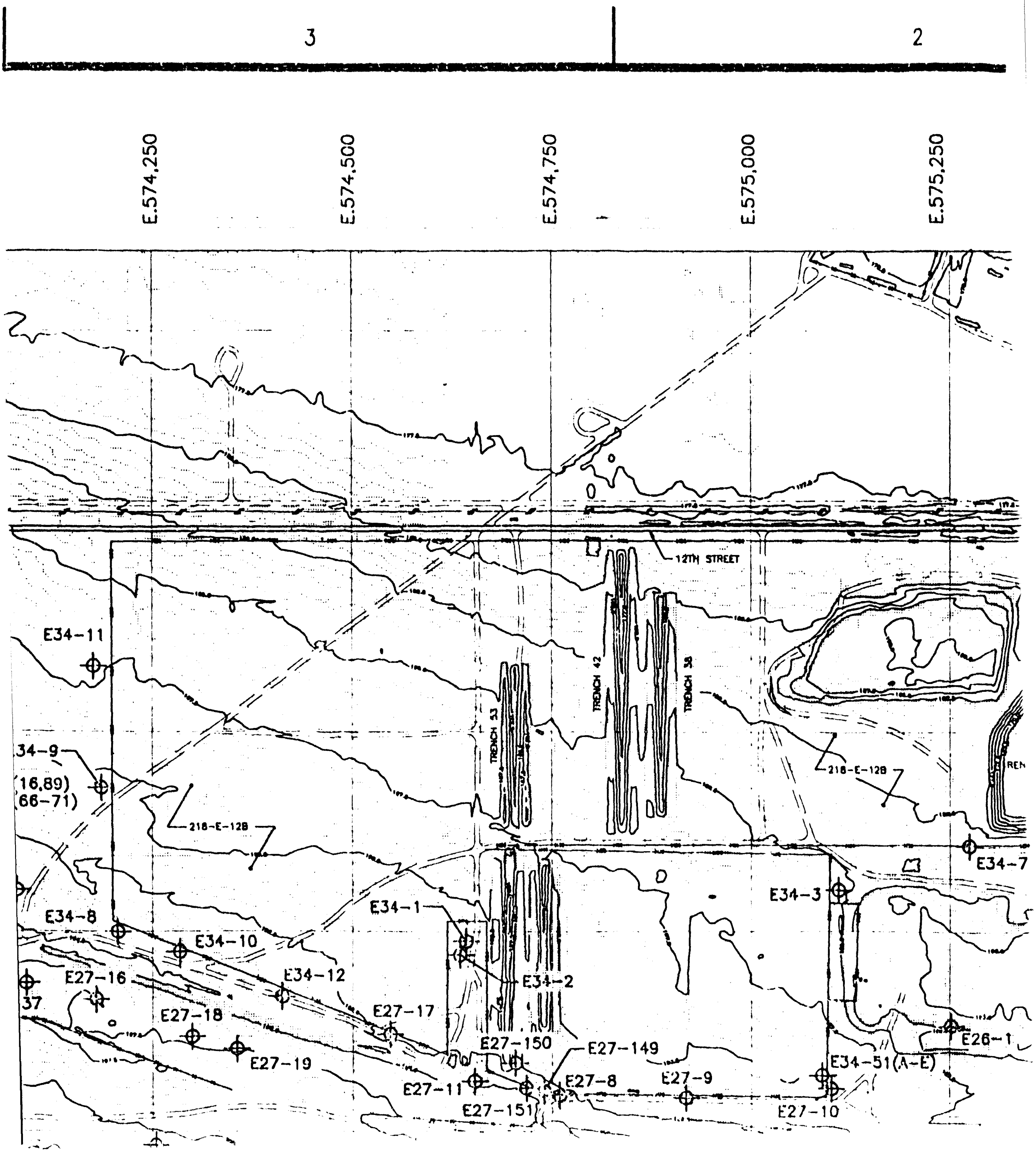
MING FROM.
)% OCCURRENCE.

IR

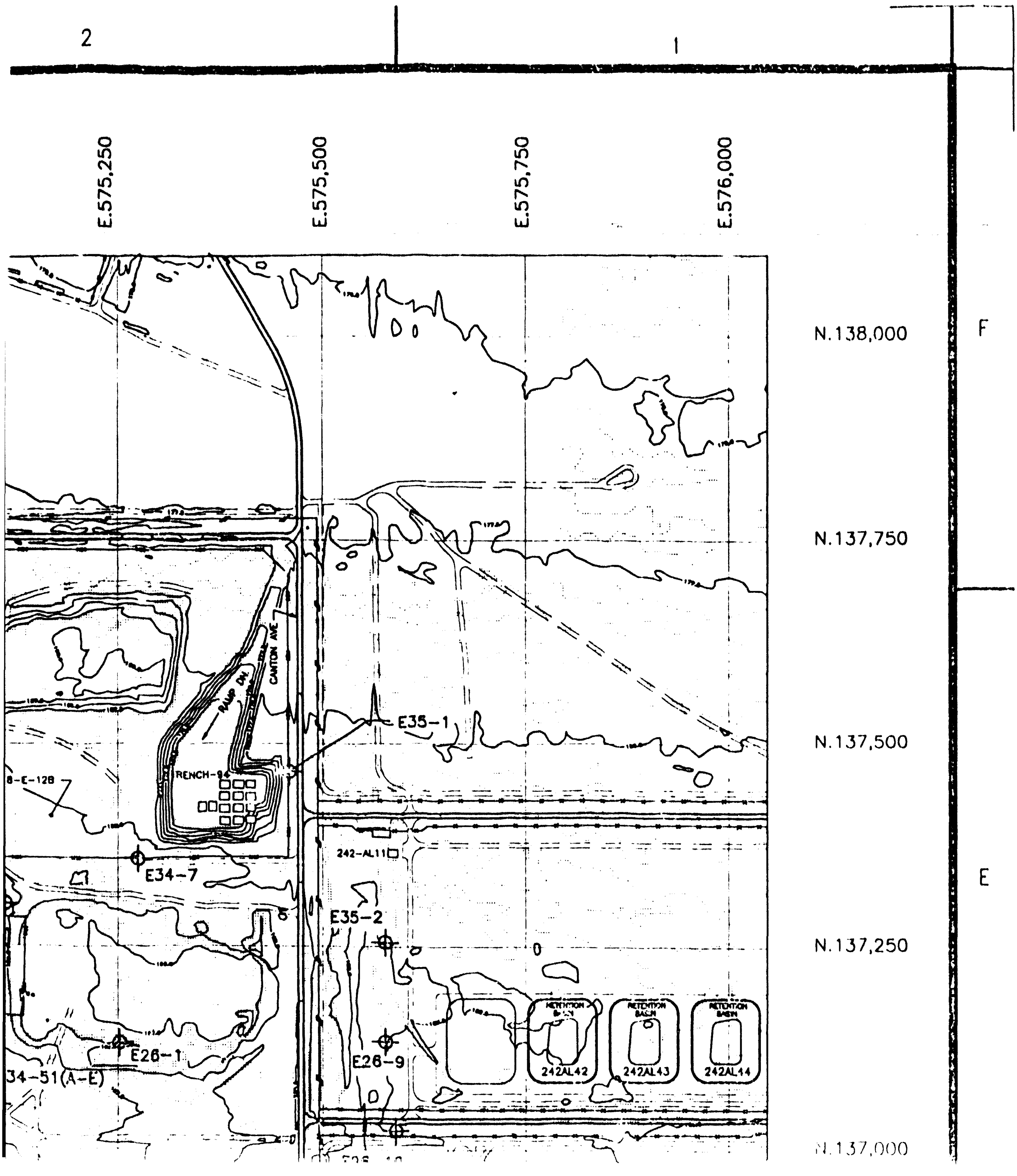
;.0
.0
2.0
8.0
4.0
1.0



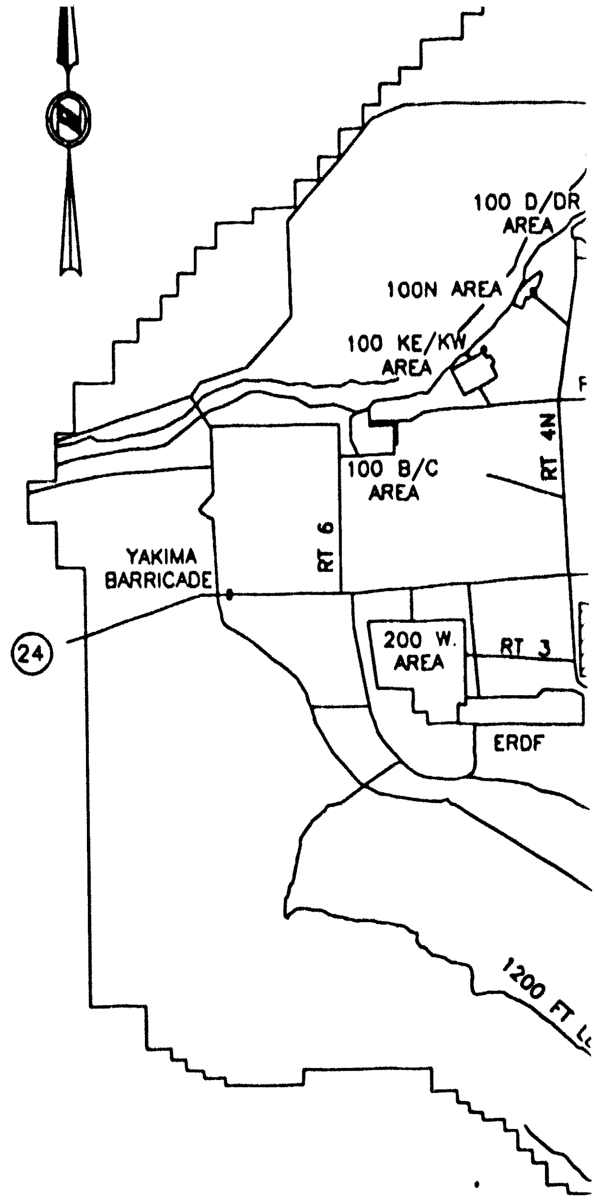
4
E.573,000
E.573,250
E.573,500
E.573,750
E.574,000
E33-(9,83-88,94-128)
E33-(176-178,206-211)
E33-(227,240-246)
E33-(248-256,259,260)
E33-(5,300,320,321)
E33-(1,314,315,296)
E33-13
12TH STREET
BALTIMORE AVE
E33-12
216-B-57
216-B-61
E33-306
E33-305
E33-35
E33-9
E34-11
E33-38
E33-15
E33-82
E33-74
E33-73
E33-81
E33-14
E33-24
E33-304
E33-79
E33-17
E33-31
E34-9
E33-8
E33-72
E33-(16,89)
E33-(66-71)
E33-42
241-BX
E33-75
E33-19
E33-32
E33-20
E33-28
E33-43
E33-58
E33-60
E33-290
E33-289
E33-288
E33-287
E33-33
E33-10
216-B-35 THRU 42
241-BX
E34-8
E33-36
E33-18
242-BL
242-B
E33-29
E33-286
271-BXR
E33-59
E27-16
E33-21
E33-(27,41,77,78)
E33-37
E33-(61-65,92,93)
E33-(51-57,147-149)
E33-(129-146,150-175)
E33-(179-204,212-221)
E28-8
E28-27
E33-(222-226,228,229)
E33-(261-264,273)
E33-(231-239,257,258)
218-E-2,2A,5,5A & 9
BALTIMORE AVE.



3
2
E.574,250
E.574,500
E.574,750
E.575,000
E.575,250
12TH STREET
TRENCH 53
TRENCH 42
TRENCH 38
218-E-12B
218-E-12B
E34-11
34-9
(16,89)
(66-71)
E34-7
E34-3
E34-1
E34-2
E34-8
E34-10
E34-12
E27-16
37
E27-18
E27-19
E27-17
E27-150
E27-149
E27-11
E27-8
E27-9
E27-151
E27-10
E34-51(A-E)
E26-1


2
1
F
E
E.575,250
E.575,500
E.575,750
E.576,000
N.138,000
N.137,750
N.137,500
N.137,250
N.137,000
E35-1
E34-7
E35-2
E26-1
E26-9
34-51(A-E)
242-AL11
RETENTION BASIN
242AL42
242AL43
242AL44
CANTON AVE
RAMP DN.
RENCH-94
8-E-128

D



C

KEY

SCALE

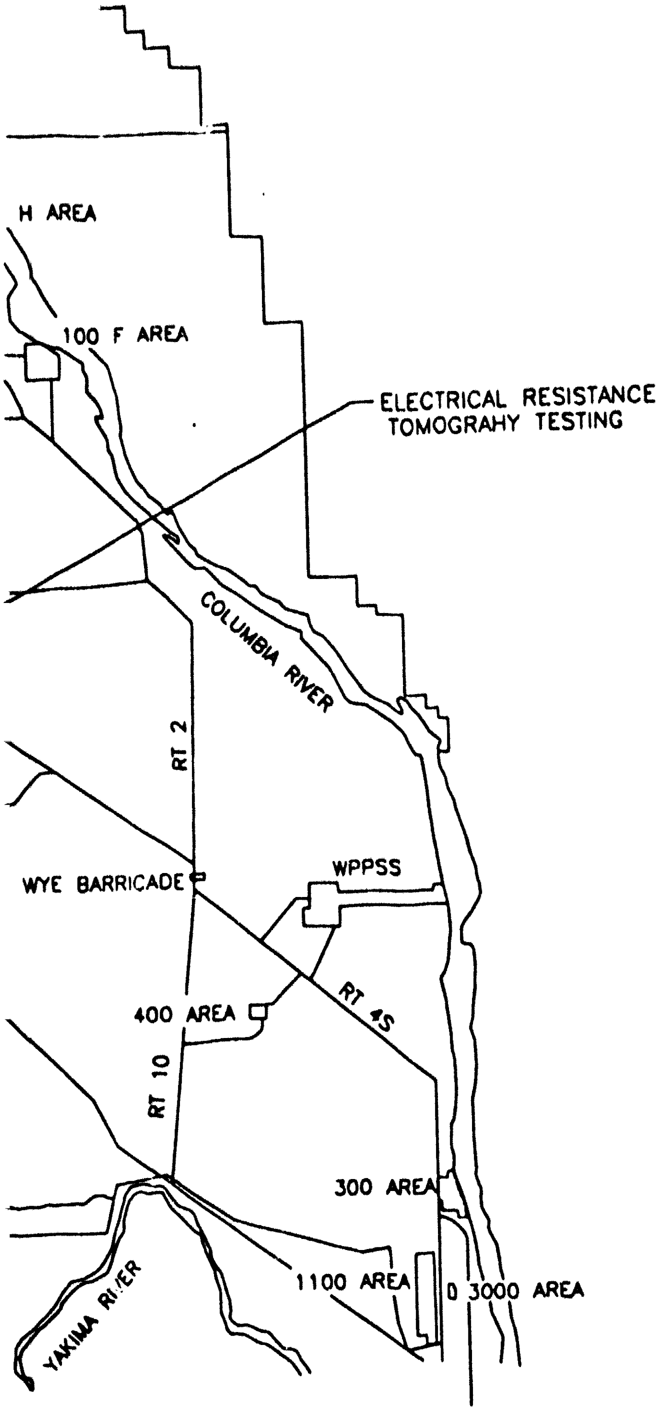
LEG

W.47,000
N.43,000 HANFORD PLANT COORDINATES (FEET)

E.576,250
N.136,000 WASHINGTON STATE COORDINATES (METERS)

215.0 INDEX CONTOUR (METERS)

INTERMEDIATE CONTOUR



AN

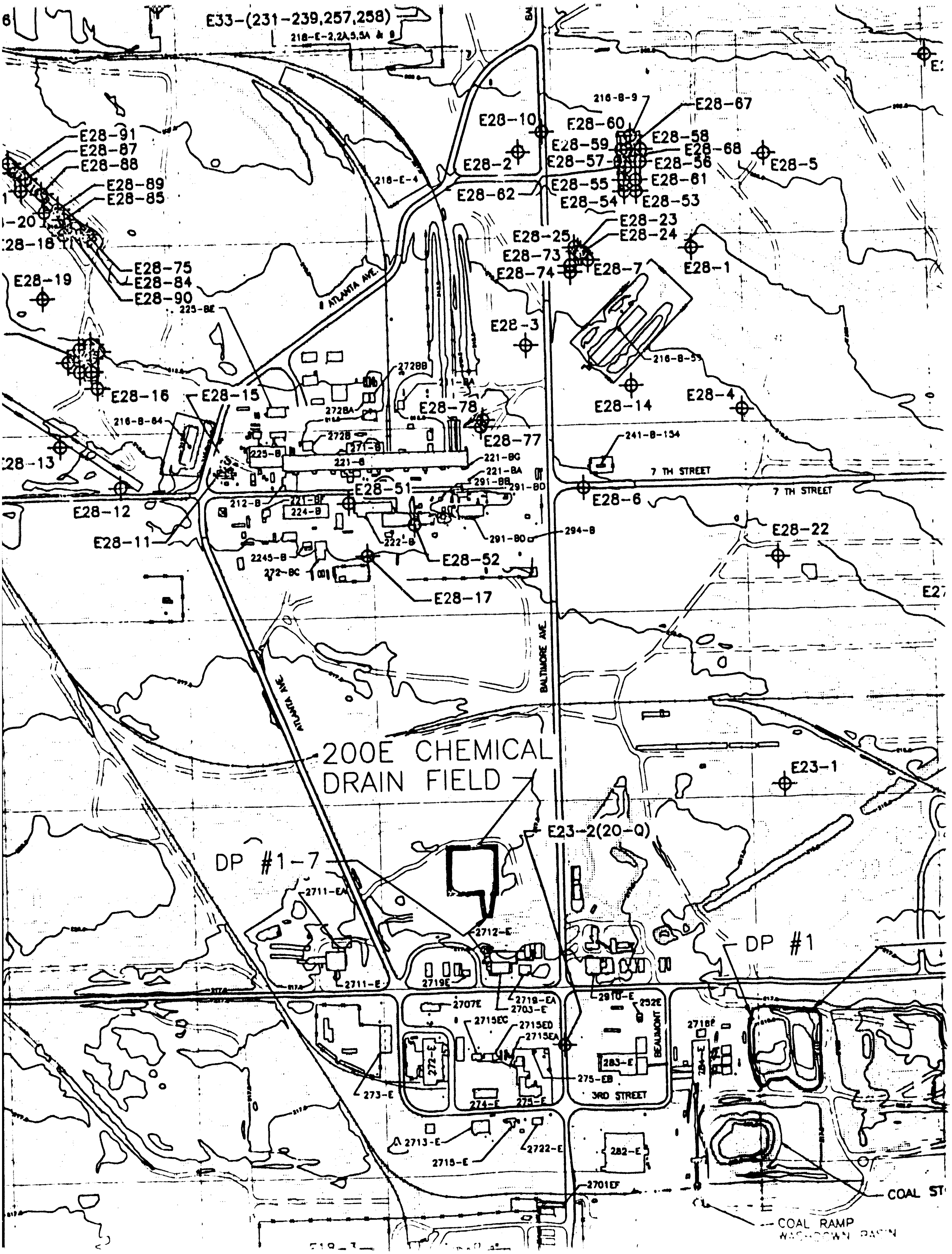
NE

BUILDINGS/STRUCTURES & TOWERS

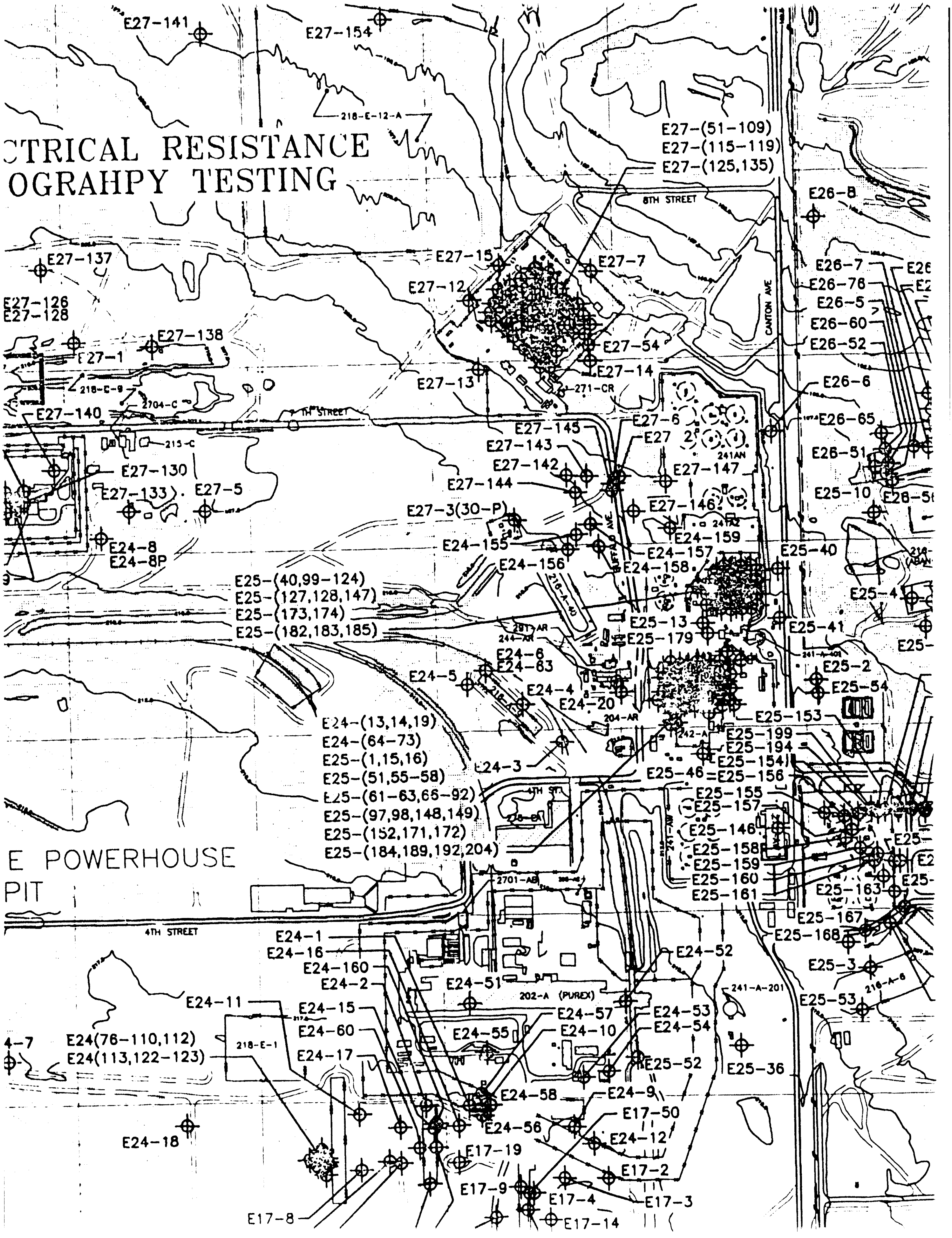
242–A BUILDING NUMBER

MOBILE OFFICES

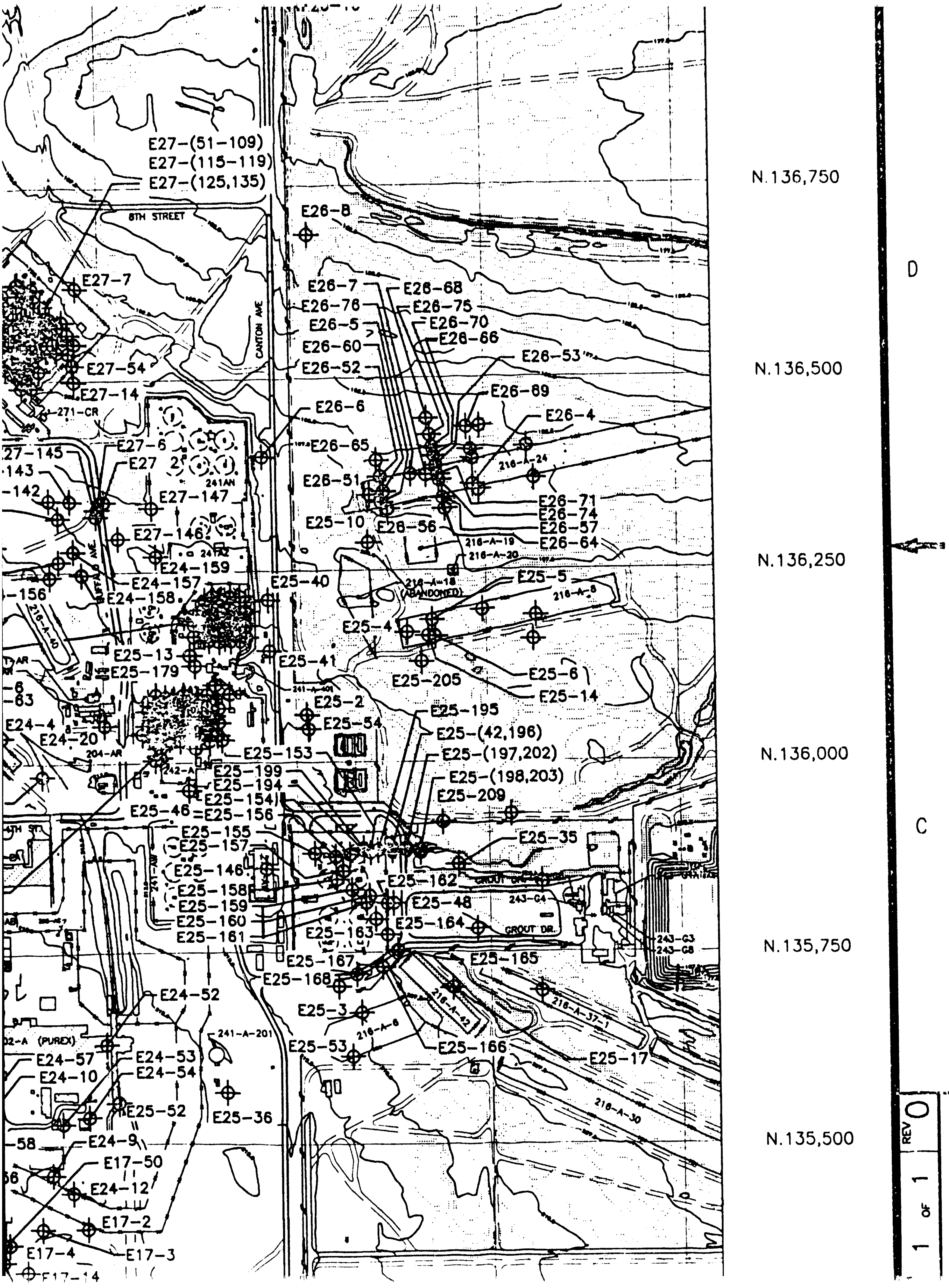
E27–1 WELL



E33-(231-239,257,258)
216-E-2,2A,5,5A & 9
E28-91
E28-87
E28-88
E28-89
E28-85
E28-18
E28-75
E28-84
E28-90
E28-19
E28-10
E28-60
E28-67
216-B-9
E28-59
E28-58
E28-68
E28-2
E28-57
E28-56
E28-5
216-E-4
E28-55
E28-61
E28-62
E28-54
E28-53
E28-23
E28-25
E28-24
E28-73
E28-1
E28-74
E28-7
ATLANTA AVE.
225-BE
E28-3
216-B-59
2728B
E28-14
E28-4
E28-16
E28-15
2728A
E28-78
216-B-64
E28-77
241-B-134
2728
225-B
221-B
221-BG
221-BA
E28-13
7 TH STREET
291-BB
291-BD
E28-51
E28-6
212-B
224-B
E28-12
E28-22
E28-11
291-BD
294-B
222-B
2245-B
E28-52
272-BC
E28-17
BALTIMORE AVE.
ATLANTA AVE.
200E CHEMICAL
DRAIN FIELD
E23-1
E23-2(20-Q)
DP #1-7
2711-EA
2712-E
DP #1
2719E
2711-E
2719-EA
2707E
2703-E
2910-E
252E
2715EC
2715ED
2715EA
2718E
272-E
283-E
BEAUMONT
284-E
275-EB
273-E
274-E
275-E
3RD STREET
2713-E
2722-E
282-E
2715-E
2701EF
COAL ST
COAL RAMP
WASHDOWN BASIN



CTRICAL RESISTANCE
OGRAHPY TESTING
E POWERHOUSE
PIT
E27-141
E27-154
218-E-12-A
E27-(51-109)
E27-(115-119)
E27-(125,135)
8TH STREET
E26-8
E27-137
E27-15
E27-7
E26-7
E27-12
E26-76
E27-126
E27-128
E26-5
E26-60
CANTON AVE
E27-138
E27-1
E27-54
E26-52
218-C-9
E27-14
E27-13
271-CR
E26-6
2704-C
E27-140
7TH STREET
E27-6
E26-65
E27-145
E27
215-C
E27-143
241AN
E26-51
E27-130
E27-142
E27-147
E27-144
E25-10
E27-133
E27-5
E27-3(30-P)
E27-146
E24-159
E24-8
E24-8P
E24-155
E24-157
E25-40
E24-156
E24-158
BUFFALO AVE
E25-(40,99-124)
E25-(127,128,147)
E25-4
E25-(173,174)
216-A-40
E25-13
E25-41
E25-(182,183,185)
291-AR
244-AR
E25-179
241-A-401
E24-6
E24-63
E25-2
E24-5
E25-54
E24-4
E24-20
E24-(13,14,19)
204-AR
E25-153
E24-(64-73)
242-A
E25-199
E25-(1,15,16)
E25-194
E24-3
E25-154
E25-(51,55-58)
E25-46
E25-156
E25-(61-63,66-92)
4TH ST
E25-155
E25-(97,98,148,149)
E25-157
E25-146
E25-(152,171,172)
E25-(184,189,192,204)
E25-158
E25-159
E25-160
2701-AB
E25-163
E25-161
4TH STREET
E25-167
E24-1
E25-168
E24-16
E24-52
E24-160
E25-3
E24-2
E24-51
241-A-201
216-A-6
E24-11
202-A (PUREX)
E25-53
E24-15
E24-57
E24-53
E24(76-110,112)
E24-60
E24-55
E24-10
E24-54
218-E-1
E24(113,122-123)
E24-17
E25-52
E25-36
E24-58
E24-9
E17-50
E24-56
E24-18
E24-12
E17-19
E17-2
E17-9
E17-4
E17-3
E17-8
E17-14


E27-(51-109)
E27-(115-119)
E27-(125,135)
8TH STREET
E26-8
CANTON AVE
E27-7
E26-7
E26-68
E26-76
E26-75
E26-5
E26-70
E26-60
E26-66
E26-52
E26-53
E27-54
E27-14
E26-69
271-CR
E26-6
E26-4
27-145
E27-6
E26-65
E27
-143
216-A-24
241AN
E26-51
-142
E27-147
E26-71
E26-74
E25-10
E26-56
E26-57
E27-146
216-A-19
E26-64
216-A-20
E24-159
E24-157
E25-40
216-A-18 (ABANDONED)
E25-5
-156
E24-158
216-A-8
BUFFALO AVE
216-A-40
E25-4
E25-13
E25-179
E25-41
E25-6
E25-205
241-A-401
E25-14
-6
-83
E25-2
E25-195
E24-4
E25-54
E24-20
E25-(42,196)
204-AR
E25-153
E25-(197,202)
242-A
E25-199
E25-(198,203)
E25-194
E25-209
E25-154
E25-46
E25-156
4TH ST.
E25-155
E25-35
E25-157
241-AW
E25-146
GROUT DR.
E25-162
E25-158
E25-159
243-G4
E25-48
E25-160
E25-164
GROUT DR.
E25-161
E25-163
243-G3
243-G8
E25-167
E25-165
E25-168
216-A-42
216-A-37-1
E24-52
E25-3
216-A-6
241-A-201
202-A (PUREX)
E25-53
E25-166
E24-57
E24-53
E25-17
E24-10
E24-54
E25-52
E25-36
216-A-30
-58
E24-9
E17-50
E24-12
E17-2
E17-4
E17-3
E17-14
N.136,750
D
N.136,500
N.136,250
N.136,000
C
N.135,750
N.135,500
REV
0
1 OF 1

C

KEY P

SCALE: N

LEGEN

W.47,000 N.43,000	HANFORD PLANT COORDINATES (FEET)
E.576,250 N.136,000	WASHINGTON STATE COORDINATES (METERS)
215.0	INDEX CONTOUR (METERS)
	INTERMEDIATE CONTOUR
	IMPROVED ROAD
	UNIMPROVED ROAD
	DIRT ROAD
	SIDEWALKS\PARKING LOTS
	RAILROADS
	SECURITY,WARNING,MISC FENCES
	POST & CHAIN (CRIB,BURIAL GROUND FENCES)
	PERIMETER FENCES

B

GENERAL NOTES

1. THIS MAP IS BASED ON AERIAL PHOTOGRAPHY FLOWN ON 6-24-89. THE ORIGINAL TOPOGRAPI BY MERRICK & COMPANY AND CERTIFIED TO MEET NATIONAL MAP ACCURACY STANDARDS. OFFICIAL COPIES OF THE MERRICK MAPS THAT SHOW THE CERTIFICATE ARE LOCATED IN THE W ENGINEERING FILES AS DRAWING NUMBERS H-2-79476 SHEET 1 AND H-2-79477 SHEET 1 TI NAMES OF ADDITIONAL FEATURES AND THE TITLE BLOCK WERE ADDED BY WESTINGHOUSE HANF

2. WASHINGTON STATE PLANE COORDINATE SYSTEM: THE OFFICIAL COORDINATE SYSTEM AS DEFINE REVISED CODE OF WASHINGTON (RCW). THE HANFORD SITE LIES WITHIN THE WASHINGTON COO SOUTH ZONE. THIS GRID COVERS THE ENTIRE SITE AND USES X (EASTINGS) AND Y (NORTHINC

A

HORIZONTAL DATUM: NAD-83 LAMBERT PROJECTION. WASHINGTON STATE PLANE COORDINATES

CONTOUR INTERVAL: 0.5 METERS.

3. HANFORD PLANT GRID: A LOCAL GRID SYSTEM WITH ITS INITIAL POINT NORTHEAST OF THE 4 COVERS 200 EAST AND 200 WEST AREA AS WELL AS GENERAL SITE WORK SUCH AS WELLS A

-AN
)NE

)

BUILDINGS/STRUCTURES & TOWERS

242-A BUILDING NUMBER

MOBILE OFFICES

E27-1 WELL

TANKS

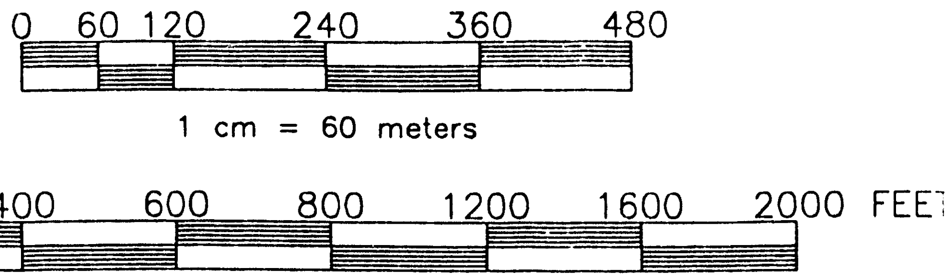
216-A-42 CRIB

218-E-10 BURIAL GROUND

DP DISCHARGE POINT

SITE PLAN

SCALE: 1:6000



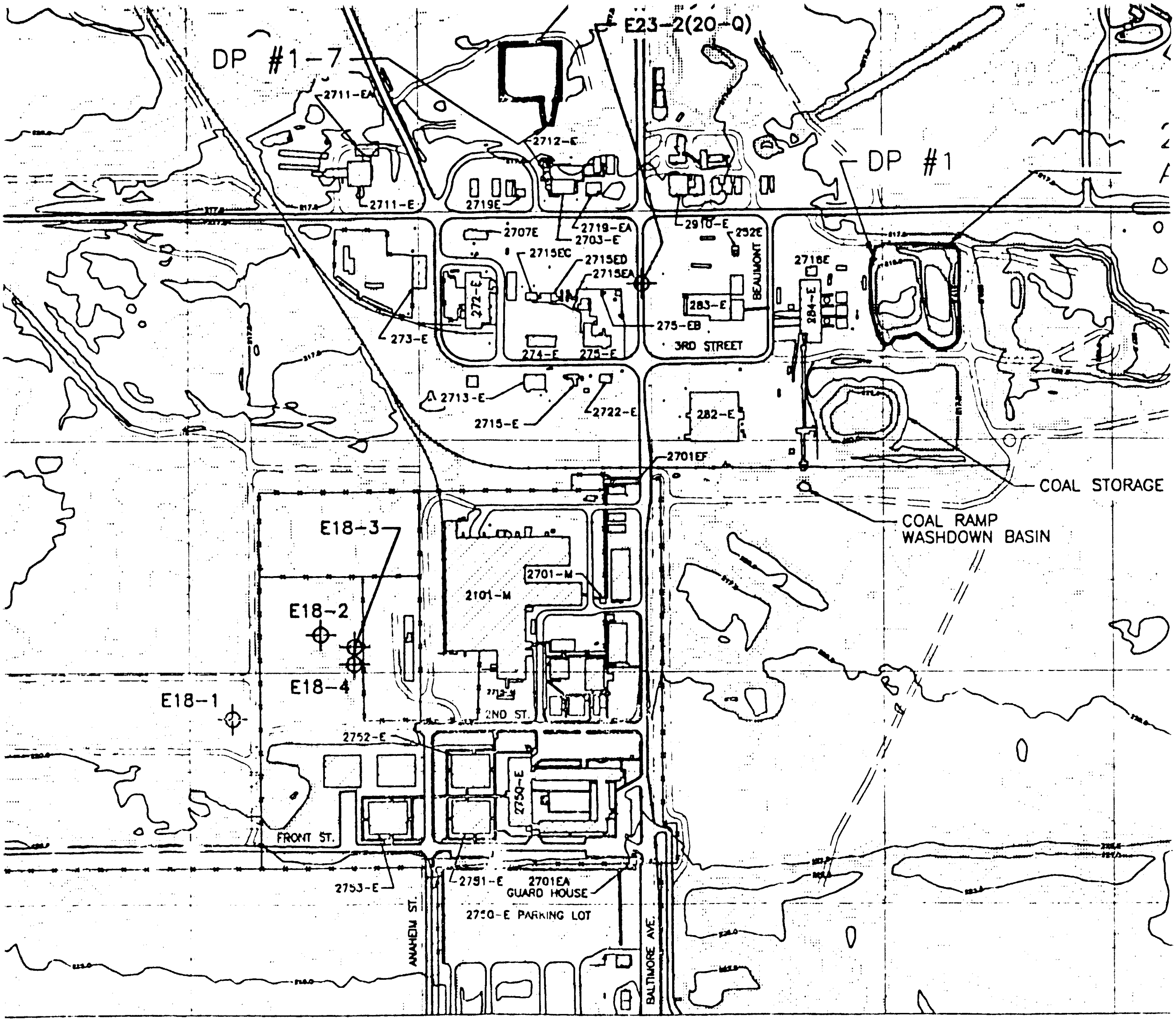
HIC MAP WAS PREPARED

:STINGHOUSE
HRU 37.
)RD COMPANY.

D BY THE
RDINATE SYSTEM,
;S) COORDINATES.

ARE SHOWN IN METERS.

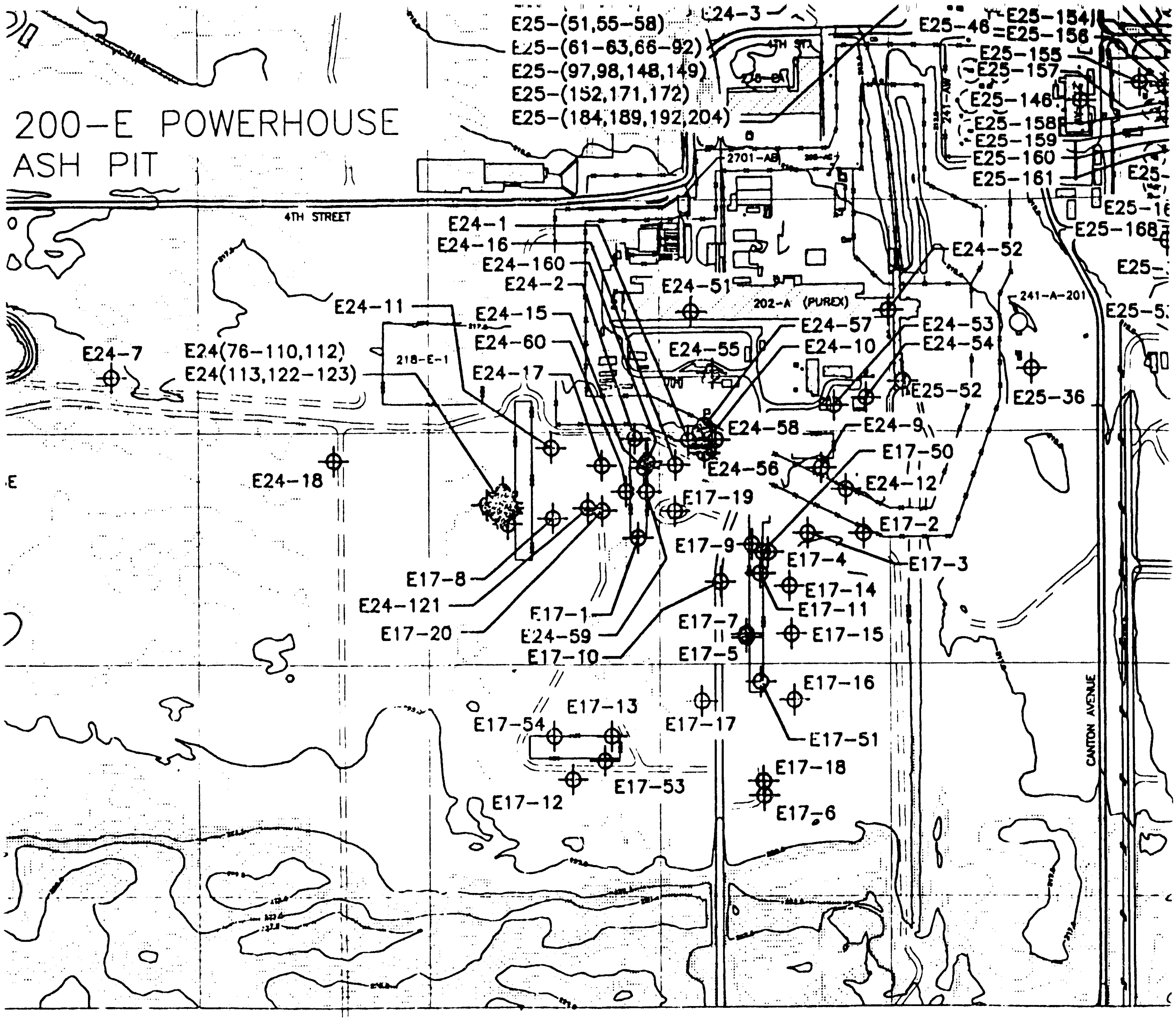
OO AREA. IT
ND BURIAL



H-13-000206	200 AREA TOPOGRAPHIC MAP
H-13-000207	200 AREA TOPOGRAPHIC MAP
H-13-000214	200 AREA TOPOGRAPHIC MAP
H-13-000215	200 AREA TOPOGRAPHIC MAP
H-13-000222	200 AREA TOPOGRAPHIC MAP
H-13-000223	200 AREA TOPOGRAPHIC MAP
H-13-000230	200 AREA TOPOGRAPHIC MAP
H-13-000231	200 AREA TOPOGRAPHIC MAP

MFD

REV NO

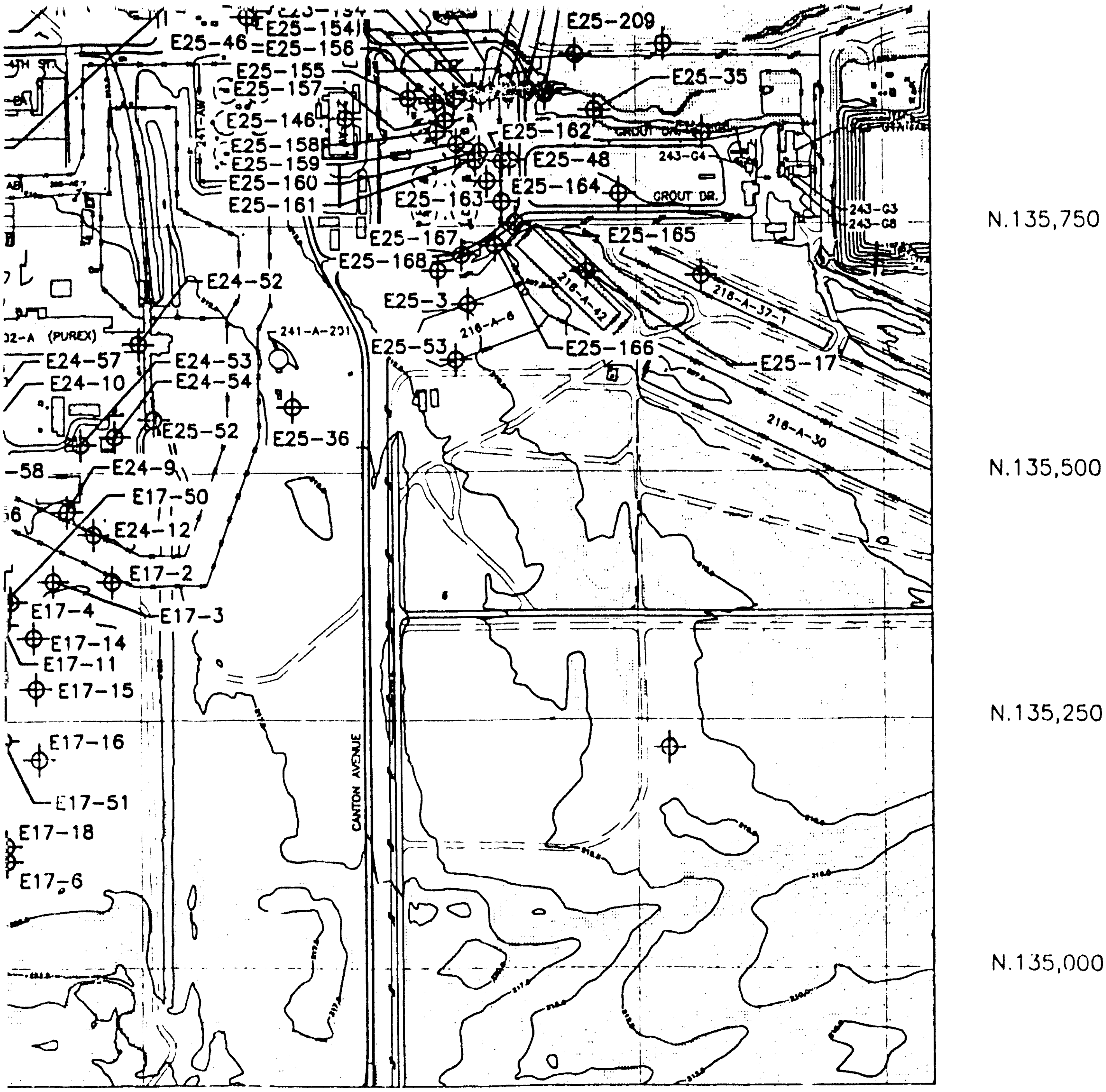


THIS MAP IS TO BE
DO NOT USE THIS

DRAWN RAFAEL TORRES	DATE 3-24-94	
CHECKED	3-24-94	
DFTG APVD	3-24-94	
COG ENGR	3-28-94	E
APVD		
APVD		
APVD		
APVD		SIZE

DESCRIPTION	REV BY DATE	CHK BY DATE	DFTG APVD DATE	COG ENGR	OTHER	OTHER

APPROVALS BY/DATE



THIS MAP IS TO BE USED FOR REFERENCE PURPOSES ONLY.
DO NOT USE THIS MAP FOR CONSTRUCTION PURPOSES.

	DATE	
DRAWN RAFAEL TORRES	3-24-94	U.S. DEPARTMENT OF ENERGY DOE Field Office, Richland Westinghouse Hanford Company
CHECKED [signature]	3-24-94	
DFTG APVD [signature]	3-24-94	
COG ENGR [signature]	3-28-94	ELECTRICAL RESISTANCE TOMOGRAPHY TESTING
APVD		
APVD		
APVD		

SIZE | BLDG NO | INDEX NO | DWG NO | REV

DWG NO H-13-000040 | SH 1 OF 1 | REV 0

C

A

APPENDIX B

PRODUCT INFORMATION

CONTENTS

FIGURES

APPENDIX B

1.0 PRODUCT INFORMATION

SECTION B. PRODUCT INFORMATION, QUESTION 1: BRIEFLY DESCRIBE ALL MANUFACTURING PROCESSES AND PRODUCTS, AND/OR COMMERCIAL ACTIVITIES. PROVIDE THE APPLICABLE STANDARD INDUSTRIAL CLASSIFICATION (SIC) CODE(S) FOR EACH ACTIVITY.

The activity that will generate the liquid discharged to the ground will be a research and development test. The technology to be tested is the ERT technology developed at the Lawrence Livermore National Laboratory (LLNL). The ERT technology has the potential to detect leaks from the bottom of underground storage tanks, such as the single-shell tanks at the Hanford Site.

1.1 ELECTRICAL RESISTANCE TOMOGRAPHY

The principal behind the ERT technology is, if a current is applied to the soil, the potential difference measured between two points will change if liquids (especially liquids with electrolytes) are added to the soil. If the potential difference is measured between an array of points, leaks over a larger area can be detected. Electrical resistance is measured by using a series of electrode plates placed at different depths below the ground surface in the casing of a borehole. Figure B-1 provides a schematic of the configuration of the boreholes, electrodes, and electrical equipment. Two critical aspects of the electrode placement are that the electrodes must be in good contact with the soil and the electrodes must be insulated from one another. Current is driven through the soil from two adjacent electrodes and the potential difference is measured between all other adjacent electrode pairs. The procedure is repeated for all combinations of adjacent source and receiver electrode positions. This scheme is similar to that used for surface dipole-dipole surveys.

1.2 PURPOSE OF THE ELECTRICAL RESISTANCE TOMOGRAPHY TESTING AT THE HANFORD SITE

The LLNL has demonstrated the ERT technology in tracking groundwater contaminant plumes at several areas around the country. To prove that the ERT technology can detect leaks at the Hanford Site, a multi-phase testing program will be needed. This permit application will covers Phase I and II of the testing. If these tests are successful, the testing will continue on to Phase III, which will take place in an actual tank farm. The primary purpose the Phase I and II tests is to determine if measurements can be made in close proximity to a large steel mass, specifically, a mockup of an underground tank.

1.3 LOCATION OF THE ELECTRICAL RESISTANCE TOMOGRAPHY TEST SITE

The site chosen for performing the ERT testing is in the 200 East Area of the Hanford Site, north of 7th Street and northwest of the inactive Semi-Works. The testing area, including tank mockup, wells, and support equipment will be confined to a maximum surface area of 300 by 300 feet. The location is shown on figures in Appendix A. This site was chosen because of the availability of a partially constructed tank and the similarity of the soil to that found at the 200 Area tank farms. The tank, known as tank 105A, is located at the approximate Hanford Site coordinates of N42680 and W50700. The tank 105A site is not known to have been used for any operational purposes and the area has been radiologically surveyed and cleared for the testing. The general area near the tank was the intended location of the 221-C Chemical Separations Plant. The plant was never constructed and construction of tank 105A was never completed. Currently, tank 105A consists of steel walls about 50 feet in diameter and 16 feet high. About one half of the tank's exterior has been bermed. The bottom of tank 105A is composed of native soils.

1.4 ELECTRICAL RESISTANCE TOMOGRAPHY TESTING

To prepare the partially completed tank 105A to function as a mockup of a tank for testing, a tank bottom will be simulated by installing thin-gauge sheet metal, wire meshing inside the tank walls, or similar material. The purpose of the simulated tank bottom is to provide an electrically continuous mass that is similar in size and electrical properties to that of a real tank. The soil will be backfilled around the walls of the tank mockup.

Also to prepare for testing, approximately 16 boreholes are planned to be installed around the tank mockup for the placement of the ERT electrodes (Figure B-2). The electrodes are to be installed on up to a 6-inch diameter poly vinyl chloride (PVC) casing. The boreholes will vary in length from approximately 35 feet to 115 feet below the surface. Because of funding constraints or testing requirements, the number of boreholes installed for the ERT Testing may vary. The casing may be installed either by using a drilling rig, or for the shallower holes, by backfilling around the casing with a backhoe. Electrodes for measuring the potential difference will be placed approximately every 5 feet along the PVC well casing.

The ERT testing will be performed in two phases. Phase I testing will consist of taking background measurements of the soil resistance, followed by quickly injecting 2,000 gallons of the sodium chloride tracer solution from a point(s) at the bottom of the tank mockup (Figure B-3). The injection rate is expected to be 200 to 400 gallons per day for 5 to 10 days. Phase I testing will simulate a leak from the bottom of an underground tank and will evaluate if the ERT method has the sensitivity to detect leaks from underground tanks.

Following a successful completion of the Phase I testing, Phase II testing will be conducted that will inject 2,000 gallons (up to a maximum of 4,000 gallons) of the sodium chloride tracer solution into the soil over a longer duration. The injection rate in Phase II testing will vary, but is expected to be about 40 gallons per day over a period of 50 days. Phase II testing will include a more realistic slow leak where the reliability of the ERT method will be evaluated under the influence of factors such as noise.

Tests also are planned that simulate rain events by applying water on the ground surface for a period of up to 24 hours. The purpose of the rain simulation is to determine if rainwater will interfere with the resistance measurements. Plans include simulating a 0.25- to 0.5- inch rainfall event over a surface area of 200 by 200 feet. Meteorological data indicates that a rainfall event as large as 0.5 inches is an infrequent event on the Hanford Site. The water used for the simulated rainwater will be Hanford Site raw water accessed at a fire hydrant located near the test site. The maximum amount of raw water expected to be used for the rain simulation tests is 25,000 gallons. The water will be applied using standard irrigation sprinklers.

Phase II could also include drilling back into areas where leaks were predicted to confirm the readings. It is hoped that information on the migration of the liquid through the soil column also can be used to validate vadose zone flow modeling.

The liquid being injected will consist of Hanford Site sanitary (potable) water with a tracer of sodium chloride added to a concentration of 0.1 molar (7,000 milligrams per liter). The concentration of 0.1 molar sodium chloride is the minimum concentration of electrolyte that is believed to be required to ensure that the plume can be measured. The Phase I and Phase II testing, including monitoring, should be completed in approximately 18 months. The maximum discharge to the soil column of the sodium chloride tracer solution will not exceed 6,000 gallons.

2.0 PLANT OPERATIONAL CHARACTERISTICS

<u>SECTION C, PLANT OPERATIONAL CHARACTERISTICS, QUESTION 3: ON A SEPARATE SHEET, DESCRIBE IN DETAIL THE TREATMENT AND DISPOSAL OF ALL WASTEWATER AS DESCRIBED ABOVE. INCLUDE A SCHEMATIC FLOW DIAGRAM FOR ALL TREATMENT AND DISPOSAL SYSTEMS.</u>

Once the ERT testing is completed, the sodium chloride tracer solution cannot be recovered and therefore becomes a wastewater. No treatment can be performed on the wastewater and no schematic diagram is included. No chemical analyses have been included in the permit application because the wastewater consists of sanitary (potable) water with only sodium chloride added. Appendix C contains information on vadose zone modeling of the waste water. The results of the modeling shows that the maximum salt concentration in the vadose zone is 10 milligrams per liter about 300 years after injection. The maximum contaminant level (MCL) for chlorine in drinking water is 250 milligrams per liter. Therefore, the ERT testing should not pose a threat to aquifer quality. Because of the long travel time through the vadose zone, the up to 25,000 gallons of raw water disposed of to the ground as a result of the rain simulation testing should not significantly affect the migration of the tracer solution to the groundwater.

3.0 WATER CONSUMPTION AND WATER LOSS

SECTION D. WATER CONSUMPTION AND WATER LOSS. QUESTION 3: ATTACH A LINE DRAWING SHOWING THE WATER FLOW THROUGH THE FACILITY. INDICATE SOURCES OF INTAKE WATER, OPERATIONS CONTRIBUTING WASTE WATER TO THE EFFLUENT, AND TREATMENT UNITS LABELED TO CORRESPOND TO THE MORE DETAILED DESCRIPTIONS IN ITEM C. CONSTRUCT A WATER BALANCE ON THE LINE DRAWING BY SHOWING AVERAGE FLOWS BETWEEN INTAKES, OPERATIONS, TREATMENT UNITS, AND OUTFALLS. IF A WATER BALANCE CANNOT BE DETERMINED (E.G., FOR CERTAIN MINING ACTIVITIES), PROVIDE A PICTORIAL DESCRIPTION OF THE NATURE AND AMOUNT OF ANY SOURCES OF WATER AND ANY COLLECTION OR TREATMENT UNITS.

This question is mainly relevant to manufacturing or treatment facilities. Although the question does not directly apply to the ERT Testing, a line drawing is provided on Figure B-4.

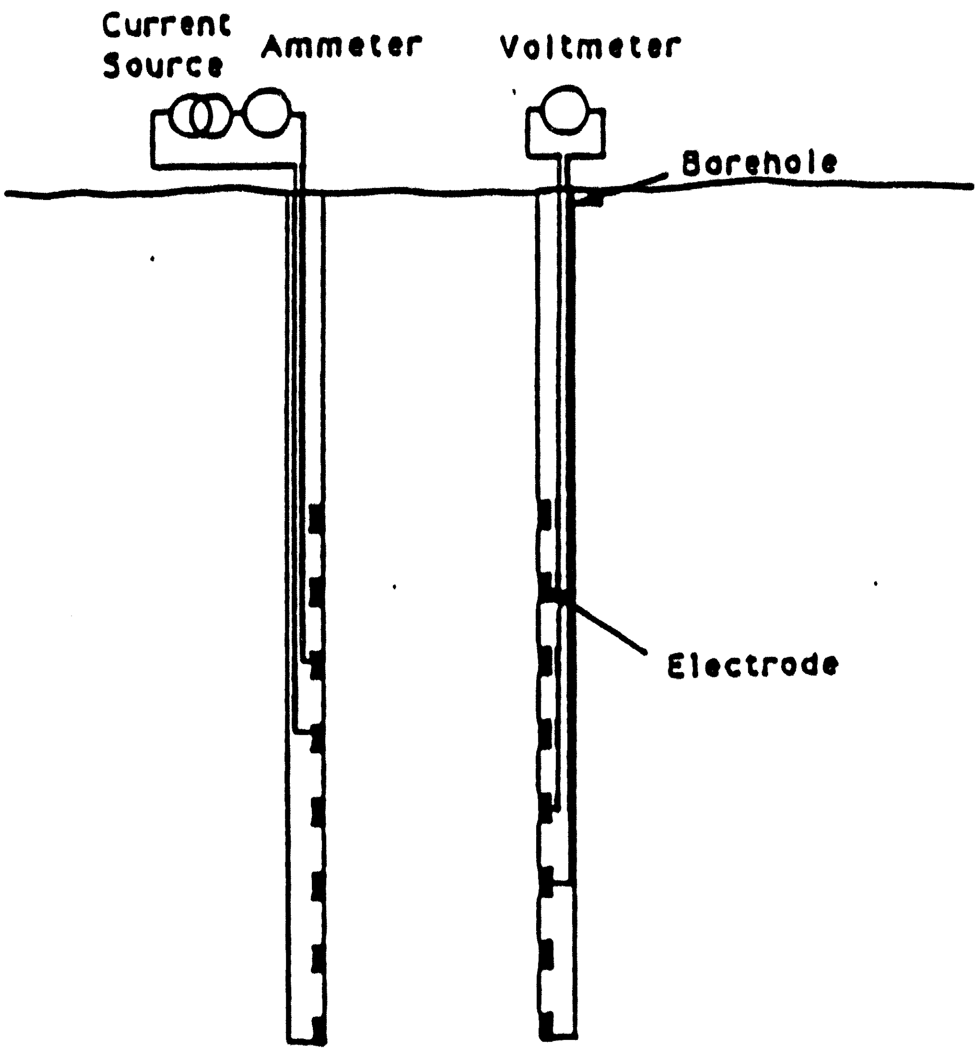


Figure B-1. Schematic of Resistivity Measurements Between Two Boreholes.

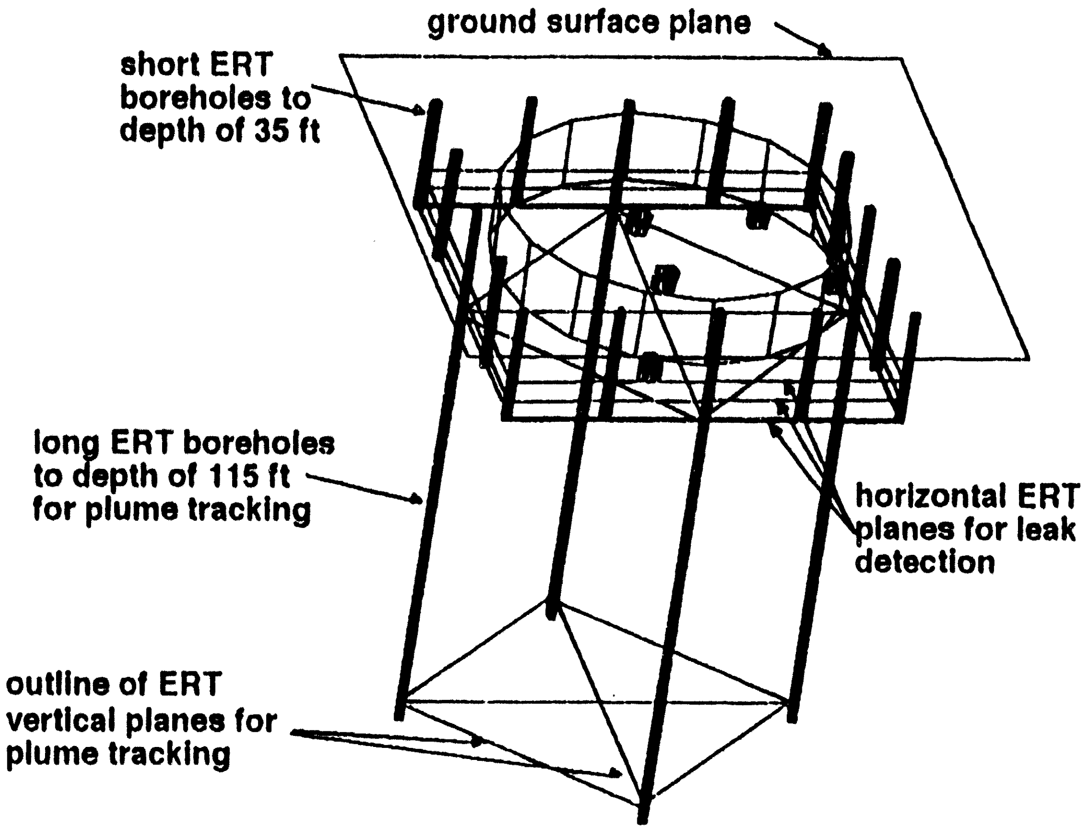


Figure B-2. Perspective View of Proposed Tank Mock-up Site.

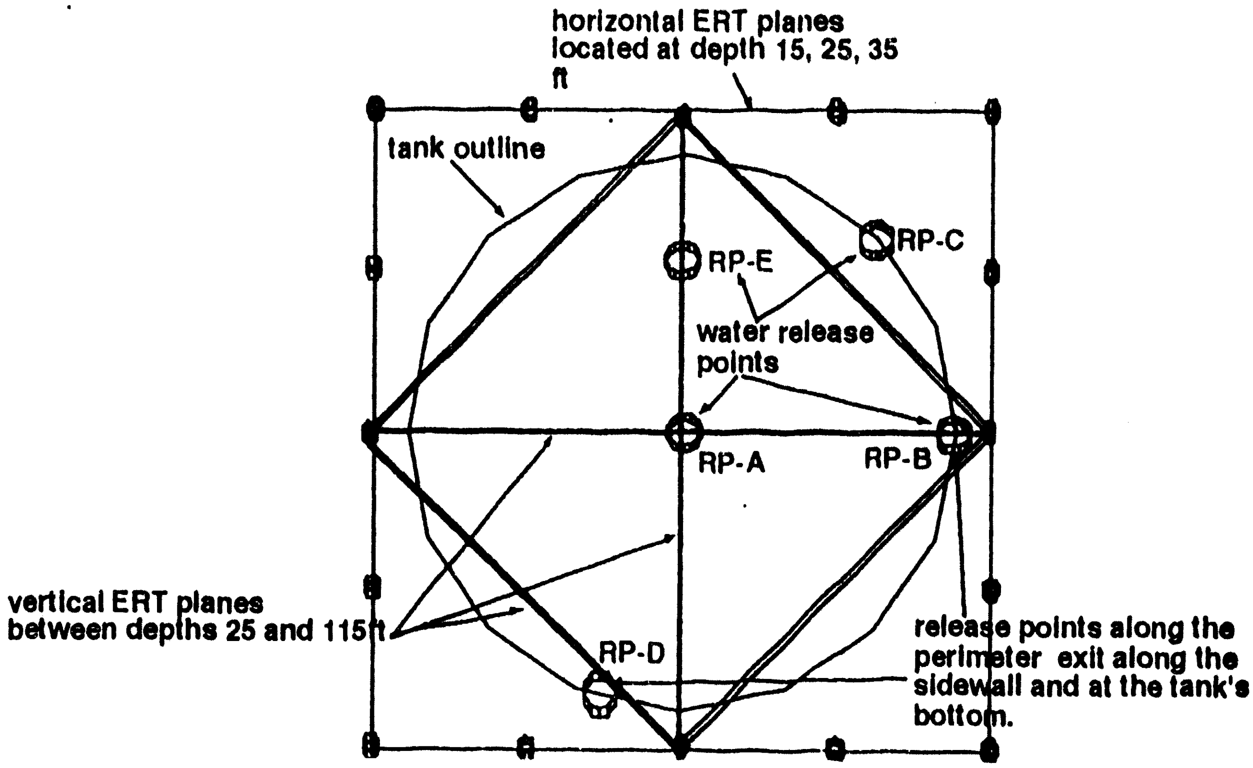


Figure B-3. Plan View of Proposed Tank Mock-up Site.

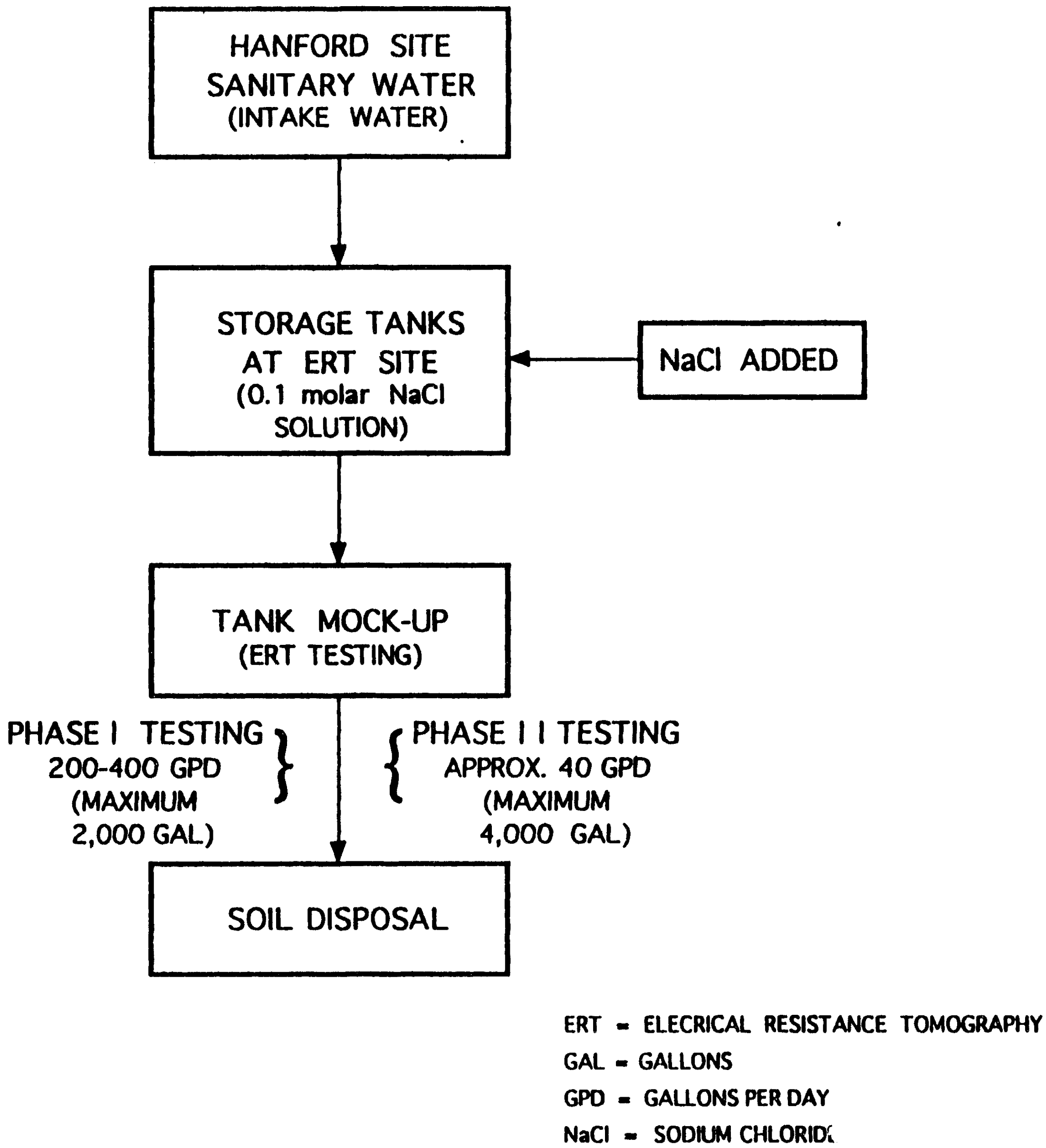


Figure B-4. Line Drawing Showing Water Flow through the Electrical Resistance Tomography Test Site.

APPENDIX C

SITE ASSESSMENT

CONTENTS

FIGURES

1.0 BOREHOLE DATA

ATTACH WELL LOGS AND WELL ID # WHEN AVAILABLE FOR ALL WELLS WITHIN 500 FEET AND ANY AVAILABLE WATER QUALITY DATA.

The topographic map in Appendix A shows six boreholes within 500 feet of the ERT test site. Five of the boreholes were less than 40 feet deep and have been abandoned and backfilled. These boreholes include the following:

- 299-E27-126 (35 feet total depth)
- 299-E27-128 (35 feet total depth)
- 299-E27-132 (35 feet total depth)
- 299-E27-137 (25 feet total depth)
- 299-E27-140 (40 feet total depth).

Borehole 299-E27-1 was completed to a total depth of 332 feet. The well consists of 8-inch carbon steel casing with a screened interval from 262 to 331 feet belowground surface. The well currently is included in the Hanford Site water-level measurement network. The last water level measurement, taken in December 1993, indicated that the water table was at approximately 281 feet below ground surface. The well is not sampled for water quality data. Because the well was drilled in 1948, the well logs could not be located.

2.0 HANFORD SITE SOILS

SECTION H, SITE ASSESSMENT, QUESTION 5: DESCRIBE SOILS ON THE SITE USING INFORMATION FROM LOCAL SOIL SURVEY REPORTS. (SUBMIT ON A SEPARATE SHEET.)

The most recent study of the soil on the Hanford Site was done by Hajek (1966). Hajek (1966) presents a soil map and descriptive report of the soils in the Benton County portion of the Hanford Site. Based on morphologic and genetic characteristics, 13 soil types were identified. An approximate land use capability classification is provided for these soils, on the basis of soil limitations for, and damage risks associated with, agricultural use. Approximate engineering classification for these soils, using the Unified Soil Classification System, also are provided by Hajek (1966). The soils at the 200 East Area predominantly consist of three soil types: Burbank loamy sand, Quincy sand (Rupert sand), and the Ephrata sandy loam. The soil types mapped on the Hanford Site are shown on Figure C-1. The soil types in the ERT test site area are shown on Figure C-2.

The Burbank loamy sand is a dark grayish brown, coarse-textured, excessively drained soil underlain by gravel. The surface soil is usually about 16 inches thick, but can be as much as 30 inches thick. The gravel content of the subsoil may range from 20 to 80 percent (by volume). The surface of the Burbank loamy sand is Group SM (silty sand) and the subsoil is group GM (silty gravel) to GP (poorly graded gravel). Group GM (silty gravel) are coarse-grained soils composed predominantly of gravels with more than 12 percent fines. Group GP (poorly graded gravel) contains coarse-grained soils that are predominantly well sorted gravels with less than 5 percent fines.

The Quincy sand (Rupert sand) represents one of the most extensive soils on the Hanford Site. The soil is grayish brown, moderately-deep, coarse sand. Quincy soils are developed under grass and sagebrush in coarse alluvial deposits mantled by wind-blown sand. Relief characteristically consists of hummocky terraces and dune-like ridges. The surface and subsoil of the Quincy sand were assigned to Group SM (silty sand), which consists of coarse-grained soils composed predominantly of sands with more than 12 percent fines.

The Ephrata sandy loam, occurring to an average depth of 12 inches, is a dark grayish-brown, medium-textured soil underlain by deep gravelly material. The topography is generally level. The surface of the Ephrata sandy loam belongs to Group SM (silty sand) to ML (silt), and the subsurface belongs to Group ML (silt). Group ML (silt) are fine-grained soils composed of silts and clays with little or no plasticity.

3.0 REGIONAL GEOLOGY AND HYDROLOGY

SECTION H, SITE ASSESSMENT, ITEM 6: DESCRIBE THE REGIONAL GEOLOGY AND HYDROGEOLOGY WITHIN ONE, MILE OF THE SITE. (SUBMIT ON SEPARATE SHEET.)

3.1 REGIONAL GEOLOGY

A summary of the regional geologic characteristics of the Pasco Basin and the Hanford Site is presented in terms of stratigraphy and structure in the following sections. Regional conditions of the area are described in Lindsey et al. (1992), Delaney et al. (1991), and Lindsey et al. (1991), which maybe consulted for additional detail.

3.2 REGIONAL STRATIGRAPHY

The Hanford Site lies within the Pasco Basin, a regional structural and topographic, sediment-filled depression. The sediments of the Pasco Basin are underlain by Miocene-age basalt of the Columbia River Basalt Group, a thick sequence of flood basalts that covers a large area in eastern Washington, western Idaho, and northeastern Oregon. The sediments overlying the basalts, from oldest to youngest, include the following:

- Miocene-Pliocene Ringold Formation
- Possible Late Pliocene or probable Early Pleistocene local alluvial deposits
- Local 'Palouse' soil of mostly eolian origin

- Pleistocene Hanford formation glaciofluvial deposits
- Holocene eolian and fluvial surficial sediments.

The generalized stratigraphy of the Hanford Site is described from oldest to youngest formation in the following sections.

3.2.1 Columbia River Basalt Group and the Ellensburg Formation

The Columbia River Basalt Group consists of an assemblage of tholeiitic, continental flood basalts of Miocene Age with accumulated thickness in excess of 10,000 feet within the Pasco Basin. These flows cover an area of more than 63,000 square miles in Washington, Oregon, and Idaho and have an estimated volume of about 40,800 square miles. The majority of the flows were erupted 17 to 14.5 million years ago (Delaney et al. 1991).

The Columbia River Basalt Group is formally divided into five formations (from oldest to youngest): Imnaha Basalt, Picture Gorge Basalt, Grande Ronde Basalt, Wanapum Basalt, and Saddle Mountains Basalt. Of these, all are present within the Pasco Basin except for the Picture Gorge Basalt. The Saddle Mountains Basalt, divided into the Ice Harbor, Elephant Mountain, Pomona, Esquatzel, Asotin, Wilbur Creek, and Umatilla Members, forms the uppermost basalt unit throughout most of the Pasco Basin. The Elephant Mountain Member is the uppermost unit beneath most of the Hanford Site, except near the 300 Area where the Ice Harbor Member is found, and north of the 200 Areas where the Saddle Mountains Basalt has been eroded down to the Umatilla Member in the Gable Gap area (Delaney et al. 1991). The Elephant Mountain Member has also been locally eroded in the vicinity of the northeast corner of the 200 East Area (Delaney et al. 1991). On anticlinal ridges bounding the Pasco Basin, erosion has removed the Saddle Mountains Basalt, exposing the Wanapum and Grande Ronde basalts (Delaney et al. 1991).

The Ellensburg Formation consists of all sedimentary units that occur between the basalt flows of the Columbia River Basalt Group in the central Columbia Basin (Reidel and Fecht 1981). The Ellensburg Formation generally consists of two main lithologies: volcaniclastics and siliciclastics. The volcaniclastics consist mainly of primary pyroclastic air-fall deposits and reworked epiclastics derived from volcanic terrains west of the Columbia Plateau. Siliciclastic strata consist of clastic, plutonic, and metamorphic detritus derived from the Rocky Mountain terrain to the east.

At the Hanford Site, the three uppermost units of the Ellensburg Formation are the Levy interbed, the Rattlesnake Ridge interbed, and the Selah interbed. The Levey interbed is confined to the vicinity of the 300 Area. The Rattlesnake Ridge and Selah interbeds are found beneath most of the Hanford Site (Lindsey et al. 1992).

3.2.2 Suprabasalt Sediments

The suprabasalt sedimentary sequence is up to approximately 750 feet thick in the west-central Cold Creek syncline, while it pinches out against the anticlinal ridges that bound or are present within the Pasco Basin (Gaylord and Poeter 1991). The suprabasalt sediments are dominated by laterally extensive deposits of the late Miocene to Pliocene age Ringold Formation and the Pleistocene-age Hanford formation. Locally occurring strata separating the Ringold and Hanford formations are assigned to the informally defined Plio-Pleistocene unit, early 'Palouse' soil, and pre-Missoula gravels, which make up the remainder of the sequence (DOE 1993).

3.2.2.1 Ringold Formation. Overlying the Columbia River Basalt Group is the late Miocene to Pliocene-age Ringold Formation (Fecht et al. 1987, DOE 1988). The Ringold Formation accumulated to thicknesses of up to 1,200 feet in the Pasco Basin (Tallman et al. 1979). On the Hanford Site, the Ringold Formation is up to 600 feet thick in the deepest part of the Cold Creek syncline south of the 200 West Area and 560 feet thick in the western Wahluke syncline near the 100-B Area (Delaney et al. 1991). The Ringold Formation pinches out against the anticlinal flanks that bound or are present within the Pasco Basin, and is largely absent in the northern and northeastern parts of the 200 East Area and adjacent areas to the north (Delaney et al. 1991, Lindsey et al. 1992). The recent studies of the Ringold Formation (Lindsey et al. 1991) indicate it is best described on the basis of sediment facies associations and their distribution. The facies associations have been divided into fluvial gravel, fluvial sand, overbank deposits, lacustrine deposits, and alluvial fans. The lower Ringold Formation contains five separate stratigraphic intervals dominated by fluvial gravels, which have been designated units A, B, C, D, and E, from oldest to youngest. These gravels units are separated by basin-wide overbank and lacustrine deposits (Lindsey et al. 1992). A more detailed discussion of the Ringold Formation stratigraphy can be found in Lindsey et al. (1991).

3.2.2.2 Post-Ringold Pre-Hanford Sediments. Thin alluvial deposits situated stratigraphically between the Ringold Formation and the Hanford formation are found within the Pasco Basin. The three informally defined units include: (1) the Plio-Pleistocene unit, (2) the early 'Palouse' soil, and (3) the Pre-Missoula gravels. The Plio-Pleistocene unit and early 'Palouse' soil are not found in or near the 200 East Area. These soils are found to the west of the 200 East Area, near the eastern boundary of the 200 West Area. The pre-Missoula gravels are not found in the 200 East Area. Because of the absence of these units from the site area, the gravels will not be discussed further. The Plio-Pleistocene unit and early 'Palouse' soil are described in detail in Last et al. (1989). The pre-Missoula gravels are discussed in PSPL (1982) and Fecht et al. (1987).

3.2.2.3 Hanford formation. The informally designated Hanford formation consists of unconsolidated, glaciofluvial sediments that were deposited during several episodes of cataclysmic flooding during the Pleistocene Epoch. The sediments are composed of pebble- to boulder-sized gravel, fine- to coarse-grained sand, and silt. These sediments are divided into three facies: (1) gravel-dominated, (2) sand-dominated, and (3) silt-dominated (Lindsey et al. 1992). These facies are referred to as coarse-grained deposits, plane-laminated sand facies, and rhythmite facies, respectively (Baker et al. 1991). The silt-dominated deposits also are referred to as 'Touchet' beds, and the gravel-dominated facies generally correspond to the Pasco gravels.

The Hanford formation is thickest in the vicinity of the 200 Areas where it is up to 350 feet thick (Lindsey et al. 1992). The formation was deposited by cataclysmic flood waters that originated from glacial Lake Missoula (Fecht et al. 1987, DOE 1988, Baker et al. 1991). The deposits are absent from ridges above approximately 1,180 feet above mean sea level, the highest level of cataclysmic flooding in the Pasco Basin (Delaney et al. 1991).

3.2.2.4 Holocene Surficial Deposits. Holocene surficial deposits consist of silt, sand, and gravel that form a less than 16 foot veneer across much of the Hanford Site. These sediments were deposited by eolian and alluvial processes (Delaney et al. 1991).

3.3 REGIONAL GEOLOGIC STRUCTURE

The Hanford Site is located within the Pasco Basin near the eastern edge of the Yakima Fold Belt. The Yakima Fold Belt consists of a series of segmented, narrow, asymmetric, east-west trending anticlines separated by broad synclines or basins that, in many cases, contain thick accumulations of Neogene- to Quaternary-aged sediments (DOE 1988, Smith et al. 1989). The Pasco Basin is one of the larger structural basins of the fold belt.

The northern limbs of the anticlines of the Yakima Fold Belt generally dip steeply to the north, or are vertical. The southern limbs generally dip at relatively shallow angles to the south. Thrust or high-angle reverse faults with fault planes that strike parallel or subparallel to the axial trends are found principally on the north sides of the anticlines. The amount of vertical stratigraphic offset associated with these faults varies (Delaney et al. 1991).

Deformation of the Yakima folds occurred under north-south compression and was contemporaneous with the eruption of the basalt flows. The fold belt was enlarging during the eruption of the Columbia River Basalt Group and continued to enlarge through the Pliocene, into the Pleistocene, and perhaps to the present (Delaney et al. 1991).

The Pasco Basin is a structural depression bounded on the north by the Saddle Mountain anticline, on the west by the Umtanum Ridge, Yakima Ridge, and Rattlesnake Hills anticlines, and on the south by the Rattlesnake Mountain anticline. The Palouse slope, a west-dipping monocline, bounds the Pasco Basin on the east. The Pasco Basin is divided into the Wahluke and Cold Creek synclines by the Gable Mountain anticline, the eastern extension of the Umtanum Ridge anticline.

The Cold Creek syncline lies between the Umtanum Ridge-Gable Mountain uplift and the Yakima Ridge uplift, and is an asymmetric and relatively flat-bottomed structure. The bedrock of the northern limb dips gently to the south, and the southern limb dips steeply to the north. The deepest parts of the Cold Creek syncline, the Wye Barricade depression, and the Cold Creek depression, are located approximately 7.5 miles southeast of the 200 Areas and just west-southwest of the 200 West Area, respectively (Tallman et al. 1979).

3.4 LOCAL GEOLOGY

The depth to the top of the Elephant Mountain Member basalt in the vicinity of the 200 East Area ranges from approximately 280 feet in the northern part to approximately 520 feet in the southern part. Overlying the basalt are sediments of the Ringold Formation, Hanford formation, and Holocene surfical deposits. The Plio-Pleistocene unit, early 'Palouse' soil and the Pre-Missoula gravels are absent in the vicinity of the 200 East Area (Lindsey et al. 1992). The following discussion emphasizes the suprabasalt sediments in the vicinity of the 200 East Area.

3.4.1 Ringold Formation

The Ringold Formation unconformably overlies the Elephant Mountain Member basalt in the southern two-thirds of 200 East, but is absent in the northern part of the 200 East Area. The Ringold Formation thickens and dips to the south, southeast, and southwest towards the axis of the Cold Creek syncline (Lindsey et al. 1992). Unit A, the lower mud sequence, and unit E are the only Ringold Formation units present in the 200 Areas.

The lowest unit of the Ringold Formation is fluvial gravel unit A. Unit A thickens and dips towards the south in the direction of the Cold Creek syncline. Unit A within the 200 East Area ranges from 0 feet thick in the northern part to approximately 100 feet thick near the southern boundary. Unit A generally is described as a clast-supported granule to cobble gravel with a sandy matrix. Clast composition varies with basalt, quartzite, porphyritic volcanics, and greenstone being the most common. Clasts of silicic plutonic rocks, gneisses, and volcanic breccias also can be found. Associated sands are generally quartzo-feldspathic with basalt content ranging from 5 to 25 percent (Lindsey et al. 1992).

The lower mud sequence overlies unit A and also dips and thickens towards the south. The lower mud sequence ranges from 0 feet thick in the northern part to approximately 50 feet thick near the southern boundary of the 200 East Area. The lower mud sequence is composed of overbank and lacustrine deposits. The overbank deposits consist of laminated to massive silt, silty fine-grained sand, and paleosols containing variable amounts of pedogenic calcium carbonate. Plane-laminated to massive clay with thin silt and sand interbeds characterize the lacustrine deposits. The lacustrine deposits contain some soft-sediment deformation (Lindsey et al. 1992).

Unit E locally overlies the lower mud sequence in the southwest corner of the 200 East Area and in the vicinity of the Grout Treatment Facility. Unit E appears to be absent from the northern and central parts of the 200 East Area. The unit thickens towards the area between 200 East and 200 West Areas. Unit E ranges from 0 feet thick in the northern and central parts of the 200 East Area to approximately 90 feet thick southwest of the 200 East Area. Unit E is a clast-supported granule to cobble gravel, similar to unit A. Locally, strata typical of the fluvial sand and overbank facies associations could be encountered within unit E (Lindsey et al. 1992).

3.4.2 Hanford formation

In the 200 East Area, the Hanford formation consists predominately of gravel-dominated and sand-dominated facies. Informally, the Hanford formation can be divided into the upper gravel sequence, middle sand sequence, and lower gravel sequence (Lindsey et al. 1992). Because of the variability of Hanford formation sediments, contacts between these sediments can be difficult to distinguish, especially where the sandy sequence is missing and the upper gravel directly overlies the lower gravel. In the 200 East Area, the Hanford formation overlies the Ringold Formation in the southern two-thirds of the area and in the northern part, the Hanford formation directly overlies the Elephant Mountain Member basalt where the Ringold Formation is absent.

The lower gravel sequence consists of coarse-grained basaltic sand and granule to boulder gravel. Other clast types include Ringold and Plio-Pleistocene rip-ups, granite, quartzite, and gneiss (Hoffman et al. 1992). Discontinuous intervals dominated by the sand-dominated facies and localized horizons of silt-dominated deposits also are present within the lower gravel sequence. The lower gravel sequence ranges from approximately 0 to 134 feet thick. The lower gravel sequence is absent in the east central part of the 200 East Area (Lindsey et al. 1992).

The middle sand sequence overlies the lower gravel sequence and is dominated by deposits of the sand-dominated facies, consisting of fine- to coarse-grained sand and granule gravel displaying plane lamination and bedding. Intercalated horizons typical of both the gravel-dominated and silt-dominated sequences also occur within the middle sand sequence, with the gravel sequence more abundant in the northern part and the silt sequence more abundant in the southern part of the 200 East Area. The middle sand sequence in 200 East ranges from 0 to 275 feet thick. The middle sand unit thins and pinches out to the north, east, and west of the 200 East Area (Lindsey et al. 1992).

The upper gravel sequence overlies the middle sand sequence in the southern part of the 200 East Area and the lower gravel unit in the northern part of the 200 East Area. Deposits comprising the upper gravel sequence are typical of the gravel-dominated facies. Lenticular horizons of sand-dominated and silt-dominated facies are encountered locally in the upper gravel sequence. The upper gravel sequence ranges from 0 to 60 feet thick. The upper gravel sequence thickens to the north and is absent in the central part of the 200 East Area.

3.4.3 Holocene Surficial Deposits

Holocene surficial deposits consist of silt, very fine- to medium-grained sand and gravel that form a <33 foot veneer across much of the Hanford Site. These sediments were deposited by a combination of eolian and alluvial processes, which have produced sheet sands that blanket the surface. Locally, most of the surfical deposits have been removed by construction activities (Lindsey et al. 1992).

3.5 REGIONAL HYDROGEOLOGY

The hydrogeology of the Pasco Basin has been broadly characterized as consisting of four primary hydrogeologic units (DOE 1988). These units correspond to the upper three formations of the Columbia River Basalt Group (Grande Ronde Basalt, Wanapum Basalt, and Saddle Mountains Basalt) and the sedimentary overburden. The basalt aquifers consist of the flood basalts of the Columbia River Basalt Group and relatively minor amounts of intercalated fluvial and volcaniclastic sediments of the Ellensburg Formation. Confined zones in the basalt aquifers are present in the sedimentary interbeds and/or interflow zones that occur between dense basalt flows. The main water-bearing portions of the interflow zones are networks of interconnecting vesicles and fractures of the basalt flow tops and bottoms (DOE 1988). The suprabasalt, sediment, or uppermost aquifer system consists of fluvial, lacustrine, and glaciofluvial sediments. This aquifer is regionally unconfined and is contained largely within the Ringold Formation and the Hanford formation. Figure C-3 provides unconfined aquifer water table elevations for the Hanford Site.

The uppermost aquifer is part of a flow system that is local to the Pasco Basin, as are the uppermost basalt interbed aquifers (Gephart et al. 1979, DOE 1988). Groundwater in these aquifer systems is probably recharged and discharged locally. Deeper in the basalt, interbed aquifer systems are part of the regional, or interbasin, flow system, which extends outside the margins of the Pasco Basin (DOE 1988). The uppermost aquifer system is regionally unconfined and occurs within the glaciofluvial sands and gravels of the Hanford formation and the fluvial/lacustrine sediments of the Ringold Formation. Confined to semi-confined aquifers of more limited extent also occur in the suprabasalt sediments of the Pasco Basin. These confined zones generally are located within the local flow system, between the unconfined aquifer and the underlying basalt surface.

3.6 LOCAL HYDROGEOLOGY

The primary hydrostratigraphic units in the 200 East Area are the confined aquifer system of the Saddle Mountain Basalt Formation and Ellensburg Formation and the unconfined to confined aquifer system of the Ringold Formation and the Hanford formation. The following discussion focuses on the hydrogeology of the suprabasalt sediments.

In the vicinity of the 200 East Area, the saturated zone is primarily composed of the Ringold gravel unit A through the central and southern portions of the area and the Ringold lower mud sequence to the east near the 216-B-3 Pond System. In the north part of 200 East where the Ringold Formation is discontinuous, the saturated zone is dominantly composed of the Hanford formation (DOE-RL 1993). The vadose zone ranges from about 317 feet thick near the southwestern part of the 200 East Area to 123 feet thick in the vicinity of the 216-B-3 Pond System (DOE-RL 1993).

The uppermost aquifer system is comprises of the unconfined aquifer, but also includes localized semiconfined and confined areas. The hydrostratigraphy of the unconfined aquifer in the 200 East Area is relatively complex because of depositional and erosional history of the geologic units (DOE-RL 1993). The unconfined aquifer in the 200 East Area occurs within the Ringold Formation and Hanford formation. The base of the unconfined aquifer is the top of the lower mud sequence along the southern and eastern areas of 200 East. Along the northern parts of 200 East, the base of the unconfined aquifer is the top of the Elephant Mountain Member basalt. The thickness of the unconfined aquifer varies from zero in the northeastern corner where basalt extends above the water table to more than 262 feet to the south (DOE-RL 1993). Within the central part of the 200 East Area, the water table is located within the Ringold unit A fluvial gravels, where the lower mud sequence is missing. In the southern part of the 200 East Area, the water table is found near the contact of the gravelly sediments of Ringold unit E and the Hanford formation (DOE-RL 1993).

A semiconfined to confined aquifer is observed in the vicinity of the 216-B-3 Pond System where the groundwater occurs in the Ringold unit A gravels and is confined by the lower mud sequence. This aquifer appears to be near only the 216-B-3 Pond System (DOE-RL 1993).

Groundwater flow in the 200 West Area is controlled by the effluent discharges associated with the 216-U-10 Pond system. Effluent discharge to the 216-U-10 Pond System has created a groundwater mound emanating from the ponds. The groundwater mound underlying the 216-U-10 Pond System causes a radial flow pattern. The radial flow pattern disrupts the regional easterly flow and splits the regional flow into two flow components; one to the southeast and one to the northwest (DOE-RL 1993). The division of the regional flow is caused by the westerly flow component of the radial flow colliding with the regional easterly flow underneath the central part of the 200 East Area. The resulting flow patterns create the division, with the northwestern flow component moving toward Gable Gap and the east-southeastern flow component moving towards the central and eastern parts of the Hanford Site.

3.7 VADOSE ZONE MODELING

The proposed ERT test at the tank 105A mock-up in the 200 East Area was simulated with the PORFLOW code (Runchal and Sager 1992). The purpose of the simulation was to estimate the proposed sodium chloride tracer concentration and spatial distribution in the underlying vadose zone and aquifer.

The maximum contaminant level (MCL), as a secondary standard, for chlorine in drinking water is 250 parts per million (ppm) or 250 milligrams per liter (mg/L) (WAC 246-290-310). The water quality criteria in WAC 173-200-040 for choride is also 250 mg/L. The chlorine MCL of 250 ppm is equivalent to a sodium chloride MCL of 415 ppm or 415 mg/L. It was assumed that the salt concentration in the proposed injection water of 2,000 gallons (7,570 liters) is 7,000 mg/L. It also was assumed that another injection of 2,000 gallons of salt solution may shortly follow the first injection from a different location. For simulation purposes, both injections were at the same tank edge location and each injection took 5 days. Six of the simulations were for one injection, and one was for two injections.

After simulating six different cases of one injection with different recharge and tracer-source tank locations, the maximum concentration of salt in the vadose zone reduces to 10 mg/L, about 300 years after the tracer test for most of the cases. The salt concentration would be even lower in the aquifer at an even later time. Figure C-4 shows the predicted sodium chloride concentration for the expected case [1 centimeter per year (cm/yr) recharge]. The travel time to the groundwater in the expected case is about 200 years. For the high-recharge case (5 cm/yr recharge), the maximum salt concentration reduces to 10 mg/L around 100 years (Figure C-5), which occurs much sooner than the 1-cm/yr recharge case because of the higher recharge causing higher velocities. Travel time to groundwater in the 5-cm/yr case is approximately 50 years.

The largest maximum salt concentration within the vadose zone is realized for the case that included no dispersion effects, which physically is not expected and is very conservative (Figure C-6). Even in the conservative no-dispersion case, the maximum salt concentration of 40 mg/L in the aquifer at 800 years is less than the MCL (415 mg/L) required for salt in drinking water.

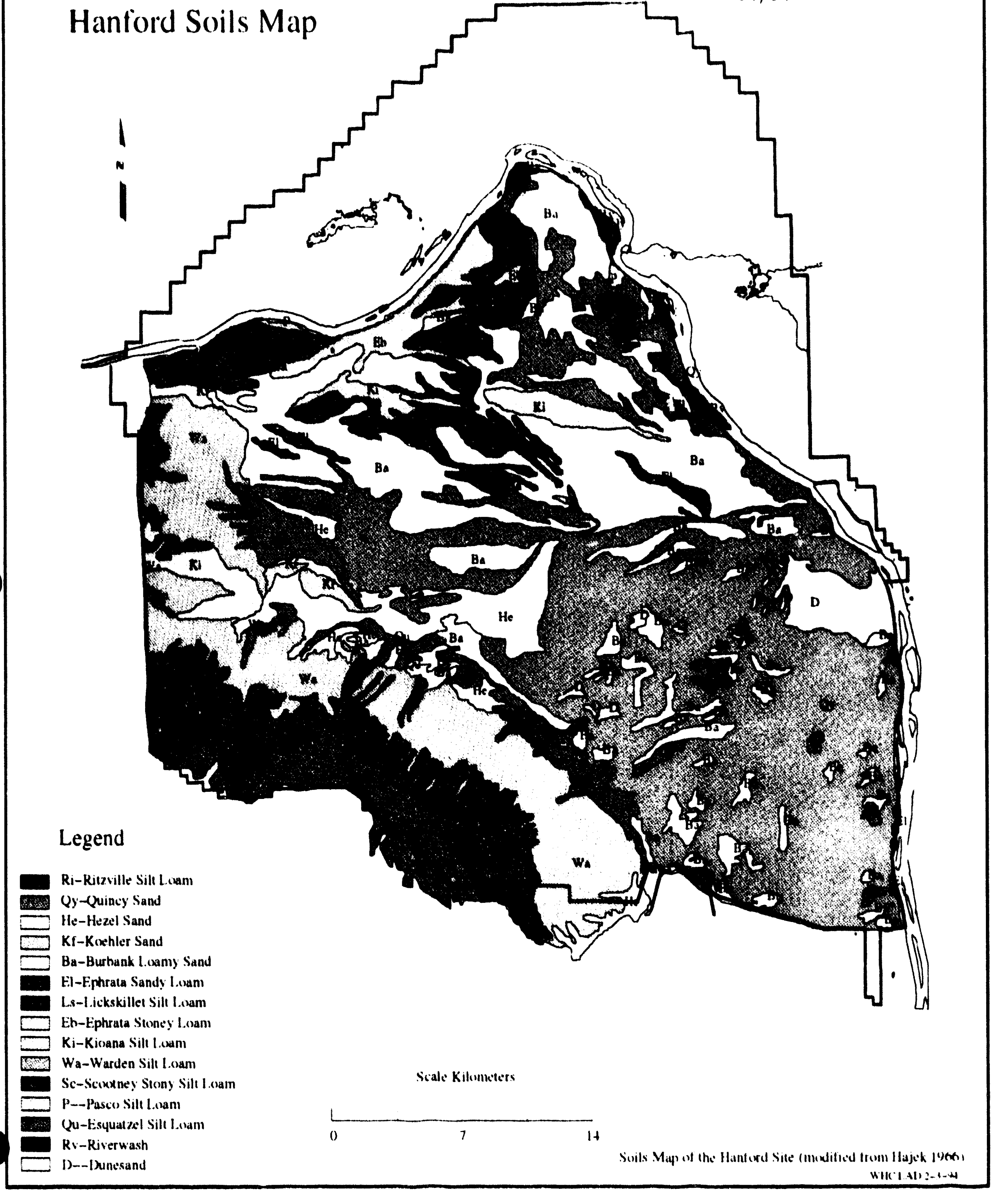
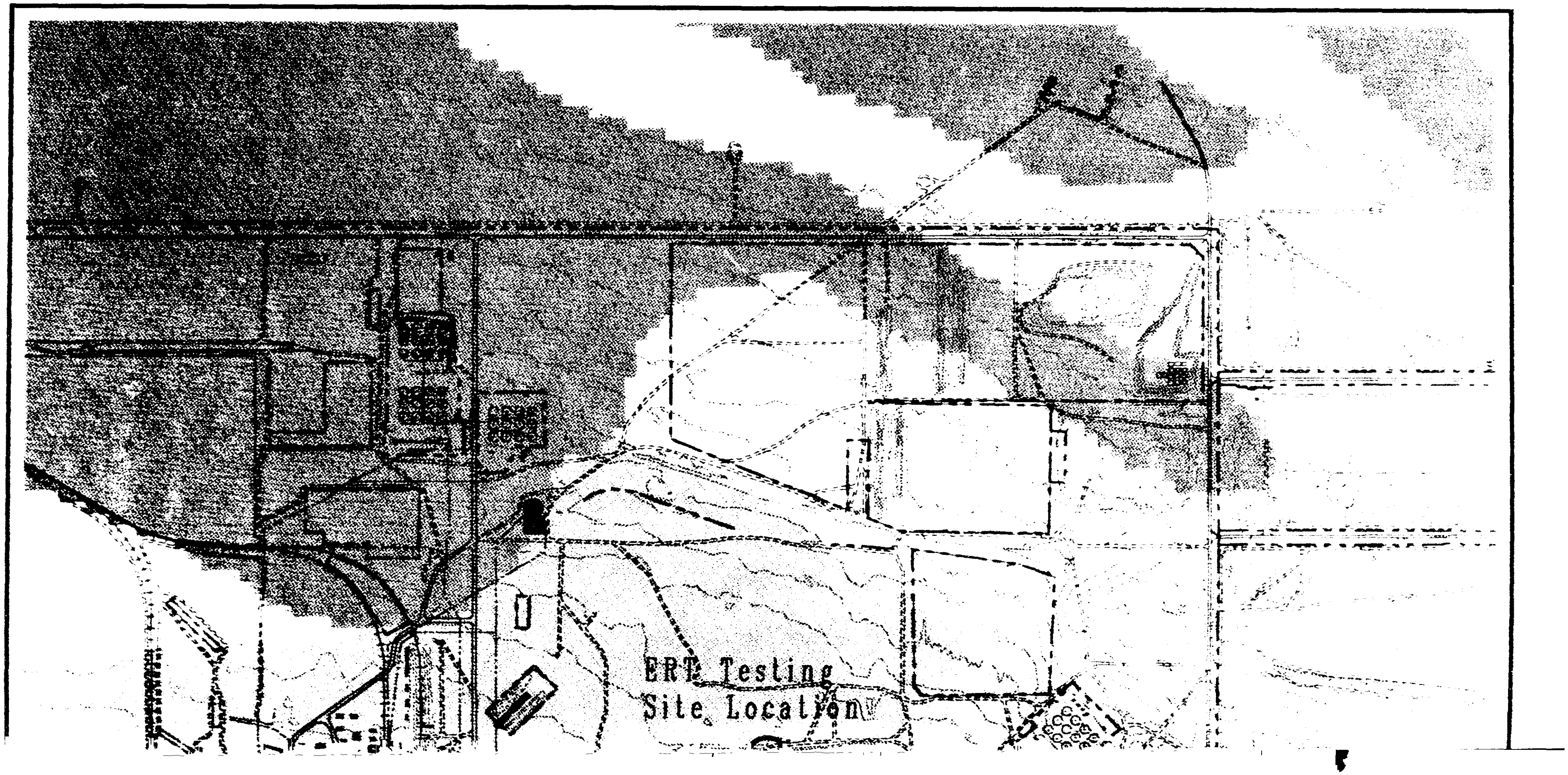


Figure C-1. Hanford Site Soil Map.


ERT Testing
Site Location

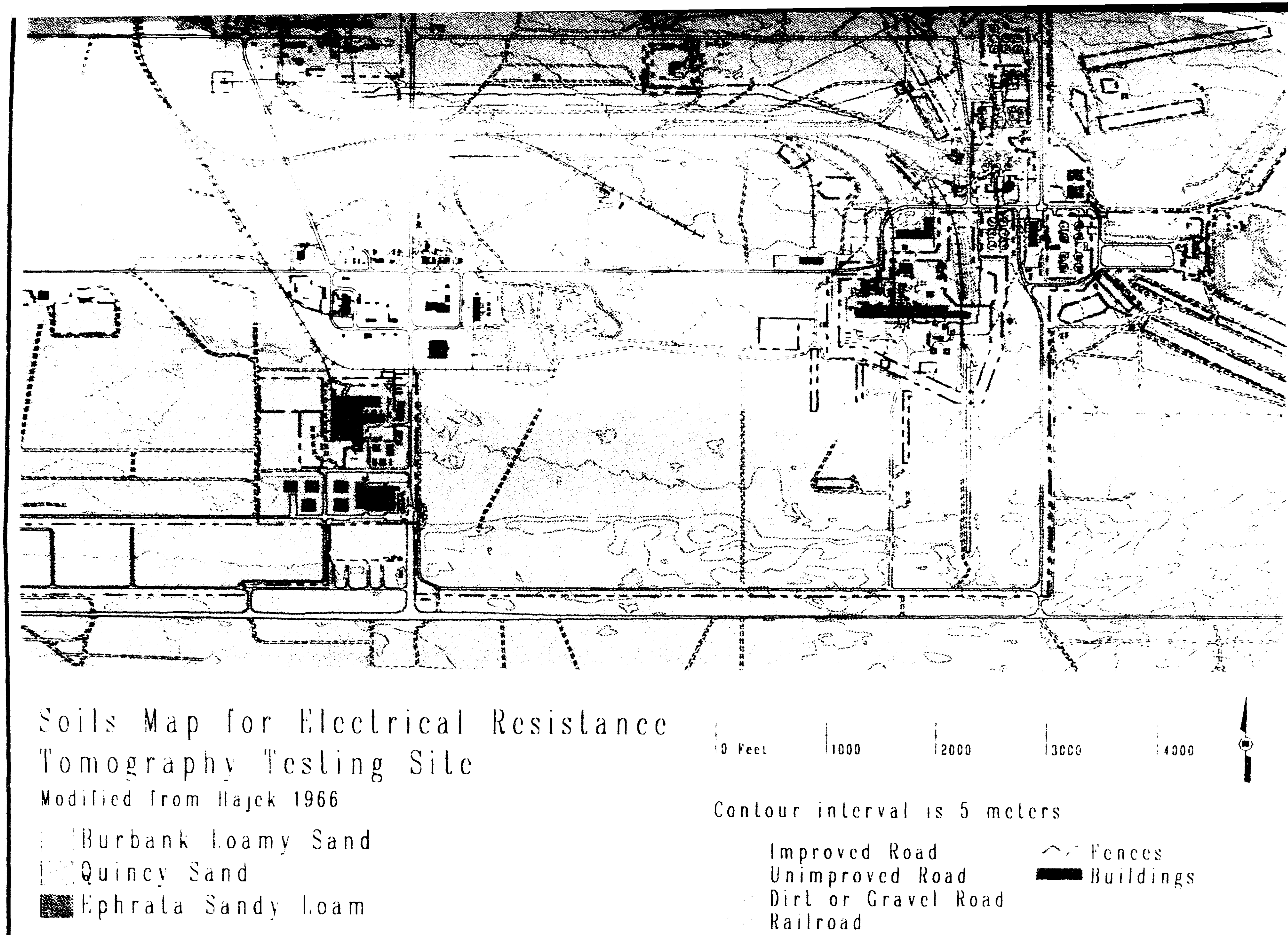


Figure C-2. Soil Types in the Electrical Resistivity Tomography Test Site Area.

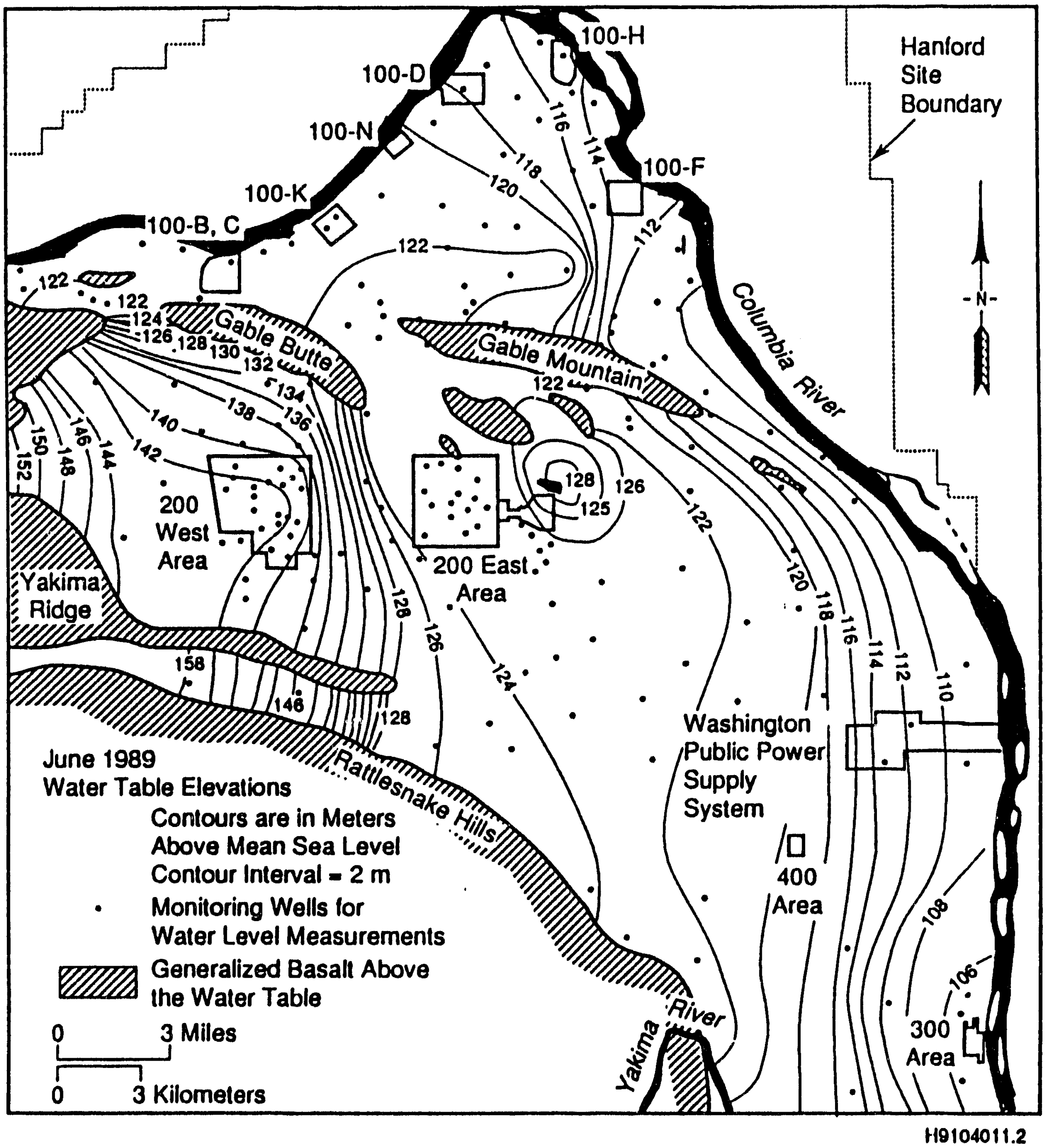


Figure C-3. Hanford Site Unconfined Water Table Map.

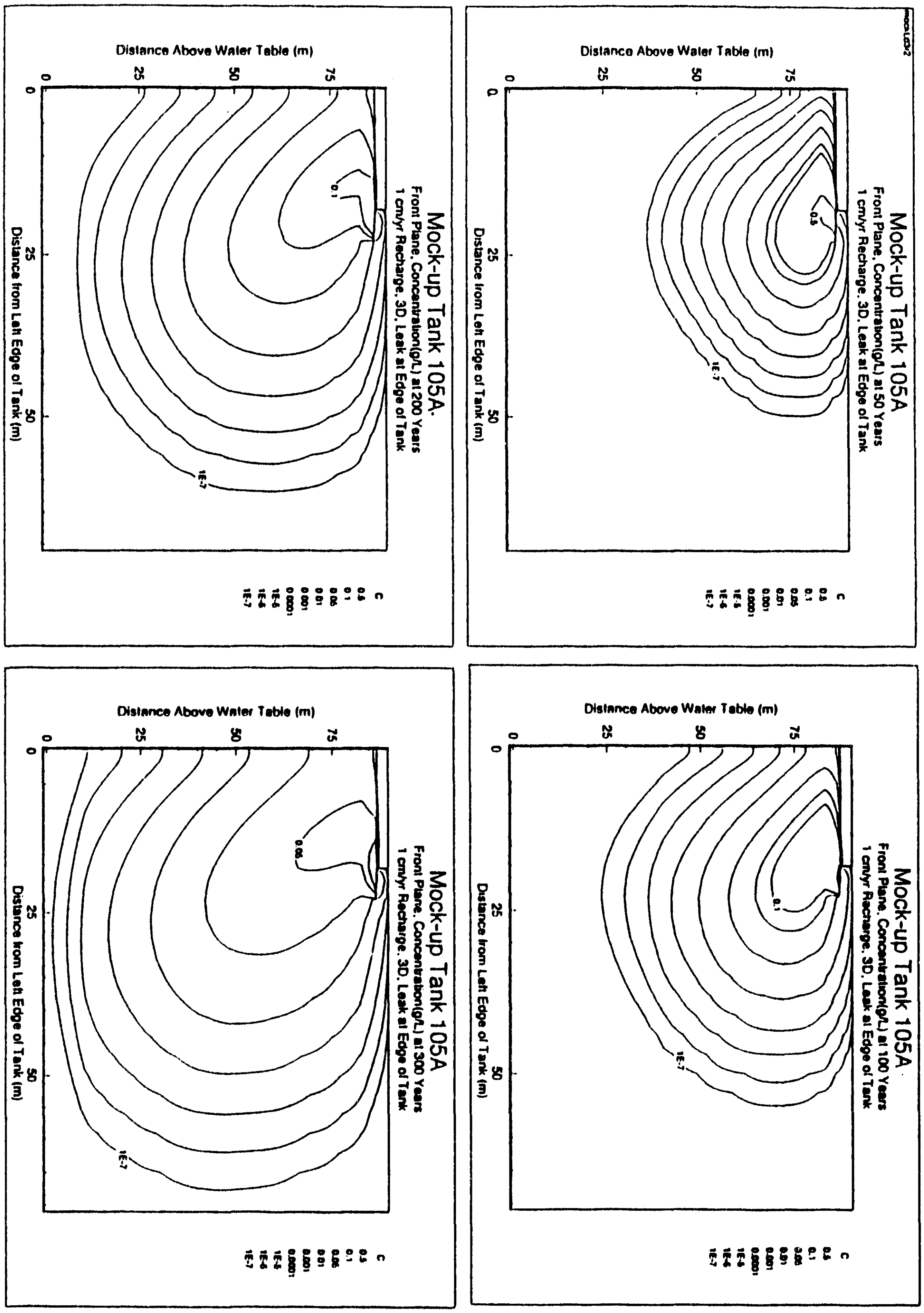


Figure C-4. Sodium Chloride Concentrations at a Recharge Rate of 1 Centimeter Per Year.

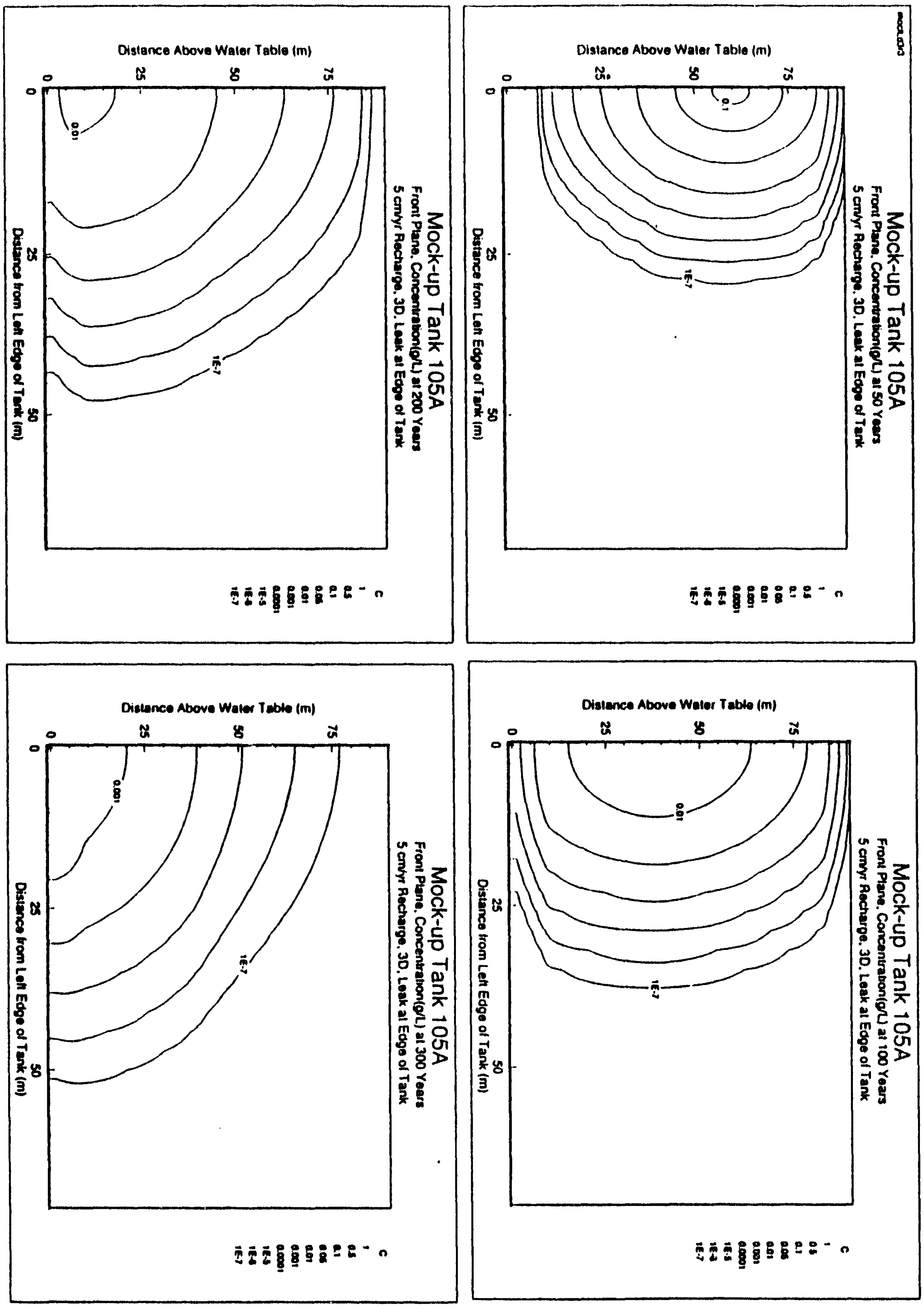


Figure C-5. Sodium Chloride Concentrations at a Recharge Rate of 5 Centimeters Per Year.

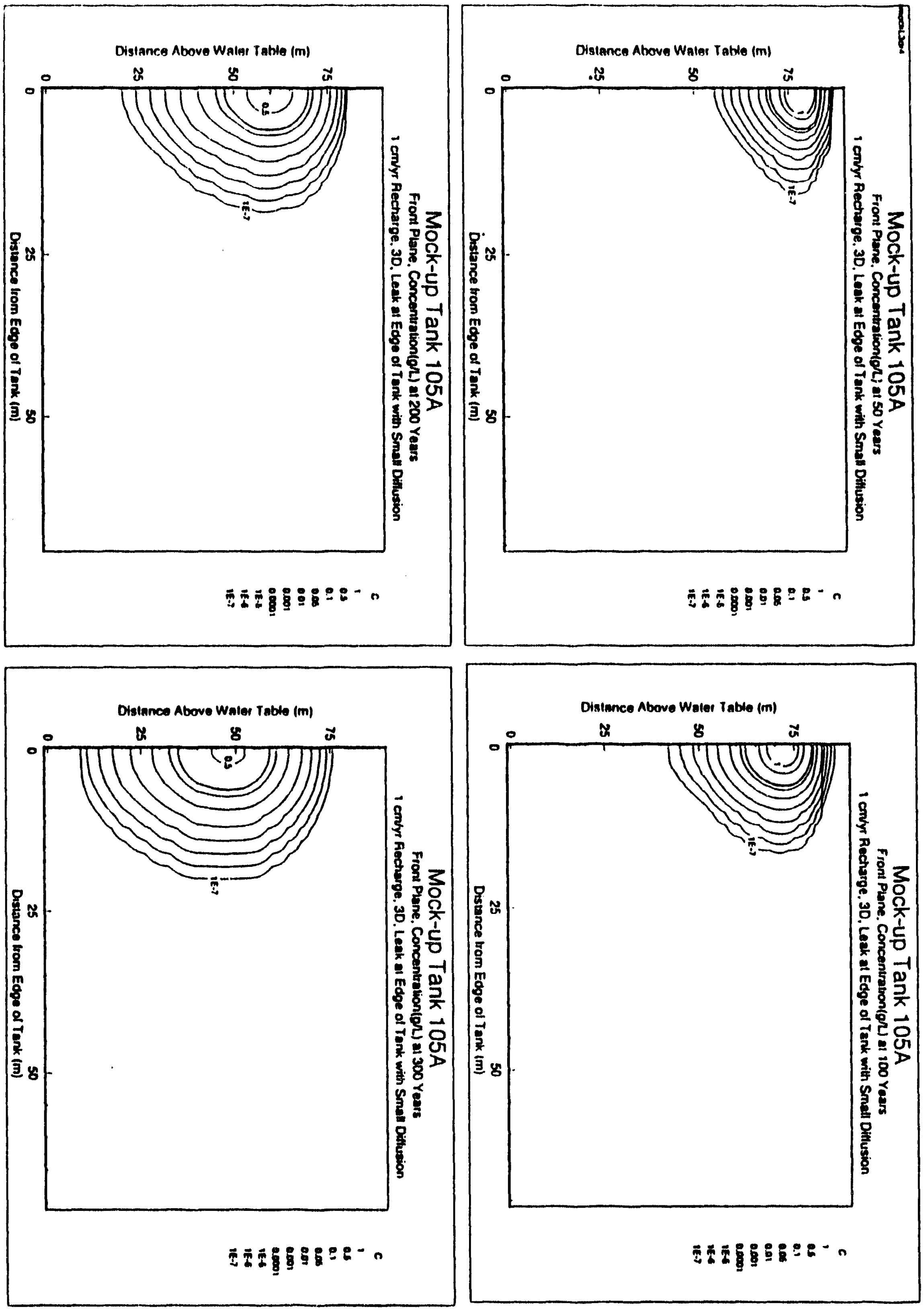


Figure C-6. Sodium Chloride Concentrations at a Recharge Rate of 1 Centimeter Per Year with Minor Diffusion.

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