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Meeting Minutes Transmittal/Approval
Unit Managers' Meeting
200 Area Groundwater and Source Operable Units
3350 George Washington Way, Richland, Washington
July 1999

APPROVAL: [signature] Date 01/21/00
Bryan Foley, 200 Area Unit Manager, RL (H0-12)

APPROVAL: [signature] Date
Jack Donnelly, 200 Area Unit Manager, Ecology (B5-18)

APPROVAL: [signature] Date 4-28-00
Dennis Faulk, 200 Area Unit Manager, EPA (B5-01)

APPROVAL: Arlene C. Tortoso Date 2/14/00
Arlene Tortoso, Groundwater Unit Manager, RL (H0-12)

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Meeting minutes are attached. Minutes are comprised of the following:

Attachment 1	–	Agenda
Attachment 2	–	Attendance Record
Attachment 3	–	300 Area UMM Minutes - July 1999
Attachment 4	–	Vadose Zone Monitoring Plan for 216-Z-9
Attachment 5	–	Soil Vapor Extraction Operating Plan at 216-Z-1A, 216-Z-18, and 26-Z-12
Attachment 6	–	Progress Report Evaluation of Vapor Flow and Transport
Attachment 7	–	200-Z-9 Carbon Tet Removal Charts
Attachment 8	–	200-ZP-2 Carbon Tet Monitoring Tables
Attachment 9	–	200-ZP-1 Carbon Tet Concentration Tables
Attachment 10	–	Status Brief on Monitoring Activities Related to the 216-B-63 Trench

Prepared by: [signature] Date 2/16/00
Amy J. Jones (H0-10)/Chloe Brewster

Concurrence by: [signature] Date 4/19/00
for Michael Graham, BHI Groundwater/Vadose Zone Integration (H0-09)

UNIT MANAGERS' MEETING AGENDA

3350 George Washington Way, Room 2A01
July 22, 1999

8:00 a. m. **200 Area**

- **200 Area Groundwater**
  - ZP-2 Non-operational Vapor Monitoring Plan for Z-9
  - SVE Operating Plan for Z-1A
  - Minutes from the Last UMM for Signature
  - Update on CRESP Activities
  - ZP-1 and ZP-2 Status
  - ITRD Update
  - Carbon Tet Strategy

- **Overview 200 Area RCRA Groundwater Monitoring (20 minutes)**
  - Status brief on monitoring activities related to 216-B-63 Ditch

- **200-CW-1 Gable Mountain/B Pond and Ditches (10 minutes)**
  - Status Work Plan
  - Discuss pH analytical constraints
  - Status hydrazine contained-in determination
  - Status air monitoring plan and waste control plan

- **200-CS-1 Chemical Sewer Waste Group (10 minutes)**
  - Status DQO Summary Report and Work Plan
  - Discuss drilling technique for S-Pond borehole

- **200-CW-5 U Pond/Z Ditches Cooling Water Waste Group (10 minutes)**
  - Status DQO schedule

- **200-BP-1 Operable Unit (10 minutes)**
  - Status Treatability Test Report

Attachment 2

~~Remedial Action and Waste Disposal~~ Unit Managers' Meeting
Official Attendance Record – 200 Areas
July 22, 1999

Please print clearly and use black ink

PRINTED NAME	ORGANIZATION	O.U. ROLE	TELEPHONE
Arlene Tortoso	DOE-RL	200 Area GW Project Mgr.	373-9631
Stuart Luttrell	PNNL	GW Project	376-6023
George C Henckel	BHI	GW Mgmt	372-9381
Craig Swanson	CHI	GW Tech. Lead	372-9353
Virginia Rohay	CHI	ZP-2 technical support	372-9098
Mark Sweeney	PNNL	B63 Project Scientist	373-0703
Dennis Faulk	EPA	RPM	376-8631
Ted Wooley	Ecology	200CW1	736-3012
Curt Wittreich	CHI	200 A Tech	372-9586
Mary E. Todd	CHI	200-CW-1 Task Manager, CHI	372-9030
Janet Badden	CHI	CS-1	2-9698

Attachment 3

MEETING MINUTES
REMEDIAL ACTION AND WASTE DISPOSAL
UNIT MANAGERS' MEETING – 200 AREA
July 22, 1999

Attendees: See Attachment #2

Agenda: See Attachment #1

Topics of Discussion:

1. <u>200 Area Groundwater</u>

   - Copies of both the ZP-2 Non-operational Vapor Monitoring Plan for Z-9 and the SVE Operating Pan for Z-1A were provided (Attachments #4 and #5). Both documents were discussed and approved by EPA and RL.

   - The minutes for the May 25, 1999 ZP-1 and ZP-2 UMM were signed by the regulators.

   - Update on CRESP Activities - Two reports resulting from the CRESP program were provided (Attachment #6) The reports were summarized and the possibility of some of the CRESP participants visiting the Hanford Site was discussed. The visit was tentatively planned for August and details will be discussed later.

   - Carbon Tet Strategy – Charts detailing the carbon tet removal levels from 200-Z-9 were provided (Attachment #7). The handout was reviewed and discussed.

   - ZP-1 and ZP-2 Status – Carbon tet monitoring tables for 200-ZP-2 (Attachment #8) and carbon tet concentration tables for 200-ZP-1 (Attachment #9) were provided. The handouts were reviewed and discussed.

   - ITRD Update – The next meeting will focus on modeling and characterization efforts, and attention to remediation will be deferred. EPA attended the West Governors Association Workshop and noted that the comments about the ITRD were positive. EPA also noted that the next DWP should include funding for ITRD work. ERC commented that the ITRD strategies could be used to develop carbon tet strategies. EPA responded that any such strategies should be developed in accordance with the five year review requirements.

2. <u>Overview 200 Area RCRA Groundwater Monitoring</u> – A status brief on the groundwater monitoring activities related to 216-B-63 Trench was provided (Attachment #10). a revised groundwater monitoring plan my be prepared next year for the site.

3. <u>200-CW-1 Gable Mountain/B Pond and Ditches</u> – This topic is deferred for discussion at the next UMM.

4. <u>200-CS-1 Chemical Sewer Waste Group</u>– This topic is deferred for discussion at the next UMM.

5. <u>200-CW-5 U Pond/Z Ditches Cooling Water Waste Group</u> – The 200-CW-5 DQO has been started and a meeting was scheduled to discuss the DQO with EPA next week.

6. <u>200-BP-1 Operable Unit</u> – EPA comments on the 200-BP-1 Treatability Test Report have been received and are being reviewed.

VADOSE ZONE MONITORING PLAN FOR 216-Z-9, JULY 1999 THROUGH SEPTEMBER 1999

Scope: Monitor carbon tetrachloride soil vapor concentrations at selected probes and wells at Z-9 during soil vapor extraction (SVE) operations at Z-1A. The components of this scope are:

- collect soil vapor samples using the rebound study sampling method and sampling pump (BHI-00947)
- analyze soil vapor samples for carbon tetrachloride using B&K at field screening level (quality control level QC-1 as defined in BHI-QA-03)
- evaluate concentration trends
- report results to 200-ZP-2 Unit Managers

Purpose: (1) To be cognizant of carbon tetrachloride concentrations and trends at the vadose-atmosphere and vadose-groundwater interfaces to ensure that non-operation of SVE systems is not negatively impacting groundwater or atmosphere. (2) To be cognizant of carbon tetrachloride concentrations and trends near the lower permeability Plio-Pleistocene layer to provide an indication of concentrations that can be expected during restart of SVE operations and to support selection of on-line wells.

Duration: Three months, July 1999 through September 1999.

Monitoring Frequency: Monthly. It is assumed that a sampler will spend 8 hrs/month for collection and analysis of samples and that a project scientist will spend 4 hrs/month for evaluation and reporting of results. Based on the rebound study and FY98 monitoring experiences, sampling and analysis of 25-30 samples is reasonable for an 8-hour day.

Monitoring Locations: Locations were selected to focus carbon tetrachloride monitoring near the vadose-atmosphere and vadose-groundwater interfaces and near the Plio-Pleistocene layer. At the recommendation of the project scientist, and with approval from the BHI task lead, these monitoring locations could be revised based on developing trends, accessibility, and/or recommendations of the sampler.

Target Zone (depth)	Z-1A	Z-9	Total
Shallow (1.5 m)	0	5	5
Near surface (3-24 m)	1	9	10
Plio-Pleistocene (25-45 m)	1	10	11
Groundwater (46-65 m)	0	4	4
Total	2	28	30

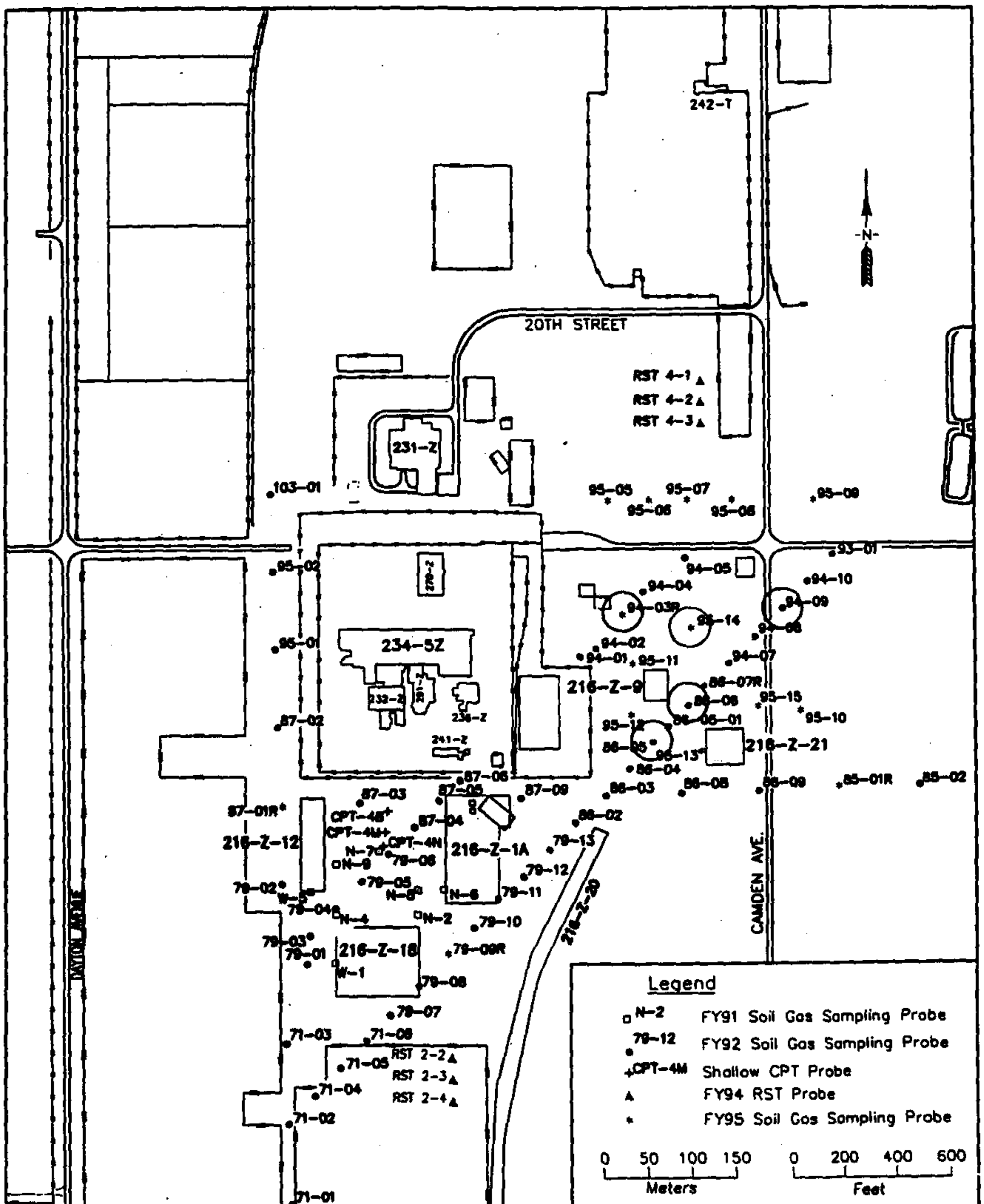
Attachment 4

Non-Operational Soil Vapor Monitoring at 216-Z-9, July through September 1999

200-ZP-2 Location (Well or Probe) /feet bgs	Site	Depth (m)	Zone	Z-1A & Z-9 1997-1998 Oct-Mar	Z-9 1998 Apr-Jun	Z-1A 1998 Jul-Sep	Z-1A & Z-9 1998-1999 Oct-Mar	Z-1A 1999 Apr-Jun	Z-9 1999 Jul-Sep
79-03/ 5 ft	Z-18	1.5	1			X		X	
79-06/ 5 ft	Z-1A	1.5	1				X	X	
79-11/ 5 ft	Z-1A	1.5	1	X		X	X	X	
86-05/ 5 ft	Z-9	1.5	1						X
86-06/ 5 ft	Z-9	1.5	1	X	X		X		X
87-03/ 5 ft	Z-18	1.5	1	X		X			
87-05/ 5 ft	Z-1A	1.5	1			X		X	
87-09/ 5 ft	Z-1A	1.5	1	X		X	X	X	
94-03R/ 5 ft	Z-9	1.5	1						X
94-09/ 5 ft	Z-9	1.5	1	X	X	X			X
95-11/ 5 ft	Z-9	1.5	1	X	X		X		
95-12/ 5 ft	Z-9	1.5	1	X	X		X		
95-14/ 5 ft	Z-9	1.5	1						X
N-6/ 5 ft	Z-1A	1.5	1	X					
CPT-13A/ 9 ft	Z-1A	2.7	2	X	X	X		X	
CPT-16/ 10 ft	Z-9	3.0	2	X	X		X		X
CPT-17/ 10 ft	Z-9	3.0	2	X	X		X		X
CPT-18/ 15 ft	Z-9	4.6	2	X	X		X		X
CPT-31/ 25 ft	Z-1A	7.6	2	X		X		X	
CPT-32/ 25 ft	Z-1A	7.6	2	X		X	X	X	
CPT-30/ 28 ft	Z-1A	8.5	2				X	X	
CPT-7A/ 32	Z-1A	9.8	2	X		X	X	X	
CPT-1A/ 35 ft	Z-1A	10.7	2	X	X	X		X	
CPT-33/ 40 ft	Z-1A	12.2	2	X		X		X	
CPT-34/ 40 ft	Z-18	12.2	2					X	X
CPT-21A/ 45 ft	Z-9	13.7	2	X	X				X
W15-220SST/ 52 ft	Z-9	15.9	2						X
CPT-9A/ 60 ft	Z-9	18.3	2	X	X	X			X
CPT-28/ 60 ft	Z-9	18.3	2	X	X	X			X
CPT-30/ 68 ft	Z-1A	20.7	2					X	
CPT-13A/ 70 ft	Z-1A	21.3	2					X	
CPT-24/ 70 ft	Z-9	21.3	2		X				X
W15-219SST/ 70 ft	Z-9	21.3	2						X
CPT-31/ 76 ft	Z-1A	23.2	2					X	
CPT-33/ 80 ft	Z-1A	24.4	2					X	
W15-82/ 82 ft	Z-9	25.0	2		X		X		X
W15-95/ 82 ft	Z-9	25.0	2		X		X		X
W15-218SST/ 86 ft	Z-9	26.0	2						X
CPT-21A/ 86 ft	Z-9	26.2	2		X		X	X	X
CPT-34/ 86 ft	Z-18	26.2	2			X		X	
CPT-28/ 87 ft	Z-9	26.5	2		X		X	X	X
CPT-1A/ 91 ft	Z-1A	27.7	2					X	X
CPT-4A/ 91 ft	Z-1A	27.7	2			X		X	
CPT-9A/ 91 ft	Z-9	27.7	2		X		X	X	X
W18-252SST/ 100 ft	Z-1A	30.5	2			X	X		
CPT-4F/ 109 ft	Z-1A	33.2	2			X			
W18-152/ 113 ft	Z-12	34.4	2			X	X	X	
W15-217/ 115 ft	Z-9	35.1	3		X		X		X
CPT-24/ 118 ft	Z-9	36.0	3		X		X		X
W15-220SST/ 118 ft	Z-9	36.0	4						X
W18-158L/ 123 ft	Z-1A	37.5	3			X	X	X	
W18-167/ 123 ft	Z-1A	37.5	3			X	X	X	
W15-219SST/ 130 ft	Z-9	39.6	4						X
W18-249/ 134 ft	Z-18	40.8	3			X	X	X	
W18-248/ 136 ft	Z-1A	41.5	3			X	X	X	
W15-219SST/ 155 ft	Z-9	47.2	5						X
W15-216L/ 184 ft	Z-9	56.1	5	X	X				
W15-220SST/ 185 ft	Z-9	56.4	5						X
W15-6L/ 189 ft	Z-9	57.6	6	X	X		X	separated at	X
W15-9L/ 189 ft	Z-9	57.6	6	X	X		X	tube cut by a	X
W18-7/ 200 ft	Z-1A	61.0	6	X		X	X		
W18-6L/ 208 ft	Z-1A	63.4	6	X		X	X		
W18-12/ 210 ft	Z-18	64.0	6			X	X		

Attachment 4

Location of Shallow Probes Selected for Monitoring at 200-ZP-2, July 1999 through September 1999



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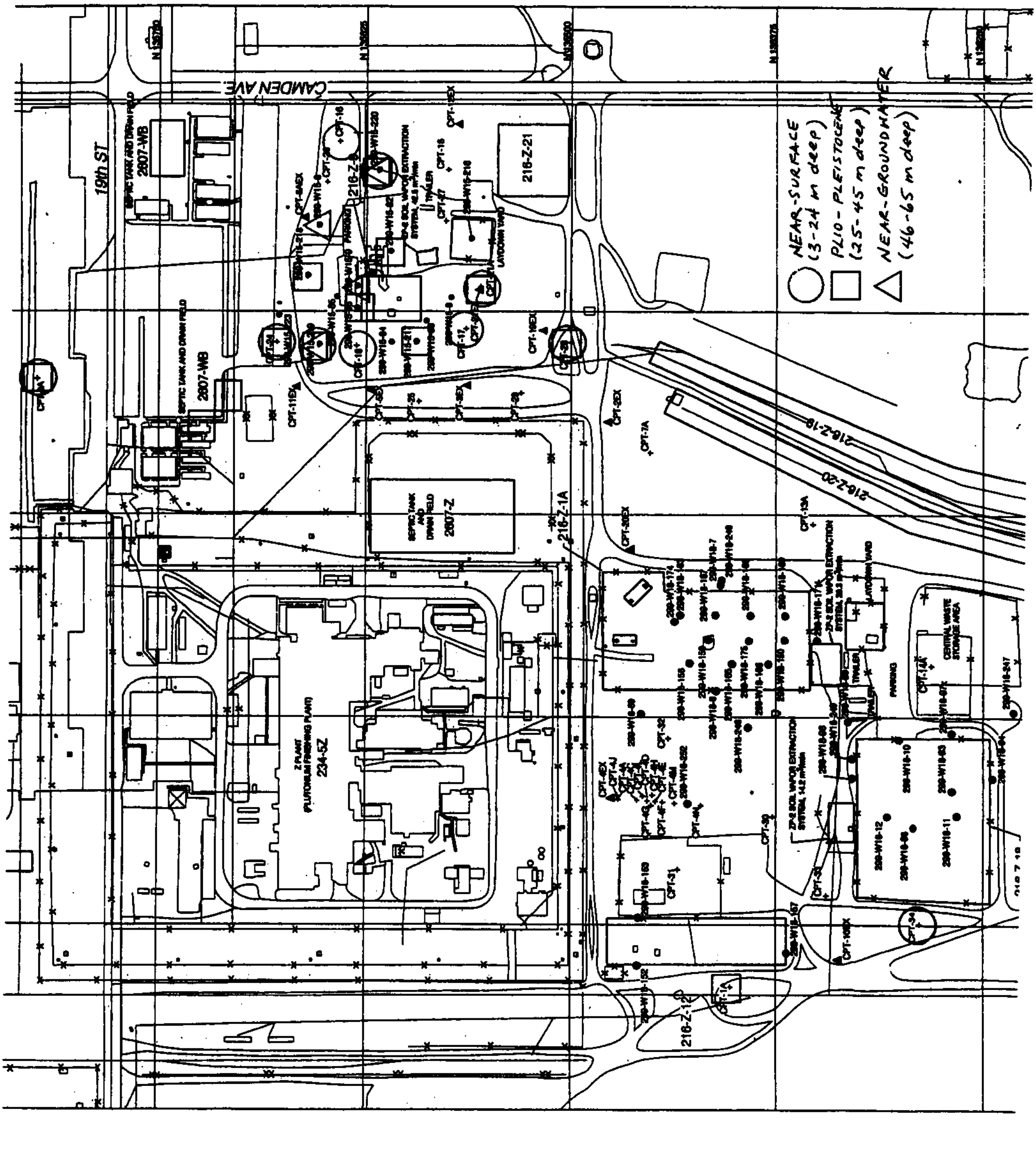
Location of Near-Surface and Plio-Pleistocene Probes and Wells Selected for Monitoring at 200-ZP-2, July 1999 through September 1999



SOIL VAPOR EXTRACTION OPERATING PLAN AT 216-Z-1A, 216-Z-18, AND 216-Z-12 July 1999 – September 1999

Seventeen on-line wells are identified for potential vapor extraction in the attached list of extraction wells for Z-1A, Z-18, and Z-12. All of these wells will be prepared for potential hook-up to the soil vapor extraction system in July-September 1999.

The June 1999 non-operational soil vapor monitoring will be conducted on 6/28/99. On 6/29/99, the sampling tubes will be removed from wells W18-152, W18-158L, W18-167, W18-249, and W18-248. The current wellhead assemblies (configured for non-operational soil vapor monitoring) will not be disturbed until the monitoring has been completed and the tubing removed on 6/29/99.

Passive soil vapor extraction is being implemented at Z-1A/Z-18/Z-12 soil vapor extraction wells with lower intervals open between the Plio-Pleistocene layer and groundwater: W18-6L, W18-7, W18-10L, W18-11L, W18-12, W18-246L, W18-247L, W18-252L.

For initial start-up operations at Z-1A/Z-18/Z-12, extraction will be implemented at four intervals in the Z-1A tile field: W18-165, W18-166, W18-168, and W18-174. During non-operational monitoring since October 1998, the highest carbon tetrachloride concentrations (maximum 492 ppmv) have been observed at wells in the tile field.

These four intervals will be characterized on the first day of operations. During continued operations, all on-line wells will be characterized each week and all off-line wells, if requested, will be characterized during the 2nd, 4th, 6th, 8th, 10th, and final weeks, according to the attached sampling and analysis plan. As before, we will plan to periodically change the mix of on-line wells during operations, based on changing concentrations, extraction interval locations, and operating experience. In general, the initial extraction wells will be nearer the carbon tetrachloride source (crib) and wells added later will expand operations away from the source.

Extraction Wells for FY 99 Soil Vapor Extraction System Operations at Z-1A/Z-18/Z-12		
Potential On-Line Wells	**Reason**	**Initial Wells**
July - September 1999		
W18-89	mass removal	
W18-96	mass removal	
W18-152	mass removal	
W18-158L	mass removal	
W18-159	mass removal	
W18-163L	mass removal	
W18-165	mass removal	X
W18-166	mass removal	X
W18-167	mass removal	
W18-168	mass removal	X
W18-169	mass removal	
W18-171L	mass removal	
W18-174	mass removal	X
W18-246U	mass removal	
W18-248	mass removal	
W18-249	mass removal	
W18-252U	mass removal	

Sampling and Analysis Plan for ZP-2 SVE Operations July 1999										
When to Monitor	Approximate Date	on-line wells	off-line wells	vacuum		flow	CCl4	CHCl3	CH2Cl2	MEK
				wellhead	system		carbon tetrachloride	chloroform	methylene chloride	MEK
first day of operations	7/1/99	X		X	X	X	X	X	X	X
beginning of 1st week	7/6/99	X		X	X	X	X	X	X	X
beginning of 2nd week	7/12/99	X	X	X	X	X	X	X	X	X
beginning of 3rd week	7/19/99	X		X	X	X	X	X	X	X
beginning of 4th week	7/26/99	X	X	X	X	X	X	X	X	X
beginning of 5th week	8/2/99	X		X	X	X	X	X	X	X
beginning of 6th week	8/9/99	X	X	X	X	X	X	X	X	X
beginning of 7th week	8/16/99	X		X	X	X	X	X	X	X
beginning of 8th week	8/23/99	X	X	X	X	X	X	X	X	X
beginning of 9th week	8/30/99	X		X	X	X	X	X	X	X
beginning of 10th week	9/7/99	X	X	X	X	X	X	X	X	X
beginning of 11th week	9/13/99	X		X	X	X	X	X	X	X
beginning of 12th week	9/20/99	X		X	X	X	X	X	X	X
last day of operations	9/30/99	X	X	X	X	X	X	X	X	X
Fax copy of monitoring records to Virginia Rohay at 372-9447 by close of day following monitoring.										

Attachment 5

06/23/99

Progress Report
Evaluation of Vapor Flow and Transport
200-West Area

Prepared by

Lisa Johnson
Joel Massmann
July 21, 1999

We have been involved in two main activities related to the vadose zone in the 200-West area. The first activity relates to the carbon tetrachloride inventory that was originally completed in 1993 (Rohay). The second activity involves developing a three-dimensional flow and transport model.

An updated version of the original 1993 carbon tetrachloride inventory has been completed. This new version, which is based on the same principles and assumptions as the first, was used to perform an error analysis based on some of the more uncertain and variable parameters of the inventory calculations. The software Crystal Ball was used to determine the effects of varying the soil-water distribution coefficient (K_d), the total porosity (n), the moisture content (Θ), and the temperature on the overall inventory of carbon tetrachloride in the vadose zone. Crystal Ball is a spreadsheet-based software program that uses the Monte Carlo method to forecast a range of results for any given situation. We were able to evaluate the impact of the above-mentioned variables on the total inventory of carbon tetrachloride, based on the calculations for the original inventory. We are currently finishing up a draft report that describes these evaluations. This should be completed in the next month.

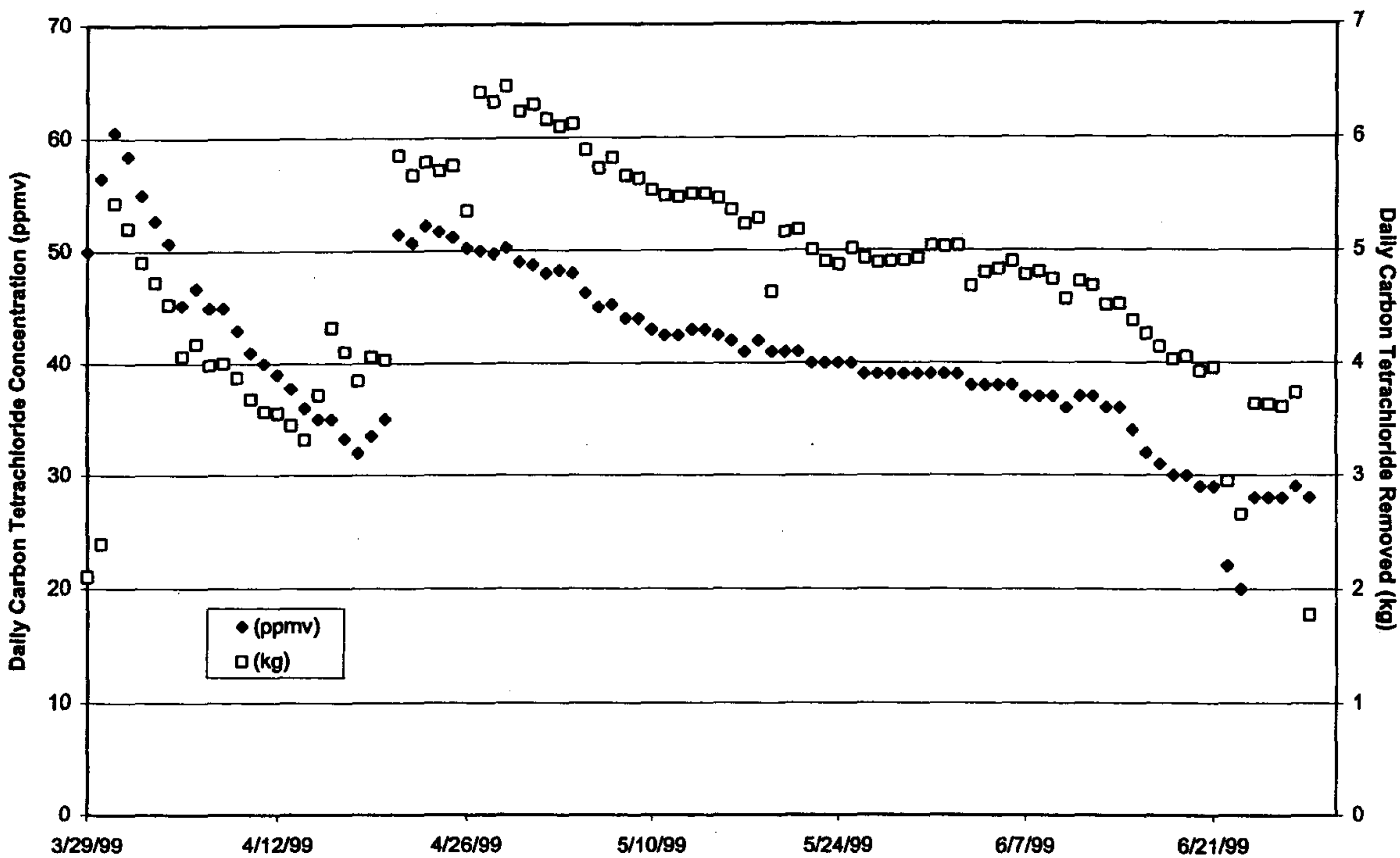
We are also continuing to develop a three-dimensional model for the vadose zone in the 200-West area. This model will be used to help estimate the potential extent of vapor diffusion that may have occurred prior to the implementation of the vapor extraction system. The model will also allow refined estimates of the carbon tetrachloride inventory by providing more realistic estimates of the amount of carbon tetrachloride lost to the atmosphere. The model builds on earlier work at the site, including the studies by Ellerd et al. (1999). These earlier studies used a two-dimensional, radial flow field. They were not able to evaluate interactions among wells or the effects of subsurface heterogeneity. The model will be used to simulate vapor flow and transport prior to vapor extraction implementation under a variety of operating scenarios for vapor extraction.

We anticipate that the model will be functional in September and we plan on conducting simulations this fall. A report describing the model and results is planned for December.

Ellerd, Michael, J.W. Massmann, D.P. Schwaegler, and V.J. Rohay, "Enhancements for Passive Vapor Extraction: The Hanford Study," *Ground Water*, Vol. 37, No. 3, May-June, 1999, pp. 427-437.

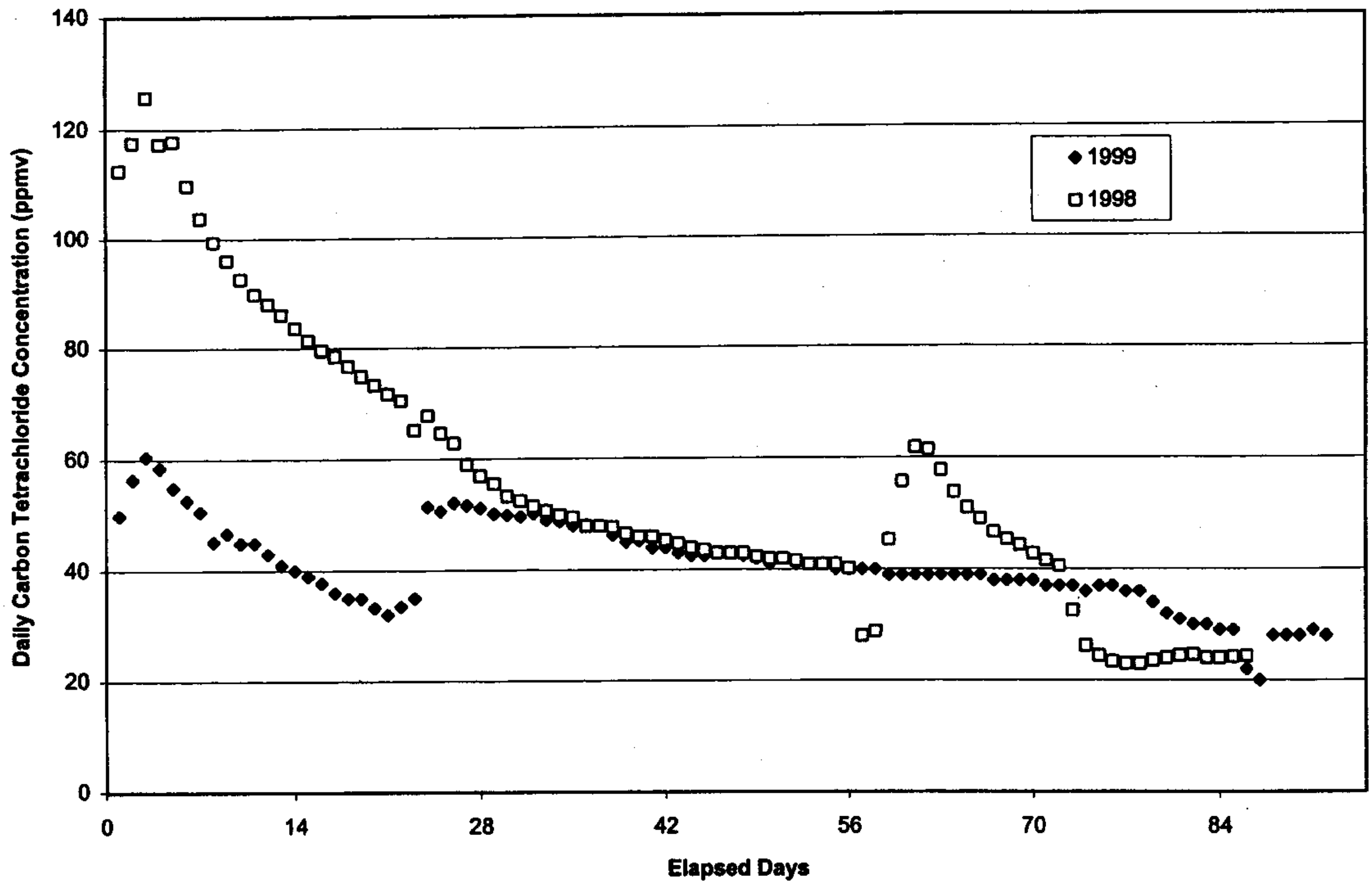
Rohay, V.J., Analysis of carbon tetrachloride evaporative losses and residual inventory beneath the 200 West Area at the Hanford Site, *WHC-SD-TI-101, Rev. 0*, Westinghouse Hanford Company, Richland, WA, 1993.

Z-9



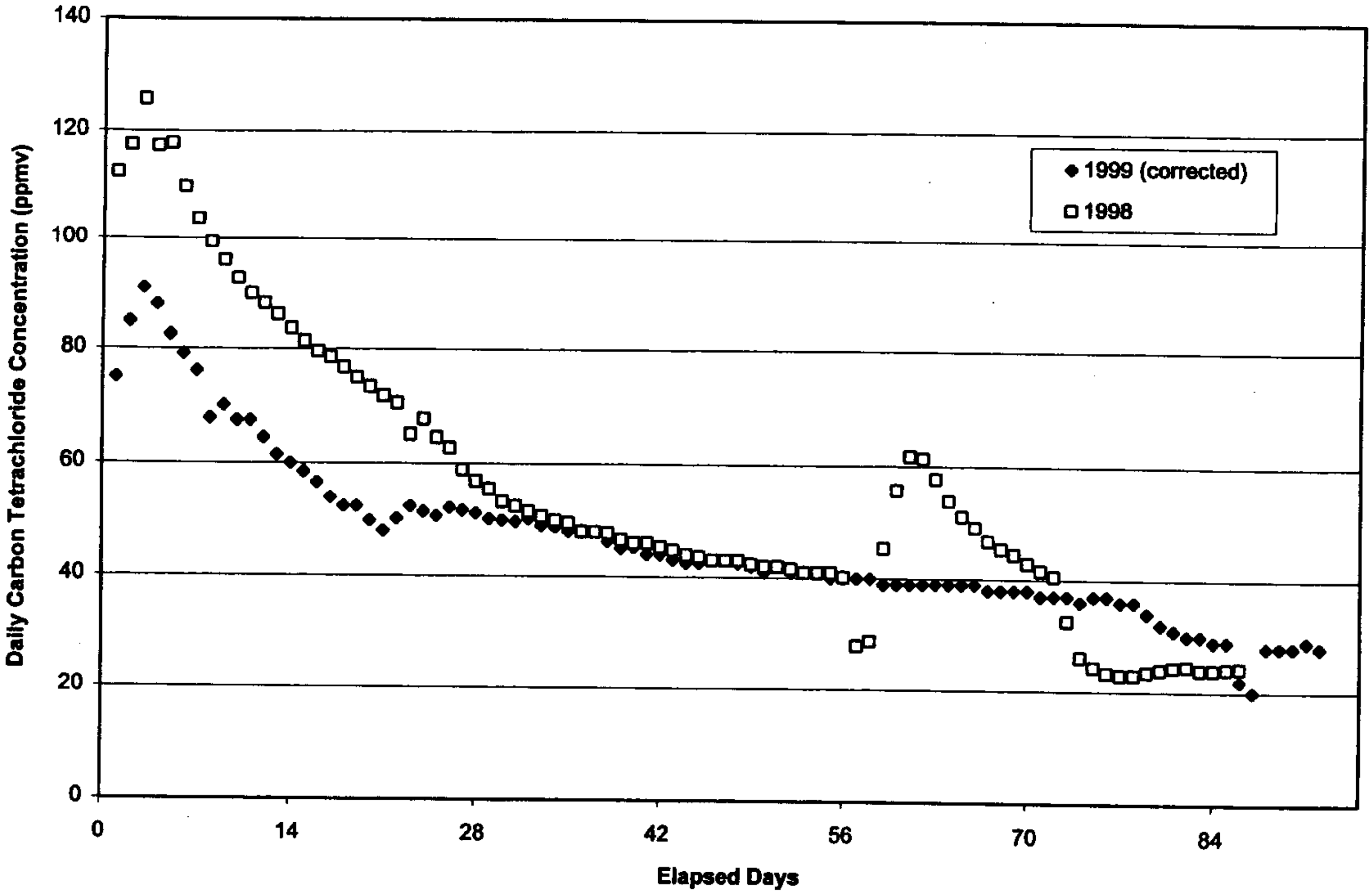
Daily Carbon Tetrachloride Concentration (ppmv)
Daily Carbon Tetrachloride Removed (kg)
(ppmv)
(kg)
0
10
20
30
40
50
60
70
0
1
2
3
4
5
6
7
3/29/99
4/12/99
4/26/99
5/10/99
5/24/99
6/7/99
6/21/99

Z-9



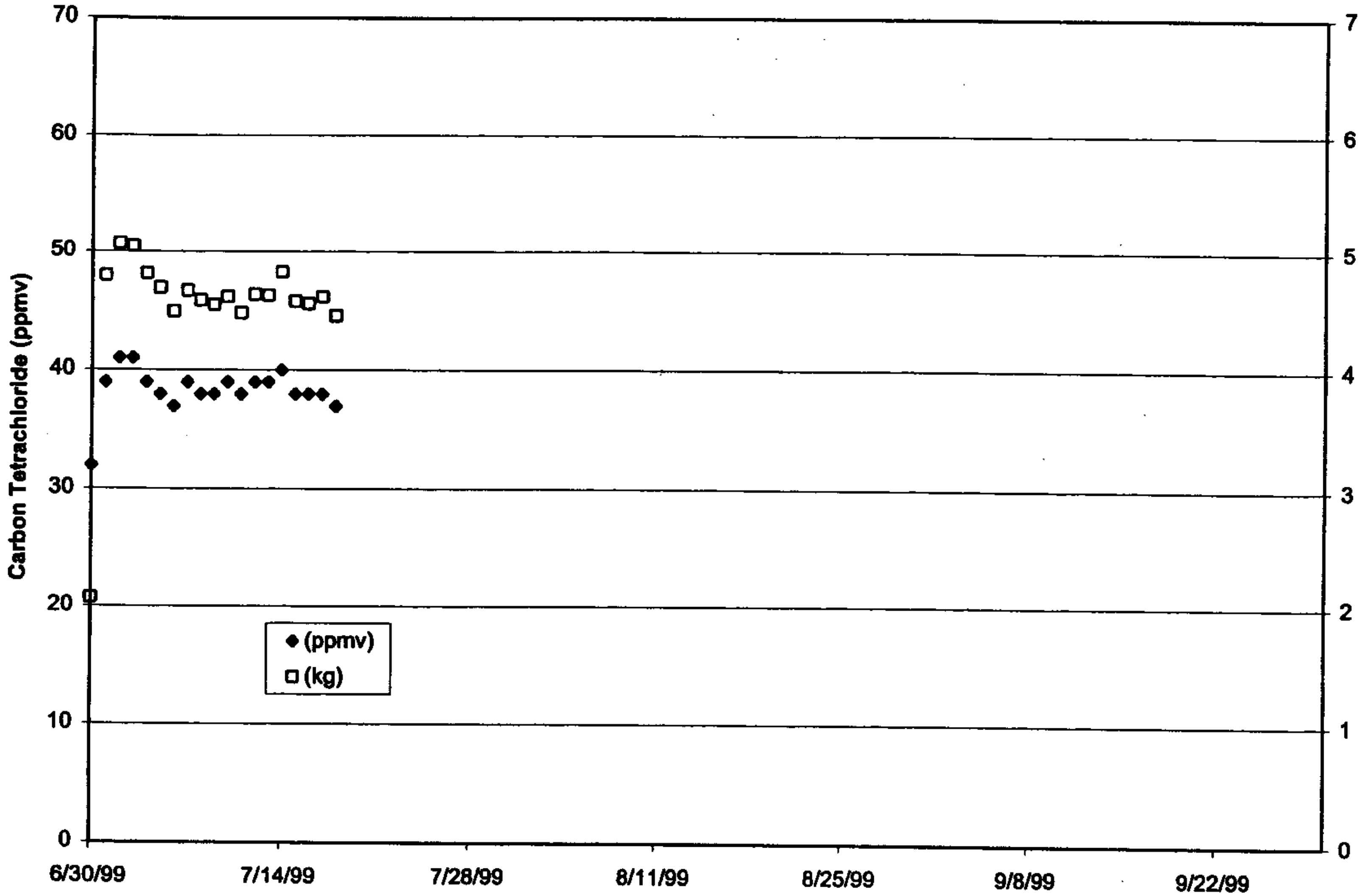
Daily Carbon Tetrachloride Concentration (ppmv)
140
120
100
80
60
40
20
0
0
14
28
42
56
70
84
Elapsed Days
1999
1998

Z-9



Daily Carbon Tetrachloride Concentration (ppmv)
140
120
100
80
60
40
20
0
0
14
28
42
56
70
84
Elapsed Days
1999 (corrected)
1998

Z-1A / Z-18 / Z-12



Attachment 7

Comparison of Maximum Carbon Tetrachloride Rebound Concentrations
Monitored at 200-ZP-2 Soil Vapor Extraction Sites
FY 1997 - FY 1999

200-ZP-2 Location (Well or Probe) /feet bgs	Site	Zone	November 1996 - July 1997 Maximum Rebound Carbon Tetrachloride (ppmv)	months* of rebound	October 1997 - September 1998 Maximum Rebound Carbon Tetrachloride (ppmv)	months* of rebound	July 1998 - June 1999 Maximum Rebound Carbon Tetrachloride (ppmv)	months* of rebound
79-03/ 5 ft	Z-18	1	0	8	0	3	0	12
79-06/ 5 ft	Z-1A	1	not measured		not measured		1.4	12
79-11/ 5 ft	Z-1A	1	0	8	0	6	2.9	12
86-06/ 5 ft	Z-9	1	1.3	8	0	9	1.9	6
87-05/ 5 ft	Z-1A	1	not measured		0	3	1.0	12
87-09/ 5 ft	Z-1A	1	not measured		1.5	3	2.6	12
95-11/ 5 ft	Z-9	1	0	8	2.1	9	2.5	6
95-12/ 5 ft	Z-9	1	1.1	8	1.5	9	1.3	6
CPT-13A/ 9 ft	Z-1A	2	not measured		0	6	1.0	12
CPT-16/ 10 ft	Z-9	2	not measured		0	9	1.5	6
CPT-17/ 10 ft	Z-9	2	not measured		4.2	9	5.1	6
CPT-18/ 15 ft	Z-9	2	not measured		6.5	9	5.0	6
CPT-31/25 ft	Z-1A	2	not measured		0	6	0	12
CPT-32/ 25 ft	Z-1A	2	not measured		9.1	6	10.0	12
CPT-30/ 28 ft	Z-18	2	not measured		not measured		3.2	12
CPT-7A/ 32 ft	Z-1A	2	not measured		2.3	6	5.4	12
CPT-1A/ 35 ft	Z-18	2	2.0	8	1.4	3	3.0	12
CPT-33/ 40 ft	Z-1A	2	not measured		2.0	3	2.6	12
CPT-34/ 40 ft	Z-18	2	2.3	8	not measured		1.5	12
CPT-30/ 68 ft	Z-18	2	1.7	8	not measured		3.0	12
CPT-13A/ 70 ft	Z-1A	2	5.2	8	not measured		5.6	12
CPT-31/ 76 ft	Z-1A	2	4.0	8	not measured		4.2	12
CPT-33/ 80 ft	Z-1A	2	5.8	8	not measured		9.2	12
W15-82/ 82 ft	Z-9	2	28.9	8	5.5	9	46.4	6
W15-95/ 82 ft	Z-9	2	not measured		15.3	9	39.4	6
CPT-21A/ 86 ft	Z-9	2	221	8	206	9	148	6
CPT-34/ 86 ft	Z-18	2	36.3	8	5.9	3	0	12
CPT-28/ 87 ft	Z-9	2	280	8	230	9	203	6
CPT-1A/ 91 ft	Z-18	2	3.9	8	not measured		4.2	12
CPT-4A/ 91 ft	Z-1A	2	not measured		7.7	3	14.4	12
CPT-9A/ 91 ft	Z-9	2	103	8	34.5	9	39.8	6
W18-252SST/ 100 ft	Z-1A	2	38.2	8	17.8	3	24.0	12
W18-152/ 113 ft	Z-12	2	46.8	8	11.1	3	33.3	12
W15-217/ 115 ft	Z-9	3	797	8	630	9	561	6
CPT-24/ 118 ft	Z-9	3	44.6	8	37.7	9	37.3	6
W18-158L/ 123 ft	Z-1A	3	not measured		143	3	492	12
W18-167/ 123 ft	Z-1A	3	323	8	79.7	3	228	12
W18-249/ 134 ft	Z-18	3	206	8	20.4	3	215	12
W18-248/ 136 ft	Z-1A	3	288	8	86.3	3	177	12
W15-6L/ 189 ft	Z-9	6	22.6	8	17.8	9	1.3	6
W15-9L/ 189 ft	Z-9	6	18.3	8	15.0	9	14.9	6
W18-7/ 200 ft	Z-1A	6	28.5	8	17.3	3	29.0	12
W18-6L/ 208 ft	Z-1A	6	36	8	31.3	6	14.5	12
W18-12/ 210 ft	Z-18	6	not measured		3.8	3	18.5	12

* - based on location (Z-1A/18/12 or Z-9) of monitoring point; specific points may be beyond SVE zone of influence during particular operating configurations
- Z-18 and Z-12 wells off-line Oct 96 - Apr 98
- CPT-1A, CPT-9A, and possibly CPT-7A appeared to be beyond SVE zone of influence in Oct 96 based on differential pressure (BHI-01105, p. 6-1)
- CPT-9A, CPT-21A, CPT-28 beyond SVE zone of influence in May 96 based on CCl4 concentrations and airflow modeling based on measured vacuums (BHI-01105, p. 6-1)

Carbon Tetrachloride Rebound Concentrations
Monitored at 200-ZP-2 Soil Vapor Extraction Sites
July 1998 - June 1999

200-ZP-2 Location (Well or Probe) /feet bgs	Zone	8/14/98 (a) CCl4 (ppmv)	9/29/98 CCl4 (ppmv)	11/5/98 CCl4 (ppmv)	12/1/98 CCl4 (ppmv)	12/31/98 CCl4 (ppmv)	1/26/99 CCl4 (ppmv)	2/23/99 CCl4 (ppmv)	3/22/99 3/23/99 CCl4 (ppmv)	4/26/99 CCl4 (ppmv)	5/25/99 CCl4 (ppmv)	6/28/99 CCl4 (ppmv)
79-03/ 5 ft	1									0	0	0
79-06/ 5 ft	1			0	0	0	0	1.2	0	0	1.4	1.2
79-11/ 5 ft	1	0	0	2.8	0	2.9	1.9	1.6	2.5	1.5	1.4	0
86-06/ 5 ft	1			— (b)	0	0	0	1.5	1.9			
87-05/ 5 ft	1									1.0	1.0	0
87-09/ 5 ft	1	0	1.5	0	0	1.1	0	0	1.2	2.6	2.4	2.3
95-11/ 5 ft	1			0	0	1.5	2.5	— (f)	— (g)			
95-12/ 5 ft	1			1.2	0	1.2	1.3	1.2	— (g)			
CPT-13A/ 9 ft	2									0	1.0	0
CPT-16/ 10 ft	2			1.5	0	0	0	1.0	0			
CPT-17/ 10 ft	2			3.2	1.7	3.2	3.7	3.4	5.1			
CPT-18/ 15 ft	2			0	0	5.0	4.5	4.6	3.3			
CPT-31/25 ft	2									0	0	0
CPT-32/ 25 ft	2	0	0	1.0	2.1	5.2	7.0	7.4	8.3	10.0	9.1	8.4
CPT-30/ 28 ft	2			0	0	0	0	0	0	3.2	0	0
CPT-7A/ 32 ft	2	1.4	1.7	1.7	2.4	2.6	5.4	3.5	3.5	3.2	3.7	2.6
CPT-1A/ 35 ft	2									2.8	3.0	2.1
CPT-33/ 40 ft	2									2.3	2.6	2.1
CPT-34/ 40 ft	2									1.3	1.4	1.5
CPT-30/ 68 ft	2									3.0	1.6	1.7
CPT-13A/ 70 ft	2									5.3	5.4	5.6
CPT-31/76 ft	2									4.2	2.2	3.2
CPT-33/ 80 ft	2									7.6	8.5	9.2
W15-82/ 82 ft	2			46.4	19.2	23.1	22.1(e)	24.6	18.5			
W15-95/ 82 ft	2			39.4	25.4	37.3	28.1	30.6	27.1			
CPT-21A/ 86 ft	2			126	74.6	140	148	142	119	90.9	61.9	82.0
CPT-34/ 86 ft	2									0 (j)	— (k)	— (k)
CPT-28/ 87 ft	2			184	65.2	203	170	156	176	98.6	53.4	93.1
CPT-1A/ 91 ft	2									4.2	0	2.4
CPT-4A/ 91 ft	2									10.9	14.1	14.4
CPT-9A/ 91 ft	2			39.0	38.6	12.4	39.8	32.2	37.7	37.5	32.0	14.2
W18-252SST/ 100 ft	2	8.9	17.8	18.2	13.3	22.7	10.7	24.0	23.2			
W18-152/ 113 ft	2	11.1	0	27.9	3.4	25.2	31.7	33.3	3.3	4.7	4.4	2.0
W15-217/ 115 ft	3			— (c)	26.8	339	348(e)	418	561			
CPT-24/ 118 ft	3			37.1	37.3	33.5	20.9	21.3	25.6			
W18-158L/ 123 ft	3	— (d)	143	172	172	— (d)	267	288	399	492	329	310
W18-167/ 123 ft	3	— (d)	79.7	127	205	— (d)	228	218	195	211	219	173
W18-249/ 134 ft	3	— (c)	20.4	215	23.3	208	188	139	76.9	81.1	77.1	90.9
W18-248/ 136 ft	3	7.1	86.3	93.5	98.0	138	136	148	144	162	177	152
W15-6L/ 189 ft	6			— (c)	0	1.3	1.1	1.2	0 (h)			
W15-9L/ 189 ft	6			— (c)	14.6	14.9	14.1	14.9	— (c)			
W18-7/ 200 ft	6	0	17.3	22.5	21.8	26.7	26.4	28.4	29.0			
W18-6L/ 208 ft	6	4.3	14.5	— (c)	— (c)	— (c)	— (c)	— (c)	— (c)			
W18-12/ 210 ft	6	1.2	3.8	7.5	12.0	13.6	12.2	18.5	15.9			

(a) sampled 8/14/98; analyzed 8/15/98
(b) probe 86-07R destroyed; substitute probe 86-06 after 11/98
(c) not in service
(d) access to Z-1A unavailable (no key)
(e) opened for vertical velocity profiling 1/6/99-1/19/99
(f) probe 95-11 clogged; substitute probe 94-02 after 2/99
(g) probe 95-11 clogged, probe 94-02 could not be located; probe 95-12 destroyed
(h) W15-6L tubing discovered on 3/23 to be separated at first splice (~ 50 ft of tubing in well); time of separation unknown.
(j) sample very difficult to pull. Approximately 1/8 L purge and sample.
(k) unable to pull sample from CPT-34/86'; attempted to pull from 60' but unable.

Table 1. Volume of Groundwater Treated and Mass of Carbon Tetrachloride Removed Since Startup of Operations at 200-ZP-1 Through July 4, 1999.

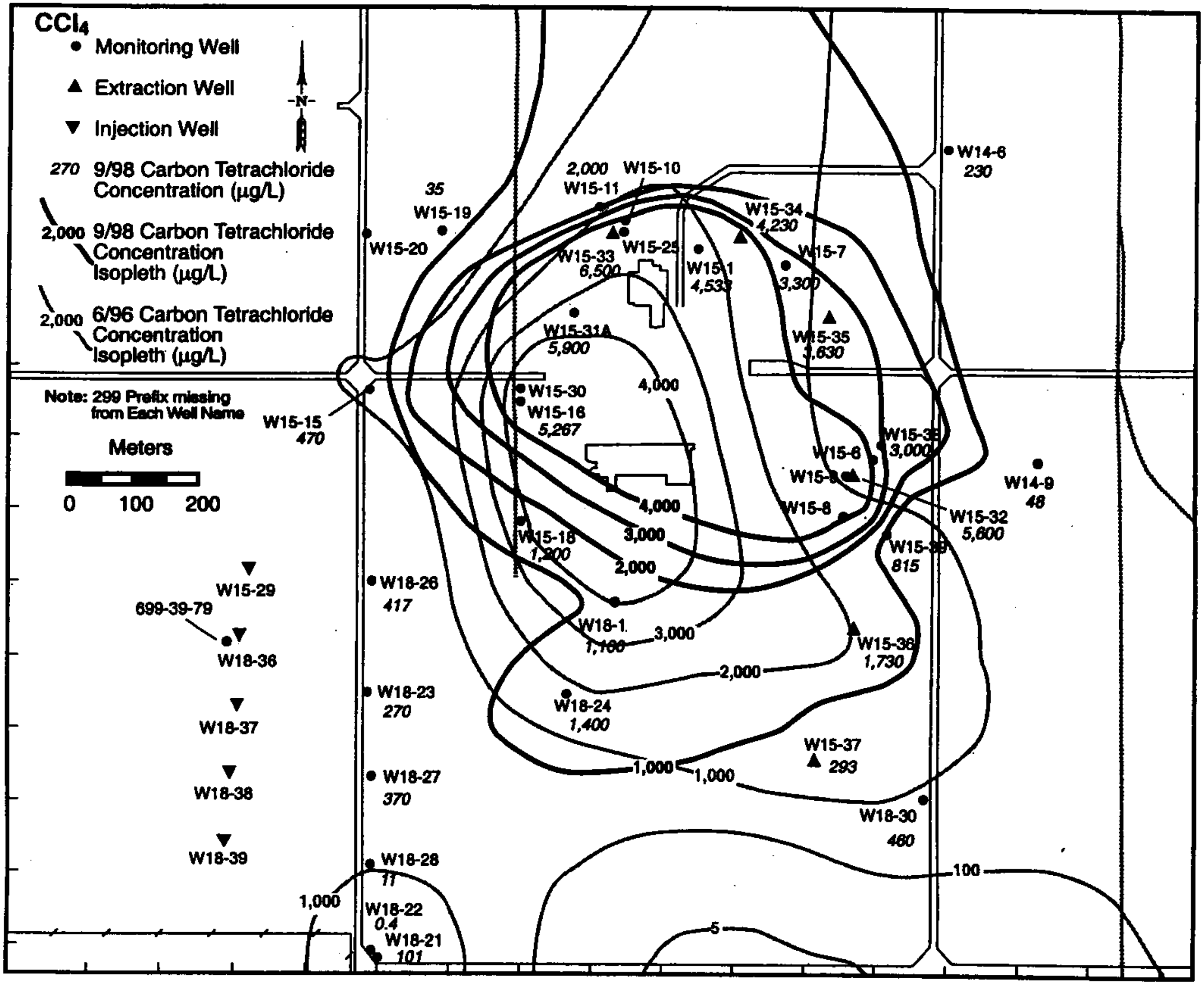
Reporting Period	Liters Treated	Mass of Carbon Tetrachloride Removed (kg)
August 1994 - July 1996	26,676,000	75.85
August 1996 – September 1996	33,232,327	60.96
October 1996 – December 1996	44,583,715	143.54
January 1997 - March 1997	69,869,604	237.2
April 1997 - June 1997	41,877,094	140.8
July 1997 – September 1997	62,469,305	228.8
October 1997 – December 1997	81,629,000	245.7
January 1998 - March 1998	72,791,000	279.5
April 1998 - June 1998	90,842,900	348.9
July 1998 – September 1998	90,899,200	338.1
October 1998 - December 1998	83,552,570	315.57
January 1999 – March 1999	77,079,156	310.2
April 1999 - July 4, 1999	92,618,174	335
Total	868,120,000	3060

Table 2. Average Concentrations for Each of the Extractions Wells and the Influent Tank at 200-ZP-1 During the Second Quarter of Fiscal Year 1999.

Well Name[a]	Minimum Value (µg/L)	Maximum Value (µg/L)	Mean Concentration FY98 (µg/L)	Mean Concentration 2nd Qtr FY99 (µg/L)	Mean Flow Rate[b] (L/min)	Overall Change
299-W15-33	4,700	7,200	6,000	6,445	17	Higher
299-W15-34	2,800	4,700	3,770	4,650	26	Higher
299-W15-35	2,800	4,500	3,660	3,712	81	Higher
299-W15-32	4,800	7,800	6,560	5,000	20	Lower
299-W15-36	1,600	2,600	2,040	1,750	30	Lower
299-W15-37	140	320	235	326	17	Higher
Influent Tank	--	4,400	3,530	4,012	--	Higher

[a] Wells listed from north to south.

[b] Some discrepancies in discharge rate at the different measurement locations were observed. These are still being resolved. Flow rates may actually be higher by about 15% to 20%.



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Attachment 9

Status brief on monitoring activities related to the 216-B-63 Trench

Operational Characteristics

Operated from March 1970 to February 1992

Received waste from B Plant via the chemical sewer line (CSL)

Approximately 330 m long and 1.5 m in depth

Maintained as an emergency discharge facility from 1992 until interim stabilization in 1994

Waste Stream (Table 1 - Sources)

Flow rates from the CSL varied from approximately 500 to 2000 L/min with an average flow of ~1200 L/min (total of 6.5 x 10^9 liters from March 1970 to August 1989)

Liquid effluent primarily contained a 70/30 percent mixture of steam condensate and raw water

Hazardous waste from discharges were recorded from 1970 to October 1985, consisting of sulfuric acid and sodium hydroxide

Radioactive soils were dredged in August 1970, but no records exist of radioactive discharges to the trench

Largest hazardous components (volumetric) discharged were sodium hydroxide and sulfuric acid

Administrative and physical controls implemented in 1985 to avoid hazardous discharges

Hydrogeology

Principal sediment types are sand and sandy-gravel units of the Hanford formation

Vadose is dominantly coarse-grained at the head end and south of the trench, finer at the tail end and north of the facility

Conceptual model indicates that significant infiltration occurs primarily in the area nearest the head end

Highest contaminant transport is likely to be in the head end area

Groundwater flows ~270° at 0.03-0.2 m/d

Monitoring Program

Began indicator parameter sampling in late 1988

Monitoring suspended from June 1990 to early 1991 because of analytical contract difficulties

Site has been in detection monitoring since 1993 and continues to present

Monitoring include semiannual sampling for indicator parameters, and annual sampling for phenols, gross alpha and gross beta, alkalinity, anions, and ICP metals

Monitoring network includes 12 wells; five upgradient on the north side of the trench and seven downgradient at the headend and southern side of the facility

Results

No exceedances have been reported

Proposed changes

The proposed attached ICN reflects a change in monitoring

Monitoring would continue semiannually at the head end of the facility where contamination would most likely be encountered

Three upgradient monitoring wells at the tail end would be removed from schedule

Table 1. B Plant Chemical Sewer Sources.

Steam	Source
Floor, funnel, sink drains	221-B pipe and operating gallery (separation building) 271-B aqueous makeup area (service building) 271-B compressor room 217-B Demineralized Water Unit Building 225-BC Compressor Building 276-B Organic Makeup Building 224-B Building
Steam condensate	221-B pipe and operating gallery (chemical makeup tank farm) 211-B station steam supply SN-172 ammonia tank heating coil Various steam trace lines
Steam condensate and/or cooling water	TK-101, -102 aqueous makeup tank heating and cooling coils (211-B) HEDTA[a] tank heating and cooling coils (211-B) TK-SF-121, -122 tanks heating and cooling coils (211-B) Various heating, ventilating and air conditioning systems
Tank overflow and drain effluent	221-B scale tanks 211-B aqueous makeup tanks 271-B aqueous makeup tanks TK-N-317 resin fluidizing tank (271-B) 211-B ammonia pump basin 217-B tanks[b] 276-B tanks TK-CS-1, -2 tanks (212-B cask station) 224-B hot water tank 2902-B water tank
Sump effluent	211-B electrical gallery
Cooling water	211-B electrical gallery instrument air compressor
Rain water	Outdoor drain near 224-B Building (storage building)

[a]Trisodium hydroxyethylethylene-diaminetriacetic acid
[b]Includes neutralized demineralizer recharge effluent

Table 2 Monitoring Wells and Constituents for 216-B-63 Trench (adapted from WHC-SD-EN-AP-165)

Well	Hydrogeologic Unit Monitored	Sampling Frequency	Water-Level Measurement	Well Standard	Other Networks
299-E27-8[87]	Top of unconfined	Semiannual	Quarterly	RCRA	LLWMA 2
299-E27-9[87]	Top of unconfined	Semiannual	Quarterly	RCRA	LLWMA 2
299-E27-11[89]	Top of unconfined	Semiannual	Quarterly	RCRA	LLWMA 2
299-E27-16[90]	Top of unconfined	Semiannual	Quarterly	RCRA	–
299-E27-17[91]	Top of unconfined	Semiannual	Quarterly	RCRA	LLWMA 2
299-E27-18[92]	Top of unconfined	Semiannual	Quarterly	RCRA	Surveillance
299-E27-19[92]	Top of unconfined	Semiannual	Quarterly	RCRA	–
299-E33-33[90]	Top of unconfined	Semiannual	Quarterly	RCRA	WMA B-BX-BY
299-E33-36[90]	Top of unconfined	Semiannual	Quarterly	RCRA	WMA B-BX-BY
299-E33-37[90]	Top of unconfined	Semiannual	Quarterly	RCRA	Surveillance
299-E34-8[90]	Top of unconfined	Semiannual	Quarterly	RCRA	Surveillance
299-E34-10[91]	Top of unconfined	Semiannual	Quarterly	RCRA	LLWMA 2, Surveillance

Contamination Indicator Parameters		Site-Specific Parameters	
pH	Total organic carbon	Alkalinity	ICP metals (filtered)
Specific conductance	Total organic halides	Anions	Phenols
		Gross alpha	Turbidity
		Gross beta	

Shading = Upgradient wells.
Superscript = Year of installation.
LLWMA = Low-level waste management area.
RCRA = Well constructed to RCRA standards.
WMA = Waste management area.

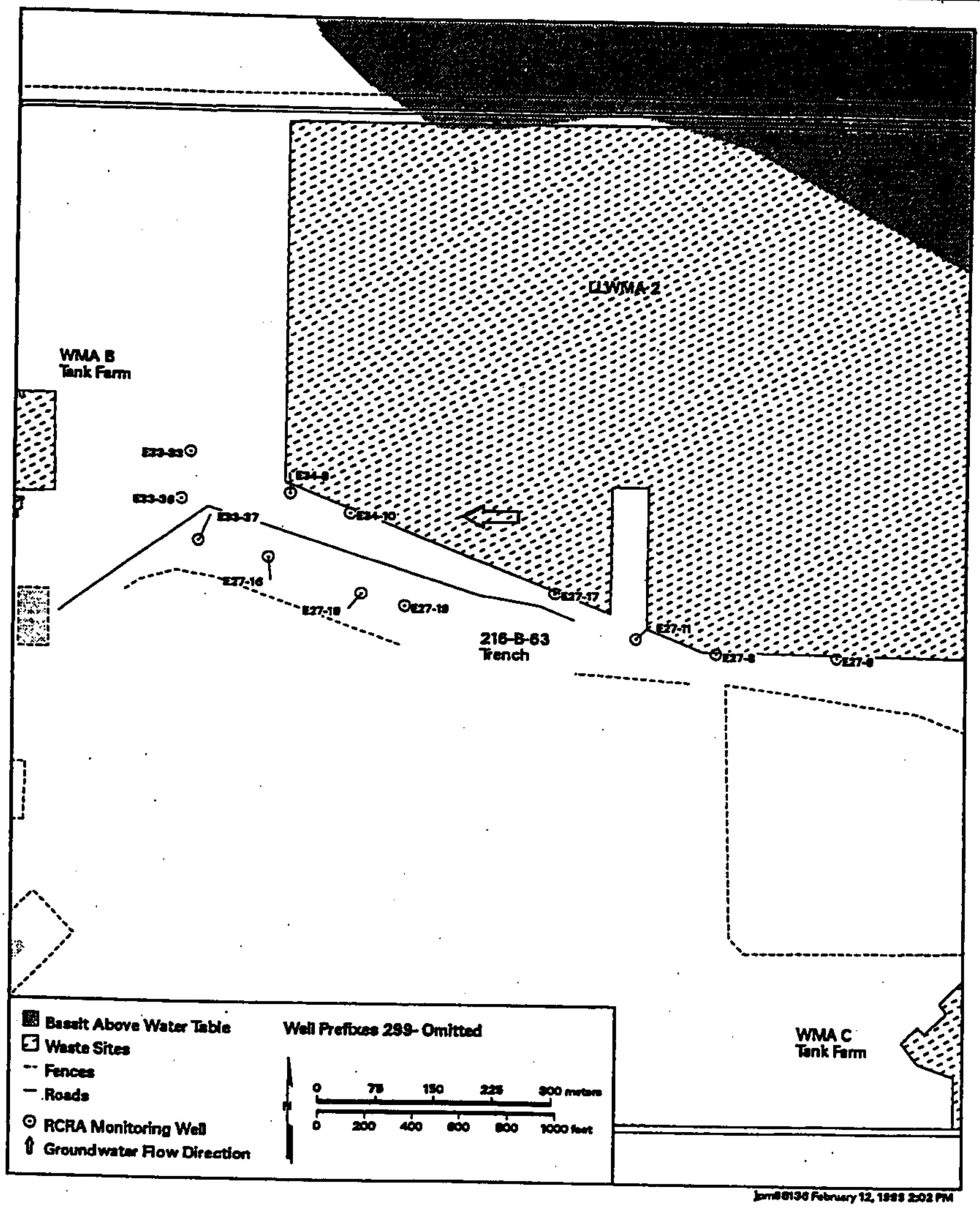


Figure 1 Monitoring Well Locations for 216-B-63 Trench

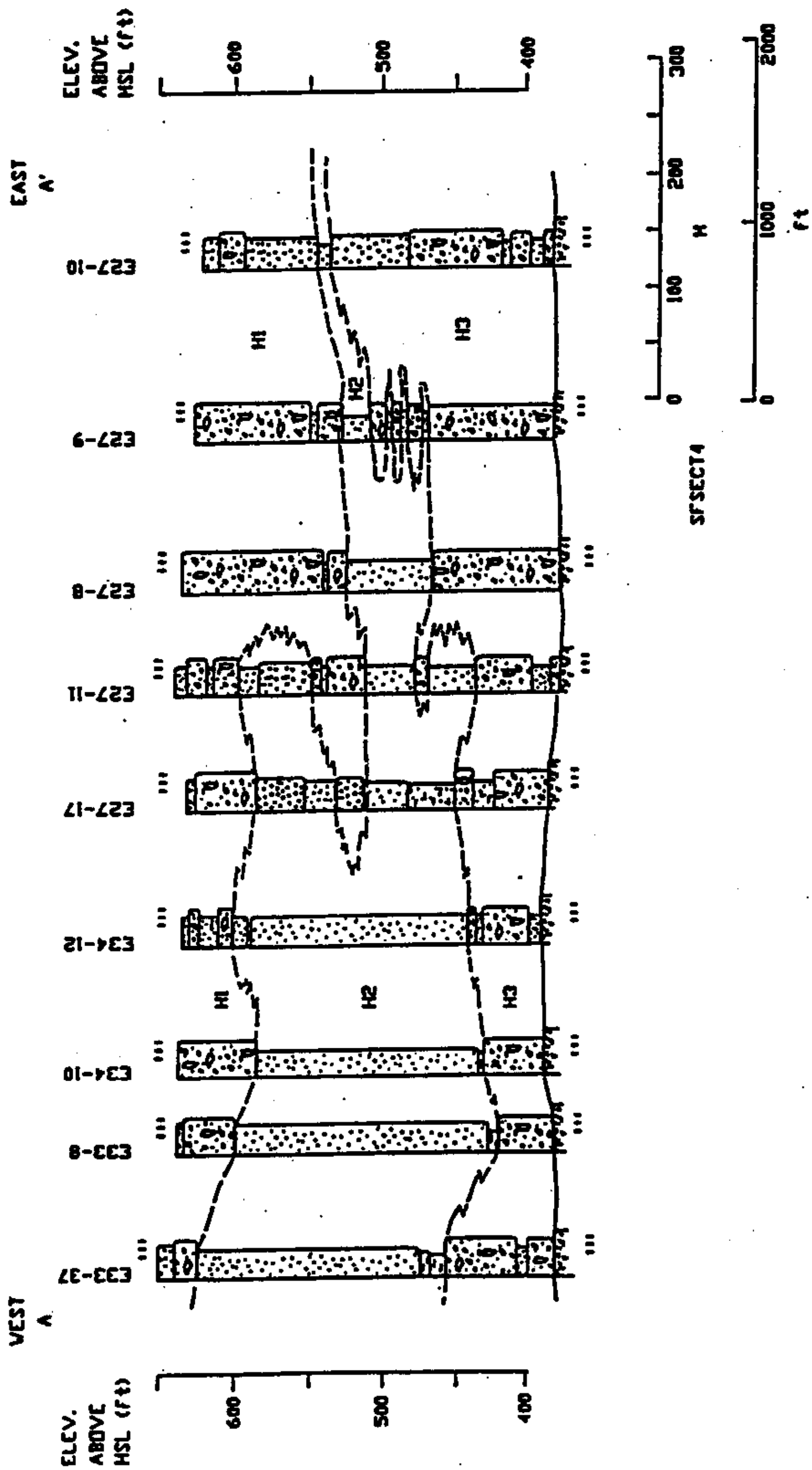


Figure 2. Cross Section Across the 216-B-63 Trench.

INTERIM CHANGE NOTICE (ICN)

A. Document No.: WHC-SD-EN-AP-165 **Revision No.:** 0

Document Title: Interim Status Groundwater Monitoring Plan for the 216-B-63 Ditch

Document's Original Author: M.D. Sweeney

Effective Date of ICN: __/__/

Change Requested By: M.D. Sweeney

B. Action:
Mark through Sections 2.3.3.3, 3.0, 3.1, 3.4, 3.4.2, 3.4.5, 3.4.5.1, 3.4.5.2, 3.4.5.3, 3.4.7, 3.5.2, 3.5.2.2, 3.6, 3.6.1, 3.6.2, Table 3, Table 5, and Appendix B in the original document. Mark through wells 299-E27-8, 299-E27-9, 299-E27-11 in Table 4. Place a reference to this ICN number near these cross-outs and place a reference to this ICN in Section 5.0. Place a reference to new sections 3.8, 3.9 after existing section 3.7 by referencing this ICN. Initial and date all changes. Attach this ICN to the front of the document.

C. Effect of Change:

Project personnel are already using the current procedures and QA plan; this update brings the monitoring plan up to date. This ICN also eliminated unnecessary and redundant well sampling by reducing the number of upgradient wells.

D. Reason for Change/Description of Change:

Reason for Change: Since the document was written, the groundwater project was transferred to Battelle and a new QA plan has been prepared. The network has also been reduced to enhance network efficiency.

Description of Change: Replaces outdated sections with current ones (see attached).

E. Document Management Decisions:
Original review/approvals no longer relevant because groundwater project has since been transferred to PNNL.
Previous distribution list is also obsolete. Current distribution:
JV Borghese
MJ Furman
MJ Hartman
SP Luttrell
RM Smith
DL Stewart
FILE

F. Approval Signatures
(Please Sign and Date)

Type of Change: (Check one):
__ Minor _X_ Major

Approval Authority: SP Luttrell, project management Date: ______

Other Approvals: MD Sweeney Date: ______
TL Almeida, QA Date: ______

2.3.3.3 Groundwater Quality. RCRA groundwater quality samples have been collected from the monitoring network since the installation of the first wells in 1987. Quarterly sampling started during the third quarter of 1988 and continued, with a break resulting from laboratory problems, until the first quarter of 1992. Starting with the second quarter of 1992, the first monitoring wells were placed on a semiannual sampling schedule. The lapse in establishing a detection-level monitoring program was due to laboratory problems (1990 to 1991), and the installation of new monitoring wells for the 216-B-63 Ditch. Subsequent wells have also been placed on semiannual sampling as they established their critical means (see Section 3.7.3). No evidence has been found that the 216-B-63 Ditch has contaminated groundwater, but there is contamination from other sites. Regional groundwater contamination in the form of tritium and nitrate, for example, can be found throughout the 200 East Area.

3.0 PHASE I--GROUNDWATER MONITORING PROGRAM

This plan has been developed in accordance with RCRA, as described in 40 CFR 265, Subpart F, to conduct an interim-status groundwater-monitoring program for the 216-B-63 Ditch. The following sections describe the groundwater monitoring history and program requirements.

3.4 DETECTION LEVEL GROUNDWATER MONITORING SYSTEM

This section describes the aquifer that is monitored, the location and justification of the monitoring wells, the frequency of sampling, and the groundwater constituents that are analyzed.

3.4.2 Background (Upgradient) Wells

Five upgradient wells (299-E27-8, 299-E27-9, 299-E27-11, and 299-E34-10) were installed as background wells to determine the background water chemistry. The revised network will rely on two of these wells, 299-E27-17 and 299-E34-10, for background water chemistry. Elimination of three upgradient wells will not degrade the revised network since the historical trends for groundwater-quality parameters in all five wells are similar. All wells were completed at the base of the unconfined aquifer, in the Hanford formation, and were screened across the entire saturated zone.

3.4.5 Well Drilling and Construction

The groundwater monitoring wells were constructed at the 216-B-63 Ditch as RCRA standard wells constructed to the generic specification for groundwater monitoring wells (WHC 1992b). WAC 173-160, Minimum Standards for Construction and Maintenance of Wells (Ecology 1973) was used to set the basic design requirements.

3.4.7 Monitoring Parameters

Groundwater samples are analyzed for the parameters listed in Table 5, as required by 40 CFR 265.92 (EPA 1980a). In addition, samples will be analyzed for tritium because of a tritium plume from the 200 East Area that passes beneath the site.

3.5.2 Hydrogeologic

Data were collected during and after construction of the monitoring wells that were used in characterizing the hydrogeology of the area around the 216-B-63 Ditch. The types and methods of data collection are discussed in the following sections.

3.5.2.2 Determination of Groundwater Flow Paths. Water table elevation measurements will be taken during sampling at the 216-B-63 Trench on a semi-annual basis. The determination of groundwater flow direction is based on routine water level measurements in all wells of the 216-B-63 Trench groundwater monitoring network. Regional water table elevation measurements obtained for annual groundwater map compilation are also used in evaluating groundwater flow direction at the 216-B-63 Trench.

3.6 Sampling and Analysis

3.6.1 Sample Collection

Procedures for groundwater sampling, documentation, sample preservation, shipment, and chain-of-custody requirements are described in PNNL or subcontractor manuals (e.g. WMNW procedures manual ES-SSPM-001) and in the quality assurance plan (PNNL 1998 or most recent revision). Samples generally are collected after three casing volumes of water have been purged from the well or after field parameters (pH, temperature, specific conductance, and turbidity) have stabilized. For routine groundwater samples, preservatives are added to the collection bottles before their use in the field. Samples to be analyzed for metals are usually filtered in the field so that results represent dissolved metals.

Procedures for field measurements are specified in the subcontractor's or manufacturer's manuals. Analytical methods are specified in contracts with laboratories, and most are standard methods from *Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods* (EPA 1986a). Alternative procedures meet the guidelines of EPA 1986a, Chapter 10.

3.6.2 Sample Frequency

Samples are collected from all groundwater monitoring wells on a semiannual basis in conformance with 40 CFR 265.93 (EPA 1980a) for analysis of the constituents listed in Table 5.

3.6.3 Reporting

A report of the results of the groundwater monitoring program must be submitted annually. This reporting requirement is consistent with 40 CFR 265.94(b) (EPA 1980a). Table 5 lists the constituents sampled for at the 216-B-63 Trench. Groundwater data for the 216-B-63 Trench are reported via the Hanford Environmental Information System (HEIS) as it is received from analytical laboratories.

3.8 QUALITY ASSURANCE AND CONTROL

The groundwater monitoring project's quality assurance/quality control (QA/QC) program is designed to assess and enhance the reliability and validity of groundwater data. The primary quantitative measures or parameters used to assess data quality are accuracy, precision, completeness, and the method detection limit. Qualitative measures include representativeness and comparability. Goals for data representativeness for groundwater monitoring projects are addressed qualitatively by the specification of well locations, well construction, sampling intervals, and sampling and analysis techniques in the groundwater monitoring plan for each RCRA facility. Comparability is the confidence with which one data set can be compared to another. The QC parameters are evaluated through laboratory checks (e.g. matrix spikes, laboratory blanks), replicate sampling and analysis, analysis of blind standards and blanks, and interlaboratory comparisons. Acceptance criteria have been established for each of these parameters (PNNL 1998), based on guidance from the U.S. Environmental Protection Agency (EPA 1986a, 1986b). When a parameter is outside the criteria, corrective actions are taken to prevent a future occurrence and affected data are flagged in the database.

3.9 DATA MANAGEMENT

The contract laboratories report analytical results electronically. The results are verified as described in the project QA plan and loaded into the Hanford Environmental Information System (HEIS) database. Field-measured parameters are entered manually or through electronic transfer. Data from HEIS may be downloaded to smaller databases, such as the Geosciences Data Analysis Toolkit (GeoDAT) for review and interpretation. Paper data reports and field records are considered to be the record copies and are stored at PNNL.

The data are reviewed at least quarterly according to a documented procedure, as described in the project QA plan. QC data are evaluated against the criteria listed in the project QA plan and data flags are assigned when appropriate. In addition, data are screened by scientists familiar with the hydrogeology of the unit, compared to historical trends or spatial patterns, and flagged if they are not representative. Other checks on data may include comparison of general parameters to their specific counterparts (e.g. conductivity to ions; gross alpha to uranium), calculation of charge balances, and comparison of calculated vs measured conductivity. If necessary, the lab may be asked to check calculations or reanalyze the sample, or the well may be resampled.

5.0 REFERENCES

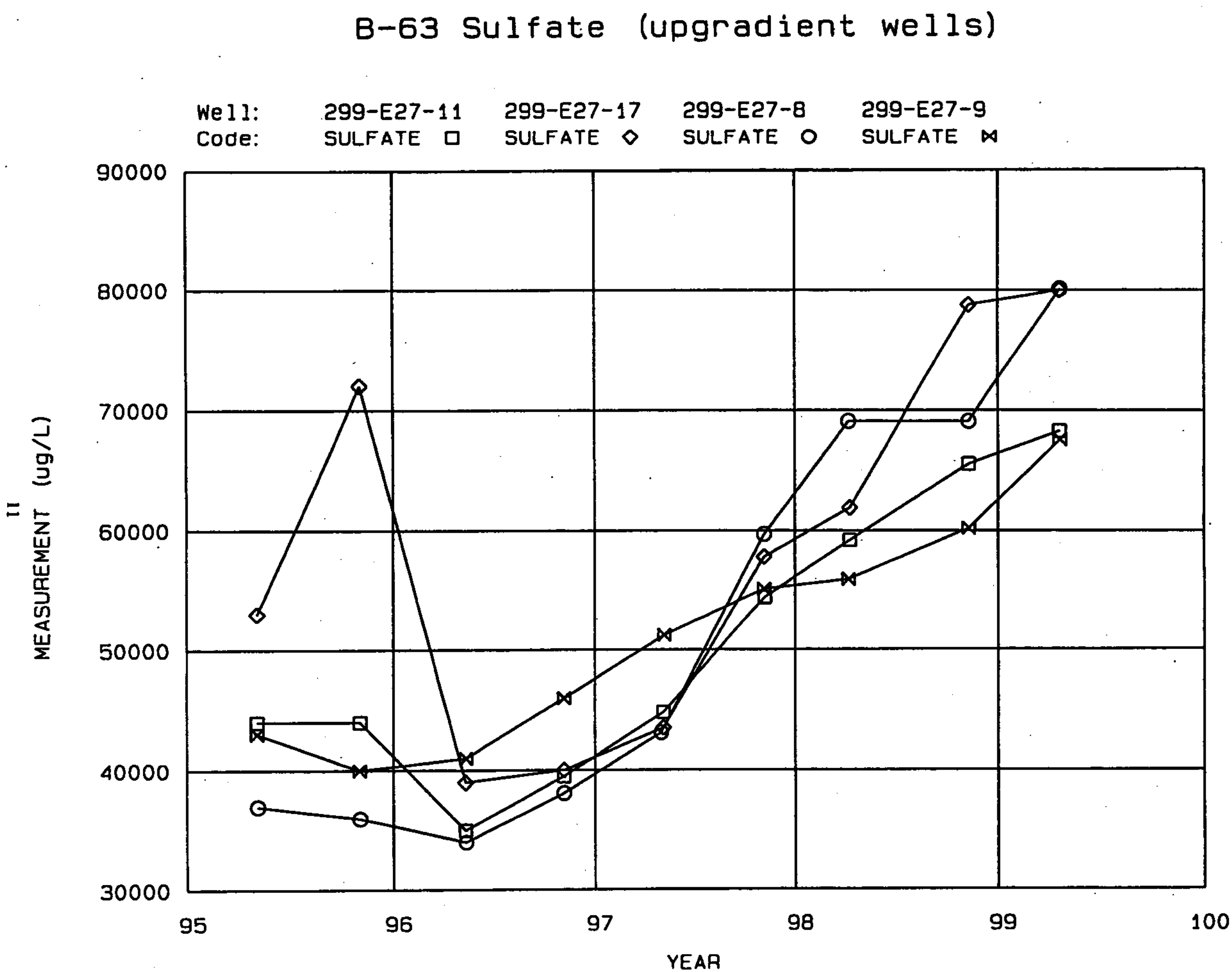
EPA, 1986a, *Test Methods for Evaluating Solid Waste*, Third Edition, SW-846, Volumes 1 and 2, U.S. Environmental Protection Agency, Washington, D.C.

EPA, 1986b, *RCRA Groundwater Monitoring Technical Enforcement Guidance Document*. OSWER-9950.1, U.S. Environmental Protection Agency, Washington DC.

PNNL, 1998, *The Hanford Ground-Water Monitoring Project Quality Assurance Project Plan*, ETD-012, Rev. 1, Pacific Northwest National Laboratory, Richland, Washington.

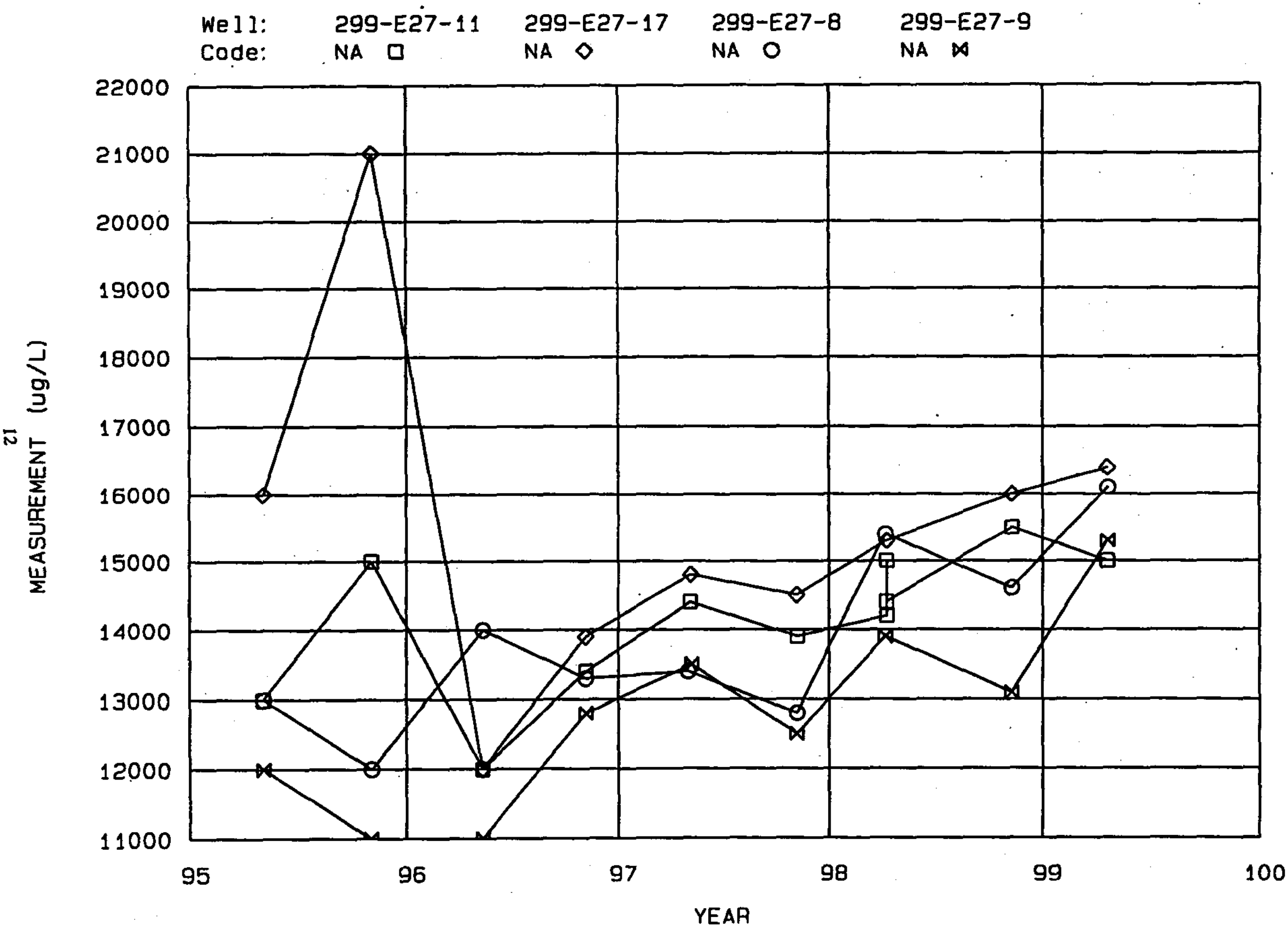
Table 5. Groundwater Sampling Parameters

Contamination indicator parameters[a]	
PH	Total organic carbon
Specific conductance	Total organic halogen
Groundwater quality parameters[b]	
Chloride	Phenols
Iron	Sodium
Manganese	Sulfate
Site specific parameters[c]	
Alkalinity	Turbidity
Gross beta	Gross alpha
Tritium	
[a]Sampled semi-annually as quadruplicates [b]Sampled annually [c]Sampled semi-annually	



Attachment 10

B-63 Sodium (upgradient wells)



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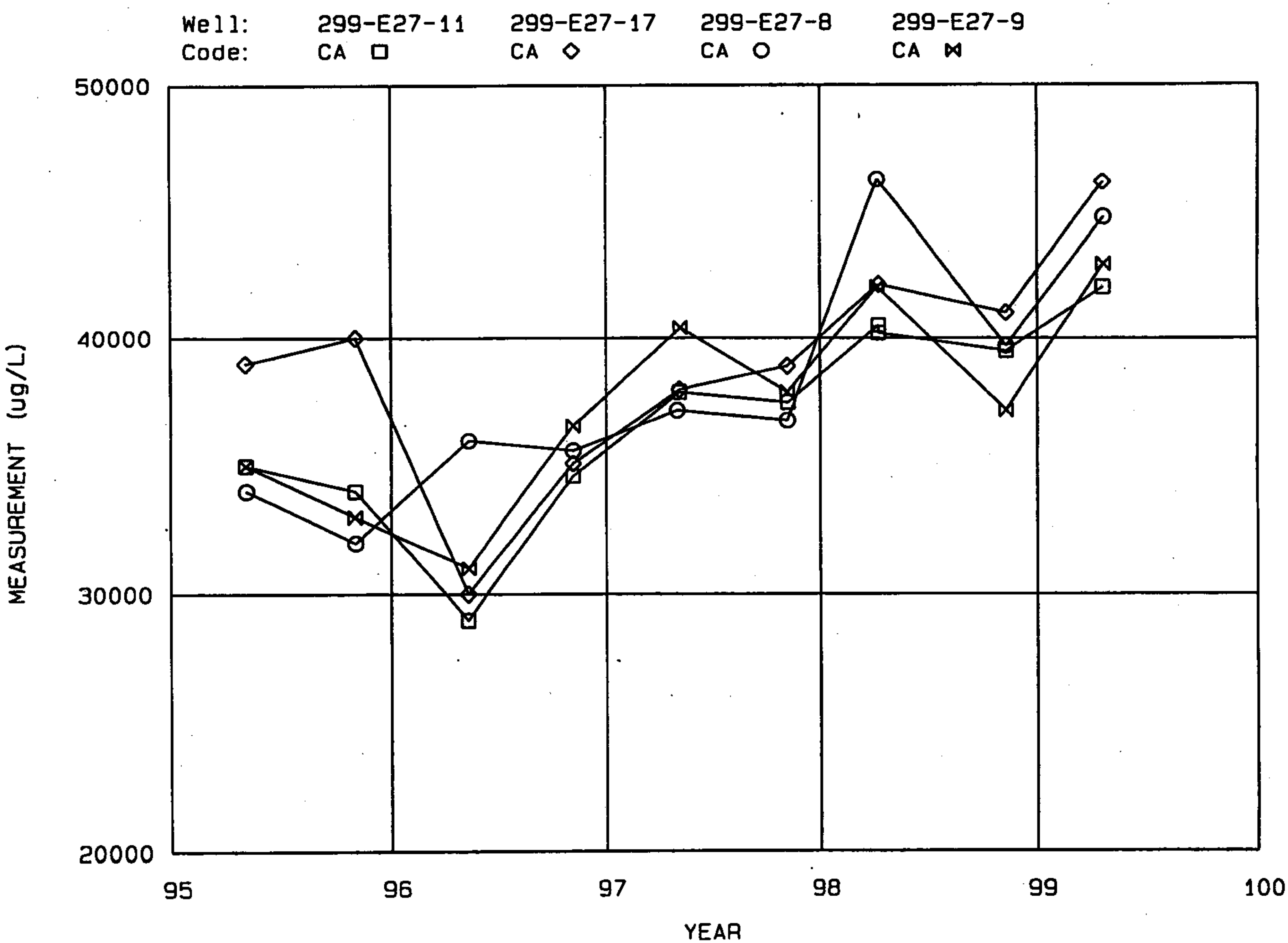
Attachment 10

B-63 Calcium (upgradient wells)



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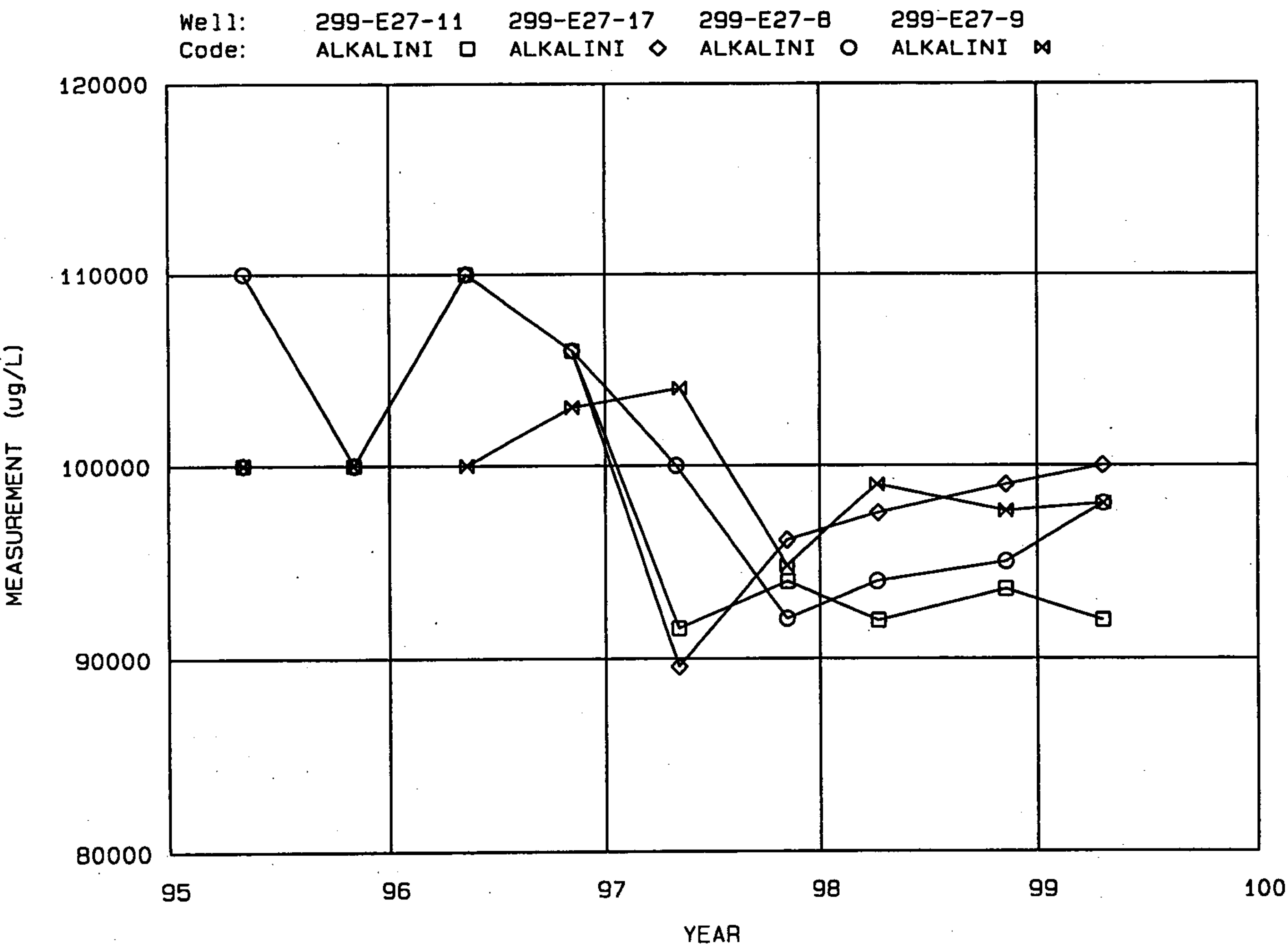
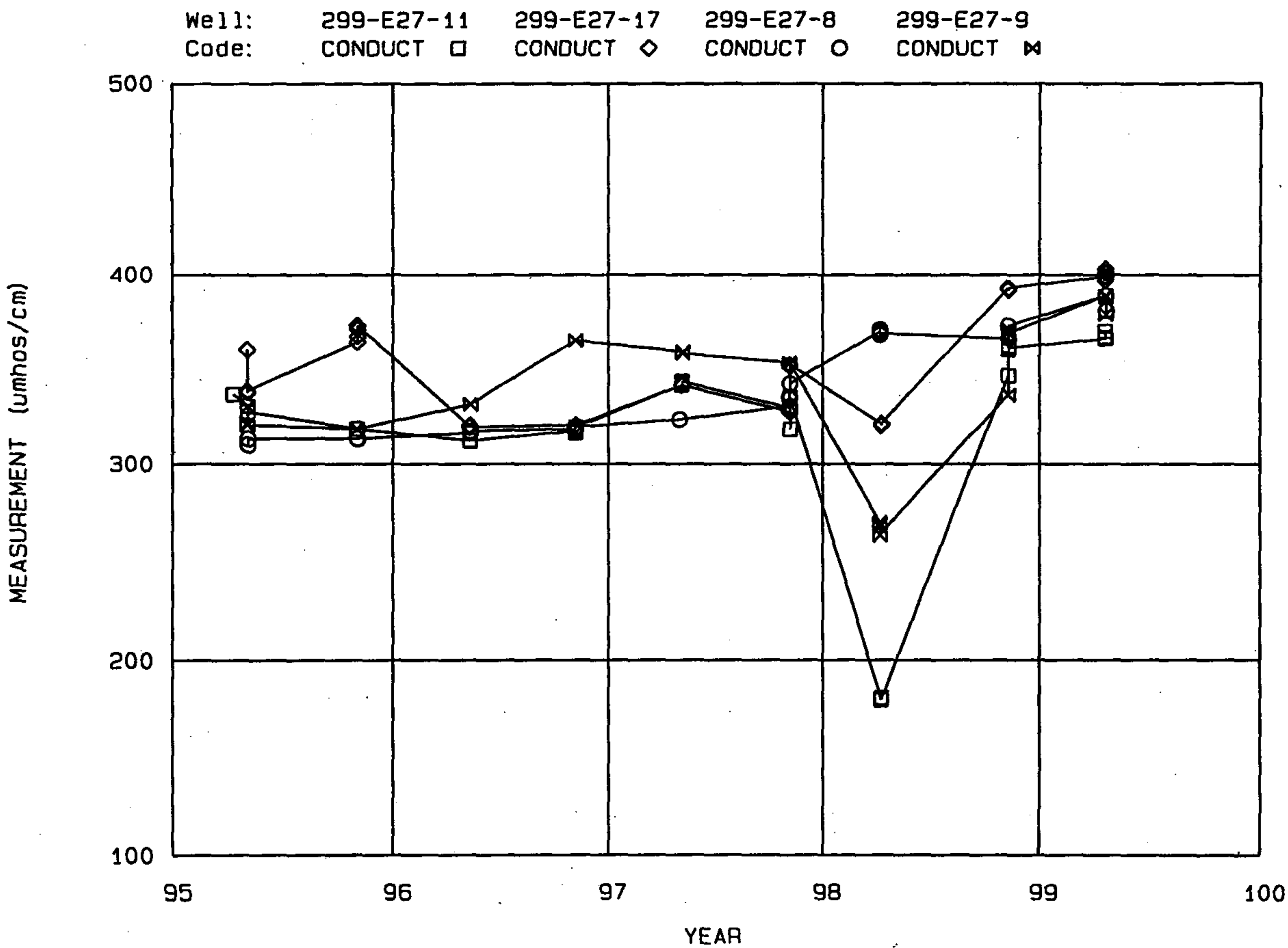
Attachment 10

B-63 Alkalinity (upgradient wells)



Attachment 10

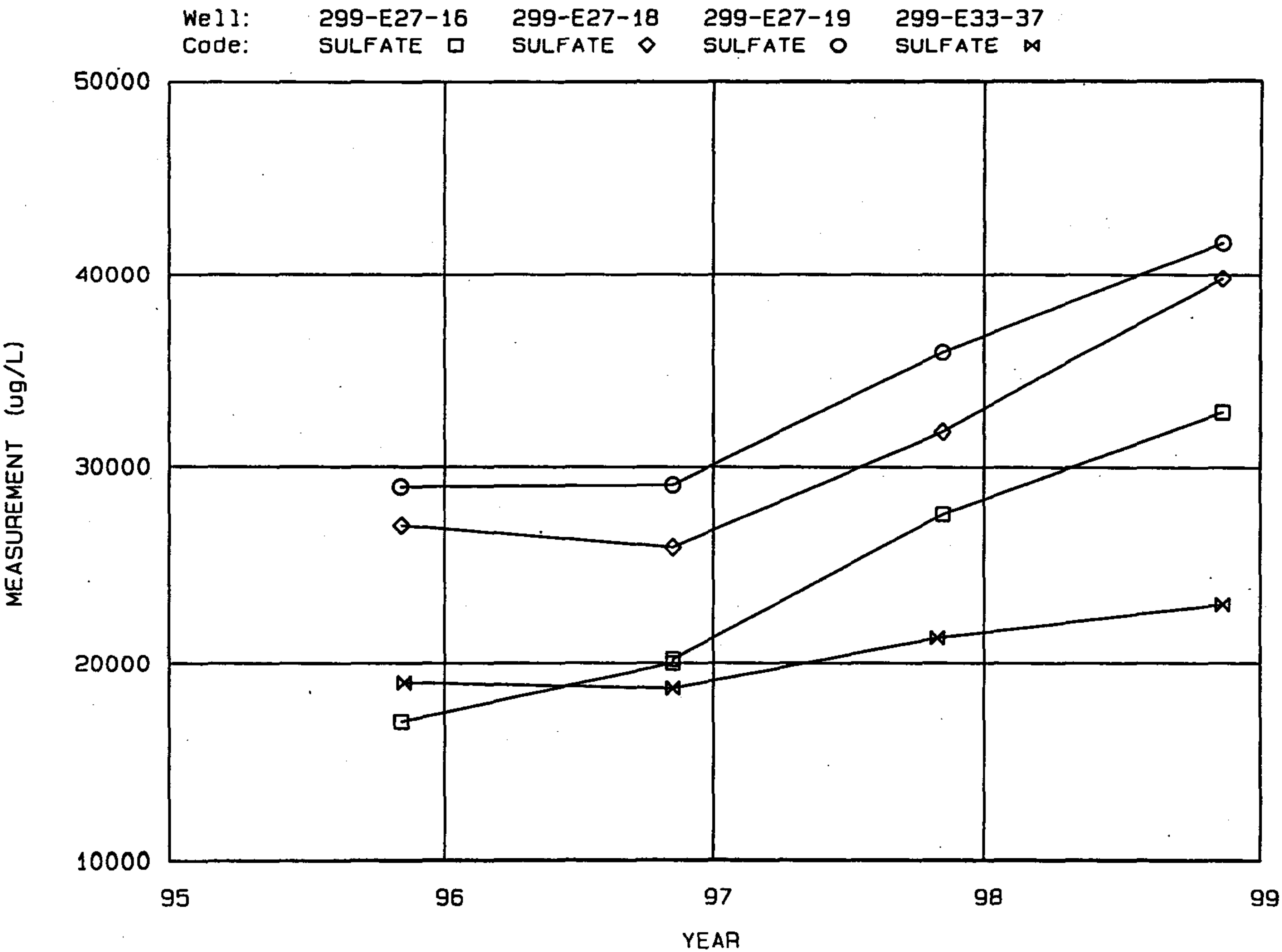
B-63 Conductivity (upgradient wells)



15

Attachment 10

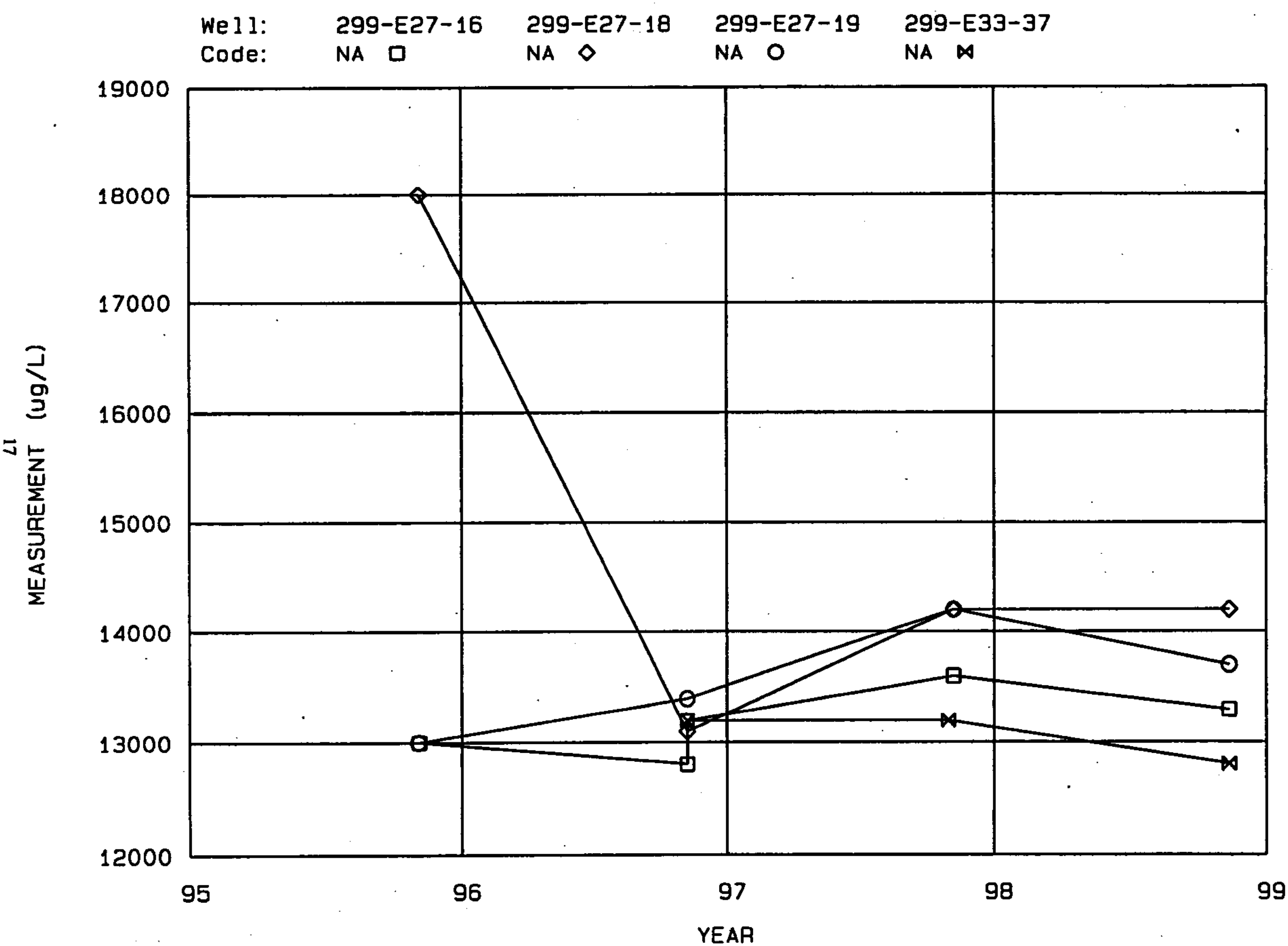
B-63 Sulfate (downgradient wells)



16

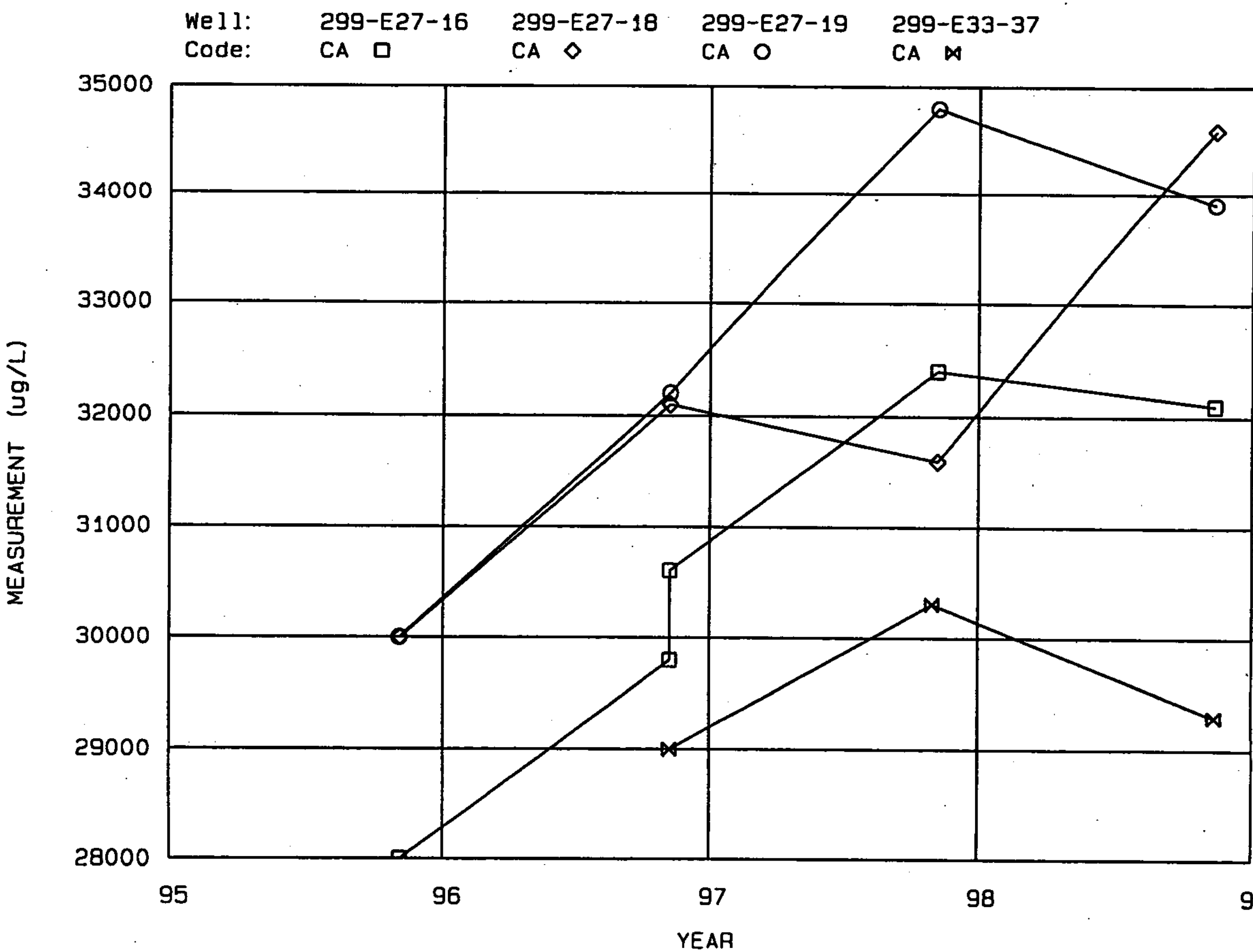
Attachment 10

B-63 Sodium (downgradient wells)



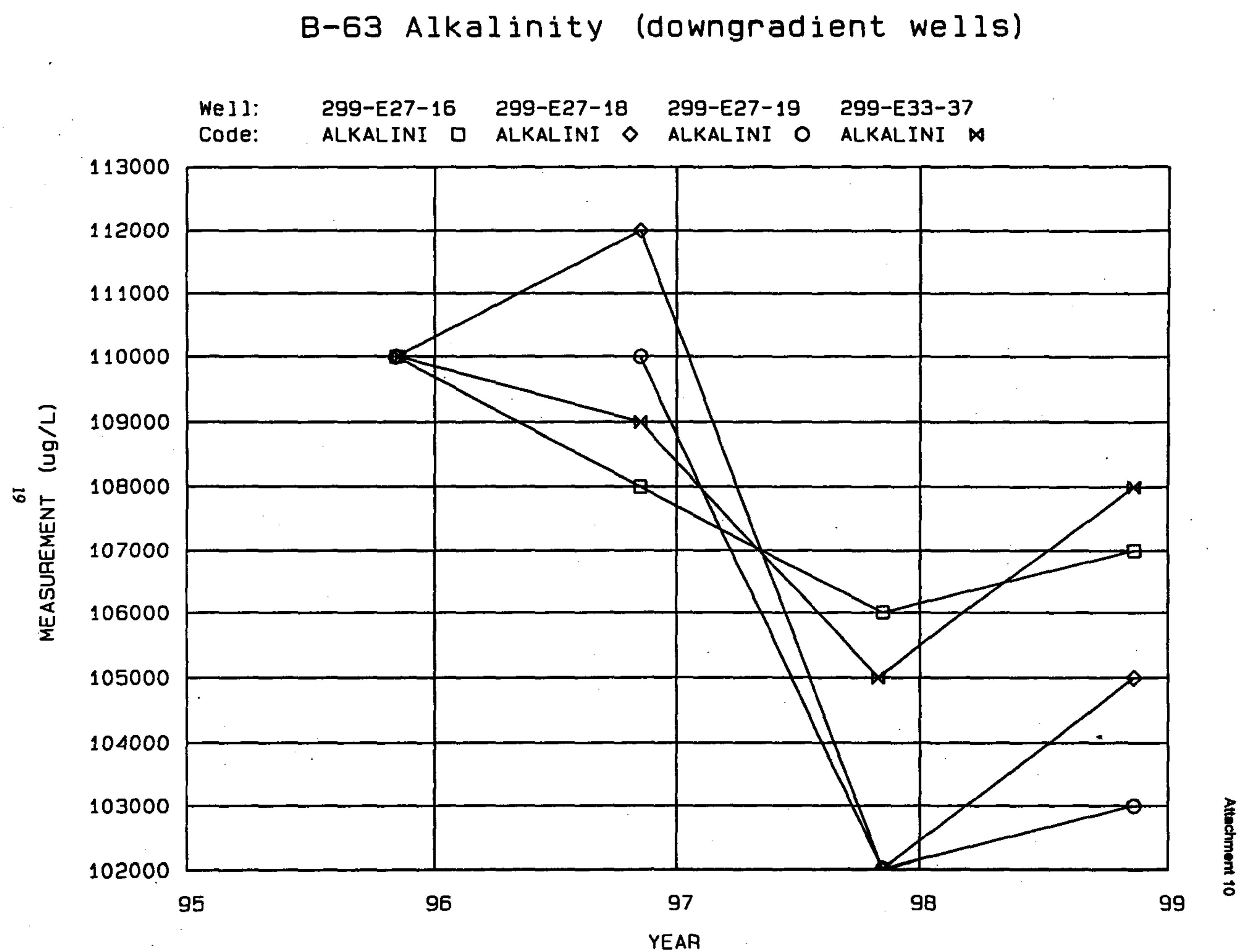
Attachment 10

B-63 Calcium (downgradient wells)

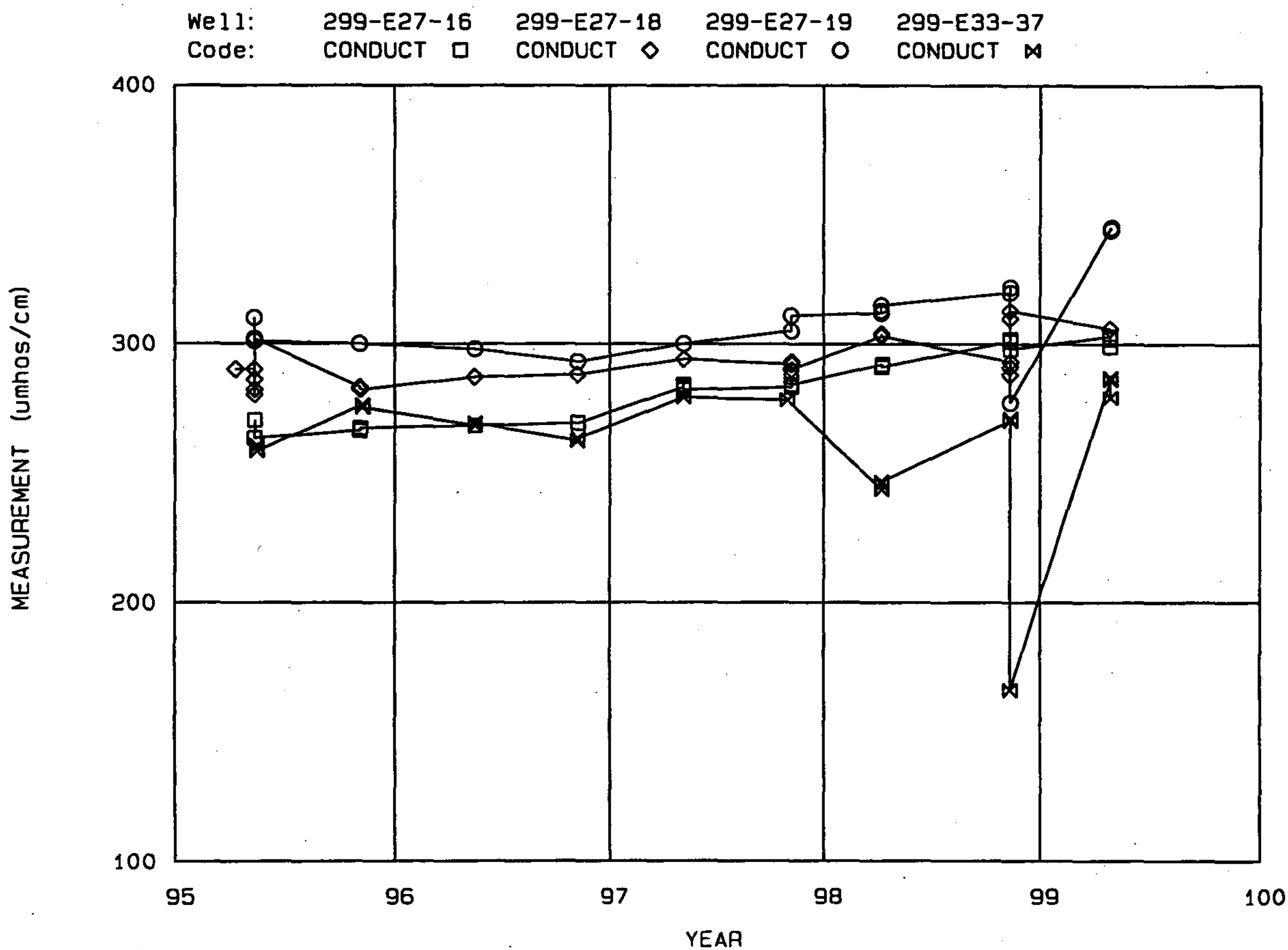


18

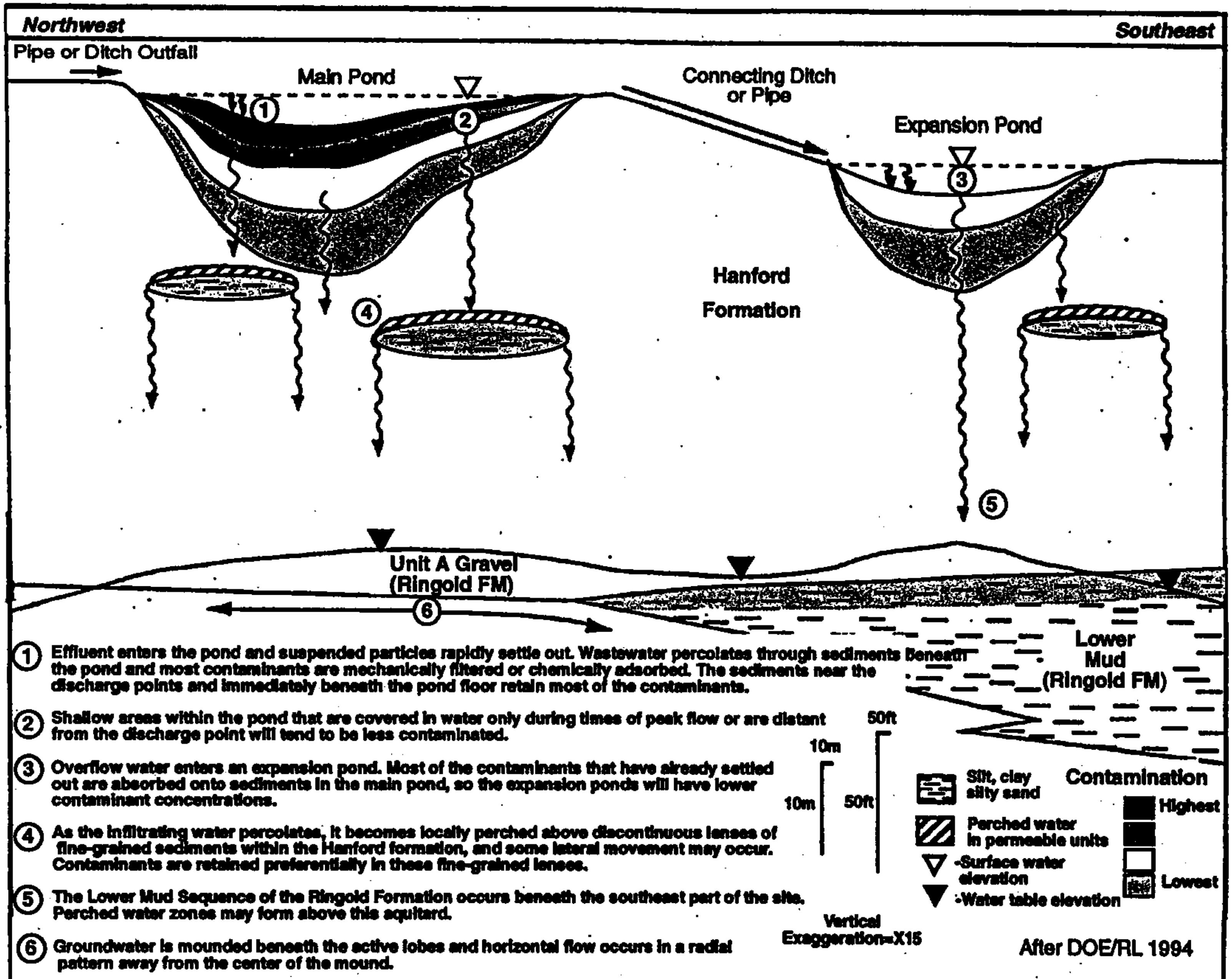
Attachment 10


B-63 Alkalinity (downgradient wells)
Well: 299-E27-16 299-E27-18 299-E27-19 299-E33-37
Code: ALKALINI □ ALKALINI ◇ ALKALINI ○ ALKALINI ⋈
113000
112000
111000
110000
109000
108000
107000
106000
105000
104000
103000
102000
MEASUREMENT (ug/L)
95
96
97
98
99
YEAR
19
Attachment 10

B-63 Conductivity (downgradient wells)



Attachment 10



SP96030099.6

Figure 3. Conceptual Model of Infiltration of Effluent at the Main Pond of the B Pond System (after DOE-RL 1994)

078810

Attachment 10

078810

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