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JUN 2 6 1996

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U.S. Environmental Protection Agency
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Richland, Washington 99352-0539

JUL 1996
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Dear Messrs. Lundstrom and Sherwood:

200-UP-1 GROUNDWATER PUMP-AND-TREAT PHASE I PROGRESS REPORT DECEMBER 1995 THROUGH MARCH 1996

The subject document is attached for your information. It summarizes and evaluates treatment, hydrologic and geochemistry data collected for the initial quarter of the pump-and-treat operations (December 1995 through March 1996).

The pump and treat system at 200-UP-1 has treated almost 64 million liters of groundwater, to remove approximately 27,000 grams of uranium, since operations began in March 1994. The system is now operating continuously at 190 liters/minute (50 gallons/minute).

If you have any questions, please feel free to contact me at 376-5778.

Sincerely,

Donna Wanek

Donna M. Wanek, Project Manager
Groundwater Project

GWP:DMW

Attachment

cc w/attach:
P. Beaver, EPA
D. Einan, EPA
D. Goswami, Ecology
S. Mohan, Ecology

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K. Porter, ITH
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# 1.0 INTRODUCTION

A groundwater pump-and-treat activity is being performed in the 200-UP-1 Groundwater Operable Unit under authority of the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1994) (change control form M-13-93-03). The purpose of the pump and treat is to contain and treat elevated concentrations of uranium and technetium-99 in the 200-UP-1 Operable Unit and collect data on aquifer response to the pump and treat.

The 200-UP-1 treatment site is located on the north side of the 216-U-17 Crib in the 200 West Area of the Hanford Site. Detailed site characterization and background information on the operable unit and the pump-and-treat activity are provided in DOE-RL (1994b) and BHI (1996a). Figure 1 shows the site plan for the pump-and-treat system.

The pump and treat began operations in March 1994 as a pilot-scale treatability test to assess the effectiveness of an ion-exchange treatment system to remove uranium and technetium-99 from extracted groundwater (DOE-RL 1994a). Pump-and-treat operations continued through August 1995, at which time the system was upgraded to increase the flow rate from 57 to 190 L/min, consistent with the interim remedial measure (IRM) proposed plan for 200-UP-1 (DOE-RL 1995a). Wells were installed to provide additional groundwater extraction and reinjection capacity, to enhance containment of high concentrations of uranium and technetium-99, and to improve aquifer response/remediation monitoring. The upgraded pump-and-treat system, referred to as the Phase I system, is expected to continue operating until an IRM record of decision is issued and implemented.

This report summarizes and evaluates treatment, hydrologic, and geochemistry data collected for the second reporting period of 200-UP-1 Phase I pump-and-treat operations (December 1995 through March 1996). Phase I operations for the first reporting period (September 1995 through November 1995) are summarized in *200-UP-1 Groundwater Pump-and-Treat Phase I Quarterly Report: September 1995 -November 1995* (BHI 1996b). Chapter 2 discusses treatment system performance; Chapter 3, the hydraulic and contaminant response of the aquifer; and Chapter 4 contains recommendations for modifications to the current well configuration and the treatment system.

# 2.0 TREATMENT SYSTEM PERFORMANCE

The following sections provide a summary of the treatment system operations and performance. Included are a historical summary of pump-and-treat activities at the 200-UP-1 Operable Unit, a description of the Phase I treatment system that is currently operating, and a discussion of process monitoring and production information for the first two reporting periods of Phase I operations (September 25 through March 31, 1995).

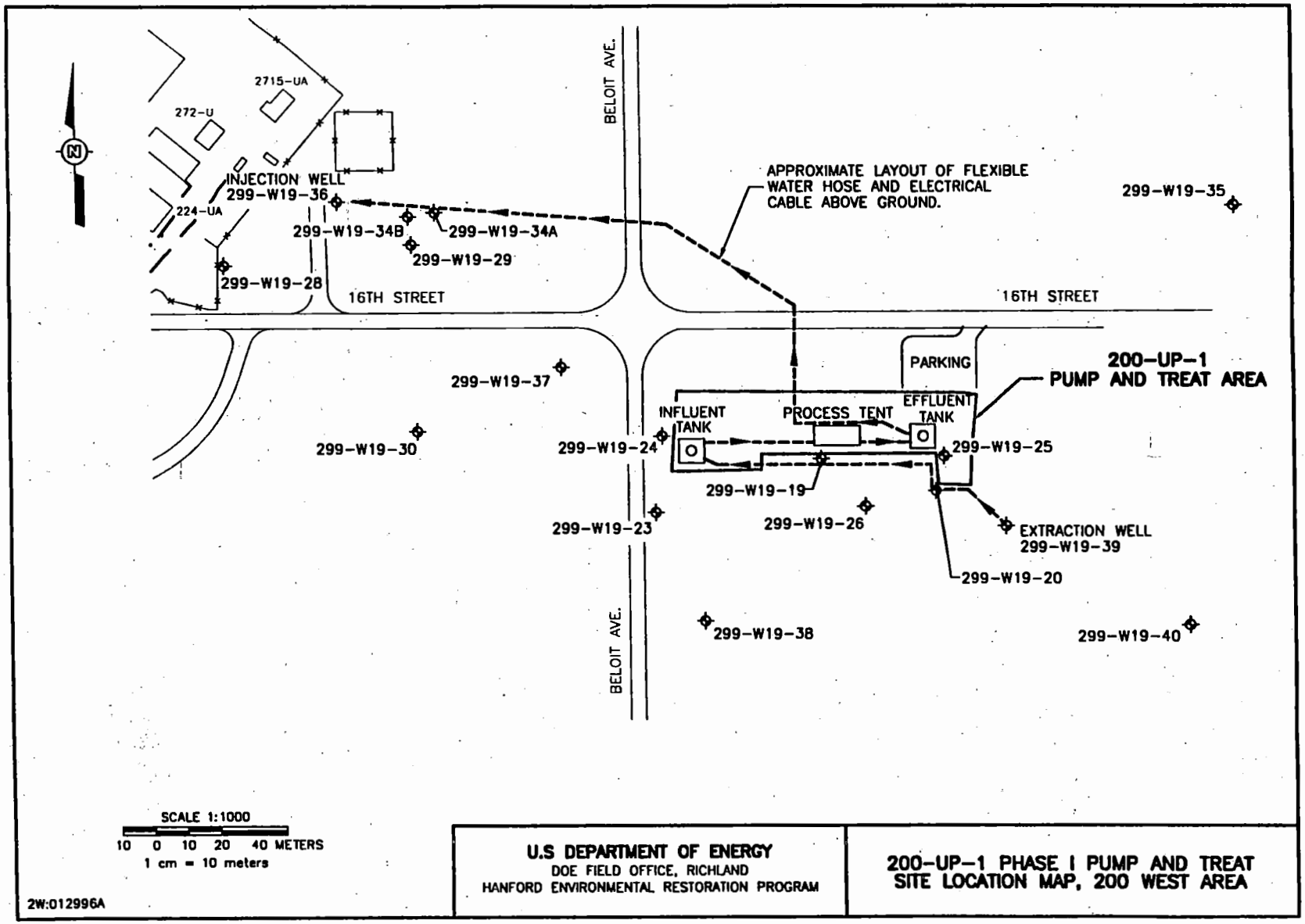


Figure 1. Site Plan for the 200-UP-1 Pump-and-Treat System.



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## 2.1 SUMMARY OF HISTORICAL OPERATIONS

Pilot-scale treatability test operations began in March 1994. Testing was conducted using extraction wells (299-W19-23 and 299-W19-24) located near the center of the uranium and technetium-99 plume. The water was continuously extracted at approximately 57 L/min, treated for uranium and technetium-99, and reinjected approximately 100 m downgradient in well 299-W19-25. Over 3.9 million liters of water was treated during the treatability test (Table 1). Average influent concentrations observed during the initial test were 1,254 µg/L for uranium (ranging from 500 to 2,080 µg/L) and 15,027 pCi/L for technetium-99 (ranging from 8,800 to 20,000 pCi/L).

Table 1. 200-UP-1 Pump-and-Treat Summary Data.

| Reporting Period | Liters Treated | Mass Technetium-99 Removed (g) | Mass Total Uranium Removed (g) | Mass Carbon Tetrachloride Removed (g) |
|---|---|---|---|---|
| 03/94 through 11/94[a] | 3,898,550 | 3.41 | 4,422 | Not Reported |
| 12/94 through 08/95 | 11,391,491 | 7.79 | 9,831 | 992 |
| 09/95 through 11/95 | 17,198,571 | 3.95 | 3,895 | 630 |
| 12/95 through 3/96 | 31,311,340 | 9.05 | 9,105 | 1,609 |
| Total | 63,799,952 | 24.20 | 27,253 | 3,231 |

[a]As reported in DOE-RL (1995b).

The average treated effluent concentrations were 0.125 µg/L uranium and 142 pCi/L technetium-99. An overall contaminant removal efficiency of greater than 99% was achieved for both uranium and technetium-99. Liquid-phase granular activated carbon (GAC) treatment was added to the pilot-scale treatment system in July 1994 to remove volatile organic compounds (VOCs) from the groundwater (VOC removal was not an objective of the test; therefore, VOC removal efficiencies were not quantified). Pilot-scale treatability test results are reported in DOE-RL (1995b) and BHI (1996a).

Treatability testing at 57 L/min continued through August 1995, at which time the pilot-scale system was upgraded to a nominal 190-L/min flow rate (referred to as Phase I upgrades). From December 1994 through August 1995, over 11 million liters of groundwater were treated for uranium, technetium-99, and carbon tetrachloride. Influent concentrations for this period ranged from approximately 700 to 1,000 µg/L for uranium, 9,000 to 12,000 pCi/L for technetium-99, and from 80 to 100 µg/L for carbon tetrachloride.

Pump-and-treat operations were suspended from August 17 to September 5, 1995, to accommodate Phase I construction activities and a large-scale aquifer test. Phase I upgrades included modifications to the treatment system to allow semi-automated 24-h/day operations at a

nominal 190-L/min flow rate. Upgrades also included replacement of the existing extraction and injection wells with higher capacity wells. Wells 299-W19-39 and 299-W19-36 were constructed during the summer of 1995 and brought on-line to provide a 190-L/min capacity for groundwater extraction and injection, respectively. The extraction well was installed on the expected downgradient edge of the target plume. The injection well was located on the expected upgradient edge of the target plume. An aquifer test was performed from September 6 through September 8, 1995, as discussed in BHI (1996b). Pump-and-treat operations resumed September 25, 1995, at the 190-L/min flow rate (Phase I operations).

## 2.2 PHASE I TREATMENT DESCRIPTION

An ion-exchange process is used to remove uranium and technetium-99 ions from groundwater by adsorption on a solid medium (i.e., resin). Extracted groundwater is filtered and pumped through a series of two or more granular resin beds. As groundwater is passed through the resin beds, ionic species in the groundwater exchange with ions on the resin and are adsorbed onto the surface of the resin. Dowex 21K (a registered trademark of Dow Chemical Company, Midland, Michigan) resin is used because of its demonstrated ability to selectively adsorb uranium and technetium-99 (DOE-RL 1995b).

For the Phase I treatment system, two ion-exchange columns (vessels containing resin beds) in series are used at any one time: a lead column for primary removal of contaminants and a polish column (Figure 2). When the lead column approaches its adsorptive capacity, breakthrough occurs (technetium-99 has been the controlling contaminant in establishing breakthrough). At that point, the lead column is taken off-line, the polish column becomes the lead column, and a new polish column is brought on-line. The off-line column is dewatered and spent resin removed; it is then refilled with fresh resin and placed in reserve pending the next breakthrough event.

Following ion-exchange treatment, liquid-phase GAC adsorption is used for removal of carbon tetrachloride (Figure 2). GAC adsorption is a unit process that has been demonstrated to effectively remove VOCs (e.g., carbon tetrachloride) from groundwater (DOE-RL 1995c). The GAC adsorption process transfers carbon tetrachloride from the groundwater onto the surface of the GAC via physical and electrochemical attraction.

The Phase I treatment system utilizes two GAC treatment skids in series, a lead skid for primary removal of contaminants and a polish skid (Figure 2). Each skid consists of two columns operated in parallel. When breakthrough of the lead skid occurs, the polish skid will be plumbed as the lead position while the spent GAC is replaced. After the GAC is replaced, that skid will be brought on-line as the polish skid.

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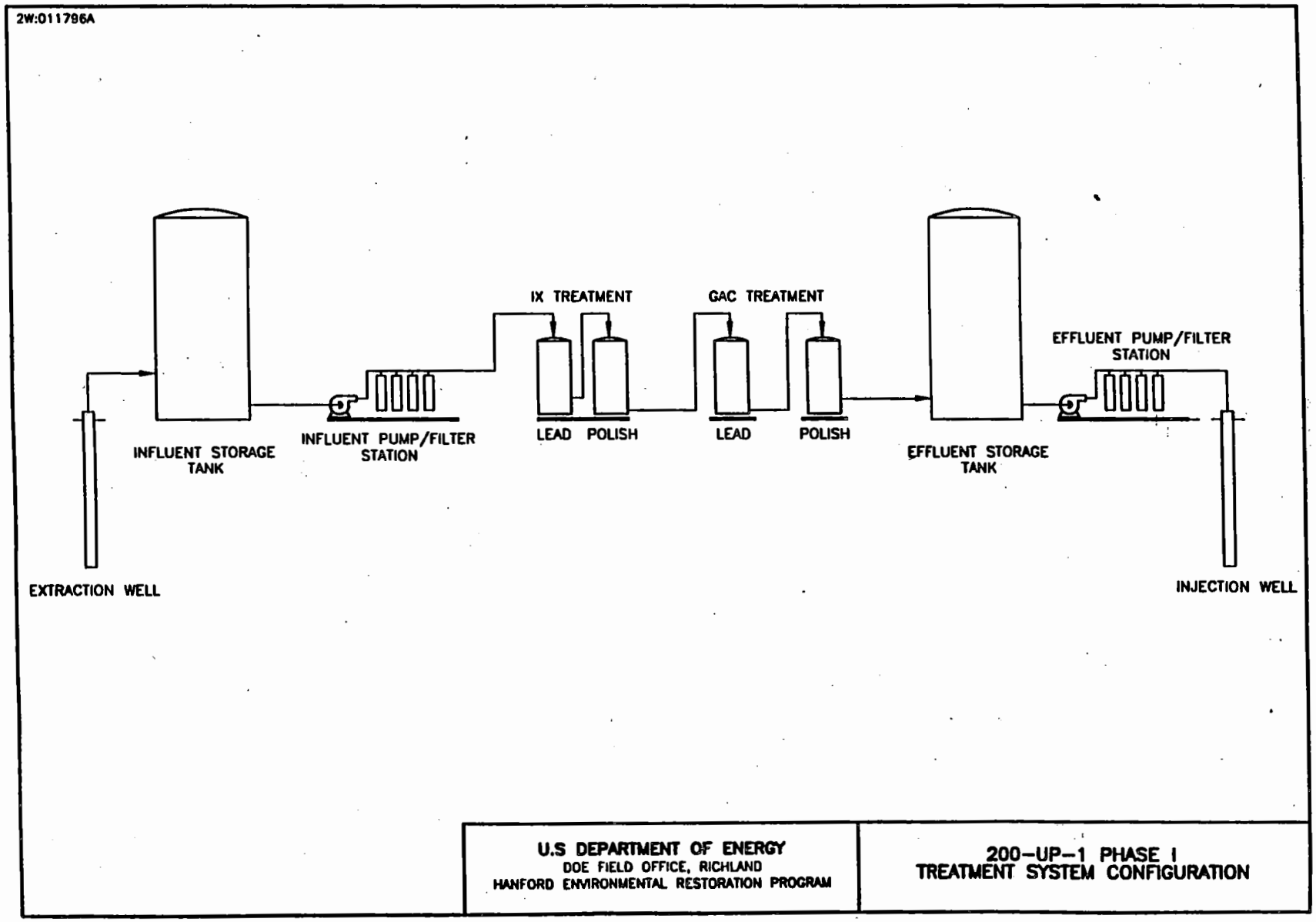


Figure 2. 200-UP-1 Phase I Treatment System Configuration.

## 2.3 PHASE I TREATMENT MONITORING

Process monitoring is performed to assess contaminant loading on the ion-exchange and GAC columns using field-screening analytical techniques. Breakthrough in the lead ion-exchange column is monitored on a biweekly basis by sampling both the column influent and effluent and comparing the results. Breakthrough is established when the effluent concentrations reach approximately 90% of the influent concentrations. The GAC treatment system is sampled on a weekly basis. This sampling effort includes an influent, post-lead GAC, and post-polish GAC sample. Breakthrough is established when the effluent carbon tetrachloride concentration from the lead GAC skid reaches approximately 50% of the influent concentrations.

Overall treatment efficiency is determined through monthly sampling of the treatment system influent (upstream of the influent filters) and effluent streams (downstream of the polish GAC column) using U.S. Environmental Protection Agency (EPA 1989) analytical protocols. The removal efficiencies are then determined for each of the targeted contaminants (uranium, technetium-99, and carbon tetrachloride).

Sampling is also performed on the spent ion-exchange resin and other process waste streams for waste-designation purposes. The ion-exchange resin samples are taken from the top and bottom of the ion-exchange column resin bed. The ion-exchange resin samples are analyzed for the following:

- Inductively coupled plasma/atomic adsorption metals
- Volatile organics analyses
- Semivolatile organics analyses
- Anions
- Nitrate/nitrites
- Technetium-99
- Total uranium
- Gross alpha
- Gross beta
- Gamma spectrometry.

The quantity of groundwater treated is tracked using a flowmeter that monitors the flow rate from the extraction well. This flowmeter is equipped with a flow totalizer that provides the cumulative volume of water extracted.

## 2.4 PHASE I TREATMENT OPERATIONS

The groundwater pump-and-treat system was operated on a near-continuous basis during this reporting period (December 1, 1995 through March 31, 1996). System availability was greater than 98% (hours operating/total hours) for the period, exceeding the goal of 80% system availability. System availability since initiation of Phase I treatment is greater than 96%. The volume of groundwater treated and the mass of contaminants removed are summarized in

Table 1. Table 2 presents the process and efficiency monitoring data for the reporting period. The 222-S Laboratory and field-screening data were used to monitor for breakthrough in the lead ion-exchange column. Offsite laboratory data were used to monitor treatment system efficiency.

A total of 31.3 million liters of groundwater was treated during this reporting period. Technetium-99 influent concentrations decreased over the reporting period from approximately 5,600 pCi/L to 3,900 pCi/L. The technetium-99 concentrations are up from the 1,750 pCi/L level recorded when Phase I activities were initiated (Figure 3). Influent uranium concentrations have remained fairly stable, ranging from 276 to 314 µg/L throughout the period, which is up slightly from the 257 µg/L noted at the initiation of Phase I pumping (Figure 4). Carbon tetrachloride levels have nearly doubled over the reporting period from 46 µg/L to 88 µg/L (Figure 5).

Breakthrough in the lead ion-exchange column occurred eight times, with a total of 7.9 $m^3$ of resin consumed. This brings the total volume of resin consumed since initiation of Phase I activities to approximately 11 $m^3$. Influent and effluent filters required replacement approximately every 2 weeks. Routine maintenance activities including instrument calibrations and treatment system interlock checks were also performed.

Samples of the spent resin were taken during removal of the spent resin from the ion-exchange column after breakthrough occurred. The sampling results are summarized in Table 3. These sampling results will be used in the designation of the resin for disposal. The results indicated the loading of contaminants including uranium and technetium-99 on the ion-exchange resin is reasonably consistent for each column sampled. Paint filter tests (which are used to indicate excessive moisture) may also be required to ensure that the drummed resin meets the acceptance requirements of the disposal facility.

Approximately one hundred 55-gal drums of spent resin are stored at a nearby centralized waste container storage area. This drum inventory accounts for all spent resin generated since initiation of the treatability test in March 1994 through this reporting period.

The treatment system achieved an average contaminant removal efficiency of greater than 90% for technetium-99 (Figure 6). This is down from approximately 99% for the last reporting period. The decrease is due to the loading of technetium-99 on the polish column once breakthrough in the lead column has been initiated. This loading results in a decrease in the noted efficiency of this column when it is moved into the lead position. Eventually, enough technetium-99 is loaded onto the polish column such that the effluent concentrations begin to rise. Average effluent concentrations for technetium-99 ranged from approximately 3 to 800 pCi/L. To mitigate this effect, an early changeout of the lead column was performed (in comparison with normal operations). This reduced the concentration of technetium-99 in the polish column, resulting in a better quality effluent as seen in the later part of the reporting period. This premature loading of the polish column is now monitored closely, and early changeouts of the lead column are scheduled as necessary to maintain a low concentration of technetium-99 in the polish column.

Table 2. 200-UP-1 Treatment Monitoring Results for the Period September 25 Through March 31, 1996. (sheet 1 of 2)

| Date | Cumulative Volume Treated (L) | Field Tc-99 Pre-Treat (pCi/L) | Field Tc-99 Post-Lead (pCi/L) | Field Total Uranium Pre-Treat (ug/L) | Field Total Uranium Post-Lead (ug/L) | Field CCL4 Influent (ug/L) | Field CCL4 Effluent (ug/L) | Off-Site Tc-99 Influent (pCi/L) | Off-Site Tc-99 Effluent (pCi/L) | Off-Site Total Uranium Influent (ug/L) | Off-Site Total Uranium Effluent (ug/L) | Off-Site CCL4 Influent (ug/L) | Off-Site CCL4 Effluent (ug/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9/25/95 | 853,536 | 1750 | 70.5 | 257 | 0.344 | | | 1970 | 3.21 | 265 | 0.0403 | | |
| 9/28/95 | 1,681,713 | 3200 | *N/A* | 296 | 0.311 | | | | | | | | |
| 10/2/95 | 2,672,255 | 2500 | 2550 | 258 | 0.383 | | | 3100 | 34.5 | 264 | 0.389 | | |
| 10/11/95 | 4,216,115 | 3420 | 3170 | 256 | 2.47 | | | | | | | | |
| 10/12/95 | 4,466,784 | 3390 | 3260 | 238 | 3.61 | 56 | 1.0 (u) | | | | | | |
| 10/17/95 | 5,935,209 | 3830 | 2390 | 200 | 3.6 | | | | | | | | |
| 10/19/95 | 6,448,838 | 3560 | 1230 | 247 | 2.68 | 49 | 0.94 (u) | | | | | | |
| 10/24/95 | 7,796,430 | 3710 | 546 | 234 | 3.23 | | | | | | | | |
| 10/27/95 | 8,524,619 | 3570 | 2820 | 204 | 2.3 | 32 | 2 (u) | | | | | | |
| 11/1/95 | 9,744,831 | 3890 | 3250 | 241 | 2.79 | | | | | | | | |
| 11/2/95 | 10,008,669 | 3650 | 3230 | 231 | 2.6 | | | | | | | | |
| 11/7/95 | 11,090,523 | 4210 | 2880 | 243 | 3.98 | | | | | | | | |
| 11/9/95 | 11,659,738 | 4610 | 2790 | 246 | 2.16 | 31 | 2 (u) | | | | | | |
| 11/14/95 | 13,033,693 | 4820 | 3460 | 254 | 1.79 | | | | | | | | |
| 11/17/95 | 13,858,596 | 5410 | 3730 | 256 | 1.43 | 30 | 2 (u) | | | | | | |
| 11/28/95 | 16,675,484 | 5210 | 3740 | 121 | 16.4 | | | | | | | | |
| 11/30/95 | 17,198,571 | 5600 | 3940 | 160 | 17.6 | 46 | 2 (u) | | | | | | |
| 12/5/95 | 18,603,404 | 5740 | 4770 | 276 | 0.761 | | | | | | | | |
| 12/7/95 | 19,141,252 | 5690 | 5230 | 272 | 0.955 | 42 | 2.1 | 5320 | 5510 * | 249 | 0.224 * | 25 | 37 * |
| 12/14/95 | 20,955,592 | 6140 | 4150 | 185 | 1.33 | | | | | | | | |
| 12/19/95 | 22,253,431 | 5840 | 5990 | 179 | 1.28 | | | | | | | | |
| 12/21/95 | 22,787,116 | 4670 | 4500 | 178 | 1.34 | 53 | 2.9 | | | | | | |
| 12/27/95 | 24,385,143 | 5980 | 5280 | 199 | 0.38 | | | | | | | | |
| 1/2/96 | 25,893,654 | 5740 | 3870 | 292 | 0.981 | | | | | | | | |
| 1/4/96 | 26,404,743 | 6140 | 6470 | 277 | 0.794 | 57 | 3.2 | | | | | | |
| 1/11/96 | 28,230,097 | 5350 | 4980 | 361 | 0.53 | | | | | | | | |
| 1/16/96 | 29,338,988 | 5460 | 2730 | 385 | 0.812 | | | | | | | | |
| 1/18/96 | 29,851,629 | 5400 | 2990 | 361 | 1.05 | 48 | 2.2 | | | | | | |
| 1/23/96 | 31,158,665 | 5480 | 3660 | 340 | 0 | | | | | | | | |
| 1/25/96 | 31,673,614 | 5250 | 4440 | 340 | 0.5 (u) | | | | | | | | |
| 1/30/96 | 32,952,906 | 4280 | 1180 | 330 | 0.5 (u) | | | | | | | | |

(u) Value reported is below the method detection limit

* Data suspect, sample was apparently taken from the post-lead position rather than from the effluent position.

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Table 2. 200-UP-1 Treatment Monitoring Results for the Period September 25 Through March 31, 1996. (sheet 2 of 2)

| Date | Cumulative Volume Treated (L) | Field Tc-99 Pre-Treat (pCi/L) | Field Tc-99 Post-Lead (pCi/L) | Field Total Uranium Pre-Treat (ug/L) | Field Total Uranium Post-Lead (ug/L) | Field CCL4 Influent (ug/L) | Field CCL4 Effluent (ug/L) | Off-Site Tc-99 Influent (pCi/L) | Off-Site Tc-99 Effluent (pCi/L) | Off-Site Total Uranium Influent (ug/L) | Off-Site Total Uranium Effluent (ug/L) | Off-Site CCL4 Influent (ug/L) | Off-Site CCL4 Effluent (ug/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2/1/96 | 33,468,158 | 4670 | 2200 | 330 | 0.5 (u) | 51 | 2.9 | 4190 | 809 | 285 | 0.143 | 55 | 2 (u) |
| 2/8/96 | 35,253,884 | 3700 | 4870 | 330 | 0.5 (u) | | | | | | | | |
| 2/13/96 | 36,467,809 | 4520 | 476 | 330 | 0.5 (u) | | | | | | | | |
| 2/15/96 | 36,940,328 | 4730 | 732 | 330 | 0.5 (u) | 47 | 3.1 | | | | | | |
| 2/20/96 | 38,217,576 | 4420 | 1440 | 330 | 0.5 (u) | | | | | | | | |
| 2/22/96 | 38,707,128 | 4130 | 84.9 | 324 | 0.57 | | | | | | | | |
| 2/27/96 | 39,973,892 | 4470 | 240 | 349 | 0.807 | | | | | | | | |
| 2/29/96 | 40,511,400 | 4500 | 380 | 322 | 1.68 | | | | | | | | |
| 3/5/96 | 41,801,479 | 4460 | 538 | 330 | 0.5 (u) | | | | | | | | |
| 3/7/96 | 42,297,277 | 4260 | 751 | 310 | 0.5 (u) | 70 | 5.9 | 4140 | 718 | 291 | 0.078 | 60 | 4 (u) |
| 3/12/96 | 43,599,165 | 4330 | 144 | 323 | 0.5 (u) | | | | | | | | |
| 3/14/96 | 44,121,533 | 4830 | 221 | 322 | 0.5 (u) | 76 | 8.1 | | | | | | |
| 3/19/96 | 45,421,983 | 4270 | 425 | 320 | 0.5 (u) | | | | | | | | |
| 3/21/96 | 45,903,397 | 4200 | 118 | 310 | 0.5 (u) | | | | | | | | |
| 3/26/96 | 47,185,831 | 3340 | 93.7 | 320 | 0.5 (u) | | | | | | | | |
| 3/28/96 | 47,713,536 | 3890 | 233 | 310 | 1.1 | | | | | | | | |

(u) Value reported is below the method detection limit

* Data suspect, sample was apparently taken from the post-lead position rather than from the effluent position.

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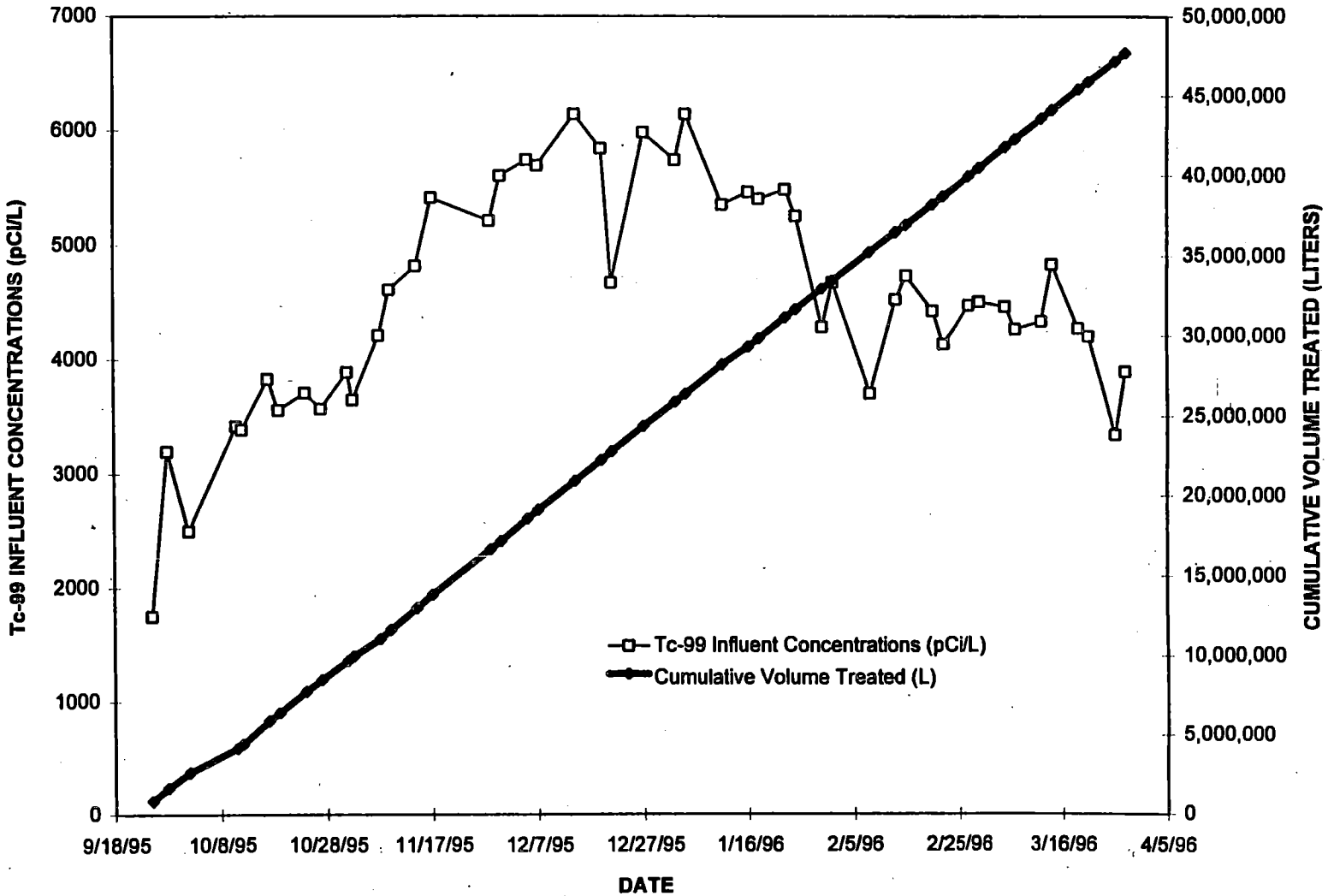


Figure 3. 200-UP-1 Influent Technetium-99 Concentrations and Volume of Groundwater Treated Versus Time.

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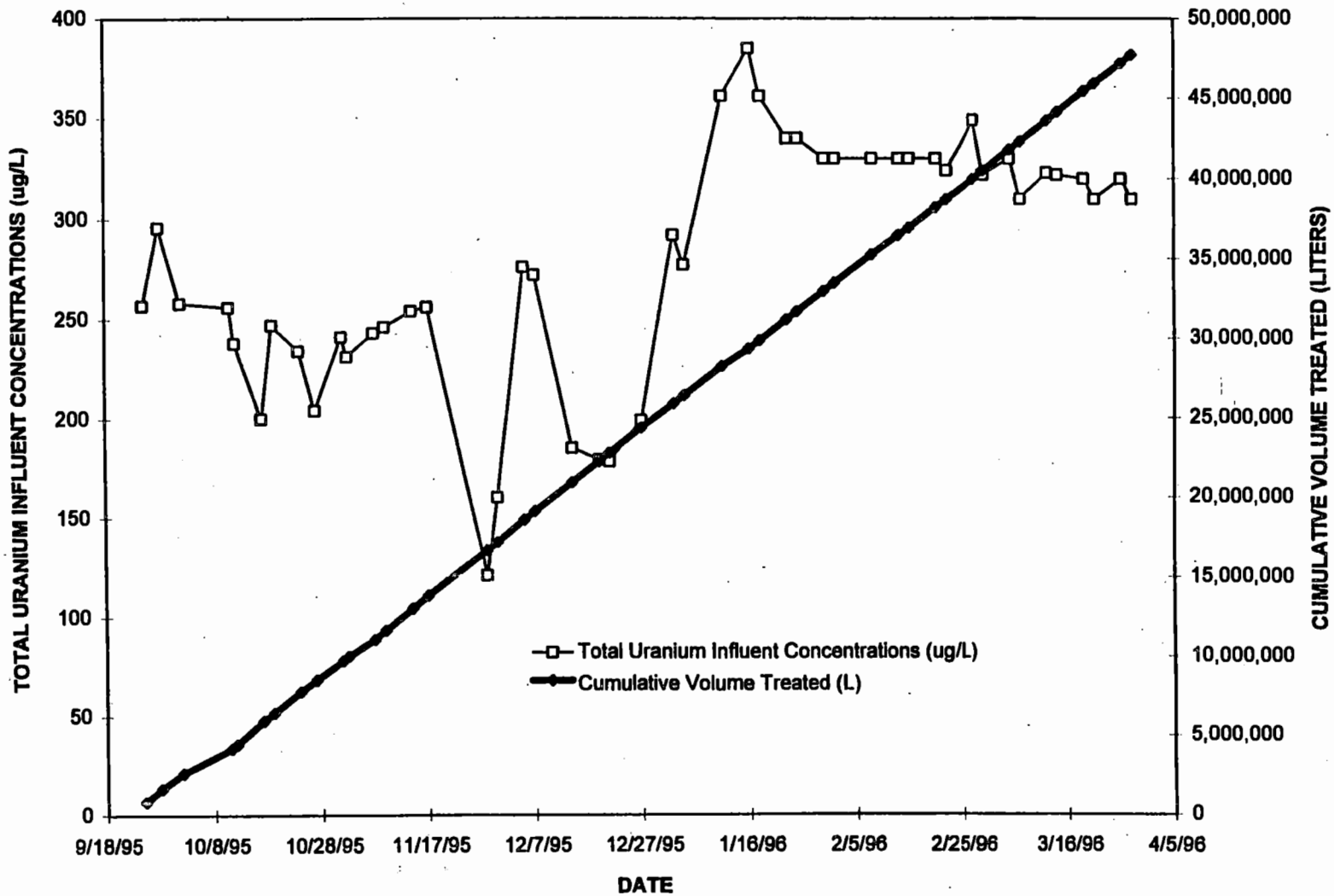


Figure 4. 200-UP-1 Influent Uranium Concentrations and Volume of Groundwater Treated Versus Time.

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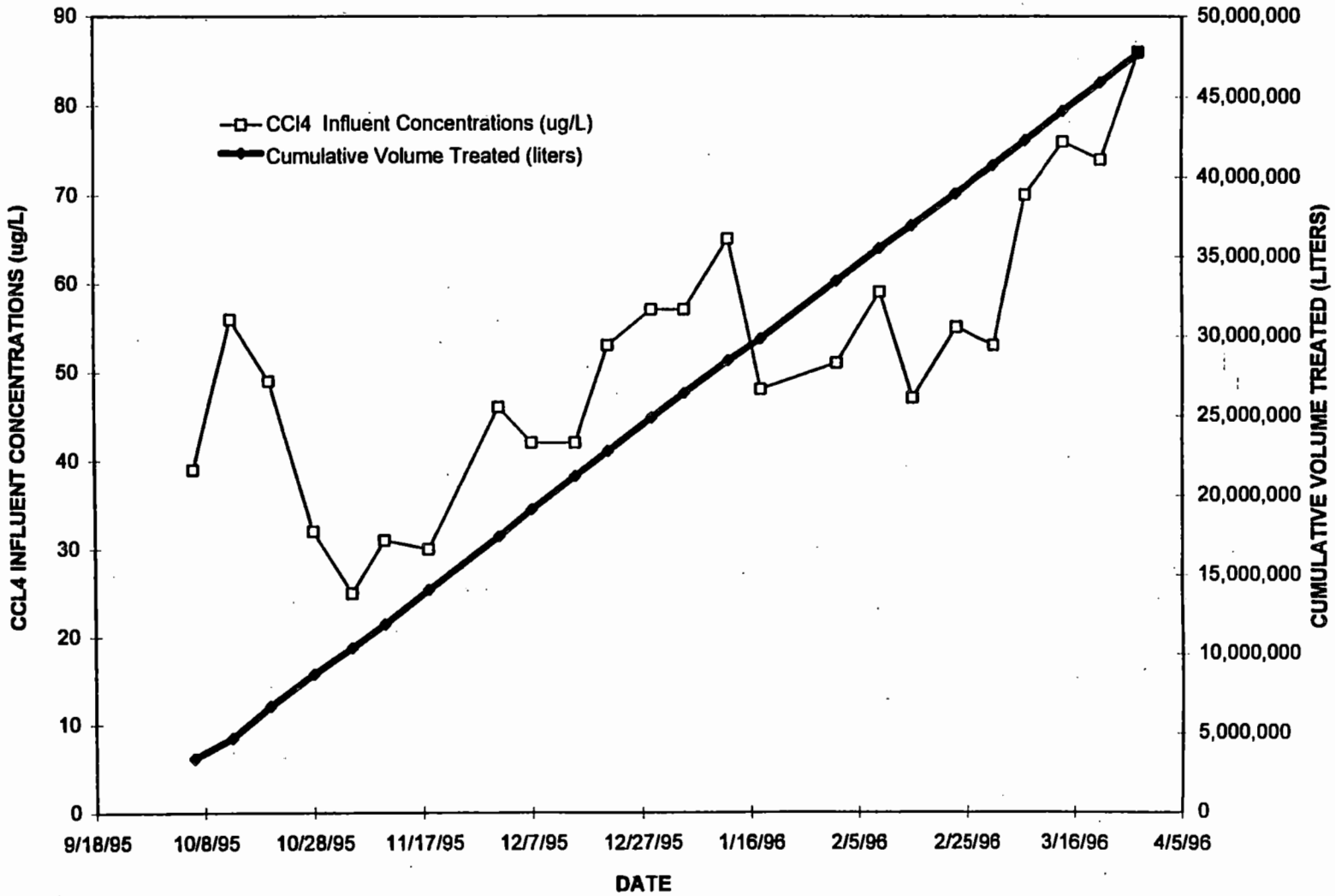


Figure 5. 200-UP-1 Influent Carbon Tetrachloride Concentrations and Volume of Groundwater Treated Versus Time.

Table 3. 200-UP-1 Spent Resin Sampling Results. (sheet 1 of 2)

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Date Sampled | 11/4/94 | 2/14/95 | 2/15/95 | 3/21/95 | 3/21/95 | 5/15/95 | 5/15/95 | 7/11/95 | 7/11/95 | 8/21/95 | 8/22/95 | 10/5/95 | 10/5/95 |
| | Location | Baseline | Top | Bottom | Top | Bottom | Top | Bottom | Top | Bottom | Top | Bottom | Top | Bottom |
| | HEIS # | BOD5J6 | BODVY8 | BODVY9 | BOF790 | BOF791 | BOFKH4 | BOFKH5 | BOG8T1 | BOG8T2 | BOGHP2 | BOGHP3 | BOGQG9 | BOGQH0 |
| Chloroform | (ug/kg) | | | 17 | 13 | 15 | | | | 40 | | 35 | 10 | |
| 2-Butanone | (ug/kg) | 62 | | | | | | | | | | | | |
| Carbon Tetrachloride | (ug/kg) | | 86 | 230 | 270 | 340 | 330 | 450 | 310 | 1100 | 1100 | 960 | 210 | 280 |
| Trichloroethene | (ug/kg) | | | 11 | | 11 | | | | 33 | | 27 | | |
| Tetrachloroethene | (ug/kg) | | | | | | | | 30 | | | | | |
| Aluminum | (mg/kg) | | | | | | | | | | | | | |
| Chromium | (mg/kg) | | 14.4 | 13.5 | 15.9 | 11.7 | 10 | 7.6 | 11.6 | 8.2 | 22.8 | 14.3 | 15 | 12.7 |
| Arsenic | (mg/kg) | | | | 0.68 | | | | | | | | | |
| Copper | (mg/kg) | | 2.6 | 2.4 | 6.7 | | 9.2 | 4.3 | 2.8 | | | | | |
| Iron | (mg/kg) | | 198 | 245 | 425 | 51.7 | 137 | 30.9 | 371 | 25.9 | 275 | 36.3 | 538 | 28.2 |
| Lead | (mg/kg) | | 0.75 | 1.1 | 2.7 | 0.34 | 0.77 | | 0.74 | | 1 | | 0.69 | |
| Selenium | (mg/kg) | | 1.9 | 0.51 | 2.2 | 2.5 | 2.7 | 2.5 | 2.2 | 2.8 | 2.2 | 2.8 | 2.4 | 2.3 |
| Vanadium | (mg/kg) | | | | 8.1 | | | | 5.2 | | 5.9 | | 5.3 | |
| Zinc | (mg/kg) | 7.3 | 52.6 | 62.6 | 120 | 133 | 6.5 | 2.4 | 38.2 | | 20.6 | 2.6 | 8 | |
| Chloride | (ug/g) | 869 | 4.16 | 3.76 | 5.53 | 3.12 | 4.03 | | 7.88 | 2.54 | 4.59 | | 4.98 | 2.69 |
| Nitrate | (ug/g) | | 55 | 39.8 | 69.6 | 34.2 | 39.1 | 14.5 | 76 | 19.4 | 39.8 | 10.9 | 30.2 | 13.7 |
| Nitrite | (ug/g) | | | | | | | | | | | | | |
| Nitrate/Nitrite | (ug/g) | | 2000 | 2970 | 3180 | 2350 | 3090 | 3710 | 1990 | 3100 | 2120 | 3020 | 3210 | 3520 |
| AM-241 | (pCi/g) | | | | 16 | | | | | | | | | |
| CO-60 | (pCi/g) | | 1.18 | 0.655 | 3.61 | | 1.53 | | 4.74 | | 2.5 | | 0.876 | |
| EU-155 | (pCi/g) | | 11.7 | 11.9 | 15 | 5.87 | 13.6 | | 18.5 | 2.08 | 16.8 | | 10.2 | |
| K-40 | (pCi/g) | | | | | | | 0.762 | | 3.92 | | | | |
| U-235 | (pCi/g) | | 208 | 202 | 307 | 96.1 | 236 | 7.22 | 340 | 36.8 | 298 | 3.5 | 175 | 2.73 |
| U-238 | (pCi/g) | | 4530 | 4510 | 6070 | 1800 | 4780 | 173 | 7120 | 786 | 5860 | 72 | 3690 | 51.2 |
| Alpha | (pCi/g) | | 2140 | 2840 | 4470 | 1570 | 4410 | 144 | 7320 | 723 | 1770 | 36.5 | 701 | 4.93 |
| Beta | (pCi/g) | | 20500 | 25100 | 28300 | 20900 | 28100 | 21600 | 41600 | 35000 | 24400 | 17800 | 15700 | 3120 |
| Tc-99 | (pCi/g) | | 46600 | 48800 | 53600 | 61700 | 47700 | 45900 | 40900 | 42900 | 108000 | 81100 | 47800 | 73800 |
| Tot-U | (ug/g) | | 11500 | 11400 | 20400 | 5480 | 15300 | 245 | 23100 | 3230 | 16900 | 238 | 12600 | 162 |

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Table 3. 200-UP-1 Spent Resin Sampling Results. (sheet 2 of 2)

| | Date Sampled | 10/25/95 | 10/25/95 | 11/16/95 | 11/16/95 | 12/5/95 | 12/5/95 | 12/27/95 | 12/27/95 | 1/11/96 | 1/11/96 | 1/24/96 | 1/24/96 | 2/1/96 | 2/1/96 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Location | Top | Bottom | Top | Bottom | Top | Bottom | Top | Bottom | Top | Bottom | Top | Bottom | Top | Bottom |
| | HEIS # | BOGRL4 | BOGRL5 | BOGRL6 | BOGSK4 | BOGSK5 | BOGSK6 | BOGSK7 | BOGSK8 | BOGSK9 | BOGSL0 | BOH691 | BOH692 | BOH693 | BOH694 |
| Chloroform | (ug/kg) | 17 | 26 | 26 | 31 | 12 | 14 | 14 | 10 | | 37 | 22 | 26 | | 19 |
| 2-Butanone | (ug/kg) | | | | | | | | | | | | | | |
| Carbon Tetrachloride | (ug/kg) | 200 | 320 | 310 | 340 | 130 | 150 | 210 | 120 | 130 | 510e | 330 | 390 | 130 | 300 |
| Trichloroethene | (ug/kg) | | 12 | 15 | 15 | 7 | 9 | 13 | | | 30 | 22 | 24 | 14 | 19 |
| Tetrachloroethene | (ug/kg) | | | | | | | | | | | | | | |
| Aluminum | (mg/kg) | | | 18.9 | | | | 38.8 | | 56.7 | | 38.9 | | 42.4 | |
| Chromium | (mg/kg) | 9.1 | 7.8 | 12.9 | 3.8 | 13.5 | 8.1 | 15.7 | 11.1 | 18.6 | 12.3 | 21.2 | 14.7 | 22.7 | 15.8 |
| Arsenic | (mg/kg) | | | 1.3 | | | | | | | | | | | |
| Copper | (mg/kg) | | | 3.1 | | | | 5.2 | | 5.2 | | 5.2 | | 9.3 | |
| Iron | (mg/kg) | 171 | 213 | 427 | 43.1 | 160 | 33.9 | 237 | 19.1 | 155 | 13.5 | 154 | 13.9 | 280 | 44.3 |
| Lead | (mg/kg) | | | 0.32 | | | | | | 0.32 | | | | | |
| Selenium | (mg/kg) | 2.6 | 2.5 | 2.4 | 2.7 | 2.4 | 3.2 | 1.9 | 3 | 2.7 | 2.8 | 2.6 | 3.3 | 3.1 | 3.3 |
| Vanadium | (mg/kg) | 5.8 | 6.1 | 11.7 | 5.4 | 7.8 | 5.2 | 7.5 | 5.8 | 7.7 | 5.9 | 7.7 | 7.5 | 10.3 | 9.1 |
| Zinc | (mg/kg) | 2.8 | 4.2 | 2.9 | | 2.1 | | 9.3 | | | | | | 7.6 | |
| Chloride | (ug/g) | 3.56 | 3.35 | 4.91 | 3.16 | 3.69 | 2.62 | 4.88 | 2.93 | 4.62 | | 6.58 | 2.64 | 4.54 | |
| Nitrate | (ug/g) | 20.9 | 19.6 | 29.9 | 15.6 | 21.8 | 13.1 | 30.8 | 14.4 | 28.4 | 10.7 | 18.3 | 12.1 | 24.6 | 11.3 |
| Nitrite | (ug/g) | | | | | | | | | | | | | | |
| Nitrate/Nitrite | (ug/g) | 3040 | 3190 | 2300 | 2250 | 1830 | 2270 | 1900 | 2480 | 1820 | 2260 | 1160 | 2330 | 1550 | 2290 |
| AM-241 | (pCi/g) | 20.8 | | | | N/A | | | | | | 71.4 | | 28.3 | |
| CO-60 | (pCi/g) | 0.759 | 0.0681 | 2.64 | | N/A | | 10.50 | 0.07 | 4.95 | | 4.99 | | 6.78 | 0.127 |
| EU-155 | (pCi/g) | 5.76 | 3.02 | 7.16 | | N/A | | 12.90 | 0.28 | 15.4 | | 20.6 | | 22.2 | 0.423 |
| K-40 | (pCi/g) | | 0.511 | | | N/A | | 2.25 | | | | | | | |
| U-235 | (pCi/g) | 96.3 | 51.4 | 146 | 8.86 | N/A | 6.66 | 232.00 | 4.81 | 246 | 281 | 343 | 1.46 | 352 | 10.4 |
| U-238 | (pCi/g) | 1570 | 861 | 2600 | 64.5 | N/A | 122 | 4,480.00 | 93.40 | 4050 | 51 | 5690 | 27.9 | 4840 | 150 |
| Alpha | (pCi/g) | 503 | 365 | 474 | 48.7 | N/A | 19.8 | 3,080 | 112 | 943 | 8.31 | 5550 | 32.4 | 5720 | 69.6 |
| Beta | (pCi/g) | 3610 | 2940 | 4690 | 1860 | N/A | 3560 | 119,000 | 103,000 | 8130 | 3040 | 22900 | 15600 | 22600 | 3080 |
| Tc-99 | (pCi/g) | 38900 | 25800 | 21600 | 30000 | N/A | 24900 | 59,600 | 50,700 | 72600 | 66800 | 58700 | 48600 | 60400 | 39700 |
| Tot-U | (ug/g) | 5890 | 3000 | 8630 | 170 | N/A | 405 | 14,700 | 3,420 | 15100 | 142 | 20700 | 91.3 | 20200 | 560 |

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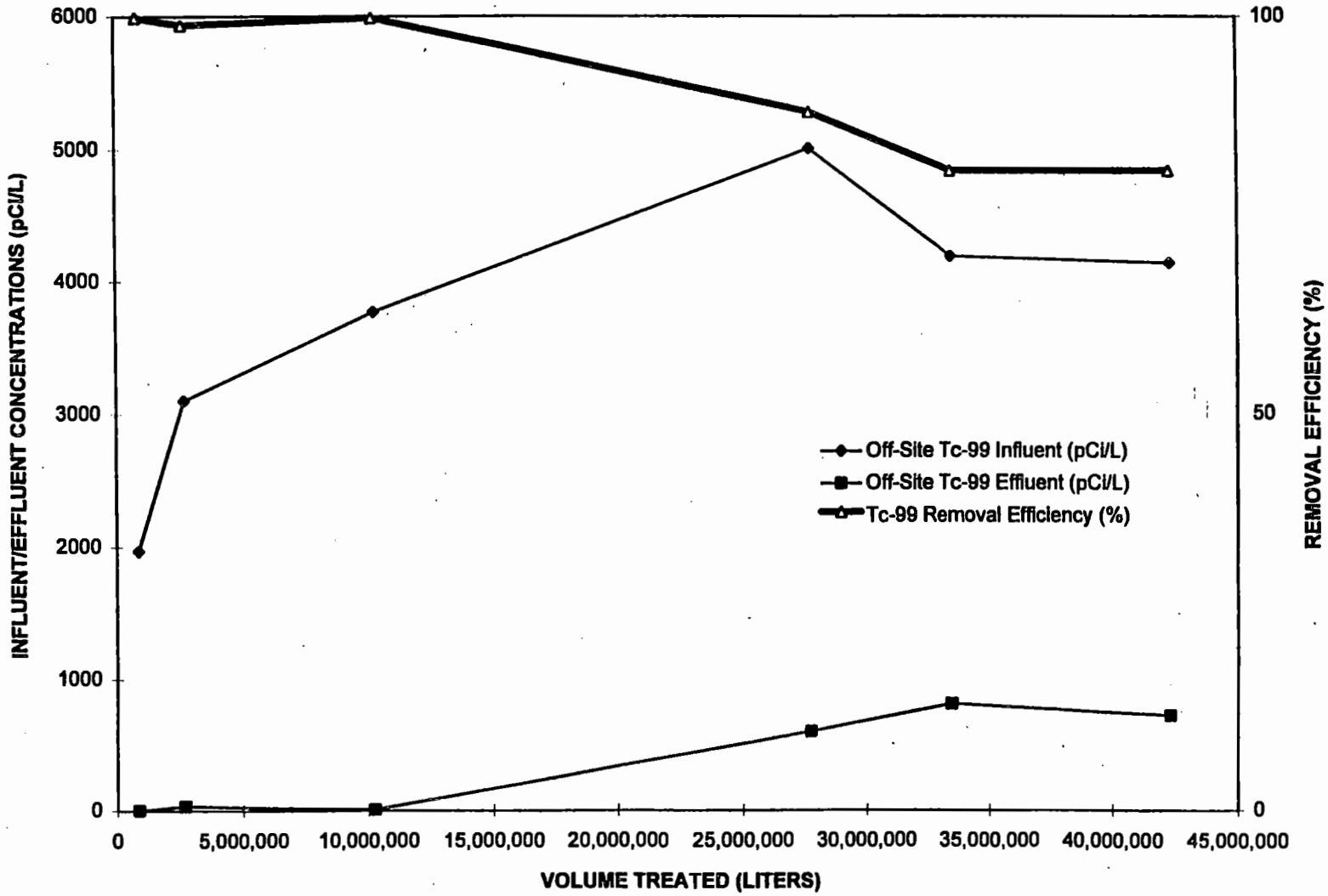


Figure 6. 200-UP-1 Treatment System Technetium-99 Removal Efficiency.

Average uranium effluent concentrations ranged from approximately 0.14 to 0.55 μg/L, respectively, achieving a removal efficiency of greater than 99% (Figure 7). Premature loading of uranium on the polish column is not a problem as with the technetium-99 due to the resin's preferential loading of uranium.

Carbon tetrachloride effluent concentrations ranged from below the method detection limit (MDL) of 2 μg/L to 8 μg/L. The increase in the effluent concentration was a result of breakthrough occurring in the lead GAC skid. Replacement of the spent GAC in the lead skid is scheduled to occur early in the next reporting period. The average removal efficiency for carbon tetrachloride ranged from 86% to 94% based on the MDL of 2 μg/L (Figure 8).

Since initiation of the pump and treat in March 1994, more than 63.8 million liters of groundwater have been treated, resulting in a removal of 24.2 g of technetium-99, 27,253 g of uranium, and 3,231 g of carbon tetrachloride. More than 9 g of technetium-99, 4,091 g of uranium, and 676 g of carbon tetrachloride were removed during the reporting period.

The onsite uranium field-screening results (performed using kinetic phosphorescence analysis) were generally within 10% to 15% of the offsite laboratory results for the influent samples. The results of the volatile organic trip blank samples associated with the offsite efficiency samples indicated no detectable levels of volatile organics.

## 3.0 AQUIFER RESPONSE

The following sections assess the response of the aquifer to the pump-and-treat operations for the second quarter of Phase I operations (December 1995 through March 1996). A summary of baseline hydrologic and target plume characteristics is presented, followed by a discussion of hydraulic and contaminant changes observed during the reporting period.

### 3.1 BASELINE STATUS

Pump-and-treat operations were suspended in August 1995 to allow equilibration of the water table before the start of a full-scale aquifer test (190 L/min) and initiation of Phase I operations. Figure 9 is a baseline water-table map constructed during this time interval. Groundwater flow in the aquifer is from the northwest to the southeast across the site. As discussed later in Section 3.2, water levels have been impacted by the ongoing pump-and-treat operations (extraction and injection of groundwater), regional water levels, and barometric pressure changes.

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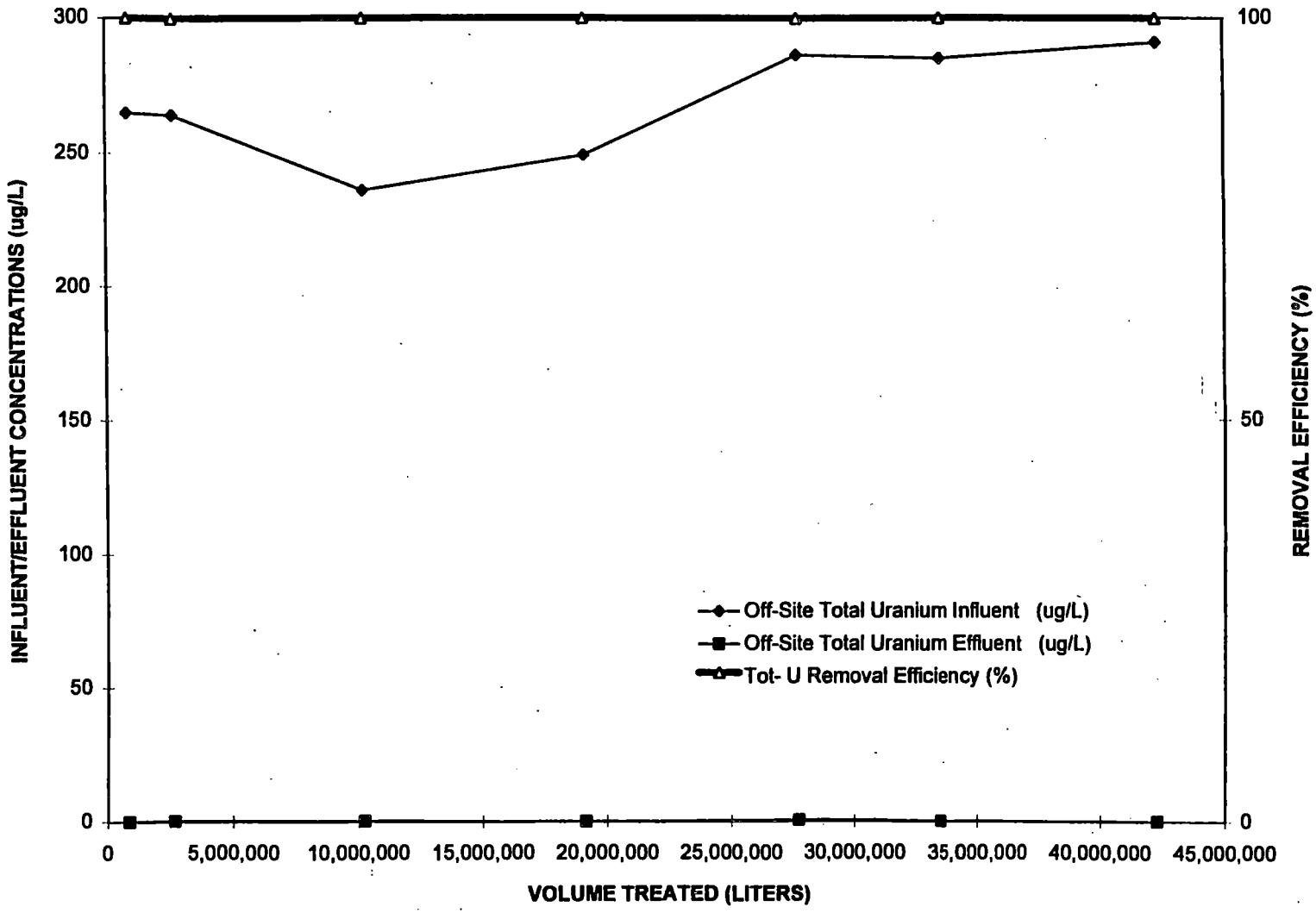


Figure 7. 200-UP-1 Treatment System Uranium Removal Efficiency.

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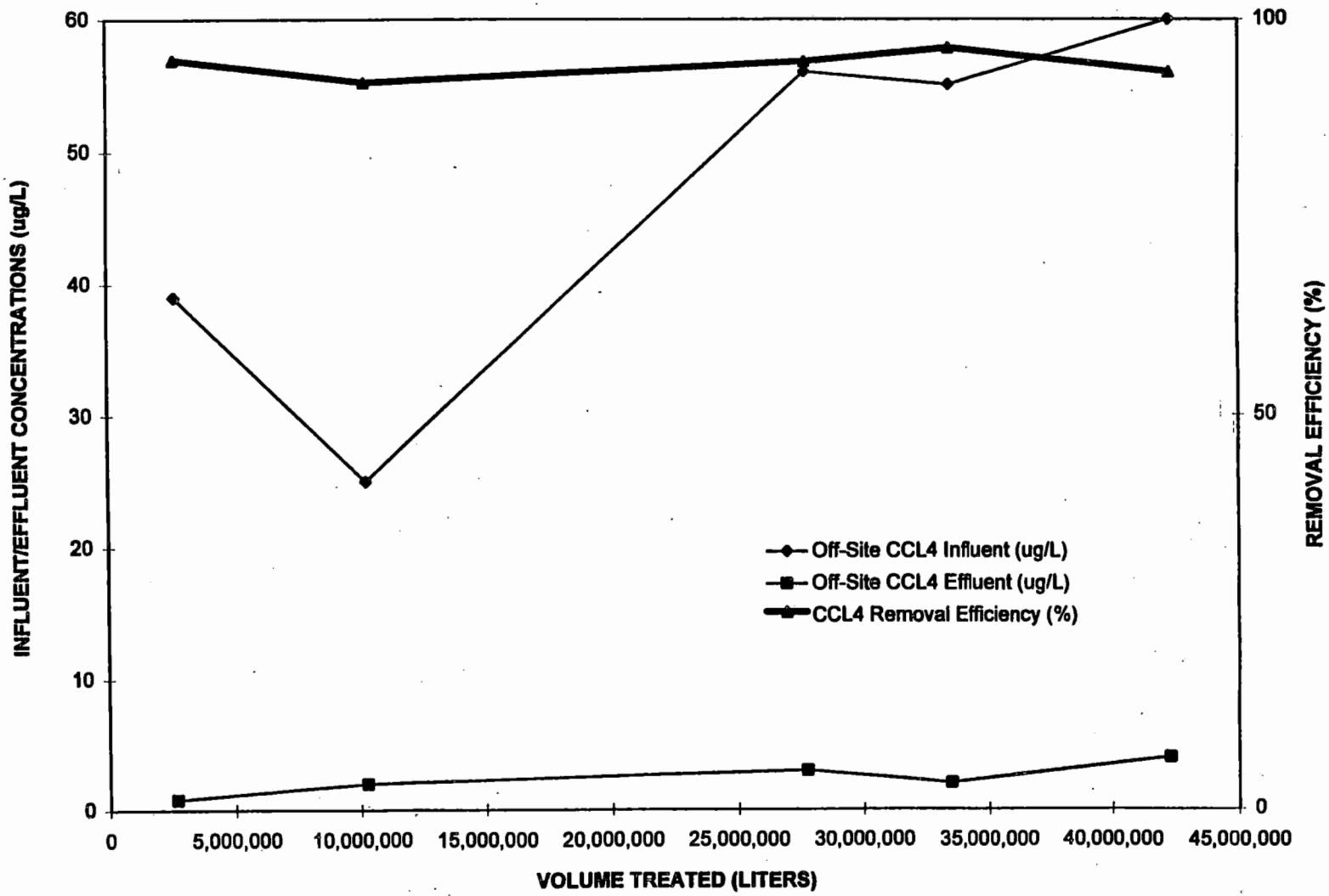


Figure 8. 200-UP-1 Treatment System Carbon Tetrachloride Removal Efficiency.

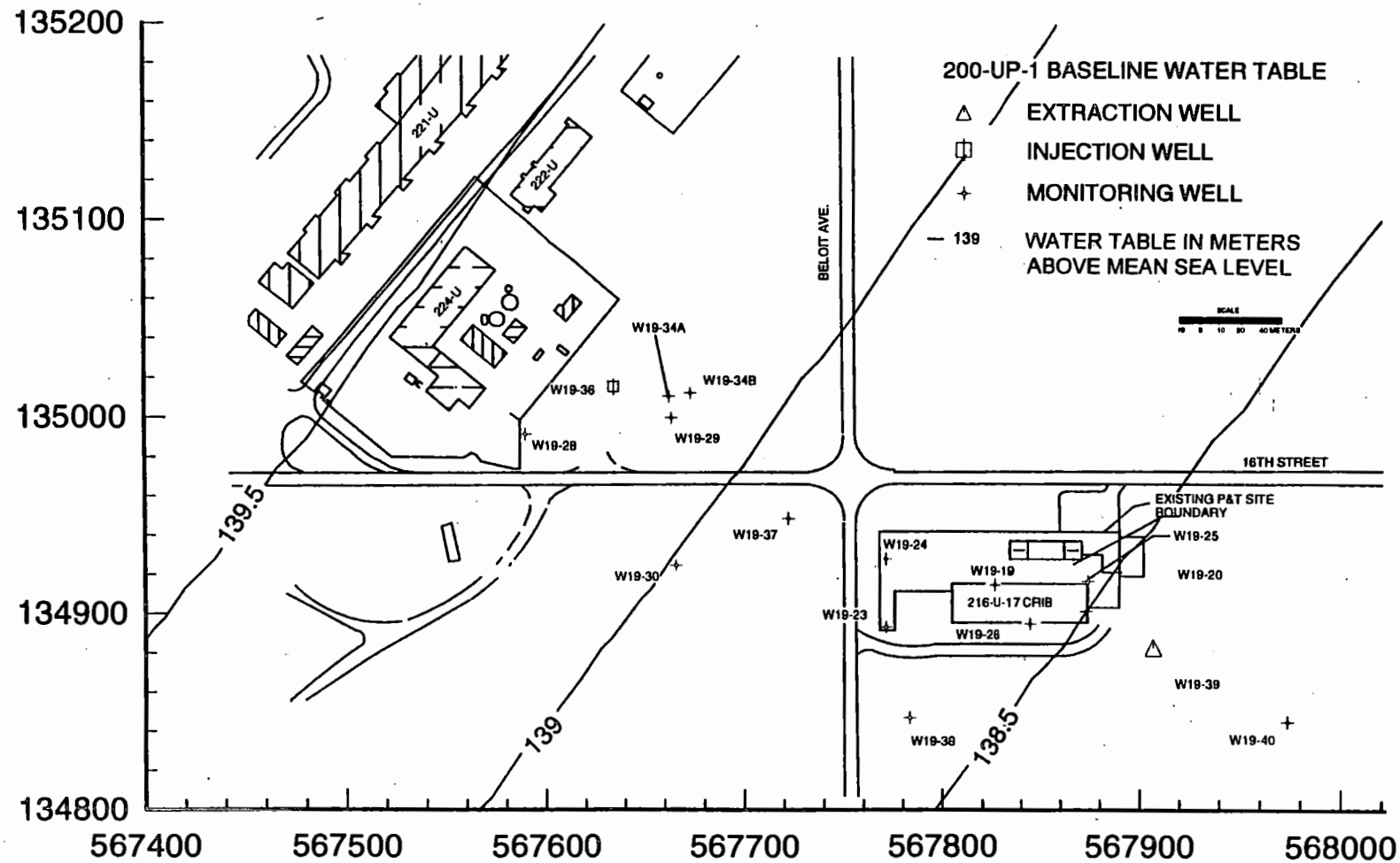


Figure 9. Baseline Water-Table Map.



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Prior to Phase I operations, pump-and-treat activities during the treatability test (57-L/min flow rate) impacted only a local portion of the target plume (DOE-RL 1995a). As reported in Table 1, about 63.8 million liters of groundwater have now been removed, processed, and reinjected over the life of the project. Almost half of this water was withdrawn during the reporting period of December 1995 through March 1996. Consequently, greater overall impact on the water table and contaminant concentrations was observed in this reporting period, as discussed in the following sections. Technetium-99 and uranium plume maps at the end of the reporting period are shown in Figures 10 and 11. For comparison, Figure 12 shows the original baseline plume map with the estimated long-term capture zone.

## 3.2 HYDRAULIC RESPONSE

Aquifer response to Phase I pumping and injection was similar to that predicted by numerical modeling and the aquifer test. Pumping has continued at approximately 180 (±20) L/min based on the extraction well flowmeter located near the well head. Figure 13 shows the drawdown and buildup at the withdrawal and injection wells. Both water-level drawdown and buildup have increased gradually over the operating period and appear to have neared equilibrium. Observed perturbations include those from system startups, shutdowns, and barometric pressure changes. Startup and shutdown responses are characterized by fairly smooth drawdown or buildup curves immediately following system shutdown and startup. These types of responses can be identified in the figures where flow rate changes occur (e.g., Figure 13), but are difficult to see because of the scale on the hydrographs. Finer scale, more periodic water-level perturbations are due to barometric pressure changes. Water-level measurements from near- and far-field observation wells are shown in Figures 14 through 16.

The hydraulic response to the pump-and-treat system and the barometric pressure responses are also superimposed on a declining regional water table. The decline is due to decay of the U Pond mound beneath the 200 West Area. This decline appears to be occurring at a rate of about 0.8 m/yr, and can be seen in Figures 14 through 16 as an overall downward trend in the area of both the extraction and injection wells.

## 3.3 CONTAMINANT RESPONSE

Contaminant distribution and concentrations have been changing in response to the Phase I pumping and treatment. Figures 17 through 19 illustrate the recent (2+ year) history of contaminant concentrations for wells in the vicinity of the pump-and-treat site. Data collected over the operating period represent both field-screening and offsite laboratory analytical results. The effects of the Phase I pump-and-treat operations are most readily apparent in the monitoring wells located near the extraction and injection wells, but are becoming more evident at a greater radial distance. Figures 20 and 21 illustrate a numerical modeling approximation of what portions of the aquifer may have been affected by the first 180 days of Phase I pump-and-treat activities. The figures show the probable extent of water exchange that has taken place since the start of the 190-L/min pump-and-treat configuration. Figures 11 and 12 show the distribution of uranium and technetium-99 concentrations as of March 31, 1996 based on field-screening data.

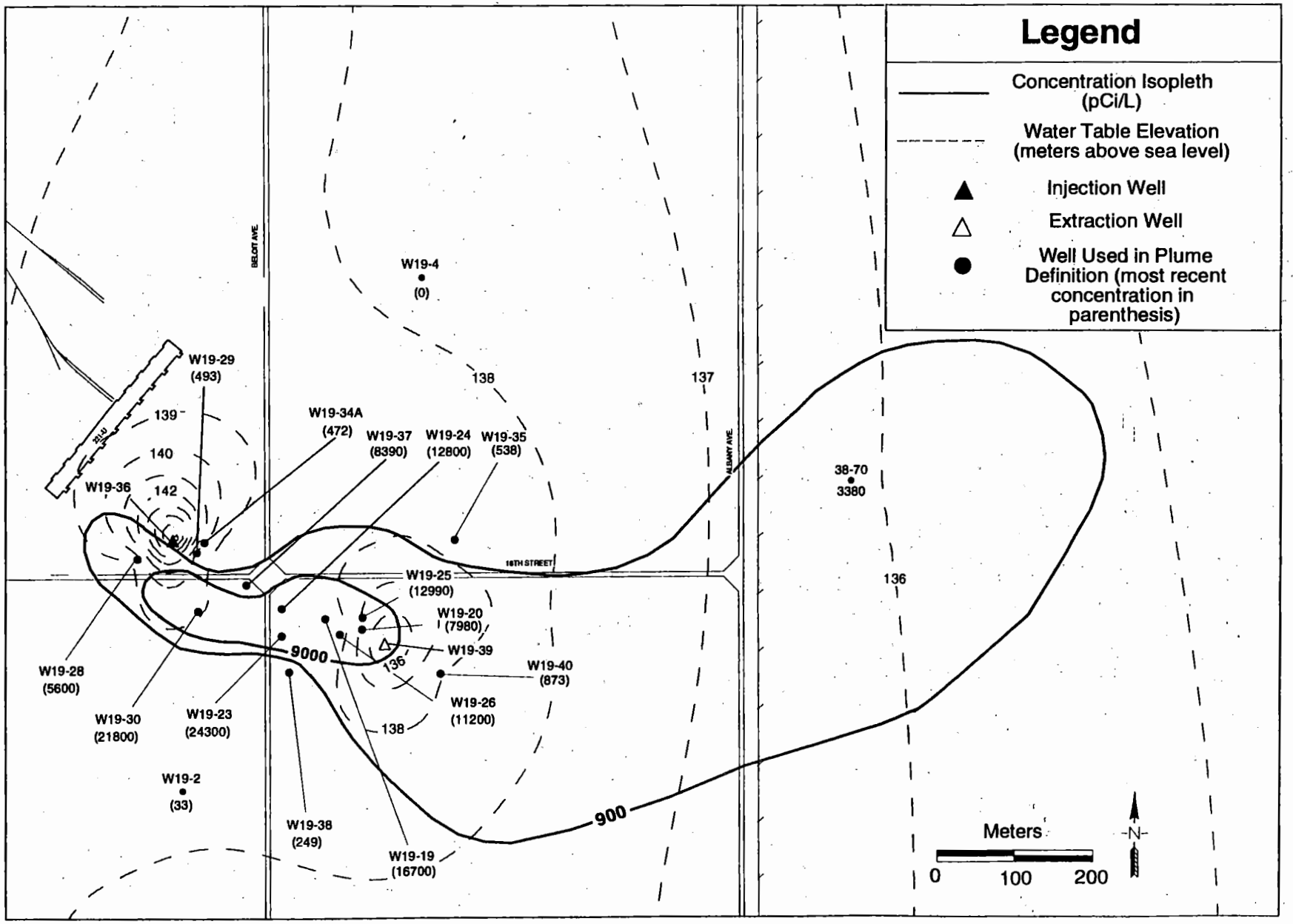


Figure 10. Technetium-99 Plume Map (pCi/L) as of March 31, 1996.



96134H.0526

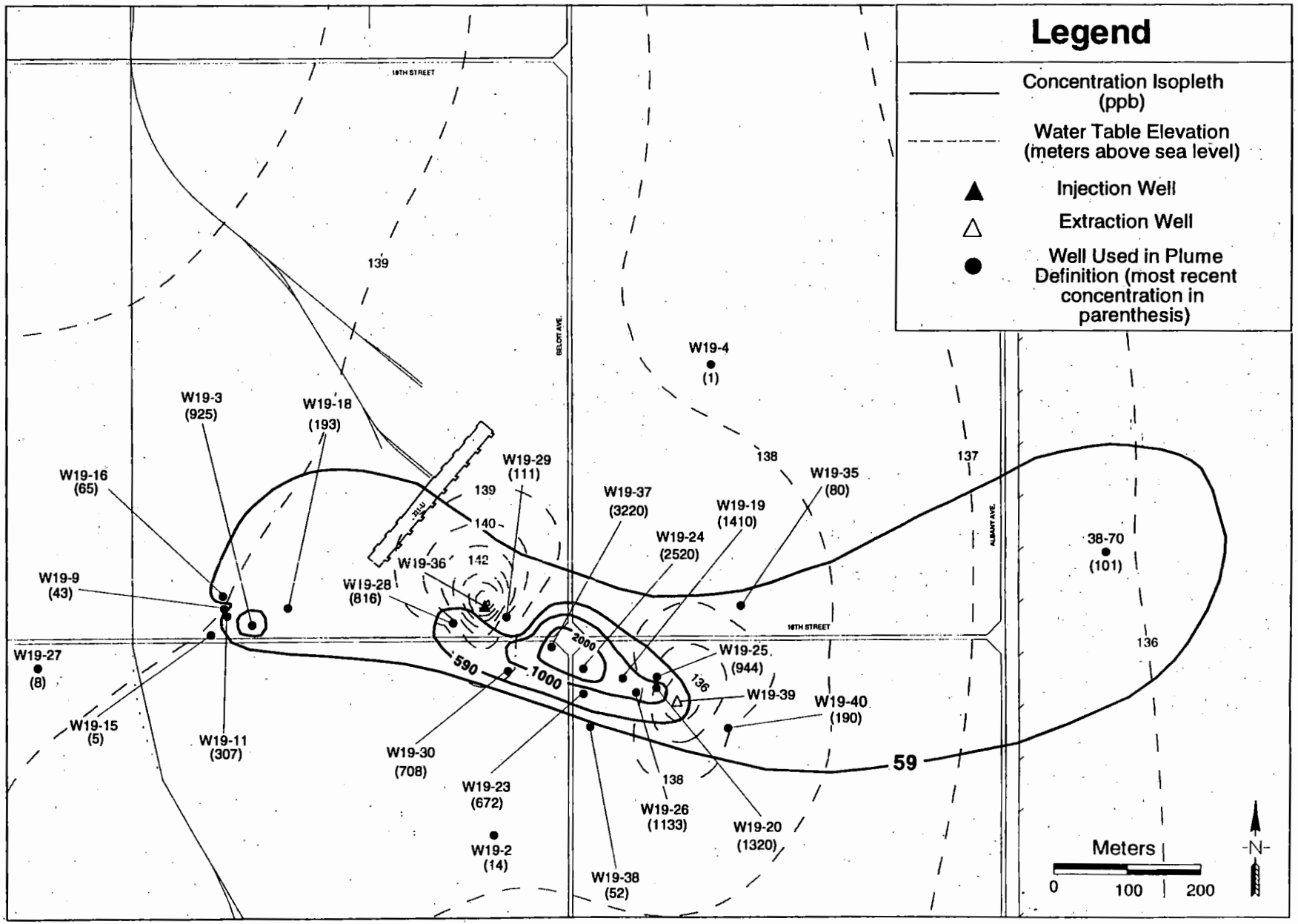


Figure 11. Uranium Plume Map (µg/L) as of March 31, 1996.



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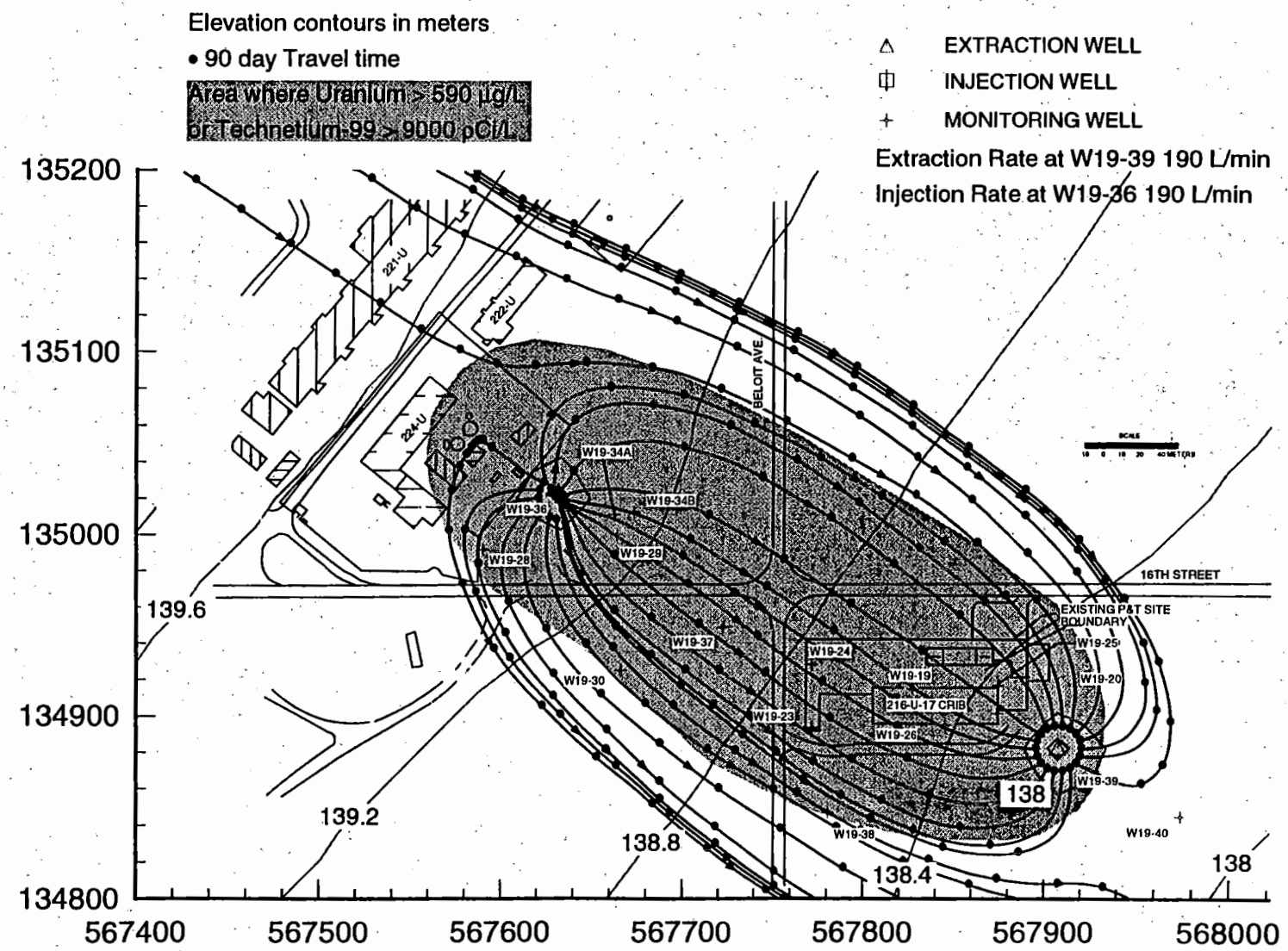


Figure 12. Baseline Plume Map and Estimated Long-Term Capture Zone Analysis.



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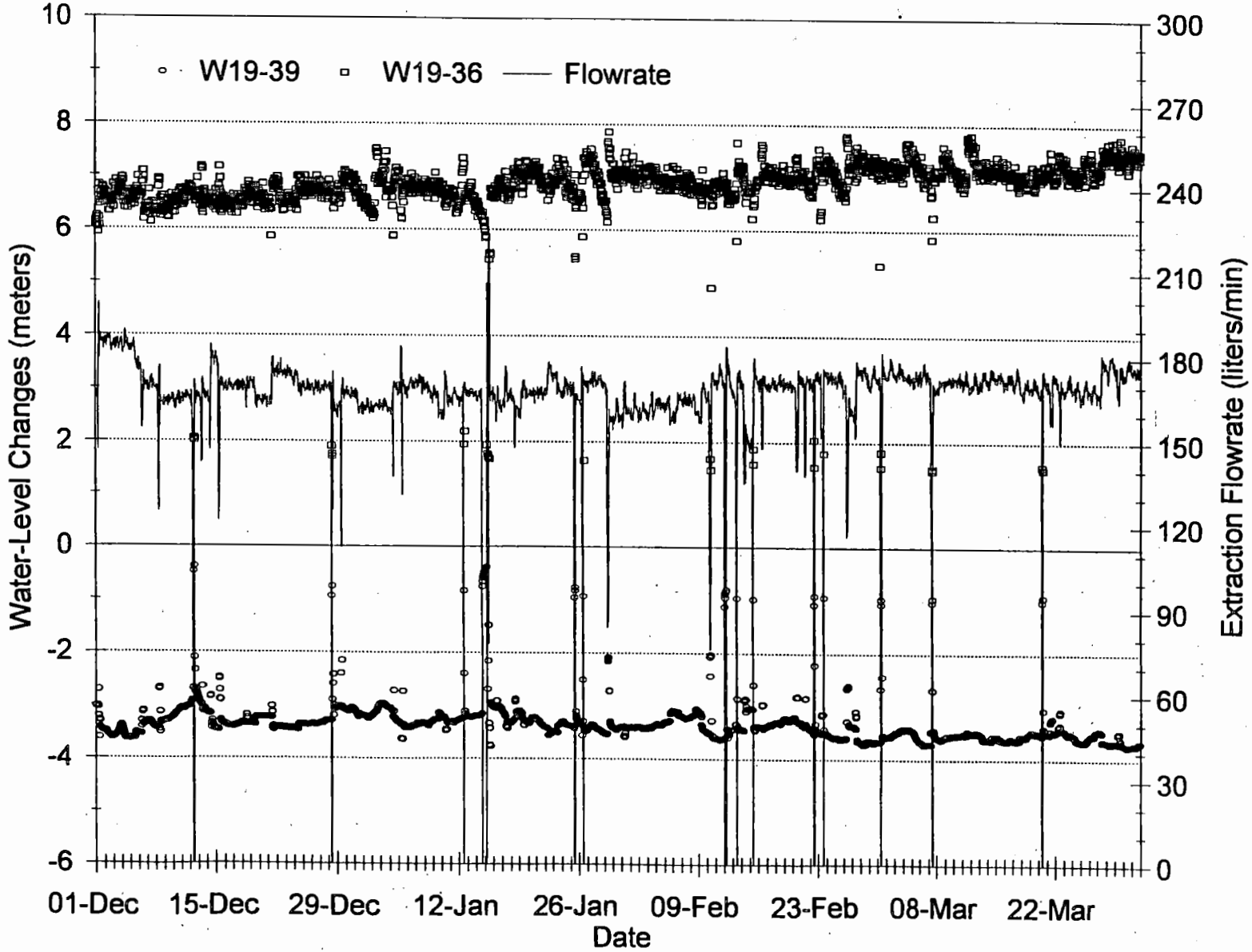


Figure 13. 200-UP-1 Extraction and Injection Well Water-Level Measurements from December 1, 1995 to March 31, 1996.

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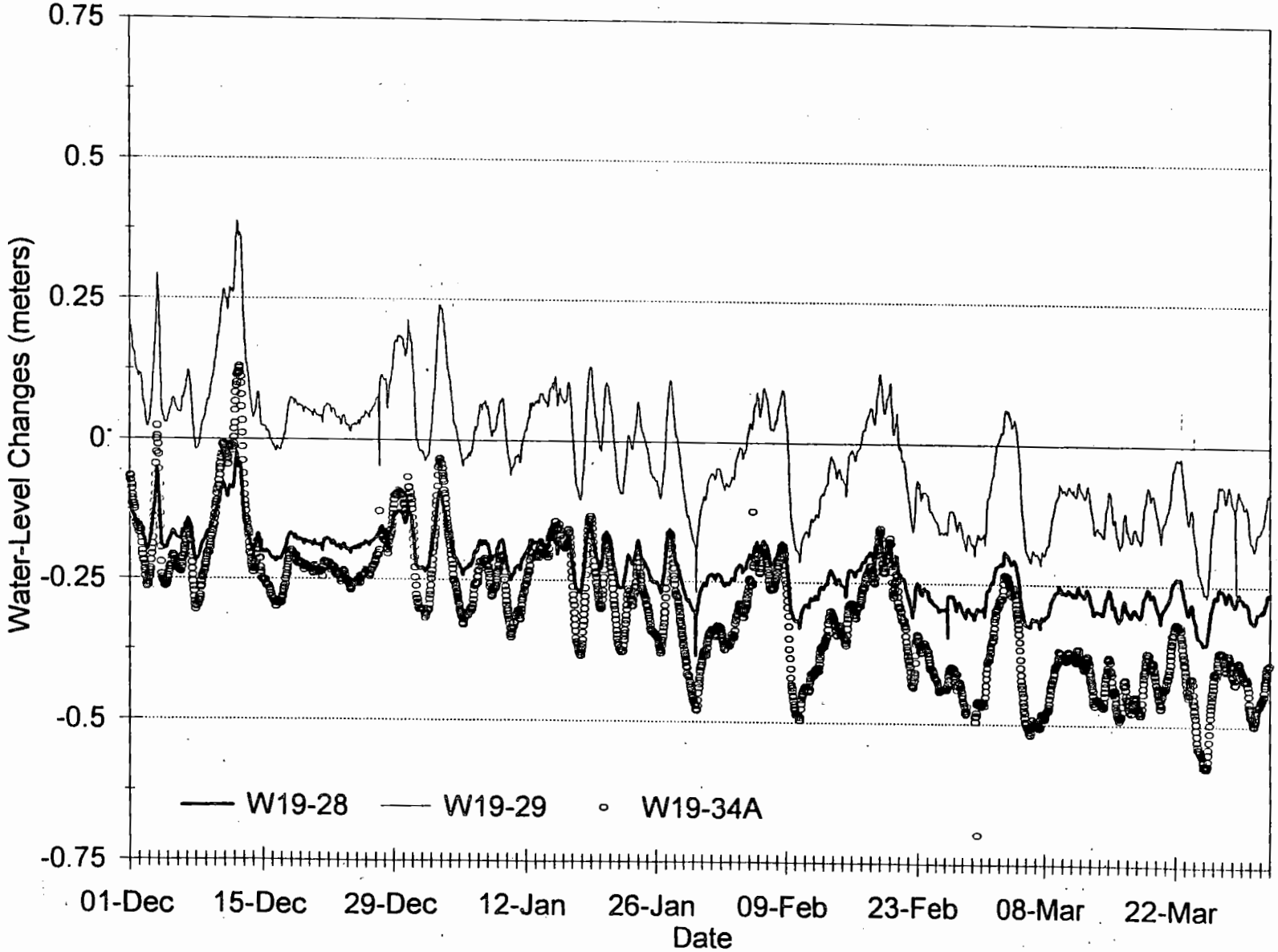


Figure 14. Water-Level Measurement Data for Observation Wells Near Injection Well 299-W19-36.

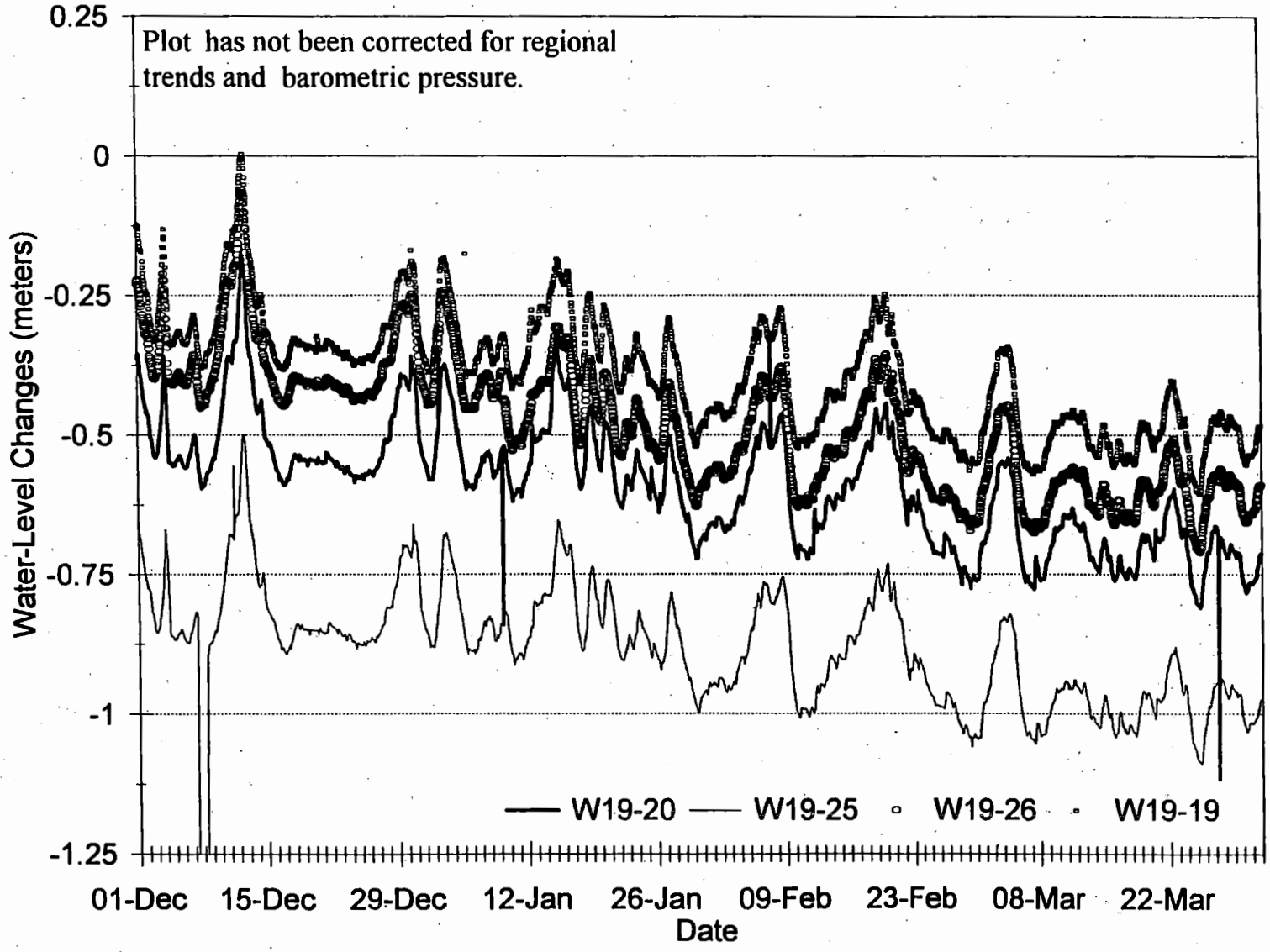


Figure 15. Water-Level Measurement Data for Observation Wells Near Extraction Well 299-W19-39.

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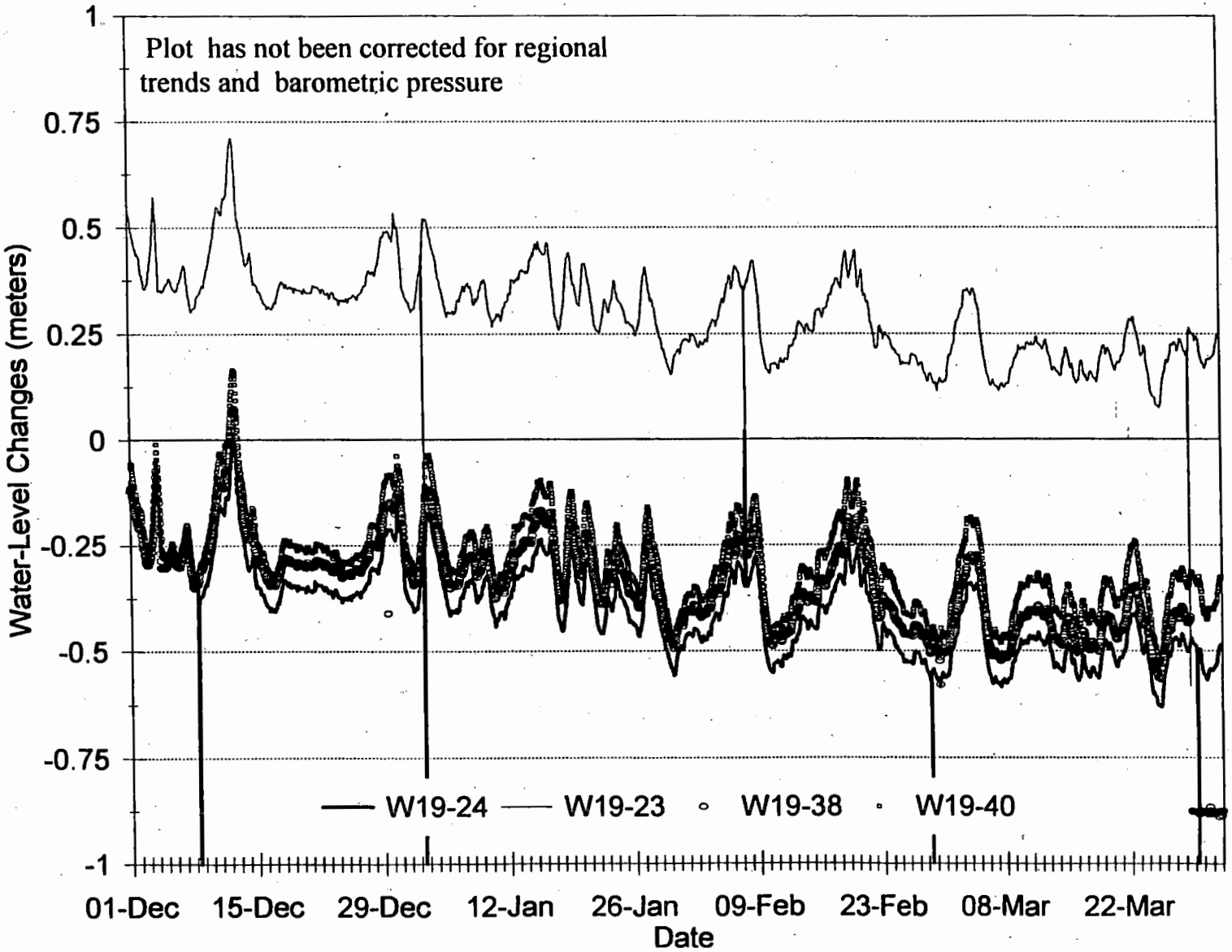


Figure 16. Water-Level Measurement Data for Other Observation Wells.

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9613494.0533

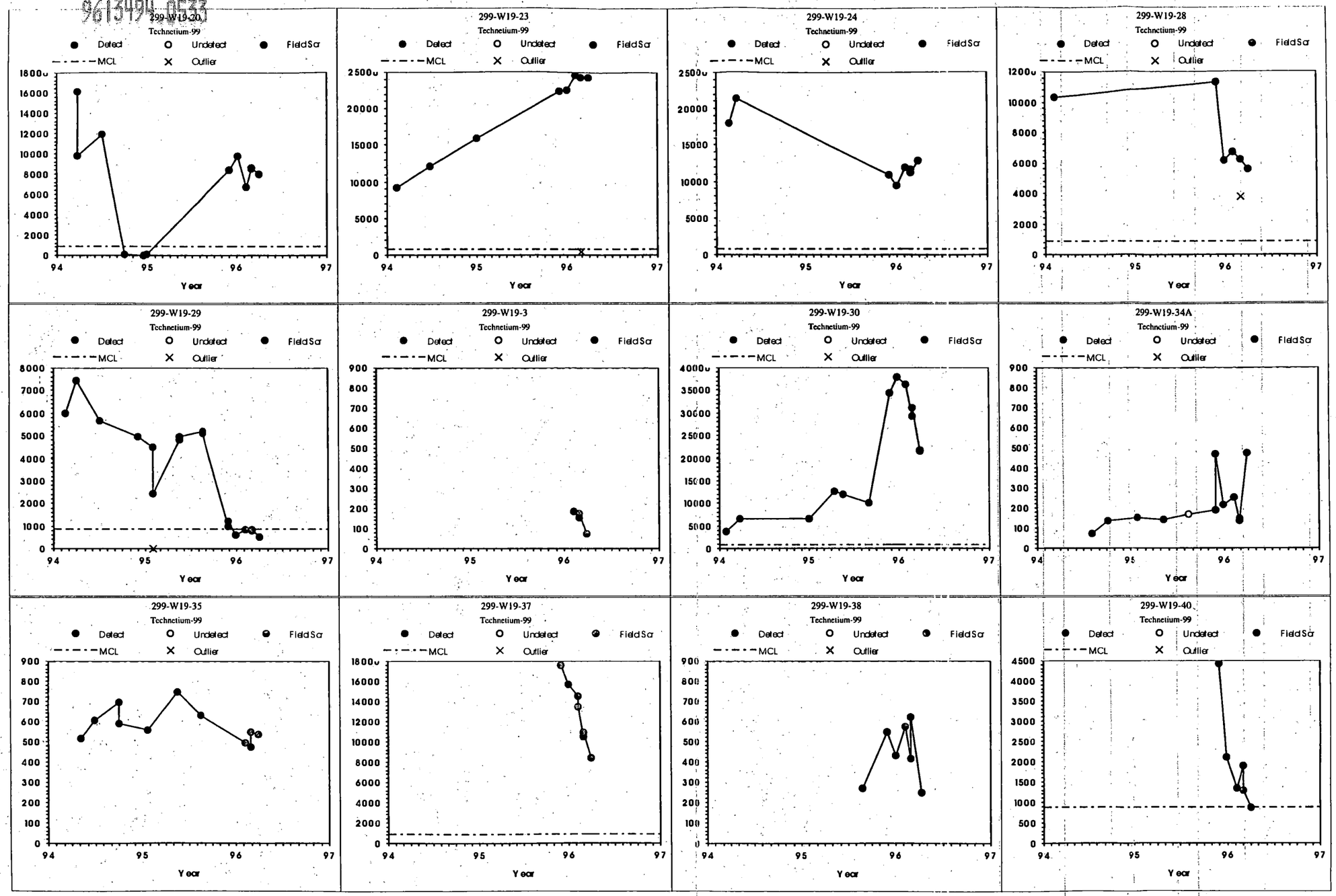


Figure 17. Technetium-99 Contamination Trend Plots for 200-UP-1 Wells.

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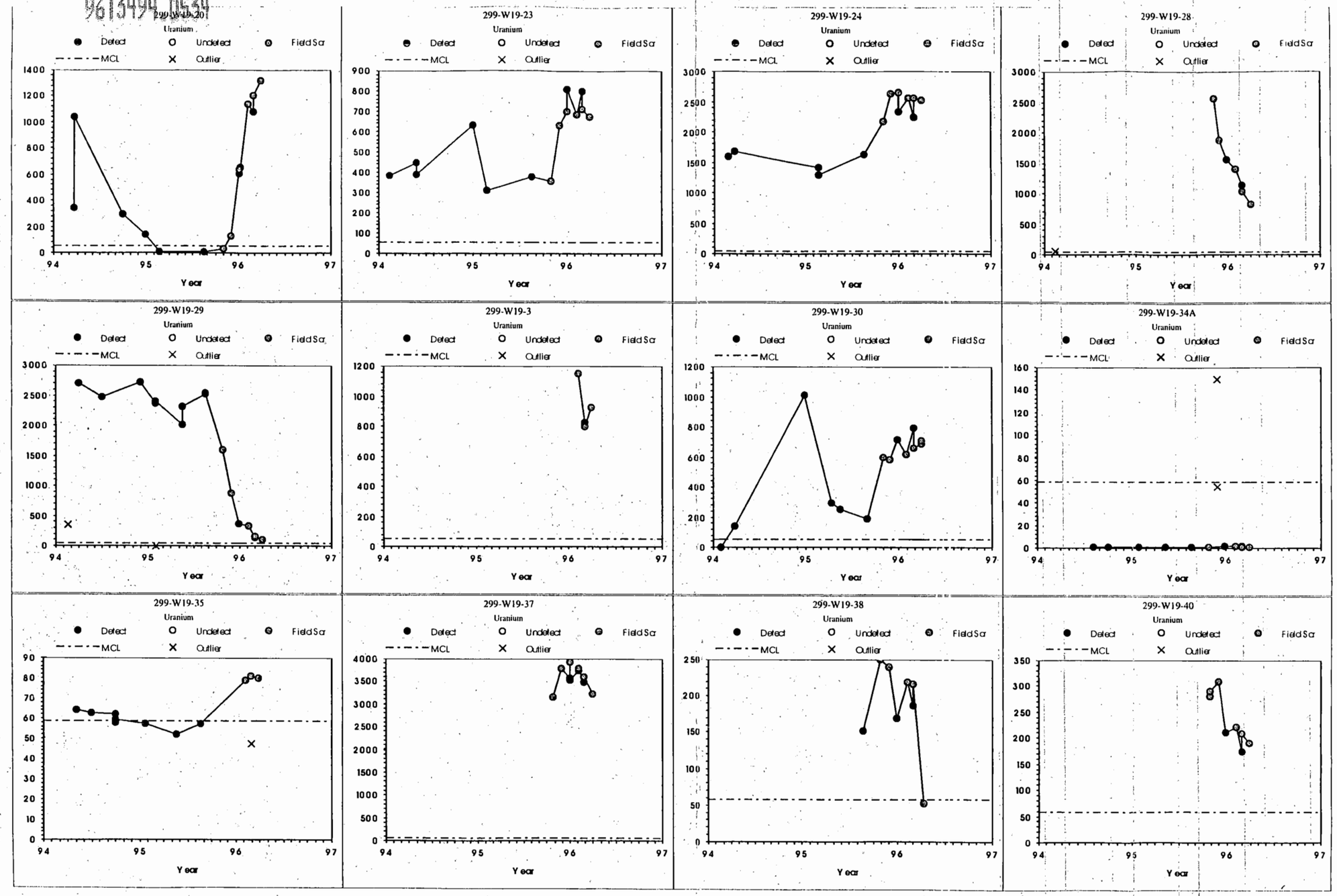


Figure 18. Uranium Contamination Trend Plots for 200-UP-1 Wells.

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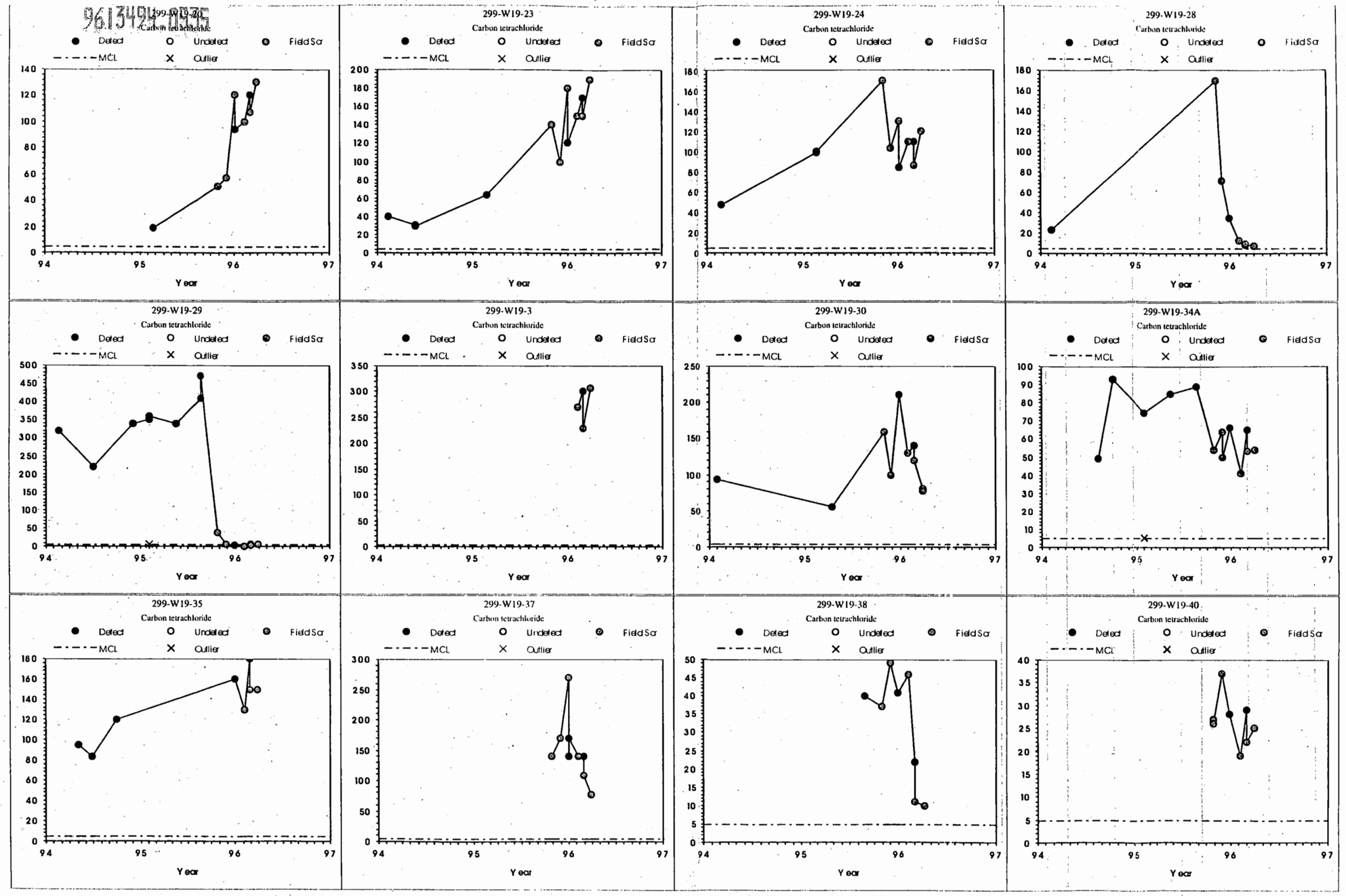


Figure 19. Carbon Tetrachloride Contamination Trend Plots for 200-UP-1 Wells.

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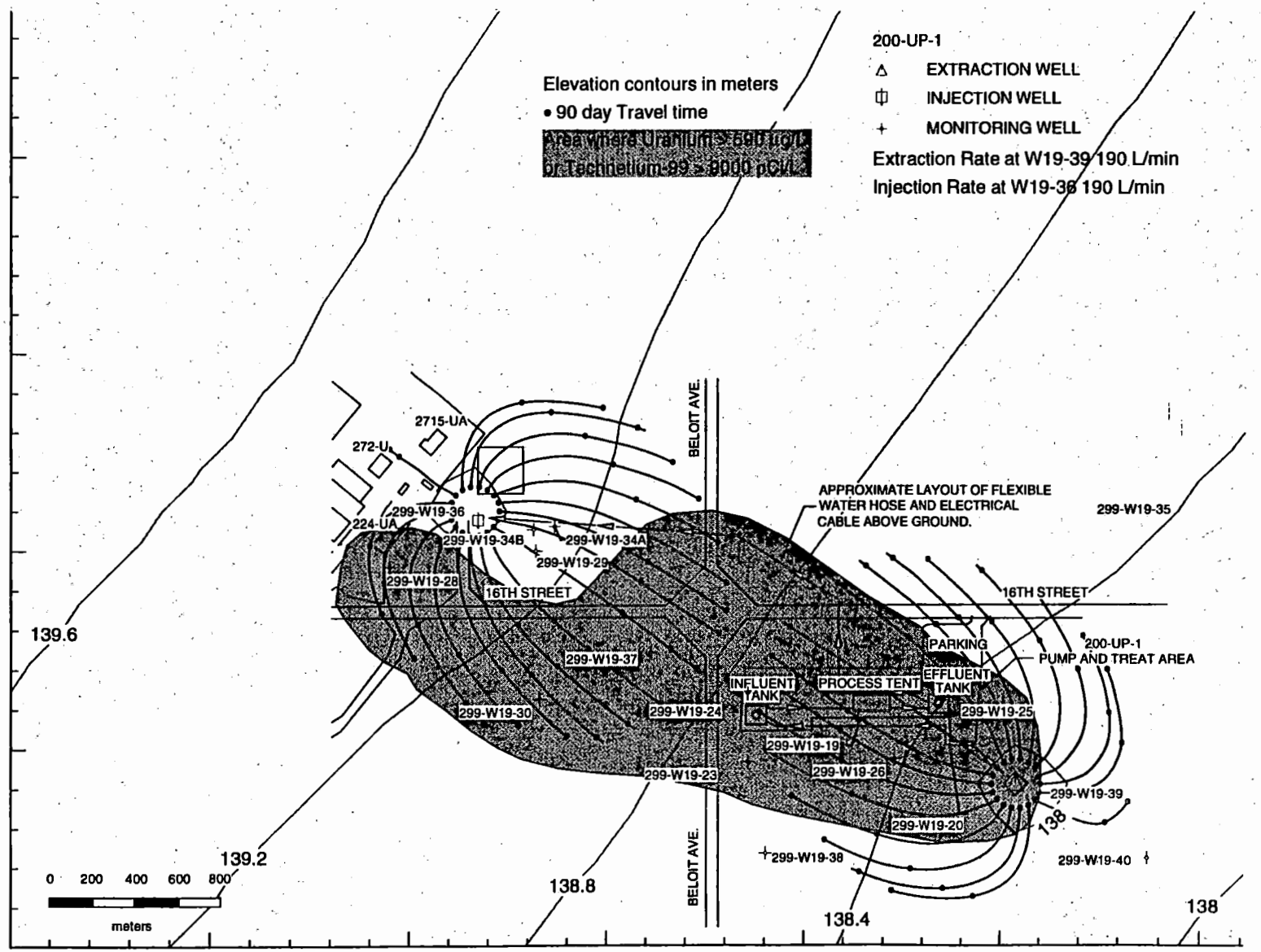


Figure 20. One-Hundred Eighty-Day Horizontal Capture Zone Analysis.

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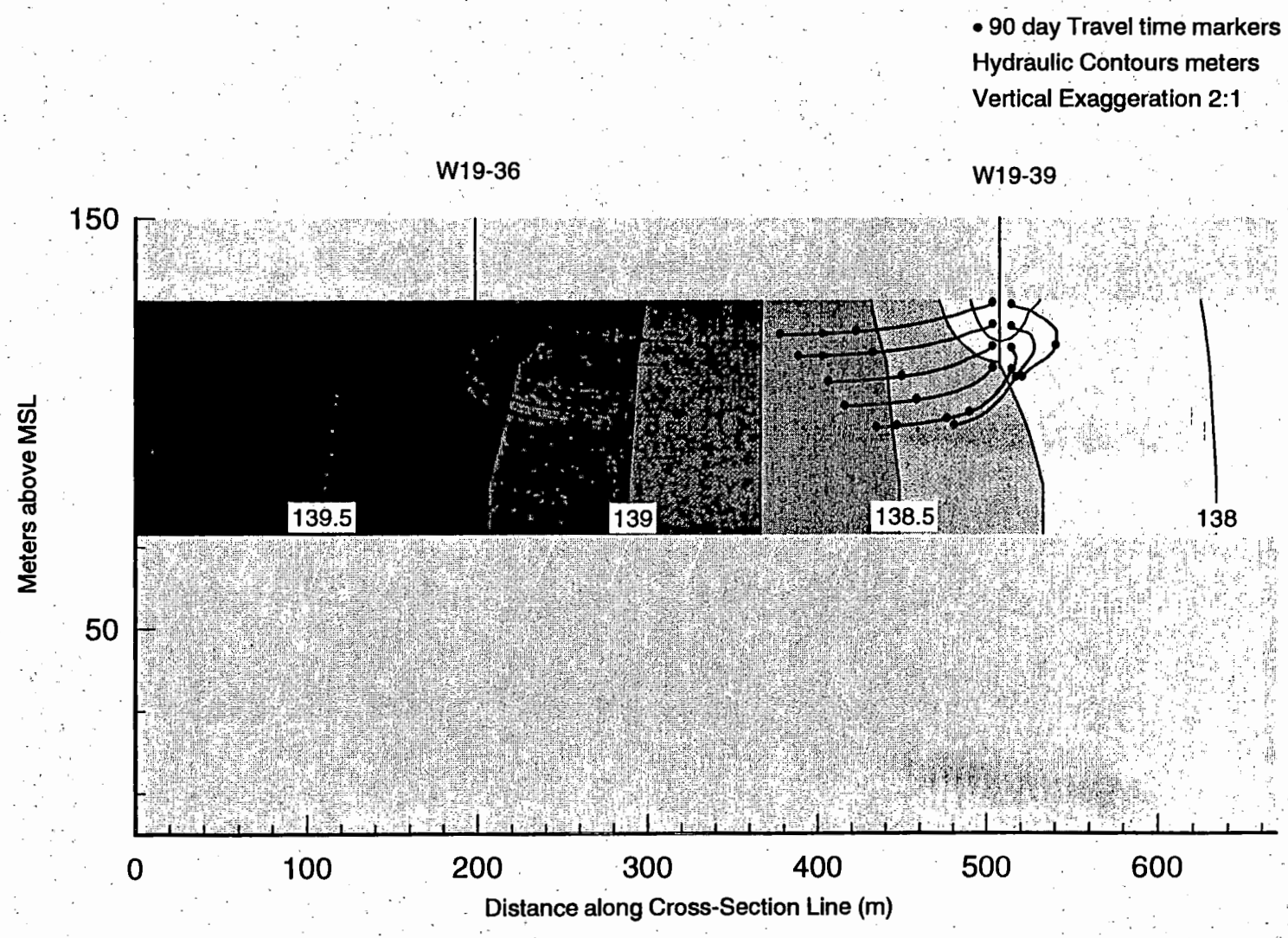



Figure 21. One-Hundred Eighty-Day Vertical Capture Zone Analysis.

It appears that significant progress has been made toward removing contaminant mass while containing further migration of the target plume. An estimated 40% of one pore volume of the high-concentration portion of the plume has been removed.

### 3.3.1 Contaminant Responses Near the Injection Well (299-W19-36)

Well 299-W19-29 is located 34 m downgradient (southeast) of the injection well. Contaminant concentrations in this well have decreased markedly since the start of Phase I operations (Figures 17 through 19). The most recent concentration data show that both uranium and technetium-99 concentrations are near their respective maximum contaminant levels (MCLs) (59 µg/L and 900 pCi/L, respectively) compared to values of about 2,500 µg/L and 5,000 pCi/L in 1995 (Figures 17 and 19). The decrease in contaminant concentration is likely due to passage of a mixing front and replacement of the contaminated water with the treated effluent. Wells 299-W19-34A and 299-W19-34B are completed deeper in the aquifer than well 299-W19-29. The apparent increases in uranium and technetium-99 in well 299-W19-34A reported in the previous quarterly report (BHI 1996b) are interpreted to be sampling artifacts because the concentrations are inconsistent. Well 299-W19-34B is completed much deeper in the aquifer and is apparently unaffected by any vertical movement of contaminants.

Concentration data for well 299-W19-28 also confirm the numerical analysis (Figure 20), i.e., that treated water reinjected into well 299-W19-36 would reach well 299-W19-28, and thereby displace more contaminated water. Concentrations of both uranium and technetium-99 have dropped significantly, from near 2,500 µg/L to almost 800 µg/L for uranium and from about 11,000 pCi/L to 6,000 pCi/L for technetium-99 (Figures 17 and 18).

Well 299-W19-37, approximately midway between extraction and injection centers, is showing what is interpreted to be a major response to pump and treat; technetium-99 concentrations have dropped from near 18,000 pCi/L to near 8,000 pCi/L, and uranium concentrations are also declining (but less drastically, probably due to a higher retardation factor).

Technetium-99 concentrations increased and then decreased in another intermediately located well, 299-W19-30 (Figure 17), which implies that contaminated water is being moved through the area, probably due to the influence of the injected water. Uranium concentrations have increased from about 250 µg/L to around 600 µg/L and appear to still be increasing. The difference in response between the two contaminants is attributed to the higher retardation factor of uranium. This area of higher concentration indicates the presence of contamination that lies near or outside the predicted southern edge of the capture zone for the extraction well.

An increase in technetium-99 concentrations is also noted in well 299-W19-23 (Figure 17), which is closer to the extraction well. This increase is expected based on the well's location within the higher concentration portion of the target plume. Hence, concentrations would increase as the center of the contaminant plume moves past this well. Note that this well and 299-W19-24 were used as extraction wells during the treatability test, which may also have affected contaminant concentrations. A similar response is noted for uranium in well 299-W19-24.

### 3.3.2 Contaminant Responses Near the Extraction Well (299-W19-39)

After 6 months of operation, uranium concentrations declined in the extraction well from about 385 µg/L to about 310 µg/L; at the same time, technetium-99 concentrations have dropped from about 6,140 pCi/L to 3,890 pCi/L. Figures 17 and 18 show the time-series concentrations of technetium-99 and uranium for the extraction well.

Well 299-W19-20 is upgradient of the extraction well and near the previously used reinjection well 299-W19-25. Contaminant concentrations in this well were initially low because of its proximity to injection well 299-W19-25 used during the treatability test. Approximately 15 million liters of treated water was injected into the aquifer through well 299-W19-25; this treated water displaced and/or mixed with the contaminated water, primarily in a downgradient direction. Concentrations over this last quarter increased from below MCLs to about 9,000 pCi/L for technetium-99 and 1,300 µg/L for uranium as the system equilibrated in response to changes in extraction and injection well usage.

Downgradient from the extraction well is monitoring well 299-W19-40 (~83 m). Contaminant concentrations have decreased from 4,500 pCi/L to below the technetium-99 MCL and from about 320 µg/L to 180 µg/L for uranium. It would appear that the capture zone extends beyond this well.

### 3.3.3 Quality Control Samples - Split and Duplicate Analyses

Table 4 presents the results for carbon tetrachloride, uranium, and technetium-99 analyses performed onsite using field-screening methods, Westinghouse Hanford Company 222-S Laboratory, and offsite by Quanterra Environmental Services. These data constitute quality control split analyses and were compared by the relative percent difference (RPD) calculation. Figure 21 shows the March 1996 uranium, technetium-99, and carbon tetrachloride field-screening results and the offsite laboratory results (i.e., Quanterra Environmental Services). The correlation between the data is generally excellent, with correlation coefficients of +0.994, +0.995, and 0.+752 for carbon tetrachloride, uranium, and technetium-99, respectively. The offsite laboratory technetium-99 result from well 299-W19-23 is an outlier and suspect.

Duplicate analyses were performed by the onsite laboratory in February and March. The RPDs for the two carbon tetrachloride analyses were 0% and 5%, respectively. The RPDs for the two uranium analyses were 1% and, for technetium-99, 7% and 3%, respectively.

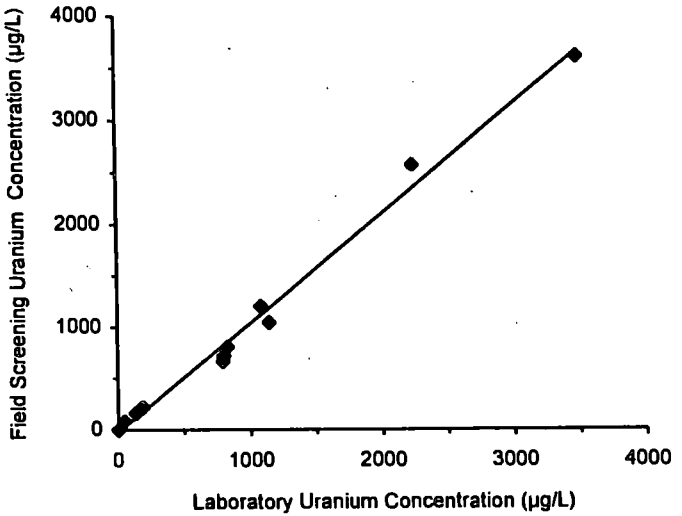
Table 4. Quality Control Results - Split Samples.

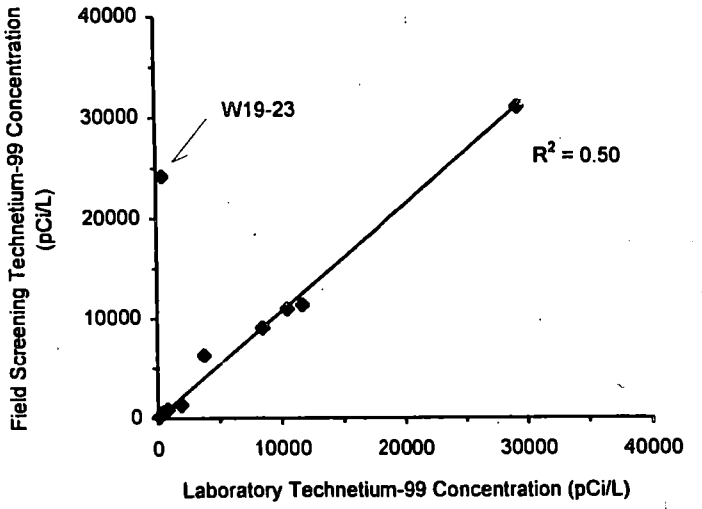
| Well | Date | $CCl_4$ Offsite laboratory (µg/L) | $CCl_4$ Field screening (µg/L) | RPD | Uranium offsite laboratory (µg/L) | Uranium field screening (µg/L) | RPD | $^{99}Tc$ offsite laboratory (pCi/L) | $^{99}Tc$ field screening (pCi/L) | RPD |
|---|---|---|---|---|---|---|---|---|---|---|
| 299-W19-20 | 1/2/96 | 94 | 120 | 24 | 603 | 640 | 6 | NA | NA | N/A |
| 299-W19-23 | 1/2/96 | 120 | 180 | 40 | 810 | 700 | 15 | NA | NA | N/A |
| 299-W19-24 | 1/2/96 | 84 | 130 | 43 | 2,340 | 2,650 | 12 | NA | NA | N/A |
| 299-W19-37 | 12/29/95 | 140 | 270 | 63 | 3,570 | 3,920 | 9 | NA | NA | N/A |
| 299-W19-3 | 2/29/96 | 300 | 230 | 26 | 826 | 799 | 3 | 153 | 176 | 14 |
| 299-W19-20 | 2/28/96 | 120 | 107 | 11 | 1,080 | 1,200 | 11 | 8,520 | 8,990 | 5 |
| 299-W19-23 | 2/28/96 | 170 | 150 | 13 | 798 | 712 | 11 | 490 | 24,200 | 192 |
| 299-W19-24 | 2/28/96 | 110 | 86 | 24 | 2,240 | 2,570 | 14 | 11,700 | 11,300 | 3 |
| 299-W19-28 | 2/26/96 | 8 | 9.5 | 17 | 1,140 | 1,040 | 9 | 3,770 | 6,260 | 50 |
| 299-W19-29 | 2/27/96 | <5 | 3.4 | NC | 132 | 159 | 19 | 807 | 857 | 6 |
| 299-W19-30 | 2/26/96 | 140 | 120 | 15 | 793 | 660 | 18 | 29,300 | 31,000 | 6 |
| 299-W19-34A | 2/29/96 | 65 | 53 | 20 | 1.46 | 1.1 | 28 | 137 | 148 | 8 |
| 299-W19-35 | 2/27/96 | 180 | 150 | 18 | 47.2 | 81 | 53 | 475 | 549 | 14 |
| 299-W19-37 | 2/26/96 | 140 | 108 | 26 | 3,490 | 3,610 | 3 | 10,500 | 10,900 | 4 |
| 299-W19-38 | 2/29/96 | 22 | 11 | 67 | 187 | 216 | 14 | 418 | 621 | 39 |
| 299-W19-40 | 2/29/96 | 29 | 22 | 27 | 175 | 208 | 17 | 1,900 | 1,300 | 38 |

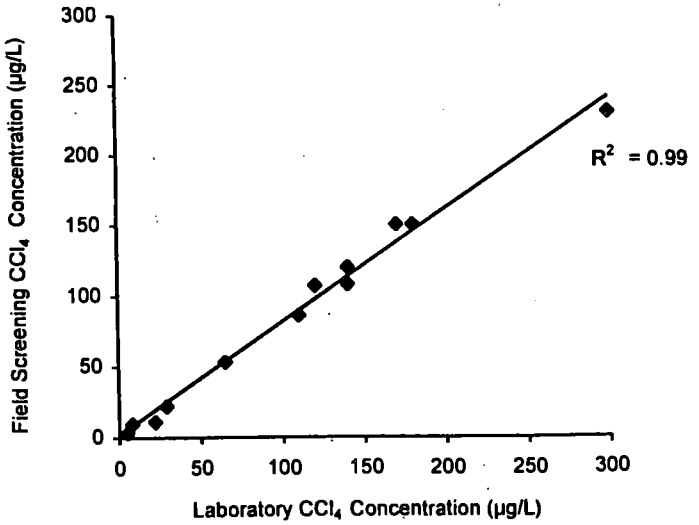
$CCl_4$ = carbon tetrachloride $^{99}Tc$ = technetium-99 RPD = relative percent difference [(a-b) / ((a+b)/2)] x 100
Laboratory = Analysis performed by Quanterra at offsite analytical laboratory.
Field screening = Analyses for $CCl_4$ and uranium performed in mobile laboratory at 200-UP-1; analyses for $^{99}Tc$ performed at 222-S Laboratory by Westinghouse Hanford Company.
NA = not analyzed N/A = not applicable NC = not calculated



9613494.0640




| Analyte | Correlation Coefficient | $R^2$ |
|---|---|---|
| Carbon tetrachloride | 0.994 | 0.99 |
| Uranium | 0.995 | 0.99 |
| Technetium-99 | 0.752 | 0.50 |

$R^2$ values near 1 indicate a good fit of trendline and data.

Figure 22. Field-Screening Versus Laboratory Results for Carbon Tetrachloride, Uranium, and Technetium-99.

## 4.0 RECOMMENDATIONS

Evaluation of the spent resin sampling results indicates that the concentration of contaminants loaded on the resin remains reasonably consistent. The use of this process knowledge could be used to minimize the sampling activities on future spent resin generated by the treatment system. At a minimum, the number of samples taken per ion-exchange column could be reduced to one sample taken from the top of the resin bed. This sample generally exhibits the highest contaminant concentrations. Further reductions in the number of samples could be made if waste designation can be made solely on process knowledge with an occasional confirmation sample (e.g., one sample from every other loaded resin bed).

Operating three ion-exchange columns in series should also be evaluated. The operation of three columns may allow for maximum loading of contaminants on the lead column without jeopardizing the quality of the effluent. Breakthrough monitoring could also be optimized by reducing the number of influent samples taken to one per week rather than two. The additional sample could be taken from the treatment system effluent stream to provide additional data on treatment system performance.

One of the objectives of the IRM is to capture the 590-µg/L portion of the uranium plume and the 9,000-pCi/L portion of the technetium-99 plume. To achieve this goal, an additional extraction well may be needed. As noted in the last report (BHI 1996b), a pumping center near the southern boundary of the target plume would be most useful. A reasonable candidate for such an effort is well 299-W19-38. Although current concentrations are low in this well, it is strategically located to capture the higher contaminant concentrations near well 299-W19-30.

## 5.0 REFERENCES

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