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Pacific Northwest National Laboratory

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U.S. Department of Energy

Groundwater Monitoring Plan for the 183-H Solar Evaporation Basins

M. J. Hartman

May 1997

Prepared for the U.S. Department of Energy
under Contract DE-AC06-76RLO 1830

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Summary

Groundwater monitoring at the 183-H Solar Evaporation Basins is regulated under Washington Administrative Code 173-303-645. Proposed in this plan is the first phase of a final-status, corrective action monitoring program for the site. The monitoring network consists of four existing wells: 199-H4-3, 199-H4-7, 199-H4-12A, and 199-H4-12C. Well 199-H4-12C is completed at the base of the unconfined aquifer; the other wells are screened at the water table. Wells 199-H4-7 and 199-H4-12A are groundwater extraction wells used in a pump-and-treat system.

Groundwater samples will be collected from each well annually. Samples will be analyzed for the following:

- constituents of concern (i.e., chromium, nitrate, technetium-99, and uranium) and fluoride
- additional constituents to aid data interpretation (e.g., alkalinity, anions, and metals)
- field parameters routinely acquired at the wellhead (e.g., pH, specific conductance, temperature, and turbidity).

The objective of monitoring during operation of the pump-and-treat system is to determine whether concentrations of the contaminants of concern are decreasing.

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1.0 Introduction

This plan describes the first phase of a final-status, corrective action groundwater monitoring program for the 183-H Solar Evaporation Basins, a *Resource Conservation and Recovery Act of 1976* (RCRA) regulated unit. The 183-H basins are included in the Hanford Site RCRA Permit (Ecology 1994) and are subject to final-status requirements for groundwater monitoring.

This plan proposes the monitoring network, list of constituents to be analyzed for, and protocols for sampling and analysis that will be employed for the 183-H basins during the operation of a pump-and-treat system for chromium-contaminated groundwater. Additional phases of groundwater monitoring will be developed as the final corrective action strategy progresses.

1.1 History of Groundwater Monitoring at the 183-H Basins

Limited groundwater monitoring was conducted during the operational life of the 183-H basins (1973 to 1985). Four wells were installed, one in 1974 and three in 1983. These wells were sampled for a limited suite of analytes. In 1986 and 1987, 18 monitoring wells were installed in response to a *Consent Agreement and Compliance Order* (Ecology and EPA 1986). A RCRA monitoring program was initiated, as described in the revised groundwater monitoring compliance plan (PNL 1986). The compliance order mandated interim-status groundwater quality assessment monitoring according to Title 40, Code of Federal Regulations (CFR) Part 265 and Washington Administrative Code (WAC) 173-303-400.

The monitoring program was modified as data were collected and analyzed. An updated program was described in the closure/postclosure plan (DOE 1991). Like the original program, DOE (1991) addressed the requirements then in effect (i.e., interim status). Interpretive reports are submitted annually to the State of Washington Department of Ecology (Ecology) along with data from other RCRA units on the Hanford Site (e.g., DOE 1996a; Hartman and Dresel 1997).

In 1994, Ecology issued a RCRA permit for the Hanford Site (Ecology 1994). The 183-H basins were included in Part V of that permit, which contains requirements specifically applicable to those treatment, storage, and disposal units that are undergoing closure. Part II, Condition II.F, of the permit specifies that a groundwater monitoring program under final status will be subject to the requirements of WAC 173-303-645.

Although the RCRA permit specified final-status requirements for groundwater monitoring, it also stated that monitoring should continue under the current (interim-status) program as described in the closure/postclosure plan (an apparent contradiction in the permit). A final-status monitoring program was proposed in 1995 (Hartman and Chou 1995) to comply with the groundwater monitoring requirements specified in Part II, Condition II.F., of the permit.

The first sample set collected under the final-status compliance monitoring plan showed that downgradient concentrations of the contaminants of concern exceeded concentration limits defined in the monitoring plan. The regulations require corrective action activities to reduce contaminant concentrations in groundwater. Remediation of the groundwater was deferred to the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) program, and RCRA monitoring continued under the compliance program defined in Hartman and Chou (1995).

The 183-H basins are located in the 100-HR-1 Source Operable Unit and the 100-HR-3 Groundwater Operable Unit, which are under the authority of RCRA past practice and CERCLA. An interim remedial measure (IRM) to pump and treat groundwater in the 100-H Area for chromium was initiated in 1996 (DOE 1996b). Extraction wells are located west, north, and east of the basins, and pumping is scheduled to begin in the summer of 1997. The objective of the IRM is to reduce the amount of chromium entering the Columbia River, where it is a potential hazard to the ecosystem. Programs were initiated to monitor the effectiveness of the IRM and to continue to monitor the entire 100-HR-3 Groundwater Operable Unit (DOE 1996c; Peterson and Raidl 1996). A series of workshops was held in early 1997 to develop a monitoring program capable of meeting the various objectives and requirements of CERCLA IRM, CERCLA operable unit, and RCRA monitoring. This plan presents the outcome for the RCRA requirements.

Methods for final remediation of 100-H Area groundwater are yet to be determined by the U.S. Department of Energy (DOE), the regulators, and members of the public.

1.2 Purpose of RCRA Monitoring

The monitoring program described in this plan is effective only during the operation of the CERCLA IRM in the 100-H Area. During the period of the IRM, RCRA monitoring will be conducted to track trends in four contaminants of concern (i.e., chromium, nitrate, technetium-99, and uranium) and fluoride. Although the IRM was designed to remove chromium only, the treatment technology will probably be effective in removing the other contaminants as well. After completion of the IRM, the RCRA monitoring program will be revised to meet the needs of final remedial measures that will be defined in future records of decision. During or after the final remedial measures, the RCRA monitoring program will again be revised to determine whether concentrations of contaminants at the point of compliance are below (and remaining below) their concentration limits. Fluoride will be monitored because it is present in the vadose zone beneath the former basins (discussed in Section 2.2).

1.3 Proposed Closure Strategy

The 183-H basins facility is a final-status treatment, storage, and disposal unit undergoing RCRA modified closure in accordance with the current postclosure plan contained in the RCRA permit as modified on December 26, 1996. A modified closure, as defined in the permit, requires that contaminated soils remaining at the unit meet Method C cleanup standards identified in the State of Washington's *Model Toxics Control Act* (RCW 70.105D) (MTCA). The DOE must provide institutional controls such as access controls and groundwater use restrictions. Reevaluation of the modified closure determination is required at least every 5 years after closure. The currently effective postclosure plan will be superseded by an update, to be incorporated into Chapter VI of the permit in December 1997.

Deep vadose zone nitrate and fluoride contamination could not meet numerical groundwater protection standards for modified closure (MTCA Method C) without excavation to the groundwater (Section 2.2). To achieve a modified closure, DOE demonstrated through groundwater modeling that levels remaining in the soil would not be a hazard to groundwater after covering the site with clean fill. This demonstration was approved by Ecology in its letter to DOE dated May 29, 1996, and allowed RCRA closure of the unit under a modified closure option. The demonstration was granted on an interim basis until a complete analysis of corrective action requirements could be made in association with CERCLA remedial actions. Final remedial action for the contamination in the vadose zone soil and the groundwater underneath the 183-H basins will be analyzed in a feasibility study and defined in a record of decision for the 100-HR-1 and/or 100-HR-3 operable units.

1.4 Responsibilities for Groundwater Monitoring

The owner/operator of the 183-H basins is DOE. The environmental restoration contractor, currently Bechtel Hanford, Inc. (BHI), is the co-operator of the basins. Pacific Northwest National Laboratory (PNNL)(a) has primary responsibility for RCRA monitoring; BHI is responsible for monitoring to support environmental restoration efforts.

The U.S. Environmental Protection Agency (EPA) and Ecology jointly administer the RCRA regulations in the State of Washington. The EPA retains oversight authority while delegating to Ecology the administration of a state program that is consistent with, or more stringent than, the corresponding federal program. At the time of operation and closure of the 183-H basins, EPA retained authority over the Land Disposal Restrictions Program (40 CFR 268) under the *Hazardous and Solid Waste Amendments of 1984*. Ecology's authorization included administration of the closure of RCRA treatment, storage, and/or disposal units.

1.5 Organization of this Plan

This plan consists of six chapters, including this Introduction. Chapter 2.0 presents the operational and physical description of the basins, along with the characteristics of the discharged waste. Chapter 3.0 defines the stratigraphy, hydrology, and chemistry beneath the basins. Chapter 4.0 defines the RCRA groundwater monitoring program, including objectives, constituents, concentration limits, point of compliance, compliance period, wells used in the monitoring activities, sampling and analysis program, and groundwater-flow direction. Chapter 5.0 outlines data management and reporting. Chapter 6.0 lists the references cited. Three appendixes provide supporting information.

(a) PNNL is operated by Battelle for DOE.

2.0 Description of 183-H Solar Evaporation Basins

This chapter provides an overview of physical structures, operational history, and waste characteristics for the 183-H basins. More detail is provided in the closure/postclosure plan (DOE 1991).

2.1 Operational History and Physical Structure

Use of the 183-H basins began in July 1973, when liquid was pumped into basin 1 but discharges ceased after 2 months. Discharge resumed in 1975 and continued until 1978, when nitrate contamination in a downgradient well was attributed to wastes from basin 1. Basins 2 and 3, with sprayed-on liners of a polyurethane material, were used beginning in 1977 and 1978 and basin 1 was permanently retired. Basin 4, with a sprayed-on butyl and Hypalon(a) liner, was also used beginning in October 1982. Basins 2, 3, and 4 were used until 1985.

Basin 1 solids and sludges were removed in 1985. Basins 2, 3, and 4 held waste consisting of three distinct layers: a basal crystalline layer, a sludge layer, and a liquid layer on top. In 1986, the liquid waste was solidified inside lined drums. The sludge and crystalline layers were removed from the basins by manually shoveling and/or scooping the material into the drums. Basins 1 and 4 were subsequently cleaned by wet sandblasting. By the end of 1990, all waste had been removed from the 183-H basins.

Sediments were removed beneath the entire "footprint" of the basins to a depth of ~1 m in 1996. Sediments were excavated to a depth of 6 m beneath former basin 1, where deeper contamination was found. The excavation was filled with clean soil to meet the surrounding grade. The site is scheduled to be revegetated in the fall of 1997.

The 183-H basins were located beside the Columbia River in the northern portion of the Hanford Site (Figure 1). Each basin was ~16 m wide and 39 m long and contained a 5-m-deep sedimentation basin and a smaller, 3-m-deep flocculation basin (Figure 2). The basins were surrounded by earthen berms.

The concrete basins were originally part of the 183-H Filter Plant, which operated concurrently with 100-H Reactor (1943 to 1964). At that time, there were 16 basins. In 1974, the filter plant and all but four basins were decontaminated and demolished. The remaining basins were modified to seal openings and to install a pipeline before being used for waste treatment.

(a) Hypalon is a trademark of E. I. DuPont de Nemours and Company, Inc.

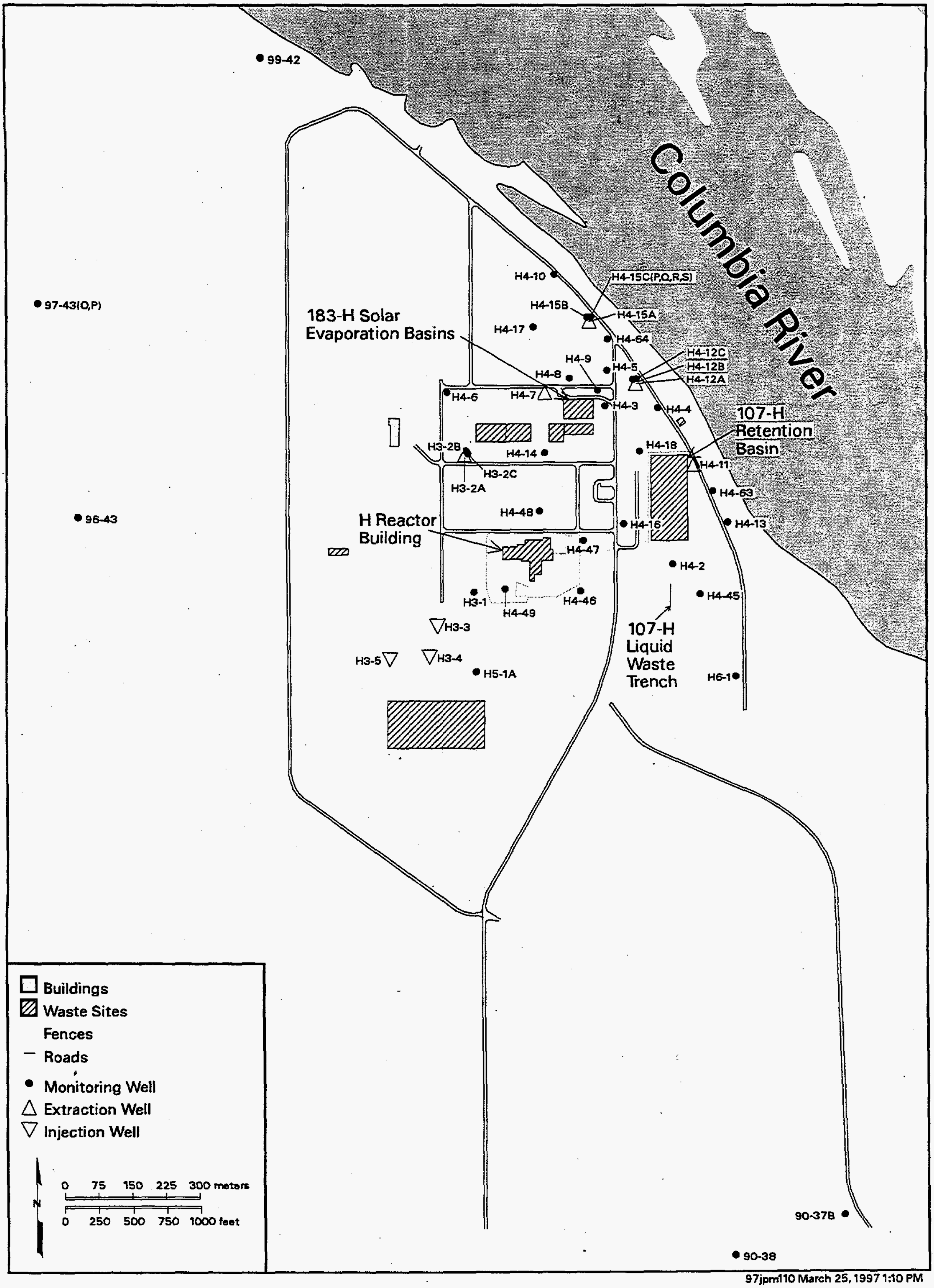

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Figure 1. Location of the 183-H Solar Evaporation Basins

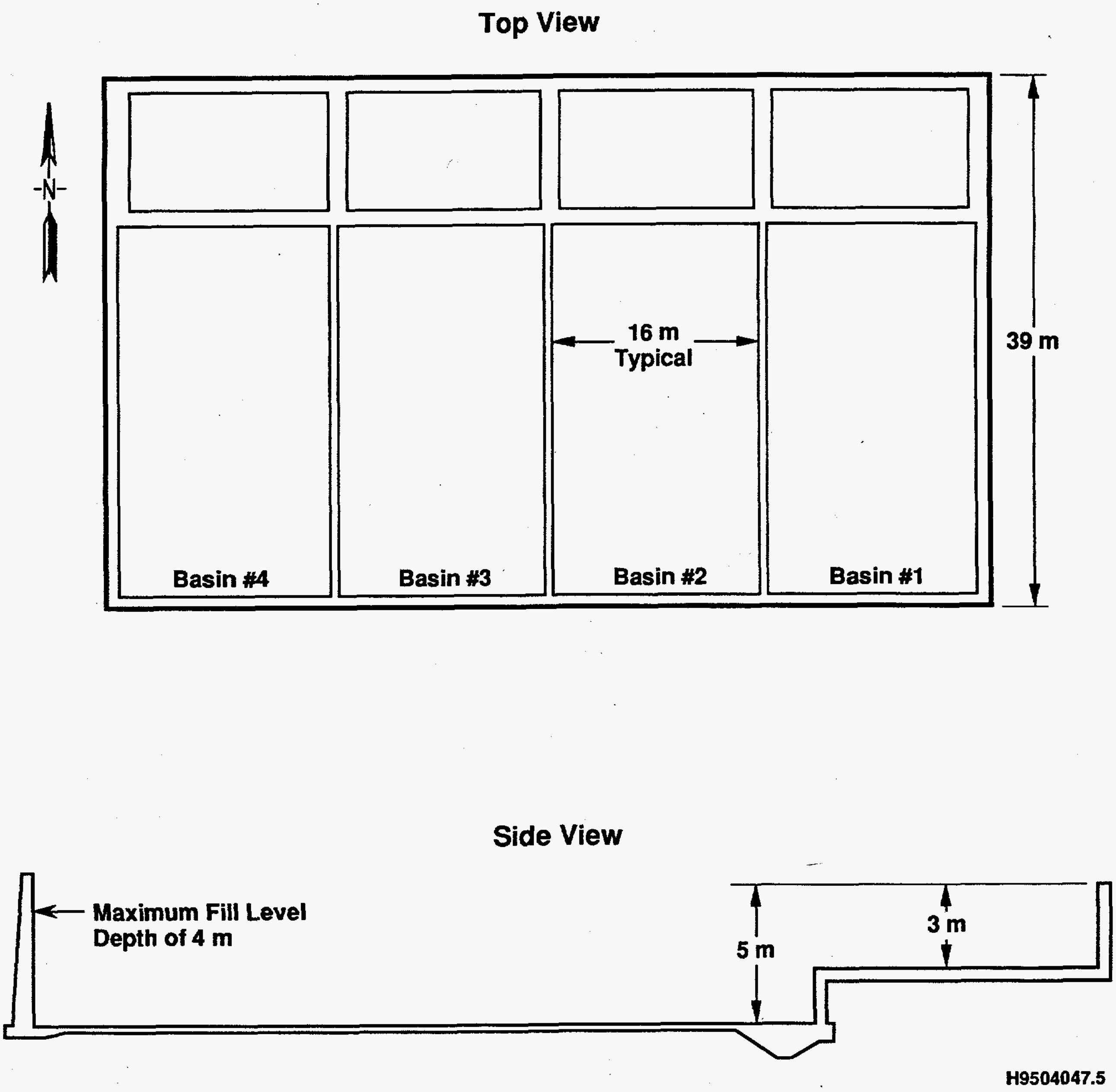

Figure 2. Dimensions of the 183-H Solar Evaporation Basins

2.2 Waste Characteristics

Waste was discharged to the basins from 1973 to 1985. During that time, 9,621,000 L of routine waste were discharged (DOE 1991). The routine waste consisted of spent acid etch solutions (i.e., chromic, hydrofluoric, nitric, and sulfuric acids), typically neutralized with sodium hydroxide. Metal constituents included aluminum, chromium, copper, manganese, nickel, silicon, uranium, and zirconium (primarily in the form of precipitates after neutralization). The resultant slurry of liquid and metal precipitates was discharged into the basins.

Chemical analyses were not performed routinely on the waste discharged during the operating life of the basins; however, chemical waste disposal permits indicate that some of the waste was corrosive (high and low pH). Up to 700 μg/L of chromium were found in a monthly composite sample.

The neutralized waste contained high concentrations of nitrate and copper from the nitric acid used in the copper-stripping procedures. Chromium waste included hexavalent chromium, mostly from the chromic acid used in fuel fabrication. After 1983, hexavalent chromium was reduced to its trivalent state before disposal. Two other minor sources of chromium were the etching of stainless steel (mostly trivalent chromium) and the disposal of various industrial solutions.

The routine waste included uranium and technetium-99, causing the material to be categorized as nontransuranic, low-level, radioactive waste.

Nonroutine waste discharged to the basins periodically included unused chemicals and spent solutions from miscellaneous processes, development tests, and laboratories. These discharges included the following components: cadmium and cadmium compounds; copper and copper compounds; oxalic acid; cyanide, mercury, and lead compounds; barium perchlorate; hydrazine; chromium and chromium compounds; vanadium pentoxide; nickel and nickel compounds.

Analyses of basin concrete indicated chemical contamination above MTCA groundwater protection standards but below MTCA Method C industrial direct soil exposure standards. The concrete also contained contaminants above dangerous waste characteristic or criteria designation limits for arsenic, barium, beryllium, cadmium, chromium, lead, mercury, nickel, selenium, and silver (Butcher and Galbraith 1995; BHI 1996). Sampling of concrete cores through the basin indicated that listed constituents (i.e., vanadium pentoxide, formic acid, and cyanide salts) were contained in the concrete at levels below MTCA Method B residential direct soil exposure and groundwater protection standards.

After removal of the basin structures, sediments beneath the basin footprint were excavated and sampled. Results are discussed by Kramer (1996). Sediment removal began in February 1996. Initially, a 0.6-m layer was taken off the entire footprint of the basins. An overlying grid was constructed, and 11 sample locations were chosen at random, with one exception. One specific location of interest was sampled beneath basin 1, where high arsenic concentrations had been found through previous sampling and this area was targeted for more information gathering. The results of this sampling effort concluded that all constituents were removed from shallow sediments to levels below residential limits, with the exception of arsenic and the mobile constituents that were known to be found in deeper vadose sediments (e.g., hexavalent chromium, nitrate, and fluoride). Deep contamination was indicated only under basin 1. On completion of shallow sediment removal, the remaining footprint was surveyed and released from its designation as a radiological area.

Concentrations of arsenic in the shallow sediment ranged from less than detection to 9 mg/kg, with a mean of 6.5 mg/kg. (Samples from a nearby former orchard had a mean arsenic concentration of 11.4 mg/kg.) The maximum concentration of hexavalent chromium was 1 mg/kg.

Based on the results of the shallow sampling, more sediment was excavated from the area beneath former basin 1, and samples from a depth of 3.4 m were analyzed. Field screening techniques were used to collect most of the data. Hexavalent chromium was detected in deep sediment only at very low levels. Arsenic also met cleanup standards at 2.7 m. Nitrate and fluoride contamination was found much deeper than earlier characterization information indicated, so the sediments were excavated to 4.6 m below basin 1 (Kramer 1996). Also, a test pit was dug to 7.6 m. Analyses of this sediment revealed that nitrate and fluoride contamination above MTCA Method B groundwater protection standards was present. The depth to groundwater is 12 to 13 m.

Fluoride concentrations in the deep sediments ranged from less than detection to 542 mg/kg. Nitrate concentrations ranged from 26.9 to 1,930 mg/kg, with a mean of 919 mg/kg. Both nitrate and fluoride had higher concentrations in the deep sediments (3.4 m) than in the shallow sediments (1.1 m). The maximum concentration of hexavalent chromium at a depth of 3.4 m was 1.07 mg/kg.

3.0 Hydrogeology

This chapter describes the stratigraphy, physical hydrology, and groundwater chemistry beneath the 100-H Area, with emphasis on the shallow sediments.

3.1 Stratigraphy

The Hanford Site is underlain by unconsolidated sediments and the Columbia River Basalt Group. Unconsolidated sediments at the 100-H Area include Hanford gravels and the Ringold Formation (Figure 3). The stratigraphy of the 100-H Area has been described by Lindsey and Jaeger (1993).

Surface sediments at the 100-H Area include Holocene deposits and backfill, generally less than 1 m thick. The Hanford formation (informal name) lies under this veneer and comprises almost exclusively coarse-grained sand and granule to boulder gravel. These gravels are uncemented and matrix poor. Strata at the base of the Hanford formation may contain material eroded from the underlying Ringold Formation, including muddy gravels mixed with quartz-rich sands. The thickness of the Hanford formation ranges from 10 to 19 m across the 100-H Area.

The Ringold Formation is ~81 m thick beneath the 100-H Area, is relatively fine grained, and has gravel units of less than a few meters thick. This formation includes the following three main stratigraphic intervals: overbank/paleosol deposits, sand and interbedded overbank/paleosol deposits, and the lacustrine-dominated lower mud unit.

3.2 Physical Hydrogeology

The two major aquifer systems present beneath the 100-H Area are the suprabasalt system and the basalt/interbed system (see Figure 3). Within the suprabasalt system, the saturated portion of the Hanford formation is defined as the unconfined or uppermost aquifer, which is 1.8 to 5.5 m thick. The underlying Ringold sediments are finer grained and form the base of the aquifer. Confined aquifers are present in coarser-grained units within the Ringold Formation.

Liikala et al. (1988) provided estimates of transmissivity based on aquifer and laboratory tests. A range of results for different hydrologic units is presented in Tables 1 and 2. The unconfined Hanford formation is, in general, more transmissive than the underlying units, though the ranges of horizontal conductivity overlap.

Groundwater generally flows from west to east in the uppermost aquifer beneath the 100-H Area and discharges to the Columbia River. The direction of groundwater flow is interpreted from water-table maps and from the shape of the contaminant plume beneath the 183-H basins. The plume shape is

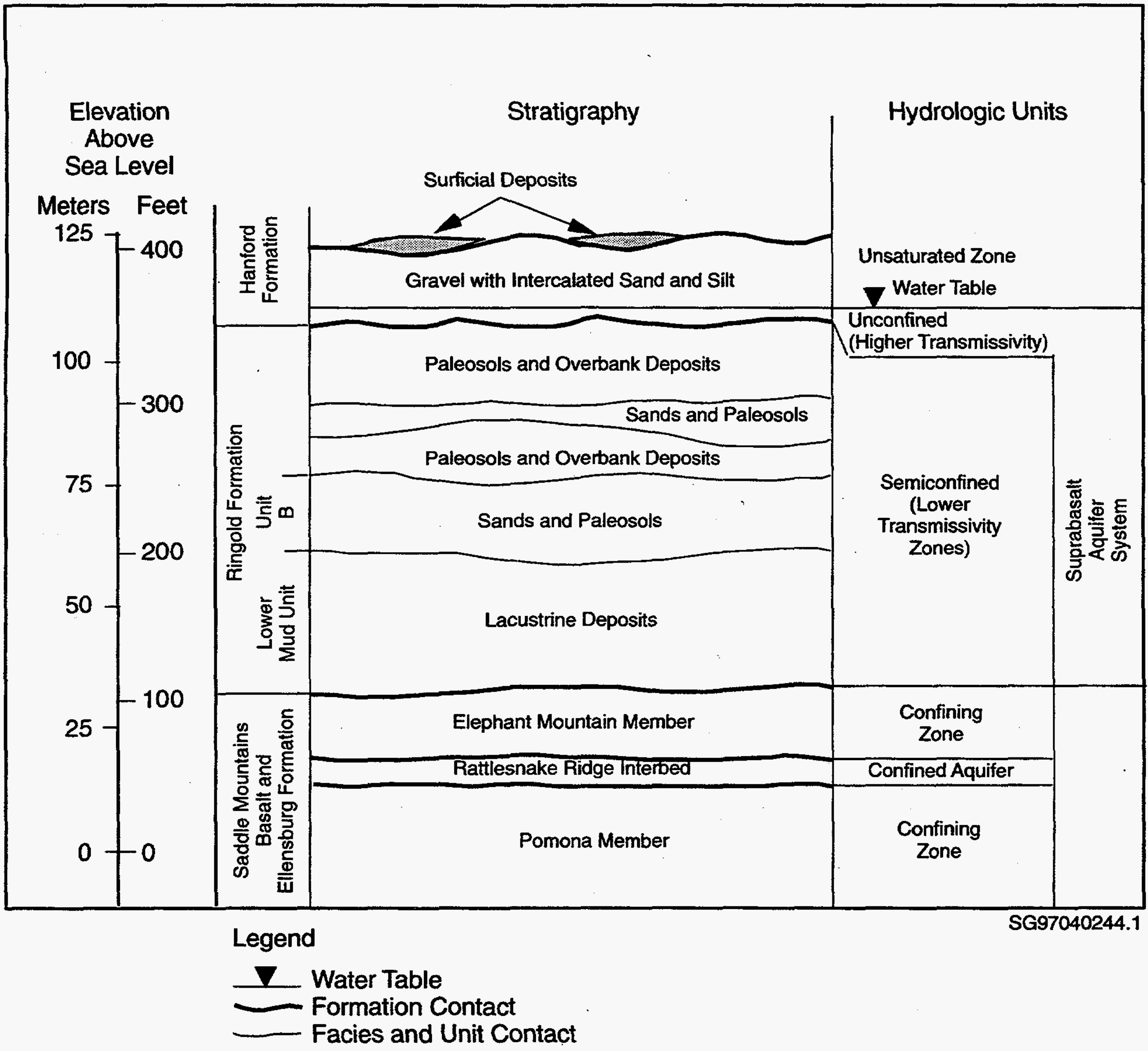

Figure 3. Generalized Hydrogeology of the 100-H Area

believed to indicate an "average" direction of flow from west to east. The water table is affected by daily and seasonal fluctuations in river stage, depending on dam operation upstream. When the river stage is high for weeks or months, the hydraulic gradient in the aquifer reverses near the river, and river water can flow into the aquifer (Figure 4). When the river level drops, this water flows from the bank back into the river. Figure 5 illustrates a more representative water table constructed from average water levels over a representative year.

Table 1. Aquifer Test Results (from PNL 1987 and Liikala et al. 1988)

Well	Transmissivity		Hydraulic Conductivity	
	ft^2/d	m^2/d	ft/d	m/d
Unconfined Aquifer (Hanford formation)				
199-H3-2A	19,000	1,800	1,900	580
199-H3-2B	600	56	100	30
199-H4-7	690(a)	64	70(a)	21
199-H4-10	53,500	4,970	5,900	1,800
199-H4-11	1,070	99	70	21
199-H4-12A	2,670	250	210	64
199-H4-12B	635	59	50	15
199-H4-13	4,240	390	420	130
199-H4-14	1,050	98	250(b)	76
199-H4-15A	2,340	220	200	60
199-H4-15B	5,530	514	460	140
199-H4-16	2,200	204	220	67
199-H4-18	550	51	80	24
Ringold Silty Sand and Gravelly Silty Sand (confining unit below unconfined aquifer)				
199-H3-2C	390	36	39	12
199-H4-12C	620	58	62	19
199-H4-15Cr	1,760	164	350	107
Ringold Upper Confined Aquifer				
199-H4-15Cq	0.7	0.07	0.14	0.043

Original transmissivity values in ft^2/d. Hydraulic conductivity calculated as $K = T/b$, where b = screened thickness (thickness of screened aquifer at the time of testing; i.e., water table to bottom of temporary screen or thickness of temporary screen, whichever is less).

(a) Liikala et al. (1988) state this number is an estimate.
(b) Well pumped dry.

Table 2. Vertical Hydraulic Conductivity

Well	Depth (ft)	Vertical Hydraulic Conductivity	
		ft/d	m/d
199-H4-12C	125 to 127	1.5E-02	4.6E-03
199-H4-15C	120 to 122	2.9E-03	8.8E-04
Laboratory analyses of split-spoon samples from "silty sand and gravelly silty sand" units (Liikala et al. 1988).			

No significant upward or downward gradient is apparent between the top of the Ringold Formation and the uppermost aquifer. Deeper confined aquifers in the Ringold Formation have higher heads than the unconfined aquifer (Liikala et al. 1988).

3.3 Groundwater Chemistry

Groundwater in the uppermost aquifer beneath the 100-H Area has been affected by liquid wastes discharged at various facilities, including the 183-H basins. The following contaminant plumes are present in the area: gross alpha/uranium, gross beta/technetium-99, tritium, nitrate, chromium, sulfate and sodium. These contaminants were all present in the wastes discharged to the 183-H basins, though chromium has other sources in the 100-H Area as well. Figures 6 through 9 illustrate the distribution of the major contaminants in the uppermost aquifer in January/February 1994. Maps constructed from data collected in 1995 and 1996 show plumes are more localized around the former basins because high river stage had diluted contaminants in groundwater near the river.

A peak in contaminant concentrations in wells monitoring the 183-H basins was observed in 1978, and is assumed to be the result of leakage from basin 1 (Figure 10). Waste was subsequently transferred from that basin to the adjacent lined basins. A second peak in contaminant concentrations was observed in 1986, and is believed to relate to cleanup activities in basin 1 (Peterson 1994). Smaller fluctuations in contaminant concentrations are related to changing stage of the Columbia River (Peterson 1990).

Contaminant concentrations generally decreased between 1986 and 1992 (Figures 11 through 14). From 1993 through 1996, concentrations have been higher, though seasonal lows are observed during periods of high river stage. The reason for the recent increase is unknown; no cleanup activities were under way that had a potential for affecting groundwater, and the increases do not appear to relate to river stage.

There is no conclusive evidence of downward migration of waste constituents from the 183-H basins based on wells completed in deeper aquifers. Well 199-H4-12C is directly in the area of basin contamination but is completed at mid-depth in a silty sand to gravelly silty sand unit in the Ringold Formation. Two adjacent wells, 199-H4-12A and 199-H4-12B, are completed at the top and bottom of

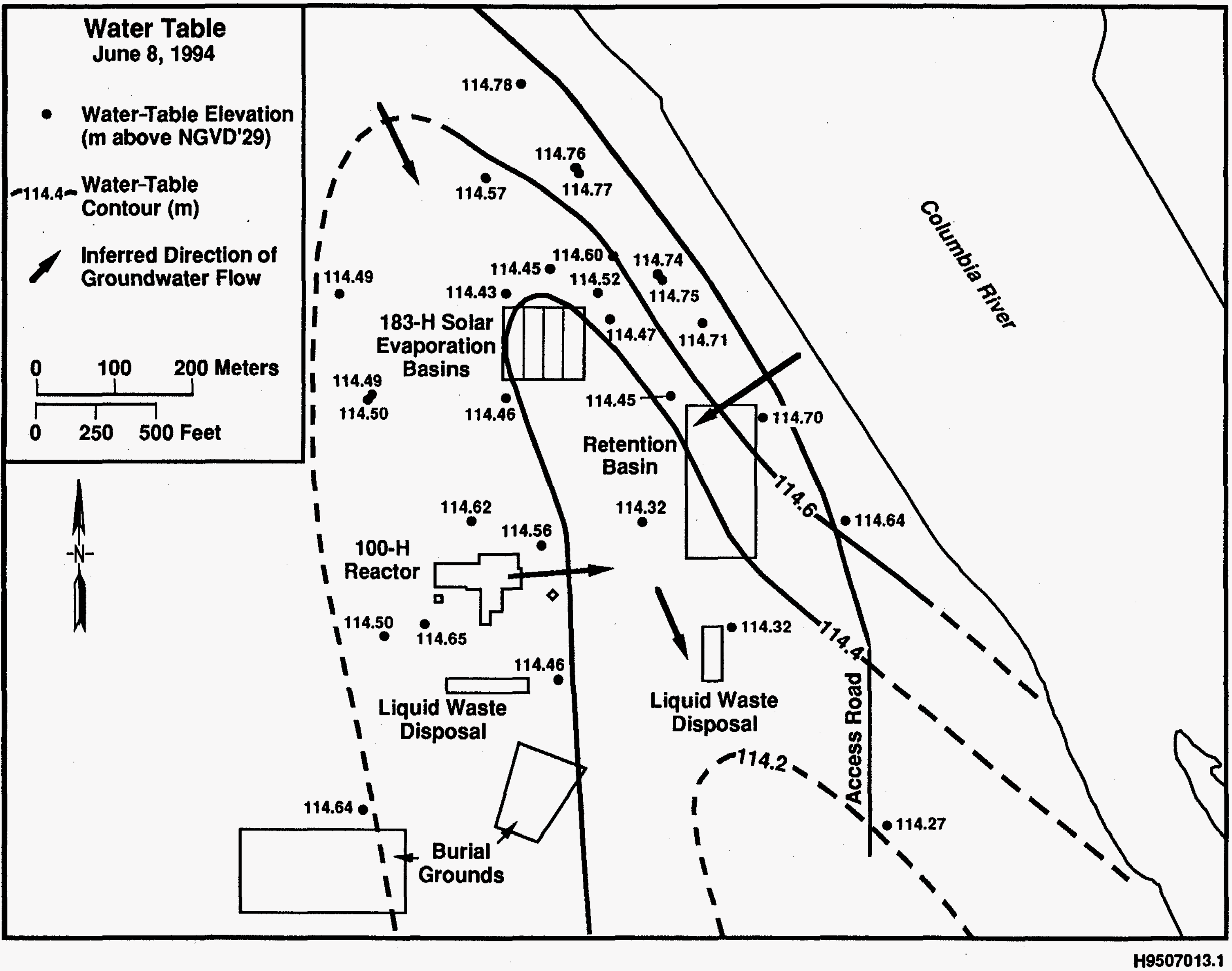

Figure 4. Water Table in the 100-H Area, June 1994

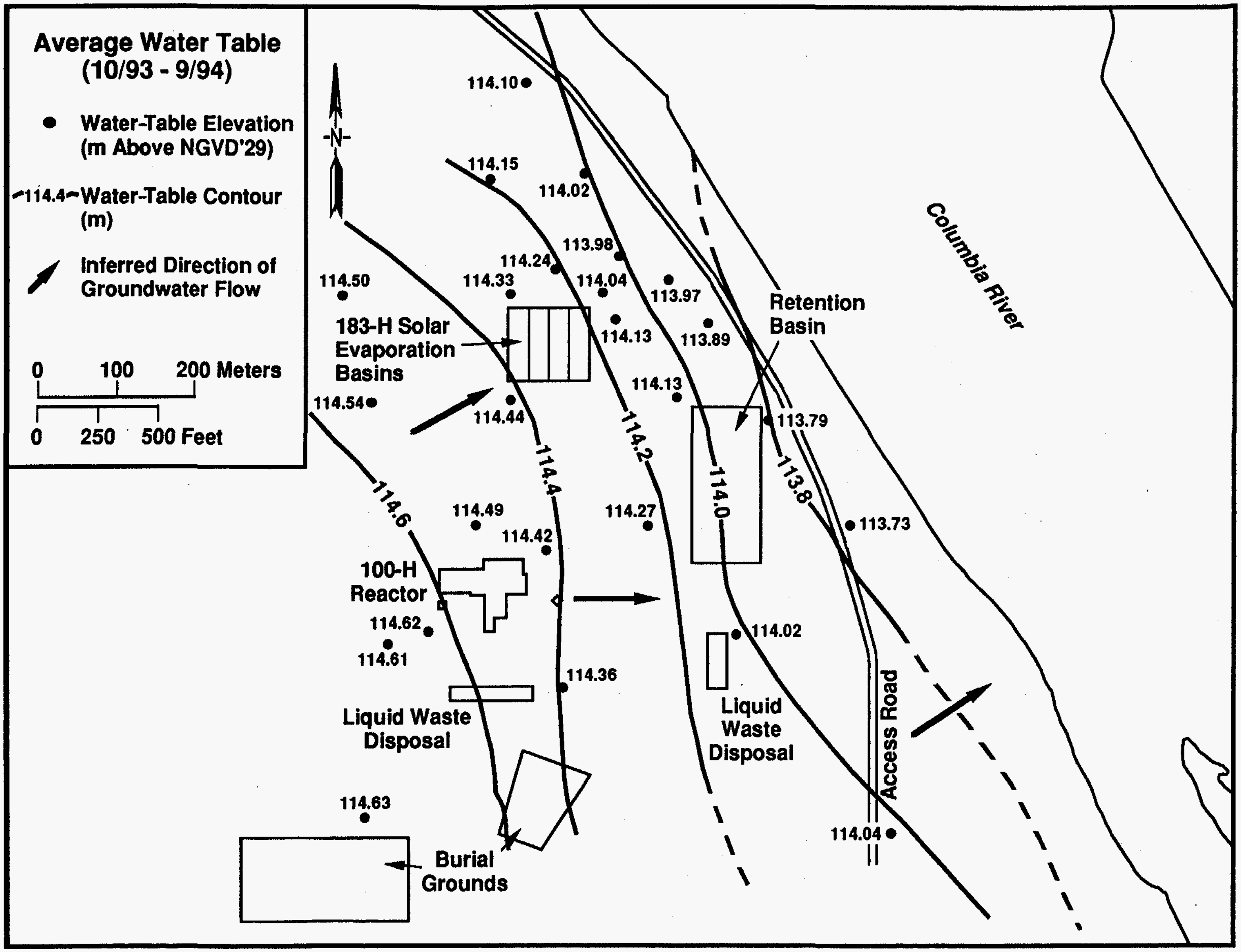

Figure 5. Average Water Table in the 100-H Area

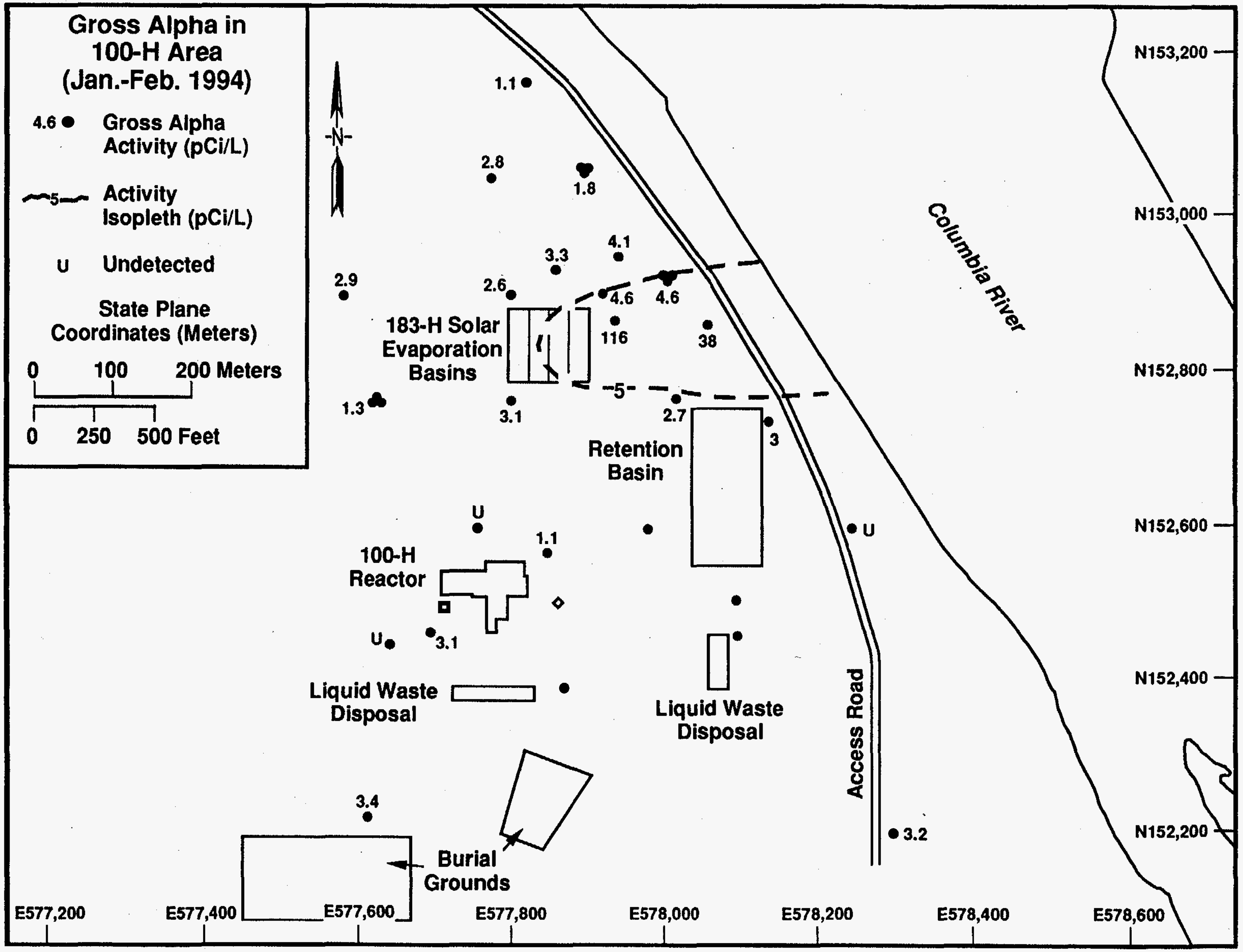

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Figure 6. Gross Alpha in the Uppermost Aquifer Beneath the 100-H Area, January and February 1994 (from Hartman 1995)

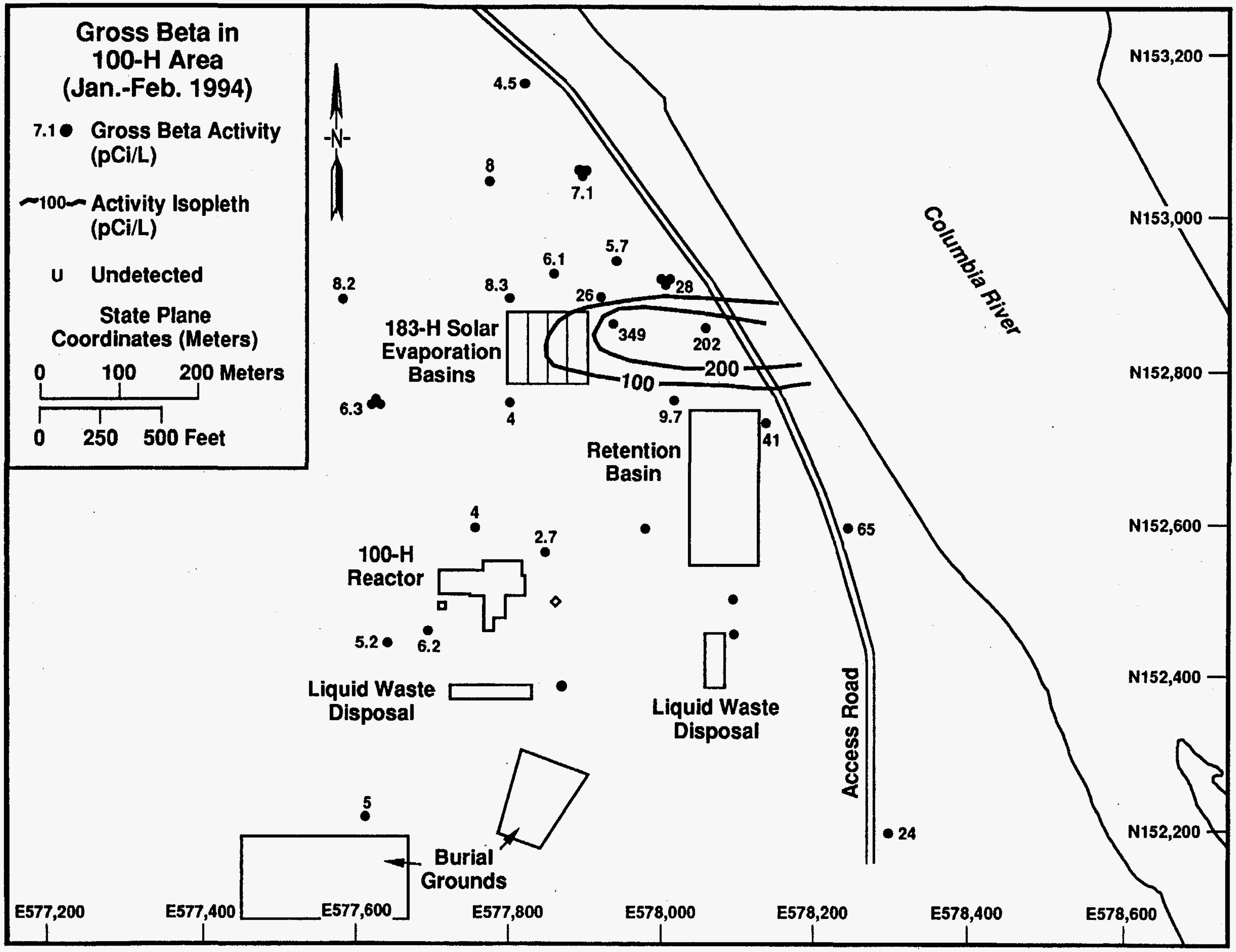

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Figure 7. Gross Beta in the Uppermost Aquifer Beneath the 100-H Area, January and February 1994 (from Hartman 1995)

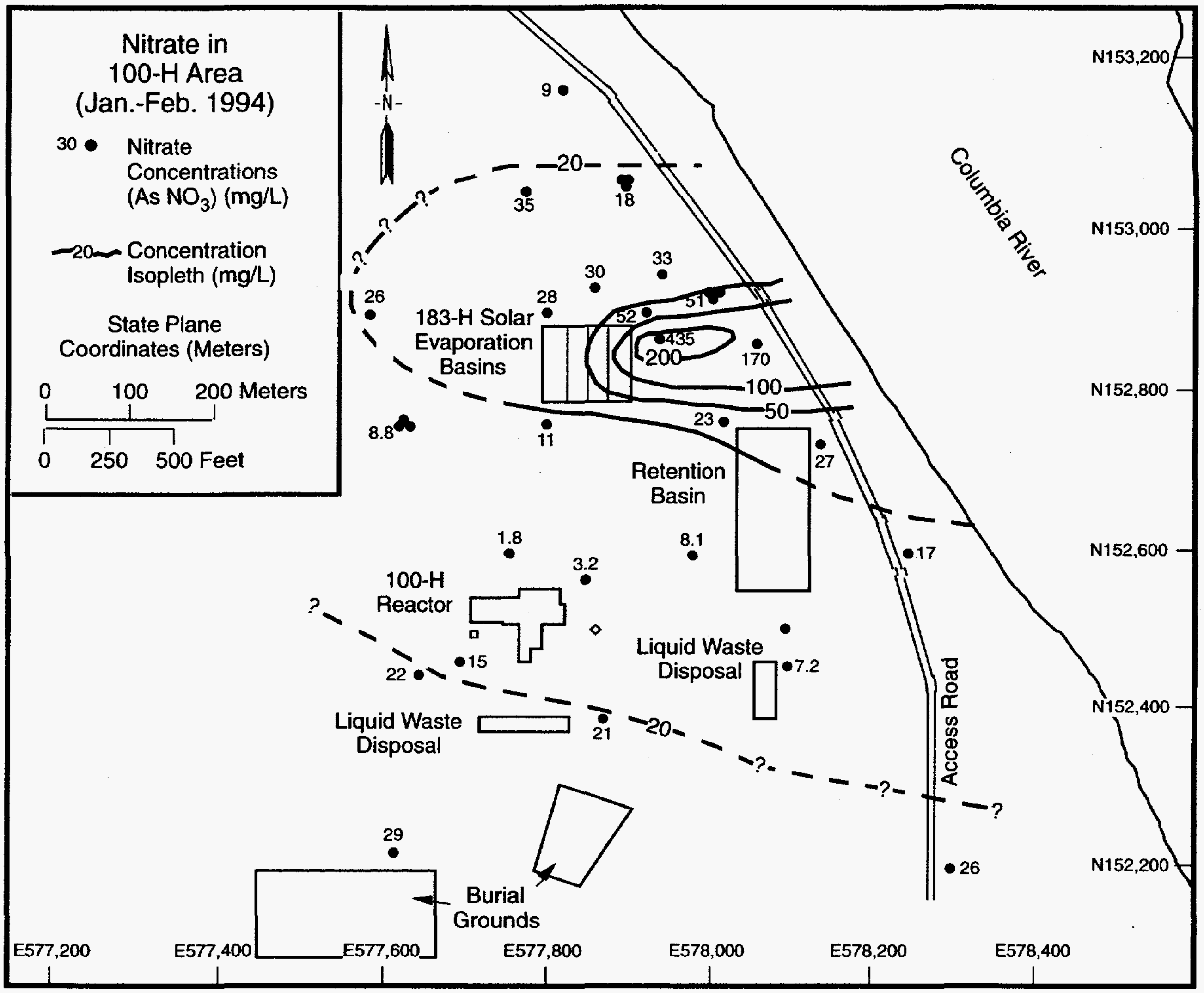

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Figure 8. Nitrate in the Uppermost Aquifer Beneath the 100-H Area, January and February 1994 (from Hartman 1995)

the unconfined aquifer, respectively. Technetium-99, uranium, and nitrate are low in well 199-H4-12C (Figures 15 and 16 illustrate the trends for uranium and nitrate); chromium is higher than in the shallower wells (Figure 17). If the 183-H basins were the source of the chromium, the other 183-H waste indicators would also be elevated, but these constituents were low in well 199-H4-12C. Thus, the source of deep chromium contamination is unclear.

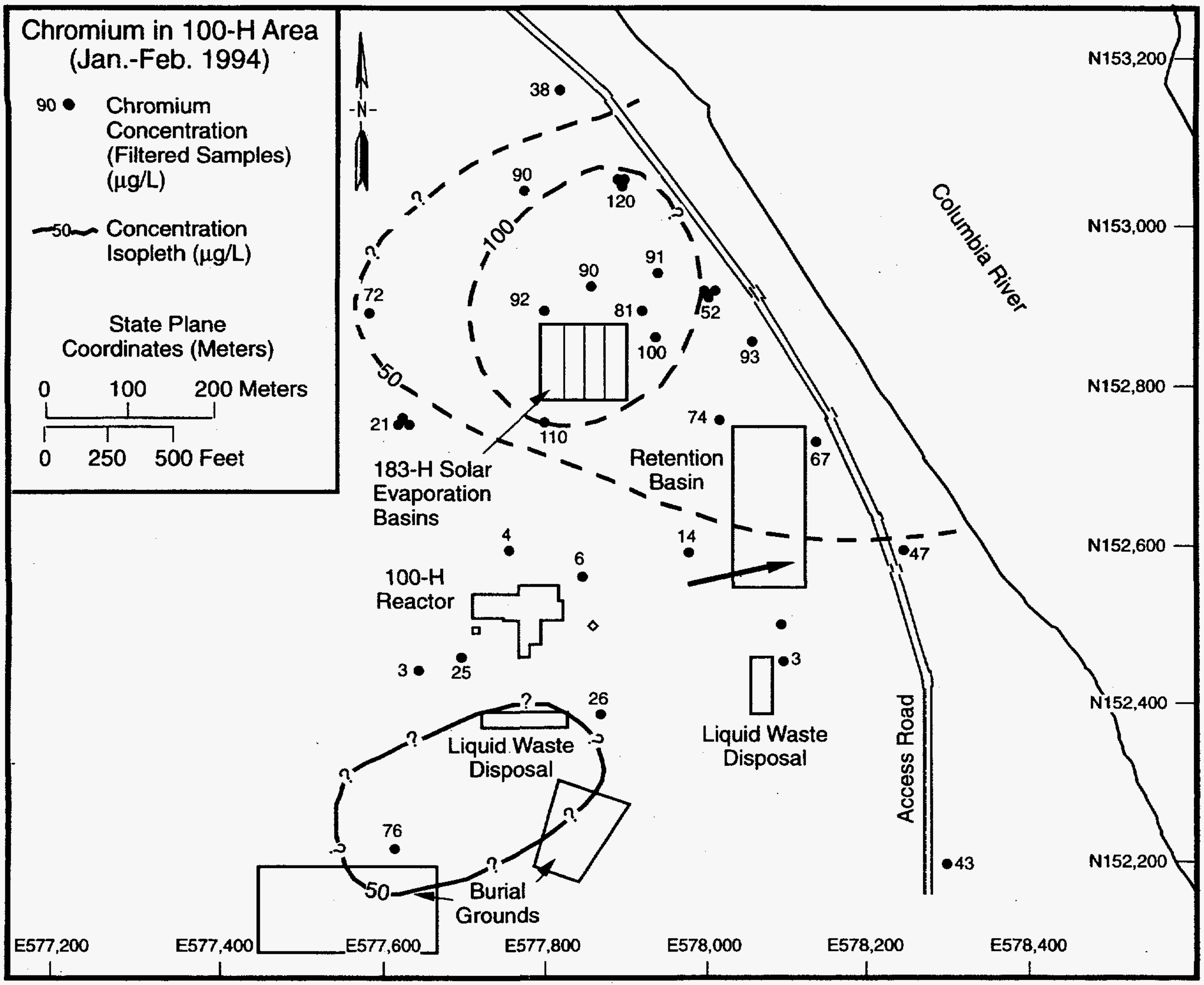

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Figure 9. Chromium in the Uppermost Aquifer Beneath the 100-H Area, January and February 1994 (from Hartman 1995)

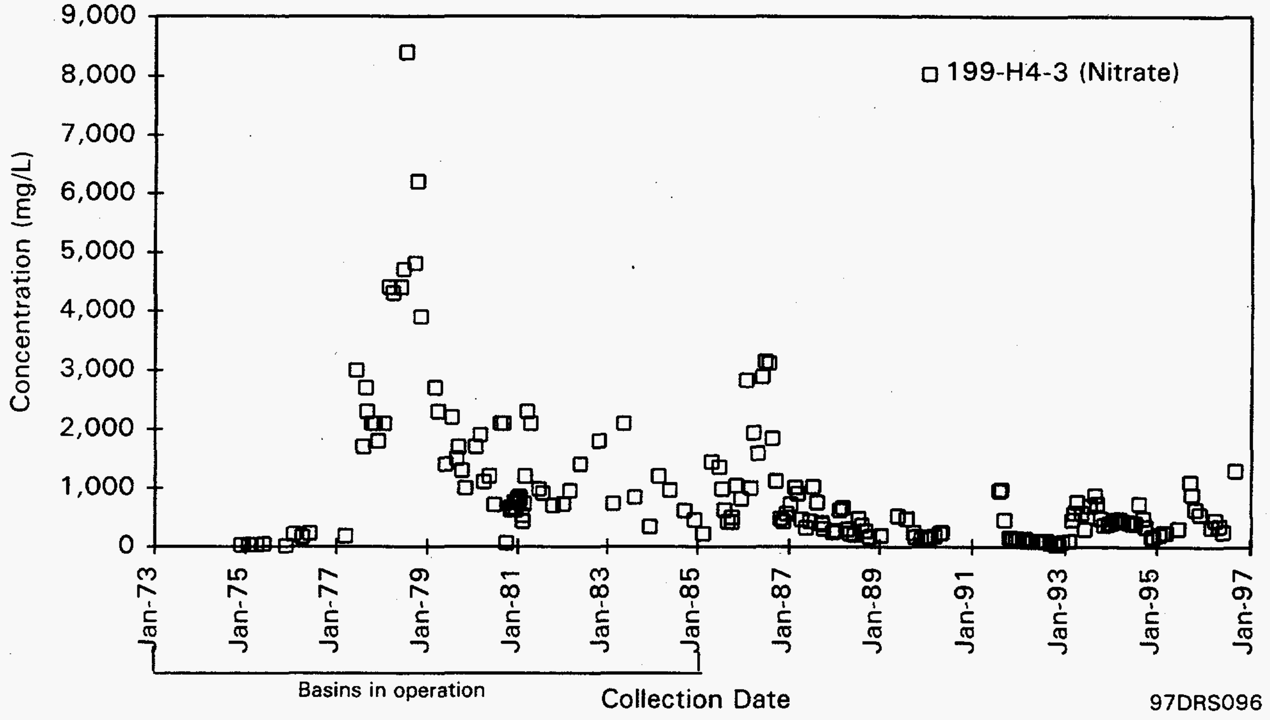


Figure 10. Nitrate Versus Time in Well 199-H4-3, 1974 Through 1996

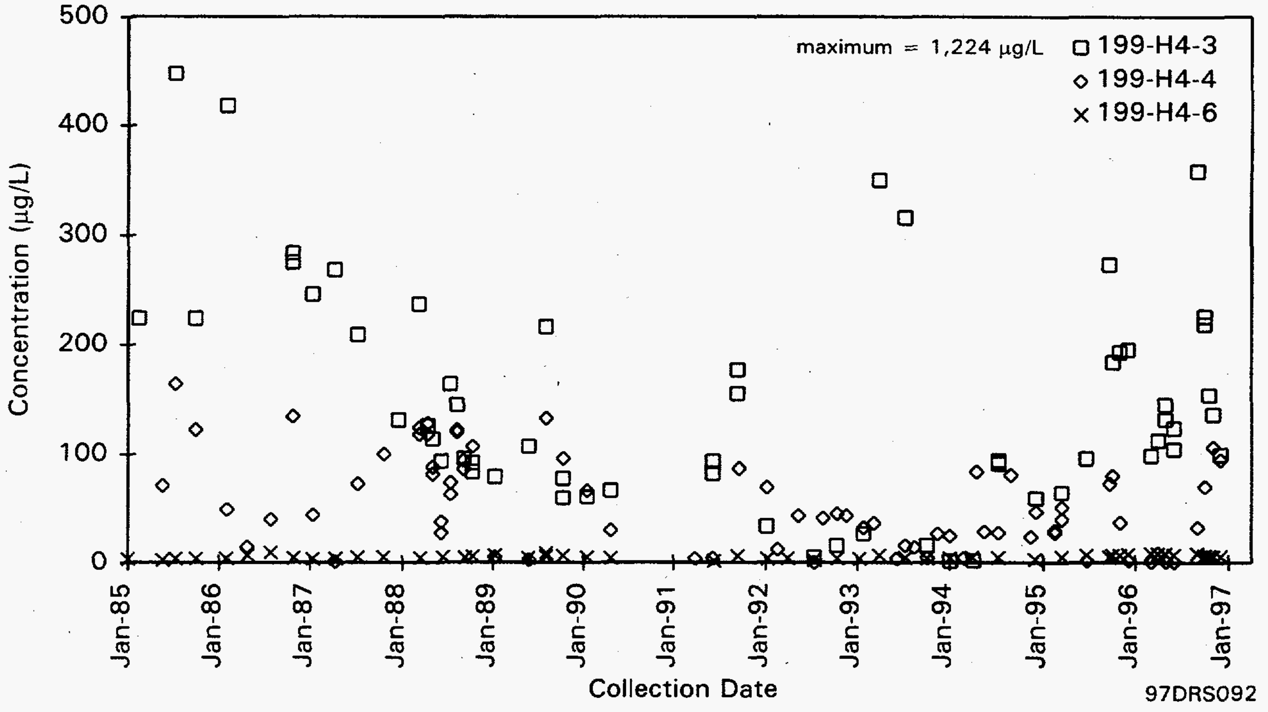


Figure 11. Uranium Versus Time in Groundwater at the 183-H Solar Evaporation Basins
(well 199-H4-3 had a maximum value of 2,090 μg/L in 1986)

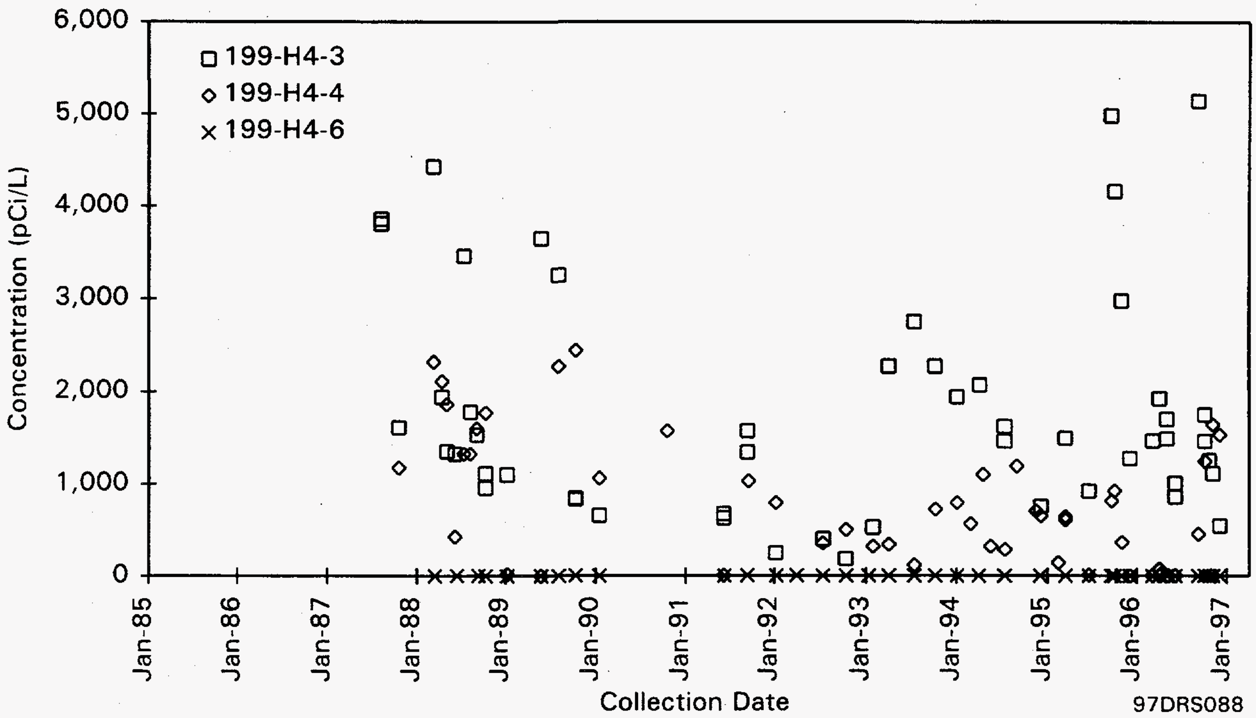
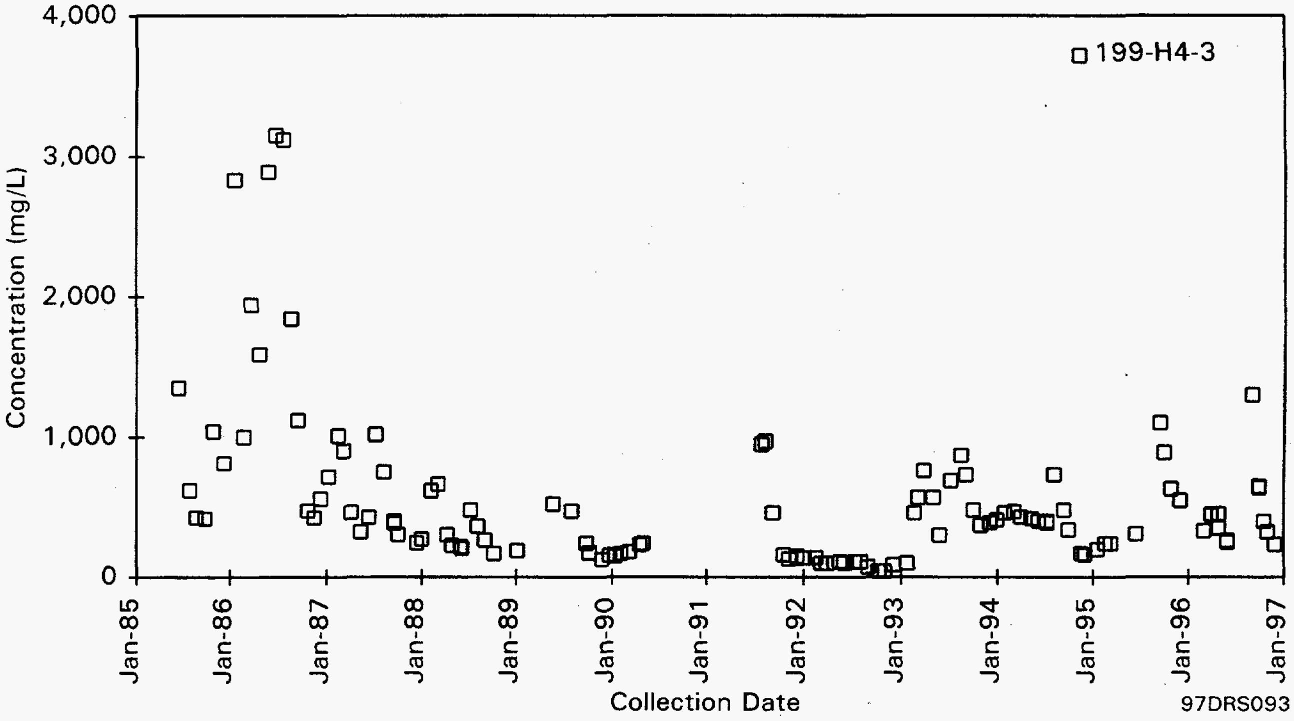


Figure 12. Technetium-99 Versus Time in Groundwater at the 183-H Solar Evaporation Basins

a)



b)

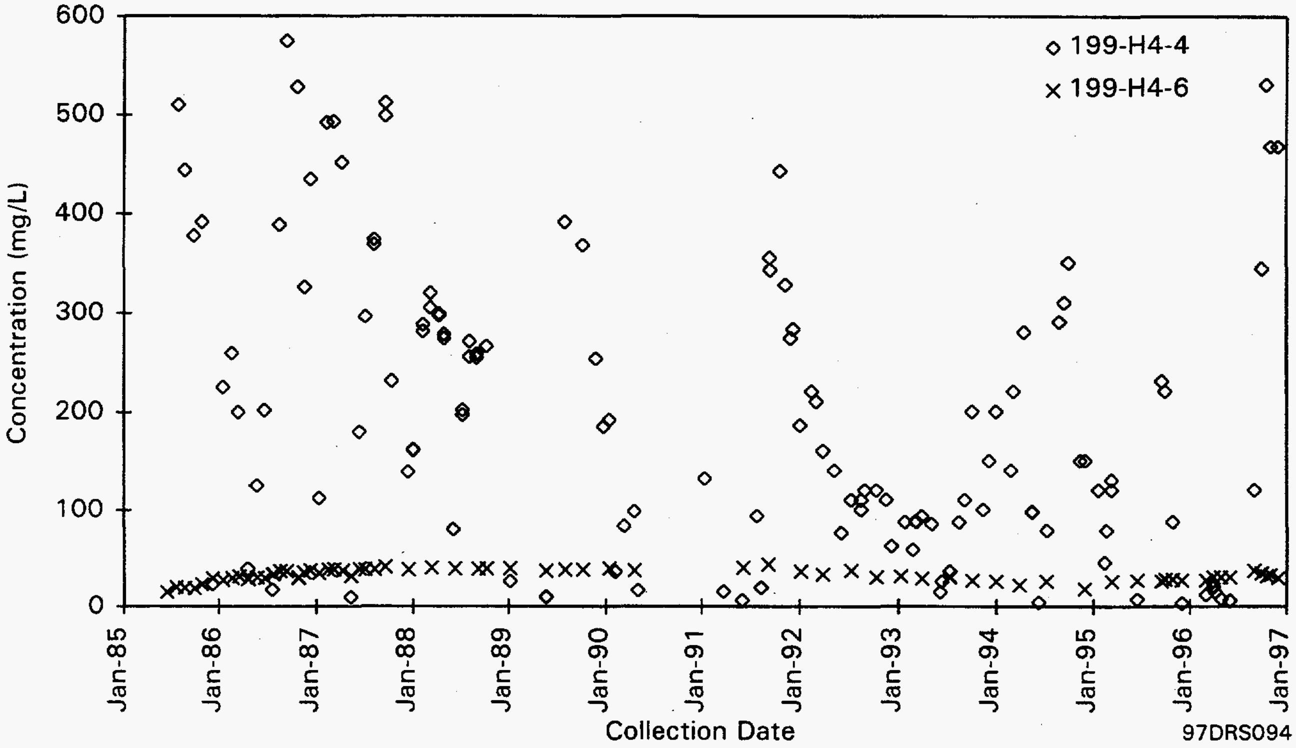


Figure 13. Nitrate Versus Time in Groundwater at the 183-H Solar Evaporation Basins

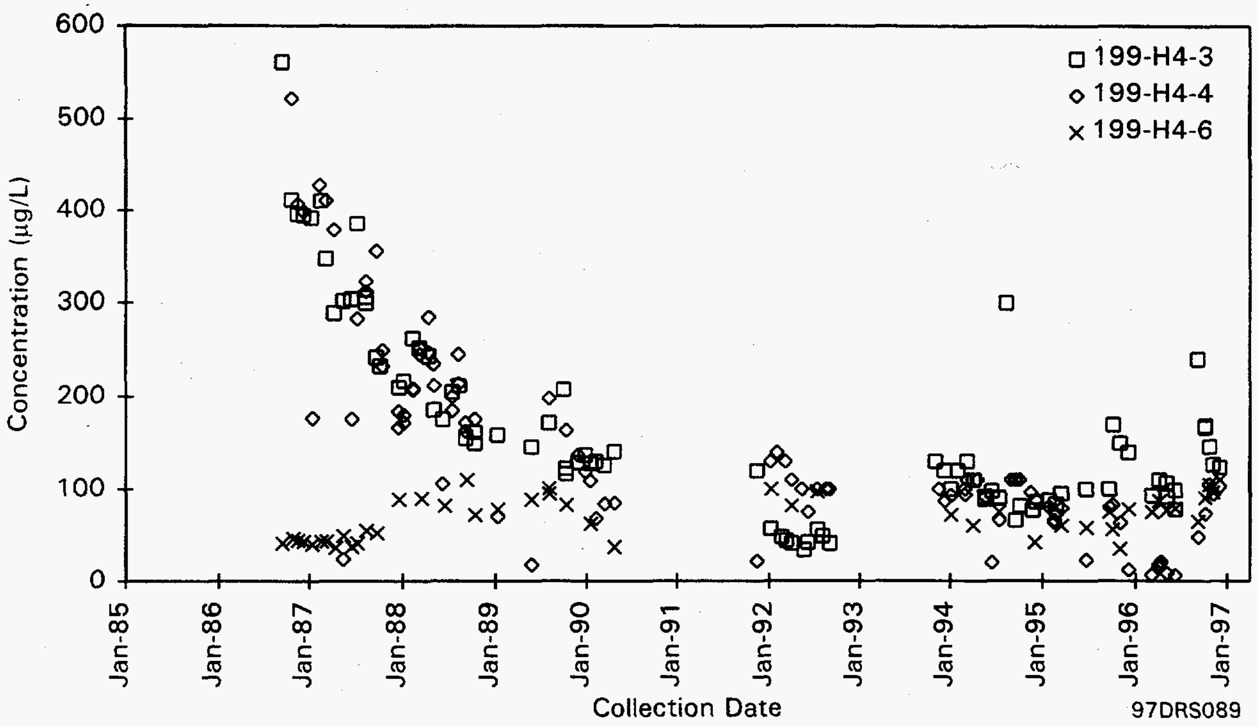


Figure 14. Chromium Versus Time in Groundwater at the 183-H Solar Evaporation Basins

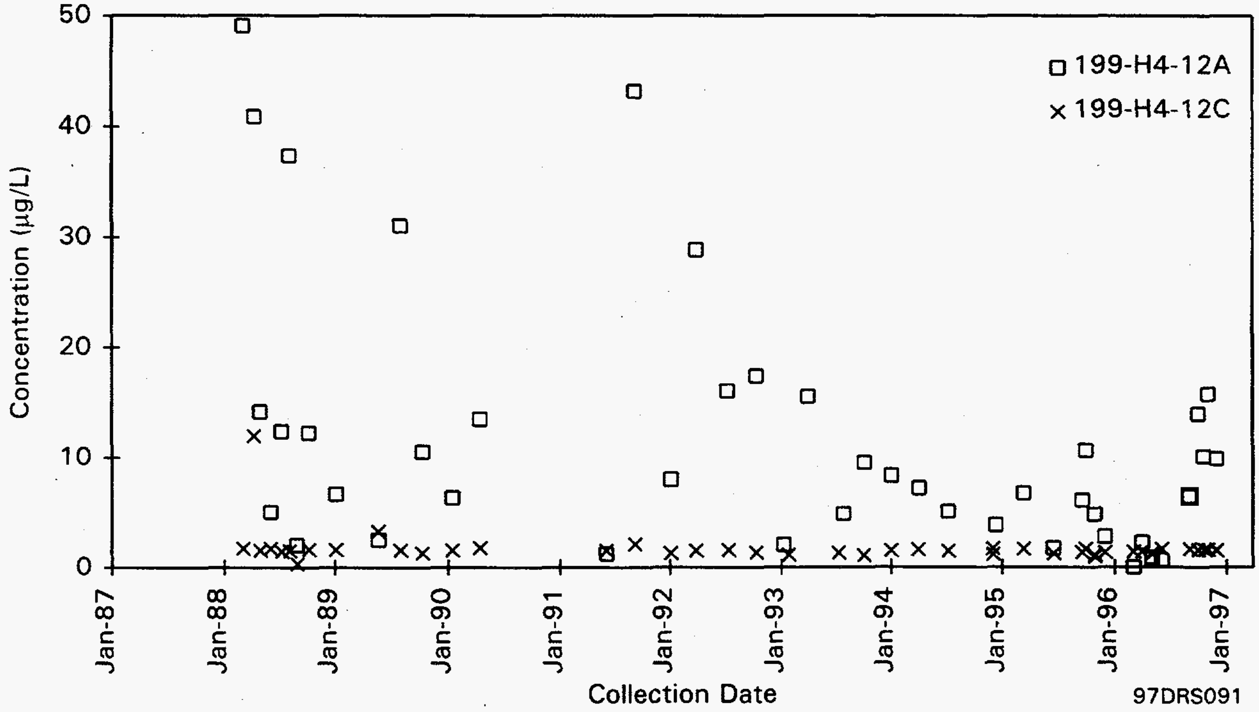


Figure 15. Uranium Versus Time in Wells 199-H3-12A (water table) and 199-H4-12C (Ringold)

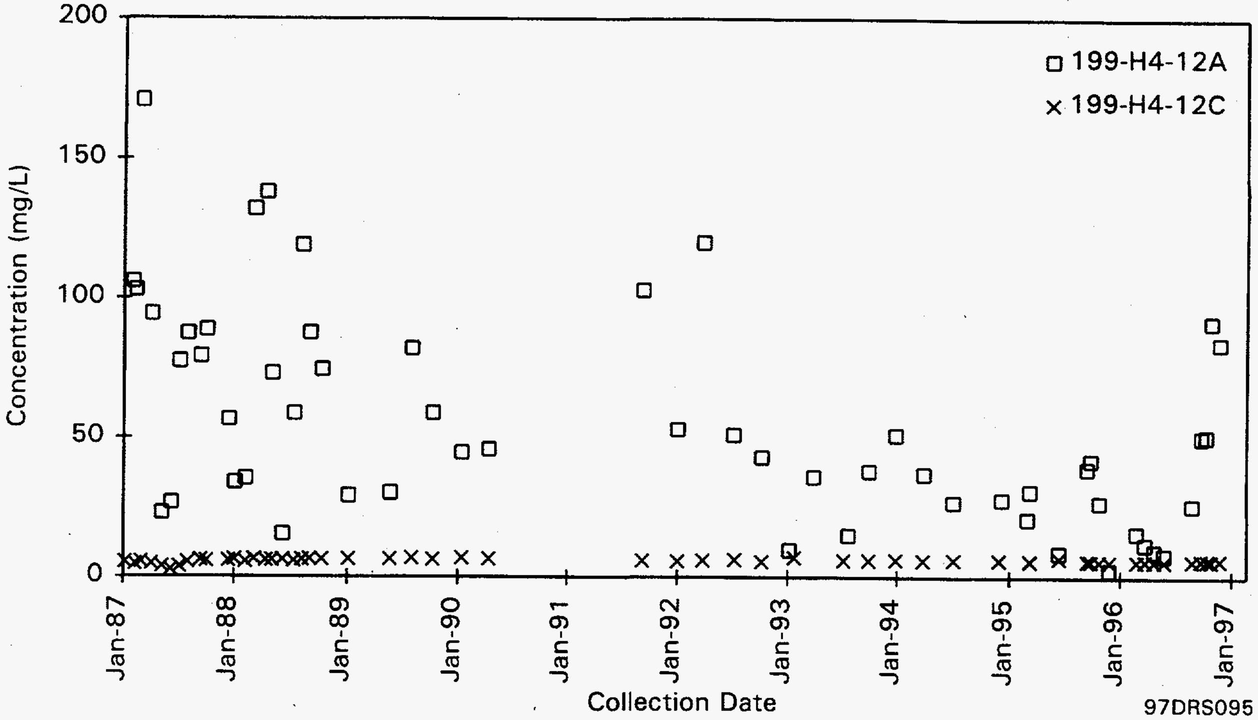


Figure 16. Nitrate Versus Time in Wells 199-H3-12A (water table) and 199-H4-12C (Ringold)

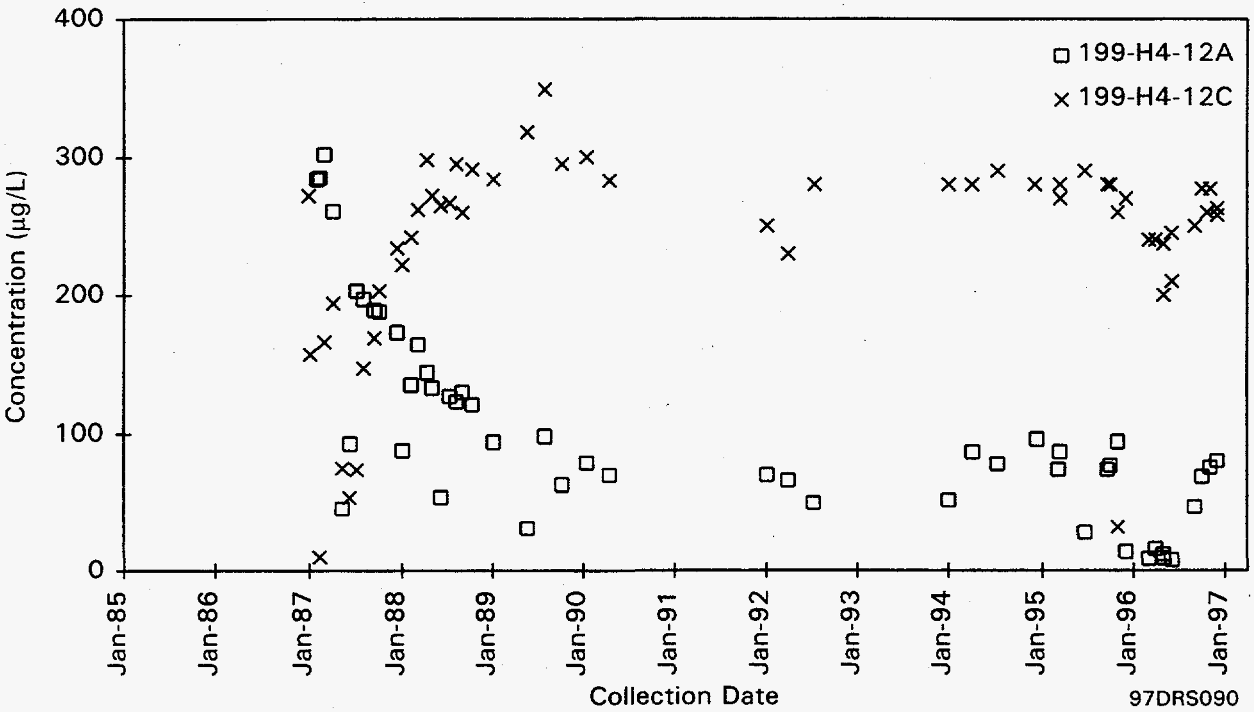


Figure 17. Chromium Versus Time in Wells 199-H3-12A (water table) and 199-H4-12C (Ringold)

4.0 Groundwater Monitoring Program

This chapter proposes the first phase of a final-status RCRA groundwater monitoring program for the 183-H basins. The groundwater monitoring program is designed to achieve the following goals in a technically sound and cost-effective manner:

- protect human health and the environment
- comply with the intent of final-status groundwater monitoring requirements for a corrective action program (WAC 173-303-645)
- contribute to groundwater investigation or remediation.

A monitoring network, consisting of a subset of existing wells, is defined, and the methods for sampling and analysis are described.

The elements of this monitoring program were determined through a data quality objectives process (EPA 1993). The primary purpose of this process is to ensure that the type, quantity, and quality of data used in monitoring are appropriate for their intended applications.

The well network, constituent list, and sampling frequency were proposed to Ecology in March 1997 (Appendix A). The monitoring network comprises four wells, compared to eight in the compliance program. Each well will be sampled once each year; wells were sampled eight times per year under the compliance program. Sampling will be coordinated with the IRM and operable unit-monitoring programs.

4.1 Objectives of RCRA Monitoring

Three stages of monitoring with three separate objectives are defined in WAC 173-303-645. Detection monitoring, outlined in WAC 173-303-645 (9), is designed to determine whether a RCRA unit has adversely affected groundwater quality (i.e., whether a leak has occurred). This is accomplished by comparing downgradient concentrations of site-specific parameters to values indicative of background concentrations. If a statistically significant increase (or pH decrease) over background occurs in any downgradient well, compliance monitoring is initiated. In compliance monitoring, downgradient groundwater concentrations of constituents of concern are compared to the concentration limits set in the facility's permit and monitoring plan. Concentration limits may be those specified in WAC 173-303-645 (5) (a) or alternative limits set by Ecology. If the concentration limits are exceeded, the site enters a corrective action program.

The 183-H basins have contaminated groundwater with chromium, nitrate, technetium-99, and uranium at concentrations that are greater than concentration limits defined by Hartman and

Chou (1995). Thus, a corrective action is required by RCRA and is deferred to groundwater cleanup under the 100-HR-3 Groundwater Operable Unit. RCRA monitoring during the IRM is intended to determine whether concentrations of the contaminants of concern are decreasing. If concentrations do not decrease significantly, the IRM design will be reevaluated.

4.2 Dangerous Waste Constituents

Chromium, nitrate, technetium-99, and uranium are the contaminants of concern for the 183-H basins (Hartman and Chou 1995). As discussed in Section 3.3, the basins have contributed chromium, nitrate, sulfate, sodium, technetium-99, and uranium to the groundwater. Of these, only chromium[a] and nitrate are dangerous waste constituents. The radioactive portion of mixed waste is interpreted by DOE to be regulated under the *Atomic Energy Act of 1954*; the nonradioactive dangerous portion of mixed waste is interpreted to be regulated under RCRA and WAC 173-303. It is the position of DOE that any procedures, methods, data, or information associated with this monitoring program that relate solely to the radioactive constituent of mixed wastes is outside the scope of the Hanford Facility RCRA Permit but are included for the sake of completeness. It is the position of Ecology that the radioactive portion influences safe storage of the waste and, therefore, information about radioactive constituents is necessary to ensure compliance with WAC 173-303 and the RCRA permit. Both agencies acknowledge the other's position, but to avoid a conflict on the issue, DOE has agreed to provide information on radioactive constituents without agreeing with Ecology's position and Ecology has agreed to accept the information in this context without giving up its position.

The following factors were considered by Hartman and Chou (1995) in deriving a constituent list for the 183-H basins: process knowledge, history of detection in site groundwater, and other sources of contamination in the area. A database of groundwater chemistry data was queried for candidate constituents for upgradient wells 199-H3-2A and 199-H4-6 and downgradient wells 199-H4-3, 199-H4-4, 199-H4-9, 199-H4-12A, and 199-H4-18. These wells were chosen to represent conditions upgradient of the basins and in the most contaminated zone downgradient of the basins.

The maximum concentration limits (MCLs) for 14 constituents are defined in Table 1 of WAC 173-303-645. Groundwater data for 183-H wells were compared to those limits (Table 3). Chromium was the only constituent that significantly exceeded the limit. Chromium concentrations exceeded the MCL in upgradient and downgradient wells. One value of silver in an upgradient well exceeded the MCL but it was orders of magnitude greater than the rest of the data from the same well and is a suspected error.

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[a] Hexavalent chromium is a dangerous waste constituent. Dissolved chromium in groundwater is assumed to be hexavalent chromium, the most soluble species.

Table 3. Groundwater Quality Compared to Drinking Water Standards

Constituent	Standard[a]	Limit	Exceed	Concentration Range[b] (µg/L) and Comments
WAC 173-303-645, Table 1				
Arsenic	-645	50 µg/L	No	All data <5 - 15 (filtered) <5 - 13 (unfiltered)
Barium	-645	1,000 µg/L	No	<20 - 110 (filtered) <20 - 190 (unfiltered)
Cadmium	-645	10 µg/L	No	<2 (filtered) <2 (unfiltered)
Chromium	-645	50 µg/L	Yes	16 - 300 (filtered) <20 - 1300 (unfiltered)
Lead	-645	50 µg/L	No	All data after 1985 <5 - 7.3 (filtered) <5 - 11.2 (unfiltered)
Mercury	-645	2 µg/L	No	All data after 1985 <0.1 (filtered) <0.1 (unfiltered)
Selenium	-645	10 µg/L	No	All data <5 (filtered) <5 - 7 (unfiltered)
Silver	-645	50 µg/L	Yes[c]	<20 (filtered) <20 (unfiltered, excluding outlier)
Endrin	-645	0.2 µg/L	Yes[d]	All data <1
Lindane[e]	-645	4 µg/L	No	All data <1
Methoxychlor	-645	100 µg/L	No	All data <3
Toxaphene	-645	5 µg/L	No	All data <1
2,4-D	-645	100 µg/L	No	All data <2
2,4,5-TP silvex	-645	10 µg/L	No	All data <2
U.S. Environmental Protection Agency Primary and Secondary Standards[f]				
1,1,1-Trichloroethane	Final MCL (EPA 1996)	200 µg/L	No	<200, except one value flagged for blank contamination
Tetrachloroethylene	Final MCL (EPA 1996)	5 µg/L	Yes[d]	All data <10 detections rare and sporadic
Methylene chloride[g]	Final MCL (EPA 1996)	5 µg/L	No	<5, except one value flagged for blank contamination

Table 3. (contd)

Constituent	Standard[a]	Limit	Exceed	Concentration Range[b] (μg/L) and Comments
Antimony	Final MCL (EPA 1996)	6 μg/L	Yes	<26 - 47 (filtered) <26 - 100 (unfiltered)
Aluminum	Final SMCL (EPA 1996)	50 to 200 μg/L	Yes	<19 - 82 (filtered) <19 - 2,800 (unfiltered)
Iron	Final SMCL (EPA 1996)	300 μg/L	Yes	All but 3 filtered samples <300 <5 - 1,700 (filtered) <20 - 5,800 (unfiltered)
Manganese	Final SMCL (EPA 1996)	50 μg/L	Yes	All but 2 filtered samples <50 <0.72 - 55 (filtered) <0.72 - 2,100 (unfiltered)
Nickel	Final MCL (EPA 1996)	100 μg/L	Yes	All but 1 filtered sample <100 <13 - 180 (filtered) <13 - 580 (unfiltered)
Uranium	EPA Proposed 1991 (EPA 1996)	20 μg/L	Yes	<0.3 - 534
Technetium-99	NIPDWR	900 pCi/L	Yes	0 - 2,750 pCi/L
Gross alpha	NPDWR 1991 40 CFR 141	15 pCi/L	Yes	<0.41 - 4,700 pCi/L
Gross beta	NPDWR 1991 40 CFR 141	50 pCi/L	Yes	<1.66 - 820 pCi/L

(a) Abbreviations for standards:

-645 μg/L	WAC 173-303-645, Table 1 (maximum concentration limits).
CFR	Code of Federal Regulations.
MCL	Maximum contaminant level.
NIPDWR	National interim primary drinking water regulation.
NPDWR	National primary drinking water regulation.
SMCL	Secondary maximum contaminant level.

(b) Range in wells 199-H3-2A, 199-H4-3, 199-H4-4, 199-H4-6, 199-H4-9, and 199-H4-18; from samples analyzed by DataChem Laboratories (after December 31, 1991), except where few or no data were available after that date, all data used as noted.

(c) One value exceeded the standard, but data review has been requested because result was unrealistically large.

(d) Samples had no detectable concentration of the constituent; exceedance caused by detection limits larger than standards.

(e) Lindane also known as gamma-BHC.

(f) Selected constituents for which there was at least 1 exceedance or for constituents where detection limit is greater than the MCL; at least 1 detection.

(g) Methylene chloride also known as dichloromethane.

Groundwater data for the 183-H basins were also compared to EPA current and proposed drinking water standards, as compiled by Buonicore (1995), and limits for gross alpha, gross beta, technetium-99, and uranium. (Appendix B contains a complete list of standards used.) Significant exceedances (see Table 3) were observed for gross alpha, gross beta, nitrate, technetium-99, and uranium. Standards were also exceeded for aluminum, antimony, iron, manganese, and nickel, but virtually only in unfiltered samples. These samples contained particulate matter believed to be derived from well screens and/or aquifer sediments. Filtered samples are believed to be more representative of groundwater quality. Exceedances could not be determined for some additional constituents that have detection limits greater than the drinking water standards. If the constituent was never detected, it does not appear in Table 3. Tetrachloroethylene has been detected sporadically, but is not believed to be significant. Gross alpha activity in 183-H groundwater comes from uranium. Gross beta activity in 183-H groundwater results from contamination with technetium-99.

The constituent list proposed in this monitoring plan includes fluoride, which was not identified as a groundwater contaminant of concern by Hartman and Chou (1995). Fluoride is present in the vadose zone beneath the former basins (see Section 2.2), and is currently below regulatory standards in groundwater downgradient of the former basins. However, fluoride concentrations downgradient of the basins are higher than upgradient. For example, fluoride in well 199-H4-3 averaged 983 µg/L between 1992 and 1996. The average concentration in upgradient well 199-H4-6 during the same period was 444 µg/L. Groundwater will continue to be analyzed for this constituent to determine whether fluoride continues to be elevated in downgradient wells.

4.3 Concentration Limits

Hartman and Chou (1995) identified the following concentration limits for the constituents of concern at the 183-H basins:

- chromium: 122 µg/L, based on background concentrations from upgradient wells 199-H3-2A and 199-H4-6
- nitrate: 45,000 µg/L (as NO_3), based on final MCL (EPA 1996)
- uranium: 20 µg/L, based on EPA proposed MCL (EPA 1996) (this value is proposed for the 183-H basins until the rule containing the subject standard is promulgated)
- technetium-99: 900 pCi/L, based on national primary drinking water standards (40 CFR 141).

These concentration limits were applied during compliance monitoring to determine whether corrective action was necessary as required under WAC 173-303-645. No formal comparison of contaminant concentrations to these limits will be made during the IRM. After completion of the IRM and future phases of corrective action, the RCRA monitoring program will be revised and contaminant concentrations will be compared to these or alternative limits to determine whether the corrective action was successful.

4.4 Point of Compliance

The point of compliance is defined in WAC 173-303-645 (6) as "...a vertical surface located at the hydraulically downgradient limit of the waste management area that extends down into the uppermost aquifer underlying the regulated units." This is the location in the uppermost aquifer where groundwater monitoring takes place and the groundwater protection standard applies. Six monitoring wells located downgradient of the 183-H basins in the contaminant plume represented the point of compliance for the compliance program.

The point of compliance is not applicable during the first phase of corrective action. After the IRM and future phases of corrective action are complete, the point of compliance will be redefined if necessary to account for changes in groundwater-flow directions. Subsequent monitoring programs will be developed to determine whether the concentrations of contaminants of concern have decreased below the concentration limits defined in Section 4.3 and whether they remain there for a period of 3 consecutive years.

4.5 Compliance Period

The compliance period is the number of years equal to the active life of the unit, any waste management activity before permitting, and the closure period. Typically, groundwater monitoring is required for 30 years following completion of closure activities, though this period may be shortened or extended by the regulatory authority. If the site undergoes corrective action, the compliance period will be extended until it can be demonstrated that the applicable limit has not been exceeded for 3 consecutive years.

4.6 Groundwater Monitoring Wells

Four wells located in the 183-H chromium plume will be monitored for RCRA requirements during pump-and-treat activities (Table 4). No upgradient wells will be monitored for RCRA while the 183-H IRM is active. Monitoring upgradient wells does not contribute to the primary objective of RCRA monitoring, which is to track concentration trends in the contaminant plume. Upgradient wells will be monitored under CERCLA. Three of the wells are completed at the top of the uppermost aquifer: wells 199-H4-7 and 199-H4-12A are extraction wells and well 199-H4-3 is a monitoring well that has historically shown the highest levels of contamination from the 183-H basins. Modeling of the capture zone for the planned IRM indicates these 3 wells will monitor water that flows directly beneath the 183-H basins.

Table 4. Proposed Final-Status Monitoring Network During Chromium Interim Remedial Action

Well	Lambert Coordinates (m)		Top of Casing (m [ft])		Surface Elevation[a] (m [ft]) NGVD29
	East	North	NAD88	NGVD29	
199-H4-3	577,940.49	152,858.54	129.299 (424.21)	128.268 (420.83)	127.460 (417.18)
199-H4-7	577,804.13	152,890.85	129.38 (424.48)	128.35 (421.09)	127.72 (419.04)
199-H4-12A	578,009.15	152,912.73	127.216 (417.38)	126.185 (413.99)	125.439 (411.55)
199-H4-12C	578,011.77	152,919.81	127.23 (417.41)	126.20 (414.03)	125.33 (411.19)

Well	Drill Date	Construction (m [ft])			Average Water Level, 1994 (m [ft])	Thickness of Screened Aquifer[e] (m [ft])	Unit Monitored
		Type[b]	Screen Depth[c]	Screen Elevation[d]			
199-H4-3	5/74	A	10.4 to 16.8 (34 to 55)	117.1 to 110.7 (383 to 362)	113.95 (373.86)	3.3 (12)	Hanford unconfined
199-H4-7	9/86	B	11.6 to 16.2 (38 to 53)	116.1 to 111.6 (381 to 366)	114.13 (374.45)	2.4 (8)	Hanford unconfined
199-H4-12A	11/86	B	10.1 to 14.6 (33 to 48)	115.3 to 110.8 (379 to 364)	113.85 (373.53)	3.1 (10)	Hanford unconfined
199-H4-12C	11/86	B	21.9 to 25.0 (72 to 82)	103.3 to 100.3 (339 to 329)	113.78 (373.28)	3.0 (10)	Ringold (semiconfined)

Coordinates and elevations from U.S. Army Corps of Engineers survey in 1993.
NAD88 = North American Datum of 1988. NGVD29 = National Geodetic Vertical Datum of 1929.
(a) Brass cap in concrete pad.
(b) Well casing and screen:
A = Perforated, 8-in.-dia. carbon steel casing. No documented annular seal or sand pack. Concrete pad at surface (depth not documented).
B = 6-in.-dia. stainless steel casing with threaded screen. Annular seal from above screen to surface.
(c) Screen depths are from ground surface as noted in geologist's logs.
(d) Surface elevation minus screen depth.
(e) For water-table wells, average water level minus elevation of bottom of screen. For well 199-H4-12C, screened thickness.

Well 199-H4-12C is located adjacent to well 199-H4-12A and is completed in a silty unit of the Ringold Formation. As discussed in Section 3.3, this well consistently has elevated concentrations of chromium, though the contaminant source is unknown. This well will be monitored to ascertain whether pumping the shallow aquifer affects chromium concentrations deeper in the Ringold sediments.

Well 199-H4-3 does not meet the requirements of WAC 173-160 for resource protection wells because it is constructed of perforated (not screened) carbon steel casing. No documentation exists that shows an annular seal being installed when the well was constructed, but it is known that a surface seal was added later. Well 199-H4-3 has consistently shown the highest levels of nitrate, technetium-99, and uranium contamination, and its inclusion in the network adds conservatism and ensures historical continuity of data. Wells 199-H4-7, 199-H4-12A, and 199-H4-12C are constructed of stainless steel casing with threaded, stainless steel screens and are compliant with WAC 173-160. The wells have sand packs around the screens with annular seals from the sand pack to the surface. As-built diagrams for all four wells are provided in Appendix C.

4.7 Groundwater Sampling and Analysis

This section describes the sampling and analysis program for the 183-H basins, including monitoring parameters, monitoring frequency, sampling protocols, and analytical methods.

4.7.1 Monitoring Parameters

Table 5 lists the constituents to be analyzed for the 183-H basins. The list includes the following:

- constituents of concern identified in Section 4.2
- additional constituents to aid data interpretation (alkalinity, anions, and inductively coupled plasma metals)
- field parameters routinely acquired at the wellhead (pH, specific conductance, turbidity, and temperature).

Table 5. List of Constituents

Dangerous Waste Constituents	Field Parameters	Other
Chromium (filtered) Fluoride Nitrate Technetium-99 Uranium	pH Specific conductance Temperature Turbidity	Alkalinity Anions Metals (filtered) by inductively coupled plasma method

4.7.2 Sampling Frequency

The wells in the RCRA monitoring network will be sampled at least annually during the active life of the IRM. This frequency is judged to be adequate to monitor contaminant trends. Monitoring for CERCLA requirements will measure chromium in certain wells more frequently (DOE 1996c).

4.7.3 Sampling Procedures

Groundwater-sampling procedures, sample collection documentation, and chain-of-custody requirements are described in the *Environmental Investigations and Site Characterization Manual* (WHC 1989) and in the *Quality Assurance Project Plan for RCRA Groundwater Monitoring Activities* (WHC 1995) or in equivalent PNNL documents. Work by subcontractors is conducted to their equivalent approved standard operating procedures.

All field sampling activities are recorded in the proper field logbook as specified in WHC (1989, Section 1.5) or equivalent PNNL documents. Wells 199-H3-12A and 199-H4-7 are extraction wells for the IRM. Groundwater is collected through a sampling port. Before sampling the other wells, the static water level is measured and recorded as specified in WHC (1989, Section 10.2). Based on the measured water level and well construction details, the volume of water in the well is calculated and documented on the well sampling form or field notebook. Each well is purged until the approval criteria are met, as specified in WHC (1989, Section 5.8). Purge water is managed according to WHC (1989, Section 10.3). If a well pumps dry because of very slow recharge or low water levels, samples are collected after recharge.

Quality assurance requirements are defined in the *Westinghouse Hanford Company Quality Assurance Manual* (WHC 1988) or in equivalent PNNL documents and Article 31 of Ecology et al. (1989). The RCRA sampling and analysis program is supported by WHC (1995) or equivalent PNNL documents. Sample preservation and chain-of-custody procedures are discussed in WHC (1989, Section 5.1).

4.7.4 Analytical Procedures

Procedures for field measurements (e.g., pH, specific conductance, temperature, and turbidity) are specified in the user's manuals for the meters used. Laboratory analytical procedures are specified in WHC (1995). Most of the analytical methods are selected from those provided in *Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods* (EPA 1990). For constituents with no analytical method specified by EPA (1990), other methods are selected as specified by WHC (1995).

4.7.5 Determining Direction of Groundwater Flow

An understanding of groundwater-flow directions is essential to evaluating the performance of the pump-and-treat system. Thus, a network of pressure transducers was placed in wells that are expected to be influenced by the system. Measurements are recorded hourly by electronic data loggers. Manual measurements are collected monthly to calibrate the transducers. Water levels are also measured manually in wells across the entire 100-H Area quarterly and before any well is sampled (except extraction wells). The procedure for measuring water levels is included in WHC (1989, Section 10.2). If the water-table elevations indicate that the IRM is not performing as expected, or the monitoring wells are not adequately monitoring the basins, the IRM will be reevaluated or the monitoring network changed.

5.0 Data Management and Reporting

5.1 Data Evaluation

Groundwater chemistry and water-level data are evaluated for precision, accuracy, representativeness, and completeness according to WHC (1992, Section 2.6) or an equivalent PNNL procedure. Data are flagged if associated with suspect quality control data. Data are also screened for completeness and representativeness by a project scientist assigned to the 183-H basins (e.g., data are compared to historical and spatial trends). Suspect data are investigated through the Request for Data Review process and are flagged in the database.

5.2 Data Storage

Data are submitted by the analytical laboratory in electronic form and are loaded into the Hanford Environmental Information System (HEIS) database. Parameters measured in the field are either entered into HEIS manually or through the electronic Field Sampling Information System. Record copies of field and laboratory data are stored at PNNL. Data from the HEIS database may be downloaded to a smaller database, such as the Geosciences Data Analysis Toolkit (GeoDAT), for data evaluation and trend analysis.

5.3 Reporting

Chemistry and water-level data from RCRA groundwater monitoring are reviewed quarterly and are publicly available in HEIS. Interpretive reports are issued annually in March (e.g., Hartman and Dresel 1997).

6.0 References

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Westinghouse Hanford Company (WHC). 1988. *Westinghouse Hanford Company Quality Assurance Manual*. WHC-CM-4-2, Richland, Washington.

Westinghouse Hanford Company (WHC). 1989. *Environmental Investigations and Site Characterization Manual*. WHC-CM-7-7, Richland, Washington.

Westinghouse Hanford Company (WHC). 1992. *Environmental Engineering and Geotechnology Procedures*. WHC-CM-7-8, Richland, Washington.

Westinghouse Hanford Company (WHC). 1995. *Quality Assurance Project Plan for RCRA Groundwater Monitoring Activities*. WHC-SD-EN-QAPP-001, Rev. 3, Richland, Washington.

Appendix A

Proposal for Resource Conservation and Recovery Act Groundwater Monitoring at the 183-H Basins During the 100-HR-3 Interim Remedial Measure

Appendix A

Proposal for Resource Conservation and Recovery Act Groundwater Monitoring at the 183-H Basins During the 100-HR-3 Interim Remedial Measure

A series of data quality objectives workshops was held in early 1997 to develop a groundwater monitoring program for the 100-HR-3 Groundwater Operable Unit. A follow-up meeting was held on March 5, 1997, between the U.S. Department of Energy (DOE), State of Washington Department of Ecology (Ecology), Pacific Northwest National Laboratory, and the Environmental Restoration Contractor. A tentative monitoring program was proposed at that meeting, including a well list, list of constituents to be analyzed for, and sampling frequency. Ecology instructed DOE to propose the program formally in a letter, which was transmitted March 14, 1997. A copy of that letter is included in this appendix.

U.S. Department of Energy
Richland Operations Office
P.O. Box 550
Richland, Washington 99352

NMWMP - Hanfor
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MAR 18 1997

Kennewick

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MAR 14 1997

Mr. Steve M. Alexander
Perimeter Areas Section Manager
Nuclear Waste Program
State of Washington
Department of Ecology
1315 W. Fourth Avenue
Kennewick, Washington 99336-6018

Dear Mr. Alexander:

PROPOSAL FOR RESOURCE CONSERVATION AND RECOVERY ACT (RCRA) GROUNDWATER MONITORING AT THE 183-H BASINS DURING THE 100-HR-3 INTERIM REMEDIAL MEASURE (IRM)

In following up on the commitments made on March 5, 1997, same subject as above, this is to present, as a proposal, the conditions that were developed during that meeting.

The main points addressed below are: 1) monitoring objective, 2) monitoring network, 3) constituents, 4) sampling frequency, and 5) water level measurements. Upon the State of Washington Department of Ecology's (Ecology) agreement with this proposal, a revised RCRA monitoring plan will be prepared.

- MONITORING OBJECTIVE: During the 100-HR-3 IRM, the objective of the RCRA-compliant monitoring is to evaluate general trends in concentrations of 183-H contaminants of concern (chromium, nitrate, uranium, technetium-99) downgradient of the facility.

- MONITORING WELLS:

  Upgradient: None

  Downgradient:
  199-H4-3
  199-H4-7
  199-H4-12A
  199-H4-12C

  Justification: Upgradient monitoring does not contribute to the monitoring objective stated above. These three downgradient wells are predicted to be directly downgradient of the basins after pumping begins, according to the capture zone model. Wells H4-7 and H4-12A are extraction wells. Well H4-3 typically contains the highest concentrations of 183-H contaminants of any shallow well. All three wells have a long historic record.

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- CONSTITUENTS:

  Constituents of concern: chromium (filtered), nitrate, technetium-99, chemical uranium

  Supporting data: Inductively Coupled Plasma (ICP) metals (filtered), anions, alkalinity

  Justification: The four constituents of concern were identified in the final-status RCRA monitoring plan based on their presence in the waste stream and their presence in groundwater at levels above maximum contaminant levels or drinking water standards. All four were above their respective concentration limits after final-status monitoring began, thereby triggering the site into a corrective action phase under RCRA (RL ltr. to S. M. Alexander from M. J. Furman "Exceedance of Concentration Limits in Groundwater at 183-H Solar Evaporation Basins," dtd. September 27, 1996). ICP metals, anions, and alkalinity are useful to evaluate general groundwater chemistry and data quality. Note that chromium is an ICP metal and nitrate is an anion, so these data will be received at no added cost.

- SAMPLING FREQUENCY: Annual

  Justification: Annual sampling is sufficient to illustrate general trends in concentrations. Four independent samples from each well, as required under final-status compliance monitoring, are not necessary during corrective action; obtaining independent samples would not aid in meeting the above stated monitoring objective.

- WATER LEVEL MEASUREMENTS:

  The purpose of water-level monitoring is to evaluate flow patterns during the IRM. Bechtel Hanford, Inc. currently maintains a transducer network in wells that are expected to be affected by groundwater extraction under the IRM. Monthly field measurements are conducted in these wells to calibrate the transducers. Additional field measurements are made twice each year over the entire 100-H Area. These data will be sufficient to evaluate flow patterns to fulfill the RCRA objective.

The conditions addressed above result in a modification to the current RCRA-compliant monitoring network by reducing the number of monitoring wells from eight to four, reducing the number of analytes measured, and the sampling frequency. As reflected in the discussions of March 5, 1997, the modified monitoring network is a melding of the RCRA-compliant and the IRM monitoring networks. This modification provides a technically and regulatively defensible, and cost effective monitoring network within the context of the Interim Remedial Action for groundwater contamination that will be conducted in the proximity of the 183-H facility.

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Ecology's prompt concurrence on these changes would be appreciated. The modified monitoring schedule and analyte list will be implemented on the first scheduled monitoring event, per the revised RCRA monitoring plan, following the start of the IRM pumping operations. If you want to discuss this matter further or require additional information, please contact me at 373-9630.

Sincerely,

Marvin J. Furman

Marvin J. Furman, Project Manager
Groundwater Project

GWP:MJF

cc: S. Leja, Ecology
W. Soper, Ecology

Concurrence: Wayne W. Soper 4-22-97
State of Washington Date
Department of Ecology

Appendix B

Drinking Water Standards

Appendix B

Drinking Water Standards

Groundwater chemistry data for the 183-H Solar Evaporation Basins were compared to drinking water standards, including those listed in Buonicore (1995) and Washington Administrative Code 173-303-645 (Table 1), plus radionuclides. Where more than one standard applied for a given constituent, the more stringent one is listed.

See the body of the report for more information on the Washington Administrative Code constituents and all other constituents for which at least one detected value exceeded the standard.

Constituent (standard, µg/L)

1,1,1-Trichloroethane (200)
1,1,2-Trichloroethane (5)
1,2-Dibromo-3-chloropropane (0.2)
1,2-Dibromoethane (0.05)
1,2-Dichlorobenzene (600)
1,2-Dichloroethane (5)
1,2-Dichloropropane (5)
1,2,4-Trichlorobenzene (70)
1,4-Dichlorobenzene (75)
2(2,4,5-Trichlorophenoxy)propionic acid (50)
2,3,7,8-Tetrachlorodibenzodioxin (0.00003)
2,4,5-TP Silvex (10)
2,4-D (70)
Acrylamide (none)
Aluminum (50 to 200)
Antimony (6)
Arsenic (50)
Barium (1,000)
Benzene (5)
Benzo[a]pyrene (0.2)
Beryllium (4)
Bis(2-ethylhexyl)adipate (400)
Cadmium (5)
Carbon tetrachloride (5)
Chlordane (2)
Chloride (250,000)
Chlorobenzene (100)

Constituent (standard, µg/L unless otherwise noted)

Ethylbenzene (70)
Fluoride (4,000)
Gross alpha (15 pCi/L)
Gross beta (50 pCi/L)
Heptachlor (0.04)
Heptachlor epoxide (0.02)
Hexachlorobenzene (1)
Hexachlorocyclopentadiene (50)
Iron (300)
Lead (15)
Lindane (0.2)
Manganese (50)
Mercury (2)
Methoxychlor (40)
Nickel (100)
Nitrate (45,000 as NO_3)
Nitrite (3,300 as NO_2)
Pentachlorophenol (1)
Selenium (10)
Silver (50)
Styrene (100)
Sulfate (250,000)
Technetium-99 (900 pCi/L)
Tetrachloroethylene (5)
Thallium (2)
Toluene (1,000)
Total dissolved solids (500,000)

Chromium (100)
cis-1,2-Dichloroethylene (70)
Copper (none)
Cyanide (200)
Dichloromethane (5)
Dinoseb (7)
Endrin (0.2)
Epichlorohydrin (none)
Toxaphene (3)
trans-1,2-Dichloroethylene (100)
Trichloroethylene (5)
Uranium (20 mg/L)
Vinyl chloride (2)
Vinylidene chloride (7)
Xylenes (mixed isomers) (10,000)
Zinc (5,000)

References

Buonicore, A. J., ed. 1995. *Cleanup Criteria for Contaminated Soil and Groundwater*. ASTM Data Series DS64, Philadelphia.

WAC 173-303-645. Washington Administrative Code. *Releases from Regulated Units*. Olympia, Washington.

Appendix C

As-Built Diagrams for 183-H Solar Evaporation Basins Corrective Action Monitoring Wells

Appendix C

As-Built Diagrams for 183-H Solar Evaporation Basins Corrective Action Monitoring Wells

The as-built diagrams and construction information are presented for wells 199-H4-3, 199-H4-7, 199-H4-12A, and 199-H4-12C.

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Sample Method: Hard tool (nom)
Drilling Fluid Used: Not documented
Additives Used: Not documented
Driller's Name: H. Baker
WA State Lic Nr: Not documented
Drilling Company: Not documented
Company Location:
Date Started: 17May74
Date Complete: Not documented

WELL NUMBER: 199-H4-3 A4629
TEMPORARY WELL NO:

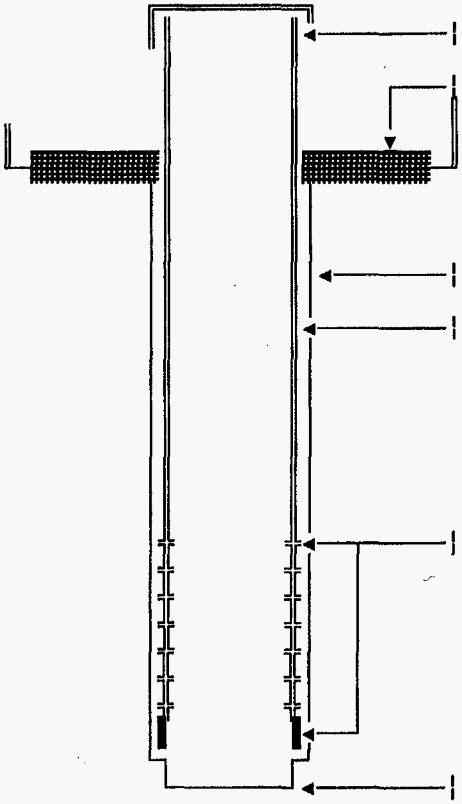
Hanford Coordinates:	N/S	N 96,372.3	E/W	W 39,079.7
State NAD83	N	152,858.54m	E	572,940.49m
Coordinates:	N	501,573	E	2,255,998

Start Card #: Not documented T R S
Elevation Ground surface: 417.6-ft Estimated

Depth to water: 39.0-ft May74
(Ground surface) 44.7-ft 12Sep94

GENERALIZED STRATIGRAPHY Driller's Log

0↔5: Not documented
5↔20: GRAVEL with SAND
20↔43: SAND with GRAVEL
43↔45: BOULDER
45↔50: SAND, GRAVEL & COBBLES
50↔55: Ringold Fm.
55 : Ringold Fm. and CALICHE



Elevation of reference point: (top of casing) [420.29-ft]
Height of reference point above ground surface [2.7-ft]
Depth of surface seal [ND]
No surface seal documented, has 4-ft x 4-ft concrete pad
7-in nominal hole, 0↔55-ft
6-in ID carbon steel casing, +2.7↔55-ft
6-in casing perforations, 34↔55-ft, 4 cuts/rd/ft
Borehole drilled depth: [~57.7-ft]

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 199-H4-3

WELL DESIGNATION : 199-H4-3
CERCLA UNIT : 100-Aggregate Area
RCRA FACILITY : 183-H Solar Evaporation Basins
HANFORD COORDINATES : N 96,372.3 W 39,079.7 [29Aug86-100H]
LAMBERT COORDINATES : N 501,574 E 2,255,998 [HANCONV]
N 152,858.54m E 572,940.49m [ACOE-NAD83]
DATE DRILLED : May74
DEPTH DRILLED (GS) : 55.0-ft
MEASURED DEPTH (GS) : 57.7-ft, 29Apr92
DEPTH TO WATER (GS) : 39.0-ft, May74;
44.7-ft, 12Sep94
CASING DIAMETER : 6-in ID carbon steel, +2.7↔55.0-ft
ELEV TOP CASING : 420.29-ft, [29Aug86-100H]
ELEV GROUND SURFACE : 417.7-ft, Estimated
PERFORATED INTERVAL : 34↔55-ft
SCREENED INTERVAL : Not Applicable
COMMENTS : FIELD INSPECTION, 12Jun90;
Carbon steel casing. 4-ft by 4-ft concrete pad,
4 posts, 1 removable. Capped and locked,
brass cap in pad with well ID. Not in radiation zone.
AVAILABLE LOGS : Driller
TV SCAN COMMENTS : 21Apr92 - Well needs cleaning.
29Apr92 - Casing ends @ 55.1-ft, open hole 55.1↔57.7-
ft., sandy bottom.
Perfs start @ 32.8-ft, 4 cuts/rd/ft.
DATE EVALUATED : Not Applicable
EVAL RECOMMENDATION : Not Applicable
LISTED USE : 100H monthly w/l measurement, 19Jun85↔12Sep94;
CURRENT USER : BHI ER w/l monitoring
WHC ES&M RCRA sampling,
PNL sitewide sampling
PUMP TYPE : Hydrostar
MAINTENANCE : Maintenance activities documented in the Hanford
Wells Database System

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: Water
Driller's Name: D. Garcia
Drilling Company: Onwego Drilling
Date Started: 02Sep86

Sample Method: Drive barrel
Additives Used: Not documented
WA State Lic Nr: 1143
Company Location: Kennewick, WA
Date Complete: 22Sep86

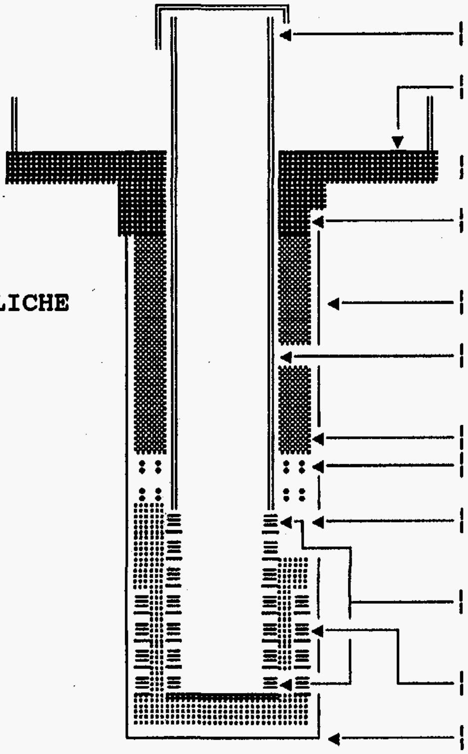
WELL NUMBER: 199-H4-7 A4638 TEMPORARY WELL NO: 1H-TW1
Hanford Coordinates: N/S N 96,479 E/W W 39,527
State NAD83 N 152,890.85m E 577,804.13m
Coordinates: N 501,679 E 2,255,550
Start Card #: Not documented T____ R____ S____
Elevation Ground surface: 418.5-ft Estimated

Depth to water: 43.0-ft Sep86
(Ground surface) 44.5-ft 12Sep94

GENERALIZED STRATIGRAPHY

Geologist's Log

0↔3: Backfill
3↔14: Sandy GRAVEL
14↔24: Sandy GRAVEL with SILT
24↔54: Sandy GRAVEL
54↔55: Silty SAND with CLAY & CALICHE Ringold Fm.



Elevation of reference point: (top of casing) [420.59-ft]
Height of reference point above ground surface [2.1-ft]
Depth of surface seal [0↔4.0-ft]
Type of surface seal, 4-ft by 4-ft concrete pad extending 4-ft into annulus
11-in nominal hole, 0↔55-ft
6-in ID stainless steel casing, +2.1↔38.0-ft
8↔20 mesh granular bentonite, 4↔25.0-ft
¼-in Volclay tablets, 25.0↔30.0-ft
10↔20 mesh silica sand, 30.0↔55.0-ft
6-in T304 stainless steel screen, 38.0↔53.0-ft, #20-slot
10-in stainless steel telescoping screen, 43.0↔53.0-ft, #40-slot
Borehole drilled depth: [55.0-ft]

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 199-H4-7

WELL DESIGNATION : 199-H4-7
CERCLA UNIT : 100-Aggregate Area
RCRA FACILITY : 183-H Solar Evaporation Basins
HANFORD COORDINATES : N 96,479 W 39,527 [30Oct86-100-H]
LAMBERT COORDINATES : N 501,679 E 2,255,550 [HANCONV]
N 152,890.65m E 577,804.13m [ACOE-NAD83]
DATE DRILLED : Sep86
DEPTH DRILLED (GS) : 55.0-ft
MEASURED DEPTH (GS) : Not documented
DEPTH TO WATER (GS) : 43.0-ft, Sep86;
44.4-ft, 12Sep94
CASING DIAMETER : 6-in ID stainless steel, +2.1↔38.0-ft
ELEV TOP CASING : 420.59-ft, [30Oct86-100H]
ELEV GROUND SURFACE : 418.5-ft, Estimated
PERFORATED INTERVAL : Not Applicable
SCREENED INTERVAL : 6-in stainless steel, #20-slot, 38↔53-ft;
10-in telescoping screen, #40-slot, 43↔53-ft
COMMENTS : FIELD INSPECTION, 12Jun90;
Stainless steel casing.
4-ft by 4-ft concrete pad, 4 posts, 1 removable.
Capped and locked, brass cap in pad with well ID.
Not in radiation zone.
AVAILABLE LOGS : Geologist
TV SCAN COMMENTS : Not Applicable
DATE EVALUATED : Not Applicable
EVAL RECOMMENDATION : Not Applicable
LISTED USE : 100 H w/l measurement, 20Nov86↔12Sep94
CURRENT USER : BHI ER w/l monitoring
WHC ES&M RCRA sampling,
PNL sitewide sampling
PUMP TYPE : Hydrostar
MAINTENANCE :

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: Water
Driller's Name: D. Ludtke
Drilling Company: Onwego Drilling
Date Started: 27Oct86

Sample Method: Hard tool Drive barrel
Additives Used: Not documented
WA State Lic Nr: 1333
Company Location: Kennewick, WA
Date Complete: 04Nov86

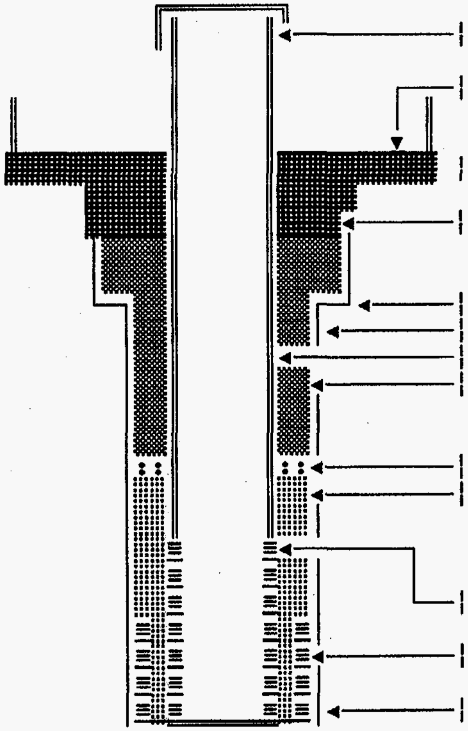
WELL NUMBER: 199-H4-12A A4616
TEMPORARY WELL NO: 1H-TC1A
Hanford Coordinates: N/S N 96,549 E/W W 38,854
State NAD83 N 152,912.73m E 528,009.15m
Coordinates: N 501,751 E 2,256,223
Start Card #: Not documented T____ R____ S____
Elevation Ground surface: 411.0-ft Estimated

Depth to water: 38.5-ft Oct86
(Ground surface) 39.3-ft 12Sep94

GENERALIZED STRATIGRAPHY

Geologist's Log

- 0↔5: Gravelly silty fine to very fine SAND
- 5↔11: Silty sandy GRAVEL
- 11↔34: Sandy GRAVEL
- 34↔35: GRAVEL with SAND
- 35↔40: Sandy GRAVEL
- 40↔45: Gravelly SAND
- 45↔51: Sandy GRAVEL
- 51↔52: Ringold, brown CLAY and CALICHE



Elevation of reference point: (top of casing) [413.50-ft]
Height of reference point above ground surface [2.5-ft]
Depth of surface seal [0↔4.5-ft]
Type of surface seal, 4-ft by 4-ft concrete surface pad extending 4.5-ft into annulus
15-in nominal hole, 0↔10-ft
11-in nominal hole, 10↔48-ft
6-in ID stainless steel casing, +2.5↔33-ft
8↔20-mesh granular bentonite, 4.5↔26-ft
¼-in Volclay tablets, 26↔28-ft
10↔20-mesh silica sand, 26↔48-ft
6-in T304 stainless steel screen, 33↔48-ft, #20-slot
10-in telescoping screen 37.5↔47.5-ft, #40-slot
Borehole drilled depth: [48.0-ft]

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 199-H4-12A

WELL DESIGNATION : 199-H4-12A
CERCLA UNIT : 100-Aggregate Area
RCRA FACILITY : 183-H Solar Evaporation Basins
HANFORD COORDINATES : N 96,549 W 38,854 [29Dec86-100H]
LAMBERT COORDINATES : N 501,751 E 2,256,223 [HANCONV]
N 152,912.73m E 578,009.15m [ACOE-NAD83]
DATE DRILLED : Nov86
DEPTH DRILLED (GS) : 48.0-ft
MEASURED DEPTH (GS) : Not documented
DEPTH TO WATER (GS) : 38.5-ft, Oct86;
39.3-ft, 12Sep94
CASING DIAMETER : 6-in ID stainless steel, +2.5↔33.0-ft
ELEV TOP CASING : 413.50-ft, [29Dec86-100H]
ELEV GROUND SURFACE : 411.0-ft, Estimated
PERFORATED INTERVAL : Not Applicable
SCREENED INTERVAL : 6-in stainless steel, #20-slot, 33↔48-ft;
10-in telescoping, #40-slot, 37.5↔47.5-ft
COMMENTS : FIELD INSPECTION, 12Jun90;
Stainless steel casing. 4-ft by 4-ft concrete pad, 4 posts, 1 removable .
Capped and locked, brass cap in pad with well ID.
Not in radiation zone.
AVAILABLE LOGS : Geologist
TV SCAN COMMENTS : Not Applicable
DATE EVALUATED : Not Applicable
EVAL RECOMMENDATION : Not Applicable
LISTED USE : 100H monthly w/l measurement, 20Nov86↔12Sep94
CURRENT USER : BHI ER w/l monitoring
WHC ES&M RCRA sampling,
PNL sitewide sampling
PUMP TYPE : Hydrostar
MAINTENANCE :

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: Water
Driller's Name: L. Bultena
Drilling Company: Onwego Drilling
Date Started: 12Aug86

Sample Method: Drive barrel
Additives Used: Not documented
WA State Lic Nr: 0066
Company Location: Kennewick, WA
Date Complete: 03Oct86

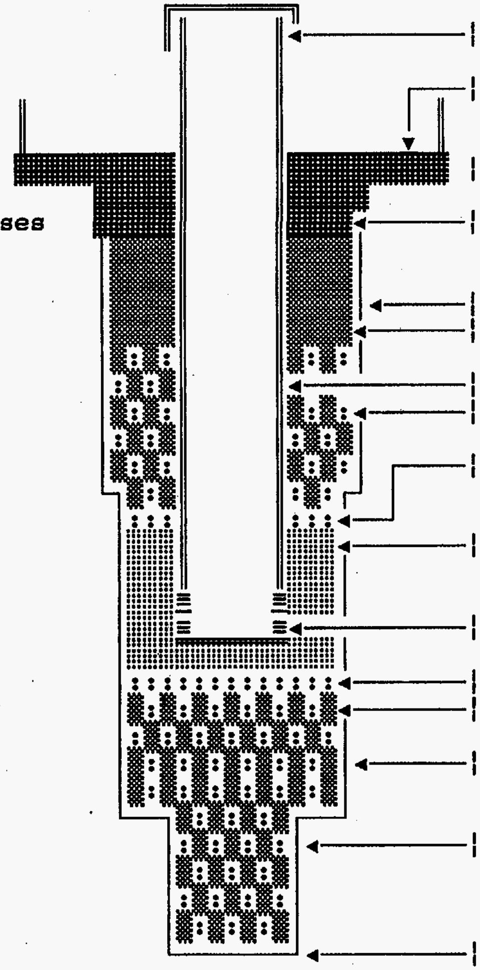
WELL NUMBER: 199-H4-12C A4618
TEMPORARY WELL NO: 1H-TC1C
Hanford Coordinates: N/S N 96,573 E/W W 38,845
State NAD83 N 152,919.81m E 578,011.77m
Coordinates: N 501,775 E 2,256,232
Start Card #: Not documented T___ R___ S___
Elevation Ground surface: 410.6-ft Estimated

Depth to water: 38.2-ft Oct86
(Ground surface) 39.2-ft 12Sep94

GENERALIZED STRATIGRAPHY

Geologist's Log

0↔5: Sandy GRAVEL
5↔10: Sandy GRAVEL with SILT lenses
10↔49: Sandy GRAVEL
49↔54: Silty, sandy GRAVEL
54↔59: Silty GRAVEL
59↔74: Gravelly SILT
74↔79: Gravelly, clayey SILT
79↔84: Gravelly SILT
84↔92: Silty SAND
92↔99: Silty SAND with CALICHE
99↔175: Silty SAND with CLAY and CALICHE
175↔179: Clayey SAND
179↔194: Clayey SILT
194↔209: Sandy SILT with CLAY
209↔219: Silty SAND with CLAY
219↔220: Silty SAND



Elevation of reference point: (top of casing) [413.52-ft]
Height of reference point above ground surface [2.9-ft]
Depth of surface seal [0↔5.0-ft]
Type of surface seal, 4-ft by 4-ft concrete pad extends 5-ft into annulus
13-in nominal hole, 0↔60-ft
Granular bentonite, 5↔28.5-ft
6-in ID T304 stainless steel casing, +2.9↔72-ft
Bentonite slurry, 28.5↔61-ft
Volclay pellets, 61↔62-ft
10↔20/20↔30/20↔40-mesh silica sand, 62↔87-ft
6-in T304 stainless steel screen, 72↔82-ft, #10-slot
Bentonite pellets, 87.0↔92.0-ft
Bentonite slurry, 92.0↔220.0-ft
11-in nominal hole, 60↔174-ft
6-in nominal hole, 174↔220-ft
NOTE: Hole was drilled open hole below 174-ft
Borehole drilled depth: [220.0-ft]

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 199-H4-12C

WELL DESIGNATION : 199-H4-12C
CERCLA UNIT : 100-Aggregate Area
RCRA FACILITY : 183-H Solar Evaporation Basins
HANFORD COORDINATES : N 96,573 W 38,845 [30Oct56-100H]
LAMBERT COORDINATES : N 501,775 E 2,256,232 [HANCONV]
N 152,919.81m E 578,011.77m [ACOE-NAD83]
DATE DRILLED : Oct86
DEPTH DRILLED (GS) : 220.0-ft
MEASURED DEPTH (GS) : Not documented
DEPTH TO WATER (GS) : 38.2-ft, Oct86;
39.2-ft, 12Sep94
CASING DIAMETER : 6-in ID stainless steel, +2.9↔72.0-ft
ELEV TOP CASING : 413.52-ft, [30Oct86-100H]
ELEV GROUND SURFACE : 410.6-ft, Estimated
PERFORATED INTERVAL : Not Applicable
SCREENED INTERVAL : 6-in stainless steel, #20-slot, 72↔82-ft;
COMMENTS : FIELD INSPECTION, 12Jun90;
Stainless steel casing. 4-ft by 4-ft concrete pad,
4 posts, 1 removable. Capped and locked, brass cap in
pad with well ID.
Not in radiation zone.
AVAILABLE LOGS : Geologist
TV SCAN COMMENTS : Not Applicable
DATE EVALUATED : Not Applicable
EVAL RECOMMENDATION : Not Applicable
LISTED USE : 100 H monthly w/l measurement, 20Nov86↔12Sep94
CURRENT USER : BHI ER w/l monitoring
WHC ES&M RCRA sampling,
PNL sitewide sampling
PUMP TYPE : Hydrostar
MAINTENANCE :

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