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DOE/RL-93-43
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Limited Field Investigation Report for the 100-HR-3 Operable Unit

Date Published
August 1993

9313027.0478

United States
Department of Energy
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Richland, Washington 99352

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ACRONYMS

ARAR	applicable or relevant and appropriate requirement
AWQC	Aquatic Water Quality Criteria
CERCLA	Comprehensive Environmental Response Compensation and Liability Act
CFR	Code of Federal Regulation
CI	confidence interval
CLP	Contract Laboratory Program
COC	contaminants of concern
COPC	contaminants of potential concern
CRBG	Columbia River Basalt Group
DOE	U.S. Department of Energy
Ecology	Washington State Department of Ecology
EII	Environmental Investigation Instruction
EPA	U.S. Environmental Protection Agency
ERA	expedited response action
HEIS	Hanford Environmental Information System
HI	hazard index
HQ	hazard quotient
HSBRAM	Hanford Site Baseline Risk Assessment Methodology
HPPS	Hanford Past-Practice Strategy
ICR	increased cancer risk
IRM	interim remedial measure
K	hydraulic conductivity
LFI	limited field investigation
LOEL	lowest observable effect level
MCL	maximum contaminant level
MCLG	maximum contaminant level goal
NCP	National Contingency Plan
QRA	qualitative risk assessment
RCRA	Resource Conservation and Recovery Act
RI/FS	Remedial Investigation/Feasibility Study
TAL	target analyte list
TBC	to-be-considered
TCL	target compound list
WHC	Westinghouse Hanford Company

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EXECUTIVE SUMMARY

This LFI was conducted to assess the applicability of interim remedial measures for reducing human health and environmental risks within the 100-HR-3 Groundwater Operable Unit. The 100-HR-3 Operable Unit is one of seven operable units associated with the 100 D and H Areas. Operable Units 100-DR-1, 100-DR-2, 100-DR-3, 100-HR-1, 100-HR-2 and 100-IU-4 address contaminant sources while 100-HR-3 addresses contamination present in the underlying groundwater.

The primary method of field investigation used during this LFI was the installation and sampling of monitoring wells. Samples were collected from the groundwater and soils, and submitted for laboratory analysis. Boreholes were surveyed for radiological contamination using downhole geophysical techniques to further delineate the locations and levels of contaminants. All samples were screened to ascertain the presence of volatile organic compounds and radionuclides. Analytical data were subjected to validation; all first round and a minimum of 10% of subsequent rounds of data associated with the LFI were validated.

A screening method was used to identify contaminants of potential concern (COPC). This screening method eliminated from further consideration, constituents that were below background. Constituents which are considered non-toxic to humans were eliminated from the human health evaluation. Inconsistency and blank contamination were also evaluated in the screening process. These COPC were then evaluated further in the qualitative risk assessment (QRA).

A QRA was performed using conservative (highest reported contaminant levels from the LFI) analyses. The QRA analysis indicates that there is a low risk for both the frequent-use scenario and the occasional-use scenario. Based on the QRA, the COPC in the groundwater in the 100 D Area are Sr-90, C-14, Cr, Mn, Sb, nitrate, and H-3. The COPC in the groundwater beneath the 100 H Area are Sr-90, Tc-99, U-238, H-3, Am-241, C-14, Mn, nitrate, and Cr. In the 600 Area of the 100-HR-3 Operable Unit, H-3, Pu-238, C-14, Mn, Sb, and Cr are the COPC. In general, concentrations of the COPC associated with operable unit activities have been decreasing with time.

A parallel qualitative ecological risk assessment was performed using a subset of the data used in the human health QRA. This assessment used conservative data from wells located closest to the Columbia River. Several non-radioactive constituents were identified as potentially posing an acute or chronic risk to fish.

Based on the low and medium risks identified, an IRM is not justified under either the frequent- or occasional-use risk scenarios. The ecological risk assessment identified medium risk to organisms in the river, assuming that the groundwater was the only water to which they were exposed. This scenario is appropriate for development of salmonids from the embryonic through fry stages. Under conditions to which the fish are exposed at the fingerling and later stages, a mixture of groundwater and surface water, a low risk was determined.

1.0 INTRODUCTION

This limited field investigation (LFI) report is a secondary document summarizing the data collection and analysis activities conducted during the 100-HR-3 Groundwater Operable Unit LFI and the associated qualitative risk assessment (QRA).

1.1 SITE LOCATION

The 100-HR-3 Operable Unit is located in the north-central portion of the Hanford Site along the southern shoreline of the Columbia River (Figure 1-1). The southern boundary of the operable unit is the southern boundary of Sections 21, 22, 23, and 24, Township 14 North, Range 26 East of the Willamette Meridian, and extending east along the southern boundary of Sections 19 and 20, Township 14 North, Range 27 East of the Willamette Meridian, to the Benton County line on the east. The operable unit also includes outfall structures and effluent pipelines which extend into the Columbia River, but excludes that portion of the 116-N-3 crib and trench which extends north of the southern boundary.

The 100-HR-3 Operable Unit is one of seven operable units associated with the 100 D/DR and 100 H Area at the Hanford Site (Figure 1-2). Three of the 100 D/DR operable units, two of the 100 H Area operable units and the 100-IU-4 Operable Unit are source operable units. The 100-HR-3 Groundwater Operable Unit includes the groundwater below the source operable units plus the adjacent groundwater, surface water, sediments, and aquatic biota impacted by the 100 D/DR and 100 H Area operations. The 100-HR-3 Operable Unit also includes that portion of the 600 Area that lies between the D/DR and H Reactors.

1.2 SITE HISTORY

The 100 D/DR Area was the site of two water-cooled, graphite moderated, plutonium production reactors. The D Reactor operated from 1944 to 1967, and the DR Reactor from 1950 to 1965. The H Area was the site of one water-cooled, graphite moderated, plutonium production reactor. The H Reactor operated from 1949 to 1965. These reactors were used to produce plutonium for nuclear weapons and used Columbia River water for cooling and other operations activities. The operation of these reactors and their ancillary facilities resulted in the disposal of large quantities of waste.

Within the 600 Area of the 100-HR-3 Operable Unit and approximately midway between the 100 D/DR and 100 H Areas is the 100-IU-4 Operable Unit sodium dichromate barrel disposal landfill. All that is known about the history of the landfill is that during 1945 it received barrels that originally contained sodium dichromate used for water treatment in the 100 Area.

Of primary concern for this LFI is the liquid waste, because it is believed to have the greatest influence on the groundwater. The major liquid waste disposal sites (Figures 1-2, 1-3, and 1-4) are:

- The reactor coolant water handling facilities which include the 116-D-7, 116-DR-9, and 116-H-7 retention basins; the 116-DR-1, 116-DR-2, 116-H-1, and 116-H-2 liquid waste disposal trenches; and the 116-DR-3, 116-DR-6, 116-DR-8, and the 116-H-9 cribs. These sites were contaminated with cooling water which contained low concentrations of radionuclides and potentially hazardous species including chromium.

- The ruptured fuel element effluent disposal facilities, which include the 116-D-2, 116-DR-4, and 116-H-4 pluto cribs.

- The decontamination waste stream disposal facilities, which include the 116-D-1A and 116-D-1B storage basin trenches; the 116-D-3, 116-D-4, and 116-H-3 cribs, and the 116-H-6 retention basin.

- Any miscellaneous liquid waste facilities which include the 116-D-6 french drain; the 116-D-7 crib, and the 120-D-1 ponds.

These facilities are discussed in more detail below and in the 100-DR-1 and 100-HR-1 Work Plans (DOE-RL 1992c, DOE-RL 1992d). The work plans for 100-HR-2 and 100-DR-2 are currently being written.

1.3 LIMITED FIELD INVESTIGATION STRATEGY

To expedite the initiation and reduce the cost of cleaning up contaminated sites at Hanford, the U.S. Department of Energy (DOE), the Washington State Department of Ecology (Ecology) and the U.S. Environmental Protection Agency (EPA) developed the *Hanford Past-Practice Strategy* (HPPS) (DOE-RL 1991a). This strategy uses existing data to make decisions and is biased-for-action. If a site poses a risk to human health or the environment, the bias is to take action to clean it up. Figure 1-5 outlines the four decision paths of the HPPS. These paths are:

- Expedited response action (ERA) is performed when a rapid response is necessary to mitigate an unacceptable health or environmental risk from a site.

- Interim remedial measure (IRM) is performed at a site that is known to pose an unacceptable, non-time critical health or environmental risk.

- Limited field investigation is performed to gather any additional information necessary to determine whether or not an ERA or an IRM is necessary.

- Remedial Investigation/Feasibility Study (RI/FS) is the baseline method of addressing potentially contaminated sites.

The LFI is an integral part of the RI/FS process and functions as a focused RI for selection of IRMs. A QRA (Chapter 3) is performed as part of the LFI, and is focused on the principal risk drivers in the operable unit. The results of this assessment may be used to help determine the need for IRMs, to select the IRMs, and to determine risk-based cleanup levels for the IRMs. If an IRM is not justified, the site is still subject to further investigation and/or remediation. A further discussion of the LFI/IRM process is provided in *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA* (EPA 1988).

The LFI at the 100-HR-3 area was conducted to determine the nature and extent of hazardous/radioactive materials present in the groundwater. This was done by collecting data from existing wells and twenty-two new wells drilled for the RI/FS. The new wells were installed to define the groundwater quality in areas of potential public or environmental exposure (e.g., near seeps and springs along the Columbia River shoreline that are downgradient of contaminant sources), to define the groundwater quality immediately downgradient of priority and potential sources of groundwater contamination, and to define the extent of known contamination. Soil samples were collected for chemical and radioactive analyses and physical property determination. Aquifer tests were also performed and hydraulic heads were measured.

The LFI for the 100-HR-3 Operable Unit included the following tasks:

- geological investigation
- vadose zone investigation
- groundwater investigation
- data evaluation
- risk assessment
- verification of applicable or relevant and appropriate requirements (ARAR)
- limited field investigation reporting.

Several data compilation reports were prepared as part of early characterization activities for the 100 Areas. Lindsey (1992) summarize the geologic data available and the geologic setting of the 100 Areas. Peterson (1992) provides an inventory of wells, chemical data, and water-level data for the northern Hanford Site. Hartman and Peterson (1992) summarize hydrologic conditions for the 100 Areas, including water table maps, waste indicator constituents, and aquifer hydraulic properties. They include an analysis of existing wells relative to their potential for future use. Lewis and Pearson

(1992) present a catalog of historical borehole geophysical data for the 100 Areas. Ledgerwood (1991) summarizes well construction and condition information for existing 100 Area wells.

A limited number of LFI tasks were conducted under a separate 100 Area site-wide effort. These tasks include:

- surface water and sediments investigation
- air investigation
- ecological investigation.

Data compilations and summaries that pertain to these areas include: Dirkes (1992) which provides an extensive annotated bibliography for river-related investigations; Peterson and Johnson (1992) summarize historical riverbank seepage, sediment and nearshore monitoring well data, and relate it to results obtained during September 1991; Campbell et al. (1993) describes the extensive data acquisition capability that exists to gather data for the Hanford Site aquifer/Columbia River interaction investigations (Tri-Party Agreement Milestone M-30); and Weiss and Mitchell (1992) present a synthesis of ecological information for the 100 Areas. The potential ARARs are discussed in the 100 Area FS (DOE-RL 1993b).

1.4 DATA VALIDATION

Data validation was performed by a qualified independent participant contractor. The validation responsibilities are defined in associated statements of work. All validation was performed in compliance with Westinghouse Hanford *Sample Management Administration Manual* WHC-CM-5-3 (WHC 1990), Section 2.1 for inorganic analyses, Section 2.2 for organics analyses, and Sections 2.3 and 2.4 for radionuclide analyses. All data packages were verified. The first round and 10% of the subsequent rounds of data were validated. The data validation process is presented in:

- *Data Validation Report for the 100-HR-3 Operable Unit 2nd Quarter Sampling* (WHC 1992a).

- *Data Validation Report for the 100-HR-3 Operable Unit Third Quarter Sampling* (WHC 1992b).

- *Data Validation Report for the 100-HR-3 Operable Unit Fourth Quarter Sampling* (WHC 1993a).

- *Data Validation Report for the 100-HR-3 Operable Unit First Quarter Groundwater Sampling* (Vukelich 1993).

Figure 1-1 100 Area Reactor Locations

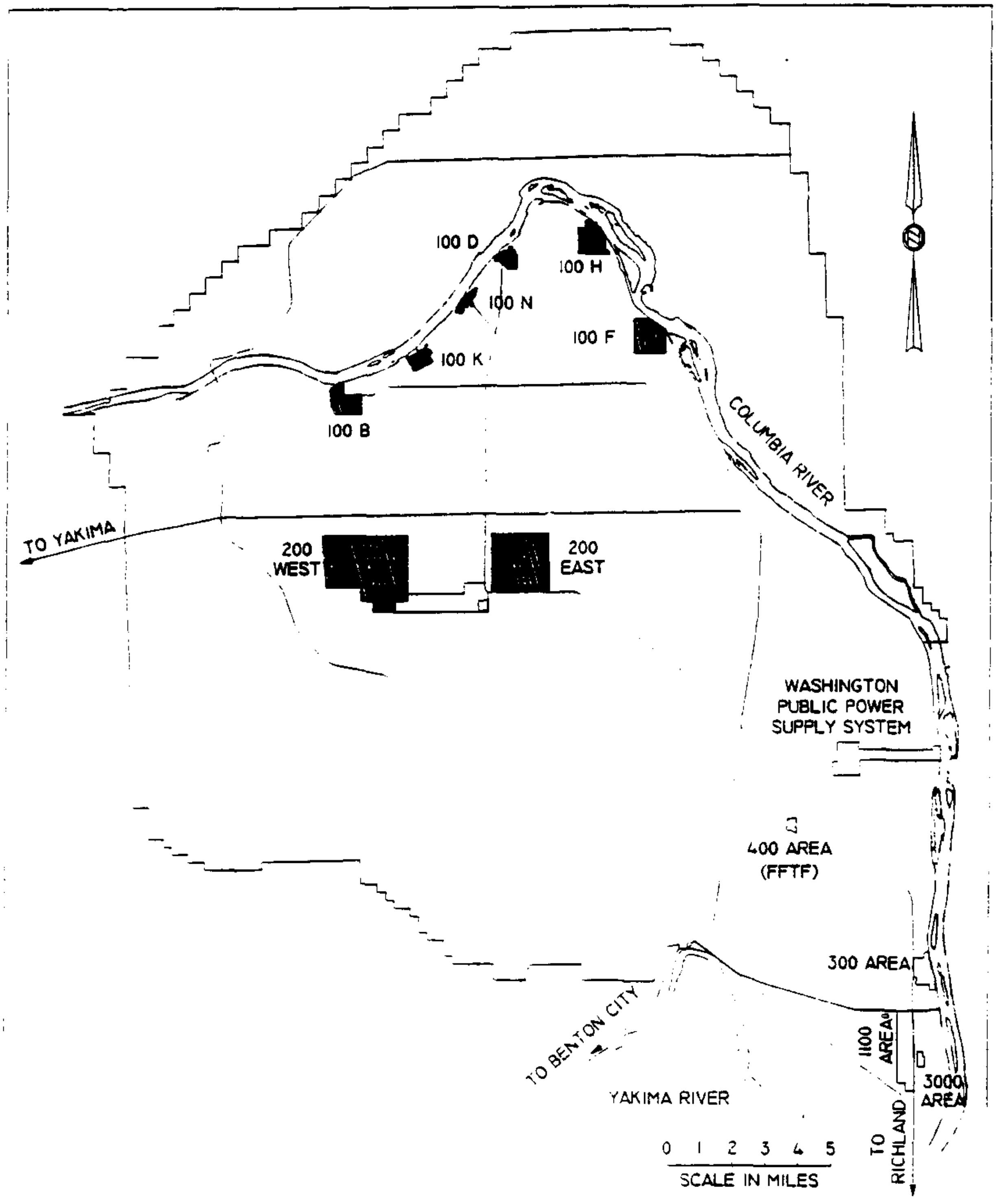

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Figure 1-2 100-HR-3 Operable Unit and Well Locations

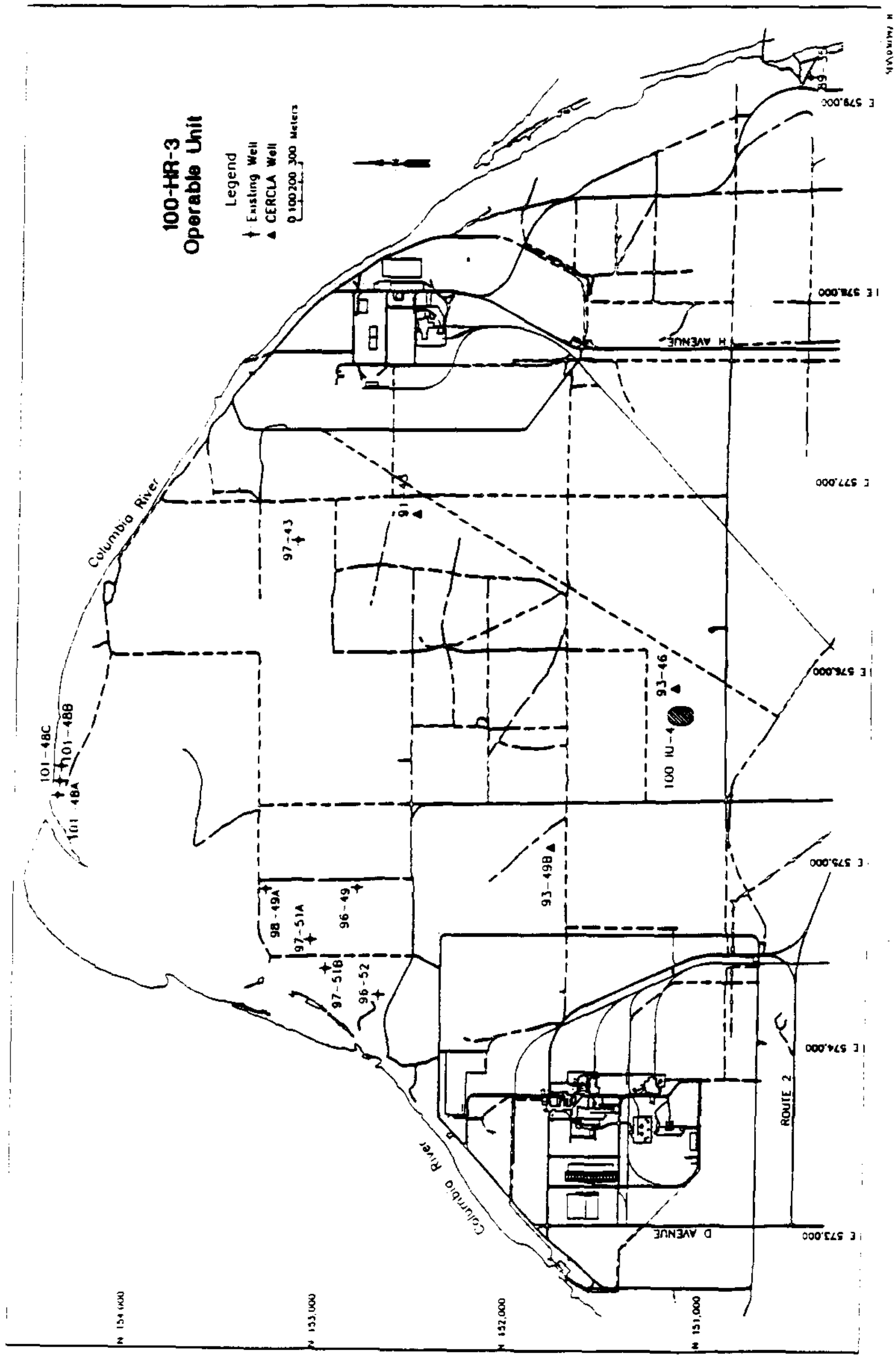


Figure 1-3 Waste Sites and Well Locations in the 100 D/DR Area

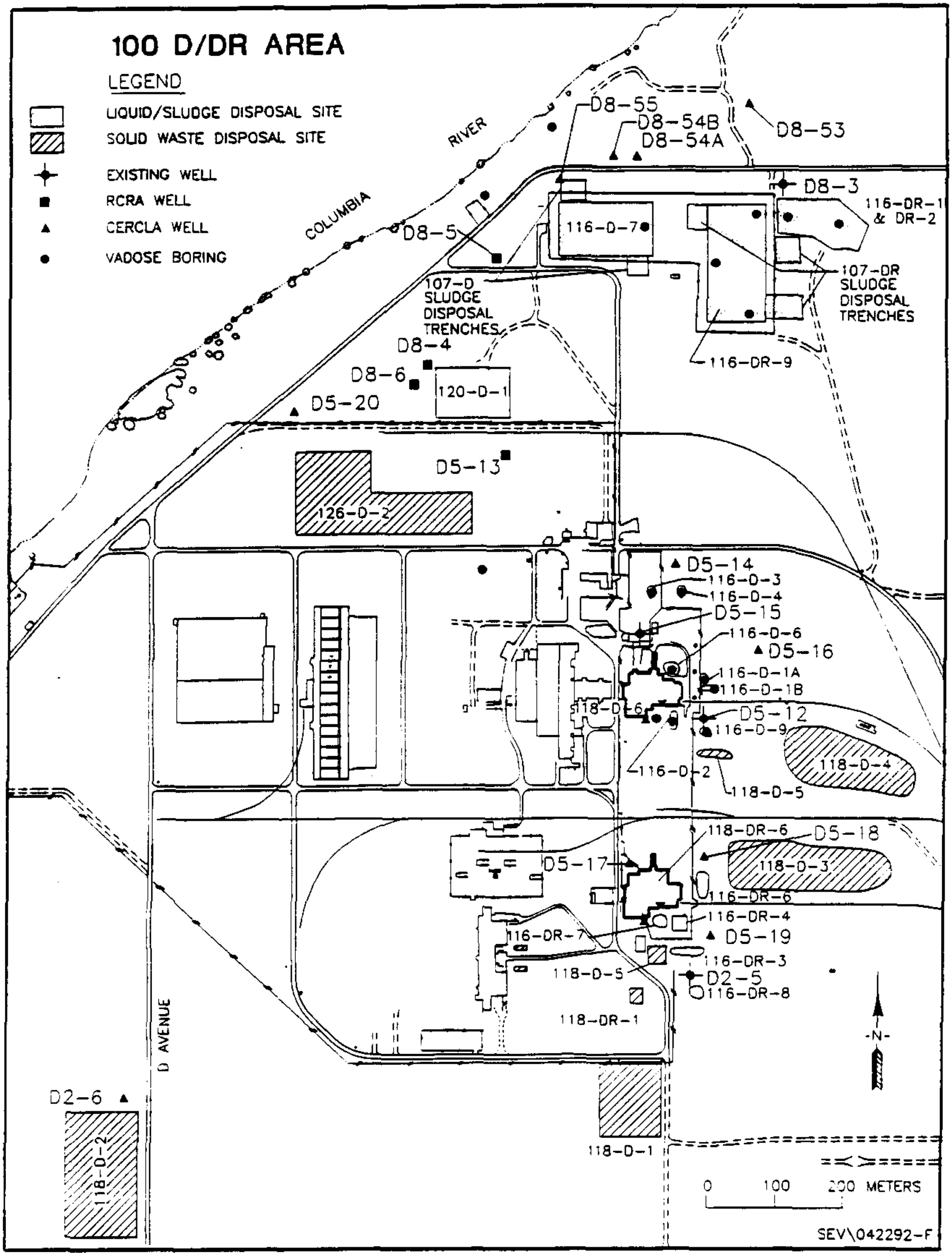


Figure 1-4 Waste Sites and Well Locations in the 100 H Area

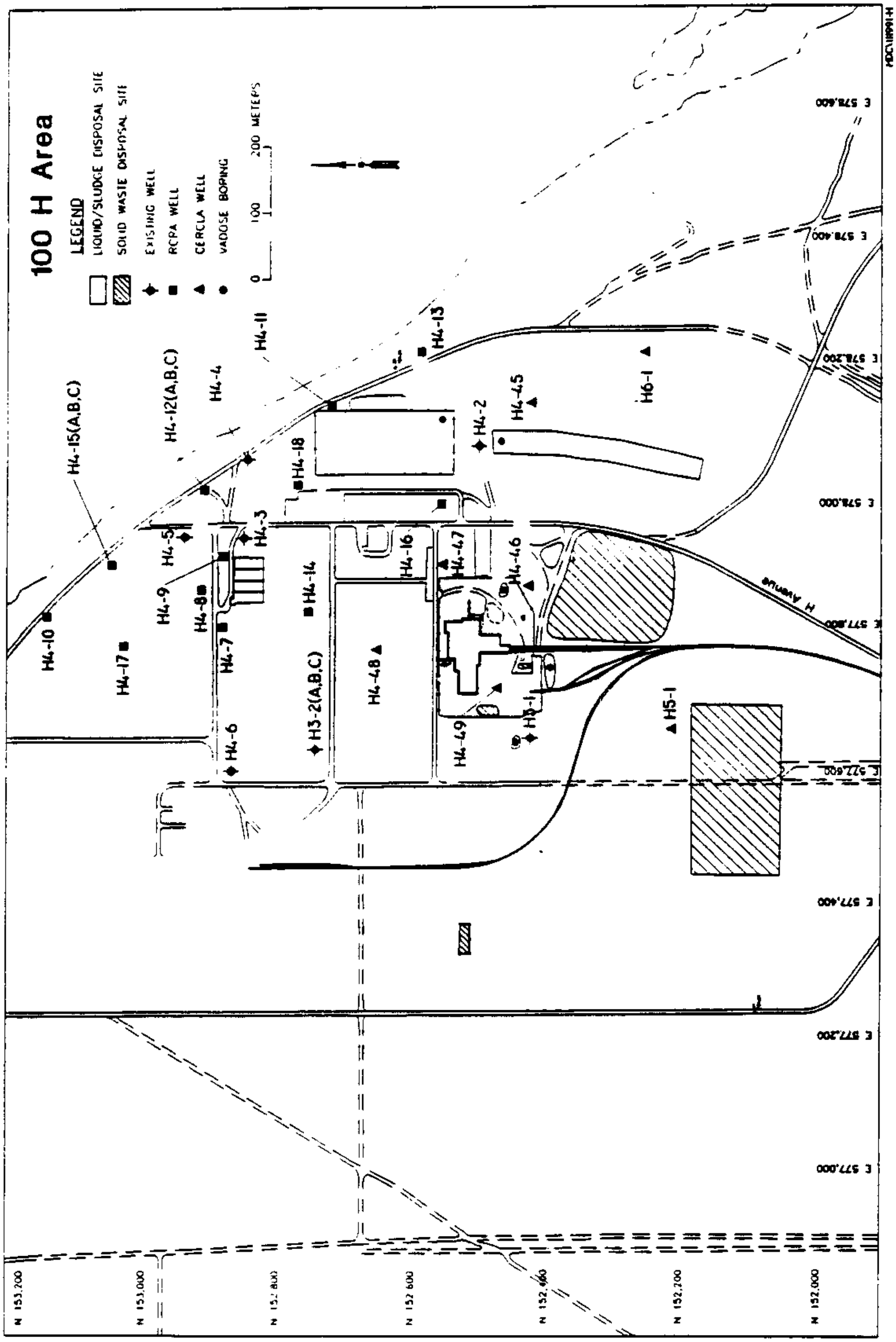
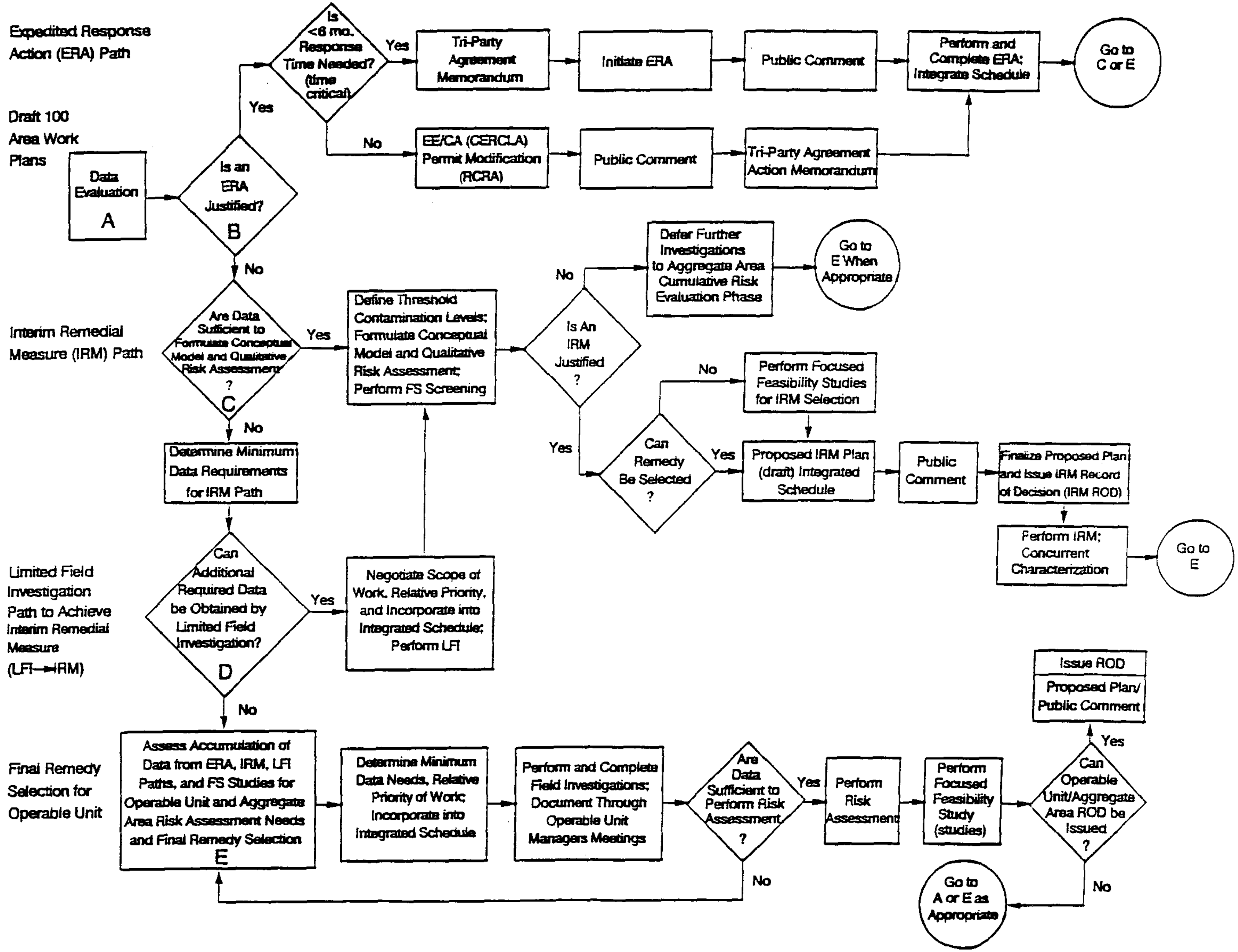


Figure 1-5

Hanford Past-Practices Strategy Decision Tree



2.0 INVESTIGATION ACTIVITIES AND RESULTS

This chapter provides a summary of the activities performed and the data collected during the 100-HR-3 LFI.

2.1 GEOLOGY

During the LFI, one deep well (199-D8-54B) and twenty-one shallow wells (199-H4-45, 199-H4-46, 199-H4-47, 199-H4-48, 199-H4-49, 199-H5-1, 199-H6-1, 199-D2-6, 199-D5-14, 199-D5-15, 199-D5-16, 199-D5-17, 199-D5-18, 199-D5-19, 199-D5-20, 199-D8-53, 199-D8-54A, 199-D8-55, 699-93-48, 699-96-43, and 699-91-46) were installed to define the groundwater quality in areas of potential public or environmental exposure, and to define the groundwater quality immediately downgradient of priority and potential sources of groundwater contamination. The justification for each well location is discussed in the 100-HR-3 Work Plan (DOE-RL 1992b). Boreholes were advanced and sampled using cable tool drilling methods and split-spoon or core barrel samplers. Cable tool drilling was used because of the gravels, cobbles and boulders common to the operable unit, and because the quantity of drilling residuals is minimal and can be easily controlled compared to other drilling methods. Detailed procedures for borehole drilling are described in the *Environmental Investigations and Site Characterization Manual*, Section 6.0 - Drilling (WHC 1988). A summary of the well construction is provided in Table 2-1; these data are also available in the Hanford Environmental Information System (HEIS).

Geologic samples were collected at 1.5 m (5 ft) intervals and at major lithologic changes. The shallow wells were drilled approximately 4.5 m (15 ft) below the water table. The deep well was drilled through the water table aquifer and completed in the upper 3 m (10 ft) of the upper confined/semiconfined aquifer.

The following discussions are based on all the data available for the D/DR and H Areas. The geologic discussions are primarily from Lindsey and Jaeger (1993) which presents a detailed description of the 100-HR-3 geology.

2.1.1 Topography

Surface topography of the 100-HR-3 Operable Unit is the product of cataclysmic flood deposition and erosion, post-flood eolian activity, and post-flood erosion and deposition associated with the Columbia River. The 100 D/DR and 100 H Areas lie on an essentially flat semi-arid bench south of the Columbia River. The elevation of the area ranges from approximately 140 m (460 ft) to 116 m (380 ft) above mean sea level (amsl). The Columbia River falls approximately 3 m (10 ft) between the 100 D/DR and 100 H Areas. The land surface slopes gradually toward the river, with a bank of up to 9 m (30 ft) at the edge of the river.

East and north of the 100 D/DR Area, a number of indistinct swells and depressions mark the location of glacial flood bars and channels that are arranged somewhat concentrically around the highland of the 100 D/DR Area. These abandoned flood features occupy successively lower elevations, down the present Columbia River channel, resulting in a "corrugated" surface that slopes gently northerly and easterly from the high ground in the southwest corner of the 100-HR-3 Operable Unit. Additional flood-related landforms are found to the south of the 100-HR-3 southern boundary.

Structurally, Hanford lies in the eastern Yakima Fold Belt. This belt consists of a series of segmented, narrow, asymmetric, and generally east-west trending anticlines. Between these anticlines lie broad, shallow synclines. The Hanford Site is situated in the Pasco Basin, a structural basin. Within the Pasco Basin, the Gable Mountain anticline separates the Wahluke and Cold Creek synclines; the 100-HR-3 Operable Unit is on the north limb of the Wahluke syncline. South of the 100-HR-3 area, basalt flows and the older units of the Ringold Formation dip steeply to the north. Beneath and to the north of the area, those same strata dip at shallow angles to the south.

2.1.2 Stratigraphy

The 100 D/DR and 100 H Areas are underlain (from oldest to youngest) by flows of Columbia River Basalt with intercalated Ellensburg Formation, six units of the Ringold Formation, the Hanford formation, and scattered Holocene deposits (Figure 2-1).

2.1.2.1 Columbia River Basalt Group and Ellensburg Formation. The Columbia River Basalt Group is an assemblage of tholeiitic, continental flood basalts of Miocene age (DOE 1988; Reidel and Hooper 1989). Isotopic age determinations indicate that basalt flows were erupted between approximately 17 to 6 million years ago (Reidel et al. 1989).

The Ellensburg Formation consists of a mix of volcaniclastic and siliciclastic deposits that occur between the basalt flows of the Columbia River Basalt Group (DOE 1988; Smith 1988).

2.1.2.2 Ringold Formation. The Ringold Formation beneath the 100 D/DR and 100 H Areas contains most of the Ringold units commonly encountered elsewhere at the Hanford Site (Figure 2-1) (Lindsey 1992). The sediments consist of semi-indurated clay, silt, fine to coarse-grained sand, and pebble to cobble sized gravel. Five facies of the Ringold Formation are:

1. Fluvial gravel - This facies consists of pebble to cobble sized gravel with a fine- to medium-grained sand matrix. Grain size distributions are often bimodal; coarse-grained sand is rare. The gravels exhibit a wide range of cementation and compaction. Low angle, lenticular bedding is common. Wide, shallow, shifting channels characterize the depositional environment.

2. Fluvial sand - This facies consists of stratified fine- to coarse-grained, quartzo-feldspathic sands. Wide, shallow channels incised into muddy floodplains characterize the depositional environment.

3. Overbank-Paleosol - This facies consists of laminated to massive silty sand, silt, clay and paleosols. Floodplain conditions characterize the depositional environment.

4. Lacustrine - This facies consists of well stratified clay with interbedded silt and silty sand. A lake with deltaic conditions characterizes the depositional environment.

5. Basaltic alluvium - This facies consists of massive to crudely stratified, weathered to unweathered, pebble to cobble basaltic gravel. The gravels commonly have a mud-rich matrix typical of deposition in an alluvial fan setting.

In the 100-HR-3 Operable Unit, a lacustrine mud unit up to 30 m (100 ft) thick forms the base of the Ringold Formation. Overlying the mud unit, fluvial sands and gravels interbedded with overbank-paleosol and lacustrine sediments comprise the remaining Ringold Formation (Lindsey and Jaeger 1993).

In the D Area, the upper 15 m (50 ft) of the Ringold Formation consists of fluvial gravel and overbank or paleosol sediments. Fluvial gravels compose the top of the Ringold Formation except in the area north of the D Area retention basins. Overbank muds and paleosols underlie the gravels. Only well 199-D8-54B in the D Area penetrates below these muds (Lindsey and Jaeger 1993).

In the H Area, the Ringold Formation is approximately 80 m (260 ft) thick with overbank silts/clays and paleosols forming the upper 30 to 38 m (100 to 125 ft). A sand layer underlies these sediments. Approximately 26 to 30 m (85 to 100 ft) of lacustrine muds (lower mud unit) form the base of the Ringold (Lindsey and Jaeger 1993).

Locally, the Hanford/Ringold contact is difficult to identify because of Ringold Formation rip-up clasts. The contact is highest west of the 100 H Area and slopes toward the Columbia River to the east. Another high is present south of the center of the 100-HR-3 Operable Unit. The axes of these highs parallel the river, suggesting that they were shaped by erosion during cataclysmic Lake Missoula flooding (Lindsey and Jaeger 1993).

2.1.2.3 Hanford Formation. The Hanford formation thickness ranges from near 0 to 24 m (80 ft). The unit is thickest in the west-central part of the 100-HR-3 Operable Unit and thins to the east. This range in thickness is due to differential erosion that occurred during the cataclysmic flooding of Lake Missoula. The Hanford formation typically consists of uncompacted and easily friable gravels in a matrix of fine- to coarse-grained quartzo-feldspathic and basalt sand. Hanford formation gravels, in the 100-HR-3 Operable Unit, commonly contain fewer basalt clasts than in other areas on the site.

Similar sediments in the 200 Areas contain many basaltic rip-up clasts (Lindsey and Jaeger 1993).

In the 100 D Area, the Hanford formation is approximately 12 to 15 m (40 to 50 ft) thick with Hanford gravels overlying Ringold Formation gravels. The Hanford formation gravels pinch out north and east of the 100 D Area.

In the 100 H Area, the Hanford formation is approximately 9 to 20 m (30 to 65 ft) thick and thickens from north to south. The sediments are mostly gravel with laterally discontinuous layers of sand forming the base of the formation in the southern part of the 100 H Area. The gravels are well stratified, uncemented and highly permeable.

2.1.2.4 Holocene Deposits. The uppermost deposits within the 100-HR-3 Operable Unit consist of a thin, discontinuous layer of Holocene-aged eolian deposits, Columbia River alluvium and man-made backfill. Eolian deposits of fine-grained silty sand < 1 m (< 3 ft) thick, blanket much of the area. Columbia River alluvium consists of channel deposited gravels, coarse-grained sands and overbank silts and sands.

2.1.3 Physical Properties

Ringold and Hanford formation physical properties for the 100 Areas were investigated using samples collected from the H, D/DR, and B/C Areas to help evaluate contaminant migration. Fifty-four physical property samples were collected from eighteen wells. In general, samples were collected from three wells in each reactor area; three samples collected from each well. One sample was collected from the top half of the well, one from the bottom half and one from below groundwater. In addition, two or three samples were collected from a single boring in each source operable unit (100-HR-1, 100-DR-1 and 100-BC-1). Soil samples were tested for: particle size distribution, moisture content, moisture retention, and saturated hydraulic conductivity. Unsaturated hydraulic conductivity and bulk density were calculated. Due to the difficulty of collecting samples of coarse-grained materials, the physical property results presented in this LFI are biased toward finer-grained soils. Although the cable tool method of drilling was used to advance the boreholes, these soil samples were collected using a drive barrel thus minimizing the effects of the drilling method.

Results of the physical property tests were:

- Density and specific gravity. Hanford formation soils are generally coarser-grained, more dense and have higher specific gravity than Ringold Formation soils.

- Moisture content. Laboratory determined moisture contents are variable and may not be representative of in situ conditions. Water was added to the boreholes during drilling.

- The laboratory determined vertical saturated hydraulic conductivity. These values are variable and do not necessarily reflect actual field conditions. This variability is due partially to the disturbed nature of sample and partially to the material itself. See Section 2.2.1 for a discussion relating to horizontal hydraulic conductivity.

2.2 HYDROGEOLOGY

In the 100-HR-3 Operable Unit there is no evidence to indicate that contamination extends beyond the uppermost part of the unconfined aquifer (Peterson 1993). Vertical contaminant migration is retarded by a thick clay/silt layer between the unconfined and the underlying confined to semiconfined underlying aquifer. In addition an upward vertical hydraulic gradient further retards or prevents downward migration of contaminants. The unconfined aquifer lies predominantly within the Hanford formation. The saturated portion of the Hanford formation is approximately 4 to 7 m (13 to 24 ft) thick across the operable unit. Hartman and Peterson (1992) and Peterson (1992, 1993) present a more detailed discussion of the hydrogeology of the 100 H and 100 D Areas.

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The Hanford unconfined aquifer is naturally recharged by runoff from surrounding highlands and through precipitation. Where the aquifer is bounded by the Columbia River, recharge through bank storage effects local changes in flow direction and water quality. Along the western Hanford boundary it is artificially recharged by irrigation. In the 200 Areas the aquifer receives artificial recharge from ponds, cribs and trenches used to dispose of waste water. In the 100 D Area the aquifer receives recharge from the 120-D-1 pond.

The groundwater conditions in the reactor areas have returned to near pre-Hanford conditions. In the past, reactor operations disposed of large volumes of liquid waste to the soil and thus created groundwater mounds. These mounds greatly affected the near river flow patterns and caused inland migration of contaminants.

Groundwater flow near the river is strongly influenced by fluctuations in Columbia River stage, which is controlled by dams. River stage can vary from 1.8 to 2.5 m (6 to 8 ft) daily and 2.5 to 3.1 m (8 to 10 ft) seasonally.

Figure 2-2 is a water-table elevation map for the 100 D Area for May 1992. Figure 2-3 depicts equivalent data available for the 100 H Area. The May 1992 map is representative of water levels during high river stage. Figures 2-4, 2-5, and 2-6 are water-table elevation maps during July 1992. The July 1992 map is generally representative of water levels during low to normal river stage. Figure 2-7 shows the water table fluctuation in the 100-HR-3 Operable Unit during 1992. River discharge exhibited a lower and earlier than normal peak. Normal peak discharge occurs during June while normal low flow occurs in October and November. These figures illustrate the following:

- the groundwater gradient near the river is approximately 0.002

- the groundwater gradient in the northern area of the operable unit is approximately 0.0006

- groundwater generally flows toward the river

- groundwater flow is parallel to the river in the 100 D Area during high river stage

- river stage commonly influences wells up to 600 m (1,950 ft) inland from the river.

The unconfined aquifer is in the Ringold Formation in the 100 D Area. Groundwater flow velocity (calculated from hydraulic conductivity and gradient) is <0.3 m/day (1 ft/day) in this unit. In the 100 H Area and in the 600 Area between 100 D and 100 H areas, the unconfined aquifer is within the Hanford formation where calculated flow velocities range from 0.3 and 2.0 m/day (2 to 6 ft/day). Under reactor operating conditions, when groundwater mounds were present, high gradients near the river may have resulted in groundwater flow velocities of as much as 15 m/day (50 ft/day) (Eliason and Hajek 1967).

A limited number of wells penetrate underlying aquifer units. Well 199-D8-54B is completed beneath a thick clay layer that appears to underlie the entire 100 D/DR Area. Wells 199-H3-2C, 199-H4-12C and 199-H4-15C are screened in lower zones of the less transmissive Ringold Formation. The Ringold Formation consists of sand layers (some of them discontinuous) interbedded with silts and/or clays. The potentiometric surface of these sandy aquifers is generally above that of the unconfined aquifer.

Only one well in the area, 199-H4-2, has been drilled into the upper aquifer of the Columbia River Basalt. This well is free flowing with approximately 14 m (46 ft) of head at the ground surface.

2.2.1 Aquifer Test Results

Aquifer tests were conducted as part of this LFI to provide those data that will be necessary to prepare preliminary designs of groundwater remediation alternatives should that be found necessary. These tests consisted of slug tests that were conducted using all new wells. The slug test method was selected to eliminate the need to dispose of large quantities of water. A slug test simulates the addition to or removal from the borehole of a known quantity of water. A blank metal "slug" was used to displace the water in the borehole. The response of the aquifer to this known change is then monitored over time and the results analyzed to determine aquifer properties. The slug tests were performed in accordance with Environmental Investigation Instruction (EII) 10.1, Aquifer Testing (WHC 1988).

During these tests, a 3.6 ℓ (0.13 ft^3) slug was rapidly lowered into the unconfined aquifer. The water level rose, saturating previously unsaturated soil. The water level changes were recorded electronically until the water level reached equilibrium (injection test). The measurements taken during this portion of the test were not analyzed due to the difficulties associated with addressing the saturation of the previously unsaturated soils.

After the water level equilibrated, the slug was rapidly removed and the water levels recorded until the water level again reached equilibrium (withdrawal test). Only the withdrawal tests were analyzed. The data were analyzed using the method of Bouwer and Rice (1976) for unconfined aquifers. Slug tests represent only very near field estimates of hydraulic conductivity and results from prolific aquifer systems are order of magnitude estimates at best. The following discussion presents the results of these tests.

Derived hydraulic conductivity values ranged from 3.1 m/d (10 ft/d) to over 100 m/d (330 ft/d) (Table 2-2). This wide range suggests that tests measure true aquifer properties and not sand pack properties. The mean hydraulic conductivity measured in the 100 D Area unconfined aquifer wells is 9.8 m/d (33.34 ft/d) compared to 28.6 m/d (943.8 ft/d) in the 100 H Area wells. This difference is apparently due to measuring Ringold Formation properties in the 100 D Area wells and Hanford formation properties in the 100 H Area wells (see Table 2-2). The value for the 100 D Area does not include hydraulic conductivity values from wells 199-D8-53, 199-D8-54A and 199-D8-55. These values may not represent typical D Area conductivities. The large volumes of liquid discharged to the 116-D-7, 116-D-9, 116-DR-1 and 116-DR-2 sites may have altered the natural hydraulic properties of the aquifer.

Two slug test values >100 m/d (330 ft/d) in wells 199-D8-53 and 199-D8-54A correlate with an infiltration test result in the 116-DR-1 trench, located just upgradient of these wells, of 152 m/d (500 ft/d) (Eliason and Hajek 1967).

Slug test hydraulic conductivities do not necessarily correlate directly with expected hydraulic conductivities for the soils screened in individual wells. For example, the hydraulic conductivity determined for the sandy gravel in well 199-D5-16 (3.0 m/d [10 ft/d]) was almost two orders of magnitude lower than that of the sand interval in well 699-91-46 (over 100 m/d [330 ft/d]).

The hydraulic conductivity for the unconfined Hanford/Ringold Formations in the 100 Areas ranges from 4.9 x 10^{-5} to 2.1 cm/s (0.14 to 5,940 ft/d) (Hartman and Peterson 1992). The data from other aquifer tests performed in the 100 Areas are provided in Hartman and Peterson (1992).

2.3 DOWNHOLE GEOPHYSICS

Gross gamma geophysical logging was performed in twenty-seven boreholes and an additional eight wells were logged using a spectral gamma tool. Table 2-3 presents the results of spectral gamma logging for all wells investigated. Man-made radionuclides were present only in wells 199-D8-2, 199-D8-3 and 199-D8-55. These wells are close to the D/DR retention basins and their associated disposal trenches.

2.4 SOIL CONTAMINATION

Samples of vadose zone soils were collected during the installation of groundwater monitoring wells. These data were used to supplement soil sampling information collected under the ongoing Resource Conservation and Recovery Act (RCRA) investigations in 100 D and 100 H Areas as well as the efforts under the LFIs conducted for the 100-DR-1 and 100-HR-1 Operable Units. These samples were analyzed to determine if the soil retained contaminants from exposure to contaminated groundwater or process effluent. Samples were collected from 1.5 m and 3 m (5 ft and 10 ft) above the current water table and at 1.5 m (5 ft) below the water table. In addition to these set sampling depths, samples were to be collected if field screening (photoionization detector and/or gamma or beta) indicated volatile organic compounds of 10 ppm or greater or radiation exceeding twice background. No additional samples were collected due to field screening; all drill cuttings were within the preselected parameter boundaries. Table 2-4 provides a description of the constituents associated with sediments analyzed.

Samples collected during this groundwater LFI confirm data collected during source LFIs in the 100 D and 100 H Areas, which are currently being written. Soil contamination is restricted to the immediate vicinity of major liquid disposal facilities. These areas are addressed in conjunction with the sources. In general, the soils do not appear to have been contaminated due to exposure to groundwater.

2.5 GROUNDWATER CONTAMINATION

Twenty-one new wells tapping the unconfined aquifer were drilled and constructed according to strict specification for resource protection wells (WHC 1988) during this LFI. These wells were designed and located to provide data on the quality of groundwater entering the Columbia River and to provide data to evaluate contaminants near known waste sources. Groundwater chemistry data were obtained from wells drilled under this LFI, from wells drilled for the RCRA facility monitoring program, and from other existing wells determined to be "fit-for-use" as monitoring structures (Ledgerwood 1991). Groundwater samples from these wells were analyzed during the second and third quarters of 1992 for Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) Contract Laboratory Program (CLP) target compound list (TCL) and target analyte list (TAL) constituents, specific anions that may be present, and for radionuclides. The detailed results of these analyses are available through the Administrative Record and are not duplicated here.

2.5.1 Validation/Verification of Historical Groundwater Data

Data regarding the chemical and radiological content of groundwater in the 100-HR-3 Operable Unit have been collected for a number of years. These data were collected under the site-wide environmental monitoring program and specialty programs under RCRA and CERCLA. These data provide a significant resource against which to judge trends and the adequacy of current information.

The majority of contaminants at the Hanford Site are radiological. The Hanford site-wide monitoring program has developed and maintained a record of these constituents for over 20 years. The routine radioanalytes included gross alpha, gross beta, H-3, Sr, and U. Non-radioactive constituents were commonly limited to nitrate and Cr. These historical data have been used, where possible, to confirm the results of sampling conducted during the LFI and to evaluate data trends. If historical and LFI data follow the same trends then the historical data are probably "valid," in the sense of being usable for this LFI.

The statistical method used (Scheffé), provided a trend window encompassing a 95% confidence interval (CI). Figures 2-8 through 2-10 provide typical examples of how 100-HR-3 groundwater data fit this analysis. The confidence interval commonly narrows about the mean value of all analyses and widens as the data differ from the historic mean. The slope of the window indicates whether the concentrations of the particular analyte are increasing or decreasing. The number of data points that fall outside the 95% CI is limited.

2.5.2 Determination of Contaminants of Potential Concern

Historical and LFI specific data were analyzed following the flow chart illustrated in Figure 2-11. This process was used to determine which analytes were of concern to human health or environmental quality. The following is a brief discussion of that process:

- Determine the maximum concentration for each analyte in the groundwater in both the 100 D/DR and 100 H Areas and the 100-HR-3 600 Area.

- Is the analyte an EPA Region X (1991) excluded element (Al, Ca, Fe, K, Mg, and Na)? These elements have been determined to be non-toxic for human health and are categorically excluded from the list of contaminants of potential concern (COPC), although they are retained for the ecological risk assessment.

- Are the LFI selected maxima internally and externally consistent? Are the maximum analyte concentrations consistent with duplicate values (internal consistency #1)? Are the concentrations consistent between sampling rounds (e.g., within the 95% CI for anticipated concentrations) (internal consistency #2)? Is the contaminant expected based on site operations or data from the closest nearby wells (external consistency)? (Note: nearby wells were evaluated even if they were far away to help determine if a contaminant was "expected.") If a maximum analyte concentration fails all of these tests then the value is determined to be inconsistent and the next highest concentration value is selected and evaluated.

An example of inconsistency is pyrene in well 199-D8-1. It was detected in the second round, but it was not detected in the split (internal consistency #1), it was not detected in the other rounds (internal consistency #2), and it was not expected based on site operations (external consistency). Therefore, the value was determined to be inconsistent. Appendix A includes a list of constituents which were eliminated due to inconsistencies and the reasons why they were eliminated.

- Are the analytes found in sample blanks associated with the sample exhibiting the maximum concentration? If the analyte is found in the associated blank, the EPA 5x-10x rule is applied (EPA 1989). For analytes commonly used in the laboratory, the value is eliminated if it is less than ten times the blank concentration. For other analytes, the value is eliminated if it is less than five times the blank concentration. If a maximum concentration value is eliminated, a new maximum concentration is identified and evaluated. This lower concentration may be able to survive this test if it is from another sampling round or batch of samples not associated with the contaminated blank.

- Does the maximum concentration exceed Hanford background? Analytes present at or below background concentrations are excluded from additional consideration analytes at or below background are excluded because if calculated cleanup levels are below background then "the cleanup level shall be established at a concentration equal to the natural background concentrations" (WAC 173-340-700(4)(d)). Background values are from Hanford site-wide characterization of the groundwater (DOE-RL 1992e). The characterization of background involved the determination of the types, and concentrations of selected analytes, that exist naturally in the groundwater at the Hanford Site. Provisional threshold levels (based on a tolerance interval approach - WAC 173-340-708) for inorganic analytes, gross alpha, gross beta, total Ra, total Sr, total U, and selected anions were developed from the characterization effort to represent site-wide background conditions (DOE-RL 1992e).

This screening method is similar to the method used for the source operable unit LFIs. The major difference is that for the source LFIs, only one round of data were available, therefore it was not possible to do a consistency check. Also, the source operable unit blanks were evaluated based on the data validation report since there is no 5x-10x rule for soils.

Tables 2-5 through 2-24 show the results of the above screening and the constituents identified as COPC. The screening process was performed for all of the wells for use in the human health evaluation and for near river wells (199-D5-20, 199-D8-4, 199-D8-5, 199-D8-53, 199-D8-54A, 199-D8-55, 199-H4-4, 199-H4-5, 199-H4-10, 199-H4-11, 199-H4-12A, 199-H4-13, 199-H4-15A, 199-H4-45, and 199-H6-1) for the ecological evaluation. In addition, for inorganics, unfiltered data were screened for the ecological evaluation and filtered inorganic data were screened for the human health evaluation. The justification for this is provided in the QRA.

Figure 2-1 Generalized Hydrostratigraphic Column of the 100-HR-3 Operable Unit

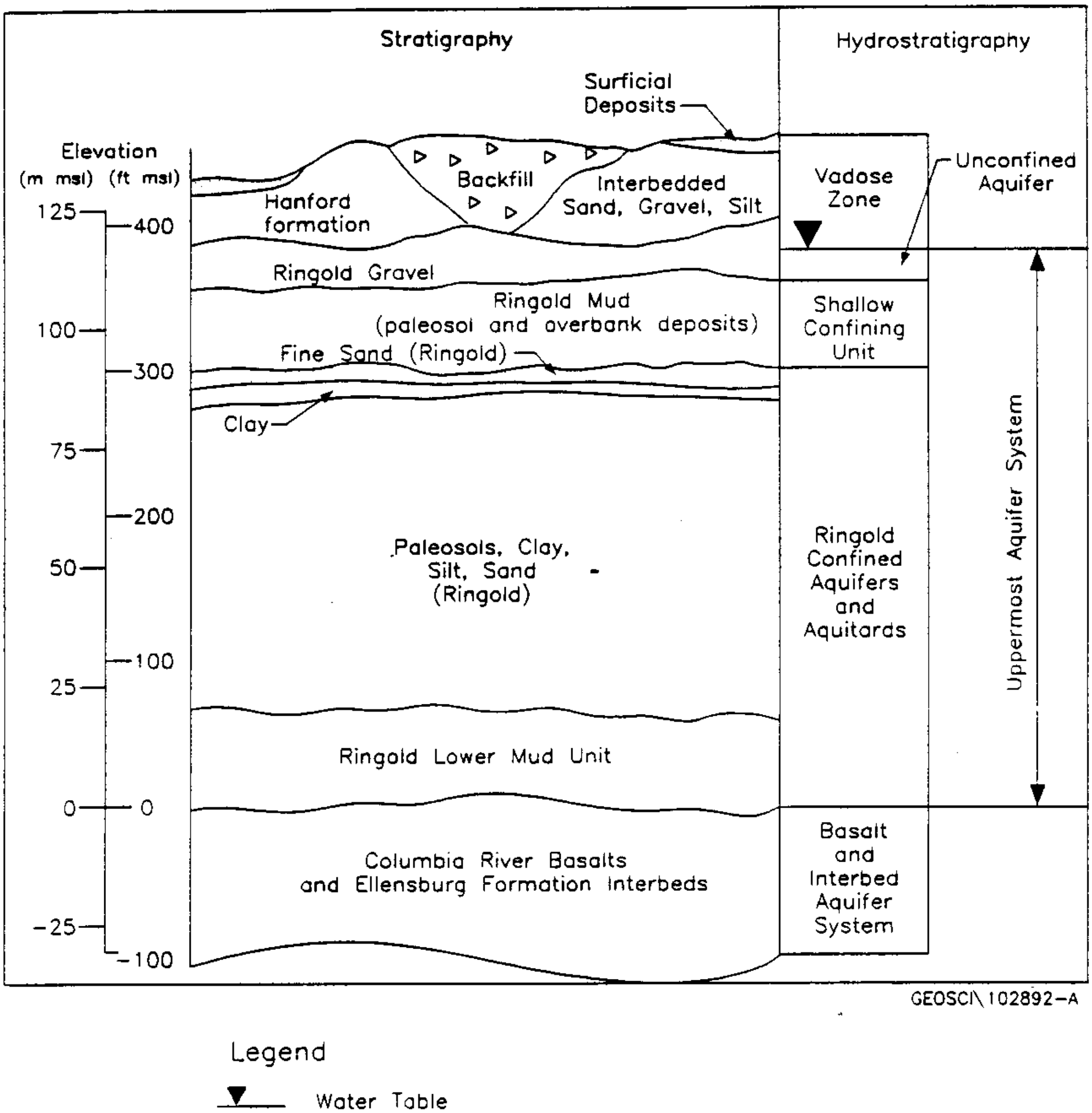

Figure 2-2 Water-Table Elevations in the 100 D Area, May 1992

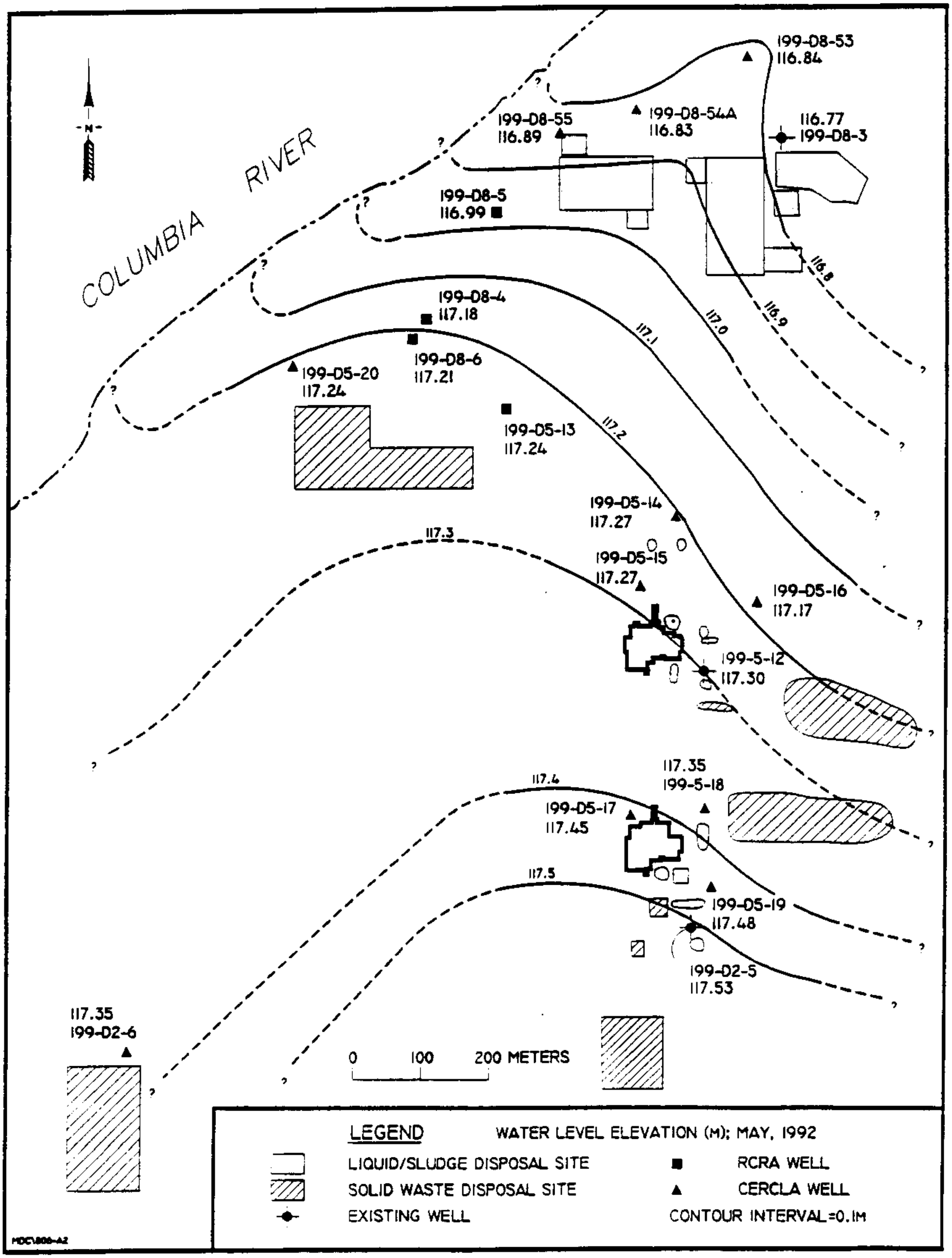

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Figure 2-3 Water-Table Elevations in the 100 H Area, May 1992

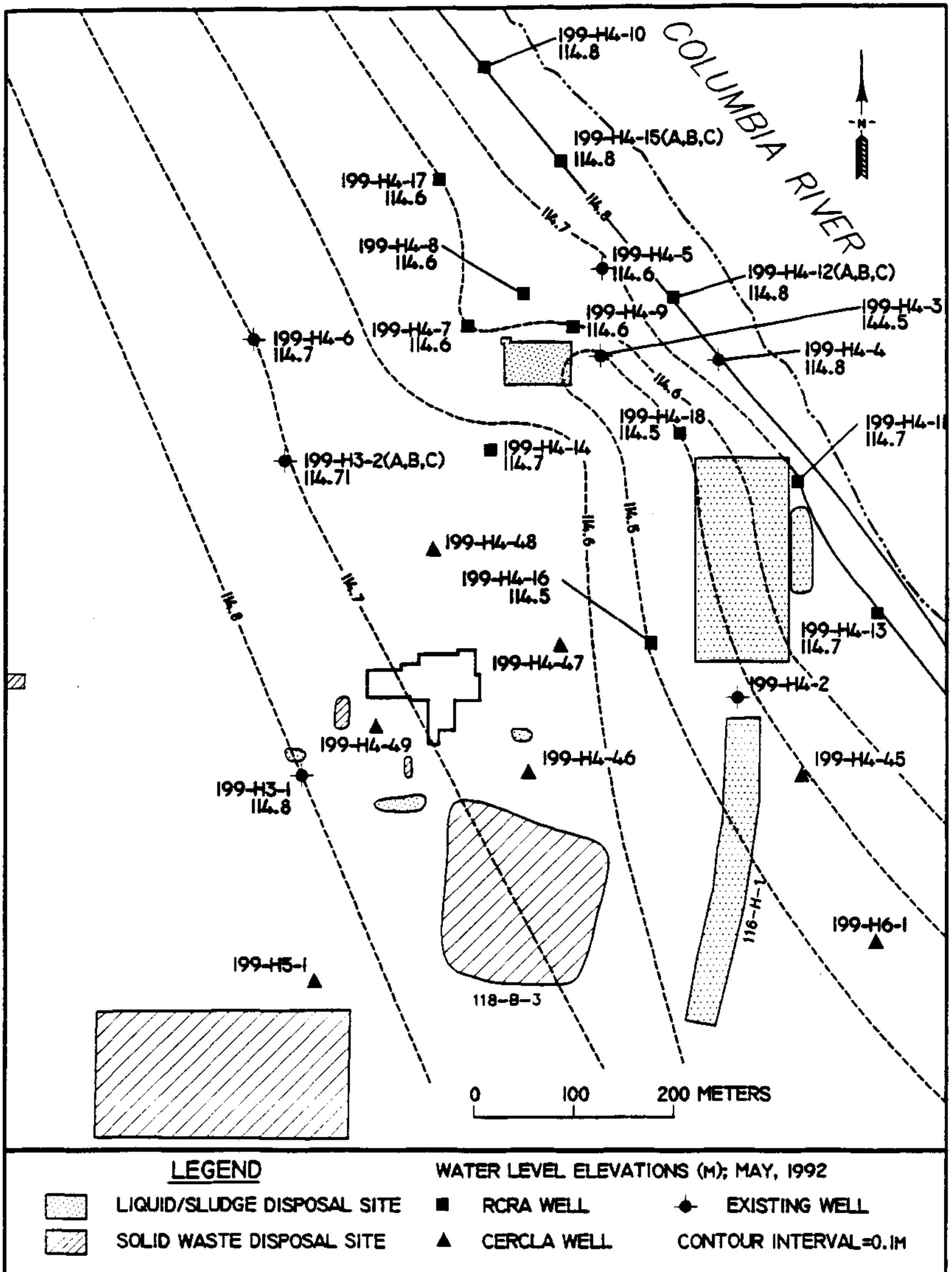

Figure 2-4 Water-Table Elevations in the 100 D Area, July 1992

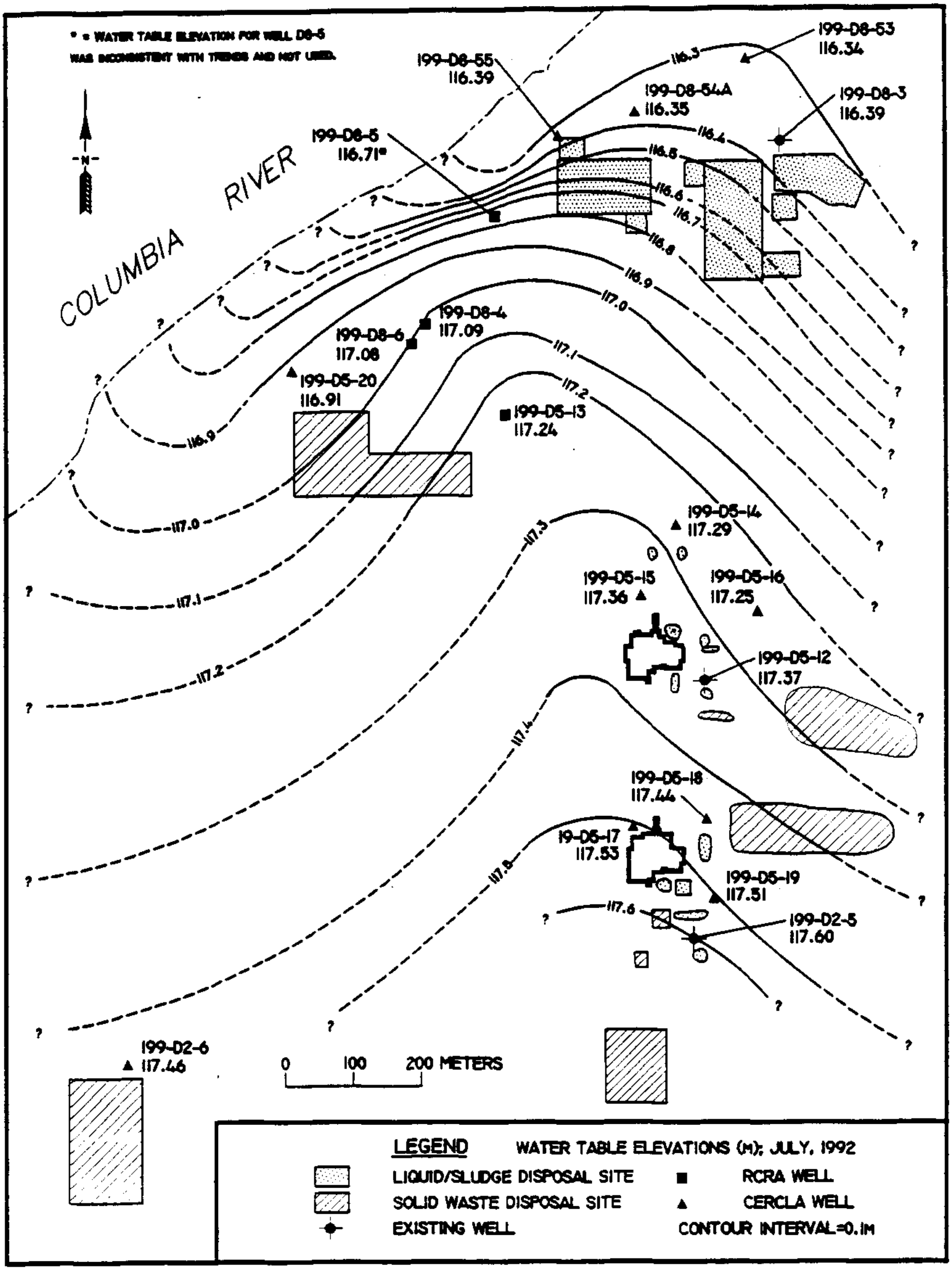

Figure 2-5 Water-Table Elevations in the 100 H Area, July 1992

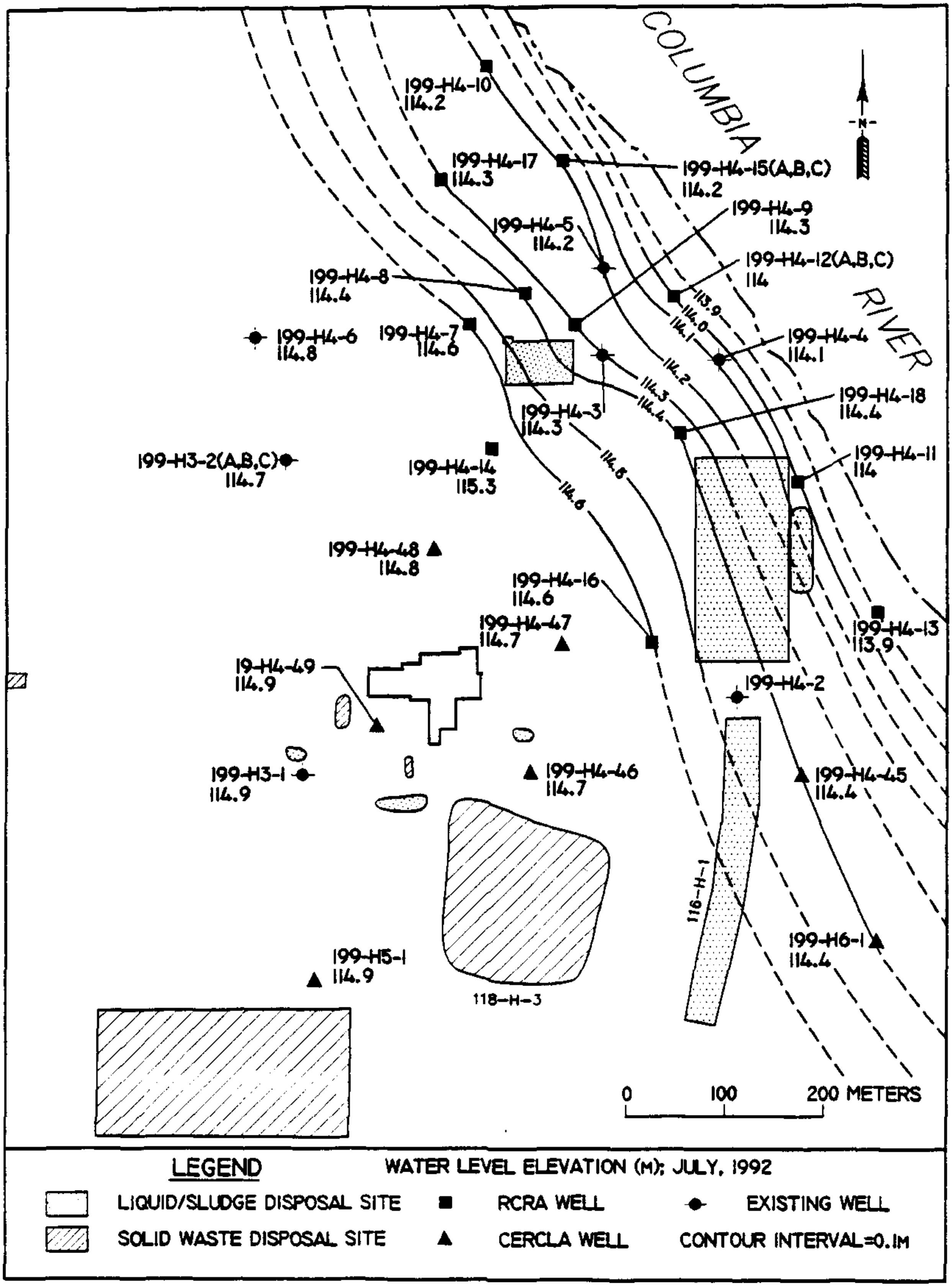

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Figure 2-6 Water-Table Overview, 100-HR-3 Operable Unit, July 1992

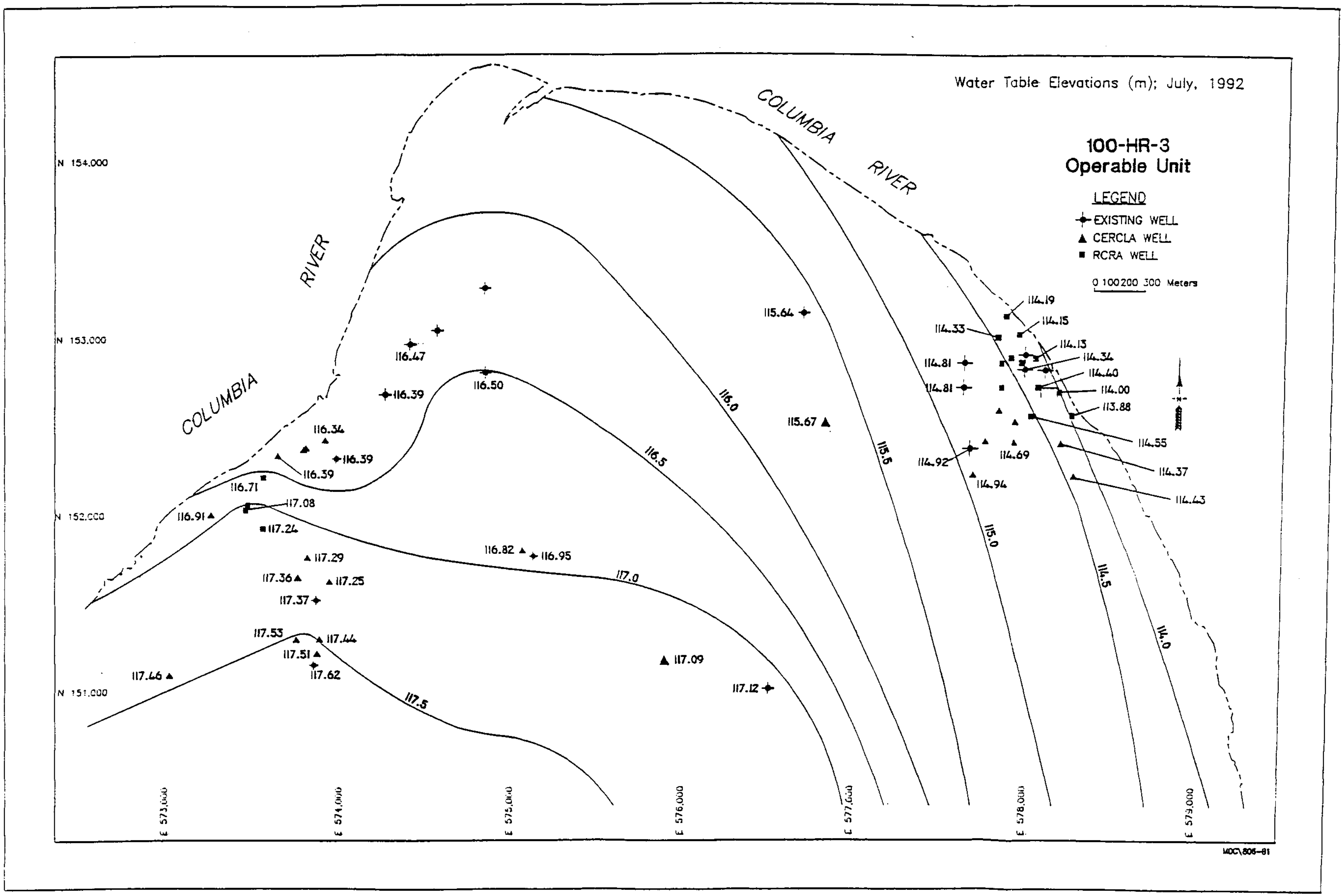
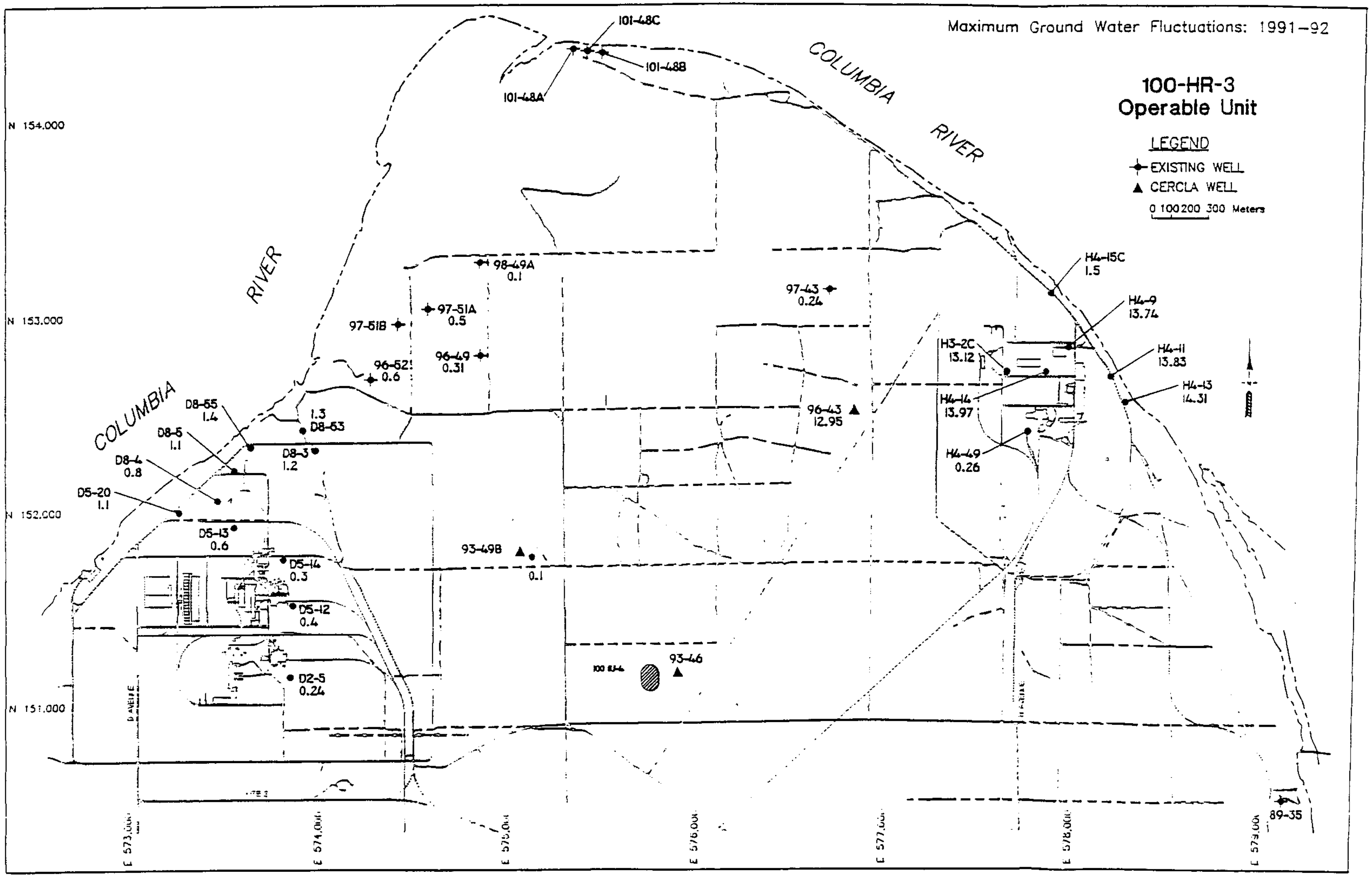


Figure 2-7 Water-Table Fluctuations in the 100-HR-3 Operable Unit, 1992



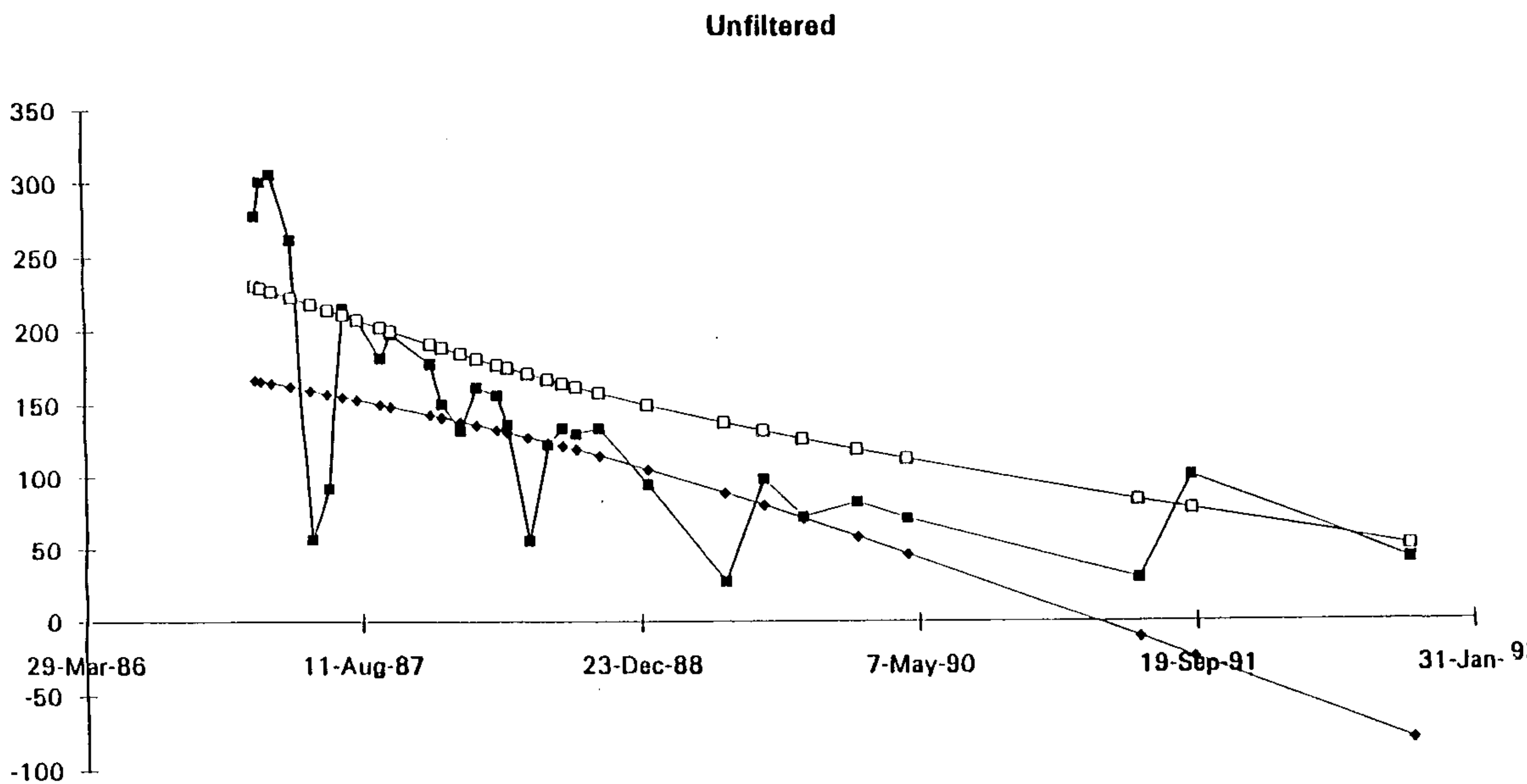


Figure 2-8 Typical 95% CI Analysis of Chromium Concentrations, Well 199-H4-12A

Figure 2-9 Typical 95% CI Analysis of Nitrate Concentrations, Well 199-D5-12

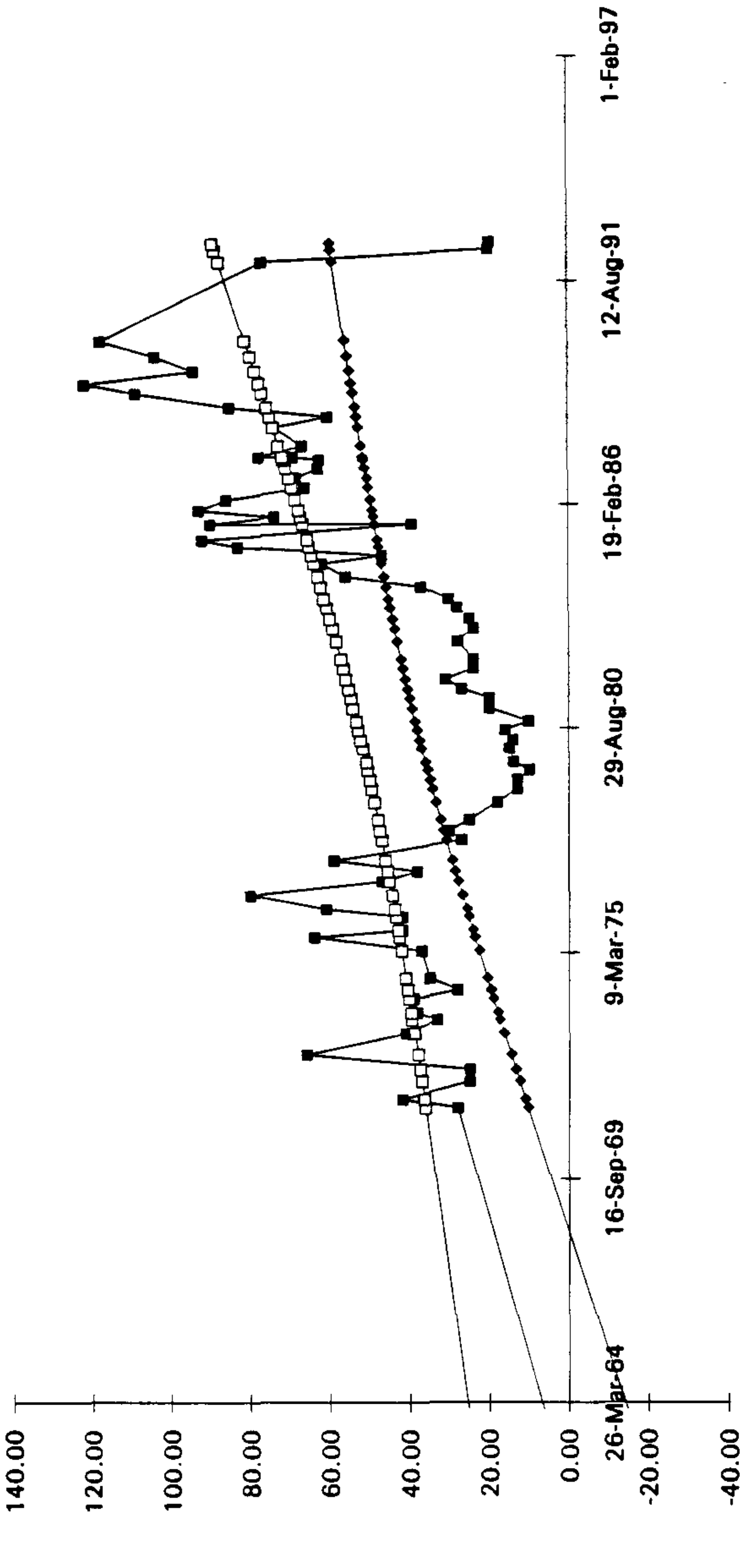
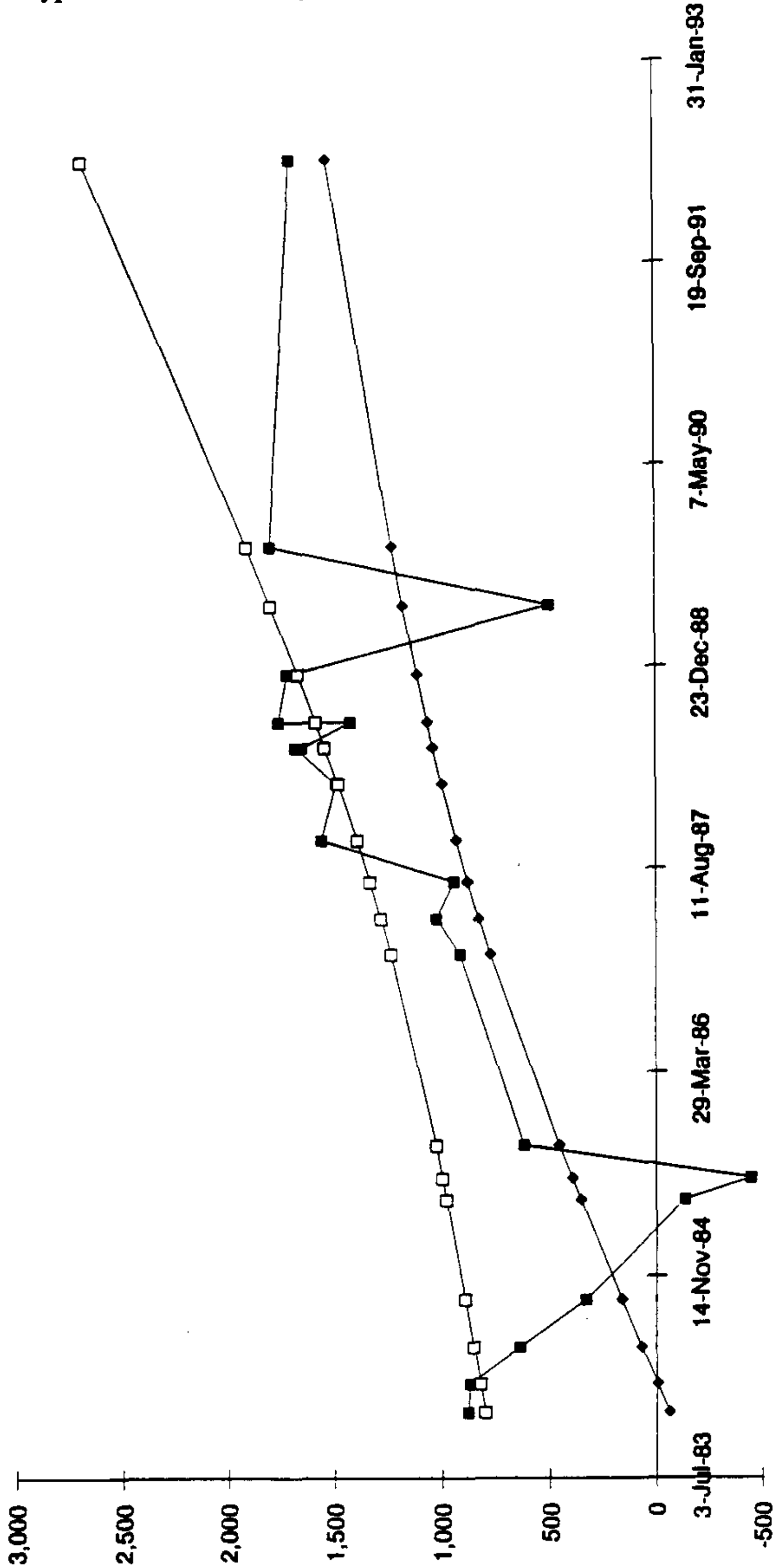


Figure 2-10 Typical 95% CI Analysis of Tritium Concentrations, Well 199-H4-4



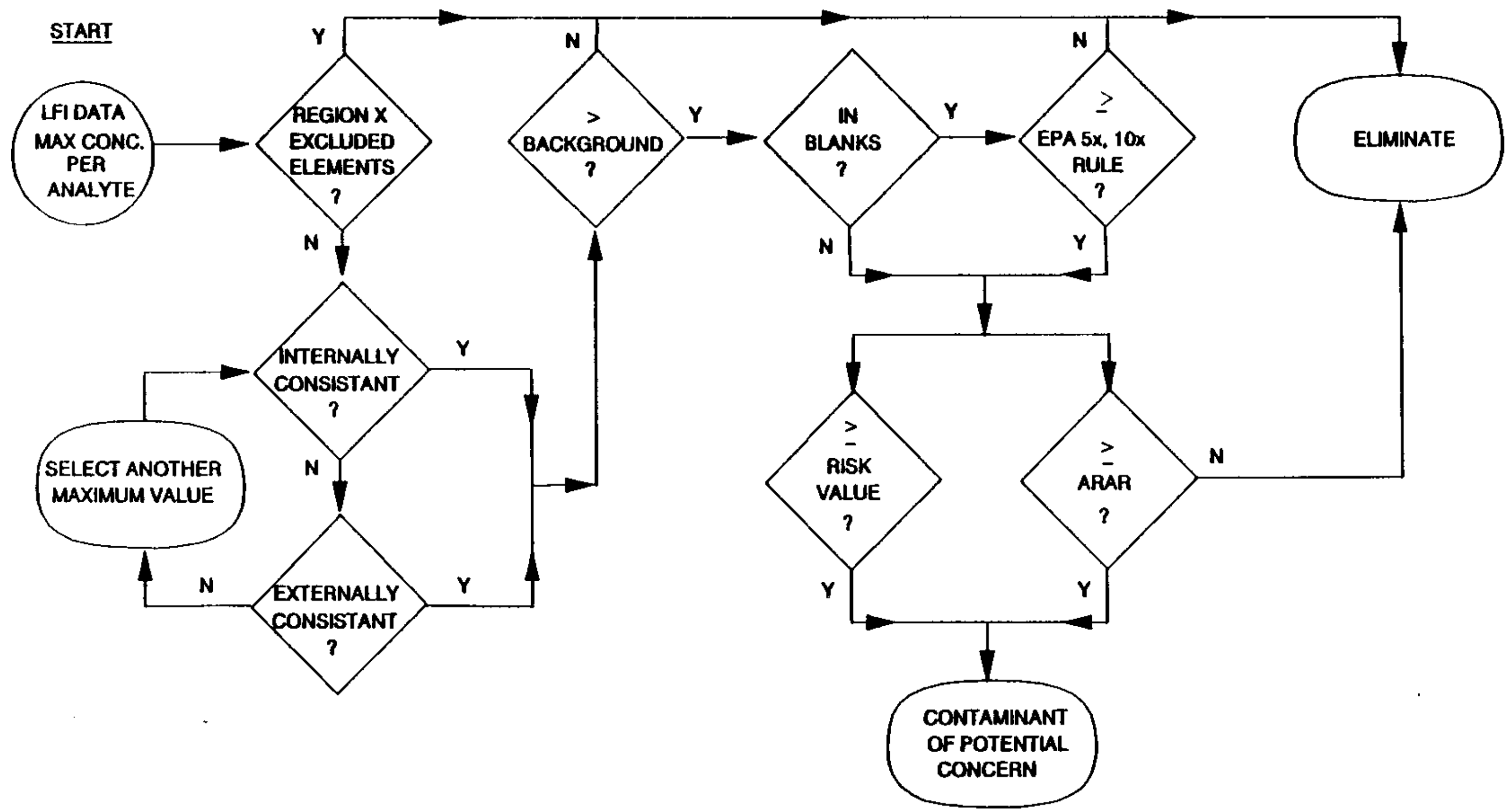


Figure 2-11 Decision Tree for Determining Contaminants of Potential Concern

Table 2-1 Inventory of Wells used in 100-HR-3 LFI
(Page 1 of 5)

WELL NUMBER	DEPTH (ft)	DIA. (in.)	COMPLETION	SCREEN INTERVAL (ft)	SAMPLE METHOD	AQUIFER TEST METHOD	FORMATION
199-H3-1	75	8	Perforated	29-74	P-Hydrost	None	Hanford/Ringold
199-H3-2(A)	56	6	Screen	36-51	P-Hydrost	None	Hanford
199-H3-2(B)	58	6	Screen	50-55	P-Hydrost	None	Hanford
199-H3-2(C)	155	6	Screen	100-110	P-Hydrost	None	Ringold
199-H4-2	386	6	Open	N/A	Capped	NA	NA
199-H4-3	55	6	Perforated	34-55	P-Hydrost	None	Hanford
199-H4-4	55	6	Tele-screen	33-43	P-Hydrost	None	Hanford
199-H4-5	60	6	Tele-screen	32-42	P-Hydrost	None	Hanford
199-H4-6	55	6	Tele-screen	39-49	P-Hydrost	None	Hanford
199-H4-7	55	6	Screen	38-53	P-Hydrost	None	Hanford
199-H4-8	55	6	Screen	38-48	P-Hydrost	None	Hanford
199-H4-9	51	6	Screen	36-46	P-Hydrost	None	Hanford
199-H4-10	38	6	Screen	23-38	P-Hydrost	None	Hanford
199-H4-11	53	6	Screen	38-53	P-Hydrost	None	Hanford
199-H4-12(A)	48	6	Screen	33-48	P-Hydrost	None	Hanford
199-H4-12(B)	51	6	Screen	45-50	P-Hydrost	None	Hanford
199-H4-12(C)	220	6	Screen	72-82	P-Hydrost	None	Ringold
199-H4-13	61	6	Screen	37-52	P-Hydrost	None	Hanford/Ringold

Table 2-1 Inventory of Wells used in 100-HR-3 LFI
(Page 2 of 5)

WELL NUMBER	DEPTH (ft)	DIA. (in.)	COMPLETION	SCREEN INTERVAL (ft)	SAMPLE METHOD	AQUIFER TEST METHOD	FORMATION
199-H4-14	53	6	Screen	38-53	P-Hydrost	None	Hanford
199-H4-15(A)	46	6	Screen	27-42	P-Hydrost	None	Hanford
199-H4-15(B)	44	6	Screen	37-42	P-Hydrost	None	Hanford
199-H4-15(C)	330	2	4 Piezometers	N/A	N/A	None	
199-H4-16	61	6	Screen	42-57	P-Hydrost	None	Hanford
199-H4-17	46.5	6	Screen	35-45	P-Hydrost	None	Hanford
199-H4-18	51	6	Screen	40-50	P-Hydrost	None	Hanford

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Table 2-1 Inventory of Wells used in 100-HR-3 LFI

WELL NUMBER	DEPTH (ft)	DIA. (in.)	COMPLETION	SCREEN INTERVAL (ft)	SAMPLE METHOD	AQUIFER TEST METHOD	FORMATION
199-H4-45	54.5	4	Screen	32-52.8	P-Hydrost	Slug	Hanford
199-H4-46	61.5	4	Screen	38.7-59.5	P-Hydrost	Slug	Hanford
199-H4-47	59.9	4	Screen	38.8-59.6	P-Hydrost	Slug	Hanford
199-H4-48	62	4	Screen	39-59.8	P-Hydrost	Slug	Hanford
199-H4-49	60	4	Screen	38-53.7	P-Hydrost	Slug	Hanford
199-H5-1	57	4	Screen	34.8-50.9	P-Hydrost	Slug	Hanford
199-H6-1	56.2	4	Screen	33.9-54.7	P-Hydrost	Slug	Hanford

Table 2-1 Inventory of Wells used in 100-HR-3 LFI

WELL NUMBER	DEPTH (ft)	DIA. (in.)	COMPLETION	SCREEN INTERVAL (ft)	SAMPLE METHOD	AQUIFER TEST METHOD	FORMATION
199-D2-5	95	8	Perforated	36-86	S Pump	None	Ringold
199-D2-6	113	4	Screen	77.2-98.3	Hydrostar	Slug	Ringold
199-D5-12	91	8	Perforated	35-90	S Pump	None	Ringold
199-D5-13[b]	97	4	Screen	76-97	P-Hydrost	Slug	Ringold
199-D5-14	101	4	Screen	77.1-98.2	P-Hydrost	Slug	Ringold
199-D5-15	101.8	4	Screen	77.4-98.2	P-Hydrost	Slug	Ringold
199-D5-16	99.9	4	Screen	77.4-98.2	P-Hydrost	Slug	Ringold
199-D5-17	115	4	Screen	75.2-96.0	P-Hydrost	Slug	Ringold
199-D5-18	100.4	4	Screen	68.1-93.5	P-Hydrost	Slug	Ringold
199-D5-19	96.6	4	Screen	74.8-95.2	P-Hydrost	Slug	Ringold
199-D5-20	103.3	4	Screen	76.2-97	P-Hydrost	Slug	Ringold
199-D8-3	80.5	6	Perforated	35-79	S. Pump	None	Hanford/Ringold
199-D8-4[b]	103	3	Screen	74-94	P-Hydrost	None	Ringold
199-D8-5[b]	85	3	Screen	63-83	P-Hydrost	Slug	Ringold
199-D8-6[b]	110	4	Screen		P-Hydrost	Slug	Ringold
199-D8-53	69.4	4	Screen	45-65.5	P-Hydrost	Slug	Ringold
199-D8-54(A)	78	4	Screen	51.5-72.6	P-Hydrost	Slug	Hanford
199-D8-55	74	4	Screen	48.6-69.4	P-Hydrost	Slug	Ringold

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Table 2-1 Inventory of Wells used in 100-HR-3 LFI
(Page 5 of 5)

WELL NUMBER	DEPTH (ft)	DIA. (in.)	COMPLETION	SCREEN INTERVAL (ft)	SAMPLE METHOD	AQUIFER TEST METHOD	FORMATION
699-89-35[a]	75	8	Perforated	20-73	NA	NA	NA
699-93-46	-	-	-	NA	-	-	-
699-93-48	83	4	Screen	41.2-62	P-Hydrost	Slug	Hanford
699-93-49(B)	NA	-	-	-	NA	NA	-
699-96-43	50.8	4	Screen	32.4-48.5	P-Hydrost	Slug	Hanford
699-96-49	100	8	Perforated	79-89	S. Pump	NA	Ringold
699-96-52		12	Dug			NA	NA
699-97-43[a]	100	8	Perforated	25-97	S. Pump	NA	Ringold
699-97-51(A)[a]	39	8	Perforated	12-39	S. Pump	NA	NA
699-97-51(B)[a]	28	12	Dug/perf.	Backfilled	N/A	NA	NA
699-98-49(A)[a]	40	10	Dug/perf	Backfilled	N/A	NA	NA
699-101-48(A)[a]	50	6	Screen	43-47	NA	NA	NA
699-101-48(B)[a]	48	6	Screen	43-47	Pump	NA	NA
699-101-48(C)[a]	77	6	Screen	43-47	NA	NA	NA

[a]Data derived from PNL-5397, Hanford Wells
[b] Hydrologic and Geologic Data Available for the Region North of Gable Mountain, Hanford Site, WA

Table 2-2 100-HR-3 Unconfined Aquifer Slug Test Summary

Well Number	Sediment Description - Field Log Sediment Description - Sieve Analysis	Screened Formation	K (ft/d)
199-D2-6	Sandy Gravel Gravelly Sand	Ringold	40
199-D5-14	Sandy Gravel/Gravelly Sand Sand	Ringold	30
199-D5-15	Sandy Gravel Gravel/Sand	Ringold	30
199-D5-16	Clayey Sandy Gravel/Sandy Gravel Sandy Gravel	Ringold	10
199-D5-17	Sandy Gravel/Clayey Sandy Gravel Gravelly Sand	Ringold?	10
199-D5-18	Sandy Gravel Sandy Gravel	Ringold	60
199-D5-19	Gravelly Sand/Clayey Sandy Gravel Sand/Gravel	Ringold	40
199-D5-20	Silty Sandy Gravel Sand	Ringold	40
199-D8-53	Silty Sandy Gravel Sandy Gravel	Ringold?	530
199-D8-54A	Silty Sandy Gravel Slightly Gravelly Sand	Hanford?	400
199-D8-55	Sandy Silty Gravel Gravel/Sand	Ringold?	20
199-H4-45	Sandy Gravel Gravelly Sand	Hanford	100
199-H4-46	Sandy Gravel/Gravelly Sand Gravelly Sand	Hanford	120
199-H4-47	Silty Sandy Gravel Sandy Gravel	Hanford	90
199-H4-48	Sandy Gravel/Gravelly Sand Slightly Gravelly Sand	Hanford	80
199-H4-49	Sandy Gravel Slightly Sandy Gravel	Hanford	90
199-H5-1	Sandy Gravel/Sand Sand	Hanford	110
199-H6-1	Sandy Gravel N/A	Hanford	70
699-93-48	Sandy Gravel Sandy Gravel	Hanford	60
699-96-43	Gravelly Sand/Silty Clay Silty Sand	Hanford	50
699-91-46	Sandy Gravel/Gravelly Sand Sand	Hanford	790

K = hydraulic conductivity
N/A = not available

Table 2-3 Summary of Spectral Gamma Logging

Borehole	Depth of Survey (ft)	Cs-137 D[1]	Cs-137 C[2]	Co-60 D[1]	Co-60 C[2]	Eu-152 D[1]	Eu-152 C[2]	Eu-154 D[1]	Eu-154 C[2]
D8-2	40	40[3]	35	40[3]	30	40[3]	80	30	12
D5-2	86	-		-		-		-	
D5-12	87	-		-		-		-	
D8-3	77	8	6	6	1	6	2	6	1
D8-54B	73	-		-		-		-	
D8-55	68	48	2	-		-		-	
H3-1	65	-		-		-		-	
H4-3	42	-		-		-		-	
H4-11	45	-		-		-		-	
H4-13	48	-		-		-		-	
H4-16	53	-		-		-		-	
H4-18	47	-		-		-		-	
H4-45	51	-		-		-		-	

[1] Depth (in feet) at which maximum concentration encountered
[2] Maximum concentration of radionuclide in pCi/g
[3] Maximum value at base of borehole, higher concentration may exist at greater depth

Table 2-4 Summary of Sediment Chemical and Radiological Analyses
Page 1 of 2

100-HR-3 SOILS CHEMISTRY AND RADIOCHEMISTRY					
Constituent	Range (mg/kg)		Radionuclide	Range (pCi/g)	
	Minimum	Maximum		Minimum	Maximum
Aluminum	1.33E+03	7.68E+03	Carbon-14	1.70E-02	1.32E+01
Antimony	u	5.50E+00	Potassium-40	1.12E+00	1.79E+01
Arsenic	u	2.10E+00	Strontium-90	4.20E-02	1.40E+00
Barium	2.00E+01	1.21E+02	Technetium-99	1.60E-01	6.20E+00
Beryliim	u	1.50E+00	Cesium-137	2.00E-02	2.48E+00
Cadmium	u	1.60E+00	Radium-226	2.40E-01	1.54E+00
Calcium	1.00E+03	2.00E+04	Thorium-228	4.07E-01	1.45E+00
Chromium	u	1.19E+02	Thorium-232	5.00E-01	5.30E-01
Cobalt	u	1.00E+01	Thorium-234	6.00E-01	-
Copper	u	1.66E+01	Uranium 233/244	6.00E-02	4.60E-01
Iron	2.00E+03	1.77E+04	Uranium-235	1.00E-03	4.70E-02
Lead	u	9.80E+00	Uranium-238	5.30E-02	1.40E+00
Magnesium	1.00E+03	6.00E+03	Plutonium 239/24	1.00E-03	7.00E-03
Manganese	1.00E+02	4.50E+02	Americium-241	3.00E-03	1.20E-02
Mercury	u	4.00E-01			
Nickel	u	5.45E+01			
Potassium	u	1.20E+03			
Selenium	u	5.00E-01			
Silver	u	2.30E+00			
Sodium	1.00E+02	5.00E+02			
Thallium	u	4.00E-01			
Vanadium	5.00E+00	4.00E+01			
Zinc	1.00E+01	4.50E+01			
Cyanide	u	5.20E+00			

Table 2-4 Summary of Sediment Chemical and Radiological Analyses (continued)
Page 2 of 2

Semi-Volatile Organic Compounds

Constituent	Number of Detections	Range Minimum	Range Maximum	Found in Adjacent Soil	Found in Groundwater (same hole)	Comment
Phenol	2	43	160	no	no	
Benzyl alcohol	2	2	4	no	no	in drill water
bis(2-chloroisopropyl)ether	1	380		no	no	
2-Nitroaniline	1	1900		no	no	
Acenaphthene	1	380		no		
Diethylphthalate	2	48	65	no	no	c.l.c.
Pentachlorophenol	3	40	130	no	no	
Carbozole	1	220		no	no	
Di-n-butylphthalate	15	38	2600	-	-	c.l.c.
Butylbenzylphthalte	4	40	3500	-	-	c.l.c.
bis(2-ethylhexyl)phthalate	11	1	5700	-	-	c.l.c.
Benzo(g,h,i)perylene	1	10		no	no	in extraction blank

c.l.c common laboratory contaminant

Volatile Organic Compounds

Constituent	Number of Detections	Range Minimum	Range Maximum	Found in Adjacent Soil	Found in Groundwater (same hole)	Comment
Chloromethane	1	2		no	no	-
Methylene Chloride	9	2	30	-	-	in field blank
Acetone	19	5	119	-	-	in field blank
1,2-Dichloroethene	2	5	6	no	no	same lab group
Chloroform	5	1	42	-	-	in drill water
Carbon tetrachloride	1	6		no	no	
Bromodichloromethane	1	4		no	no	in drill water
Trichloroethene	4	2	3	yes	no	
2-Hexanone	1	10		no	no	
Toluene	8	1	21	yes	no	

Table 2-5 D/DR Area LFI Volatile and Semivolatile Organic Data Summary
(Page 1 of 3)

(ug/l)

Analyte	Max. Conc.	Well #	>Bkg.?	Elim.	COPC
1,1,1-Trichloroethane	U	NA	NA	X	
1,1,2,2-Tetrachloroethane	U	NA	NA	X	
1,1,2-Trichloroethane	U	NA	NA	X	
1,1-Dichloroethane	U	NA	NA	X	
1,1-Dichloroethene	U	NA	NA	X	
1,2-Dichloroethane	U	NA	NA	X	
1,2-Dichloroethene	U	NA	NA	X	
1,2-Dichloropropane	U	NA	NA	X	
2-Butanone	U	NA	NA	X	
2-Hexanone	U	NA	NA	X	
4-Methyl-2-Pentanone	U	NA	NA	X	
Acetone	U	NA	NA	X	
Benzene	U	NA	NA	X	
Bromodichloromethane	U	NA	NA	X	
Bromoform	U	NA	NA	X	
Bromomethane	U	NA	NA	X	
Carbon Disulfide	U	NA	NA	X	
Carbon Tetrachloride	U	NA	NA	X	
Chlorobenzene	U	NA	NA	X	
Chloroethane	U	NA	NA	X	
Chloroform	12	D5-20	NA		X
Chloromethane	U	NA	NA	X	
cis-1,3-Dichloropropene	U	NA	NA	X	
Dibromochloromethane	U	NA	NA	X	
Ethylbenzene	U	NA	NA	X	
Methylenechloride	U	NA	NA	X	
Styrene	U	NA	NA	X	
Tetrachloroethene	U	NA	NA	X	
Toluene	U	NA	NA	X	
trans-1,3-Dichloropropene	U	NA	NA	X	
Trichloroethene	U	NA	NA	X	
Vinyl Chloride	U	NA	NA	X	
Xylenes (total)	U	NA	NA	X	

Table 2-5 D/DR Area LFI Volatile and Semivolatile Organic Data Summary
(Page 2 of 3)

(ug/l)

Analyte	Max. Conc.	Well #	Elim.	COPC
Diethyl phthalate	U	NA	X	
1,2,4-Trichlorobenzene	U	NA	X	
1,2-Dichlorobenzene	U	NA	X	
1,3-Dichlorobenzene	U	NA	X	
1,4-Dichlorobenzene	U	NA	X	
2,4,5-Trichlorophenol	U	NA	X	
2,4,6-Trichlorophenol	U	NA	X	
2,4-Dichlorophenol	U	NA	X	
2,4-Dimethylphenol	U	NA	X	
2,4-Dinitrophenol	U	NA	X	
2,4-Dinitrotoluene	U	NA	X	
2,6-Dinitrotoluene	U	NA	X	
2-Chloronaphthalene	U	NA	X	
2-Chlorophenol	U	NA	X	
2-Methylnaphthalene	U	NA	X	
2-Methylphenol	U	NA	X	
2-Nitroaniline	U	NA	X	
2-Nitrophenol	U	NA	X	
3,3'-Dichlorobenzidine	U	NA	X	
3-Nitroaniline	U	NA	X	
4,6-Dinitro-2-methylphenol	U	NA	X	
4-Bromophenylphenyl ether	U	NA	X	
4-Chloro-3-methylphenol	U	NA	X	
4-Chloroaniline	U	NA	X	
4-Chlorophenylphenyl ether	U	NA	X	
4-Methylphenol	U	NA	X	
4-Nitroaniline	U	NA	X	
4-Nitrophenol	U	NA	X	
9H-Carbazole	U	NA	X	
Acenaphthene	U	NA	X	
Acenaphthylene	U	NA	X	
Anthracene	U	NA	X	
Benzo(a)anthracene	U	NA	X	
Benzo(a)pyrene	U	NA	X	
Benzo(b)fluoranthene	U	NA	X	
Benzo(ghi)perylene	U	NA	X	
Benzo(k)fluoranthene	U	NA	X	
Bis(2-chloroethoxy)methane	U	NA	X	
Bis(2-chloroethyl)ether	U	NA	X	
Bis(2-chloroisopropyl)ether	U	NA	X	
Bis(2-ethylhexyl)phthalate	22	D8-5		X
Butylbenzylphthalate	U	NA	X	
Chrysene	U	NA	X	
Di-n-butylphthalate	1 J	D8-5		X
Di-n-octylphthalate	U	NA	X	

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Table 2-5 D/DR Area LFI Volatile and Semivolatile Organic Data Summary
(Page 3 of 3)

(ug/l)

Analyte	Max. Conc.	Well #	Elim.	COPC
Dibenz[a,h]anthracene	U	NA	X	
Dibenzofuran	U	NA	X	
Diethylphthalate	U	NA		
Dimethyphthalate	U	NA	X	
Fluoranthene	U	NA	X	
Fluorene	U	NA	X	
Hexachlorobenzene	U	NA	X	
Hexachlorobutadiene	U	NA	X	
Hexachlorocyclopentadiene	U	NA	X	
Hexachloroethane	U	NA	X	
Indeno(1,2,3-cd)pyrene	U	NA	X	
Isophorone	U	NA	X	
N-nitroso-di-n-dipropylamine	U	NA	X	
N-Nitrosodiphenylamine	U	NA	X	
Naphthalene	U	NA	X	
Nitrobenzene	U	NA	X	
Pentachlorophenol	U	NA	X	
Phenanthrene	U	NA	X	
Phenol	U	NA	X	
Pyrene	U	NA	X	

U: Undetected
J: Estimated Value
NA: Not applicable

Table 2-6 D/DR Area LFI Filtered Inorganic Data Summary

Filtered (ug/l)

Analyte	Max. Conc.	Well #	Non-Toxic	> Bkg. ?	ELIM.	COPC
Aluminum	U	NA	NA	NA	X	
Antimony	U	NA	NA	NA	X	
Arsenic	6 B	D5-14	NO	NO	X	
Barium	139 B	D8-3	NO	YES		X
Beryllium	U	NA	NA	NA	X	
Cadmium	U	NA	NA	NA	X	
Calcium	125000	D2-12	YES	YES	X	
Chromium	2020	D5-15	NO	YES		X
Cobalt	U	NA	NA	NA	X	
Copper	6 B	D5-14	NO	NO	X	
Iron	95 B	D2-5	YES	YES	X	
Lead	6.6 *	D2-6	NO	YES		X
Magnesium	27400	D5-19	YES	YES	X	
Manganese	175	D5-17	NO	YES		X
Mercury	U	NA	NA	NA	X	
Nickel	10 B	D8-53	NO	NO	X	
Potassium	9310	D8-3	YES	YES	X	
Selenium	U	NA	NA	NA	X	
Silver	U	NA	NA	NA	X	
Sodium	22900	D5-17	YES	NO	X	
Thallium	U	NA	NA	NA	X	
Vanadium	19.2 B	D2-5	NO	YES		X
Zinc	U	NA	NA	NA	X	
Cyanide	U	NA	NA	NA	X	
Nitrates	33000	D8-3	NO	YES		X

Shading indicates reason for elimination.
All concentrations are ug/L
U= Not detected
NA= Not applicable
Qualifiers:
B= estimated value, less than the contract detection limit
*= duplicate analysis not within control limits

Table 2-7 D/DR Area LFI Pesticide Data Summary

(ug/l)

Analyte	Max. Conc.	Well #	>Bkg.?	Elim.	COPC
4,4'-DDD	U	NA	NA	X	
4,4'-DDE	U	NA	NA	X	
4,4'-DDT	U	NA	NA	X	
Aldrin	U	NA	NA	X	
Alpha-BHC	U	NA	NA	X	
Alpha-chlordane	U	NA	NA	X	
Aroclor-1016	U	NA	NA	X	
Aroclor-1221	U	NA	NA	X	
Aroclor-1232	U	NA	NA	X	
Aroclor-1242	U	NA	NA	X	
Aroclor-1248	U	NA	NA	X	
Aroclor-1254	U	NA	NA	X	
Aroclor-1260	U	NA	NA	X	
Beta-BHC	U	NA	NA	X	
Delta-BHC	U	NA	NA	X	
Dieldrin	U	NA	NA	X	
Endosulfan I	U	NA	NA	X	
Endosulfan II	U	NA	NA	X	
Endosulfan sulfate	U	NA	NA	X	
Endrin	U	NA	NA	X	
Endrin Aldehyde	U	NA	NA	X	
Endrin Ketone	U	NA	NA	X	
Gamma-BHC	U	NA	NA	X	
Gamma-chlordane	U	NA	NA	X	
Heptachlor	U	NA	NA	X	
Heptachlor epoxide	U	NA	NA	X	
Methoxychlor	U	NA	NA	X	
Toxaphene	U	NA	NA	X	

U: Undetected
NA: Not applicable

Table 2-8 D/DR Area LFI Radionuclide Data Summary

(pCi/l +/- 2 sigma)

Analyte	Max. Conc.	Well #	>Bkg.?	Elim.	COPC
Americium 241	U	NA	NA	X	
Barium 140	U	NA	NA	X	
Beryllium 7	U	NA	NA	X	
Carbon 14	42 J	D8-54A	NA		X
Cerium 141	U	NA	NA	X	
Cerium-144	U	NA	NA	X	
Cesium 134	U	NA	NA	X	
Cesium 137	U	NA	NA	X	
Chromiun 51	U	NA	NA	X	
Cobalt 58	U	NA	NA	X	
Cobalt 60	U	NA	NA	X	
Europium 152	U	NA	NA	X	
Europium 154	U	NA	NA	X	
Europium-155	U	NA	NA	X	
Gross Alpha	U	NA	NA	X	
Gross Beta	81	D5-12	Yes		X
Iodine 131	U	NA	NA	X	
Iron 59	U	NA	NA	X	
Manganese 54	U	NA	NA	X	
Plutonium 238	U	NA	NA	X	
Plutonium 239/240	U	NA	NA	X	
Potassium 40	U	NA	NA	X	
Radium 226	U	NA	NA	X	
Radium-223	U	NA	NA	X	
Ruthenium 103	U	NA	NA	X	
Ruthenium 106	U	NA	NA	X	
Strontium 90	7.2	D8-54A	NA	X	
Technetium 99	U	NA	NA	X	
Thorium 228	U	NA	NA	X	
Thorium 232	U	NA	NA	X	
Tritium	78000	D5-17	NA		X
Uranium 233/234	1.5	D5-17	No	X	
Uranium 235	U	NA	NA	X	
Uranium 238	1.3	D5-14	No	X	
Zinc 65	U	NA	NA	X	
Zirconium 95	U	NA	NA	X	

U: Undetected
NA: Not applicable

Table 2-9 D/DR Area LFI Other Constituent Data Summary

(mg/l)

Analyte	Max. Conc.	Well #	Non-toxic?	>Bkg.?	Elim.	COPC
Alkalinity	116 J	D5-14	NO	No	X	
Ammonia	0.75	D5-17	NO	NA		X
C.O.D.	50 J	D5-17	NO	NA		X
Chloride	38.8	D8-54A	NO	Yes		X
Electric Cond.	797	D5-12	NO	Yes		X
Fluoride	0.5	D5-16	NO	No	X	
Hydrazine	U		NA	NA	X	
Nitrate/Nitrite	45	D8-3	NO	Yes		X
pH	9.8 J - 6.55 J	NA	NO	Yes		X
Phosphate	0.4	D2-6	NA	No	X	
Sulfate	215	D5-12	NO	Yes		X
Sulfide	1	D5-19	NA	NA		X
T.D.S.	627 J	D5-12	NO	NA		X
T.O.C.	4.8	D5-15	NO	Yes		X
T.O.X.	25.2	D8-3	NO	NA		X

U: Undetected
J: Estimated Value
NA: Not Applicable

Table 2-10 H Area LFI Volatile and Semivolatile Organic Data Summary
(Page 1 of 3)

(ug/l)

Analyte	Max. Conc.	Well #	>Bkg.?	Elim.	COPC
1,1,1-Trichloroethane	U	NA	NA	X	
1,1,2,2-Tetrachloroethane	U	NA	NA	X	
1,1,2-Trichloroethane	U	NA	NA	X	
1,1-Dichloroethane	U	NA	NA	X	
1,1-Dichloroethene	U	NA	NA	X	
1,2-Dichloroethane	U	NA	NA	X	
1,2-Dichloroethene	U	NA	NA	X	
1,2-Dichloropropane	U	NA	NA	X	
2-Butanone	U	NA	NA	X	
2-Hexanone	U	NA	NA	X	
4-Methyl-2-Pentanone	U	NA	NA	X	
Acetone	U	NA	NA	X	
Benzene	U	NA	NA	X	
Bromodichloromethane	U	NA	NA	X	
Bromoform	U	NA	NA	X	
Bromomethane	U	NA	NA	X	
Carbon Disulfide	U	NA	NA	X	
Carbon Tetrachloride	U	NA	NA	X	
Chlorobenzene	U	NA	NA	X	
Chloroethane	U	NA	NA	X	
Chloroform	53	H4-47	NA		X
Chloromethane	U	NA	NA	X	
cis-1,3-Dichloropropene	U	NA	NA	X	
Dibromochloromethane	U	NA	NA	X	
Ethlybenzene	U	NA	NA	X	
Methylenechloride	U	NA	NA	X	
Styrene	U	NA	NA	X	
Tetrachloroethene	U	NA	NA	X	
Toluene	U	NA	NA	X	
trans-1,3-Dichloropropene	U	NA	NA	X	
Trichloroethene	U	NA	NA	X	
Vinyl Chloride	U	NA	NA	X	
Xylenes (total)	U	NA	NA	X	

Table 2-10 H Area LFI Volatile and Semivolatile Organic Data Summary
(Page 2 of 3)

(ug/l)

Analyte	Max. Conc.	Well #	Elim.	COPC
Diethyl phthalate	U	NA	X	
1,2,4-Trichlorobenzene	U	NA	X	
1,2-Dichlorobenzene	U	NA	X	
1,3-Dichlorobenzene	U	NA	X	
1,4-Dichlorobenzene	U	NA	X	
2,4,5-Trichlorophenol	U	NA	X	
2,4,6-Trichlorophenol	U	NA	X	
2,4-Dichlorophenol	U	NA	X	
2,4-Dimethylphenol	U	NA	X	
2,4-Dinitrophenol	U	NA	X	
2,4-Dinitrotoluene	U	NA	X	
2,6-Dinitrotoluene	U	NA	X	
2-Chloronaphthalene	U	NA	X	
2-Chlorophenol	U	NA	X	
2-Methylnaphthalene	U	NA	X	
2-Methylphenol	U	NA	X	
2-Nitroaniline	U	NA	X	
2-Nitrophenol	U	NA	X	
3,3'-Dichlorobenzidine	U	NA	X	
3-Nitroaniline	U	NA	X	
4,6-Dinitro-2-methylphenol	U	NA	X	
4-Bromophenylphenyl ether	U	NA	X	
4-Chloro-3-methylphenol	U	NA	X	
4-Chloroaniline	U	NA	X	
4-Chlorophenylphenyl ether	U	NA	X	
4-Methylphenol	U	NA	X	
4-Nitroaniline	U	NA	X	
4-Nitrophenol	U	NA	X	
9H-Carbazole	U	NA	X	
Acenaphthene	U	NA	X	
Acenaphthylene	U	NA	X	
Anthracene	U	NA	X	
Benzo(a)anthracene	U	NA	X	
Benzo(a)pyrene	U	NA	X	
Benzo(b)fluoranthene	U	NA	X	
Benzo(ghi)perylene	U	NA	X	
Benzo(k)fluoranthene	U	NA	X	
Bis(2-chloroethoxy)methane	U	NA	X	
Bis(2-chloroethyl)ether	U	NA	X	
Bis(2-chloroisopropyl)ether	U	NA	X	
Bis(2-ethylhexyl)phthalate	U	NA	X	
Butylbenzylphthalate	U	NA	X	
Chrysene	U	NA	X	
Di-n-butylphthalate	U	NA	X	
Di-n-octylphthalate	U	NA	X	

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Table 2-10 H Area LFI Volatile and Semivolatile Organic Data Summary
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(ug/l)

Analyte	Max. Conc.	Well #	Elim.	COPC
Dibenz[a,h]anthracene	U	NA	X	
Dibenzofuran	U	NA	X	
Diethylphthalate	U	NA	X	
Dimethyphthalate	U	NA	X	
Fluoranthene	U	NA	X	
Fluorene	U	NA	X	
Hexachlorobenzene	U	NA	X	
Hexachlorobutadiene	U	NA	X	
Hexachlorocyclopentadiene	U	NA	X	
Hexachloroethane	U	NA	X	
Indeno(1,2,3-cd)pyrene	U	NA	X	
Isophorone	U	NA	X	
N-nitroso-di-n-dipropylamine	U	NA	X	
N-Nitrosodiphenylamine	U	NA	X	
Naphthalene	U	NA	X	
Nitrobenzene	U	NA	X	
Pentachlorophenol	U	NA	X	
Phenanthrene	U	NA	X	
Phenol	U	NA	X	
Pyrene	U	NA	X	

U: Undetected
NA: Not applicable

Table 2-11 H Area LFI Filtered Inorganic Data Summary

Filtered (ug/l)

Analyte	Max. Conc.	Well #	Non-Toxic	> Bkg. ?	ELIM.	COPC
Aluminum	U	NA	NA	NA	X	
Antimony	U	NA	NA	NA	X	
Arsenic	5.2 B	H4-47	NO	NO	X	
Barium	120 a	H4-15B	NO	YES		X
Beryllium	U	NA	NA	NA	X	
Cadmium	U	NA	NA	NA	X	
Calcium	66000	H4-17	YES	YES	X	
Chromium	410	H4-14	NO	YES		X
Cobalt	U	NA	NA	NA	X	
Copper	8.1 B	H4-49	NA	NO	X	
Iron	61.7 B	H4-49	YES	NO	X	
Lead	2.1 B	H4-49	NO	NO	X	
Magnesium	16200	H5-1A	YES	NO	X	
Manganese	175	H5-1	NO	YES	X	
Mercury	U	NA	NA	NA	X	
Nickel	12.9 B	H4-46	NO	NO	X	
Potassium	6550	H5-1	YES	NO	X	
Selenium	U	NA	NA	NA	X	
Silver	U	NA	NA	NA	X	
Sodium	27600	H5-1	YES	NO	X	
Thallium	U	NA	NA	NA	X	
Vanadium	8.1 B	H4-49	NO	NO	X	
Zinc	123	H5-1	NO	YES		X
Cyanide	U	NA	NA	NA	X	
Nitrates	32000	H6-1	NO	YES		X

Shading indicates reason for elimination.
All concentrations are ug/L
ND= Not detected
NA= Not applicable
a= Only sampled in the 3rd round
Qualifiers:
B= estimated value, less than the contract detection limit

Table 2-12 H Area LFI Pesticide Data Summary

(ug/l)

Analyte	Max. Conc.	Well #	>Bkg.?	Elim.	COPC
4,4'-DDD	U	NA	NA	X	
4,4'-DDE	U	NA	NA	X	
4,4'-DDT	U	NA	NA	X	
Aldrin	U	NA	NA	X	
Alpha-BHC	U	NA	NA	X	
Alpha-chlordane	U	NA	NA	X	
Aroclor-1016	U	NA	NA	X	
Aroclor-1221	U	NA	NA	X	
Aroclor-1232	U	NA	NA	X	
Aroclor-1242	U	NA	NA	X	
Aroclor-1248	U	NA	NA	X	
Aroclor-1254	U	NA	NA	X	
Aroclor-1260	U	NA	NA	X	
Beta-BHC	U	NA	NA	X	
Delta-BHC	U	NA	NA	X	
Dieldrin	U	NA	NA	X	
Endosulfan I	U	NA	NA	X	
Endosulfan II	U	NA	NA	X	
Endosulfan sulfate	U	NA	NA	X	
Endrin	U	NA	NA	X	
Endrin Aldehyde	U	NA	NA	X	
Endrin Ketone	U	NA	NA	X	
Gamma-BHC	U	NA	NA	X	
Gamma-chlordane	U	NA	NA	X	
Heptachlor	U	NA	NA	X	
Heptachlor epoxide	U	NA	NA	X	
Methoxychlor	U	NA	NA	X	
Toxaphene	U	NA	NA	X	

U: Undetected
NA: Not applicable

Table 2-13 H Area LFI Radionuclide Data Summary

(pCi/l +/- 2 sigma)

Analyte	Max. Conc.	Well #	>Bkg.?	Elim.	COPC
Americium-241	U	NA	NA	X	
Barium-140	U	NA	NA	X	
Beryllium-7	U	NA	NA	X	
Carbon-14	72	H4-45	NA		X
Cerium-141	U	NA	NA	X	
Cerium-144	U	NA	NA	X	
Cesium-134	U	NA	NA	X	
Cesium-137	U	NA	NA	X	
Chromiun-51	U	NA	NA	X	
Cobalt-58	U	NA	NA	X	
Cobalt-60	U	NA	NA	X	
Europium-152	U	NA	NA	X	
Europium-154	U	NA	NA	X	
Europium-155	U	NA	NA	X	
Gross Alpha	3.1 J	H5-1A	No	X	
Gross Beta	28	H4-45	Yes		X
Iodine-131	U	NA	NA	X	
Iron-59	U	NA	NA	X	
Manganese-54	U	NA	NA	X	
Plutonium-238	U	NA	NA	X	
Plutonium-239/240	U	NA	NA	X	
Potassium-40	U	NA	NA	X	
Radium-226	U	NA	NA	X	
Radium-223	U	NA	NA	X	
Ruthenium-103	U	NA	NA	X	
Ruthenium-106	U	NA	NA	X	
Strontium-90	13	H4-45	NA		X
Technetium-99	4.6 J	H4-45	NA		X
Thorium-228	U	NA	NA	X	
Thorium-232	U	NA	NA	X	
Tritium	9300	H5-1A	NA		X
Uranium-233/234	2.8	H6-1	No	X	
Uranium-235	.14 J	H4-49	No	X	
Uranium-238	2.2	H5-1A	Yes		X
Zinc-65	U	NA	NA	X	
Zirconium-95	U	NA	NA	X	

J: Estimated value
U: Undetected
NA: Not applicable

Table 2-14 H Area LFI Other Constituent Data Summary

(mg/l)

Analyte	Max. Conc.	Well #	Non-toxic?	>Bkg.?	Elim.	COPC
Alkalinity	171	H5-1A	NO	No	X	
Ammonia	0.05	H6-1	NO	NA		X
C.O.D.	30	H6-1	NO	NA		X
Chloride	12.9	H5-1A	NO	Yes		X
Electric Cond.	509 UMHO	H5-1A	NO	No	X	
Fluoride	0.4	H5-1A	NO	No	X	
Hydrazine	U		NA	NA	X	
Nitrate/Nitrite	6.89	H5-1A	NO	No	X	
pH	8.2 J - 5.9 J	NA	NO	Yes		X
Phosphate	0.4	H6-1	NA	No	X	
Sulfate	68	H5-1A	NO	No	X	
Sulfide	26	H4-45	NA	NA		X
T.D.S.	365	H5-1A	NO	NA		X
T.O.C.	2.8	H5-1A	NO	Yes		X
T.O.X.	58.2 J	H4-47	NO	NA		X

U: Undetected
J: Estimated Value
NA: Not Applicable

Table 2-15 600 Area LFI Volatile and Semivolatile Organic Data Summary
(Page 1 of 3)

(ug/l)

Analyte	Max. Conc.	Well #	>Bkg.?	Elim.	COPC
1,1,1-Trichloroethane	[illegible]	NA	NA	X	
1,1,2,2-Tetrachloroethane	[illegible]	NA	NA	X	
1,1,2-Trichloroethane	[illegible]	NA	NA	X	
1,1-Dichloroethane	[illegible]	NA	NA	X	
1,1-Dichloroethene	[illegible]	NA	NA	X	
1,2-Dichloroethane	[illegible]	NA	NA	X	
1,2-Dichloroethene	[illegible]	NA	NA	X	
1,2-Dichloropropane	[illegible]	NA	NA	X	
2-Butanone	[illegible]	NA	NA	X	
2-Hexanone	[illegible]	NA	NA	X	
4-Methyl-2-Pentanone	[illegible]	NA	NA	X	
Acetone	[illegible]	NA	NA	X	
Benzene	[illegible]	NA	NA	X	
Bromodichloromethane	[illegible]	NA	NA	X	
Bromoform	[illegible]	NA	NA	X	
Bromomethane	[illegible]	NA	NA	X	
Carbon Disulfide	[illegible]	NA	NA	X	
Carbon Tetrachloride	[illegible]	NA	NA	X	
Chlorobenzene	[illegible]	NA	NA	X	
Chloroethane	[illegible]	NA	NA	X	
Chloroform	1 J	96-49	NA		X
Chloromethane	[illegible]	NA	NA	X	
cis-1,3-Dichloropropene	[illegible]	NA	NA	X	
Dibromochloromethane	[illegible]	NA	NA	X	
Ethlybenzene	[illegible]	NA	NA	X	
Methylenechloride	[illegible]	NA	NA	X	
Styrene	[illegible]	NA	NA	X	
Tetrachloroethene	[illegible]	NA	NA	X	
Toluene	[illegible]	NA	NA	X	
trans-1,3-Dichloropropene	[illegible]	NA	NA	X	
Trichloroethene	[illegible]	NA	NA	X	
Vinyl Chloride	[illegible]	NA	NA	X	
Xylenes (total)	[illegible]	NA	NA	X	

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Table 2-15 600 Area LFI Volatile and Semivolatile Organic Data Summary
(Page 2 of 3)

(ug/l)

Analyte	Max. Conc.	Well #	Elim.	COPC
Diethyl phthalate	U	NA	X	
1,2,4-Trichlorobenzene	U	NA	X	
1,2-Dichlorobenzene	U	NA	X	
1,3-Dichlorobenzene	10	91-46		X
1,4-Dichlorobenzene	U	NA	X	
2,4,5-Trichlorophenol	U	NA	X	
2,4,6-Trichlorophenol	U	NA	X	
2,4-Dichlorophenol	U	NA	X	
2,4-Dimethylphenol	U	NA	X	
2,4-Dinitrophenol	U	NA	X	
2,4-Dinitrotoluene	10 J	91-46		X
2,6-Dinitrotoluene	U	NA	X	
2-Chloronaphthalene	U	NA	X	
2-Chlorophenol	10	91-46		X
2-Methylnaphthalene	U	NA	X	
2-Methylphenol	U	NA	X	
2-Nitroaniline	U	NA	X	
2-Nitrophenol	U	NA	X	
3,3'-Dichlorobenzidine	10 B	91-46		X
3-Nitroaniline	U	NA	X	
4,6-Dinitro-2-methylphenol	25	91-46		X
4-Bromophenylphenyl ether	U	NA	X	
4-Chloro-3-methylphenol	U	NA	X	
4-Chloroaniline	U	NA	X	
4-Chlorophenylphenyl ether	U	NA	X	
4-Methylphenol	U	NA	X	
4-Nitroaniline	U	NA	X	
4-Nitrophenol	U	NA	X	
9H-Carbazole	U	NA	X	
Acenaphthene	U	NA	X	
Acenaphthylene	U	NA	X	
Anthracene	10	96-43		X
Benzo(a)anthracene	U	NA	X	
Benzo(a)pyrene	U	NA	X	
Benzo(b)fluoranthene	U	NA	X	
Benzo(ghi)perylene	U	NA	X	
Benzo(k)fluoranthene	U	NA	X	
Bis(2-chloroethoxy)methane	U	NA	X	
Bis(2-chloroethyl)ether	U	NA	X	
Bis(2-chloroisopropyl)ether	U	NA	X	
Bis(2-ethylhexyl)phthalate	4 J	97-51A		X
Butylbenzylphthalate	U	NA	X	
Chrysene	U	NA	X	
Di-n-butylphthalate	U	NA	X	
Di-n-octylphthalate	U	NA	X	

Table 2-15 600 Area LFI Volatile and Semivolatile Organic Data Summary (Page 3 of 3)

(ug/l)

Analyte	Max. Conc.	Well #	Elim.	COPC
Dibenz(a,h)anthracene	U	NA	X	
Dibenzofuran	U	NA	X	
Dimethyphthalate	U	NA	X	
Fluoranthene	U	NA	X	
Fluorene	U	NA	X	
Hexachlorobenzene	U	NA	X	
Hexachlorobutadiene	U	NA	X	
Hexachlorocyclopentadiene	U	NA	X	
Hexachloroethane	U	NA	X	
Indeno(1,2,3-cd)pyrene	U	NA	X	
Isophorone	U	NA	X	
N-nitroso-di-n-dipropylamine	U	NA	X	
N-Nitrosodiphenylamine	U	NA	X	
Naphthalene	U	NA	X	
Nitrobenzene	10	96-43		X
Pentachlorophenol	U	NA	X	
Phenanthrene	U	NA	X	
Phenol	U	NA	X	
Pyrene	U	NA	X	

B: Analyte found in laboratory blank
U: Undetected
J: Estimated Value
NA: Not applicable

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Table 2-16 600 Area LFI Filtered Inorganic Data Summary

(ug/l)

Analyte	Max. Conc.	Non-Toxic	>Bkg.?	Elim.	COPC
Aluminum	U	NA	NA	X	
Antimony	U	NA	NA	X	
Arsenic	5.1 B	No	No	X	
Barium	85.5 B	No	Yes		X
Beryllium	U	NA	NA	X	
Cadmium	U	NA	NA	X	
Calcium	52100	Yes	No	X	
Chromium	170	No	Yes		X
Cobalt	U	NA	NA	X	
Copper	U	NA	NA	X	
Iron	U	NA	NA	X	
Lead	U	NA	NA	X	
Magnesium	12200	No	No	X	
Manganese	U	NA	NA	X	
Mercury	U	NA	NA	X	
Nickel	U	NA	NA	X	
Potassium	5230	Yes	No	X	
Selenium	U	NA	NA	X	
Silver	U	NA	NA	X	
Sodium	21500	Yes	No	X	
Thallium	U	NA	NA	X	
Vanadium	16.2 B	No	Yes		X
Zinc	U	NA	NA	X	

B: Value below the contract required detection limit
U: Undetected
NA: Not applicable

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Table 2-17 600 Area LFI Pesticide Data Summary

(ug/l)

Analyte	Max. Conc.	Well #	>Bkg.?	Elim.	COPC
4,4'-DDD	0.1	91-46	NA		X
4,4'-DDE	U	NA	NA	X	
4,4'-DDT	U	NA	NA	X	
Aldrin	U	NA	NA	X	
Alpha-BHC	U	NA	NA	X	
Alpha-chlordane	U	NA	NA	X	
Aroclor-1016	U	NA	NA	X	
Aroclor-1221	U	NA	NA	X	
Aroclor-1232	U	NA	NA	X	
Aroclor-1242	U	NA	NA	X	
Aroclor-1248	U	NA	NA	X	
Aroclor-1254	U	NA	NA	X	
Aroclor-1260	U	NA	NA	X	
Beta-BHC	U	NA	NA	X	
Delta-BHC	U	NA	NA	X	
Dieldrin	U	NA	NA	X	
Endosulfan I	0.05	96-43	NA		X
Endosulfan II	U	NA	NA	X	
Endosulfan sulfate	.1 J	96-43	NA		X
Endrin	U	NA	NA	X	
Endrin Aldehyde	U	NA	NA	X	
Endrin Ketone	U	NA	NA	X	
Gamma-BHC	U	NA	NA	X	
Gamma-chlordane	U	NA	NA	X	
Heptachlor	U	NA	NA	X	
Heptachlor epoxide	U	NA	NA	X	
Methoxychlor	U	NA	NA	X	
Toxaphene	U	NA	NA	X	

J: Estimated value
U: Undetected
NA: Not applicable

Table 2-18 600 Area LFI Radionuclide Data Summary

(pCi/l +/- 2 sigma)

Analyte	Max. Conc.	Well #	>Bkg.?	Elim.	COPC
Americium 241	0.051	96-43	NA		X
Carbon 14	U	NA	NA	X	
Cerium-144	U	NA	NA	X	
Cesium 134	U	NA	NA	X	
Cesium 137	U	NA	NA	X	
Chromium 51	U	NA	NA	X	
Cobalt 58	U	NA	NA	X	
Cobalt 60	U	NA	NA	X	
Europium 152	U	NA	NA	X	
Europium 154	U	NA	NA	X	
Europium-155	U	NA	NA	X	
Gross Alpha	U	NA	NA	X	
Gross Beta	5.4	96-43	No	X	
Iron 59	U	NA	NA	X	
Plutonium 238	U	NA	NA	X	
Plutonium 239/240	U	NA	NA	X	
Potassium 40	U	NA	NA	X	
Radium 226	U	NA	NA	X	
Radium-223	U	NA	NA	X	
Ruthenium 106	U	NA	NA	X	
Strontium 90	0.091	91-46	No	X	
Technetium 99	U	NA	NA	X	
Thorium 228	U	NA	NA	X	
Thorium 232	U	NA	NA	X	
Tritium	11000	96-43	NA		X
Uranium 233/234	1.7	96-43	No	X	
Uranium 235	U	NA	NA	X	
Uranium 238	1.4	96-43	No	X	
Zinc 65	26	91-46	NA		X

U: *Undetected*
NA: Not applicable

Table 2-19 600 Area LFI Other Constituent Data Summary

(mg/l)

Analyte	Max. Conc.	Well #	>Bkg.?	Elim.	COPC
Alkalinity	113	97-43	No	X	
Ammonia	0.05	96-43	NA		X
C.O.D.	30	96-49	NA		X
Chloride	8.4 J	96-43	No	X	
Electric Cond.	469 UMHO	96-49	No	X	
Fluoride	0.6	93-48	No	X	
Hydrazine	U	NA	NA	X	
Nitrate/Nitrite	4.26	97-51A	No	X	
pH	8 - 7	NA	No	X	
Phosphate	U	NA	NA	X	
Sulfate	35.6	93-48	No	X	
Sulfide	U	NA	NA	X	
T.D.S.	273	97-51A	NA		X
T.O.C.	0.88	93-48	No	X	
T.O.X.	55.6	96-49	NA		X

U: Undetected
J: Estimated Value
NA: Not Applicable

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Table 2-20 D/DR Area LFI Unfiltered Inorganic Data Summary for Near River Wells

Unfiltered (ug/l)

Analyte	Max. Conc.	Well #	> Bkg.?	Elim.	COPC
Aluminum	579	D8-54A	YES		X
Antimony	U	NA	NA	X	
Arsenic	4 (B)	D5-20	NO	X	
Barium	92 (E,B)	D8-53	YES		X
Beryllium	U	NA	NA	X	
Cadmium	U	NA	NA	X	
Calcium	80600	D8-53	YES		X
Chromium	443	D8-53	YES		X
Cobalt	U	NA	NA	X	
Copper	8 (B)	D8-53	NO	X	
Iron	2490	D5-20	YES		X
Lead	3.1	D8-55	NO	X	
Magnesium	15100	D5-20	NO	X	
Manganese	62	D5-20	YES		X
Mercury	U	NA	NA	X	
Nickel	90	D8-55	YES		X
Potassium	5140	D8-54A	NO	X	
Selenium	U	NA	NA	X	
Silver	U	NA	NA	X	
Sodium	14800	D5-20	NO	X	
Thallium	U	NA	NA	X	
Vanadium	19.6 B	D5-20	YES		X
Zinc	54	D8-53	YES		X
Cyanide	U	NA	NA	X	
Nitrates	14100	D8-53	YES		X

Shading indicates reason for elimination.
All concentrations are ug/L
U= Not detected
NA= Not applicable
Qualifiers:
B= estimated value, less than the contract detection limit
E= estimated due to presence of interference

Table 2-21 H Area LFI Unfiltered Inorganic Data Summary for Near River Wells

Unfiltered (ug/l)

Analyte	Max. Conc.	Well #	> Bkg.?	Elim.	COPC
Aluminum	335	H4-45	YES		X
Antimony	U	NA	NA	X	
Arsenic	5 B	H6-1	NO	X	
Barium	77 B	H6-1	YES		X
Beryllium	U	NA	NA	X	
Cadmium	U	NA	NA	X	
Calcium	67300	H6-1	YES		X
Chromium	48	H6-1	YES		X
Cobalt	U	NA	NA	X	
Copper	U	NA	NA	X	
Iron	351	H6-1	YES		X
Lead	7	H6-1	YES		X
Magnesium	9200	H6-1	NO	X	
Manganese	87	H6-1	YES		X
Mercury	U	NA	NA	X	
Nickel	10 B	H6-1	NO	X	
Potassium	6750	H6-1	NO	X	
Selenium	U	NA	NA	X	
Silver	U	NA	NA	X	
Sodium	16600	H6-1	NO	X	
Thallium	U	NA	NA	X	
Vanadium	17.1 B	H6-1	YES		X
Zinc	17 B	H6-1	NO	X	
Cyanide	U	NA	NA	X	
Nitrates	7	H6-1	NO	X	

Shading indicates reason for elimination.
All concentrations are ug/L
U= Not detected
NA= Not applicable
Qualifiers:
B= estimated value, less than the contract detection limit

3.0 QUALITATIVE RISK ASSESSMENT

This section provides a summary of the QRA which was performed for the 100-HR-3 Operable Unit. Complete results of the QRA are be provided in the 100-HR-3 QRA (WHC 1993b). The QRA is intended to provide information to support the HPPS.

The QRA for the 100-HR-3 Operable Unit is an evaluation of risk for a predefined set of human and environmental exposure scenarios. The QRA is not intended to replace or be a substitute for a baseline risk assessment. This report includes qualitative assessments of threats to human health receptors and ecological receptors from groundwater associated with the 100-HR-3 Operable Unit. The QRA is prepared as agreed upon by the 100 Area Tri-Party unit managers, and as recommended in the *Hanford Site Baseline Risk Assessment Methodology* (HSBRAM) (DOE-RL 1993a).

3.1 QRA SUMMARY OF DATA ANALYSIS AND UNCERTAINTY

Prior to the evaluation of risk in the QRA, the COPC (as defined in Chapter 2) were further screened against risk-based concentrations and ARARs, as recommended in the HSBRAM (DOE-RL 1993a). The risk-based concentrations were at an incremental cancer risk (ICR) of 1E-07 and a hazard quotient (HQ) of 0.1.

An overview of the QRA data and uncertainty in that data are summarized in the following sections.

3.1.1 Overview of QRA Data

The data used to conduct the QRA are LFI data from two rounds of sampling for groundwater evaluations. Spring data are taken from *Sampling and Analysis of 100 Area Springs* (DOE-RL 1992a). Confidence levels are estimated for the data based on available knowledge of the waste site. Confidence in the contaminant identification is based primarily on the quality of the data used in the QRA. The confidence in the concentrations is based on the data quality and confidence in the representativeness of that data. Confidence in the identification of contaminants and concentrations is rated as high, medium, or low.

A "low" rating is generally given when there is little or no data available for a site; a "medium" rating is given when the available data are not comparable (i.e., for a different media than is being evaluated); and a "high" rating is given when available data are of known quality, and are from the same site and type of media being evaluated.

3.1.2 Uncertainty in the QRA Data

The uncertainty in the data and the identification of contaminants is reflected in the qualitative high, medium, or low rankings that are assigned for the 100-HR-3 Operable Unit.

A high confidence rating is given for contaminant identification in the groundwater evaluation at the 100-HR-3 Operable Unit since the LFI data used were collected specifically for characterization of the 100 D/DR, 100 H and 600 Area groundwater, and the data are of known quality. The confidence in the concentrations is given a medium rating for organic and radioactive data, because the data were only from two sampling rounds. The confidence in the concentrations for inorganic data is given a medium-to-low rating because the data were only from two sampling rounds, and there are no turbidity data to determine whether the unfiltered data are representative of actual groundwater quality.

A high confidence rating is given for contaminant identification in the springs evaluations, because the springs data were collected specifically for evaluation of the springs entering the Columbia River, including the 100 D/DR and 100 H Area springs, and the data are of acceptable quality. The confidence in the concentrations is given a medium rating for the radioactive, inorganic, and wet chemistry data because the data were only from one sampling round. There were no organic data collected for the springs evaluation.

The degree of uncertainty in the identification of contaminants and the contaminant concentrations must be considered when evaluating the total risks for the 100-HR-3 Operable Unit. For example, if there is high confidence in the contaminants and medium to low confidence in the concentrations, the estimated risks for the frequent-use and occasional-use scenarios may be over or under estimated. A range of confidence indicates a qualitative interpretation of available media, and the risk characterization.

3.2 HUMAN HEALTH QRA AND UNCERTAINTY

This section includes an overview of the human health QRA, uncertainties in contaminants and concentrations, the exposure assessment, and the toxicity assessment for the 100-HR-3 QRA.

3.2.1 Qualitative Overview of the Human Health QRA

Maximum contaminant concentrations from available LFI and springs data were summarized, compared to the site-wide background data, screened following procedures specified in HSBRAM (DOE-RL 1993a), and carried through the risk assessment.

Two exposure scenarios (frequent- and occasional-use) and two pathways (groundwater ingestion and inhalation of volatile organics from groundwater use) for the QRA have been discussed and selected by the 100 Area Tri-Party unit managers for evaluation in the QRA. Currently, there are no frequent- or occasional-users of the subgroups evaluated in the 100-HR-3 Operable Unit. The Columbia River is used recreationally near the 100-HR-3 Operable Unit, however, any ingestion of groundwater or springs is controlled through access restrictions. The occasional-use scenario is intended to represent a conservative estimate for potential trespassers on the site. The risks presented in the QRA are not actual risks but estimates of potential risks under frequent- or occasional-use.

Summaries of the human health QRA are provided in Tables 3-1, 3-2, 3-3, 3-4, and 3-5 for 100 D/DR Area, 100 H Area, 600 Area, springs at the 100 D/DR Area, and springs at the 100 H Area subgroups, and include for each subgroup:

- the qualitative risk estimation
- the risk driving contaminant for the frequent-use and occasional-use scenarios
- the risk driving pathway for the frequent-use and occasional-use scenarios.

The qualitative risk estimations for carcinogens are grouped into high (ICR $>$ 1E-02), medium (ICR 1E-04 to 1E-02), low (ICR 1E-06 to 1E-04) and very low ($<$ 1E-06) risk categories based on the results presented in the QRA (WHC 1993b). The qualitative risk estimations for non-carcinogens are grouped into HQ or hazard index (HI) ≥ 1.0 and HQ or HI < 1.0 risk categories.

Given the assumptions about exposure, toxicity, and other variables; the risk estimates, both carcinogenic and non-carcinogenic, presented in this QRA are deterministic estimates based on multiple uncertainties. Consequently, uncertainty exists for the evaluation of the contaminants, the exposures, the toxicities and the risk characterization for the QRA. This uncertainty is discussed more extensively in the following sections.

3.2.1.1 Qualitative Overview of the Human Health QRA for the 100 D/DR Area. The following is a summary of the human health risk assessment for the 100 D/DR Area:

- Three radioactive contaminants (H-3, C-14, and Sr-90) are the risk-drivers and together present a low risk under the frequent-use scenario. Carbon-14 is a naturally occurring radionuclide.
- Tritium presents a low estimated risk for the occasional-use scenario, all other radioactive contaminants are estimated to be very low in this scenario.

- The non-radioactive carcinogenic contaminants that present a risk in the frequent-use scenario are chloroform, bis(2-ethylhexyl)phthalate, and 1,1,2,2-tetrachlorethane for both the ingestion and inhalation pathways with the exception of bis(2-ethylhexyl)phthalate which is not evaluated for the inhalation pathway. These contaminants present a low estimated risk. It should be noted, however, that bis(2-ethylhexyl)phthalate and chloroform concentrations may be affected by laboratory contamination. Therefore, the concentrations used to define the ICRs for these parameters may not be representative of actual groundwater quality. Due to the qualitative nature of the assessment, there was not enough information to eliminate these contaminants from the QRA.

- Chromium, Mn, nitrate as N, and Sb present a risk for non-carcinogenic contaminants in the frequent-use scenario for the ingestion pathway (HQ or HI $\geq$ 1).

- There is no risk for non-radioactive carcinogenic or non-carcinogenic contaminants in the occasional-use scenario (HQ or HI $<$ 1).

- In general, the estimated risks for the frequent-use scenario are two orders of magnitude greater than for the occasional-use scenario.

3.2.1.2 Qualitative Overview of the Human Health QRA for the 100 H Area. The following is a summary of the human health risk assessment for the 100 H Area:

- Six radioactive contaminants (H-3, C-14, Sr-90, Tc-99, U-238, and Am-241) are the risk-drivers and together present a low risk under the frequent-use scenario. Carbon-14 is a naturally-occurring radionuclide.

- Radioactive contaminants present very low risks in the occasional-use, however, the combined risk for all radioactive contaminants in this scenario is estimated to be low.

- Chloroform is the only non-radioactive carcinogenic contaminant that presents a risk in the frequent-use scenario. Chloroform presents a medium risk for the inhalation pathway and a low risk for the ingestion pathway. It should be noted, however, that chloroform concentrations may be affected by laboratory contamination. Therefore, the concentrations used to define the ICRs for these parameters may not be representative of actual groundwater quality. Due to the qualitative nature of the assessment, there was not enough information to eliminate this contaminant from the QRA.

- Chromium, Mn, and nitrate as nitrogen present a risk for non-carcinogenic contaminants in the frequent-use scenario for the ingestion pathway (HQ or HI $\geq$ 1).

- There is no risk for non-radioactive carcinogenic or non-carcinogenic contaminants in the occasional-use scenario.

- In general, the estimated risks for the frequent-use scenario are two orders of magnitude greater than for the occasional-use scenario.

3.2.1.3 Qualitative Overview of the Human Health QRA for the 600 Area. The following is a summary of the human health risk assessment for the 600 Area:

- Three radioactive contaminants (H-3, C-14, and Pu-238) are the risk-drivers and together present a low risk under the frequent-use scenario. Carbon-14 is a naturally-occurring radionuclide.

- Radioactive contaminants present very low risks in the occasional-use scenario.

- Chloroform is the only non-radioactive carcinogenic contaminant that presents a risk in the frequent-use scenario (for the inhalation pathway only). It poses a low risk for the inhalation pathway. It should be noted, however, that chloroform concentrations may be affected by laboratory contamination. Therefore, the concentrations used to define the ICRs for these parameters may not be representative of actual groundwater quality. Due to the qualitative nature of the assessment there was not enough information to eliminate this contaminant from the QRA.

- Chromium, Mn, and Sb are the only contaminants that present a risk for non-carcinogenic contaminants in the frequent-use scenario for the ingestion pathway (HQ or HI $\geq$ 1).

- There is no risk for non-radioactive carcinogenic or non-carcinogenic contaminants in the occasional-use scenario (HQ or HI $<$ 1).

- In general, the estimated risks for the frequent-use scenario are two orders of magnitude greater than for the occasional-use scenario.

3.2.1.4 Qualitative Overview of the Human Health QRA for the Springs at the 100 D/DR Area. The following is a summary of the human health risk assessment for the springs at the 100 D/DR Area:

- Two radioactive contaminants (H-3 and Sr-90) are the risk-drivers and together present a low risk under the frequent-use scenario.

- Radioactive contaminants present very low risks in the occasional-use scenario.

- There are no carcinogenic non-radioactive contaminants identified in this subgroup, therefore the risk is very low for the frequent-use scenario.

- Chromium is the only non-carcinogenic contaminant that presents a risk in the frequent-use scenario for the ingestion pathway (HQ or HI ≥ 1).

- There is no risk for non-radioactive carcinogenic or non-carcinogenic contaminants in the occasional-use scenario (HQ or HI < 1).

- In general, the estimated risks for the frequent-use scenario are two orders of magnitude greater than for the occasional-use scenario.

3.2.1.5 Qualitative Overview of the Human Health QRA for the Springs at the 100 H Area. The following is a summary of the human health risk assessment for the springs at the 100 H Area:

- Two radioactive contaminants (H-3 and Sr-90) are the risk-drivers and together present a low risk under the frequent-use scenario.

- Radioactive contaminants present very low risks in the occasional-use scenario.

- There are no carcinogenic non-radioactive contaminants identified in this subgroup, therefore there is no risk in the frequent-use scenario (HQ or HI < 1).

- Each individual contaminant has an HQ (or HI) < 1 in the frequent-use scenario, however the combined risk (HQ or HI) for the non-carcinogenic contaminants is estimated to be > 1.

- There is no risk for non-radioactive carcinogenic or non-carcinogenic contaminants in the occasional-use scenario (HQ or HI < 1).

- In general, the estimated risks for the frequent-use scenario are two orders of magnitude greater than for the occasional-use scenario.

3.2.1.6 Qualitative Overview of the Human Health QRA for the 100-HR-3 Operable Unit. The following is a summary of the human health risk assessment for the 100-HR-3 Operable Unit incorporating the results of each subgroup:

- One radioactive contaminant (H-3) is a risk-driver that is present throughout the 100-HR-3 Operable Unit at a low risk under the frequent-use scenario. Strontium-90 is present in four out of five subgroups at a low risk. Carbon-14 (a naturally-occurring radionuclide) is present in three out of the five subgroups at a low risk.

- Tritium is the only radioactive contaminant present at a low risk in the occasional-use scenario, occurring in only one subgroup (100 D/DR Area) in the 100-HR-3 Operable Unit. All other radioactive contaminants are estimated to be very low risk in this scenario throughout the 100-HR-3 Operable Unit.

- For non-radioactive carcinogenic contaminants, chloroform is present in all groundwater subgroups in the 100-HR-3 Operable Unit (100 D/DR, 100 H, and 600 Areas), in the frequent-use scenario at an estimated medium risk for the inhalation pathways and a low risk for the ingestion pathway. It should be noted, however, that chloroform concentrations may be affected by laboratory contamination. Therefore, the concentrations used to define the ICRs for these parameters may not be representative of actual groundwater quality. All other non-radioactive, carcinogenic contaminants in the 100-HR-3 Operable Unit have very low estimated risks.

- There are no non-radioactive, carcinogenic contaminants that present a risk in either of the springs subgroups.

- For non-carcinogenic contaminants, Cr has an HQ >1 in four out of the five subgroups in the 100-HR-3 Operable Unit for the ingestion pathway in the frequent-use scenario. Manganese has an HQ or HI > 1 in all groundwater subgroups in the 100-HR-3 Operable Unit (100 D/DR, 100 H, and 600 Areas). Nitrate as nitrogen has an HQ or HI > 1 in the 100 D/DR Area, and the 100 H Area.

- Chromium is the only non-carcinogenic contaminant present in the springs, at the 100 D/DR Area only, with an HQ or HI ≥ 1.

- There is no risk for non-radioactive carcinogenic or non-carcinogenic contaminants in the occasional-use scenario throughout the 100-HR-3 Operable Unit HQ or HI < 1).

- In general, the estimated risks for the frequent-use scenario are two orders of magnitude greater than for the occasional-use scenario throughout the 100-HR-3 Operable Unit.

3.2.2 Uncertainty in Contaminants and Concentrations

Uncertainty in contaminant identification and contaminant concentrations is related to the accuracy of the data used in the QRA. The accuracy of the data is based on its quality and representativeness.

The LFI data used in the QRA are CLP data of high quality. However, some uncertainty exists in the inorganic contaminant concentrations used in the QRA due to the unavailability of turbidity data. It is unknown whether the concentrations represent actual groundwater conditions, or represent suspended particulates resulting from poor well development. Therefore, the inorganic concentrations used in the QRA may be higher than actual groundwater concentrations, resulting in over estimates of risk. The inclusion of turbidity data, and additional rounds of data would reduce this uncertainty.

There is uncertainty associated with the identification of bis(2-ethylhexyl)phthalate and chloroform as contaminants of potential concern. Bis(2-ethylhexyl)phthalate is considered a common laboratory contaminant. It is likely that the concentrations reported for these two parameters may be affected by laboratory contamination, and therefore may not be representative of groundwater quality in the 100-HR-3 Operable Unit.

The sample locations were selected specifically for the characterization of the 100-HR-3 Operable Unit and are considered representative. However, only two rounds of data were used in the QRA evaluation and may result in under or over estimations of risk.

In general, the use of maximum concentrations to calculate risks for the QRA may result in an over estimation of risk.

3.2.3 Uncertainty in the Exposure Assessment

The QRA (WHC 1993b) estimates risk that might occur under frequent- or occasional-use based on the agreements by the 100 Area Tri-Party unit managers. Therefore, the QRA provides frequent-use and occasional-use scenarios, although these are not current land uses in the 100-HR-3 Operable Unit. While risk is based on the best knowledge of current contaminated conditions, it does not represent actual risks since neither frequent- or occasional-use of the operable unit currently occurs.

Uncertainty exists in the exposure assessments because they are presented as a bounding of potential exposures (i.e., frequent-use such as residential, or occasional-use such as recreational). The receptors evaluated for the 100-HR-3 Operable Unit are based on assumed receptors under current contaminant conditions. For some radionuclides, radioactive decay over time can significantly reduce the concentrations to which a receptor may be exposed. However, groundwater flow can transport radioactive contaminants away from the operable unit before concentrations are significantly reduced by radioactive decay.

3.2.4 Uncertainty in the Toxicity Assessment

Uncertainty is associated with the toxicity values and the toxicity information available to assess potential adverse effects. This uncertainty in the information and the lack of specific toxicity information contribute to uncertainty in the toxicity assessment. For non-radioactive contaminants identified at the 100-HR-3 Operable Unit, there is relatively good information for potential exposures through the oral route. However, toxicity values and information to evaluate the inhalation route of exposure are more limited.

Lead, although known to be quite toxic to sensitive individuals, does not have either a reference dose or slope factor. Also, because the use of models in the QRA was limited, EPAs lead model was not applied. The concentrations of Pb detected in each subgroup in the 100-HR-3 Operable Unit are less than the EPA assigned maximum contaminant level (MCL) of 0.05 mg/L, but exceed the EPA assigned maximum contaminant level goal (MCLG) of 0 mg/L (40 Code of Federal Regulations [CFR] 141), and the subgroup-specific hardness-dependent criteria established for ecological effects (CFWQC) (EPA 1986).

Uncertainty exists as to whether Cr is in the hexavalent or trivalent state. Hexavalent chromium is assumed for the QRA because it provides the most conservative evaluation and was the form used (e.g., sodium dichromate) at some 100 D/DR, 100 H, and 600 Area source operable units.

3.2.5 Uncertainty in the Risk Characterization

The estimated risks or hazard quotients by themselves do not fully characterize the risk impacts associated with environmental contamination. Such an evaluation must be understood in light of the uncertainties presented above. The risk estimates are based on single point estimates from LFI data assuming two different sets of exposure assumptions (frequent- and occasional-use).

Uncertainty in the risk characterization results from summing cancer risks or HQs across contaminants and pathways which gives equal weight to toxicity information derived from different sources or species. Exposures to multiple contaminants may result in additive effects or effects that are greater or less than additive.

Uncertainty in the risk characterization is possible because only two rounds of data were used to evaluate each subgroup in the operable unit. The selection of data is based on available information at the time the QRA was prepared. As additional information is identified and incorporated into the LFI report for the 100-HR-3 Operable Unit, the QRA should be updated to utilize additional pertinent information.

3.3 ECOLOGICAL RISK ASSESSMENT AND UNCERTAINTY

The following section provides an overview, uncertainties and a summary and conclusion for the ecological risk assessment.

3.3.1 Overview of the Qualitative Ecological Risk Assessment

The qualitative ecological risk assessment for the 100-HR-3 Operable Unit was completed for selected aquatic organisms expected to be in or associated with the Columbia River. Receptor dose/response was determined by comparison to regulatory benchmarks such as DOE Order 5400.5 and Aquatic Water Quality Criteria (EPA 1986).

The objective of the ecological risk assessment is to screen for relative ecological risks to evaluate whether an IRM is necessary. To achieve this objective it was necessary to perform the assessment with limited operable-unit-specific analytical and ecological data.

3.3.2 Uncertainty in Contaminants and Concentrations

Similar to the discussion in Section 3.2.2 the uncertainty in contaminant concentrations is related to the accuracy of the data. For the QRA, uncertainty exists in both contaminants identified and exposure concentration. As for the human health assessment, the maximum contaminant concentration was used.

3.3.3 Uncertainty in Exposure Assessment

Unlike the human health exposure scenarios (residential/recreational), where humans are hypothetically exposed to contaminants in a high-priority waste site, the ecological evaluation models the potential exposure of organisms suspected to be present in the river near the operable unit. The issues of concern for an ecological risk assessment (particularly qualitative) are the uncertainties in using an assortment of environmental variables in risk modeling. This begins with the source term. If this number is not realistic, no amount of modeling will overcome this deficiency. For example, in the case of the ecological evaluation, the maximum reported groundwater concentration was used as the source term and no river dilution was considered.

Generally, site specific organisms (e.g., salmon, whitefish, riparian mammals) are identified as potentially associated with site contaminants, but little if any data exists concerning transfer of contaminants to these organisms. For fish, it was assumed that they were continuously exposed to the source term. This results in significant uncertainty in the exposure scenario because they are mobile and will not be continuously exposed. The risks developed in the ecological evaluation are not actual risks, but estimates of potential risk under high-frequency use by the organism. The actual use is not known, however, it can be safely assumed that exposure would be less than presented in this evaluation.

3.3.4 Uncertainty in the Toxicity Assessment

Uncertainty associated with aquatic toxicity values is significant, particularly for non-radiological contaminants. Benchmark or toxicity values were developed based on laboratory tests and are extrapolated to the environment. This approach tends to build conservatism into the toxicity value.

The effects of chronic exposure of organisms to radionuclides is not known. At low dose levels organisms can repair damage to correct for radiological dose. However, existing dose/response relationships were developed at high dose levels and extrapolated to chronic levels. In addition, no regulatory benchmarks exist for radionuclides other than the 1 rad/day reported by the DOE (Order 5400.5).

3.3.5 Uncertainty in the Risk Assessment

The major source of uncertainty in this screening assessment is using the source terms undiluted by the river and assuming that all of the contaminant is available for bioaccumulation. Based upon the flow of the Columbia River actual concentrations of radionuclides and metals will be well below the source term.

The uncertainty associated with the approach used in the qualitative ecological risk assessment for the 100-HR-3 Operable Unit waste sites is significant because data used as the source term were assumed to be available for uptake by aquatic organisms. No allowance was made for environmental fate that would reduce contaminant bioavailablility or dilution effects in the Columbia River. For the purpose of the risk assessment, Cr is assumed to be hexavalent. Until additional information is available on the distribution of tri and hexavalent chromium this approach increases the uncertainty of the results.

3.3.6 Summary and Conclusions of the Environmental Evaluation

The 100-HR-3 Operable Unit includes groundwater, which potentially affects the Columbia River. Source term information was developed from groundwater well constituent concentrations and maximum river and springs concentrations. Two sets of groundwater source term data were used in the risk characterization. They are the maximum groundwater concentrations in the near-river wells in the 100 D/DR and 100 H Areas. Spring and river concentrations were not used in the risk characterization but are discussed below. The groundwater, river and spring concentrations establish a set of boundaries.

For radionuclides, no dose exceeded the 1 rad/day benchmark established by DOE Order 5400.5. For hazardous chemicals, near-river well concentrations exceeded chronic lowest observable effect levels (LOEL) for Al, Cr and Pb at the 100 D/DR Area; and Cr, Fe, and Pb at the 100 H Area.

The risk characterization becomes problematic for the 100-HR-3 because source information was developed based on well concentrations. Assuming the values from near-river wells better represent concentrations entering the Columbia River, dilution of these concentrations, once in the river, should result in rapid reduction of these concentrations to levels below any possible risk level. This appears to be the case. To provide a reality assessment of the risk from radionuclides to aquatic organisms, river H-3 concentrations ranged from <200 to 400 pCi/L. Spring concentrations ranged from <200 to 3800 pCi/L. Strontium-90 was not detectable in river samples and ranged from <1 to 12.7 pCi/L for spring samples (100 H Area). Technetium-99 ranged from

<1 to 3.4 pCi/L and <2 to 12 pCi/L for river and spring samples respectively and total U ranged from 0.3 to 0.53 pCi/L and 0.66 to 278 pCi/L for river and spring samples. It should be noted that the 278 pCi/L was detected in only one water sample and most samples were generally < 1 pCi/L. Radium was detected in one river sample and Th detected in one spring sample. These results are generally less than the source terms used to calculate risk to aquatic organisms and support the conclusion of not exceeding 1 rad/day; radionuclides do not present an ecological risk.

For non-radiological contaminants, Al, Ba, Cr, Fe, Mn, V and Zn were elevated in either springs or the river. Aluminum was elevated at both the 100 D/DR and 100 H Area springs and the river. Highest concentrations were observed for the 100 H Area springs and river samples. Spring concentrations exceeded both acute and chronic LOELs; only the chronic LOEL was exceeded for the river. Barium and Fe were also detected at all spring and river stations. No toxicity data are available for Ba. Only an acute LOEL was exceeded for Fe. Chromium was only detected in spring samples and not in the river. The highest concentrations of Cr for 100 D/DR and 100 H Area springs were 0.124 and 0.052 mg/l, respectively. Both concentrations exceed the acute and chronic LOELs. Manganese was detected in 100 H Area spring and river samples. No aquatic standard exists for Mn, however concentrations were very low. Vanadium was detected in the 100 H Area river sample at a very low concentration. Zinc concentrations were detected in both 100 D/DR and 100 H Area springs and one 100 H Area river sample. The highest concentration of Zn was observed in a river sample (0.261 mg/L), which is the only concentration that exceeded any LOEL (both acute and chronic).

Since the 100 Area is a known area of chinook salmon spawning, and the maximum groundwater concentrations exceed the acute and chronic LOEL for hexavalent Cr, there is an increased likelihood of risk from Cr. Becker (1990) reported that survival of young chinook salmon and trout are adversely affected at Cr concentrations of 0.08 mg/L and growth appeared to be retarded at the 0.013 mg/L. All maxima exceed 0.013 mg/L.

In summary, releases of radionuclides into the river from the 100 D/DR and 100 H Areas do not show any potential risk from near-river well maximum source terms or actual spring and river sampling. For hazardous chemicals, increased potential risk is indicated for Al, Cr, and Fe for the 100 D/DR source terms; and Al in the springs. For the 100 H Area increased potential risk is indicated for Cr, Fe, and Zn for near river well maximum source terms, Al for spring and river maximums, and Zn for the river maximum. There is a concern about the effects of Al and Cr on juvenile chinook and trout. However, even though some constituents were detected in the spring and river samples, the realization of any risk is minimal or very localized because of the large dilution of spring flow by the Columbia River.

3.4 QUALITATIVE OVERVIEW OF POTENTIAL GROUNDWATER IMPACTS FROM SOURCES IN THE 100-HR-3 OPERABLE UNIT AND UNCERTAINTY

The constituents in sediments or soils associated with high-priority waste units in the 100 D/DR, 100 H, and 600 Area source operable units may migrate through the vadose zone and into the groundwater. The only source operable units that have been evaluated at the time of this QRA are the 100-DR-1 Operable Unit in the 100 D/DR Area (WHC 1993d); and the 100-HR-1 Operable Unit in the 100 H Area (WHC 1993e). The remaining four source operable units have not had LFI or QRA evaluations. As these evaluations occur or become available, pertinent information should be incorporated in the QRA.

The uncertainty associated with groundwater impacts from 100 D/DR, 100 H, and 600 Area source operable units is due to a variety of factors:

- lack of LFI data or QRA evaluations for four of the six source operable units overlying the 100-HR-3 Operable Unit
- lack of information regarding constituent solubilities, soil/water partitioning, and infiltration rates
- lack of source and groundwater data from upgradient areas outside of the 100 Area.

Table 3-1. Human Health Risk Assessment Summary for the 100 D/DR Area.

Contaminant Type	Frequent-Use Scenario[a]			Occasional-Use Scenario[b]		
	Estimated Qualitative Risk	Risk-Driving Contaminant	Risk-Driving Pathway	Estimated Qualitative Risk	Risk-Driving Contaminant	Risk-Driving Pathway
Radioactive	low	C-14, H-3, Sr-90	ingestion only[c]	low	H-3	ingestion only[c]
Nonradioactive-Carcinogenic	low	chloroform, 1,1,2,2-tetrachloroethane, and bis(2-ethylhexyl) phthalate	ingestion and volatile inhalation	very low	none	none
Nonradioactive-Non-carcinogenic	HQ or HI $\geq$ 1	Sb, Cr, Mn, nitrate as nitrogen	ingestion	HQ or HI < 1	none	none

[a]Frequent-use scenario is based on residential scenario.
[b]Occasional-use scenario is based on recreational scenario.
[c]The inhalation pathway is evaluated for volatile non-radioactive contaminants only.

Table 3-2. Human Health Risk Assessment Summary for the 100 H Area.

Contaminant Type	Frequent-Use Scenario[a]			Occasional-Use Scenario[b]		
	Estimated Qualitative Risk	Risk-Driving Contaminant	Risk-Driving Pathway	Estimated Qualitative Risk	Risk-Driving Contaminant	Risk-Driving Pathway
Radioactive	low	Am-241, C-14, H-3, Sr-90, Tc-99, and U-238,	ingestion only[c]	very low to low[d]	none	none
Non-radioactive-Carcinogenic	medium	chloroform	volatile inhalation	very low	none	none
Non-radioactive-Non-carcinogenic	HQ or HI $\geq$ 1	Cr, Mn, nitrate as nitrogen	ingestion	HQ or HI < 1	none	none

[a]Frequent-use scenario is based on residential scenario.
[b]Occasional-use scenario is based on recreational scenario.
[c]The inhalation pathway is evaluated for volatile non-radioactive contaminants only.
[d]The sum of the radioactive contaminant risks is >1E-06, however each individual radioactive contaminant has a risk <1E-06.

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Table 3-3. Human Health Risk Assessment Summary for the 600 Area.

Contaminant Type	Frequent-Use Scenario[a]			Occasional-Use Scenario[b]		
	Estimated Qualitative Risk	Risk-Driving Contaminant	Risk-Driving Pathway	Estimated Qualitative Risk	Risk-Driving Contaminant	Risk-Driving Pathway
Radioactive	low	C-14, H-3, Pu-238	ingestion only[c]	very low	none	none
Nonradioactive-Carcinogenic	low	chloroform	volatile inhalation	very low	none	none
Nonradioactive-Non-carcinogenic	HQ or HI ≥ 1	Mn, Sb, Cr	ingestion	HQ or HI < 1	none	none

[a]Frequent use scenario is based on residential scenario.
[b]Occasional use scenario is based on recreational scenario.
[c]The inhalation pathway is evaluated for volatile non-radioactive contaminants only.

Table 3-4. Human Health Risk Assessment Summary for the Springs at the 100 D/DR Area.

Contaminant Type	Frequent-Use Scenario[a]			Occasional-Use Scenario[b]		
	Estimated Qualitative Risk	Risk-Driving Contaminant	Risk-Driving Pathway	Estimated Qualitative Risk	Risk-Driving Contaminant	Risk-Driving Pathway
Radioactive	low	Sr-90, H-3	ingestion	very low	none	none
Nonradioactive-Carcinogenic	very low	none	none	very low	none	none
Nonradioactive-Noncarcinogenic	HQ or HI ≥ 1	Cr	ingestion	HQ or HI < 1	none	none

[a]Frequent-use scenario is based on residential scenario.
[b]Occasional-use scenario is based on recreational scenario.

Table 3-5. Human Health Risk Assessment Summary for the Springs at the 100 H Area.

Contaminant Type	Frequent-Use Scenario[a]			Occasional-Use Scenario[b]		
	Estimated Qualitative Risk	Risk-Driving Contaminant	Risk-Driving Pathway	Estimated Qualitative Risk	Risk-Driving Contaminant	Risk-Driving Pathway
Radioactive	low	Sr-90, H-3	ingestion	very low	none	none
Nonradioactive-Carcinogenic	very low	none	none	very low	none	none
Nonradioactive-Noncarcinogenic	HQ or HI > 1[c]	Cr, Mn	ingestion	HQ or HI < 1	none	none

[a]Frequent-use scenario is based on residential scenario.
[b]Occasional-use scenario is based on recreational scenario.
[c]The sum of the nonradioactive, noncarcinogenic contaminant risks in unity, however each individual contaminant has a risk of <1.

4.0 CONTAMINANTS OF CONCERN IN THE GROUNDWATER

Groundwater chemistry data were obtained from analysis of samples collected from wells drilled under this LFI and from pre-1991 wells determined to be "fit-for-use" as monitoring structures (Ledgerwood 1992). The following sections discuss the analytes which were detected in the LFI groundwater sampling and identified as COPC in the QRA. The discussion is divided into sections discussing 100 D/DR, 100 H, and the 100-HR-3 600 Area. The COPC data from the four rounds of LFI sampling are shown in Tables 4-1, 4-2 and 4-3. No contaminants of concern (COC) (constituents with a medium or high risk) were identified in the QRA.

4.1 CONTAMINANTS OF CONCERN IN THE 100 D/DR AREA

Numerous contaminants of concern were identified as COPC based on the QRA. The QRA identified Cr, Mn, Sb, H-3, C-14, S-90, Cr, bis(2-ethylhexyl)phthalate, chloroform, nitrate and 1,1,2,2-tetrachloroethane as COPC for human health. The QRA identified Al, Cr, and Pb as COPC for the ecological evaluation. Antimony, Al, Mn, and 1,1,2,2-tetrachloroethane data are not consistent (see discussion in Section 2.5.2 and Appendix A) when all four rounds of data are evaluated and are therefore excluded from further discussion. Lead concentrations are below background and are also eliminated from further discussion.

Chromium contamination at levels well above the drinking water standard (see Section 4.5) is present in the groundwater beneath the 100 D Area (Figure 4-1). Locally the reported levels exceed 2 mg/L, which was the sodium dichromate concentration of reactor cooling water. This level of contamination is indicative of a concentrated source. Two potential source areas have been identified:

- Pipes leading from the 100 D sodium dichromate supply tanks located north of the 105 D Reactor building. This facility provided the original feed source for corrosion control for that reactor. Concentrated sodium dichromate was stored in two tanks and then transferred via pressurized lines to the 190 D building where it was added to the reactor cooling water. Leaks, spills or washdown remnants in the vicinity of the tank would be consistent with normal operating practices. Above background concentrations are found along the pipeline route; this is consistent with leaks in the piping.

- The 100 D/DR sodium dichromate distribution pump. After the 100 DR Reactor was constructed and both reactors were brought on line, the corrosion control chemical system was placed so that both reactors could be serviced. A single pumping station was built next to a railroad spur between the reactors. Lines were constructed leading from this location to the 190 D and DR buildings. Rail cars containing sodium dichromate were positioned on the siding, connected to the pumping station and emptied directly to the 190 buildings with no supplemental storage. Leaks and rail car washout reportedly occurred at the pump station, as a small french drain was incorporated into the operation. No monitoring wells are located near this site.

Chromium contamination occurs in wells near the D/DR retention basins. Retention basins are not major chromium sources in other reactor areas (H and B/C), suggesting that the Cr concentrations may be the result of a more concentrated source. Groundwater flow direction in the vicinity of the D and DR Reactors is not clearly defined. The high concentrations evident near the 100 D Reactor appear to be separate from those near the retention basins. There is only a limited distribution of monitoring wells in this area making analysis somewhat subjective.

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A separate area of elevated Cr concentration is noted at well 199-D2-6, suggesting that the 118-D-2 burial ground may be a contributing source.

Strontium-90 occurs in detectable concentrations up to the drinking water standard of 8 pCi/L (see Section 4.5) immediately north of the 116-DR-9 retention basin (Figure 4-2). The only wells in which it was detected are D8-53 (8 pCi/L), D8-54A (7 pCi/L) and, D8-3 (5 pCi/L). Historical records of Sr-90 extend back to 1988; concentrations have remained essentially constant since that time. Strontium-90 was below detection level in all other 100 D wells sampled.

Tritium levels are elevated near the DR Reactor (Figure 4-3), at concentrations above the drinking water standard (see Section 4.5); ranging up to 74,000 pCi/L. Well D2-5 provides historical H-3 concentration data starting in 1964. During the 1970's H-3 concentrations averaged about 25,000 pCi/L; they then declined to a low of about 2000 pCi/L in 1986. Concentrations have been increasing since then to 40,000 pCi/L in July 1992. The reason for this increase is not known.

Nitrate (NO_3) concentrations reported as N are commonly near or above the drinking water standard of 10 mg/L (see Section 4.5) over the entire operable unit. The highest value (88 mg/L) was determined for well D8-3 (Figure 4-4). Other high concentrations (77 and 45 mg/L) are found near the 105 D and 105 DR Reactors respectively. Nitric acid used for numerous purposes is the probable source of the nitrogen compounds.

Concentrations of chloroform are reported in many samples collected from the 100 D/DR Area. In the majority of these cases, blanks submitted along with the samples also show positive chloroform concentrations. Chloroform is commonly generated during the chlorination of drinking water supplies and thus is ubiquitous in the accessible environment. There is no known or suspected source of operations that generated or disposed of chloroform; the substance is not carried further in the LFI analysis.

Bis(2-ethylhexyl)phthalate was reported in numerous samples. This compound is a primary component of plastic products where it is used to maintain material pliability. The compound is ubiquitous in the modern environment and is not indicative of site-specific contamination.

Carbon-14 was only detected in one well (199-D5-19). In this well, the C-14 analysis was rejected in the first round, it was detected at an estimated value of 68 pCi/L in the second round, and was not detected in the third round. Therefore, it is not certain whether or not C-14 is even present in the D/DR Area and another round of sampling from this well is required.

4.2 CONTAMINANTS OF CONCERN IN THE 100 H AREA

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In the 100 H Area, contaminants can generally be traced to the facility or facilities from which they originated. Operating history for specific facilities in that area confirm the findings of the groundwater analyses. The QRA identified H-3, C-14, Sr-90, Tc-99, U-238, Am-241, Cr, Mn, chloroform and nitrate as COPC for human health. Chromium, Fe, and Pb were identified as COPC for the ecological evaluation. Americium-241 and Mn data are not consistent (see discussion in Section 2.5.2 and Appendix A) when all four rounds of data are evaluated and are therefore excluded from further discussion.

Technetium-99 is found almost exclusively in conjunction with the uranium plume emanating from the 183 H basins, which no longer contain any hazardous wastes and are being decommissioned (Figure 4-5). Technetium-99 is to be expected here due to the processes involved in producing the wastes disposed to the facility.

Strontium-90 is found almost exclusively associated with groundwater flow downgradient of the retention basins (Figure 4-6). Other reactor areas show similar Sr-90 distributions.

Nitrate is associated with a plume emanating from the solar evaporation ponds at 183 H (Figure 4-7). This plume results from disposed nitric acid used during the fuel fabrication process. High nitrate salts were placed in the facility, the salts are highly soluble and move readily with the groundwater.

Chromium contamination may have come from any of several sources within the 100 H Area (Figure 4-8). Chromium as dichromate was disposed of as an incidental waste during the operating period of the reactor. All cooling water was treated to a concentration of 2 mg/L dichromate as a corrosion inhibitor. Concentrated sodium dichromate was stored on site in large tanks and then transferred to the cooling water in either the 183 H Water Treatment Plant or the 190 Pumping Plant before passing through the reactor. This water then followed the normal path for cooling water, eventually being discharged to the Columbia River. High concentrations of Cr were also present in the fuel fabrication wastes placed in the 183 H Solar Evaporation Ponds. (The 183 H facility contained several water clarification and treatment cells that were used for the solar evaporation in the 1970's.) Both sources have contributed to the occurrence of chromium contamination.

Chloroform was reported in sample analyses associated with the 100 H Area. In the majority of cases these samples were accompanied by blanks that also showed positive chloroform concentrations. Although chloroform was carried through the QRA analysis, it is not considered as a contaminant for this LFI.

A maximum lead concentration of 0.012 mg/L was reported for the 100 H Area. Although Pb was used extensively in the reactor facility, metallic Pb is not readily leached in the reactor environment. There is no known reactor source for soluble Pb in the groundwater. Recent work by Preyer (1991) indicates that lead arsenate pesticides may be remobilized in the environment. These pesticides may have been used in the pre-Hanford orchards common the 100 H Area vicinity.

Tritium was found in most of the wells in the 100 H Area, although at relatively low concentrations. The maximum concentration was 11,000 pCi/L in wells 199-H4-46 and 199-H4-49. The highest concentrations are found in the southern portion of the H Area and are associated with reactor disposal areas.

Uranium-238 was found in low concentrations in several wells in the vicinity of the H Reactor. The highest concentration observed during the LFI sampling was 2.3 pCi/L in well 199-H4-46. Uranium is known to have been placed in the 183 H basins, although the U-238 results from this area were rejected.

Carbon-14 was found in a few wells (199-H4-4, 199-H4-6, 199-H4-11, 199-H4-12A, and 199-H4-49) in the 100 H Area. These ^{14}C concentrations have only been observed in one round of sampling, therefore it is uncertain whether or not ^{14}C is actually present in the 100 H Area.

Iron (unfiltered) was only analyzed for in the wells in the vicinity of the reactor. The concentrations appear to have been decreasing over time. The highest concentration (unfiltered) in the last round was 173 μg/L in well 199-H5-1. In the near river wells in the last sampling round, the highest concentrations was 14.2 μg/L.

4.3 CONTAMINANTS OF CONCERN IN THE 600 AREA

The QRA identified H-3, C-14, Pu-238, chloroform, Cr, Mn, and Sb as COPC for human health in the 600 Area of 100-HR-3. The 600 Area wells were not evaluated for ecological risk, since none of the wells are near the river. Carbon-14, Pu-238, Mn, and Sb results are not consistent (see discussion in Section 2.5.2 and Appendix A) when all four rounds of data are evaluated and are therefore excluded from further discussion.

Chromium concentrations are elevated to about 170 μg/L in wells 699-96-43 and 699-97-43, about one half mile upgradient of the 100 H Area (Figure 4-9). The source of this Cr is unknown. The 100-IU-4 Operable Unit was initially the suspected source.

However, that site was eliminated as a suspect source when it was remediated in April 1992 as an ERA. During remediation the underlying soils were determined to be insufficiently contaminated to affect the groundwater.

Tritium was detected in the 5 wells sampled in the 600 Area of 100-HR-3 (Figure 4-10). The highest concentration was 11,000 pCi/L in well 699-96-43. All of the 600 Area well concentrations were well below the 20,000 pCi/L maximum concentration level (MCL) (see Section 4.5).

Chloroform was reported in sample analyses associated with the 600 Area. In the majority of cases these samples were accompanied by blanks that also showed positive chloroform concentrations. Although chloroform was carried through the QRA analysis, it is not considered as a contaminant for this LFI.

4.4 CONFINED AQUIFER

Confined aquifers in the 100-HR-3 Operable Unit are found in the Ringold Formation and within the Columbia River Basalt Group (CRBG). A limited number of wells tap these confined units. Sand lenses in the upper portions of the Ringold Formation often act as semiconfined aquifers with vertical leakage occurring in either direction depending on interactions of the unconfined aquifer with the Columbia River. During periods of high river stage, potentials may be downward. During normal and low river stages, potentials are generally upward. Heads increase with depth through the Ringold Formation and into the basalt aquifers of the CRBG.

Contaminants are locally present to the base of the unconfined aquifer in the 100-HR-3 Operable Unit. In no case are 100 Area related contaminants found in any portion of the confined aquifer system. A possible exception to this is Cr in well 199-H4-12C which is completed at mid-depth in the Ringold Formation. Because other waste indicators are not elevated in this well, the current interpretation is that the Cr is representative of formation water quality (Peterson 1993).

4.5 POTENTIAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS AND TO-BE-CONSIDERED GUIDANCE

Potential chemical-specific ARARs for the 100-HR-3 Operable Unit are discussed in the following sections. Potential location-specific ARARs are identified in the *100 Area Feasibility Study Phases 1 and 2* (DOE-RL 1993b).

Safe Drinking Water Act. The MCL prescribed in EPA's National Primary Drinking Water Regulations[1] under the Safe Drinking Water Act are relevant and appropriate regulations for the 100-HR-3 Operable Unit. Secondary MCLs are

[1]Title 40 CFR as amended at 56FR 32113, July 15, 1991; 57 FR 1852, January 15, 1992; 57 FR 22178, May 27, 1992; 57 FR 24747, June 10, 1992; 57 FR 28788, June 29, 1992; 57 FR 31838, July 17, 1992.

to-be-considered (TBC) per the National Contingency Plan (NCP). Title 40 Code of Federal Regulations (CFR) 141.16 limits the concentrations of photon and beta particle emitters to levels which would not exceed an annual dose equivalent to the total body or any internal organ of 4 mrem/yr. This section also prescribes a methodology for calculating the concentration of radionuclides using a daily intake of 2 liters per day and the 168 hour data listed in *Maximum Permissible Body Burdens and Maximum Permissible Concentration of Radionuclides in Air or Water for Occupational Exposures* (NBS 1963). Primary MCLs, MCLGs, and Secondary MCLs are listed in Table 4-4.

Model Toxics Control Act. The Model Toxics Control Act (MTCA) (WAC 173-340) defines ground and surface water standards for both residential and industrial scenarios. The MTCA does not include standards for radionuclides.

Additional ARARs and TBC guidelines are included in Table 4.4. The DOE Order 5400.5 establishes groundwater standards based on a 100 mrem/yr dose. Converting these standards to correspond to a 4 mrem/yr dose (by dividing by 25) results in the following levels:

- tritium - 80,000 pCi/L
- carbon-14 - 2,800 pCi/L
- strontium-90 - 40 pCi/L
- technicium-99 - 4,000 pCi/L
- uranium-238 - 24 pCi/L.

Figure 4-1 Chromium Concentrations in the 100 D/DR Area Groundwater

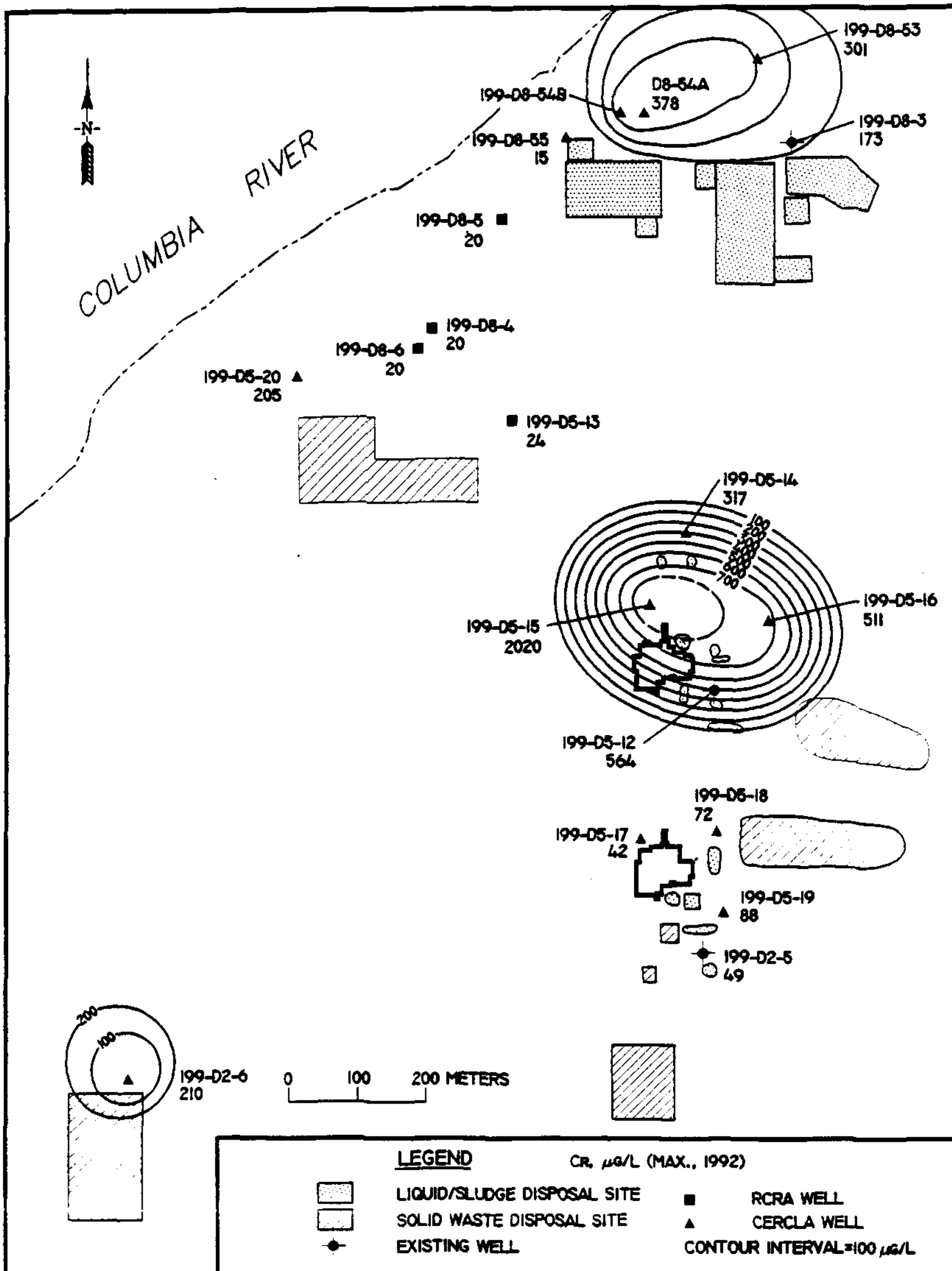

Figure 4-2 Strontium Concentrations in the 100 D/DR Area Groundwater

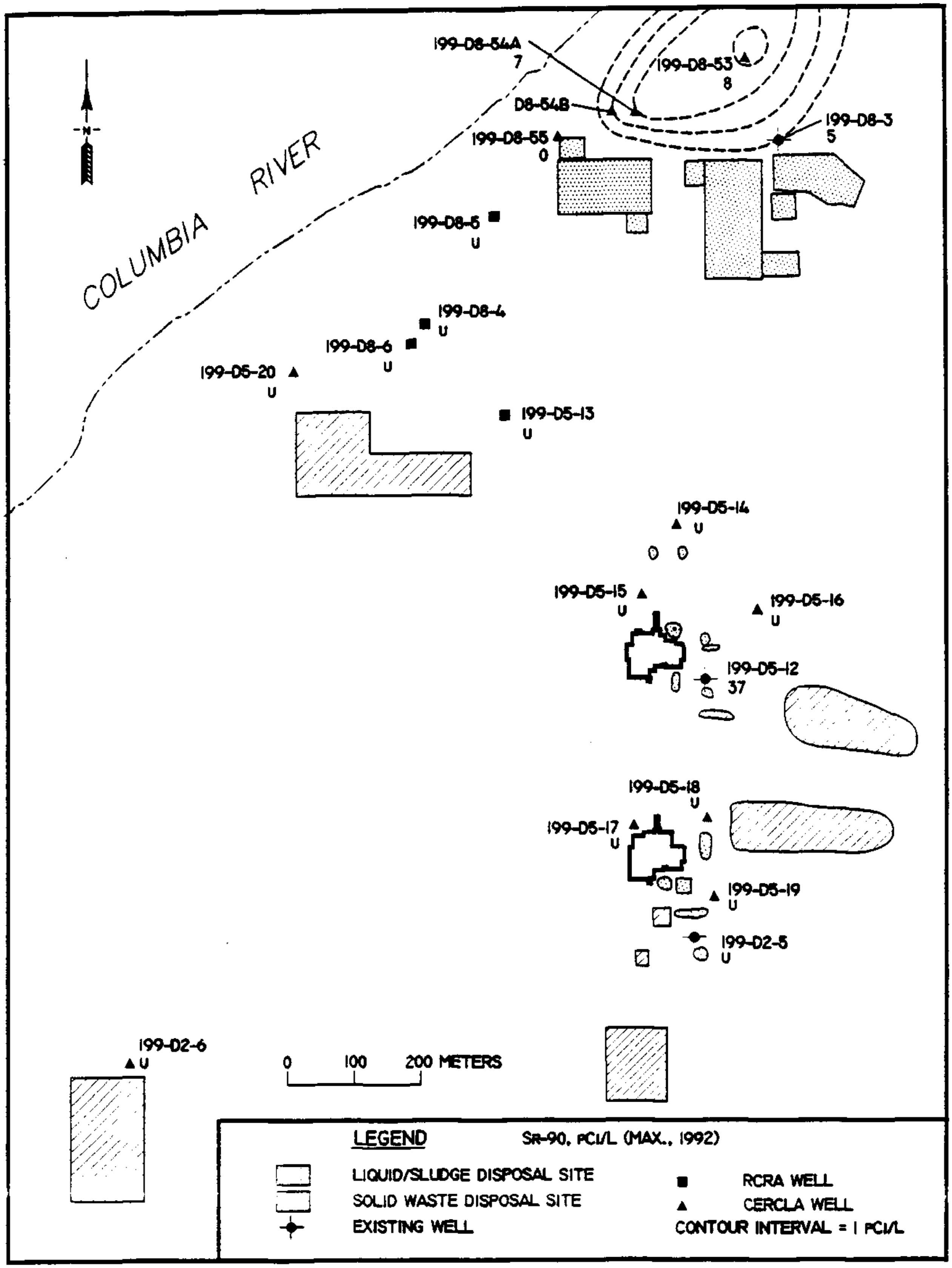

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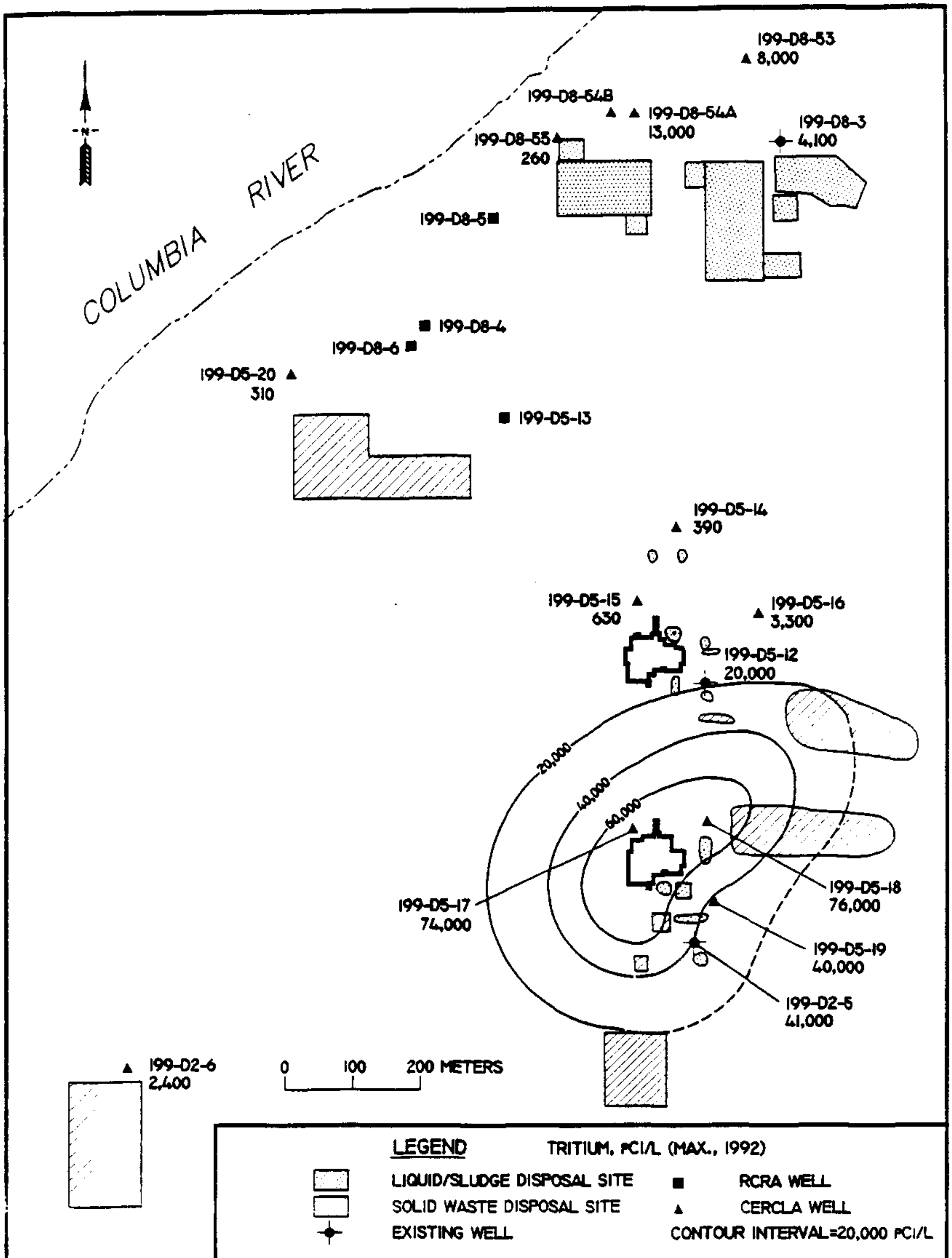
Figure 4-3 Tritium Concentrations in the 100 D/DR Area Groundwater



9313027.0573

Figure 4-4 Nitrate/Nitrite-Nitrogen Concentrations in the 100 D/DR Groundwater

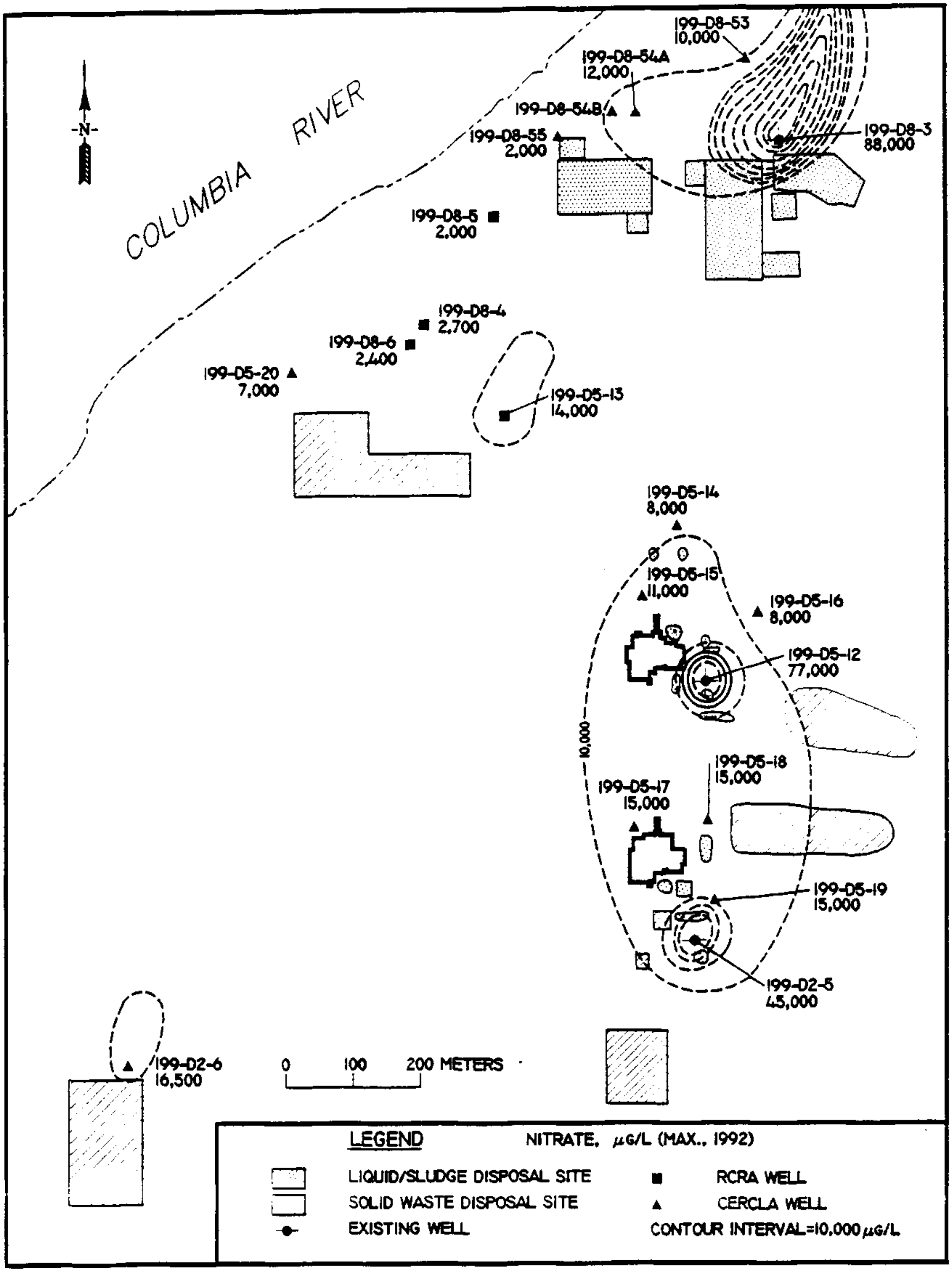


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Figure 4-5 Technetium-99 Concentrations in the 100 H Area Groundwater

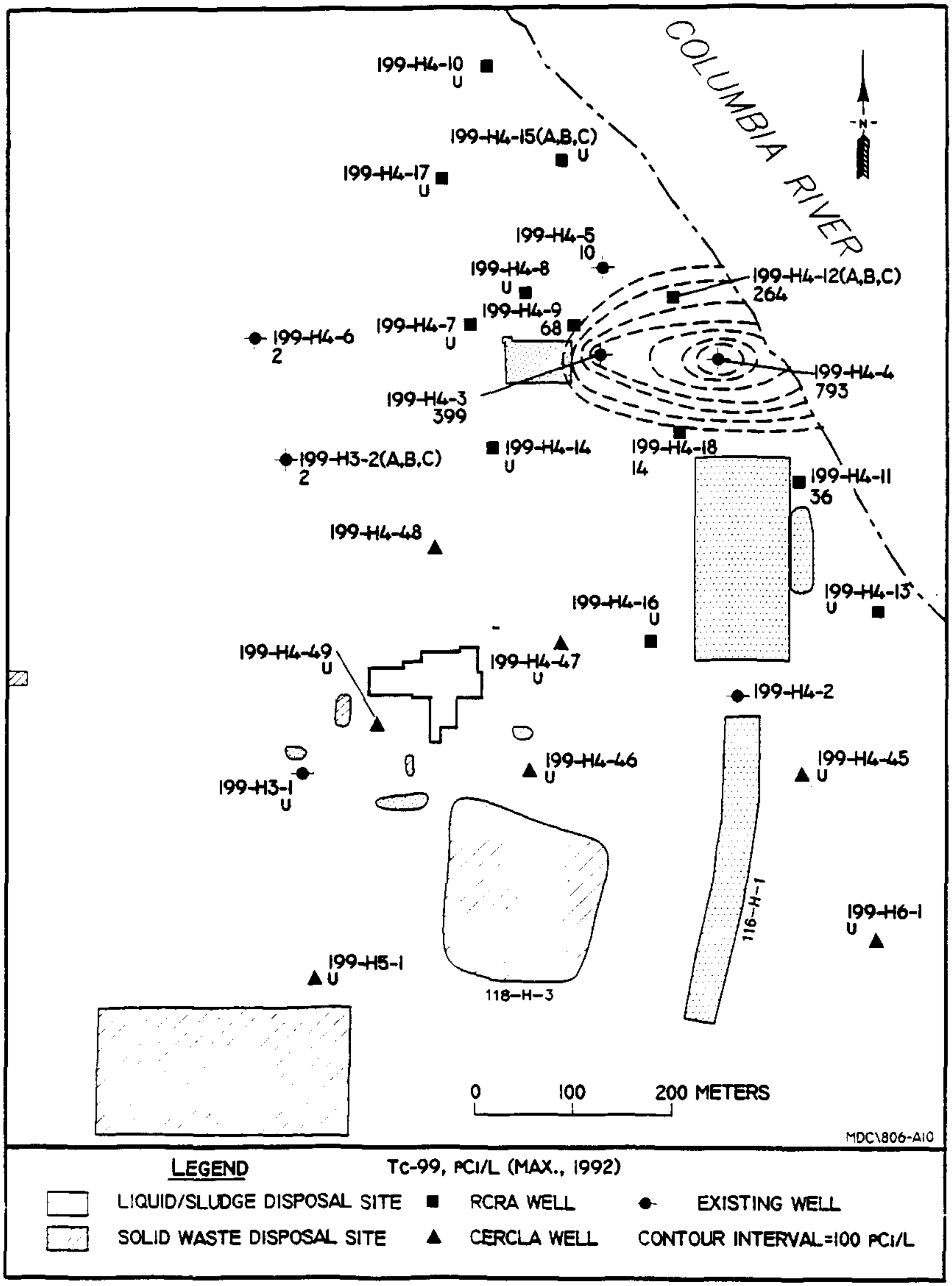

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Figure 4-6 Strontium-90 Concentrations in the 100 H Area Groundwater

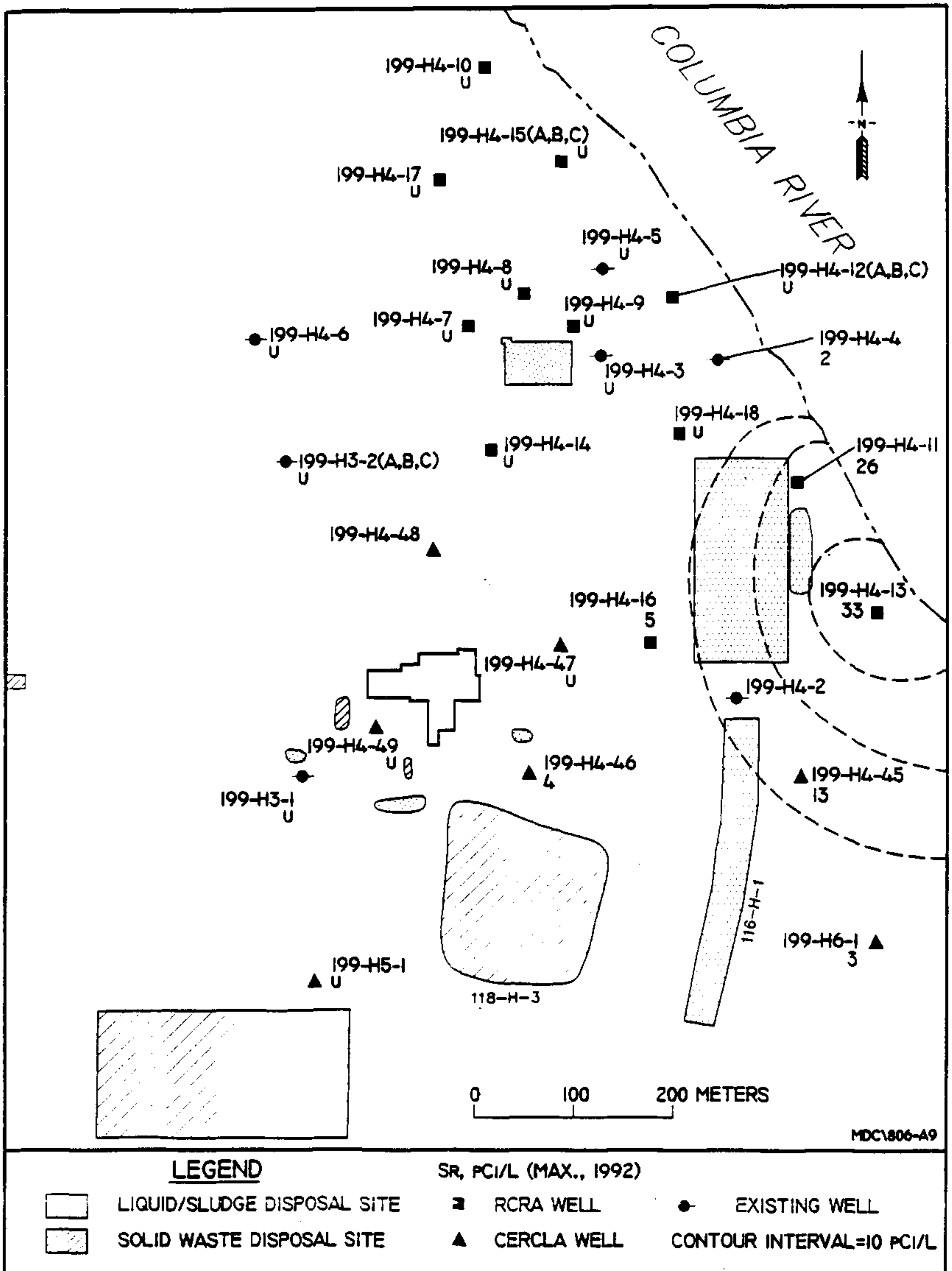

Figure 4-7 Nitrate/Nitrite-Nitrogen Concentrations in the 100 H Area Groundwater

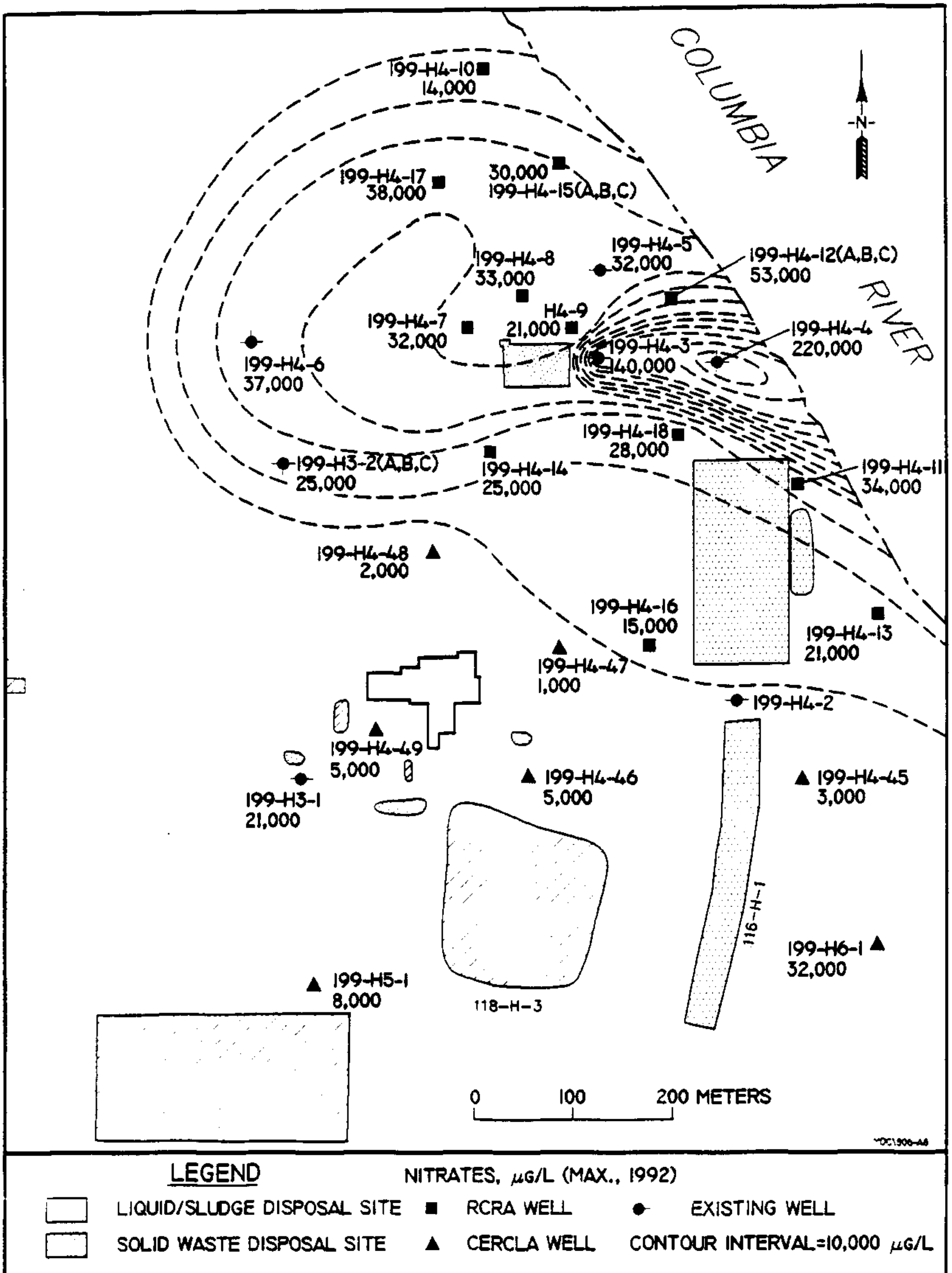

Figure 4-8 Chromium Concentrations in the 100 H Area Groundwater

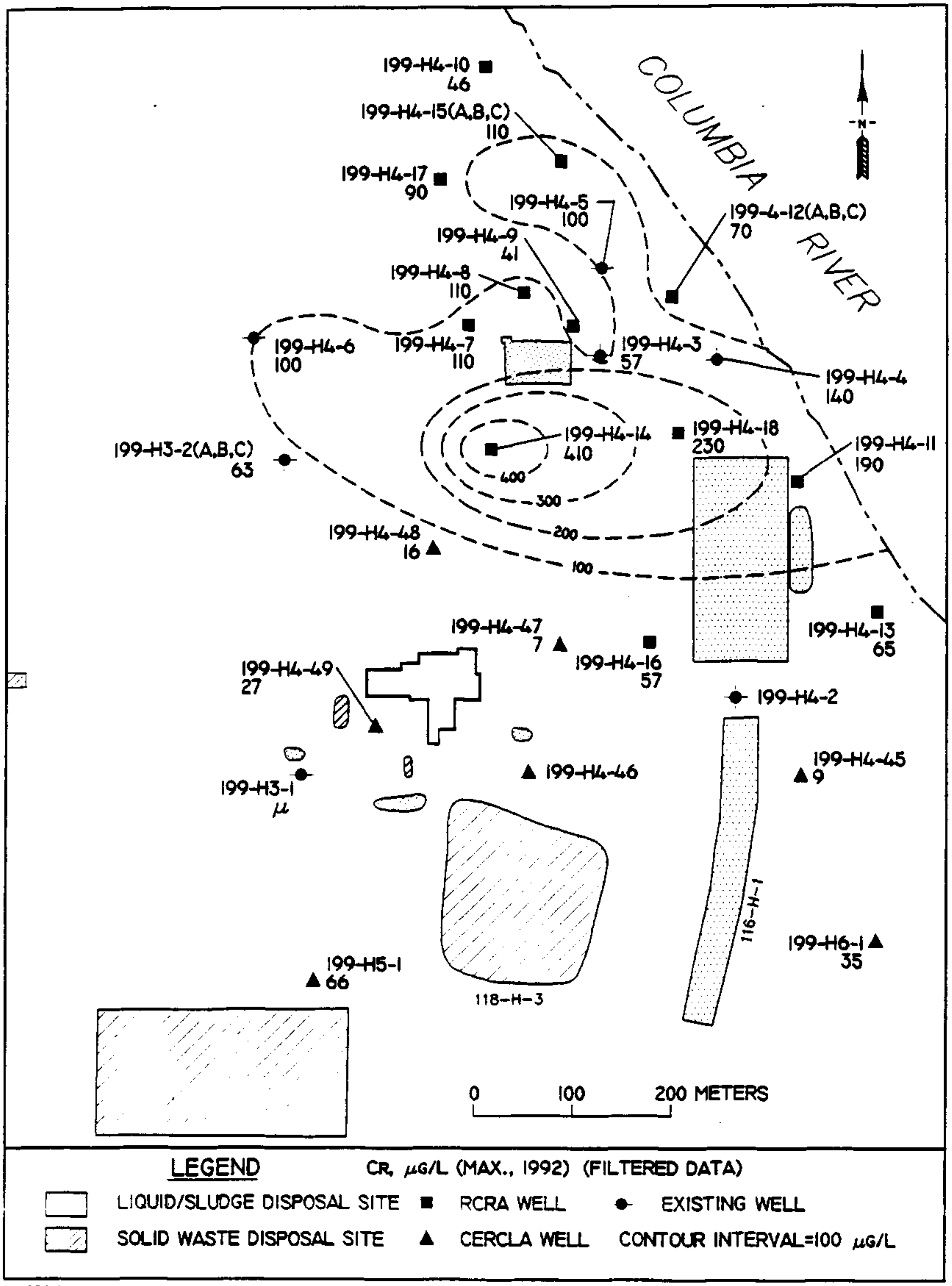

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Figure 4-9
Chromium Concentrations in the 600 Area Groundwater

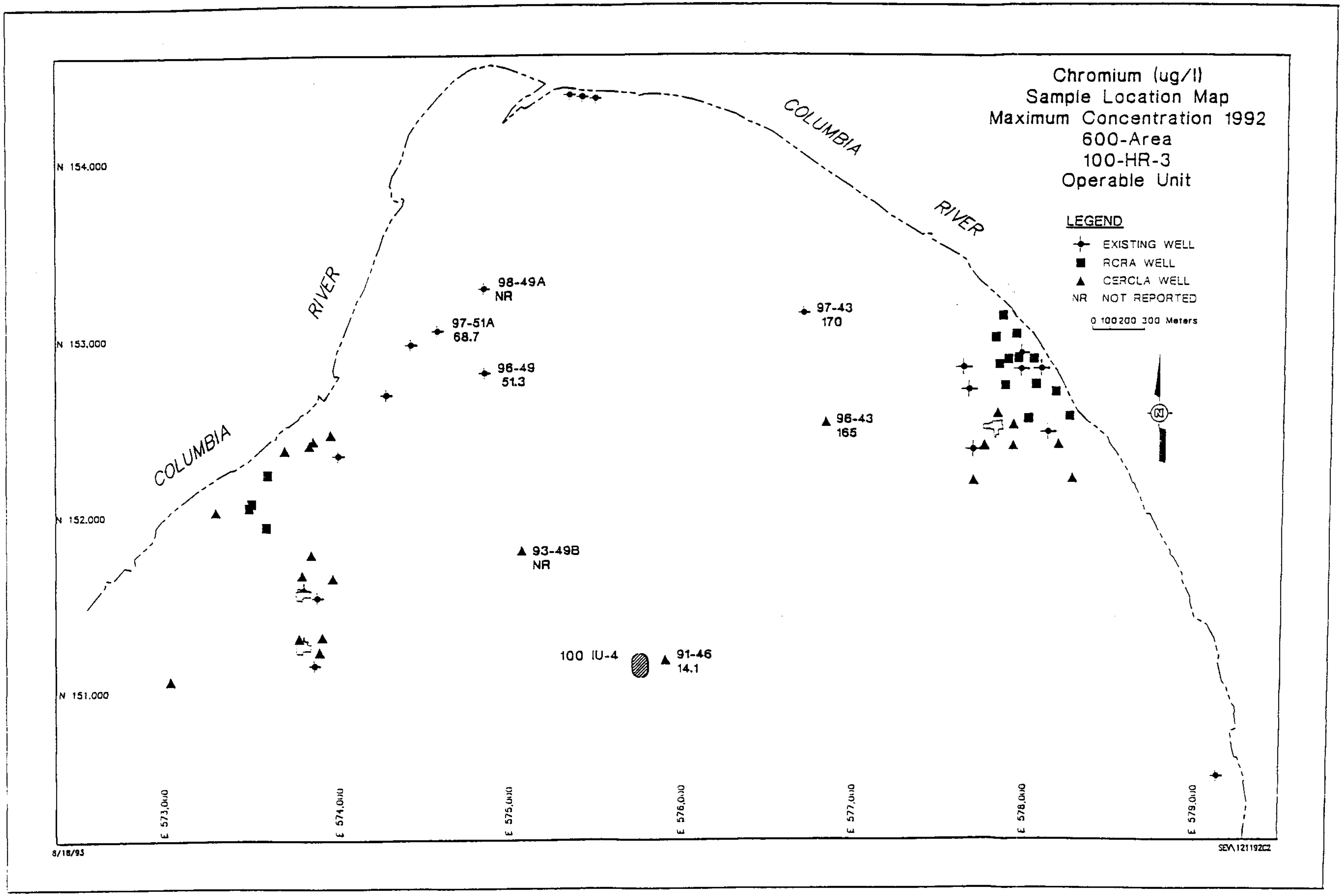

Figure 4-10
Tritium Concentrations in the 600 Area Groundwater

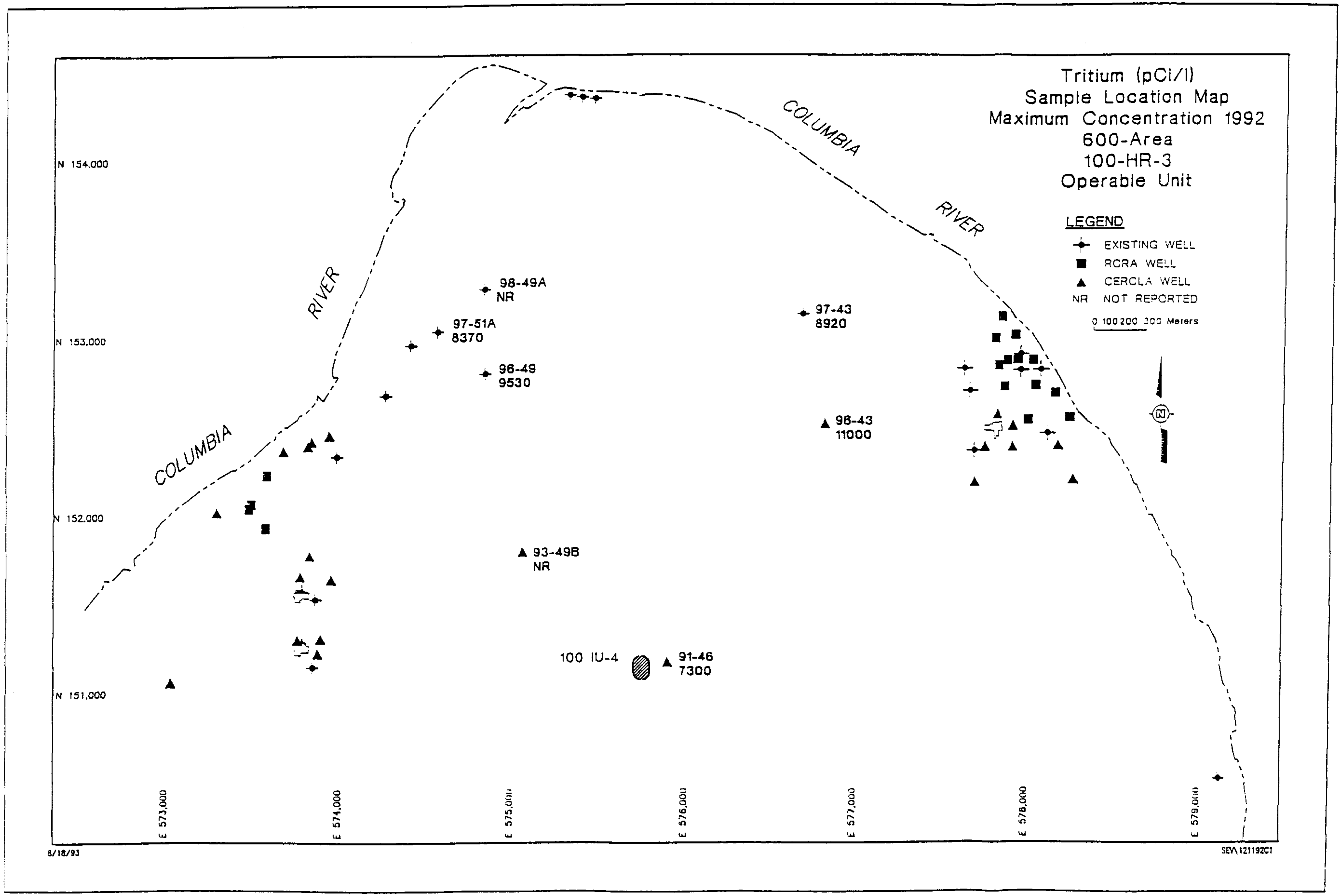

Table 4-1 D/DR Area Contaminant of Potential Concern Data
(Page 1 of 5)

Well Number	D5-13	D8-3						D8-4	D8-5	D8-6
Round Number	1	1	2	Split (2)	Split (2)	3	4	1	1	1
Sample Number@	B06CF0	B06CL9	B07336	B07358	B07356	B07KY5	B084V9	B06CF2	B06CF4	B06CF6
Tritium (pCi/l)	NA	3300	4100	NA	3900	3600	3500	NA	NA	NA
Strontium-90 (pCi/l)	U	U	2	NA	3	2.5 R	3 J	U	U	U
Carbon-14 (pCi/l)	46 R	U	U	NA	2.4	U	NA	19 R	12 R	39 R
Chloroform (ug/l)	4 J	3 J	U	1 J	U	2 J	NA	2 J	3 J	5 J
1,1,2,2 Tetrachloroethane (ug/l)	U	U	U	U	U	U	NA	U	U	U
Bis(2-ethylhexyl)phthalate (ug/l)	U	U	.9 J	NA	U	24	NA	4 J	22	U
Manganese (ug/l)[a]	U	10 B/2 B	U/U	U	U	U	U/U	U	U	U
Nitrate/Nitrite (mg/l)	NA	33	26.4	NA	45	32.7	29.7	NA	NA	NA
Antimony (ug/l)[a]	U	U/U	U/U	U	U	U/NA	U/U	U	U	U
Aluminum (ug.l)[a]	U	150 B/U	U/U	U	U	U/NA	U/U	U	U	U
Chromium (ug/l)[a]	U	139/326	173/162	190	199	167/NA	147/146	U	U	U
Lead (ug/l)[a]	U	U/U	3 B/4 M	U	U	2.7 B/NA	U/U	U	U	U

Well Number	D2-5						
Round Number	1	2	Duplicate (2)	3	4	Duplicate (4)	Split (4)
Sample Number@	B06CH9	B072G9	B07369	B07L10	B084X7	B08513	B08517
Tritium (pCi/l)	41000	39000	40000	38000	36000	36000	29000
Strontium-90 (pCi/l)	U	U	U	U	U	U	-.5 R
Carbon-14 (pCi/l)	U	U	U	U	NA	NA	NA
Chloroform (ug/l)	1 J	U	U	U	NA	NA	NA
1,1,2,2 Tetrachloroethane (ug/l)	U	U	U	U	NA	NA	NA
Bis(2-ethylhexyl)phthalate (ug/l)	U	U	U	U	NA	NA	NA
Manganese (ug/l)[a]	1 B/5 B	7 B/15 B	7 B/14 B	U/U	U/U	U/2.5 B	U/2.9 B
Nitrate/Nitrite (mg/l)	10	4.21	2.68	8.29 J	20.6	10.5	9.4
Antimony (ug/l)[a]	U/U	U/U	U/U	U/U	U/U	U/U	U/U
Aluminum (ug.l)[a]	47 B/U	U/U	U/U	U/U	U/U	U/U	U/U
Chromium (ug/l)[a]	49/390	36/40	35/43	U/44.1	37.7/38.6	36.4/43	43.6/42.8
Lead (ug/l)[a]	U/U	4/4 W	4/3 WB	U/U	U/U	1.6 B/U	U/U

Table 4-1 D/DR Area Contaminant of Potential Concern Data
(Page 2 of 5)

Well Number	D2-6							
Round Number	1	2	Split (2)	Split (2)	3	Split (3)	Duplicat (3)	4
Sample Number@	B06CJ2	B072K4	B07360	B07362	B07L20	B07L94	B07LB5	B084X9
Tritium (pCi/l)	2400 R	2100	2200	NA	2200	NA	2300	2400
Strontium-90 (pCi/l)	U	U	U	NA	U	NA	U	U
Carbon-14 (pCi/l)	43 R	U	4.6	NA	U	NA	U	NA
Chloroform (ug/l)	3 J	U	U	2 J	3 J	4 J	3 J	NA
1,1,2,2 Tetrachloroethane (ug/l)	U	U	U	U	U	U	U	NA
Bis(2-ethylhexyl)phthalate (ug/l)	4 J	U	U	NA	54	U	U	NA
Manganese (ug/l)[a]	86/98	12 B/20	18	13 B	1.5 B/2.8 B	U/U	1.8 B/2.2 B	3.2 B/6.8 B
Nitrate/Nitrite (mg/l)	14	11.1	16.5	NA	12.6	16.4	14.1	13.3
Antimony (ug/l)[a]	U/U	U/U	U	U	NA	NA	NA	U/U
Aluminum (ug.l)[a]	U/51 B	U/29 B	79 B	U	22.5 B/U	U/U	U/U	29.4 B/U
Chromium (ug/l)[a]	122/156	210/266	242	218	178/190	192/200	175/198	156/169
Lead (ug/l)[a]	1 B/3	4/2 WB	U	U	2.7 B/U	U/U	U/4.3 N*	6.6*/U

Well Number	D5-12				D5-14			
Round Number	1	2	3	4	1	2	3	4
Sample Number@	B06CJ5	B072M4	B07KY0	B084W1	B06CJ8	B072C9	B07KX5	B084W3
Tritium (pCi/l)	20000	17000	35000	41000	300 J	390 J	360 J	620
Strontium-90 (pCi/l)	U	37	32 R	41 J	U	U	-.31 R	U
Carbon-14 (pCi/l)	U	U	U	NA	U	U	U	NA
Chloroform (ug/l)	8 J	8 J	6 J	NA	U	8 J	9 J	NA
1,1,2,2 Tetrachloroethane (ug/l)	U	U	U	NA	U	U	U	NA
Bis(2-ethylhexyl)phthalate (ug/l)	U	50	U	NA	U	U	U	NA
Manganese (ug/l)[a]	2 B/2 B	6 B/7 B	U	3.6 B/15 B	110/145	34/33	12 B/NA	U/3.6 B
Nitrate/Nitrite (mg/l)	20	19.7	20.2	11.7	8	9.48	9.41	1.06
Antimony (ug/l)[a]	14.3 B/U	U/U	U/NA	U/U	U/U	U/U	U/U	U/U
Aluminum (ug.l)[a]	U/U	U/22 B	U/NA	U/U	71 B/311	58 B/81 B	U/NA	U/U
Chromium (ug/l)[a]	564/275	540/556 *	353/NA	268/263	410 EN/483 N	317/343 *	657/NA	917/961
Lead (ug/l)[a]	U/U	2 NB/3	2.6 WJ/NA	U/U	3 B/3 B	3 WN/4	2 B/NA	U/1.6 B

Table 4-1 D/DR Area Contaminant of Potential Concern Data
(Page 3 of 5)

Well Number	D5-15				D5-16			
Round Number	1	2	3	4	1	2	3	4
Sample Number@	B06CK1	B072G4	B07L15	B084W5	B06CK4	B072J9	B07KX0	B084W7
Tritium (pCi/l)	570	630	1200	660	3300	3100	2700	4000
Strontium-90 (pCi/l)	U	1 J	1.1 J	1.4 J	U	U	.13 R	U
Carbon-14 (pCi/l)	U	U	U	NA	U	U	U	NA
Chloroform (ug/l)	10	12	12	NA	U	13	12	NA
1,1,2,2 Tetrachloroethane (ug/l)	U	U	U	NA	U	U	U	NA
Bis(2-ethylhexyl)phthalate (ug/l)	U	U	U	NA	U	U	U	NA
Manganese (ug/l)[a]	24/27	4 B/8 B	U/U	U/U	62/54	18/23	19.9/NA	16.5/15.3
Nitrate/Nitrite (mg/l)	11	9.53	11 J	12.2	8	7.72	9.75	14.7
Antimony (ug/l)[a]	14.8 B/U	U/U	U/U	U/U	U/U	U/U	U/U	U/U
Aluminum (ug.l)[a]	U/32 B	U/53 B	U/U	27 B/U	370/116 B	U/87 B	U/NA	U/U
Chromium (ug/l)[a]	2020/2090	1790/1740	1880/1810	1570/1630	712 NE/748 N	811/ 839 *	1020/NA	907/877
Lead (ug/l)[a]	2 B/4 N*	3/4 W	NA/U	U/2 WB	4 W/2 B	3 NB/7	2.3 B/NA	U/U

Well Number	D5-17				D5-18			
Round Number	1	2	3	4	1	2	3	4
Sample Number@	B06CK7	B07319	B07L30	B084W9	B06CL0	B07341	B07L00	B084X1
Tritium (pCi/l)	72000	74000	78000	72000	72000	76000	67000	73000
Strontium-90 (pCi/l)	U	U	U	U	U	U	.31 R	U
Carbon-14 (pCi/l)	U	50 BX	U	NA	U	U	U	NA
Chloroform (ug/l)	2 J	U	3 J	NA	U	U	2 J	NA
1,1,2,2 Tetrachloroethane (ug/l)	U	U	U	NA	U	U	U	NA
Bis(2-ethylhexyl)phthalate (ug/l)	U	U	U	NA	U	U	U	NA
Manganese (ug/l)[a]	167/320	175/186	136/142	102/108	256/385	24/44	U/NA	U/5.5 B
Nitrate/Nitrite (mg/l)	15	16.5	NA	18.4	15	14	13.9	18.5
Antimony (ug/l)[a]	U/U	U/U	U/21.2	U/U	U/U	U/U	U/NA	U/U
Aluminum (ug.l)[a]	U/6310	U/511	U/42.2 B	52.3 B/49.5 B	497/2580	U/92 B	U/NA	U/U
Chromium (ug/l)[a]	33/89	NA	52/68.4	51/64	66 NE/139 N	72/122	74.9/NA	76/76.8
Lead (ug/l)[a]	2 WB/5 N*	U/2 B	2.2 B/NA	1.9 WB/2 B	1 B/3 B	4/2 WB	2.5 B/NA	2.4 B/U

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Table 4-1 D/DR Area Contaminant of Potential Concern Data
(Page 4 of 5)

Well Number	D5-19				D5-20				
Round Number	1	2	3	4	1	2	Duplicat (2)	3	4
Sample Number@	B06CL3	B072D4	B07L05	B084X3	B06CL6	B07314	B07364	B07KZ0	B084X5
Tritium (pCi/l)	39000 R	40000	39000	38000	250 J	300 J	310 J	U	340
Strontium-90 (pCi/l)	U	U	U	U	U	U	U	.54 R	U
Carbon-14 (pCi/l)	43 R	68 BX	U	NA	U	U	U	U	NA
Chloroform (ug/l)	U	U	2 J	NA	U	10	U	12	NA
1,1,2,2 Tetrachloroethane (ug/l)	U	U	U	NA	U	U	U	U	NA
Bis(2-ethylhexyl)phthalate (ug/l)	U	U	U	NA	16	2 J	2 J	U	NA
Manganese (ug/l)[a]	134/67	5 B/11 B	U/NA	U/1.9 B	52/62	3 B/8 B	3 B/8 B	U/NA	1.3 B/6.8 B
Nitrate/Nitrite (mg/l)	15	13.7	13.1	19.4	7	5.97	5.78	7.51	6.98
Antimony (ug/l)[a]	U/U	U/U	U/U	U/U	U/U	U/U	U/U	U/NA	U/U
Aluminum (ug.l)[a]	2140/1140	U/40 B	U/NA	U/U	1040/1480	U/91 B	U/82 B	U/NA	U/U
Chromium (ug/l)[a]	88 NE/176 N	86/127	83.2/NA	84.9/85	201 NE/264 N	205/219	188/235	178/NA	194/207
Lead (ug/l)[a]	2 WB/3 B	2 B/3	3.1 WJ/NA	U/2.3 B	2 B/4	5/3 B	3 B/U	3.6/NA	U/U

Well Number	D8-53				D8-54A			
Round Number	1	2	3	4	1	2	3	4
Sample Number@	B06CM2	B072C4	B07KW5	B084V1	B06CM5	B072F9	B07KV5	B084V5
Tritium (pCi/l)	8000 R	6900	8800	10000	13000	12000	19000	16000
Strontium-90 (pCi/l)	7 R	8	4.8 R	5.4 J	7	4	2.7 R	7.2 J
Carbon-14 (pCi/l)	36 R	U	U	NA	42 J	U	U	NA
Chloroform (ug/l)	U	U	3 J	NA	U	U	5 J	NA
1,1,2,2 Tetrachloroethane (ug/l)	U	U	U	NA	U	U	U	NA
Bis(2-ethylhexyl)phthalate (ug/l)	U	2 J	33	NA	U	.5 J	U	NA
Manganese (ug/l)[a]	4 B/25	U/16	U/NA	U/U	2 B/33	U/4 B	U/NA	U/U
Nitrate/Nitrite (mg/l)	10	8.08	11.4	14.1	12	9.8	12.8	1.43
Antimony (ug/l)[a]	U/U	U/U	U/NA	U/U	U/U	U/U	U/NA	U/U
Aluminum (ug.l)[a]	24 B/1060	U/174 B	U/NA	U/U	24 B/579	U/130 B	U/NA	U/U
Chromium (ug/l)[a]	301 NE/443 N	275/373 *	344/NA	331/350	378 NE/412 N	350/346 "	421/NA	410/415
Lead (ug/l)[a]	1 B/2 B	1 NB/3 B	1.5 B/NA	2.7 B/1.7 B	2 B/2 B	2 NB/3	1.7 B/NA	1.5 B/2.3 B

Table 4-1 D/DR Area Contaminant of Potential Concern Data
(Page 5 of 5)

Well Number	D8-55			
Round Number	1	2	3	4
Sample Number@	B06CN1	B072L9	B07KV0	B084V3
Tritium (pCi/l)	260 J	U	U	U
Strontium-90 (pCi/l)	U	U	U	U
Carbon-14 (pCi/l)	U	U	U	NA
Chloroform (ug/l)	U	U	3 J	NA
1,1,2,2 Tetrachloroethane (ug/l)	U	U	U	NA
Bis(2-ethylhexyl)phthalate (ug/l)	U	U	U	NA
Manganese (ug/l)[a]	2 B/24	U/19	U/NA	U/3 B
Nitrate/Nitrite (mg/l)	2	1.3	1.51	2.06
Antimony (ug/l)[a]	U/U	U/U	NA	U/U
Aluminum (ug.l)[a]	U/200	U/110 B	U/NA	U/U
Chromium (ug/l)[a]	9 NEB/169 N	15/159 *	19.6/NA	14.6/45.1
Lead (ug/l)[a]	2 WB/3 M	5N/3	2.5 B/NA	U/3.1

@ : Sample number reported is number for the majority of the analyses, inorganic filtered samples have different sample numbers
[a]: Filtered/Unfiltered
NA: Not Available
J: Estimated Value
B(inorganics): Estimated value below contract required detection limit
U: Undetected
R: Rejected data
M: Duplicate injection presision not met
W: AA analysis is out of control limits
N: Spiked sample recovery not within control limits
*: Duplicate analysis not within control limits
E: Estimated value due to the presence of interference

Table 4-2 H Area Contaminant of Potential Concern Data (Page 1 of 4)

Well Number	H4-45				H4-46				
Round Number	1	2	3	4	1	2	3	4	Duplicate (4)
Sample Number@	B06CN4	B072M9	B07L85	B084Y3	B06CN7	B07324	B07L70	B084Y5	B08515
Carbon-14 (pCi/l)	U	72	U	NA	45 J	U	U	NA	NA
Chloroform (ug/l)	NA	26	31	NA	17	U	9 J	NA	NA
Chromium (ug/l)[a]	8.8/23.5	7.1/22.5	14.4/20.2	14.4/13.8	38/85.9	44.2/54.4	49.7/52.7	44/47.3	42.8/48.8
Iron (ug/l)[a]	52.6/601	U/184	10.8 B/33.8 B	6.5 U/14.2 B	U/1180 J	79.6	170/15.4 B	U/U	U/U
Lead (ug/l)[a]	U/U	U/U	1.7 B/3	U/U	U/2.7	1.2/U	3 B/3.9	U/2.1 B	U/2.3 B
Nitrate/Nitrite (mg/l)	[b]	2.67 J	1.72	2.37	[b]	5.23 J	3.8	6.01	5.58
Strontium-90 (pCi/l)	13	11	9.4 R	13	1.8	4	.89 R	2.5 J	2.4 J
Technetium-99 (pCi/l)	4.6 J	U	U	NA	4.7 J	U	U	NA	NA
Tritium (pCi/l)	620	770	1500	1700	7500	8900	11000	8700	8300
Uranium-238 (pCi/l)	.54 R	0.61	0.58	NA	1.9 R	2.3	2.2	NA	NA

Well Number	H4-47					
Round Number	1	Duplicate (1)	2	3	4	Split (4)
Sample Number@	B06CP0	B06CR4	B07346	B07L40	B084Y7	B08519
Carbon-14 (pCi/l)	U	U	U	U	NA	NA
Chloroform (ug/l)	41	37	33	53	NA	NA
Chromium (ug/l)[a]	4/11.3	3.5/10.2	7.1/16.6	4.2 B/3.9 B	U/U	U/U
Iron (ug/l)[a]	U/51.2 J	U/35 J	U/220	58.4 B/ 45.2 B	U/U	U/83.1 B
Lead (ug/l)[a]	U/2.1 J	U/1.6	2.1/U	16.3/4.5	2.1 B/U	U/U
Nitrate/Nitrite (mg/l)	[b]	[b]	1.16 J	0.37	0.63	0.66
Strontium-90 (pCi/l)	U	U	U	-.11 R	U	.56 R
Technetium-99 (pCi/l)	U	U	3.6	U	NA	NA
Tritium (pCi/l)	700	620	U	410	280 J	180
Uranium-238 (pCi/l)	.33R	.33 R	0.51	0.24	NA	NA

Table 4-2 H Area Contaminant of Potential Concern Data
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Well Number	H4-48				H4-49			
Round Number	1	2	3	4	1	2	3	4
Sample Number@	B06CP3	B072D9	B07L75	B084Y9	B06CP6	B072H4	B07L80	B084Z1
Carbon-14 (pCi/l)	U	U	U	NA	NA	36 J	U	NA
Chloroform (ug/l)	NA	25	41	NA	12	24	1 J	NA
Chromium (ug/l)[a]	7.5/30.8	16.2/39.4	U/U	11.4/13.8	26.5/87.9	7.8/45.3	46.2/NA	26.6/30.1
Iron (ug/l)[a]	37.7/2750	U/1380	U/U	U/110	U/825	U/312	U	61.7 B/10.8 B
Lead (ug/l)[a]	U/U	1.6/U	12.1N*J/U	1.3 *B/U	U/1.8	2.1/U	2.1 B/NA	1.6 B/1.7 B
Nitrate/Nitrite (mg/l)	[b]	2.21 J	U	0.97	[b]	1.15 J	2.91	3.3
Strontium-90 (pCi/l)	U	U	U	U	NA	U	.18 R	U
Technetium-99 (pCi/l)	U	U	U	NA	NA	U	U	NA
Tritium (pCi/l)	900	1600	430	900	NA	3000	11000	5300
Uranium-238 (pCi/l)	.49 R	0.8	0.31	NA	NA	0.96	2	NA

Well Number	H5-1				H6-1				
Round Number	1	2	3	4	1	Split (1)	2	3	4
Sample Number@	B06CP9	B072K9	B07L45	B084Y1	B06CQ2	B06CQ5	B072N4	B07L50	B08729
Carbon-14 (pCi/l)	66 R	U	U	NA	12	27 R	U	U	NA
Chloroform (ug/l)	U	U	1 J	NA	11	11	12	11	NA
Chromium (ug/l)[a]	44.8/127	66.3/74.9	72.2/NA	71/99.9	29.1/41.8	35/47.8	24.7/42	43.5/45.6	39.7/37.8
Iron (ug/l)[a]	35.7/2070	U/33.2	U	6 B/173	U/329 J	180/U	U/351	49 B/18.7 B	27.2 B/U
Lead (ug/l)[a]	U/5.1	2.3/U	2 B/NA	U/1.8B	U/2.3 J	U/U	12.1 R/6.8 R	2 B/2.4 B	3.7 M*/U
Nitrate/Nitrite (mg/l)	[b]	6.32 J	4.82	6.89	[b]	[b]	6.9 J	5.51	5.93
Strontium-90 (pCi/l)	.5 R	U	1.4 R	U	1.5	2.5 R	2.9	4.2 R	6.4
Technetium-99 (pCi/l)	.14 R	U	U	NA	-0.22	.14 R	6.5	U	NA
Tritium (pCi/l)	9900 R	9300	9100	9300	7100	5500 R	5900	6600	6700
Uranium-238 (pCi/l)	1.6 R	1.6	2.2	NA	2.1 R	14 R	1.8	1.9	NA

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Table 4-2 H Area Contaminant of Potential Concern Data
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Well Number	H3-2A	H3-2B	H4-3	H4-4	H3-1	H3-2C	H4-5	H4-6	H4-7	H4-8
Round Number	1	1	1	1	1	1	1	1	1	1
Sample Number@	B06CT5	B06CT7	B06CT9	B06CV1	B06CV3	B06CV5	B06CV7	B06CV9	B06CW1	B06CW3
Carbon-14 (pCi/l)	NA	U	U	40 J	42 R	U	35 R	56 J	21 R	U
Chloroform (ug/l)	2 J	10 J	U	1 J	U	U	U	1 J	U	U
Chromium (ug/l)[a]	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA
Iron (ug/l)[a]	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA
Lead (ug/l)[a]	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA
Nitrate/Nitrite (mg/l)	[b]	[b]	[b]	[b]	[b]	[b]	[b]	[b]	[b]	[b]
Strontium-90 (pCi/l)	NA	U	U	U	.012 R	U	.31 R	U	.032 R	U
Technetium-99 (pCi/l)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Tritium (pCi/l)	NA	2600	300 J	1700	1100 R	U	1500R	4700	3500 R	4100
Uranium-238 (pCi/l)	NA	.89 R	6.3 R	.23 R	.9 R	.45 R	1.5 R	1.8 R	1.2 R	1.5 R

Well Number	H4-9	H4-10	H4-11	H4-12A	H4-12B	H4-13	H4-14	H4-15A
Round Number	1	1	1	1	1	1	1	1
Sample Number@	B06CW5	B06CW7	B06CW9	B06CX1	B06CX3	B06CX7	B06CX9	B06CY1
Carbon-14 (pCi/l)	17 R	31 R	69 J	52	30 R	3.4 R	U	U
Chloroform (ug/l)	U	U	1 J	U	U	U	NA	U
Chromium (ug/l)[a]	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA
Iron (ug/l)[a]	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA
Lead (ug/l)[a]	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA	NA/NA
Nitrate/Nitrite (mg/l)	[b]	[b]	[b]	[b]	[b]	[b]	[b]	[b]
Strontium-90 (pCi/l)	.12 R	-.33 R	26	U	.33 R	29 R	U	U
Technetium-99 (pCi/l)	NA	NA	NA	NA	NA	NA	NA	NA
Tritium (pCi/l)	570 R	3200 R	2400	1800	740 R	1800 R	2400	2300
Uranium-238 (pCi/l)	.75 R	.24 R	1.8 R	1.9 R	1.8R	1.2 R	.95 R	.68 R

Table 4-2 H Area Contaminant of Potential Concern Data
(Page 4 of 4)

Well Number	H4-15B	H4-16	H4-17	H4-18B
Round Number	1	1	1	1
Sample Number@	B06CY3	B06CY7	B06CY9	B06CZ1
Carbon-14 (pCi/l)	14 R	23 R	29 R	U
Chloroform (ug/l)	U	U	U	U
Chromium (ug/l)[a]	NA/NA	NA/NA	NA/NA	NA/NA
Iron (ug/l)[a]	NA/NA	NA/NA	NA/NA	NA/NA
Lead (ug/l)[a]	NA/NA	NA/NA	NA/NA	NA/NA
Nitrate/Nitrite (mg/l)	[b]	[b]	[b]	[b]
Strontium-90 (pCi/l)	.22 R	3.7 R	.11 R	1.1
Technetium-99 (pCi/l)	NA	NA	NA	NA
Tritium (pCi/l)	2100 R	2300 R	4000 R	2300
Uranium-238 (pCi/l)	.9 R	.88 R	1.5 R	1.5 R

@: Sample number reported is number for the majority of the analyses, inorganic filtered samples have different sample numbers
[a]: Filtered/Unfiltered
[b]: Nitrate and Nitrite reported separately
NA: Not Available
J: Estimated Value
U: Undetected
R: Rejected Value
B(inorganics): Estimated value below contract required detection limits
*: Duplicate analysis not within control limits

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Table 4-3 600 Area Contaminant of Potential Concern Data
(Page 1 of 2)

Well Number	96-43					93-48					
Round Number	1	Duplicate (1)	2	3	4	1	2	3	Split (3)	Duplicate (3)	4
Sample Number@	B06CF8	B06CR7	B072L4	B07L25	B08503	B06CG4	B072F4	B07L35	B07L90	B07LB0	B084Z5
Antimony (ug/l)[a]	16/11	U/11 R	U/16.3	17.1 B/U	U/U	NA/NA	U/U	NA/NA	U/U	U/NA	U/U
Carbon-14 (pCi/l)	U	U	U	U	NA	NA	U	U	U	U	NA
Chloroform (ug/l)	U	U	U	1 J	NA	NA	U	1 J	U	1 J	NA
Chromium (ug/l)[a]	U/U	165/139 B	158/U	158/160	159/156	NA/NA	U/U	NA/NA	U/U	U/NA	28.4/U
Manganese (ug/l)[a]	U/U	U/U	U/U	U/2 B	U/1.2 B	NA/NA	U/U	U/NA	U/U	U/NA	U/U
Plutonium-238 (pCi/l)	0.011	U	0	U	NA	NA	U	U	NA	U	NA
Tritium (pCi/L)	11000	U	11000	NA	NA	NA	U	NA	NA	NA	NA

Well Number	96-49				97-43				
Round Number	1	3	4	Duplicate (4)	1	Split (1)	2	3	4
Sample Number@	B06CG7	B07L55	B084Z9	B08511	B06CH0	B06CR1	B072N9	B07L65	B084Z7
Antimony (ug/l)[a]	NA/NA	U/U	U/U	U/U	NA\NA	NA/NA	NA/NA	U/U	U/U
Carbon-14 (pCi/l)	NA	U	NA	NA	NA	NA	NA	U	NA
Chloroform (ug/l)	NA	1 J	NA	NA	NA	NA	NA	1 J	NA
Chromium (ug/l)[a]	NA/NA	46.5/51.3	42.2/46	42.8/41.7	NA\NA	NA/NA	NA/NA	162/166	162/166
Manganese (ug/l)[a]	NA/NA	U/2.3 B	U/U	U/U	NA/NA	NA/NA	NA/NA	U/U	U/U
Plutonium-238 (pCi/l)	NA	U	NA	NA	NA	NA	NA	U	NA
Tritium (pCi/L)	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table 4-3 600 Area Contaminant of Potential Concern Data
(Page 2 of 2)

Well Number	97-51A				98-49 A	91-46			
Round Number	1	2	3	4	1	1	2	3	4
Sample Number@	B06CH3	B073Q7	B07L60	B08501	BO6CH6	B06CG1	B072H9	B07KZ5	B084Z3
Antimony (ug/l)[a]	NA/NA	NA/NA	U/U	NA/U	NA/NA	U/U	U/U	U/U	U/U
Carbon-14 (pCi/l)	NA	NA	U	NA	NA	U	U	U	NA
Chloroform (ug/l)	NA	NA	U	NA	NA	U	U	1 J	NA
Chromium (ug/l)[a]	NA/NA	NA/NA	62.2/68.7	72.7/58.7	NA/NA	U/U	U/U	NA/14.1	16.1/8.8 B
Manganese (ug/l)[a]	NA/NA	280/NA	U/1.2 B	U/2.5 B	NA/NA	U/U	U/U	U/U	2.3 B/4.1 B
Plutonium-238 (pCi/l)	NA	NA	U	NA	NA	U	U	U	NA
Tritium (pCi/L)	NA	U	NA	NA	NA	U	U	NA	NA

@ : Sample number reported is number for the majority of the analyses, inorganic filtered samples have different sample numbers

[a]: Filtered/Unfiltered

NA: Not Available

J: Estimated Value

U: Undetected

B(inorganics): Estimated value below contract required detection limits

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Table 4-4 Potential Chemical-Specific ARARs and TBCs
(Page 1 of 2)

Constituent	Safe Drinking Water Act				RCRA Subpart F (e)	MTCA (groundwater/ surface water) (f)	EPA Water Quality Criteria (chronic/acute) (g)	Washington Water Quality Standards (chronic/acute) (h)
	Primary MCL (a)	MCLG (b)	Secondary MCL (c)	Proposed MCL (d)				
Tritium	20,000			60,900				
Carbon-14	6,400			3,200				
Strontium-90	8			42				
Technetium-99	2,400			3,790				
Uranium-238	320	0 (i)		14.6				
Chromium	100	100			50	80 / 810	11/16	11/16
Lead	15 (j)	0			50			(k)
Iron			300					
Nitrate	10,000	10,000						
Chloroform	100					7.17 / 283		
Bis(2 ethylhexyl) phthalate						6.25 / 6.56		

Table 4-4 Potential Chemical-Specific ARARs and TBCs
(Page 2 of 2)

NOTE: All units for radionuclides in pCi/L; all other units in ug/L.

(a) 40 CFR 141.16 (radionuclides), 40 CFR 141.61 (organics), 40 CFR 141.62 (inorganics), as amended at 56 FR 31838 July 17, 1992

(b) 40 CFR 141.50 and 51 as amended at 56 FR 31838 July 17, 1992

(c) 40 CFR 143.3 as amended at 56 FR 3597 January 30, 1991 - TBC under federal regulations, possible ARAR under MTCA

(d) 56 FR 33120 July 18, 1991 - Proposed rules - TBC

(e) 40 CFR 264.94

(f) WAC 173-340-720, Model Toxics Control Act, Groundwater Cleanup Standards, Method B and WAC 173-340-730 Surface Water Cleanup Standards, Method B

(g) EPA's "Quality Criteria for Water 1986" and EPA's "Update #2 to Quality Criteria for Water 1986" - TBCs for surface waters only

(h) WAC 173-201-047, Toxic Substances - applies to surface waters only

(i) Proposed MCLG, 56 FR 33051 July 18, 1991 - Proposed rules - TBC

(j) Action level as prescribed in 40 CFR 141.80

(k) $\leq e^{(1.273\,[\ln(\text{hardness})] - 4.705)}$ / $\leq e^{(1.273\,[\ln(\text{hardness})] - 1.460)}$

5.0 CONCLUSIONS

The LFI at the 100-HR-3 Area was conducted to determine the nature and extent of hazardous/radioactive materials present in the groundwater. The analytical results from the groundwater sampling were compared to Hanford Site background values as well as calculated risk values and groundwater potential ARARs to determine COPC.

Based on the QRA and data presented in Chapter 4, H-3, C-14, Sr-90, Cr, and nitrate have been identified as COPC for human health in the 100 D/DR Area. The risks for the occasional- and frequent-use scenarios are low to very low. Chromium has been identified as the COPC from the ecological evaluation in the 100 D/DR Area based on near river wells. Chromium poses a potential chronic or acute risk from spring concentrations. Chromium was not detected in the Columbia River samples.

The QRA and data in Chapter 4 identified H-3, C-14, Sr-90, Tc-99, U-238, chloroform, Cr, and nitrate as COPC for human health in the 100 H Area. The risks for the occasional- and frequent-use scenarios are low to very low. Chromium, Fe, and Pb were identified as COPC from the ecological evaluation based on near river well concentration. These constituents exceed the chronic LOEL. Chromium was not detected in Columbia River samples, although it was present in the springs. Iron was present in both the Columbia River and spring samples above the LOEL.

The QRA identified H-3, chloroform and Cr as COPC for human health in the 600 Area of 100-HR-3. The risks for the occasional- and frequent-use scenarios are low to very low. The 600 Area wells were not evaluated for ecological risk, since none of the wells are near the river.

The results of the LFI confirm that groundwater contamination has resulted from previous activities in the 100-HR-3 Area. No IRM is recommended based on human health concerns because no COC were identified (i.e., low risk related to the current site usage and to frequent- and occasional-use scenarios). An IRM may be necessary based on the chromium and iron concentrations in the near river wells, springs and/or the Columbia River. Identification and characterization of contaminants in the groundwater should continue through the RI/FS process. This effort should be coordinated with other 100-HR-3 Area RI/FS and decommissioning and decontamination activities. Monitoring of key groundwater contaminants should be continued until remedial actions associated with the source operable units are completed. The extent of groundwater contamination should then be reevaluated as well as the associated risk.

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APPENDIX A

Rejected Maximum Concentration Logic

100-HR-3 D-Area Rejected Maximum Concentrations and Logic

Volatiles (ug/L)

Analyte	Value	Well	Round	Logic behind rejection
1,1,2,2-Tetrochloroethane	2 J	D5-16	2	Not consistent between duplicate and rounds
4-Methyl-2-pentanone	3 J	D5-16	2	Not consistent between duplicate and rounds
Acetone	4 BJ	D2-6	3	Not consistent between duplicate and rounds
Chloroform	13	D5-16	2	Not consistent between duplicate and rounds
Methylene chloride	5 J	D8-6	1	Value less than 10X the blank result
Methylene chloride	4 J	D8-3	3	Not consistent between rounds
Methylene-chloride	4 J	D5-16	3	Not consistent between rounds
Methylene chloride	3 J	D5-19	3	Not consistent between rounds
Methylene chloride	3 J	D5-18	3	Not consistent between rounds
Methylene chloride	3 J	D5-14	3	Not consistent between rounds
Methylene chloride	3 J	D5-12	3	Not consistent between rounds
Methylene chloride	2 JB	D2-6	3	Not consistent between rounds

100-HR-3 D-Area Rejected Maximum Concentrations and Logic

Wet Chemistry and Anions (mg/L)

Analyte	Value	Well	Round	Logic behind rejection
Alkalinity	176	D5-17	2	Not consistent between rounds
Hydrazine	R*		2	Rejected value
Phosphate	0.4	D8-55	3	Not consistent between rounds
Phosphate	0.4	D8-54A	3	Not consistent between rounds
Phosphate	0.4	D8-53	3	Not consistent between rounds
Phosphate	0.4	D5-20	3	Not consistent between rounds
Phosphate	0.4	D8-3	3	Not consistent between rounds
Sulfide	R*		2	Rejected value
TOC	13.4	D2-6	3	Not consistent between duplicate and rounds
TOX	R*		2	Rejected value

*: Includes all rejected values in rounds indicated

100-HR-3 D-Area Rejected Maximum Concentrations and Logic

Radioisotopes (pCi/L)

Analyte	Value	Well	Round	Logic behind rejection
Americium-241	R*		1,2,3	Rejected value
Americium-241	-0.003	D8-53	2	Not consistent between rounds
Barium-140	R*		2	Rejected value
Beryllium-7	R*		2	Rejected value
Carbon-14	R*		1,2	Rejected value
Cerium-141	R*		2	Rejected value
Cerium-144	R*		2	Rejected value
Cesium-134	R*		2	Rejected value
Cesium-137	R*		2	Rejected value
Cobalt-58	R*		2	Rejected value
Cobalt-60	R*		2	Rejected value
Europium-152	R*		2	Rejected value
Europium-154	R*		2	Rejected value
Europium-155	R*		2	Rejected value
Iodine-131	R*		2	Rejected value
Iron-59	R*		2	Rejected value
Manganese-54	R*		2	Rejected value
Plutonium-238	R*		2	Rejected value

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100-HR-3 D-Area Rejected Maximum Concentrations and Logic

Radioisotopes (pCi/L)

Analyte	Value	Well	Round	Logic behind rejection
Plutonium-239/240	.019 J	D8-3	3	Not consistent between rounds
Plutonium-239/240	R*		2	Rejected value
Radium-226	R*		2	Rejected value
Ruthenium-103	R*		2	Rejected value
Ruthenium-106	R*		2	Rejected value
Strontium-90	41 J	D5-12	4	Not consistent between rounds
Strontium-90	R*		1,2,3	Rejected value
Technetium-99	14	D5-20	1	Not consistent between rounds
Technetium-99	7	D8-55	1	Not consistent between rounds
Technetium-99	R*		1,2,3	Rejected value
Thorium-228	R*		1,2	Rejected value
Thorium-228	37	D5-16	3	Not consistent between rounds
Thorium-228	22	D5-17	1	Not consistent between rounds
Thorium-232	R*		2	Rejected value
Uranium-233/234	R*		1,2	Rejected value
Uranium-235	R*		2	Rejected value
Uranium-235	.11 J	D5-17	3	Not consistent between rounds
Uranium-238	R*		2	Rejected value
Zinc-65	R*		2	Rejected value
Zirconium-95	R*		2	Rejectec value

* Includes all rejected values for the rounds listed

100-HR-3 D-Area Rejected Maximum Concentrations and Logic

Semi-Volitales (ug/l)

Analyte	Value	Well	Round	Logic behind rejection
Bis(2-ethylhexyl)phthalate	54	D2-6	3	Not consistent between duplicate and rounds
Bis(2-ethylhexyl)phthalate	50	D5-12	2	Not consistent between rounds
Bis(2-ethylhexyl)phthalate	33	D8-53	3	Not consistent between rounds
Bis(2-ethylhexyl)phthalate	24	D8-3	3	Not consistent between rounds
Diethylphthalate	2J	D2-6	1	Not consistent between rounds
Diethylphthalate	2 J	D5-19	2	Not consistent between rounds
Diethylphthalate	1 J	D8-3	2	Not consistent between split and rounds
Phenol	1 J	D8-3	2	Not consistent between split and rounds
Pyrene	1 J	D8-3	2	Not consistent between split and rounds

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100-HR-3 D-Area Rejected Maximum Concentrations and Logic

Pesticides (ug/l)

Analyte	Value	Well	Round	Logic behind rejection
No pesticides detected				

100-HR-3 D-Area Rejected Maximum Concentrations and Logic

Filtered Inorganics (ug/L)

Analyte	Value	Well	Round	Logic behind rejection
Aluminum	2140	D5-19	1	Not consistent with other rounds
Aluminum	1040	D5-20	1	Not consistent with other rounds
Aluminum	497	D5-18	1	Not consistent with other rounds
Aluminum	370	D5-16	1	Not consistent with other rounds
Aluminum	150	D8-3	1	Not consistent with other rounds
Aluminum	71	D5-14	1	Not consistent with other rounds
Aluminum	58	D5-14	2	Not consistent with other rounds
Aluminum	52.3	D5-17	4	Not consistent with other rounds
Aluminum	29.4	D2-6	4	Not consistent with other rounds
Aluminum	47	D2-5	1	Not consistent with other rounds
Aluminum	27	D5-15	4	Not consistent with other rounds
Aluminum	24	D8-53	1	Not consistent with other rounds
Aluminum	24	D8-54A	1	Not consistent with other rounds
Antimony	14.8	D5-15	1	Not consistent with other rounds
Antimony	14.3	D5-12	1	Not consistent with other rounds
Arsenic	2.4	D5-20	4	Not consistent with other rounds
Arsenic	4	D5-20	1	Not consistent with other rounds
Arsenic	4	D2-5	1	Not consistent with other rounds
Arsenic	6.2	D2-5	4	Not consistent with other rounds
Arsenic	3.6	D2-5	4	Not consistent with other rounds
Beryllium	0.58	D5-20	4	Not consistent with other rounds
Cadmium	1.6	D2-6	3	Not consistent with other rounds, duplicate, or split
Iron	132	D5-19	1	Not consistent with other rounds
Manganese	256	D5-18	1	Not consistent with other rounds
Mercury	0.36	D2-5	2	Not consistent with other rounds or duplicate
Mercury	0.29	D2-6	3	Not consistent with other rounds or duplicate
Mercury	0.22	D2-6	3	Not consistent with other rounds or duplicate
Mercury	0.24	D5-15	3	Not consistent with other rounds
Mercury	0.29	D2-6	3	Not consistent with other rounds, duplicate, or split
Mercury	0.22	D2-6	3	Not consistent with other rounds, duplicate, or split
Mercury	0.2	D5-13	1	Not consistent with other rounds
Mercury	0.15	D5-17	3	Not consistent with other rounds
Nickel	52	D5-13	1	Not consistent with other rounds
Nickel	16.2	D2-6	4	Not consistent with other rounds
Selenium	21	D5-19	1	Not consistent with other rounds
Selenium	7	D5-17	1	Not consistent with other rounds
Selenium	6	D2-6	3	Not consistent with other rounds, duplicate, or split
Selenium	6	D5-18	1	Not consistent with other rounds
Selenium	5.4	D2-5	3	Not consistent with other rounds
Selenium	5	D5-12	1	Not consistent with other rounds
Selenium	4	D5-12	4	Not consistent with other rounds
Selenium	4	D8-54A	2	Not consistent with other rounds
Zinc	43	D5-17	1	Not consistent with other rounds
Zinc	28	D5-19	1	Not consistent with other rounds
Zinc	22	D5-18	1	Not consistent with other rounds
Zinc	16	D5-20	1	Not consistent with other rounds
Zinc	5.3	D5-20	4	Not consistent with other rounds
Zinc	8	D5-14	1	Not consistent with other rounds

100-HR-3 Unfiltered Near River Well Rejected Maximum Concentrations and Logic

D-Area Unfiltered Inorganics (ug/L)

Analyte	Value	Well	Round	Logic behind rejection
Aluminum	1480	D5-20	1	Not consistent with other rounds
Aluminum	1060	D5-53	1	Not consistent with other rounds
Cobalt	2.8	D8-53	2	Not consistent with other rounds
Lead	4	D5-20	1	Not consistent with other rounds
Silver	3	D8-53	2	Not consistent with other rounds

H-Area Unfiltered Inorganics (ug/L)

Analyte	Value	Well	Round	Logic behind rejection
Arsenic	6 B	H4-45	1	Not consistent with other rounds
Beryllium	6 B	H6-1	1	Not consistent with other rounds or split
Cobalt	2.5 B	H4-45	2	Not consistent with other rounds
Copper	5 B	H6-1	1	Not consistent with other rounds or split
Copper	4 B	H6-1	2	Not consistent with other rounds
Copper	2 B	H4-45	2	Not consistent with other rounds

100-HR-3 H-Area Rejected Maximum Concentrations and Logic

Filtered Inorganics (ug/L)

Analyte	Value	Well	Round	Logic behind rejection
Aluminum	50.5	H4-49	4	Not consistent with other rounds
Aluminum	26	H4-49	2	Not consistent with other rounds
Aluminum	39.5	H4-45	3	Not consistent with other rounds
Aluminum	30	H4-45	2	Not consistent with other rounds
Aluminum	37.9	H6-1	4	Not consistent with other rounds
Aluminum	35	H6-1	2	Not consistent with other rounds
Aluminum	36.4	H4-47	3	Not consistent with other rounds
Aluminum	35	H4-47	2	Not consistent with other rounds
Beryllium	1	H5-1	2	Not consistent with other rounds
Beryllium	1	H4-49	2	Not consistent with other rounds
Cadmium	1.6	H4-45	3	Not consistent with other rounds
Cadmium	3.1	H6-1	2	Not consistent with other rounds
Cobalt	2.8	H4-48	4	Not consistent with other rounds
Cobalt	1.4	H4-45	3	Not consistent with other rounds
Cobalt	1.4	H4-47	3	Not consistent with other rounds
Cobalt	1.4	H6-1	3	Not consistent with other rounds
Lead	16.3	H4-47	3	Not consistent with other rounds
Lead	12	H6-1	2	Not consistent with other rounds
Lead	12.1	H4-48	3	Not consistent with other rounds
Lead	3	H4-46	3	Not consistent with other rounds
Selenium	7	H4-45	1	Not consistent with other rounds
Selenium	5	H6-1	1	Not consistent with other rounds or splits

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100-HR-3 H-Area Rejected Maximum Concentrations and Logic

Volatiles (ug/L)

Analyte	Value	Well	Round	Logic behind rejection
Acetone	53	H4-46	1	Not consistent between duplicate and rounds
Acetone	20	H4-45	3	Not consistent between rounds
Acetone	7 JN	H5-1	2	Not consistent between rounds
Benzene	2 J	H4-47	3	Not consistent between rounds
Methylene chloride	55	H4-11	1	Concentration lower than 10X the blank value
Methylene chloride	8 BJ	H4-46	3	Not consistent between rounds
Methylene chloride	7 BJ	H6-1	3	Not consistent between rounds
Methylene chloride	5 BJ	H4-45	3	Not consistent between rounds
Methylene chloride	4 J	H5-1A	3	Not consistent between rounds
Methylene chloride	4 J	H4-4	1	Concentration lower than 10X the blank value
Methylene chloride	3 J	H4-49	3	Not consistent between rounds
Methylene chloride	2 J	H4-6	1	Concentration lower than 10X the blank value
Methylene chloride	2 J	H4-15A	1	Concentration lower than 10X the blank value

100-HR-3 H-Area Rejected Maximum Concentrations and Logic

Wet Chemistry and Anions (mg/L)

Analyte	Value	Well	Round	Logic behind rejection
Hydrazine	R*		2	Rejected value
TOX	R*		2	Rejected value

*: Includes all rejected values in rounds indicated

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100-HR-3 H-Area Rejected Maximum Concentrations and Logic

Radioisotopes (pCi/L)

Analyte	Value	Well	Round	Logic behind rejection
Americium-241	.28 J	H4-45	2	Not consistent between rounds
Americium-241	R*		1	Rejected value
Barium-140	R*		1	Rejected value
Beryllium-7	R*		1	Rejected value
Cerium-141	R*		1	Rejected value
Cerium-144	R*		1	Rejected value
Cesium-134	R*		1	Rejected value
Cesium-137	R*		1	Rejected value
Cobalt-58	R*		1	Rejected value
Cobalt-60	R*		1	Rejected value
Europium-154	R*		1	Rejected value
Europium-155	R*		1	Rejected value
Europium-155	R*		1	Rejected value
Gross Alpha	R*		1,2,3	Rejected value
Iodine-131	R*		1	Rejected value
Iron-59	R*		1	Rejected value
Manganese-54	R*		1	Rejected value
Plutonium-238	R*		1	Rejected value
Plutonium-239/240	R*		1	Rejected value
Potassium-40	R*		1	Rejected value
Radium-226	18	H4-47	2	Not consistent between rounds
Radium-226	R*		1	Rejected value
Ruthenium-103	R*		1	Rejected value
Ruthenium-106	R*		1	Rejected value
Strontium-90	R*		1	Rejected value
Technetium-99	6.5	H6-1	2	Not consistent between rounds
Technetium-99	4.6 J	H4-45	1	Not consistent between rounds
Thorium-228	R*		1	Rejected value
Thorium-232	53	H6-1	1	Not cojsistent between rounds
Thorium-232	R*		1	Rejected value
Tritium	11000	H4-49	3	Not consistent between rounds
Tritium	11000	H4-46	3	Not consistent between rounds
Tritium	R*		1	Rejected value
Uranium-233/234	R*		1	Rejected value
Uranium-235	R*		1	Rejected value
Uranium-235	0.26	H6-1	3	Not consistent between rounds
Uranium-235	.15 J	H4-47	3	Not consistent between rounds
Uranium-238	R*		1	Rejected value
Zinc-65	R*		1	Rejected value
Zirconium-95	R*		1	Rejected value

* Includes all rejected values for the rounds listed

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100-HR-3 H-Area Rejected Maximum Concentrations and Logic

Semi-Volitales (ug/l)

Analyte	Value	Well	Round	Logic behind rejection
2,4-Dinitrophenol	48 J	H6-1	1	Not consistent between rounds
Bis(2-ethylhexyl)phthalate	1 J	H4-49	3	Not consistent between rounds

100-HR-3 H-Area Rejected Maximum Concentrations and Logic

Pesticides (ug/l)

Analyte	Value	Well	Round	Logic behind rejection
Alpha-BHC	.05 J	H5-1	1	Not consistent between rounds
Delta-BHC	.05 J	H5-1	1	Not consistent between rounds
Gamma-BHC (Lindane)	.05 J	H5-1	1	Not consistent between rounds
4,4'-DDE	.1 J	H5-1	1	Not consistent between rounds
4,4'-DDD	.1 J	H5-1	1	Not consistent between rounds

100-HR-3 600 Area Rejected Maximum Concentrations and Logic

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Volatiles (ug/L)

Analyte	Value	Well	Round	Logic behind rejection
1,1,1-Tricholorethane	10	91-46	1	Not consistent between rounds
	10	93-48	2	Not consistent between rounds
1,1,2,2-Tetrachloroethane	10	93-48	2	Not consistent between rounds
	10	91-46	2	Not consistent between rounds
1,1,2-Trichloroethane	10 B	93-48	2	Not consistent between rounds
1,1-Dichloroethane	10	91-46	1	Not consistent between rounds
1,1-Dichloroethene	10 B	91-46	1	Not consistent between rounds
1,2-Dichloroethane	10	91-46	1	Not consistent between rounds
1,2-Dichloroethene	10	91-46	2	Not consistent between rounds
1,2-Dichloropropane	10 B	93-48	2	Not consistent between rounds
	10 J	91-46	2	Not consistent between rounds
2-Butanone	10	91-46	1	Not consistent between rounds
2-Hexanone	10B	91-46	2	Not consistent between rounds
4-Methyl-2-pentanone	10	96-43	2	Not consistent between rounds
Acetone	6 BJ	97-43	3	Not consistent between rounds
Chloroform	1 J	91-46	3	Not consistent between rounds
	1 J	96-43	3	Not consistent between rounds
	1 J	93-48	3	Not consistent between rounds
Cis-1,3-Dichloropropene	10 J	96-43	2	Not consistent between rounds
Ethylbenzene	10	96-43	1	Not consistent between duplicate and rounds
	10	96-43	2	Not consistent between rounds
Methylenechloride	5 JB	93-48	3	Not consistent between rounds
	4 J	91-46	3	Not consistent between rounds
	4 BJ	96-43	3	Not consistent between rounds
	3 J	93-48	3	Not consistent between rounds
Tetrachloroethene	10	91-46	1	Not consistent between rounds
Toluene	1 J	96-43	1	Not consistent between duplicate and rounds
Vinyl chloride	10	96-43	1	Not consistent between rounds
	10 J	96-43	1	Not consistent between rounds
Xylenes (total)	10	96-43	1	Not consistent between duplicate and rounds
	10 B	91-46	2	Not consistent between rounds

100-HR-3 600 Area Rejected Maximum Concentrations and Logic

Wet Chemistry and Anions (mg/L)

Analyte	Value	Well	Round	Logic behind rejection
Alkalinity	134	96-43	3	Not consistent between roudsn
	120	91-46	3	Not consistent between rounds
	120	93-48	3	Not consistent between duplicate and rounds
Ammonia	0.05	91-46	3	Not consistent between rounds
	0.05	93-48	3	Not consistent between duplicate and rounds
Chemical Oxygen Demand	30	91-46	3	Not consistent between rounds
	30	93-48	3	Not consistent between duplicate and rounds
	30	96-43	3	Not consistent between rounds
Chloride	19.7	97-51A	3	Not consistent between rounds
	15.1	96-49	3	Not consistent between rounds
	9.6	97-43	3	Not consistent between rounds
Fluoride	0.6	91-46	3	Not consistent between rounds
Phosphate	0.4	91-46	3	Not consistent between rounds
	0.4	93-48	3	Not consistent between duplicate and rounds
	0.4	96-43	3	Not consistent between rounds
	0.4	96-49	3	Not consistent between rounds
	0.4	97-43	3	Not consistent between rounds
	0.4	97-51A	3	Not consistent between rounds
	0.4	93-48	2	Not consistent between rounds
	.4 B	96-43	1	Not consistent between duplicate and rounds
Sulfate	69	97-51A	3	Not consistent between rounds
	61	96-49	3	Not consistent between rounds
	54	97-43	3	Not consistent between rounds
	42	96-43	3	Not consistent between rounds
Sulfides	1	93-48	3	Not consistent between duplicate and rounds
	1	96-43	3	Not consistent between rounds

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100-HR-3 600 Area Rejected Maximum Concentrations and Logic

Filtered Inorganics (ug/L)

Analyte	Value	Well	Round	Logic behind rejection
Aluminum	29.8 B	96-43	3	Not consistent between rounds
	25.4	96-43	1	Not consistent between duplicate and rounds
Antimony	17.1 B	96-43	3	Not consistent between rounds
	16	96-43	1	Not consistent between duplicate and rounds
Arsenic	8.3 B	91-46	4	Not consistent between rounds
	7.1 B	91-46	3	Not consistent between rounds
Cadmium	1.3 B	97-43	3	Not consistent between rounds
	1.2 B	96-49	3	Not consistent between rounds
Iron	180	93-48	3	Not consistent between duplicate and rounds
	32	97-43	2	Not consistent between rounds
	30.4 B	96-49	3	Not consistent between rounds
	26.2 B	96-43	4	Not consistent between duplicate and rounds
	22.8 B	91-46	4	Not consistent between rounds
	12.1 B	97-51A	3	Not consistent between rounds
	11.6 B	96-43	3	Not consistent between rounds
Lead	3.5	91-46	3	Not consistent between rounds
	2.8 B	93-48	3	Not consistent between duplicate and rounds
	2.1 B	93-48	3	Not consistent between rounds
	1.7 BJ	91-46	1	Not consistent between rounds
Magnesium	12500	96-43	3	Not consistent between rounds
	12300	96-43	4	Not consistent between rounds
Manganese	2.3 B	91-46	4	Not consistent between rounds
Mercury	0.25	96-43	3	Not consistent between rounds
	0.25	96-49	3	Not consistent between rounds
	0.25	97-51A	3	Not consistent between rounds
	.15 B	97-43	3	Not consistent between rounds
Nickel	3	96-43	1	Not consistent between duplicate and rounds
Selenium	3.1 J	93-48	2	Not consistent between rounds
Silver	3.4 B	96-43	3	Not consistent between rounds
	3.4 B	96-49	3	Not consistent between rounds
Vanadium	16.8 B	91-46	3	Not consistent between rounds
Zinc	11.6 B	96-43	3	Not consistent between rounds
	11	91-46	1	Not consistent between rounds
	4.7 B	97-51A	3	Not consistent between rounds

100-HR-3 600 Area Rejected Maximum Concentrations and Logic

Radioisotopes (pCi/L)

Analyte	Value	Well	Round	Logic behind rejection
Chromium-51	R*		1	Rejected Value
Colbalt-60	8.6 B	96-43	1	Not consistent between duplicate and rounds
Europium-152	R*		2	Rejected Value
Europium-154	R*		2	Rejected Value
Gross Alpha	R*		3	Rejected Value
Plutonium-238	0.011	96-43	1	Not consistent between duplicate and rounds
	0	96-43	2	Not consistent between rounds
Plutonium 239/240	0	93-48	2	Not consistent between rounds
Potassium-40	270	96-43	1	Not consistent between duplicate and rounds
	190 J	93-48	2	Not consistent between rounds
Radium-226	R		2	Rejected Value
	14	96-43	2	Not consistent between rounds
Ruthenium-106	81 J	93-48	2	Not consistent between rounds
Technetium-99	R*		3	Rejected Value
Thorium-228	12 J	96-43	2	Not consistent between rounds
	R*		2	Rejected Value
Thorium-232	44	91-46	1	Not consistent between rounds

* Includes all rejected values for the rounds listed

100-HR-3 600 Area Rejected Maximum Concentrations and Logic

Semi-Volitales (ug/l)

Analyte	Value	Well	Round	Logic behind rejection
1,2,4-Trichlorobenzene	10 B	91-46	2	Not consistent between rounds
	10 B	93-48	2	Not consistent between rounds
1,2-Dichlorobenzene	10	91-46	1	Not consistent between rounds
	10	93-48	2	Not consistent between rounds
1,4-Dichlorobenzene	10 B	91-46	2	Not consistent between rounds
	10	93-48	2	Not consistent between rounds
2,4,5-Trichlorophenol	25 B	91-46	1	Not consistent between rounds
	25	93-48	2	Not consistent between rounds
2,4,6-Trichlorophenol	10	91-46	2	Not consistent between rounds
2,4-Dichlorophenol	10 B	91-46	2	Not consistent between rounds
2,4-Dimethylphenol	10	91-46	1	Not consistent between rounds
	10 B	93-48	2	Not consistent between rounds
2,4,-Dinitrophenol	25 B	93-48	2	Not consistent between rounds
2-Chloronaphthalene	10 B	93-48	2	Not consistent between rounds
2-Methylnaphthalene	10	91-46	2	Not consistent between rounds
2-Methylphenol	10 B	91-46	2	Not consistent between rounds
	10 B	93-48	2	Not consistent between rounds
2-Nitroaniline	25	91-46	2	Not consistent between rounds
2-Nitrophenol	10 B	91-46	1	Not consistent between rounds
	10	93-48	2	Not consistent between rounds
	10 B	96-43	2	Not consistent between rounds
3-Nitroaniline	25	96-43	1	Not consistent between rounds
	25	96-43	1	Not consistent between rounds
4-Bromophenylphenyl ether	10 B	96-43	1	Not consistent between duplicate and rounds
4-Chloro-3-methylphenol	10 B	91-46	1	Not consistent between rounds
	10	96-43	1	Not consistent between duplicate and rounds
4-Chloroaniline	10	91-46	2	Not consistent between rounds
	10 B	96-43	1	Not consistent between duplicate and rounds
4-Chlorophenylphenyl ether	10 B	91-46	2	Not consistent between rounds
	10	96-43	1	Not consistent between rounds
	10	96-43	1	Not consistent between rounds
4-Methylphenol	10 B	96-43	1	Not consistent between rounds
	10 B	96-43	1	Not consistent between rounds
4-Nitroaniline	25	96-43	1	Not consistent between duplicate and rounds
4-Nitrophenol	25 B	96-43	1	Not consistent between rounds
	25	96-43	1	Not consistent between rounds
Chrysene	10	96-43	1	Not consistent between duplicate and rounds
Di-n-butylphthalate	.7 J	93-48	3	Not consistent between duplicate and rounds
Dibenzofuran	10 J	93-48	2	Not consistent between rounds
Fluroanthene	10	96-43	1	Not consistent between duplicate and rounds
Hexachlorobenzene	10 J	91-46	1	Not consistent between rounds
Hexachlorocyclopentadiene	10 B	93-48	2	Not consistent between rounds
Nitrobenzene	R*		1	Rejected Value
Pentachlorophenol	25 B	96-43	1	Not consistent between duplicate and rounds
	25 B	96-43	2	Not consistent between rounds
Phenanthrene	10 B	91-46	2	Not consistent between rounds

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100-HR-3 600 Area Rejected Maximum Concentrations and Logic

Semi-Volitales (ug/l)

Analyte	Value	Well	Round	Logic behind rejection
Phenanthrene	10 B	96-43	1	Not consistent between duplicate and rounds
	10	96-43	2	Not consistent between rounds
Phenol	10	93-48	2	Not consistent between rounds
Pyrene	10	93-48	2	Not consistent between rounds

* Includes all rejected values in the rounds incated

100-HR-3 600 Area Rejected Maximum Concentrations and Logic

Pesticides (ug/l)

Analyte	Value	Well	Round	Logic behind rejection
4,4'-DDE	0.1	96-43	1	Not consistent between rounds
	0.1	96-43	1	Not consistent between rounds
4,4'-DDT	.1 B	96-43	1	Not consistent between duplicate and rounds
Aroclor-1016	1 J	96-43	1	Not consistent between duplicate and rounds
Aroclor-1221	2	96-43	1	Not consistent between duplicate and rounds
	2	96-43	2	Not consistent between rounds
	R*		1	Rejected Value
Aroclor-1232	1	96-43	1	Not consistent between duplicate and rounds
	R*		1,2	Rejected Value
Aroclor-1242	1	96-43	1	Not consistent between duplicate and rounds
Endosulfan II	0.1	96-43	1	Not consistent between duplicate and rounds
	R*		1	Rejected value
	0.1	96-43	2	Not consistent between rounds
Endrin	R*		2	Rejected value
Endrin aldehyde	R*		1	Rejected value
	0.1	96-43	1	Not consistent between duplicate and rounds
Endrin Ketone	0.1	96-43	1	Not consistent between duplicate and rounds

* Includes all rejected values for the rounds indicated