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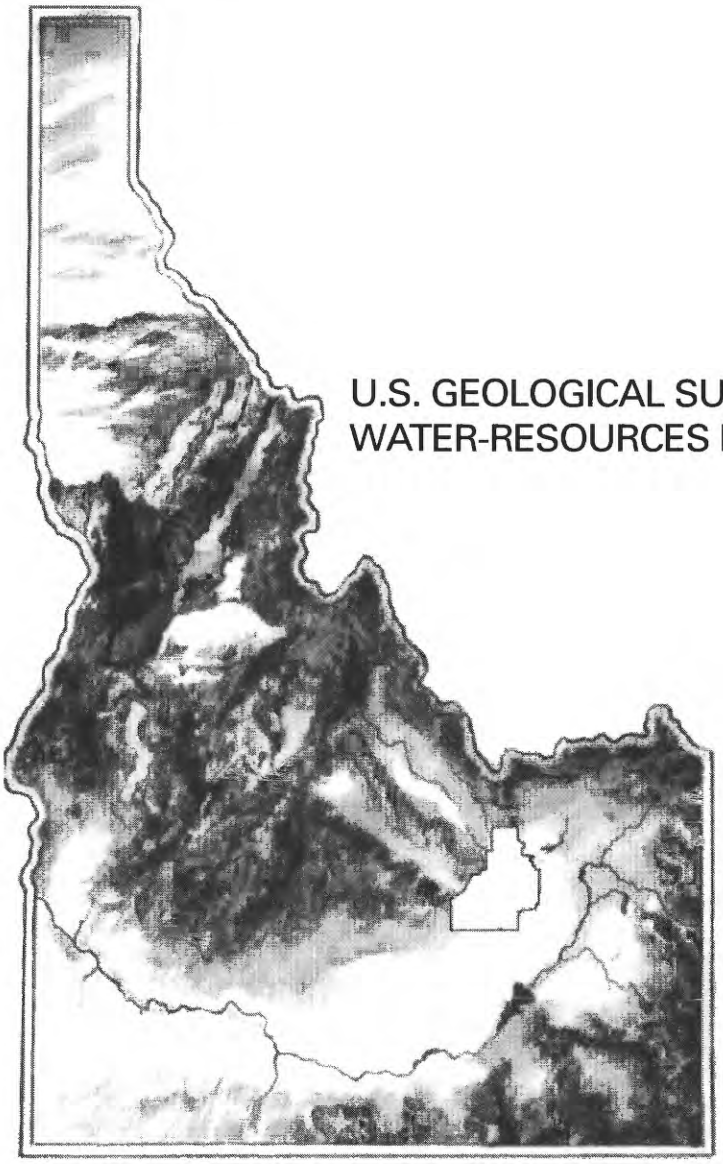
DISTRIBUTION OF SELECTED RADIOCHEMICAL AND CHEMICAL CONSTITUENTS IN PERCHED GROUND WATER, IDAHO NATIONAL ENGINEERING LABORATORY, IDAHO, 1992–95



U.S. GEOLOGICAL SURVEY
WATER-RESOURCES INVESTIGATIONS REPORT 98-4026

Prepared in cooperation with the
U.S. DEPARTMENT OF ENERGY

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DISTRIBUTION OF SELECTED RADIOCHEMICAL AND CHEMICAL CONSTITUENTS IN PERCHED GROUND WATER, IDAHO NATIONAL ENGINEERING LABORATORY, IDAHO, 1992-95

by Roy C. Bartholomay

U.S. GEOLOGICAL SURVEY
Water-Resources Investigations Report 98-4026

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Idaho Falls, Idaho
February 1998

U.S. DEPARTMENT OF THE INTERIOR

BRUCE BABBITT, Secretary

U.S. GEOLOGICAL SURVEY

Thomas J. Casadevall, Acting Director

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CONVERSION FACTORS AND ABBREVIATED UNITS

Multiply	By	To obtain
inch (in.)	25.4	millimeter
foot (ft)	.3048	meter
mile (mi)	1.609	kilometer
square foot (ft^2)	.0929	square meter
square mile (mi^2)	2.590	square kilometer
gallon (gal)	3.785	liter
pound (lb)	.4536	kilogram
curie (Ci)	$3.7x10^{10}$	becquerel
picocurie per milliliter (pCi/mL)	.037	becquerel per milliliter
picocurie per liter (pCi/L)	.037	becquerel per liter

For temperature, degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) by using the formula °F = (1.8)(°C)+32.

Sea level: In this report, "sea level" refers to the National Geodetic Vertical Datum of 1929—a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called Sea Level Datum of 1929.

Abbreviated units used in report: µg/L (microgram per liter), and mg/L (milligram per liter).

DISTRIBUTION OF SELECTED RADIOCHEMICAL AND CHEMICAL CONSTITUENTS IN PERCHED GROUND WATER, IDAHO NATIONAL ENGINEERING LABORATORY, IDAHO, 1992–95

By Roy C. Bartholomay

Abstract

Radiochemical and chemical wastes generated at facilities at the Idaho National Engineering Laboratory (INEL) have been discharged to infiltration ponds at the Test Reactor Area (TRA) and the Idaho Chemical Processing Plant (ICPP) and buried at the Radioactive Waste Management Complex (RWMC) since 1952. Disposal of waste-water to ponds and infiltration of surface water at waste-burial sites have resulted in formation of perched ground water in basalts and in sedimentary interbeds above the Snake River Plain aquifer. Perched ground water is an integral part of the pathway for waste-constituent migration to the aquifer.

The U.S. Geological Survey, in cooperation with the U.S. Department of Energy, maintains a continuous monitoring network at the INEL to determine hydrologic trends and to monitor the movement of wastewater discharged from facilities. This report presents an analysis of water-level and water-quality data collected from perched ground water at the INEL during 1992–95.

During 1992–95, tritium concentrations in water from wells completed in deep perched ground water at the TRA generally decreased or were variable. During July-October 1995, concentrations ranged from less than the reporting level to 158±5 picocuries per milliliter (pCi/mL). The maximum tritium concentration in the shallow perched ground water at the TRA during 1992–95 was 3,940±60 pCi/mL in January 1992. By October 1995, the tritium concentration in water from the same well had decreased to 22.4±0.9 pCi/mL. Tritium concentrations in water from wells at the TRA were affected by distance of the well from the radioactive-waste ponds, depth of the water below the ponds, monthly variations in the amount of tritium discharged, discontinued use of the radioactive-waste ponds, radioactive decay, and dilution from nonradioactive water.

During 1992–95, strontium-90 concentrations in water from wells completed in deep perched ground water at the TRA were variable. During October 1995, concentrations were from 6.4±0.9 to 143±5 pCi/L. Cesium-137, chromium-51, and cobalt-60 all were detected in water from a shallow well near the leaky radioactive-waste pond retention basin.

Dissolved chromium concentrations in perched ground water at the TRA during 1995 were from less than 5 to 590 micrograms per liter. The largest concentrations were in water from wells north and west of the radioactive-waste ponds. Dissolved sodium concentrations were from 7.1 to 1,200 milligrams per liter (mg/L) in 1995. Dissolved sulfate concentrations were from 18 to 3,900 mg/L. The largest concentrations of sodium and sulfate were in water from a well near the chemical-waste pond.

During 1992–95, tritium concentrations in water from wells completed in deep perched ground water near the ICPP infiltration ponds generally decreased because of decreased disposal; strontium-90 concentrations were variable. In October 1995, tritium concentrations ranged from less than the reporting level to 1.0±0.2 pCi/mL; strontium-90 concentrations were below the reporting level in all wells.

During 1992–95, concentrations of sodium, chloride, sulfate, and nitrate in water from wells completed in perched ground water near the ICPP

infiltration ponds were similar to the concentrations of the constituents in the wastewater discharged.

During 1992–94, concentrations of americium-241 and plutonium-238 were above the reporting level in one sample each from a well completed in perched ground water at the RWMC. Other radionuclides had concentrations below the reporting levels.

INTRODUCTION

The Idaho National Engineering Laboratory (INEL) encompasses about 890 mi^2 of the eastern Snake River Plain in southeastern Idaho (fig. 1). Facilities at the INEL are operated by the U.S. Department of Energy (DOE) and are used in the development of peacetime atomic-energy applications, nuclear-safety research, defense programs, and advanced energy concepts. Radiochemical and chemical wastes generated at these facilities have been contained in wastewater discharged to infiltration ponds since 1952. Radiochemical and chemical wastes also have been buried at the INEL. Disposal of wastewater to infiltration ponds and infiltration of surface water at waste-burial sites have resulted in formation of perched ground water in basalts and in sedimentary interbeds that overlie the Snake River Plain aquifer. Perched ground water is an integral part of the pathway for waste-constituent migration to the aquifer.

The DOE requires information about the mobility of dilute radiochemical and chemical-waste constituents in perched ground water at the INEL to monitor the possible movement of these constituents to the Snake River Plain aquifer. Waste-constituent mobility is, in part, determined by (1) hydraulic properties of saturated and unsaturated basalts and sedimentary interbeds, (2) the location, quantity, and method of waste disposal, (3) waste-constituent chemistry, and (4) the geochemical processes taking place in the perched ground water. This study was done by the U.S. Geological Survey (USGS) in cooperation with the DOE's Idaho Operations Office.

Purpose and Scope

In 1949, the U.S. Atomic Energy Commission, which later became the DOE, requested that the USGS describe the water resources of the area now known as the INEL. The purpose of the study was to characterize the water resources before development of nuclear-reactor testing facilities. Since 1949, the USGS has maintained a monitoring network at the INEL to determine hydrologic trends and to delineate the movement of facility-related radiochemical and chemical wastes in perched ground water and in the Snake River Plain aquifer.

The purpose of this report is to present an analysis of water-level and water-quality data collected from selected wells completed in perched ground water at selected INEL facilities during 1992–95 as part of the continuing hydrogeologic investigation at the INEL. This report describes the history of waste disposal and the distribution and concentrations of selected radiochemical and chemical constituents in perched ground water at the Test Reactor Area (TRA), Idaho Chemical Processing Plant (ICPP), and Radioactive Waste Management Complex (RWMC). Perched ground water also has been detected beneath infiltration ponds and ditches at other facilities at the INEL but is not discussed in this report because of the relatively small quantity of wastewater and associated radiochemical and chemical constituents discharged.

Acknowledgments

The DOE Radiological and Environmental Sciences Laboratory (RESL) analyzed water samples for radiochemical constituents. Technical staff at the RESL during 1992–95 were supervised by different people, most recently R. Douglas Carlson, Director. The author is grateful for technical review of the manuscript by Joanna N. Thamke and Linda M. Williams of the USGS.

Previous Investigations

Several reports that describe the geology and hydrology of the INEL are listed in the references at the end of the report; copies can be obtained at the USGS INEL Project Office.

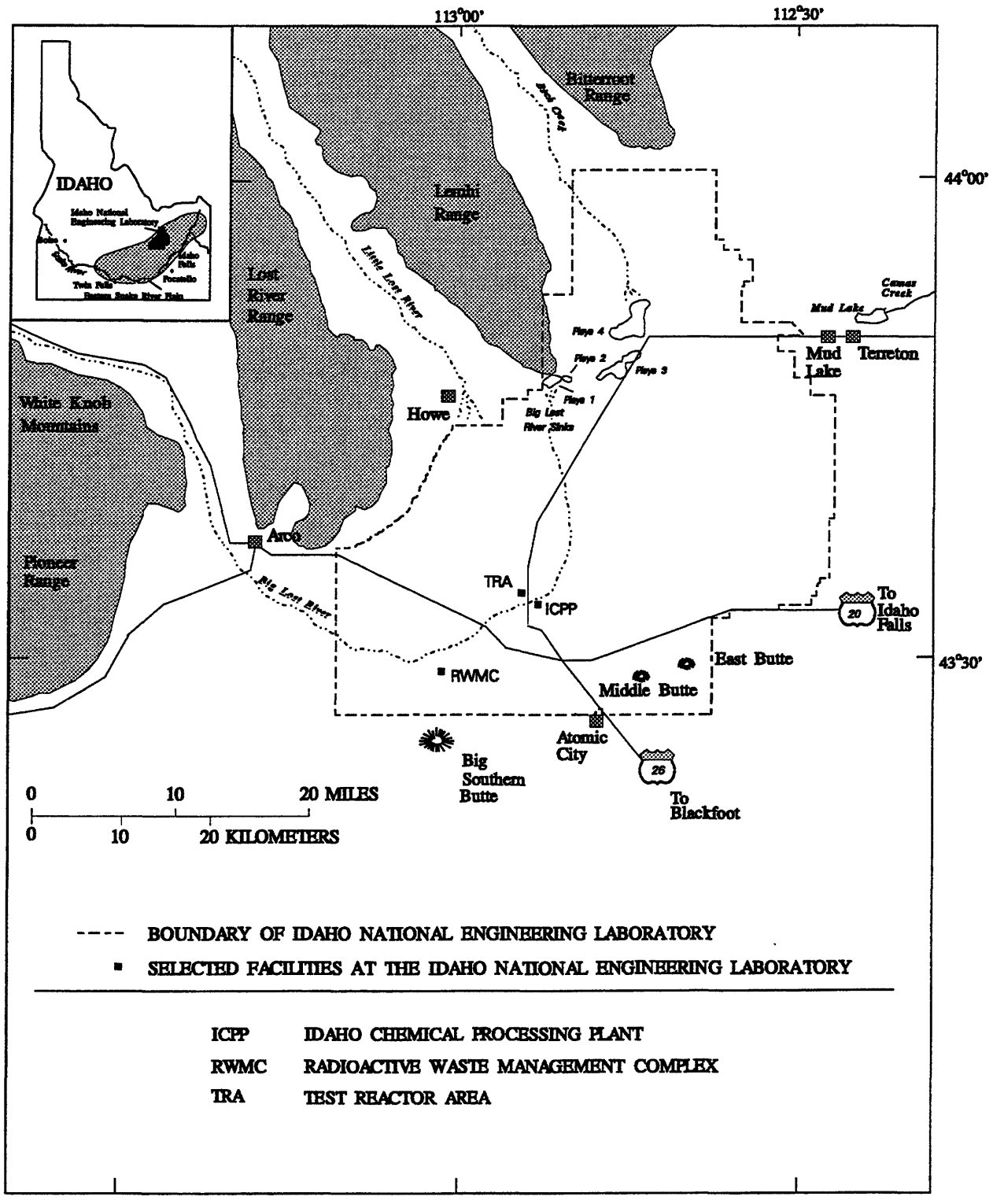

Figure 1. Location of the Idaho National Engineering Laboratory and selected facilities.

The extent of perched ground water at the TRA and the distribution of selected wastewater constituents in perched ground water are discussed in a series of annual reports describing the hydrology of the National Reactor Testing Station. The series includes a report by Barraclough, Teasdale, and Jensen (1967) and a report by Barraclough, Teasdale, and others (1967). An analysis of perched ground water at the TRA is presented in a comprehensive discussion of conditions related to the disposal of wastewater to the subsurface at the INEL (Robertson and others, 1974). Later reports present data on perched ground water at the TRA, ICPP, and RWMC: Barraclaugh and others (1981) described hydrologic conditions during 1974–78; Lewis and Jensen (1985) described hydrologic conditions during 1979–81; and Pittman and others (1988) described hydrologic conditions during 1982–85.

Hull (1989) developed a conceptual model that described migration pathways for wastewater and constituents from the radioactive-waste ponds at the TRA. Cecil and others (1991) discussed mechanisms responsible for formation of perched ground water at the TRA and ICPP and described the distribution of chemical and radiochemical constituents in perched ground water at the TRA, ICPP, and RWMC during 1986–88. Tucker and Orr (1998) described the hydrologic conditions and concentrations of selected radiochemical and chemical constituents in perched ground water during 1989–91.

Anderson and Lewis (1989) and Anderson (1991) correlated geophysical logs to describe a complex sequence of basalt flows and sedimentary interbeds in the unsaturated zone underlying the RWMC, TRA, and ICPP. This stratigraphy is the geologic framework within which perched ground water has formed. Ackerman (1991) analyzed data from 43 aquifer tests conducted for 22 wells to estimate transmissivity of basalts and sedimentary interbeds containing perched ground water beneath the TRA and ICPP.

Robertson (1977) used a three-segment numerical model to simulate flow and transport of chemical and radionuclide constituents through perched ground water at the TRA. The model included effects of convection, hydrodynamic dispersion, radioactive decay, and adsorption.

Ground-Water Monitoring Networks

Ground-water monitoring networks are maintained at the INEL to characterize the occurrence, movement, and quality of perched ground water beneath INEL facilities. These networks consist of wells from which water-level and water-quality data periodically are obtained. Data from the monitoring networks are on file at the USGS INEL Project Office.

Water-level Monitoring Network.—The INEL perched-water-level monitoring network was designed to determine the extent of perched ground water and the volume of perched water in storage. Water levels in 43 wells were monitored during 1992–95 (fig. 2). At the TRA, the network included 22 wells to monitor deep perched ground-water levels and 11 wells to monitor shallow perched ground-water levels. At the ICPP, the network included eight wells to monitor perched ground-water levels around the ICPP infiltration ponds and one well to monitor the water-level changes in deep perched ground water beneath the ICPP. Perched ground water at the RWMC was monitored in one well. Well locations and the frequency of water-level measurements (as of December 1995) are shown on figure 2.

Water-quality Monitoring Network.—The radiochemical and chemical character of perched ground water beneath INEL facilities was determined from analyses of water samples collected as part of the water-quality monitoring network to identify contaminant concentrations and define the pattern of waste migration in perched ground water and in the Snake River Plain aquifer.

The type, frequency, and depth of ground-water sampling generally depended on the information needed in a specific area. Water samples routinely were collected and analyzed for concentrations of tritium, strontium-90, cesium-137, cobalt-60, plutonium-238, the sum of plutonium-239 and plutonium-240 (undivided), americium-241, dissolved and hexavalent chromium, sodium, chloride, sulfate, nitrate, and volatile organic

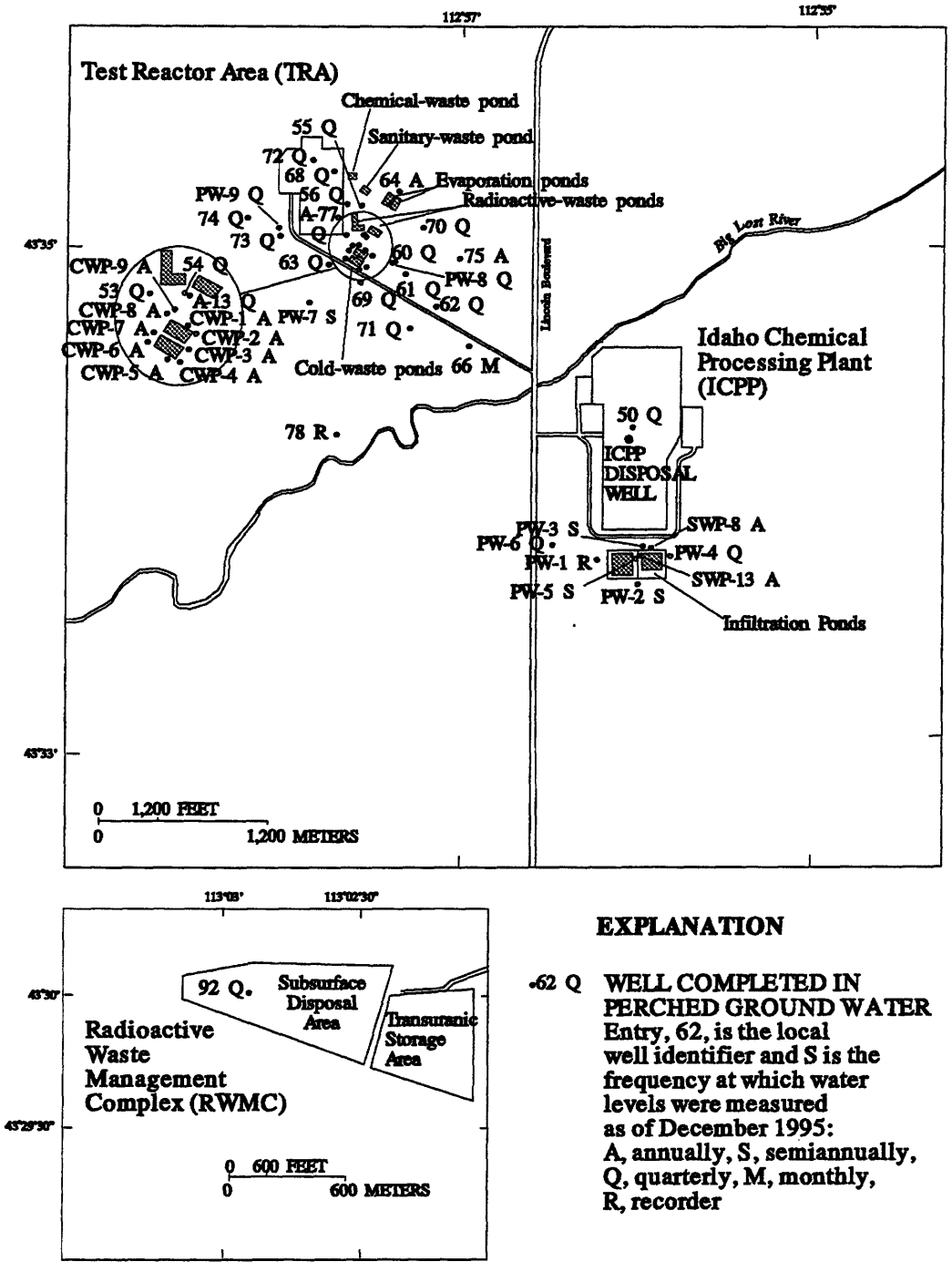

Figure 2. Location of selected wells and frequency of water-level measurements (as of December 1995) in perched ground water, Test Reactor Area, Idaho Chemical Processing Plant, and Radioactive Waste Management Complex.

compounds. Measurements of specific conductance, pH, and water temperature were made at each well. Water samples were analyzed for concentrations of radiochemical constituents at the RESL and for chemical constituents at the National Water Quality Laboratory (NWQL) in Arvada, Colo. The location of wells in the water-quality monitoring network for perched ground water beneath INEL facilities during 1992–95 and the frequency of sample collection are shown in figure 3 and table 1. The constituents for which each well is sampled for are listed in Mann (1996, Attachment 1).

Water-Quality Sampling Methods and Quality Assurance

Methods used to sample for selected constituents generally followed the guidelines established by the USGS (Goerlitz and Brown, 1972; Stevens and others, 1975; Wood, 1981; Claassen, 1982; W.L. Bradford, USGS, written commun., 1985; Wershaw and others, 1987; and Fishman and Friedman, 1989).

Water samples were collected in accordance with a quality-assurance plan for quality-of-water activities conducted by personnel at the INEL Project Office. The plan was finalized in June 1989, and revised in March 1992, and in 1996 (Mann, 1996). In general, about 10 percent of the samples collected are for quality assurance. Quality-assurance samples include blanks, equipment blanks, splits, duplicates, and replicates. Comparative studies to determine agreement between analytical results for individual water-sample pairs by laboratories involved in the INEL Project Office quality-assurance program are summarized by Wegner (1989), Williams (1996), and Williams (1997). Additional quality-assurance studies by personnel at the INEL Project Office include an evaluation of field sampling and preservation methods for strontium-90 (Cecil and others, 1989); a study comparing different pump types used for sampling purgeable organic compounds (Knobel and Mann, 1993); an analysis of tritium and strontium-90 concentrations in water from wells after purging different borehole volumes (Bartholomay, 1993), and an analysis of the effects of different preservation types on nutrient concentrations (Bartholomay and Williams, 1996).

Guidelines for Interpreting Results of Radiochemical Analyses

Concentrations of radionuclides are reported with an estimated sample standard deviation, **s**, that is obtained by propagating sources of analytical uncertainty in measurements. The following guidelines for interpreting analytical results are based on an extension of a method proposed by Currie (1984).

In the analysis for a particular radionuclide, laboratory measurements are made on a target sample and a prepared blank. Instrument signals for the sample and the blank vary randomly. Therefore, it is essential to distinguish between two key aspects of the problem of detection: (1) the instrument signal for the sample must be larger than the signal observed for the blank before the decision can be made that the radionuclide was detected; and (2) an estimation must be made of the minimum radionuclide concentration that will yield a sufficiently large observed signal before the correct decision can be made for detection or non-detection of the radionuclide. The first aspect of the problem is a qualitative decision based on an observed signal and a definite criterion for detection. The second aspect of the problem is an estimation of the detection capabilities of a given measurement process.

In the laboratory, instrument signals must exceed a critical level of 1.6**s** before the qualitative decision can be made as to whether the radionuclide was detected. At 1.6**s**, there is about a 95-percent probability that the correct conclusion—not detected—will be made. Given a large number of samples, as many as 5 percent of the samples with measured concentrations larger than or equal to 1.6**s**, which were concluded as being detected, might not contain the radionuclide. These measurements are referred to as false positives and are errors of the first kind in hypothesis testing.

Once the critical level of 1.6**s** has been defined, the minimum detectable concentration may be determined. Concentrations that equal 3**s** represent a measurement at the minimum detectable concentration. For true concentrations of 3**s** or larger, there is a 95-percent or larger probability that the

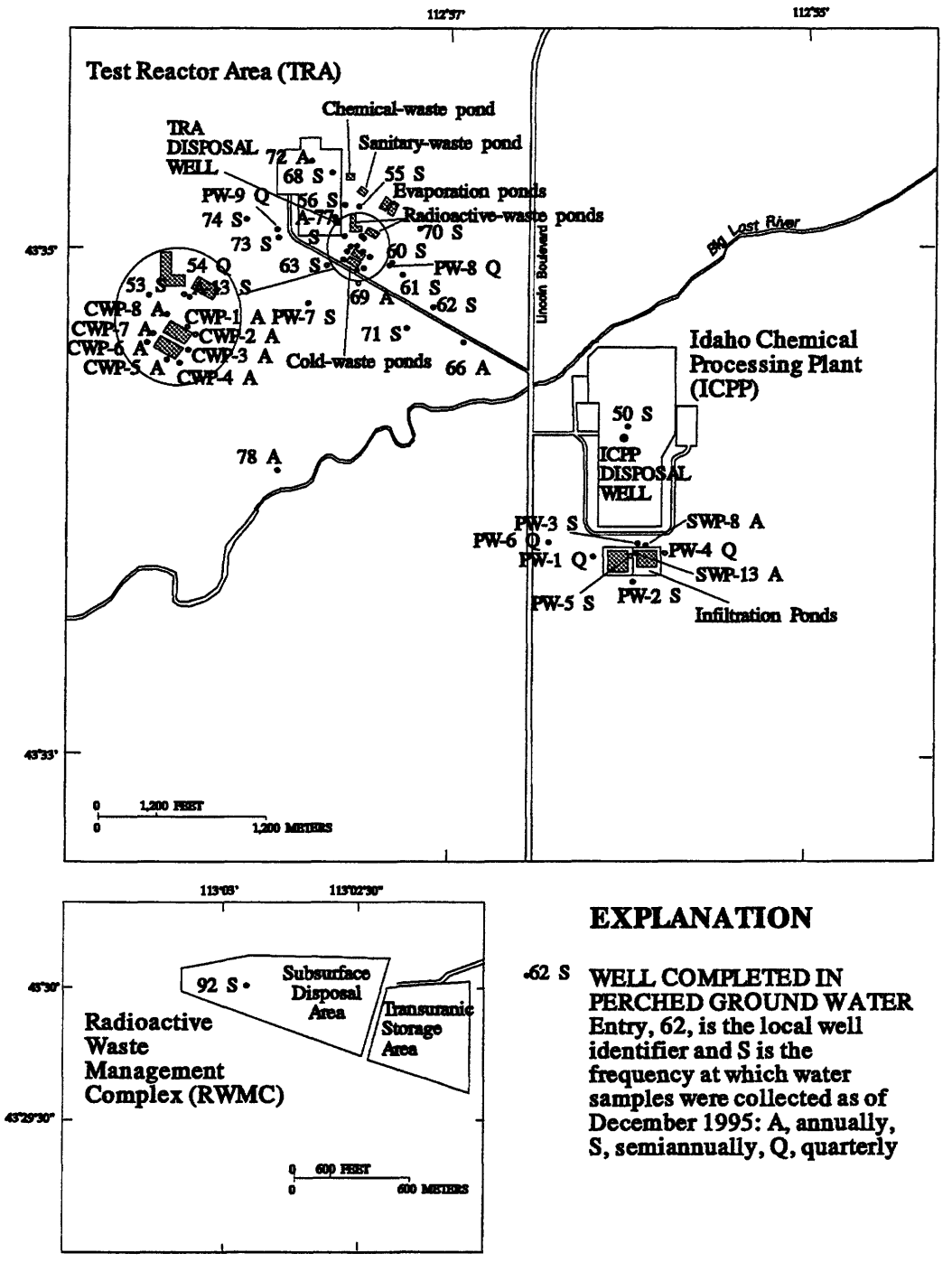

Figure 3. Location of selected wells and frequency of water-quality sample collection (as of December 1995) in perched ground water, Test Reactor Area, Idaho Chemical Processing Plant, and Radioactive Waste Management Complex.

radionuclide was detected in a sample. In a large number of samples, the conclusion—not detected— will be made in 5 percent of the samples that contain true concentrations at the minimum detectable concentration of 3s. These measurements are referred to as false negatives and are errors of the second kind in hypothesis testing.

True radionuclide concentrations between 1.6s and 3s have larger errors of the second kind. That is, there is a larger-than-5-percent probability of false negative results for samples with true concentrations between 1.6s and 3s. Although the radionuclide might have been detected, such detection may not be considered reliable; at 1.6s, the probability of a false negative is about 50 percent.

The critical level and minimum detectable concentration are based on counting statistics alone and do not include systematic or random errors inherent in laboratory procedures. The values 1.6s and 3s vary slightly with background or blank counts, with the number of gross counts for individual analyses, and for different radionuclides. In this report, radionuclide concentrations less than 3s are considered to be below a "reporting level." The critical level, minimum detectable concentration, and reporting level aid the reader in the interpretation of analytical results and do not represent absolute concentrations of radioactivity which may or may not have been detected.

Many analytical results of environmental radioactivity measurements are at or near zero. If the true concentration for a given radionuclide is zero, a given set of analytical results for that radionuclide should be distributed about zero, with an equal number of negative and positive measurements. Negative analytical results occur if the radioactivity of a water sample is less than the background radioactivity or the radioactivity of the prepared blank sample in the laboratory (American Society for Testing and Materials, 1992, p. 126; Knobel, Orr, and Cecil, 1992, p. 51).

Geohydrologic Setting

The eastern Snake River Plain is a northeast oriented structural basin about 200 mi long and 50 to 70 mi wide. The plain consists of surficial alluvial and eolian sediments and basalt outcrops underlain by a layered sequence of basalt flows and sedimentary interbeds. Individual basalt flows are from 10 to 50 ft thick, although the average thickness is from 20 to 25 ft (Mundorff and others, 1964, p. 143). The surficial sediments and sedimentary interbeds consist of sand, silt, clay, and lesser amounts of gravel. Locally, rhyolitic flows and tuffs are exposed at the land surface or exist at depth.

The top of the Snake River Plain aquifer is about 450 ft below land surface at the TRA and ICPP and about 600 ft below land surface at the RWMC. The unsaturated zone beneath these facilities consists of alluvial and eolian sediments, basalt flows, and sedimentary interbeds and is typical of the stratigraphy at the INEL. Anderson and Lewis (1989), Anderson (1991), and Anderson and Bowers (1995) described the stratigraphic sequence of the unsaturated zone and uppermost part of the Snake River Plain aquifer at selected INEL facilities. This sequence was formed by extrusion and cooling of basaltic lava followed by periods of quiescence and sedimentary deposition (Nace and others, 1975, p. 16). Vertical and horizontal fractures developed as lava flows cooled. These fractures and interflow rubble zones are primary conduits through which water is transmitted.

Locally, perched ground water has formed in the basalt and in sedimentary interbeds in response to recharge from wastewater infiltration ponds and localized infiltration of snowmelt and rain. Perched ground water also has formed from infiltration of Big Lost River water (fig. 1). Transmissivity estimates from 22 wells completed in perched ground water ranged from 1.0 to 15,000 ft^2/day (Ackerman, 1991, p. 10). Differences in the vertical hydraulic conductivity of basalt layers and sedimentary interbeds in the unsaturated zone provide mechanisms for the development of perched ground water (Cecil and others, 1991, p. 17). The vertical hydraulic conductivity of a sedimentary interbed is typically smaller than that of an overlying basalt layer. Perched ground water is closely associated with sedimentary interbeds beneath the TRA, ICPP, and RWMC. Several perched water zones exist below each facility and a

more detailed description of the perched zones can be found in Cecil and others (1991). Alterations in the baked zones between two basalt layers may contribute to reduced vertical hydraulic conductivity. Dense, unfractured basalt or sediment and chemical filling of fractures near the upper contact of a basalt layer limit the capability of the basalt to transmit water.

DISTRIBUTION OF SELECTED RADIOCHEMICAL AND CHEMICAL CONSTITUENTS IN PERCHED GROUND WATER

Radiochemical and chemical constituents in wastewater migrate to the Snake River Plain aquifer through perched ground water beneath wastewater infiltration ponds at the TRA and ICPP. Perched ground water beneath the RWMC has formed from infiltration of snowmelt and rain and contains constituents leached from buried radioactive and organic chemical wastes. The extent of this perched ground water is affected by the waste-disposal practices.

Wastewater-disposal sites at INEL facilities are the principal sources of radiochemical and chemical constituents in the Snake River Plain aquifer. These sites have included infiltration ponds and ditches, evaporation ponds, drain fields, pits, and disposal wells. During 1992–95, wastewater was discharged into infiltration and evaporation ponds and drain fields. Waste materials buried at the RWMC (fig. 1) also are a source of some constituents in ground water.

Radioactive-waste-disposal data presented in this report were obtained from a series of radioactive-waste-management information reports (Litteer and others, 1993; Taylor, 1994; French and others, 1995b; and French and others, 1996b). Chemical-waste-disposal data were obtained from a series of nonradiological-waste-management information reports (Randall and Sims, 1993; Sims and Taylor, 1994; French and others, 1995a; and French and others, 1996a). The radioactive- and chemical-waste-disposal data were collected by contractors at each facility. A detailed description of the waste-disposal history at selected facilities is presented by Bartholomay and others, 1997, p. 13-18.

Test Reactor Area

Deep and shallow perched ground water has formed at the TRA in response to wastewater disposal to the radioactive-waste, chemical-waste, cold-waste, and sanitary-waste ponds. During 1992-95, approximately 236 million gal/yr of wastewater was discharged to infiltration and evaporation ponds at the TRA. A detailed description of the factors that affect the formation of perched ground water is presented by Cecil and others (1991, p. 16-17). Selected radiochemical and inorganic chemical constituents in wastewater have been monitored in the shallow and deep perched ground water since the early 1960's.

Water samples from nine wells (A-13, A-77, CWP-1 through CWP-5 and CWP-7-8) completed in shallow perched ground water in sediments near the TRA routinely were collected and analyzed during 1992–95 (fig. 3) for selected radiochemical and chemical constituents. Water samples from 20 wells (53 through 56, 60 through 63, 66, 68 through 74, 78, and PW-7 through PW-9) completed in deep perched ground water beneath the TRA also were collected. The selection of radiochemical and chemical constituents for analyses was based on waste-disposal history at the TRA. Radiochemical constituents selected were tritium, strontium-90, and gamma analyses; chemical constituents selected were chromium, sodium, chloride, and sulfate. The distribution of these constituents is summarized in the following sections.

Tritium.—During 1952–93, approximately 10,500 Ci of tritium was in wastewater discharged to the radioactive-waste ponds at the TRA. In August 1993, two lined evaporation ponds, which prevent radioactive wastewater from entering the ground, replaced the radioactive-waste ponds (B.R. Orr, USGS, oral commun., 1996). Before 1980, tritium, which has a half-life of 12.3 years, (Walker and others, 1989, p. 20) accounted for less than 20 percent of the total radioactivity discharged to the ponds. Most other radioactive constituents discharged to the ponds have very short half-lives. After 1980, tritium accounted for more than 90

percent of the total radioactivity. During 1992–95, about 96 percent of the total radioactivity was from tritium. About 430 Ci of tritium was discharged to the radioactive-waste infiltration and evaporation ponds during 1992–95. The volume of wastewater and the curies of tritium discharged to the radioactive-waste and evaporation ponds during 1960–95 are shown in figure 4.

Well TRA A-77 is completed in shallow perched ground water in alluvium near the TRA retention basin (fig. 5), a basin into which radioactive wastewater flowed before disposal to the radioactive waste ponds. Some wastewater reportedly has leaked to the subsurface through cracks in the retention basin (U.S. DOE, Environmental Sciences Branch, Radiological and Environmental Sciences Laboratory, 1991, p. 29). The largest tritium concentration in water from well TRA A-77 during 1989–91 was 3,790±50 pCi/mL (Tucker and Orr, 1998, p.15). In 1992, the largest tritium concentration increased slightly to 3,940±60 pCi/mL (table 2). In October 1995, the tritium concentration in water from well TRA A-77 was 22.4±0.9 pCi/mL. Throughout 1986–95, the tritium concentrations were variable (fig. 6). Because of the shallow depth of well TRA A-77 and its proximity to the leaking retention basin, the variability in tritium concentrations in this well may be the result of variations in tritium disposal rates.

The largest tritium concentration in water from well TRA A-13, also completed in the shallow perched ground water, was 1.1±0.3 pCi/mL during 1986–88 (Cecil and others, 1991, p. 33); during 1989–95, tritium concentrations were less than the reporting level. The small tritium concentrations in well TRA A-13, located between the radioactive-waste ponds and the cold-waste ponds, likely are affected by the large quantity of water discharged to the cold-waste ponds.

During 1989–95, tritium was not detected in water from wells CWP-1 through CWP-8, which monitor shallow perched ground water around the cold-waste ponds at the TRA. Before 1988, tritium was not detected in water from wells CWP-1 through CWP-7. During 1986–88, a maximum tritium concentration of 0.8±0.2 pCi/mL in water from well CWP-8 was measured. The maximum tritium concentration in water from well CWP-9 (fig. 2) decreased from 6.3±0.2 pCi/mL during 1982–85 to 1.1±0.2 pCi/mL during 1986–88 (Cecil and others, 1991, p. 35). CWP-9 has not been sampled since 1988. The absence of detectable concentrations of tritium in most of the CWP wells is attributed to the large quantity of nonradioactive wastewater discharged to the cold-waste ponds since 1982 that has diluted any residual radioactive-waste pond water.

In July-October 1995, tritium concentrations were at or above the reporting levels in water from 12 wells completed in deep perched ground water at the TRA. Concentrations are shown in figure 5 and in table 2. Tritium concentrations ranged from 0.6±0.2 pCi/mL in well 62 to 158±5 pCi/mL in well PW-9. Water from four wells contained tritium concentrations from 83.4±2.9 to 158±5 pCi/mL; water from the eight other wells contained 0.6±0.2 to 24.8±1.0 pCi/mL.

Water samples collected in October 1995 from wells 73 and PW-9 contained 83.4±2.9 and 158±5 pCi/mL of tritium, respectively. Water in well 74 contained 93.1±1.7 pCi/mL in April 1992; well 74 has been dry since 1992. These wells are more than 1,500 ft west of the radioactive-waste ponds. Relatively large tritium concentrations in water from these wells indicate that the chemistry of perched ground water west of the TRA has been affected by water from the radioactive-waste ponds.

Tritium concentrations in water from 12 wells completed in the deep perched ground water were moderately constant or declined during 1992–95. During 1992–95, tritium concentrations remained near reporting levels in water from wells PW-7, 60, and 63; concentrations in wells 68, 69, and 72 were less than reporting levels (table 2). Concentrations in water from wells 61, 62, 66, 71, PW-8, and PW-9 all were above reporting levels, were largest at some time during April 1992 through October 1993, and have generally declined since October 1993. The concentration declines are attributed to the discontinuation of use of the radioactive-waste ponds.

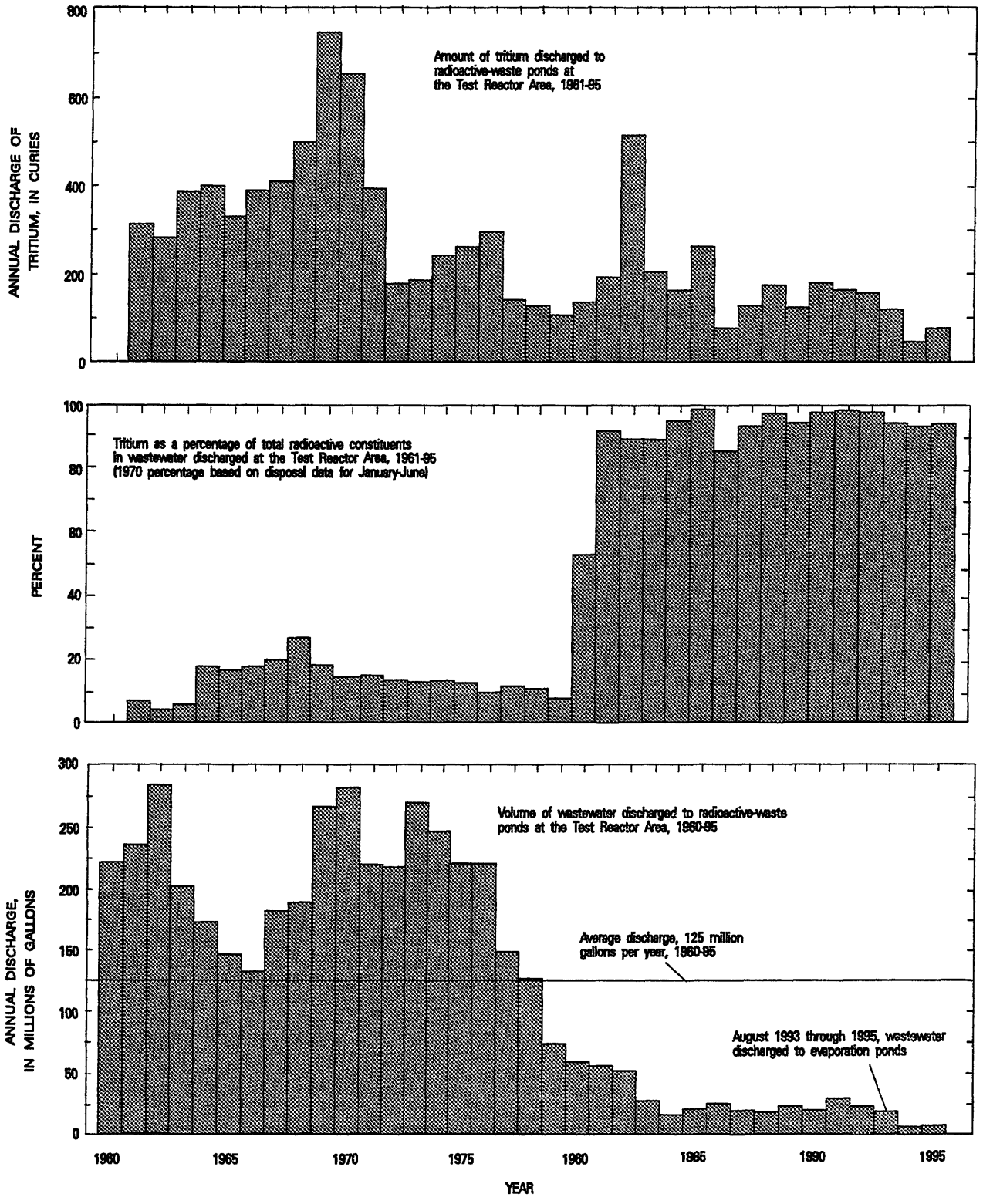

Figure 4. Amount of tritium discharged, tritium as a percentage of total radioactive constituents in wastewater discharged, and volume of wastewater discharged to the radioactive-waste infiltration and evaporation ponds, Test Reactor Area, 1960–95.

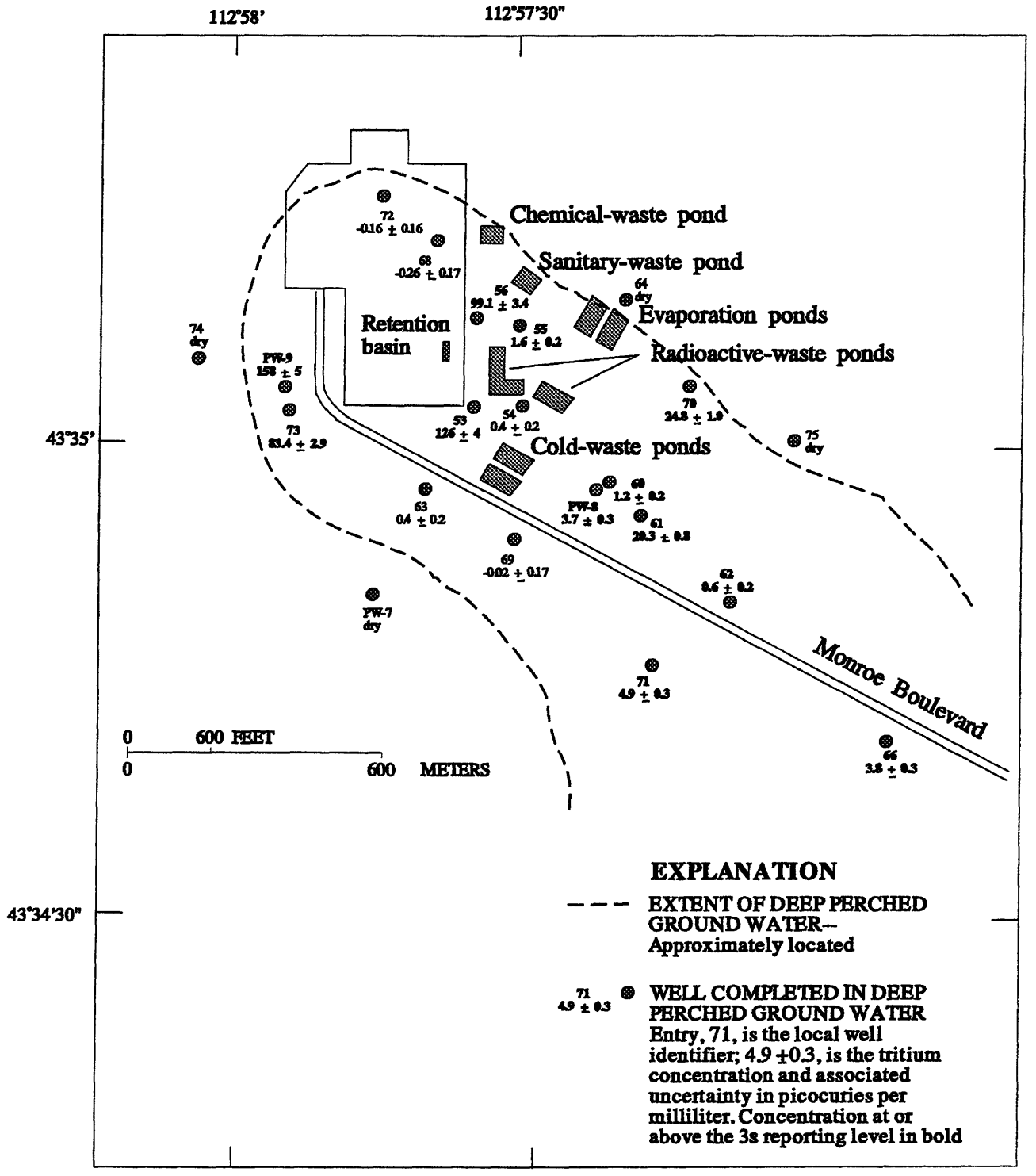

Figure 5. Tritium concentrations in deep perched ground water, Test Reactor Area, July-October, 1995.

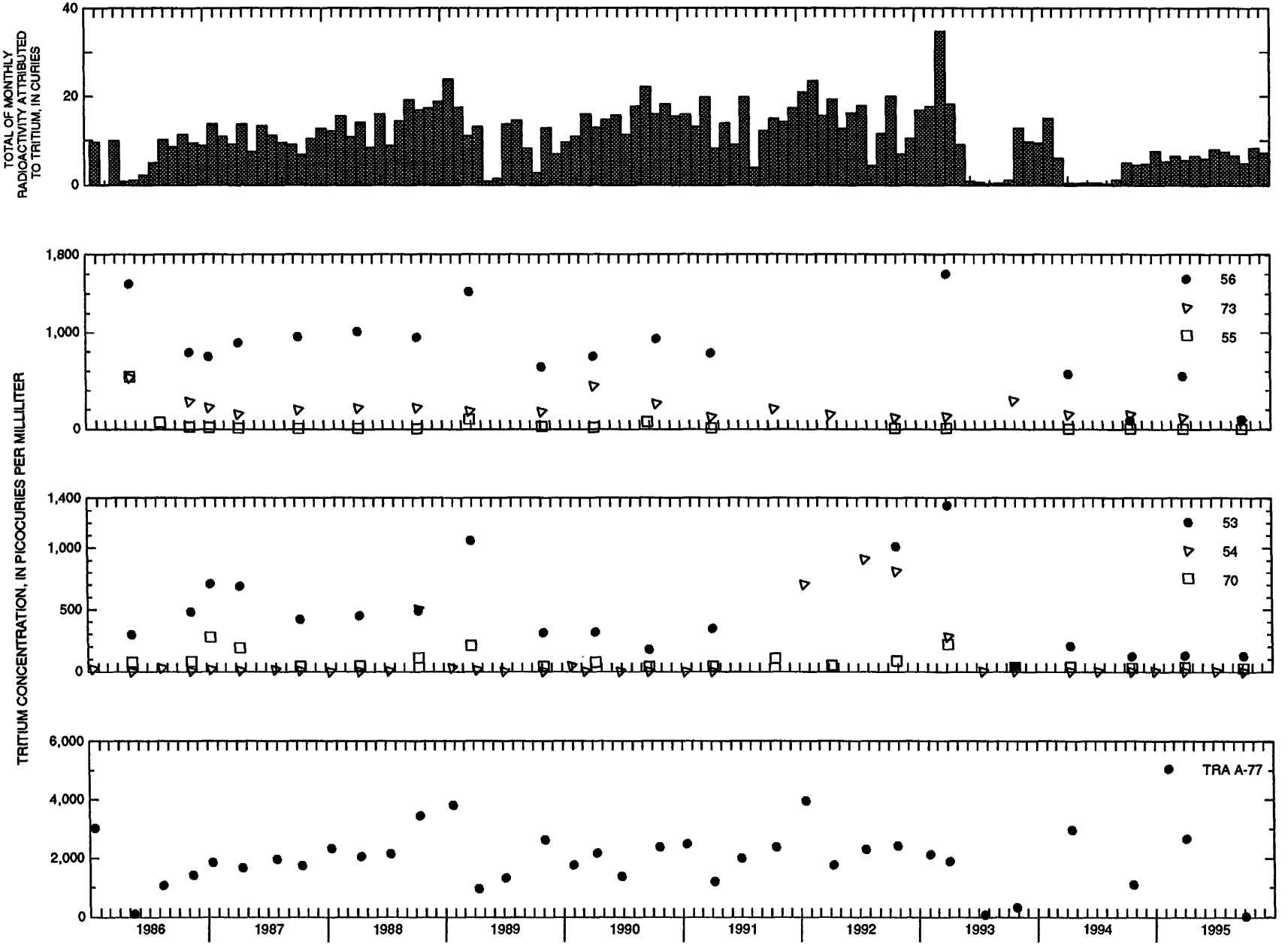

Figure 6. Monthly total of radioactivity attributed to tritium discharged to the Test Reactor Area radioactive-waste infiltration and evaporation ponds, and tritium concentrations in perched ground water from selected wells, 1986-95.

In contrast, tritium concentrations in water from wells 53, 54, 55, 56, 70, and 73 varied considerably during 1992–95. For example, the tritium concentration in water from well 53 ranged from 41.6±1.5 to 1,340±20 pCi/mL (table 2). Wells 53, 54, 55, and 56 are directly adjacent to the radioactive-waste ponds (fig. 3). Wells 70 and 73 are about 900 ft east and 1,500 ft west of the radioactive-waste ponds, respectively. Variations in tritium concentrations in water from these wells may be attributed to fluctuations in disposal rates and to mixing of water from the radioactive- and cold-waste ponds.

Hydrographs of water levels in wells 60, 63, and 73 (fig. 7) indicate that wastewater disposal to the cold-waste ponds since 1982 has hydraulically dominated perched ground-water flow to the west and south. The effect of disposal to the cold-waste ponds was attenuated in well 70 water levels, to the east. Water levels in these wells declined significantly in 1992 (fig. 7), when wastewater discharge to the cold-waste ponds was much less than in other years. Because of the effect of disposal to the cold-waste ponds on water levels, tritium concentrations in perched ground water west of the TRA are likely to decrease as nonradioactive wastewater from the cold-waste ponds displaces water derived from earlier radioactive-waste pond disposal.

Monthly tritium disposal rates and tritium concentrations in water from selected wells were plotted for selected wells during 1986–95 to define the distribution of tritium in perched ground water and to determine the effects of variations in tritium disposal rates (fig. 6). The largest monthly tritium disposal rate to the ponds was in March 1993 (fig. 6). Disposal to evaporation ponds began in August 1993. Corresponding increases in tritium concentrations in water from wells 53, 56, and 70 indicate that tritium concentrations were related, in part, to tritium disposal rates. During 1986–95, increases and decreases in tritium concentrations in water from well 73 lagged from 3 to 13 months behind increases and decreases in well 56. This time lag suggests that tritium in ground water moves from the radioactive-waste ponds to well 73 within this period.

Changes in tritium concentrations in water from well 54 did not correspond directly to monthly changes in tritium disposal. This lack of correspondence indicate that other factors, including hydraulic effects and dilution from the cold-waste ponds, affect tritium concentrations in water from this well. Large concentrations of tritium during 1992 (fig. 6) correspond to a lower rate of wastewater discharge into the cold-waste ponds during 1992. Tritium concentrations in water from wells PW-8 and 60, both east of the cold-waste ponds, also were larger in 1992 than in other years.

Several factors have affected the distribution of tritium in perched ground water at the TRA. These factors include proximity of the well to the radioactive-waste ponds, the depth of the water below the ponds, and variations in the tritium disposal rate. Since 1982, tritium concentrations also have been affected by dilution from the cold-waste ponds. The replacement of the radioactive-waste ponds with the evaporation ponds in 1993 also contributed to declines in tritium concentrations in perched ground water as did radioactive decay. Also, infiltration from the Big Lost River has diluted tritium concentrations in perched ground water southeast of the TRA.

Strontium-90.—During 1952–95, approximately 93 Ci of strontium-90 was in wastewater discharged to the radioactive-waste ponds at the TRA, an average of 2.1 Ci/yr. During 1992–95, about 0.3 Ci was discharged to the radioactive-waste and evaporation ponds. Strontium-90 has a half-life of 29.1 years (Walker and others, 1989, p. 29).

During 1992–95, strontium-90 concentrations in water from wells TRA A-77 and TRA A-13, completed in shallow perched ground water, were above the reporting levels (table 2). Concentrations in water from well TRA A-77 were from 1,090±30 pCi/L in February 1993 to 4,120±120 pCi/L in July 1993 with an anomalously high concentration of 48,000±1,500 pCi/L in October 1995 (table 2). The large strontium-90 concentration in October 1995 may be attributed to the large amount of suspended sediment in the water sample.

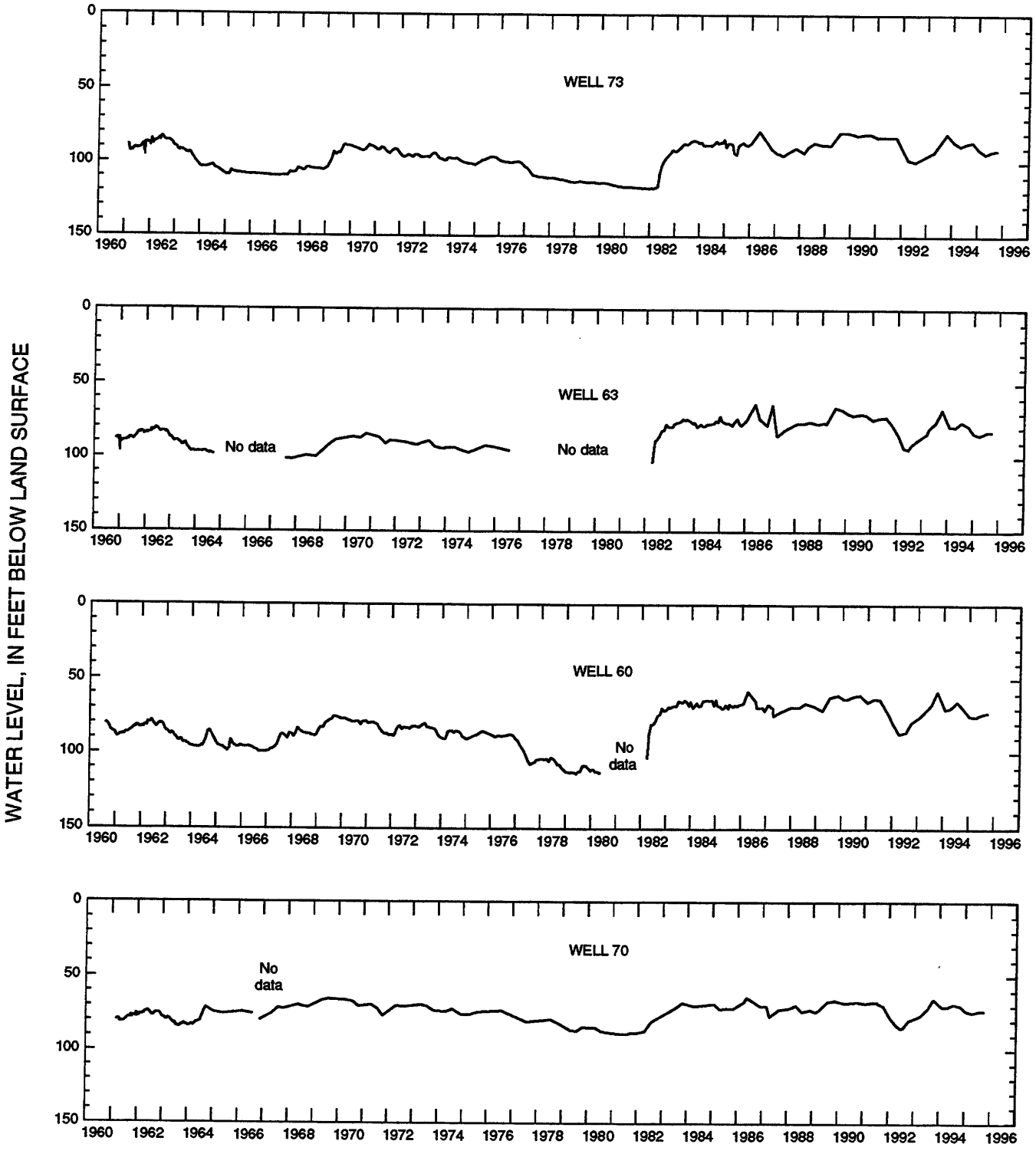

Figure 7. Water levels in selected wells, Test Reactor Area, 1960–95.

In October 1995, concentrations of strontium-90 in water from wells 53, 54, 55, 56, 60, 63, 70, and PW-8, completed in deep perched ground water at the TRA were above reporting levels (table 2 and fig. 8); concentrations were from 6.4±0.9 pCi/L in well 55 to 143±5 pCi/L in well 53. The distribution of strontium-90 concentrations in water from these wells during 1992–95 is attributed to chemical equilibrium reactions between strontium-90 sorbed to sediments beneath the radioactive-waste ponds and strontium-90 in solution in water passing through those sediments. Strontium-90 has not been detected in water from the Snake River Plain aquifer beneath the TRA (Bartholomay and others, 1997, p. 30); the absence of detectable concentrations indicates that strontium-90 probably is sorbed to sediments.

Concentrations of strontium-90 in water from well 53 steadily increased from 65 pCi/L in October 1992 to 143 pCi/L in October 1995. Water in wells 60 and 63 contained strontium-90 concentrations below reporting levels in 1992 but above the reporting levels in 1995. Fluctuations could not be correlated with disposal of strontium-90 to the ponds because only small amounts of strontium-90 were discharged to the ponds during most of 1992–95.

Cesium-137.—About 138 Ci of cesium-137 was in wastewater discharged to the radioactive-waste ponds at the TRA during 1952–95. The average disposal rate decreased from 2.0 Ci/yr during 1979–81 (Lewis and Jensen, 1985) to 0.65 Ci/yr during 1982–85 (Pittman and others, 1988, p. 35). The average disposal rate of cesium-137 during 1986–88 was 0.23 Ci/yr (Cecil and others, 1991, p. 36); the rate decreased during 1989–91 to 0.02 Ci/yr (Tucker and Orr, 1998, p. 17) and averaged 0.7 Ci/yr during 1992–95. Cesium-137 has a half-life of 30.17 yrs (Walker and others, 1989, p. 34).

Only water from shallow well TRA A-77 had a detectable concentration of cesium-137 during 1992–95. Concentrations that exceeded the reporting level ranged from 310±50 pCi/L in October 1994 to 3,680±180 pCi/L in October 1993. The general absence of detectable concentrations of cesium-137 in perched ground water at the TRA probably is due to a reduction in cesium disposal rates and to sorption of cesium-137 to minerals in sediments. The variable presence of cesium-137 in water from well TRA A-77 probably is due to the proximity of the well to the leaky retention basin and to the amount of suspended sediment in the water samples collected.

Chromium-51.—A total of 2,381 Ci of chromium-51 was in wastewater discharged to the radioactive-waste ponds during 1979–95. The average disposal rate of chromium-51 during 1979–81 was 766 Ci/yr (Pittman and others, 1988, p. 35). A total of 25.7 Ci of chromium-51 was discharged during 1986–88, an average of 8.6 Ci/yr (Cecil and others, 1991, p. 35). During 1989–91 a total of 11.6 Ci was discharged for an average of 3.9 Ci/yr (Tucker and Orr, 1998, p. 17). During 1992–95, a total of 10 Ci was discharged, an average of 2.5 Ci/yr. The half-life of chromium-51 is 27.7 days (Walker and others, 1989, p. 24).

Because of the reduction in the amount of chromium-51 discharged and the relatively short half-life, this radionuclide was not detected in water from wells completed in deep perched ground water during 1986–88 (Cecil and others, 1991, p. 35). Chromium-51 was not detected in shallow perched ground water from wells TRA A-13 and CWP-1 through CWP-9 during 1982–88. During 1989–91, chromium-51 was detected in water from wells TRA A-77, 53, and 56 (Tucker and Orr, 1998, p. 17). During 1992–95, chromium-51 was detected only in shallow well TRA A-77. Concentrations ranged from 2,700±500 to 24,500±1,300 pCi/L. The presence of chromium-51 in this well probably is due to its proximity to the leaky retention basin.

Cobalt-60.—Approximately 442 Ci of cobalt-60 was in wastewater discharged to the radioactive-waste ponds at the TRA during 1952–88. The average disposal rate of cobalt-60 decreased from 2.3 Ci/yr during 1979–81 to 1 Ci/yr during 1982–85 (Pittman and others, 1988). The average disposal rate was 2.2 Ci/yr during 1986–88, 0.15 Ci/yr during 1989–91, and about 0.8 Ci/yr during 1992–95. The half-life of cobalt-60 is 5.27 years (Walker and others, 1989, p. 25).

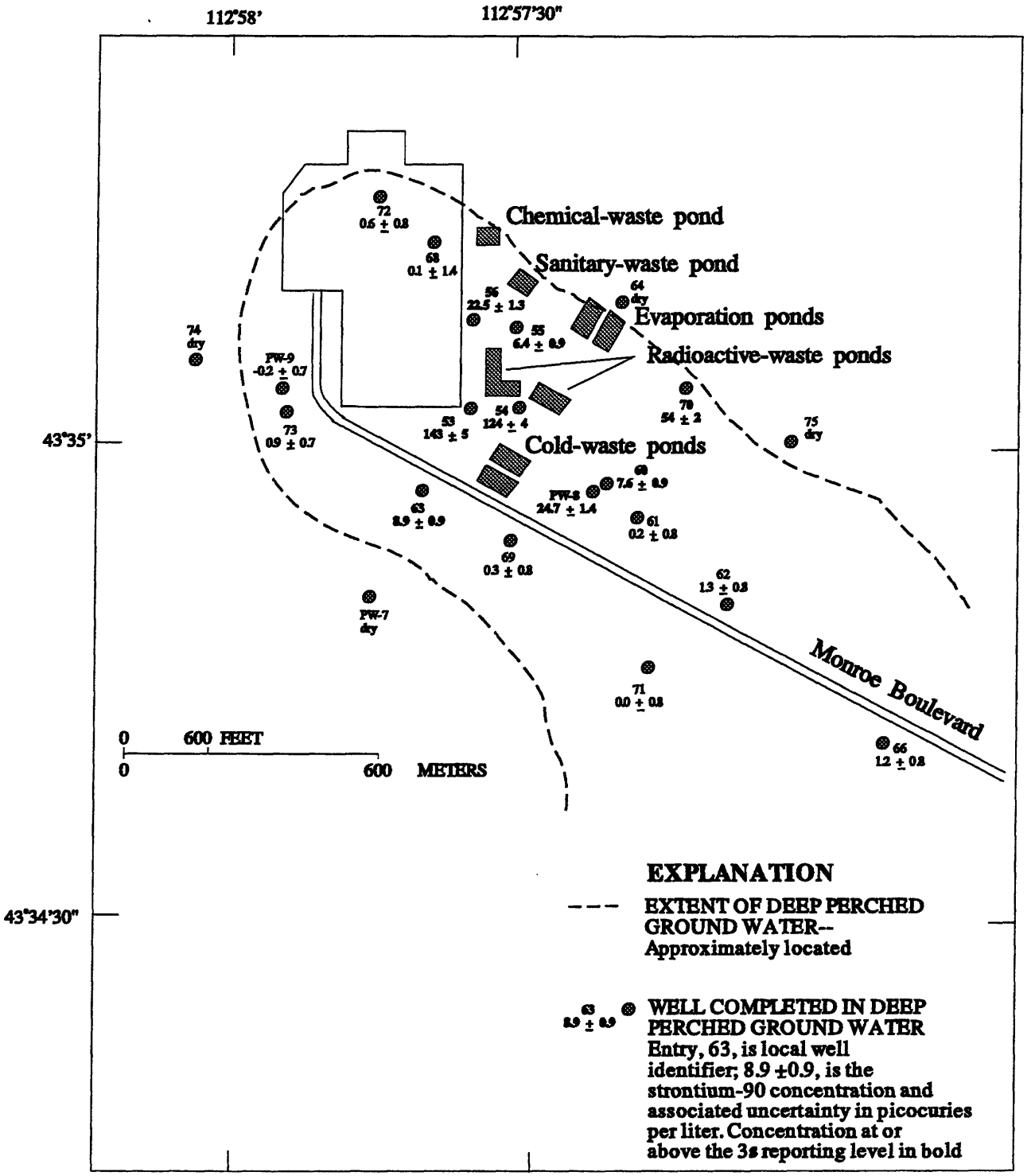

Figure 8. Strontium-90 concentrations in deep perched ground water, Test Reactor Area, July-October 1995.

During 1992–95, cobalt-60 concentrations exceeded the reporting level in water from wells TRA A-77, 53, 54, 56, and 73 (table 2). Concentrations of cobalt-60 in water from well TRA A-77 were from 1,000±80 to 110,000±3,000 pCi/L. The presence of cobalt-60 in the wells probably is due to their proximity to the radioactive-waste ponds and to the leaky retention basin.

Chromium.—An estimated 24,000 lb of nonradioactive chromium in wastewater from TRA cooling-tower operations was discharged to the radioactive-waste ponds during 1952–64 (Mann and Knobel, 1988, p. 7-10). During 1964–72, a disposal well at the TRA was used for disposal of chromium directly to the Snake River Plain aquifer. In October 1972, chromium was replaced by a polyphosphate as a corrosion inhibitor in cooling-tower operations. No disposal of chromium to the subsurface was reported after 1972.

During 1992–95, concentrations of dissolved chromium in water from shallow perched ground water ranged from less than 1 µg/L in several wells to 20 µg/L in well TRA A-77. During 1992–95, dissolved chromium was detected in water from 19 wells completed in deep perched ground water at the TRA (table 3). The maximum concentration of dissolved chromium was 590 µg/L in well 53 in October 1995. In July-October 1995, concentrations of dissolved chromium from deep perched ground water ranged from less than 5 µg/L in wells 69, 72, and 78 to 590 µg/L in well 53 (table 3 and fig. 9). The largest concentrations were in water from wells north and west of the radioactive-waste ponds (53, 56, 73, and PW-9). The distribution of chromium indicates that water from these wells contains constituents that were discharged to the radioactive-waste ponds before 1965.

In addition to dissolved chromium, samples were analyzed for hexavalent chromium because of its potential toxic effect on living organisms. During 1992–95, concentrations of dissolved hexavalent chromium in shallow perched ground water ranged from less than 1 to 2 µg/L and, in deep perched ground water, from less than 1 to 630 µg/L (table 3). In October 1995, concentrations ranged from 1 µg/L in well 68 to 630 µg/L in well 53 and was 10 to 100 percent of total dissolved chromium.

Sodium.—Approximately 672,000 lb of sodium was in wastewater discharged to the chemical-waste pond during 1992–95, an annual average of 168,000 lbs. The average sodium concentration in wastewater discharged to the chemical-waste pond was 3,000 mg/L.

During 1992–95, sodium concentrations in shallow perched ground water ranged from 1 mg/L in well TRA A-77 to 22 mg/L in well TRA A-13. Sodium concentrations in water from 19 wells completed in deep perched ground water also were determined. In July-October 1995, sodium concentrations ranged from 7.1 mg/L in well 78 to 1,200 mg/L in well 68 (table 3). The large concentration in water from well 68 is attributed to the large concentrations of sodium in wastewater discharged to the chemical-waste pond.

Chloride.—During 1992–95, approximately 4,430 lb of chloride was in wastewater discharged to the cold-waste ponds. Chloride concentrations in shallow perched ground water ranged from 0.4 mg/L in well TRA A-77 to 35 mg/L in well TRA A-13 and, in deep perched ground water, from 3.6 mg/L in well 78 to 110 mg/L in well 60 (table 3).

Sulfate.—During 1992–95, approximately 2,382,000 lb of sulfate was in wastewater discharged to the chemical-waste and cold-waste ponds at TRA, an average of 595,500 lb/yr. This represents a decline from the 920,000 lb/yr discharged during 1989–91 (Tucker and Orr, 1998). Sulfate concentrations in ground water were not monitored routinely at the INEL until 1995.

During 1995, sulfate concentrations in water from wells completed in deep perched ground water ranged from 18 mg/L in well 78 to 3,900 mg/L in well 68 (table 3). The large concentration of sulfate in water from well 68 is due to the large quantity of sulfate discharged to the chemical-waste pond. The average sulfate concentration in wastewater discharged to the chemical-waste pond was about 6,900 mg/L in 1995 and about 3,900 mg/L in October 1995 (French and others, 1996a, p. TRA-6). The maximum concentration in shallow perched ground water was 310 mg/L in well

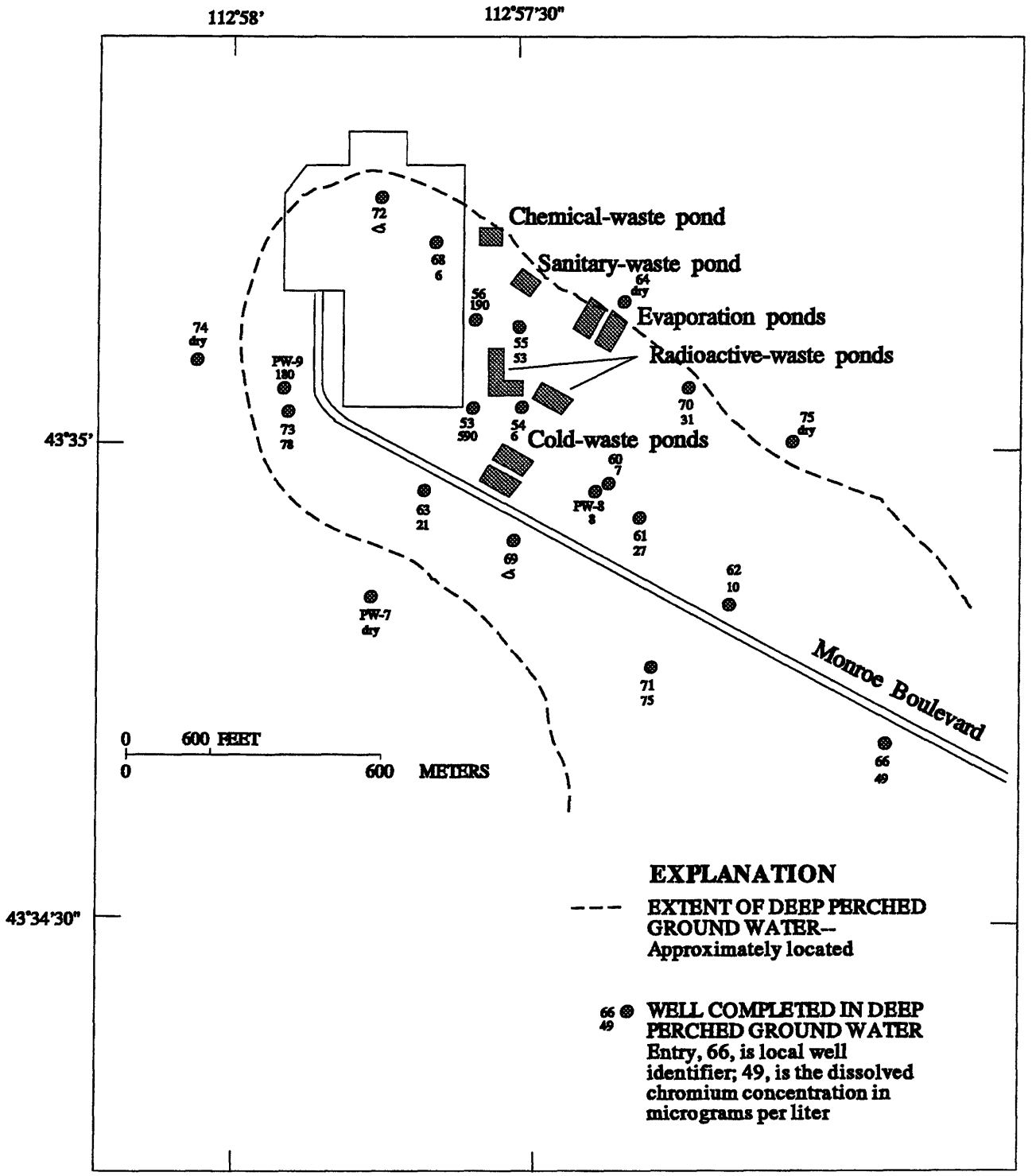

Figure 9. Dissolved chromium concentrations in deep perched ground water, Test Reactor Area, July-October 1995.

CWP-1. This concentration is attributed to sulfate disposal to nearby cold-waste ponds which, in 1995, averaged 255 mg/L. Concentrations in water from wells 53, 54, 60, 63, and PW-8, completed in deep perched ground water near the cold-waste ponds, were from 200 to 300 mg/L in 1995 (fig. 10). These large concentrations indicate that water in the wells also was influenced by discharge into the cold-waste ponds. Although similar quantities of sulfate were discharged to both the chemical-waste and cold-waste ponds, the larger volume of water discharged to the cold-waste ponds diluted the sulfate concentration in the perched water near the ponds.

Idaho Chemical Processing Plant

Two wastewater-infiltration ponds were constructed south of the ICPP in 1984 and 1985 to replace the ICPP deep disposal well (fig. 3). Wastewater infiltrating from these ponds has formed perched ground water in the basalt and in sedimentary interbeds above the eastern Snake River Plain aquifer. The volumes of wastewater discharged to the well and infiltration ponds during 1962–95 are shown in figure 11. Annual discharge to the well and ponds ranged from 260 million gal in 1963 to 665 million gal in 1993 and averaged about 430 million gal. The average annual discharge during 1992–95 was about 570 million gal. Perched ground water also has been identified in other areas beneath the ICPP and may be attributed to other infiltration ponds, leaking wastewater lines, leach fields, ruptured casing in the upper part of the ICPP deep disposal well, and landscape irrigation (Tucker and Orr, 1998).

Many auger holes were drilled in 1983 to obtain geohydrologic and engineering data at the site of the planned ICPP infiltration ponds. Two of these holes (SWP-8 and SWP-13) subsequently were used to monitor shallow perched ground water in surficial sediment at the ponds. Wells PW-1, -2, -3, -4, -5, and -6 were completed in 1986 to monitor deep perched ground water levels and water-quality changes under the ICPP disposal ponds (fig. 3). Well 50 was used to monitor deep perched ground water near the ICPP deep disposal well. All these wells were sampled quarterly or semiannually during 1992–95 (table 1). Concentrations of selected constituents in water from these wells and auger holes are summarized in the following sections.

Tritium.—Most of the radioactivity in wastewater discharged to the infiltration ponds at the ICPP has been from tritium. Approximately 960 Ci of tritium in wastewater was discharged to the ICPP infiltration ponds during 1984–88. During 1986–88, the average rate of tritium disposal was 185 Ci/yr (Cecil and others, 1991). During 1989–91, 2.7 Ci of tritium was discharged to the ponds and during 1992–95, 0.3 Ci was discharged (fig. 11).

The tritium concentration in well SWP-8, completed in shallow perched water, was 0.8±0.2 pCi/L in July 1995. Well SWP-13 was dry during 1992–95. During 1992–95, the maximum tritium concentration in water from wells completed in deep perched ground water beneath the infiltration ponds was 31.4±0.8 pCi/mL in well PW-6 (table 4). Tritium concentrations in water from wells near the infiltration ponds had declined significantly from concentrations during 1986–88, when disposal of tritium was about 185 Ci/yr. In October 1995, tritium concentrations in deep perched ground water beneath the infiltration ponds ranged from less than the 3s reporting level in PW-4 and -5 to 1.0±0.2 pCi/mL in PW-3 (table 4 and fig. 12). Well PW-6 was dry in October 1995; the tritium concentration in the sample collected in January 1995 was 24.5±1.0 pCi/mL.

During 1992–95, tritium concentrations in perched ground water in the wells closest to the ponds declined or remained less than 5 pCi/mL (table 4); declines can be attributed to the large decrease in disposal of tritium to the ponds. Fluctuations in tritium concentrations are attributed to changes in disposal from one pond to the other. Tritium concentrations in water from well PW-6 also generally declined during 1992–95.

During 1992–95, tritium concentrations in water from well 50 (fig. 12) generally declined from 82.5±1.6 pCi/mL in January 1992 to 51.1±1.8 pCi/mL in October 1995. The large tritium concentrations in water from well 50 may be due to leakage of wastewater from ruptures in the deep

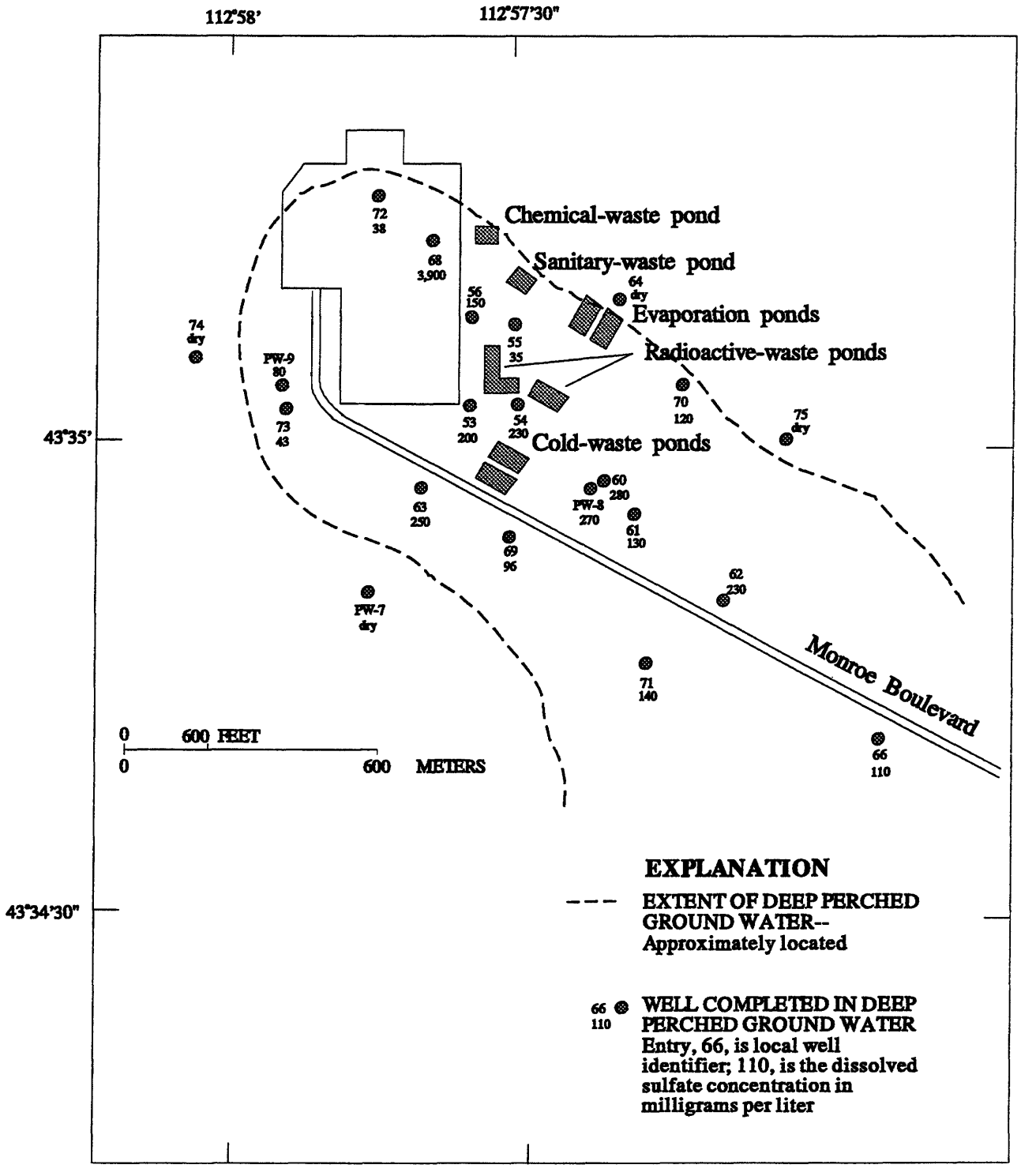

Figure 10. Dissolved sulfate concentrations in deep perched ground water, Test Reactor Area, July-October 1995.

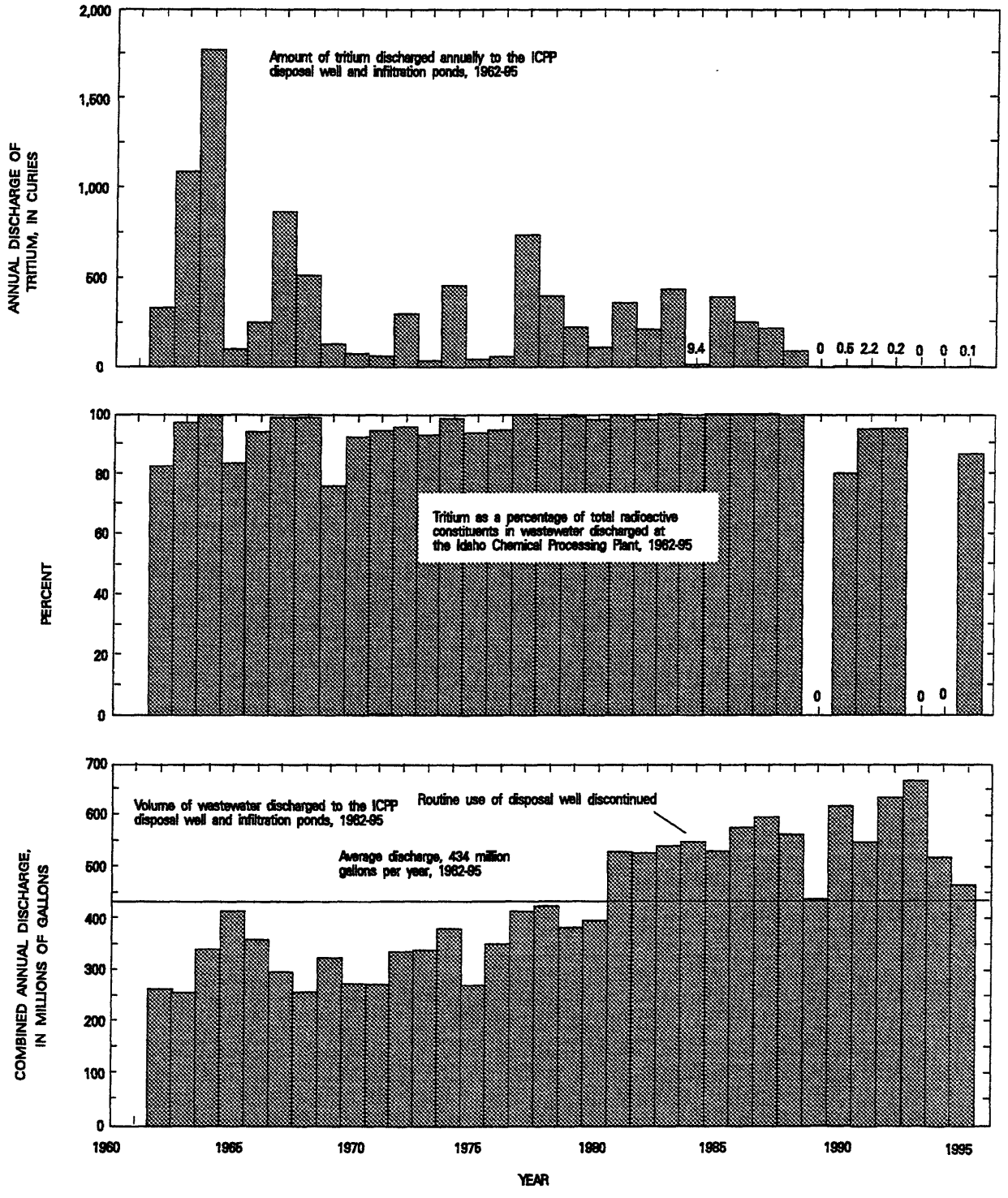

Figure 11. Amount of tritium discharged, tritium as a percentage of total radioactive constituents in wastewater discharged, and volume of wastewater discharged to the disposal well and infiltration ponds, Idaho Chemical Processing Plant, 1962–95.

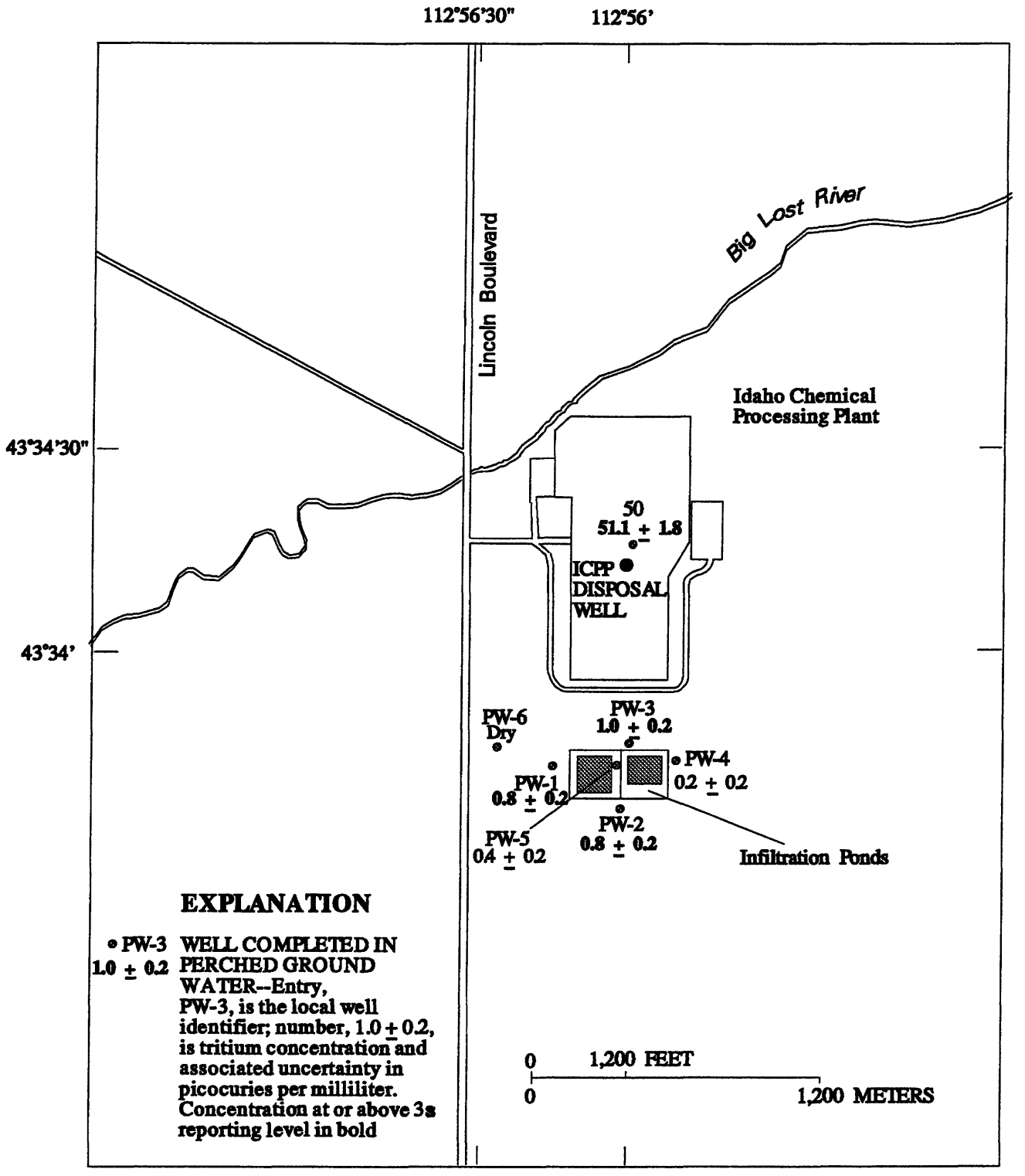

Figure 12. Tritium concentrations in deep perched ground water, Idaho Chemical Processing Plant, October 1995.

disposal well casing or to leakage from wastewater lines at the ICPP (Tucker and Orr, 1998).

Strontium-90.—Approximately 0.3 Ci of strontium-90 was in wastewater discharged to the ICPP infiltration ponds during 1984–91. Approximately 0.007 Ci was discharged during 1992–95, a decrease from the 1989–91 amount of 0.07 Ci (Tucker and Orr, 1998, p. 22). Additional sources of strontium-90 in perched ground water at the ICPP include more than 33 Ci of strontium-90 reported to have been disposed to a shallow pit (fig. 13) in 1962–63 (Robertson and others, 1974, p. 119).

The strontium-90 concentration in well SWP-8, completed in shallow perched ground water, was 5.7±1.0 pCi/L in July 1995 (table 4). During 1992–95, concentrations of strontium-90 were variable in water from all the wells completed in the deep perched ground water beneath the ICPP infiltration ponds. The maximum concentration was 17±2 pCi/L in a water sample collected from PW-1 in April 1992 (table 4). In October 1995, strontium-90 concentrations in deep perched ground water in wells closest to the ponds were below the reporting level (fig. 13).

Strontium-90 concentrations in perched ground water in wells closest to the ICPP infiltration ponds were largest in surficial sediments and decreased with distance and depth from the ponds. Concentration decreases are attributed to decreased discharge rates and sorption of strontium-90 to surficial and interbed sediments.

The largest concentrations of strontium-90 in perched ground water at the ICPP were in well 50 near the ICPP disposal well. During 1992–95, strontium-90 concentrations in water from well 50 ranged from 164±5 pCi/L in April 1995 to 239±10 pCi/L in October 1993 (table 4). Strontium-90 concentrations in water from well 50 may be due to leakage of wastewater from ruptures in the deep disposal well casing or to leakage from wastewater lines at the ICPP.

Cesium-137.—Wastewater discharged to the ICPP infiltration ponds during 1984–91 contained about 0.49 Ci of cesium-137. During 1992–95, wastewater discharged to the ponds contained about 0.005 Ci of cesium-137.

During 1992–95, concentrations of cesium-137 did not exceed the reporting level in the perched ground water in wells closest to the infiltration pond or in well 50. The absence of detectable concentrations of cesium-137 in perched ground water at the ICPP is attributed to sorption of cesium-137 to minerals in sediments.

Sodium.—Approximately 3 million lb of sodium was discharged to the ICPP infiltration ponds during 1992–95. The concentration of sodium in wastewater was nearly constant; the discharge-weighted average concentration of sodium for 1992–95 was 158 mg/L.

The shallow perched ground water from well SWP-8 contained 200 mg/L of sodium in July 1995. During 1992–95, sodium concentrations in deep perched ground water in wells closest to the infiltration ponds ranged from 90 mg/L in well PW-6 to 190 mg/L in wells PW-1 and -5 (table 5). In October 1995, sodium concentrations were 170 mg/L in all wells with water. Sodium concentrations in shallow and deep perched ground water at the ICPP infiltration ponds were similar to the sodium concentrations in the wastewater.

Sodium concentrations in water from well 50 were nearly constant during 1992–95. The concentration in October 1995 was 63 mg/L. These sodium concentrations may be due to leakage of wastewater from the ruptured deep disposal well casing or to leakage from wastewater pipelines at the ICPP.

Chloride.—Approximately 4.9 million lb of chloride was in wastewater discharged to the ICPP infiltration ponds during 1992–95. The concentration of chloride in wastewater remained relatively constant; the discharge-weighted average concentration of chloride during 1992–95 was 261 mg/L.

During 1992–95, chloride concentrations in water from well SWP-8, used for monitoring shallow perched ground water near the ponds, were from 280 to 330 mg/L. During 1992–95, chloride concentrations in deep perched ground water in

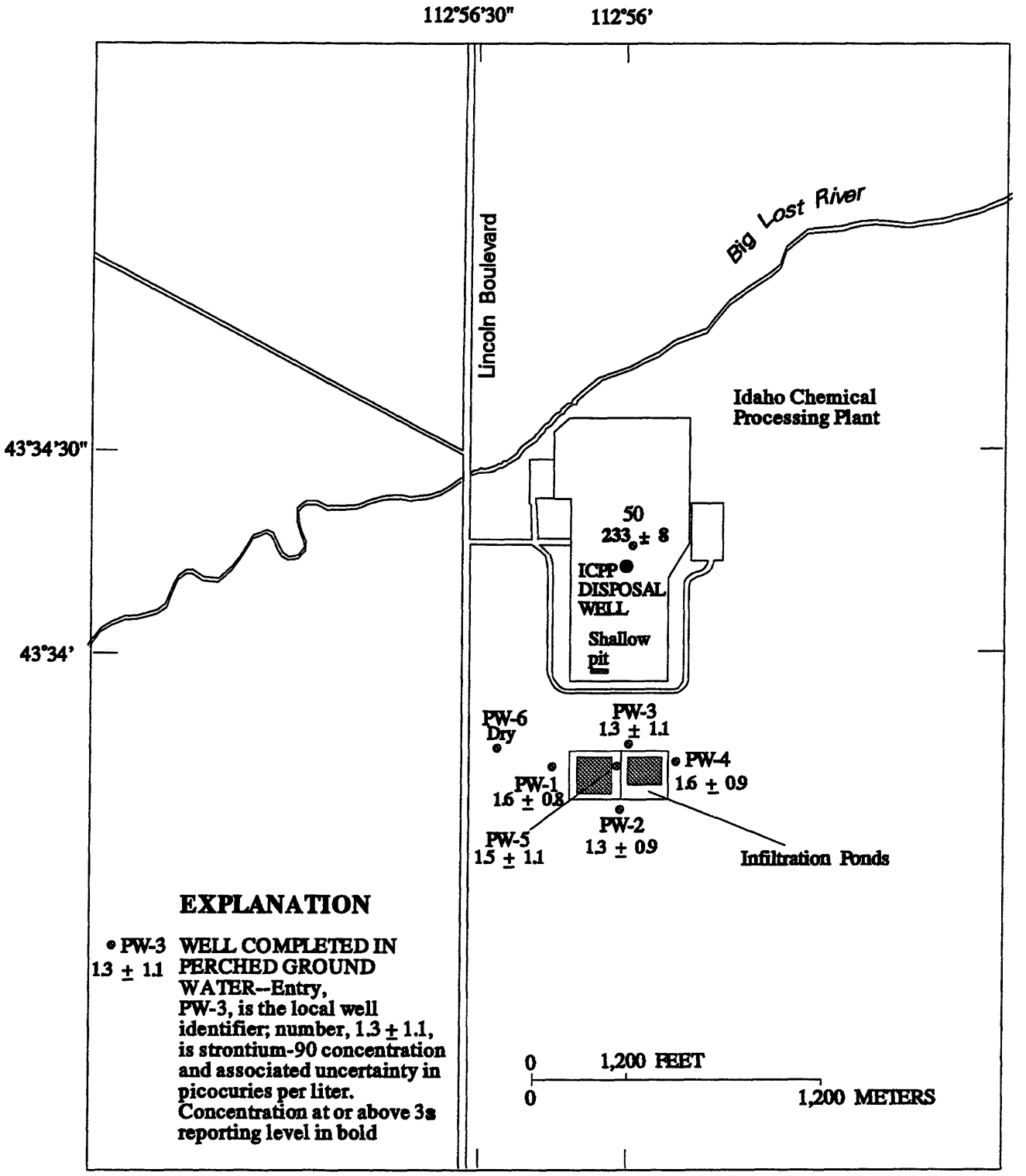

Figure 13. Strontium-90 concentrations in deep perched ground water, Idaho Chemical Processing Plant, October 1995.

wells closest to the infiltration ponds ranged from 89 mg/L in well PW-6 to 350 mg/L in well PW-5 (table 5); in October 1995, concentrations ranged from 260 to 280 mg/L (table 5 and fig. 14). The chloride concentrations in shallow and deep perched ground water at the ICPP infiltration ponds were similar to the chloride concentrations in wastewater.

During 1992–95, chloride concentrations in water from well 50 were from 60 mg/L in October 1995 to 73 mg/L in January 1992 (table 5). The chloride concentrations may be due to leakage of wastewater from the ruptured deep disposal well casing or to leakage from wastewater pipelines at the ICPP.

Sulfate.—Approximately 500,000 lb of sulfate was in wastewater discharged to the ICPP infiltration ponds during 1992–95. The concentration of sulfate in wastewater was nearly constant; the discharge-weighted average concentration in 1992–95 was 27 mg/L.

Sulfate analyses were added to the water-sampling schedule in 1995 (table 5). Sulfate concentrations in shallow perched ground water from well SWP-8 contained 47 mg/L of sulfate in July 1995, which was slightly higher than the average wastewater concentration. Sulfate concentrations in water from wells completed in the deep perched ground water closest to the ICPP infiltration ponds ranged from 25 to 28 mg/L in 1995 (table 5). These concentrations were consistent with the average concentration in the wastewater.

The concentration of sulfate in one water sample from well 50 (table 5) was 42 mg/L in October 1995. The sulfate concentration may be due to leakage of wastewater from the ruptured casing of the deep disposal well or to leakage from wastewater pipelines at the ICPP.

Nitrate.—Approximately 165,000 lb of nitrate was in wastewater discharged to the ICPP infiltration ponds during 1992–95. The concentration of nitrate (as nitrogen) in wastewater ranged from an average of 1.1 mg/L in 1995 to an average of 4.0 mg/L in 1992; the discharge-weighted average concentration during 1992–95 was 2.0 mg/L.

Nitrite plus nitrate (as nitrogen) analyses are done annually on shallow perched ground water wells at the infiltration ponds and on water from well 50. In addition, the April 1992 sample from PW-5 was analyzed for nitrite plus nitrate because of a special request. Nitrite analyses indicate that almost all the nitrite plus nitrate concentration is from nitrate.

Nitrite plus nitrate (as nitrogen) concentrations in water from three wells that tap the perched ground water beneath the infiltration ponds ranged from 1.5 mg/L in PW-5 to 5.4 mg/L in SWP-8. These concentrations were consistent with the nitrate concentrations in wastewater.

During 1992–95, nitrite plus nitrate (as nitrogen) concentrations in water from well 50 ranged from 34 mg/L in October 1992 and 1995 to 61 mg/L in October 1993 (table 5). The nitrate concentration may be due to a combination of leakage of wastewater from the ruptured deep disposal well casing and from leakage from wastewater pipelines at the ICPP.

Radioactive Waste Management Complex

Solid and liquid radioactive and chemical wastes have been buried in trenches and pits excavated in the surficial sediment at the Subsurface Disposal Area (SDA) at the RWMC (fig. 3) since 1952. Before 1970, little or no sediment was retained between the excavation bottoms and the underlying basalt. Since 1970, a layer of sediment has been retained in trenches and pits to inhibit downward migration of waste constituents. These constituents include transuranic wastes (disposed of in trenches until 1970), other radiochemical and inorganic chemical constituents, and organic compounds.

About 550 Ci of plutonium-238, 21,000 Ci of plutonium-239, 4,900 Ci of plutonium-240, 165,000 Ci of plutonium-241, and 51,000 Ci of americium-241 were buried in the SDA during 1954–70 (Barraclough and others, 1976, p. 11). An estimated 88,400 gal of organic waste was buried before 1970 (Mann and Knobel, 1987, p. 1). These buried wastes included about 24,400 gal of carbon tetrachloride, 39,000 gal of lubricating oil, and

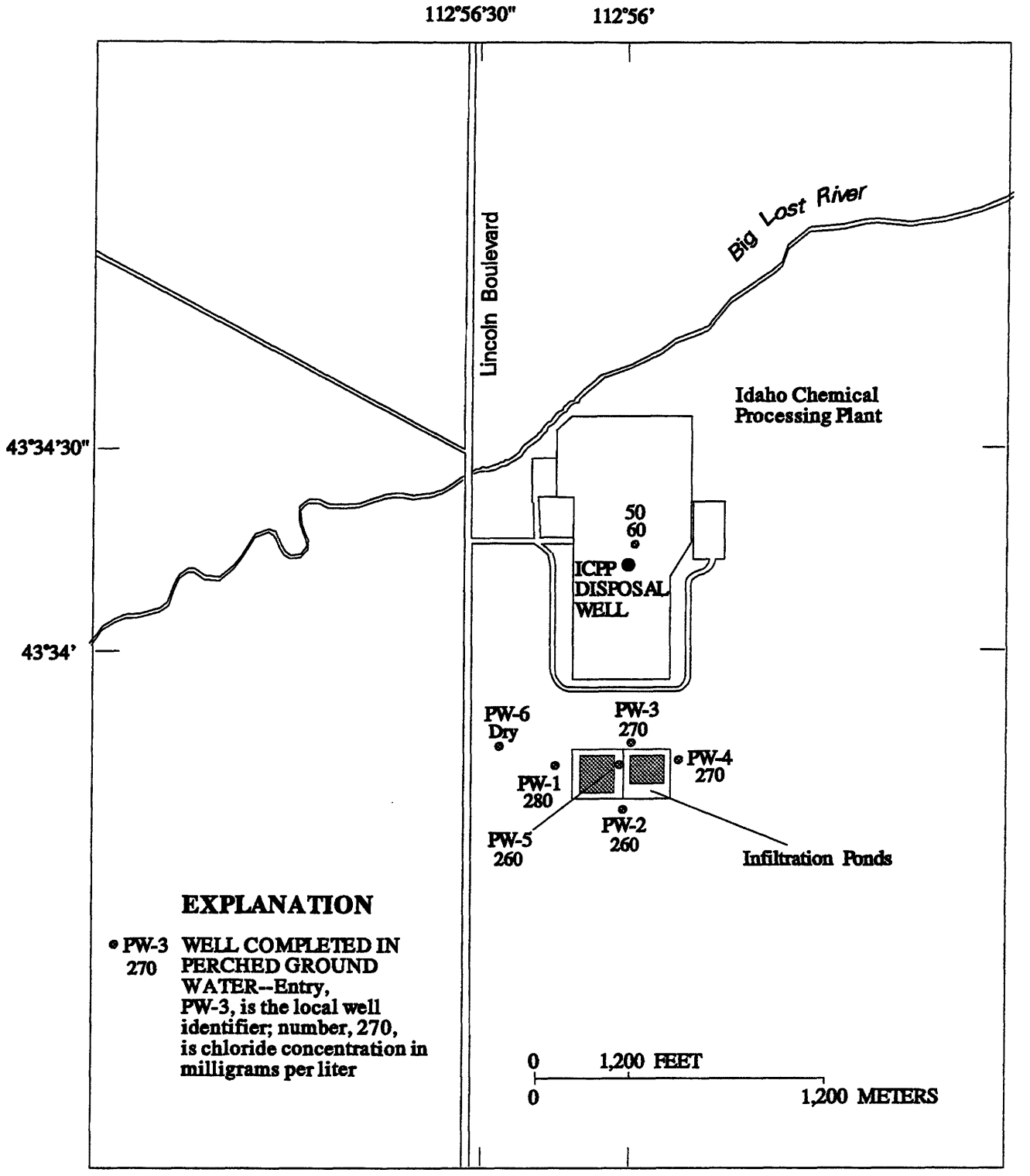

Figure 14. Dissolved chloride concentrations in deep perched ground water, Idaho Chemical Processing Plant, October 1995.

about 25,000 gal of other organic compounds, including trichloroethane, trichloroethylene, perchloroethylene, toluene, and benzene.

Perched ground water beneath the RWMC is in sedimentary interbeds in basalts and can be attributed, in part, to local infiltration of snowmelt and rain.

Well 92 (fig. 3) is in the SDA of the RWMC and is completed in a deep sedimentary interbed (Anderson and Lewis, 1989, p. 29) 214 ft below land surface. Perched water in this well has moved through overlying sediments and basalt and may contain waste constituents leached from radiochemical and organic chemical wastes buried in the SDA. Small amounts of water in well 92 frequently preclude collection of an adequate sample for analyses. Samples were collected in April and October 1992, and November 1994.

During 1992–94, two radiochemical constituents were detected in water samples from well 92. The concentration of americium-241 was above the reporting level in October 1992 and the concentration of plutonium-238 was above the reporting level in November 1994 (table 6). Concentrations of all radionuclides in all other samples collected were below the reporting level.

Chloride concentrations in water from two samples collected from well 92 were 86 and 89 mg/L during 1992–94 (table 6).

In 1987, nine purgeable organic compounds were detected in water from well 92 (Mann and Knobel, 1987, p. 16-17). In January 1990, water from well 92 contained 230 µg/L of carbon tetrachloride, 300 µg/L of chloroform, 72 µg/L of trichloroethene, 37 µg/L of 1,1,1-trichloroethane, 5.6 µg/L of 1,1-dichloroethane, and 4.5 µg/L of tetrachloroethane (J.M. Cleveland, U.S. Geological Survey, written commun., 1990). In April 1992, water from well 92 contained 2,400 µg/L of carbon tetrachloride, 1,500 µg/L of chloroform, 1,500 µg/L of trichloroethylene, 210 µg/L of 1,1,1-trichloroethane, 180 µg/L of tetrachloroethylene, 23 µg/L of 1,1-dichloroethene, 18 µg/L of 1,1-dichloroethane, 9.6 µg/L of 1,2-dichloropropane, 1.6 µg/L of 1,2-dichloroethane, 1.4 µg/L of cis-1,2-dichloroethene, 0.9 µg/L of 1,1,2-trichloroethane, 0.4 µg/L of trichlorofluoromethane, 0.3 µg/L of toluene, 0.3 µg/L of trans-1,2-dichloroethene, 0.3 µg/L of 1,1,1,2-tetrachloroethane, 0.2 µg/L of benzene, 0.2 µg/L of dichlorobromomethane, and 0.2 µg/L of dichlorodifluoromethane.

A water sample was collected from well 92 in June 1989 for analyses of 54 extractable acid and base/neutral organic compounds. None of the 54 compounds were detected at concentrations exceeding their respective reporting levels, but several tentatively identified organic compounds were detected (Knobel, Bartholomay, and others, 1992, p. 37-38).

SUMMARY

Deep and shallow perched ground water is present in basalt and sediments beneath several facilities at the INEL as a result of low-level radioactive, chemical, and sanitary wastewater discharge to infiltration ponds since 1952. During 1992–95, approximately 236 million gal/yr was discharged to infiltration and evaporation ponds at the TRA, and 570 million gal/yr was discharged to infiltration ponds at the ICPP.

About 430 Ci of tritium was discharged to the TRA radioactive-waste infiltration and evaporation ponds during 1992–95. Tritium concentrations in water from wells completed in shallow perched ground water ranged from less than the reporting level at nine wells near the cold-waste pond to 22.4±0.9 pCi/mL in well TRA A-77, near the retention basin. In 1995, tritium concentrations in water from wells completed in deep perched ground water ranged from less than the reporting levels to 158±5 pCi/mL.

Several factors have affected the distribution of tritium in perched ground water in wells at the TRA. These factors include proximity of the well to the radioactive-waste ponds, depth of water below the ponds, variations in tritium disposal rates, and radioactive decay. Tritium concentrations also were affected by dilution from the cold-waste ponds. The replacement of the radioactive-waste ponds by evaporation ponds in 1993 contributed to declines in tritium concentrations in perched ground water. Additional dilution of

tritium concentrations in perched ground water southeast of the TRA can be attributed to infiltration of Big Lost River water.

During 1952–95, approximately 93 Ci of strontium-90 was in wastewater discharged to the TRA radioactive-waste ponds. Only 0.3 Ci was discharged to the ponds during 1992–95. In October 1995, concentrations of strontium-90 were above reporting levels in deep perched ground water from eight wells; concentrations were from 6.4±0.9 to 143±5 pCi/L. The distribution of strontium-90 in perched water at the TRA and the small quantity of strontium-90 discharged indicate that concentration variations probably are due to chemical equilibrium reactions between strontium-90 sorbed to sediments beneath the radioactive-waste ponds and strontium-90 in solution in water passing through those sediments.

The general absence of detectable concentrations of cesium-137 in perched ground water at the TRA probably is due to a reduction in disposal rates and to sorption of cesium-137 to minerals in sediments. The presence of cesium-137, chromium-51, and cobalt-60 in shallow perched ground water is attributed to the proximity of the well to the leaky radioactive-waste pond retention basin and to the large amount of suspended sediment in the water samples collected.

Wastewater from TRA cooling-tower operations containing an estimated 24,000 lb of chromium was discharged to the radioactive-waste ponds during 1952–64. In July-October 1995, concentrations of dissolved chromium in deep perched ground water at the TRA ranged from less than 5 to 590 µg/L. The largest concentrations were in water from wells north and west of the radioactive-waste ponds. This distribution of chromium indicates that water from these wells contains constituents that were discharged to the radioactive-waste ponds before 1965.

Approximately 672,000 lb of sodium was discharged to the TRA chemical-waste pond during 1992–95. In July-October 1995, sodium concentrations ranged from 7.1 to 1,200 mg/L. The large sodium concentration in water from a well near the chemical-waste pond was due to the large sodium concentrations in wastewater discharged to the chemical-waste pond.

Wastewater that contained about 2,382,000 lb of sulfate was discharged to the chemical-waste and cold-waste ponds at TRA during 1992–95. During 1995, the sulfate concentration in water from wells completed in deep perched ground water was from 18 to 3,900 mg/L. The large sulfate concentration in water from a well near the chemical-waste pond was due to the large sulfate concentrations in wastewater discharged to the pond.

Two infiltration ponds were constructed south of the ICPP in 1984 and 1985 to replace the ICPP deep disposal well. Wastewater from these ponds has formed perched ground water in the basalt and in sedimentary interbeds above the eastern Snake River Plain aquifer. Perched ground water has been identified in other areas beneath the ICPP and may be attributed to other infiltration ponds, leaking wastewater lines, leach fields, ruptured casing in the upper part of the ICPP deep injection well, and landscape irrigation.

Approximately 960 Ci of tritium was discharged to the ICPP infiltration ponds during 1984–88. During 1986–88, the average rate of tritium disposal was 185 Ci/yr. During 1989–91, 2.7 Ci of tritium was discharged to the ponds and during 1992–95, 0.3 Ci was discharged. During 1992–95, tritium concentrations in water from wells closest to the infiltration ponds declined significantly from concentrations during 1986–88. In October 1995, tritium concentrations in deep perched ground water beneath the infiltration ponds ranged from less than the reporting level to 1.0±0.2 pCi/mL.

Approximately 0.3 Ci of strontium-90 was contained in wastewater discharged to the ICPP infiltration ponds during 1984–95. During 1992–95, the maximum strontium-90 concentration was 17±2 pCi/L in water from well PW-1 in 1992. In October 1995, strontium-90 concentrations in deep perched ground water in wells closest to the ponds were below the reporting level. Strontium-90 concentrations in perched ground water in wells closest to the ICPP infiltration ponds were largest

in surficial sediments and decreased with distance and depth from the ponds. Concentration decreases are attributed to decreased discharge rates and sorption of strontium-90 to surficial and interbed sediments.

Wastewater discharged to the ICPP infiltration ponds during 1984–91 contained about 0.49 Ci of cesium-137. During 1992–95, wastewater discharged to the ponds contained about 0.005 Ci of cesium-137. Concentrations of cesium-137 did not exceed the reporting level in perched ground water. The absence of detectable concentrations of cesium-137 in perched ground water at the ICPP is attributed to sorption of cesium-137 to minerals in sediments.

Approximately 3 million lb of sodium was discharged to the ICPP infiltration ponds during 1992–95. Sodium concentrations in deep perched ground water near the infiltration ponds were from 90 to 190 mg/L, similar to sodium concentrations in the wastewater.

Approximately 4.9 million lb of chloride was discharged to the ICPP infiltration ponds during 1992–95. Chloride concentrations in deep perched ground water near the infiltration ponds were from 89 to 350 mg/L, similar to chloride concentrations in wastewater.

Approximately 500,000 lb of sulfate was discharged to the ICPP infiltration ponds during 1992–95. During 1995, sulfate concentrations in deep perched ground water beneath the ICPP infiltration ponds were from 25 to 28 mg/L, similar to sulfate concentrations in wastewater.

Approximately 165,000 lb of nitrate was discharged to the ICPP infiltration ponds during 1992–95. Nitrite plus nitrate (as nitrogen) concentrations in three samples of perched ground water beneath the infiltration ponds were from 1.5 to 5.4 mg/L, similar to the concentrations in the wastewater. Nitrite plus nitrate (as nitrogen) concentrations in perched water near the ICPP deep disposal well ranged from 34 to 61 mg/L.

Tritium and other radiochemical and inorganic chemical constituents in perched water from well 50, near the ICPP deep injection well, may be due to leakage of wastewater from ruptures in the deep disposal well casing or from leaky wastewater pipelines.

Perched ground water beneath the RWMC is in sedimentary interbeds in basalts and can be attributed, in part, to local infiltration of snowmelt and rainfall and, therefore, may contain waste constituents leached from radiochemical and organic chemical wastes buried at the RWMC. In water from well 92, the concentration of americium-241 was above the reporting level in October 1992 and the concentration of plutonium-238 was above the reporting level in November 1994. Chloride concentrations in two samples from well 92 were 86 and 89 mg/L. During April 1992, a sample contained 18 purgeable organic compounds with concentrations greater than the reporting levels.

SELECTED REFERENCES

Ackerman, D.J., 1991, Transmissivity of perched aquifers at the Idaho National Engineering Laboratory, Idaho: U.S. Geological Survey Water-Resources Investigations Report 91-4114 (DOE/ID-22099), 27 p.

----- 1995, Analysis of steady-state flow and advective transport in the Eastern Snake River Plain aquifer system, Idaho: U.S. Geological Survey Water-Resources Investigations Report 94-4257 (DOE/ID-22120), 25 p.

American Society for Testing and Materials, 1992, ASTM standards on precision and bias for various applications: Philadelphia, Pa., American Society for Testing and Materials Publication code number (PCN) 03-511092-34, 478 p.

Anderson, S.R., 1991, Stratigraphy of the unsaturated zone and uppermost part of the Snake River Plain aquifer at the Idaho Chemical Processing Plant and Test Reactors Area, Idaho National Engineering Laboratory, Idaho: U.S. Geological Survey Water-Resources Investigations Report 91-4010 (DOE/ID-22095), 71 p.

Anderson, S.R., and Bowers, B., 1995, Stratigraphy of the unsaturated zone and uppermost part of the Snake River Plain aquifer at Test Area North, Idaho National Engineering Laboratory, Idaho: U.S. Geological Survey Water-Resources Investigations Report 95-4130 (DOE/ID-22122), 47 p.

Anderson, S.R., and Lewis, B.D., 1989, Stratigraphy of the unsaturated zone at the Radioactive Waste Management Complex, Idaho National Engineering Laboratory, Idaho: U.S. Geological Survey Water-Resources Investigations Report 89-4065 (DOE/ID-22080), 54 p.

Barraclough, J.T., and Jensen, R.G., 1976, Hydrologic data for the Idaho National Engineering Laboratory site, Idaho, 1971 to 1973: U.S. Geological Survey Open-File Report 75-318 (DOE/ID-22055), 52 p.

Barraclough, J.T., Lewis, B.D., and Jensen, R.G., 1981, Hydrologic conditions at the Idaho National Engineering Laboratory, Idaho, emphasis: 1974–1978: U.S. Geological Survey Water-Resources Investigations Open-File Report 81-526 (DOE/ID-22060), 77 p.

Barraclough, J.T., Robertson, J.B., and Janzer, V.J., 1976, Hydrology of the solid waste burial ground, as related to the potential migration of radionuclides, Idaho National Engineering Laboratory, *with a section on* Drilling and sample analyses, by L.G. Saindon: U.S. Geological Survey Open-File Report 76-471 (DOE/ID-22056), 183 p.

Barraclough, J.T., Teasdale, W.E., and Jensen, R.G., 1967, Hydrology of the National Reactor Testing Station, Idaho, 1965: U.S. Geological Survey Open-File Report (DOE/ID-22048), 107 p.

Barraclough, J.T., Teasdale, W.E., Robertson, J.B., and Jensen, R.G., 1967, Hydrology of the National Reactor Testing Station, Idaho, 1966: U.S. Geological Survey Open-File Report (DOE/ID-22049), 95 p.

Bartholomay, R.C., 1990a, Digitized geophysical logs for selected wells on or near the Idaho National Engineering Laboratory, Idaho: U.S. Geological Survey Open-File Report 90-366 (DOE/ID-22088), 347 p.

----- 1990b, Mineralogical correlation of surficial sediment from area drainages with selected sedimentary interbeds at the Idaho National Engineering Laboratory, Idaho: U.S. Geological Survey Water-Resources Investigations Report 90-4147 (DOE/ID-22092), 18 p.

----- 1993, Concentrations of tritium and strontium-90 in water from selected wells at the Idaho National Engineering Laboratory after purging one, two, and three borehole volumes: U.S. Geological Survey Water-Resources Investigations Report 93-4201 (DOE/ID-22111), 21 p.

Bartholomay, R.C., Knobel, L.L., and Davis, L.C., 1989, Mineralogy and grain size of surficial sediment from the Big Lost River drainage and vicinity, with chemical and physical characteristics of geologic materials from selected sites at the Idaho National Engineering Laboratory, Idaho: U.S. Geological Survey Open-File Report 89-384 (DOE/ID-22081), 74 p.

Bartholomay, R.C., Orr, B.R., Liszewski, M.J., and Jensen, R.G., 1995, Hydrologic conditions and distribution of selected radiochemical and chemical constituents in water, Idaho National Engineering Laboratory, Idaho, 1989 through 1991: U.S. Geological Survey Water-Resources Investigations Report 95-4175 (DOE/ID-22123), 47 p.

Bartholomay, R.C., Tucker, B.J., Ackerman, D.J., and Liszewski, M.J., 1997, Hydrologic conditions and distribution of selected radiochemical and chemical constituents in water, Idaho National Engineering Laboratory, Idaho, 1992 through 1995: U.S. Geological Survey Water-Resources Investigations Report 97-4086 (DOE/ID-22137), 57 p.

Bartholomay, R.C., and Williams, L.M., 1996, Evaluation of preservation methods for selected nutrients in ground water at the Idaho National Engineering Laboratory, Idaho: U.S. Geological Survey Water-Resources Investigations Report 96-4260 (DOE/ID-22131), 16 p.

Bennett, C.M., 1990, Streamflow losses and ground-water level changes along the Big Lost River at the Idaho National Engineering Laboratory, Idaho: U.S. Geological Survey Water-Resources Investigations Report 90-4067 (DOE/ID-22091), 49 p.

Busenberg, Eurybiades, Weeks, E.P., Plummer, L.N., and Bartholomay, R.C., 1993, Age dating ground water by use of chlorofluorocarbons (CCl_3F and CCl_2F_2), and distribution of chlorofluorocarbons in the unsaturated zone, Snake River Plain aquifer, Idaho National Engineering Laboratory, Idaho: U.S. Geological Survey Water-Resources Investigations Report 93-4054 (DOE/ID-22107), 47 p.

Cecil, L.D., Knobel, L.L., Wegner, S.J., and Moore, L.L., 1989, Evaluation of field sampling and preservation methods for strontium-90 in ground water at the Idaho National Engineering Laboratory, Idaho: U.S. Geological Survey Water-Resources Investigations Report 89-4146 (DOE/ID-22083), 24 p.

Cecil, L.D., Orr, B.R., Norton, T., and Anderson, S.R., 1991, Formation of perched groundwater zones and concentrations of selected chemical constituents in water, Idaho National Engineering Laboratory, Idaho, 1986–88: U.S. Geological Survey Water-Resources Investigations Report 91-4166 (DOE/ID-22100), 53 p.

Claassen, H.C., 1982, Guidelines and techniques for obtaining water samples that accurately represent the water chemistry of an aquifer: U.S. Geological Survey Open-File Report 82-1024, 49 p.

Currie, L.A., 1984, Lower limit of detection-definition and elaboration of a proposed position for radiological effluent and environmental measurements: U.S. Nuclear Regulatory Commission NUREG/CR-4007, 139 p.

Fishman, M.J., and Friedman, L.C., eds., 1989, Methods for determination of inorganic substances in water and fluvial sediments: U.S. Geological Survey Techniques of Water-Resources Investigations, book 5, chap. A1, 545 p.

French, D.L., Lisee, D.J., and Taylor, K.A., 1995a, Idaho National Engineering Laboratory nonradiological waste management information for 1994 and record-to-date: U.S. Department of Energy, Waste Management Programs Division, Idaho Operations Office Publication, DOE/ID-10057 (94), [variously paged].

----- 1995b, Radioactive waste management information for 1994 and record-to-date: U.S. Department of Energy, Waste Management Programs Division, Idaho Operations Office Publication, DOE/ID-10054 (94), [variously paged].

----- 1996a, Idaho National Engineering Laboratory nonradiological waste management information for 1995 and record-to-date: U.S. Department of Energy, Waste Management Programs Division, Idaho Operations Office Publication, DOE/ID-10057 (95), [variously paged].

----- 1996b, Radioactive waste management information for 1995 and record-to-date: U.S. Department of Energy, Waste Management Programs Division, Idaho Operations Office Publication, DOE/ID-10054 (95), [variously paged].

Goerlitz, D.F., and Brown, Eugene, 1972, Methods for analysis of organic substances in water: U.S. Geological Survey Techniques of Water-Resources Investigations, book 5, chap. A3, 40 p.

Hull, L.C., 1989, Conceptual model and description of the affected environment for the TRA warm waste pond (Waste Management Unit TRA-03): EG&G Idaho Informal Report EGG-ER-8644, 125 p.

Idaho Department of Health and Welfare, 1977, Idaho regulations for public drinking water systems: Idaho Department of Health and Welfare, Division of Environment Publication, title 1, chap. 8, 44 p.

Jones, P.H., 1961, Hydrology of waste disposal, National Reactor Testing Station, Idaho, an interim report: U.S. Atomic Energy Commission, Idaho Operations Office Publication, IDO-22042-USGS, 152 p.

Knobel, L.L., Bartholomay, R.C., Cecil, L.D., Tucker, B.J., and Wegner, S.J., 1992, Chemical constituents in the dissolved and suspended fractions of ground water from selected sites, Idaho National Engineering Laboratory and vicinity, Idaho, 1989: U.S. Geological Survey Open-File Report 92-51 (DOE/ID-22101), 56 p.

Knobel, L.L., Bartholomay, R.C., and Orr, B.R., 1997, Preliminary delineation of natural geochemical reactions, Snake River Plain aquifer system, Idaho National Engineering Laboratory and vicinity, Idaho: U.S. Geological Survey Water-Resources Investigations Report 97-4093 (DOE/ID-22139), 52 p.

Knobel, L.L., and Mann, L.J., 1988, Radionuclides in ground water at the Idaho National Engineering Laboratory, Idaho: U.S. Geological Survey Open-File Report 88-731 (DOE/ID-22077), 37 p.

----- 1993, Sampling for purgeable organic compounds using positive-displacement piston and centrifugal submersible pumps—a comparative study: Ground Water Monitoring Review, Spring 1993, p. 142-148.

Knobel, L.L., Orr, B.R., and Cecil, L.D., 1992, Summary of background concentrations of selected radiochemical and chemical constituents in ground water from the Snake River Plain aquifer, Idaho—estimated from an analysis of previously published data: Journal of the Idaho Academy of Science, v. 28, no. 1, p. 48-61.

Lewis, B.D., and Jensen, R.G., 1985, Hydrologic conditions at the Idaho National Engineering Laboratory, Idaho, 1979–1981 update: U.S. Geological Survey Hydrologic Investigations Atlas HA-674, 2 sheets.

Liszewski, M.J., and Mann, L.J., 1992, Purgeable organic compounds in ground water at the Idaho National Engineering Laboratory, Idaho, 1990 and 1991: U.S. Geological Survey Open-File Report 92-174 (DOE/ID-22104), 19 p.

----- 1993, Concentrations of 23 trace elements in ground water and surface water at and near the Idaho National Engineering Laboratory, Idaho, 1988–91: U.S. Geological Survey Open-File Report 93-126 (DOE/ID-22110), 44 p.

Litteer, D.L., Randall, V.C., Sims, A.M., and Taylor, K.A., 1993, Radioactive waste management information for 1992 and record-to-date, Idaho National Engineering Laboratory: U.S. Department of Energy, Waste Management Programs Division, Idaho Operations Office Publication, DOE/ID-10054 (92), [variously paged].

Lucius, J.E., Olhoeft, G.R., Hill, P.L., and Duke, S.K., 1989, Properties and hazards of 108 selected substances: U.S. Geological Survey Open-File Report 89-491, 538 p.

Mann, L.J., 1996, Quality-assurance plan and field methods for quality-of-water activities, U.S. Geological Survey, Idaho National Engineering Laboratory, Idaho: U.S. Geological Survey Open-File Report 96-615 (DOE/ID-22132), 37 p.

Mann, L.J., and Cecil, L.D., 1990, Tritium in ground water at the Idaho National Engineering Laboratory: U.S. Geological Survey Water-Resources Investigations Report 90-4090 (DOE/ID-22090), 35 p.

Mann, L.J., and Knobel, L.L., 1987, Purgeable organic compounds in ground water at the Idaho National Engineering Laboratory, Idaho: U.S. Geological Survey Open-File Report 87-766 (DOE/ID-22074), 23 p.

-----1988, Concentrations of nine trace metals in ground water at the Idaho National Engineering Laboratory, Idaho: U.S. Geological Survey Open-File Report 88-332 (DOE/ID-22075), 17 p.

Morris, D.A., Barraclough, J.T., Chase, G.H., Teasdale, W.E., and Jensen, R.G., 1965, Hydrology of subsurface waste disposal, National Reactor Testing Station, Idaho, annual progress report, 1964: U.S. Atomic Energy Commission, Idaho Operations Office Publication, IDO-22047-USGS, 186 p.

Morris, D.A., Barraclough, J.T., Hogenson, G.M., Shuter, Eugene, Teasdale, W.E., Ralston, D.A., and Jensen, R.G., 1964, Hydrology of subsurface waste disposal, National Reactor Testing Station, Idaho, annual progress report, 1963: U.S. Atomic Energy Commission, Idaho Operations Office Publication, IDO-22046-USGS, 97 p.

Morris, D.A., Hogenson, G.M., Shuter, Eugene, and Teasdale, W.E., 1963, Hydrology of waste disposal, National Reactor Testing Station, Idaho, annual progress report, 1962: U.S. Atomic Energy Commission, Idaho Operations Office Publication, IDO-22044-USGS, 99 p.

Mundorff, M.J., Crosthwaite, E.G., and Kilburn, Chabot, 1964, Ground water for irrigation in the Snake River Basin in Idaho: U.S. Geological Survey Water-Supply Paper 1654, 224 p.

Nace, R.L., Voegeli, P.T., Jones, J.R., and Deutsch, Morris, 1975, Generalized geologic framework of the National Reactor Testing Station, Idaho: U.S. Geological Survey Professional Paper 725-B, 49 p.

Olmsted, F.H., 1962, Chemical and physical character of ground water in the National Reactor Testing Station, Idaho: U.S. Atomic Energy Commission, Idaho Operations Office Publication, IDO-22043-USGS, 142 p.

Orr, B.R., and Cecil, L.D., 1991, Hydrologic conditions and distribution of selected chemical constituents in water, Snake River Plain aquifer, Idaho National Engineering Laboratory, Idaho, 1986 to 1988: U.S. Geological Survey Water-Resources Investigations Report 91-4047 (DOE/ID-22096), 56 p.

Orr, B.R., Cecil, L.D., and Knobel, L.L., 1991, Background concentrations of selected radionuclides, organic compounds, and chemical constituents in ground water in the vicinity of the Idaho National Engineering Laboratory: U.S. Geological Survey Water-Resources Investigations Report 91-4015 (DOE/ID-22094), 52 p.

Pittman, J.R., Jensen, R.G., and Fischer, P.R., 1988, Hydrologic conditions at the Idaho National Engineering Laboratory, 1982 to 1985: U.S. Geological Survey Water-Resources Investigations Report 89-4008 (DOE/ID-22078), 73 p.

Randall, V.C., and Sims, A.M., 1993, Idaho National Engineering Laboratory nonradiological waste management information for 1992 and record-to-date: U.S. Department of Energy, Waste Management Programs Division, Idaho Operations Office Publication, DOE/ID-10057 (92), [variously paged].

Robertson, J.B., 1977, Numerical modeling of subsurface radioactive solute transport from waste-seepage ponds at the Idaho National Engineering Laboratory: U.S. Geological Survey Open-File Report 76-717 (DOE/ID-22057), 68 p.

Robertson, J.B., Schoen, Robert, and Barraclough, J.T., 1974, The influence of liquid waste disposal on the geochemistry of water at the National Reactor Testing Station, Idaho, 1952-1970: U.S. Geological Survey Open-File Report (DOE/ID-22053), 231 p.

Shakofsky, Stephanie, 1995, Changes in soil hydraulic properties caused by construction of a simulated waste trench at the Idaho National Engineering Laboratory, Idaho: U.S. Geological Survey Water-Resources Investigations Report 95-4058 (DOE/ID-22121), 26 p.

Sims, A.M., and Taylor, K.A., 1994, Idaho National Engineering Laboratory nonradiological waste management information for 1993 and record-to-date: U.S. Department of Energy, Waste Management Programs Division, Idaho Operations Office Publication, DOE/ID-10057 (93), [variously paged].

Stevens, H.H., Jr., Ficke, J.F., and Smoot, G.F., 1975, Water temperature—influential factors, field measurement, and data presentation: U.S. Geological Survey Techniques of Water-Resources Investigations, book 5, chap. D1, 65 p.

Stone, M.A.J., Mann, L.J., and Kjelstrom, L.C., 1993, Statistical summaries of streamflow data for selected gaging stations on and near the Idaho National Engineering Laboratory, Idaho, through September 1990: U.S. Geological Survey Water-Resources Investigations Report 92-4196 (DOE/ID-22109), 35 p.

Taylor, K.A., 1994, Radioactive waste management information for 1993 and record-to-date, Idaho National Engineering Laboratory: U.S. Department of Energy, Waste Management Programs Division, Idaho Operations Office Publication, DOE/ID-10054 (93), [variously paged].

Timme, P.J., 1995, National Water Quality Laboratory, 1995 services catalog: U.S. Geological Survey Open-File Report 95-352, 120 p.

Tucker, B.J., and Orr, B.R., 1998, Distribution of selected radiochemical and chemical constituents in perched ground water, Idaho National Engineering Laboratory, Idaho, 1989–91: U.S. Geological Survey Water Resources Investigations Report 98-4028 (DOE/ID-22144), 62 p.

U.S. Department of Energy, Environmental Sciences Branch, Radiological and Environmental Sciences Laboratory, 1991, INEL site environmental surveillance data for the fourth quarter, 1990: U.S. Department of Energy Environmental Surveillance Quarterly Report, 49 p.

U.S. Environmental Protection Agency, 1995, Protection of environment-Code of Federal Regulations 40: Washington, D.C., Office of the Federal Register, National Archives and Records Administration, Pts. 87 to 149, 1,349 p.

U.S. Geological Survey, 1985, National water summary, 1984--Hydrologic events, selected water-quality trends, and ground-water resources: U.S. Geological Survey Water-Supply Paper 2275, 467 p.

Walker, E.H., 1964, Subsurface geology of the National Reactor Testing Station, Idaho: U.S. Geological Survey Bulletin 1133-E, 22 p.

Walker, F.W., Parrington, J.R., and Feiner, Frank, 1989, Nuclides and isotopes, chart of the nuclides (14th ed.): General Electric Company, Nuclear Energy Operations, 57 p.

Wegner, S.J., 1989, Selected quality assurance data for water samples collected by the U.S. Geological Survey, Idaho National Engineering Laboratory, 1980 to 1988: U.S. Geological Survey Water-Resources Investigations Report 89-4168 (DOE/ID-22085), 91 p.

Wershaw, R.L., Fishman, M.J., Grabbe, R.R., and Lowe, L.E., 1987, Methods for the determination of organic substances in water and

fluvial sediments: U.S. Geological Survey Techniques of Water-Resources Investigations, book 5, chap. A3, 80 p.

Williams, L.M., 1996, Evaluation of quality assurance/quality control data collected by the U.S. Geological Survey for water-quality activities at the Idaho National Engineering Laboratory, Idaho, 1989 through 1993: U.S. Geological Survey Water-Resources Investigations Report 96-4148 (DOE/ID-22129), 115 p.

----- 1997, Evaluation of quality assurance/quality control data collected by the U.S. Geological Survey for water-quality activities at the Idaho National Engineering Laboratory, Idaho, 1994 through 1995: U.S. Geological Survey Water-Resources Investigations Report 97-4058 (DOE/ID-22136), 87 p.

Wood, W.W., 1981, Guidelines for collection and field analysis of ground-water samples for selected unstable constituents: U.S. Geological Survey Techniques of Water-Resources Investigations, book 1, chap. D2, 24 p.

Table 1. Location, construction, and sample-collection method and frequency of wells completed in perched ground water at the Idaho National Engineering Laboratory

[Well identifier: see figure 3 for location of wells. Sampling method: Pump - sample collected with a pump (pumping rate in gallons per minute). Bail - sample collected with a bailer; depth, at which samples were collected in feet below land surface. Sampling frequency: A, annual; S, semiannual; Q, quarterly. Symbol: <, less than]

Well identifier	Location		Well construction		Water-sample collection	
	Latitude	Longitude	Well diameter (inches)	Well depth (feet)	Method	Frequency
CWP-1	43°34'59"	112°57'26"	10	66.0	Bail (65)	A
CWP-2	43°34'58"	112°57'24"	10	52.5	Bail (52)	A
CWP-3	43°34'55"	112°57'25"	10	60.5	Bail (60)	A
CWP-4	43°34'54"	112°57'26"	10	61.0	Bail (60)	A
CWP-5	43°34'55"	112°57'29"	10	53.5	Bail (53)	A
CWP-6	43°34'56"	112°57'33"	10	52.5	Bail (52)	A
CWP-7	43°34'58"	112°57'32"	10	53.5	Bail (53)	A
CWP-8	43°35'00"	112°57'30"	10	66.0	Bail (65)	A
PW-1	43°33'49"	112°56'08"	10	117	Pump (1.5)	Q
PW-2	43°33'45"	112°55'57"	10	131	Bail (125)	S
PW-3	43°33'51"	112°55'58"	10	125	Bail (120)	S
PW-4	43°33'49"	112°55'49"	10	136	Pump (6)	Q
PW-5	43°33'49"	112°55'57"	10	124	Pump (8)	S
PW-6	43°33'53"	112°56'22"	10	125	Bail (125)	Q
PW-7	43°34'47"	112°57'47"	10	237	Bail (237)	S
PW-8	43°34'57"	112°57'21"	10	166	Pump (8)	Q
PW-9	43°35'01"	112°57'55"	10	200	Pump (5)	Q
SWP-8	43°33'51"	112°55'54"	8	26	Bail (26)	S
SWP-13	43°33'49"	112°55'57"	8	32	Bail (32)	S
TRA A-13	43°35'02"	112°57'28"	1.5	59	Bail (59)	S
TRA A-77	43°35'07"	112°57'38"	2	33	Bail (33)	S
50	43°34'19"	112°56'02"	6	405	Pump (<1)	S
53	43°35'02"	112°57'35"	6	90	Pump (6)	S
54	43°35'02"	112°57'28"	6	91	Pump (6)	Q
55	43°35'09"	112°57'29"	6	79	Pump (6)	S
56	43°35'09"	112°57'35"	6	80	Pump (1)	S
60	43°34'57"	112°57'20"	6	117	Pump (6)	S
61	43°34'53"	112°57'16"	10	123	Pump (6)	S
62	43°34'46"	112°57'06"	8	165	Pump (5)	S

Table 1. Location, construction, and sample-collection method and frequency of wells completed in perched ground water at the Idaho National Engineering Laboratory—Continued

Well identifier	Location		Well construction		Water-sample collection	
	Latitude	Longitude	Well diameter (inches)	Well depth (feet)	Method	Frequency
63	43°34'55"	112°57'40"	10	97	Pump (5)	S
66	43°34'39"	112°56'57"	6	475	Bail (214)	A
68	43°35'15"	112°57'39"	10	128	Pump (1)	S
69	43°34'50"	112°57'29"	10	115	Pump (5)	A
70	43°35'03"	112°57'11"	8	100	Pump (6)	S
71	43°34'40"	112°57'15"	8	184	Pump (<1)	S
72	43°35'19"	112°57'46"	6	177	Pump (1)	A
73	43°35'01"	112°57'54"	6	127	Pump (1.5)	S
74	43°35'05"	112°58'06"	6	192	Bail (192)	S
78	43°34'13"	112°57'36"	7	204	Bail (200)	A
92	43°30'01"	113°02'53"	6	214	Bail (213)	S

Table 2. Concentrations of tritium, strontium-90, cesium-137, and other radionuclides in perched ground water from selected wells, Test Reactor Area, 1992-95

[Analyses were performed by the Radiological and Environmental Sciences Laboratory. Analytical uncertainties are reported as 1s. Concentrations that are equal to or greater than the reporting level of 3 times the 1s value are shown in boldface type. Abbreviations: (m/d/y), month/day/year; pCi/mL, picocurie per milliliter; pCi/L, picocurie per liter; Co-60, cobalt-60; Cr-51, chromium-51; Ag-108, silver-108. Symbol: NR indicates analysis not requested; ND indicates not detected]

Well identifier	Date sampled (m/d/y)	Tritium (pCi/mL)	Strontium-90 (pCi/L)	Cesium-137 (pCi/L)	Other radionuclides (pCi/L)
CWP-1	9/29/92	0.1±0.2	0±2	NR	NR
	5/8/93	-.09±0.17	-1.8±1.6	11±17	ND
	10/14/93	-.29±0.17	2.5±1.6	NR	NR
	7/19/94	-.05±0.17	-.9±1.6	NR	NR
	7/13/95	-.12±0.17	0±0.8	NR	NR
CWP-2	5/5/93	0±0.2	1±2	15±21	ND
	10/14/93	-.1±0.2	2±2	NR	NR
	7/20/94	-.01±0.17	-.5±1.7	NR	NR
	7/13/95	-.16±0.16	1.3±0.8	NR	NR
CWP-3	9/29/92	.10±0.2	0±2	NR	NR
	5/5/93	-.12±0.17	-1±2	-13±21	ND
	10/14/93	-.1±0.2	1.2±1.5	NR	NR
	7/20/94	-.12±0.16	-1±2	NR	NR
	7/14/95	-.1±0.17	.7±0.8	NR	NR
CWP-4	9/29/92	.2±0.2	-1±2	NR	NR
	5/5/93	0±0.2	-2.8±1.6	-10±30	ND
	10/14/93	-.12±0.17	.4±1.5	NR	NR
	7/20/94	0±0.17	-.9±1.6	NR	NR
	7/14/95	-.06±0.17	1.8±0.8	NR	NR
CWP-5	5/5/93	.1±0.2	1.0±1.8	-10±30	ND
	10/14/93	0±0.2	.8±1.5	NR	NR
	7/20/94	-.09±0.16	-2.3±1.7	NR	NR
	7/14/95	0±0.2	1.4±0.9	NR	NR
CWP-7	5/5/93	-.28±0.16	-1±2	10±20	ND
	10/15/93	-.14±0.17	-1.3±1.7	NR	NR
CWP-8	5/5/93	-.16±0.16	1.4±1.8	40±30	ND
	10/15/93	0±0.2	-.2±1.5	NR	NR
	7/20/94	-.1±0.16	0±2	NR	NR
	7/14/95	-.12±0.17	.4±0.8	NR	NR

Table 2. Concentrations of tritium, strontium-90, cesium-137, and other radionuclides in perched ground water from selected wells, Test Reactor Area, 1992-95—Continued

Well identifier	Date sampled (m/d/y)	Tritium (pCi/mL)	Strontium-90 (pCi/L)	Cesium-137 (pCi/L)	Other radionuclides (pCi/L)
PW-7	1/17/92	.4±0.2	1.8±1.5	NR	NR
	4/21/92	.5±0.2	-1.2±1.4	-10±30	ND
	7/13/92	**.7±0.2**	-1.9±1.6	NR	NR
	10/28/92	.5±0.2	4±3	NR	NR
	4/24/93	.4±0.2	2±2	0±20	ND
	7/17/93	**.7±0.2**	-5±2	NR	NR
	10/22/93	.4±0.2	0±2	NR	NR
	4/29/94	.5±0.2	-1±2	10±20	ND
PW-8	1/10/92	**239±4**	**12±2**	NR	NR
	4/7/92	**377±6**	**11±2**	0±30	ND
	7/13/92	**304±5**	**8±2**	NR	NR
	10/13/92	**144±2**	**10±2**	NR	NR
	4/6/93	**28±0.7**	**7±2**	-30±20	ND
	7/17/93	**14.6±0.5**	**16±2**	NR	NR
	10/7/93	**7.0±0.4**	5±3	NR	NR
	1/20/94	**10.8±0.5**	**15±2**	NR	NR
	4/8/94	**6.4±0.4**	**11±2**	0±30	ND
	7/13/94	**3.8±0.3**	**14±2**	NR	NR
	9/29/94	**4.0±0.3**	**10±2**	NR	NR
	1/18/95	**5.4±0.3**	**22.6±1.3**	NR	NR
	4/10/95	**4.9±0.3**	**21.2±1.3**	5±13	ND
	7/12/95	**3.9±0.3**	**22.9±1.3**	NR	NR
	10/3/95	**3.7±0.3**	**24.7±1.4**	NR	NR
PW-9	1/21/92	**226±4**	-1.4±1.9	NR	NR
	4/21/92	**219±4**	.3±1.4	-20±20	ND
	7/13/92	**209±3**	-.6±1.6	NR	NR
	10/15/92	**219±4**	0±2	NR	NR
	2/4/93	**232±4**	-2±2	NR	NR
	4/6/93	**237±4**	-.7±1.6	0±30	ND
	7/20/93	**219±4**	-1±2	NR	NR
	10/8/93	**193±6**	-5±2	NR	NR
	1/14/94	**182±6**	-1.6±1.8	NR	NR

Table 2. Concentrations of tritium, strontium-90, cesium-137, and other radionuclides in perched ground water from selected wells, Test Reactor Area, 1992-95—Continued

Well identifier	Date sampled (m/d/y)	Tritium (pCi/mL)	Strontium-90 (pCi/L)	Cesium-137 (pCi/L)	Other radionuclides (pCi/L)
PW-9-cont.	4/25/94	**180±6**	0±2	40±20	ND
	7/12/94	**164±5**	0±2	NR	NR
	10/24/94	**168±6**	1±2	NR	NR
	1/18/95	**161±5**	-.4±0.7	NR	NR
	4/7/95	**163±5**	-1.1±0.7	30±40	ND
	7/11/95	**162±5**	.13±0.76	NR	NR
	10/6/95	**158±5**	-.2±0.7	NR	NR
TRA A-13	7/19/93	.4±0.2	**42±3**	NR	NR
	10/13/93	.16±.17	**41±3**	NR	NR
	4/29/94	0±0.2	**45±4**	-10±22	ND
	10/31/94	.1±0.2	**73±4**	0±20	ND
	4/27/95	.3±0.2	**53±2**	30±40	ND
	10/4/95	.1±0.2	**42±2**	14±21	ND
TRA A-77	1/17/92	**3,940±60**	**1,960±60**	NR	NR
	4/10/92	**1,760±30**	**1,360±40**	**1,080±70**	Co-60, **1,340±90**
	7/21/92	**2,290±30**	**2,530±80**	NR	NR
	10/29/92	**2,410±30**	**1,900±60**	**630±60**	Cr-51, **24,500±1,300** Co-60, **2,570±140**
	2/5/93	**2,120±30**	**1,090±30**	NR	NR
	4/5/93	**1,880±30**	**1,170±40**	30±30	Co-60, **1,000±80**
	7/20/93	**72.5±1.4**	**4,120±120**	NR	NR
	10/28/93	**316±10**	**3,050±90**	**3,680±180**	Ag-108, 190±70 Co-60, **16,800±700**
	4/28/94	**2,960±100**	**2,020±70**	**3,200±200**	Co-60, **5,800±400**
	10/26/94	**1,100±40**	**1,600±50**	**310±50**	Cr-51, **8,900±1,000** Co-60, **2,950±150**
	4/18/95	**2,650±90**	**1,890±60**	**380±50**	Cr-51, **2,700±500** Co-60, **2,050±120**
	10/17/95	**22.4±0.9**	**48,200±1,500**	**1,600±400**	Co-60, **110,000±3,000**
53	10/28/92	**1,010±10**	**65±4**	NR	NR
	4/19/93	**1,340±20**	**72±4**	25±16	Co-60, **230±30**
	10/15/93	**41.6±1.5**	**75±4**	NR	NR
	4/18/94	**206±7**	**111±5**	50±30	ND

Table 2. Concentrations of tritium, strontium-90, cesium-137, and other radionuclides in perched ground water from selected wells, Test Reactor Area, 1992-95—Continued

Well identifier	Date sampled (m/d/y)	Tritium (pCi/mL)	Strontium-90 (pCi/L)	Cesium-137 (pCi/L)	Other radionuclides (pCi/L)
53-cont.	10/25/94	**122±4**	**120±6**	NR	NR
	4/7/95	**128±4**	**145±5**	0±20	ND
	10/4/95	**126±4**	**143±5**	NR	NR
54	1/22/92	**703±10**	**109±6**	NR	NR
	8/3/92	**910±13**	**95±6**	NR	NR
	10/16/92	**812±12**	**95±5**	NR	NR
	4/19/93	**282±4**	**86±5**	-10±20	Co-60, **90±20**
	7/21/93	**3.9±0.3**	**101±5**	NR	NR
	10/13/93	**4.8±0.3**	**94±5**	NR	NR
	4/19/94	**2.8±0.3**	**87±5**	10±30	ND
	7/11/94	**2.3±0.2**	**87±5**	NR	NR
	10/25/94	**1.8±0.2**	**126±6**	NR	NR
	1/4/95	**4.4±0.3**	**129±4**	NR	NR
	4/7/95	**2.0±0.2**	**116±4**	0±30	ND
	7/12/95	**2.7±0.3**	**141±5**	NR	NR
	10/4/95	.4±0.2	**124±4**	NR	NR
55	10/16/92	**4.7±0.3**	**13±2**	NR	NR
	5/4/93	**6.9±0.3**	**6±2**	0±30	ND
	4/18/94	**1.5±0.2**	**6±2**	20±30	ND
	10/25/94	**.9±0.2**	**10±2**	NR	NR
	4/10/95	**.9±0.2**	**6.4±0.9**	0±30	ND
	10/4/95	**1.6±0.2**	**6.4±0.9**	NR	NR
56	4/29/93	**1,600±20**	**61±4**	-34±15	Co-60, **300±30**
	4/25/94	**571±19**	**76±5**	20±20	Co-60, **90±30**
	10/26/94	**86.1±3.0**	**84±5**	NR	NR
	4/18/95	**551±18**	**50±2**	14±16	ND
	10/4/95	**99.1±3.4**	**22.5±1.3**	NR	NR
60	1/10/92	**130±2**	2±2	NR	NR
	4/7/92	**199±3**	2±3	-10±30	ND
	7/13/92	**151±3**	.6±1.7	NR	NR
	9/29/92	**60.8±1.2**	2±2	NR	NR
	4/1/93	**1.1±0.2**	2±2	-16±21	ND

Table 2. Concentrations of tritium, strontium-90, cesium-137, and other radionuclides in perched ground water from selected wells, Test Reactor Area, 1992-95—Continued

Well identifier	Date sampled (m/d/y)	Tritium (pCi/mL)	Strontium-90 (pCi/L)	Cesium-137 (pCi/L)	Other radionuclides (pCi/L)
60-cont.	7/17/93	**1.3±0.2**	.6±1.5	NR	NR
	10/7/93	0±0.2	-3±2	NR	NR
	4/6/94	**1.3±0.2**	**7.3±1.7**	-40±30	ND
	9/29/94	**1.0±0.2**	-.4±1.5	NR	NR
	4/10/95	**2.2±0.2**	**6.8±0.9**	-10±30	ND
	10/3/95	**1.2±0.2**	**7.6±0.9**	NR	NR
61	4/8/92	**17.2±0.6**	-3±2	20±20	ND
	10/13/92	**27.5±0.7**	-2±2	NR	NR
	4/12/93	**52.1±1.1**	1±2	10±20	ND
	10/6/93	**58.3±2.1**	.4±1.5	NR	NR
	4/28/94	**36.7±1.4**	1.6±2.2	-14±29	ND
	10/27/94	**25.7±1.0**	1.2±1.8	NR	NR
	4/12/95	**24.3±1.0**	.2±0.6	-10±20	ND
	10/3/95	**20.3±0.8**	.2±0.8	NR	NR
62	4/9/92	**7.2±0.4**	1.2±1.3	16±22	ND
	10/3/92	**4.8±0.3**	0±2	NR	NR
	4/12/93	**2.3±0.2**	3±2	60±30	ND
	9/30/93	**1.4±0.2**	1±2	NR	NR
	4/25/94	**1.5±0.2**	4±2	30±20	ND
	10/24/94	**.9±0.2**	0±2	NR	NR
	4/12/95	**1.1±0.2**	**3.1±0.7**	-10±30	ND
	10/3/95	**.6±0.2**	1.3±0.8	NR	NR
63	4/9/92	**7.9±0.4**	-.7±1.4	0±30	ND
	10/14/92	**1.9±0.2**	1±2	NR	NR
	4/6/93	.11±0.17	1±2	10±20	ND
	10/13/93	.4±0.2	**7±2**	NR	NR
	4/25/94	.4±0.2	**7±2**	3±14	ND
	10/27/94	**.7±0.2**	**11±2**	NR	NR
	4/7/95	**.6±0.2**	**7.9±0.9**	-30±30	ND
	10/14/95	.4±0.2	**8.9±0.9**	NR	NR
66	4/29/92	**6.7±0.4**	2.4±1.5	-20±30	ND
	10/28/92	**7.7±0.4**	-2±2	NR	NR

Table 2. Concentrations of tritium, strontium-90, cesium-137, and other radionuclides in perched ground water from selected wells, Test Reactor Area, 1992-95—Continued

Well identifier	Date sampled (m/d/y)	Tritium (pCi/mL)	Strontium-90 (pCi/L)	Cesium-137 (pCi/L)	Other radionuclides (pCi/L)
66-cont.	4/24/93	**14.2±0.5**	1±2	50±30	ND
	10/22/93	**11.5±0.6**	1.2±1.8	NR	NR
	7/28/94	**6.7±0.4**	1±2	NR	NR
	7/17/95	**3.8±0.3**	1.2±0.8	NR	NR
68	1/17/92	-.16±0.18	-.3±1.4	NR	NR
	4/10/92	-.1±0.2	1.5±1.8	0±20	ND
	7/21/92	0±0.2	-1±3	NR	NR
	10/29/92	0±0.2	-2.7±1.7	NR	NR
	2/5/93	.2±0.2	-5±4	NR	NR
	4/29/93	-.13±0.17	-1±2	10±20	ND
	7/20/93	.25±0.17	-5±3	NR	NR
	10/28/93	-.11±0.17	2±2	NR	NR
	4/29/94	-.17±0.17	.9±1.7	0±30	ND
	10/26/94	0±0.2	-2.0±1.6	NR	NR
	4/25/95	-.08±0.17	-1.2±1.0	-50±30	ND
	10/17/95	-.26±0.17	.1±1.4	NR	NR
69	4/9/92	.1±0.18	3±2	40±20	ND
	10/14/92	.11±0.18	-1.7±1.9	NR	NR
	4/13/93	0±0.2	-.9±1.6	15±19	ND
	10/12/93	-.17±0.17	.6±1.5	NR	NR
	7/11/94	-.1±0.16	1±2	NR	NR
	7/6/95	-.02±0.17	.3±0.8	NR	NR
70	4/9/92	**50.5±1.1**	**51±4**	-30±30	ND
	10/14/92	**87.1±1.6**	**44±4**	NR	NR
	4/12/93	**219±4**	**38±3**	40±30	ND
	10/7/93	**36±1.3**	**44±4**	NR	NR
	4/20/94	**36.8±1.4**	**45±3**	-20±30	ND
	10/27/94	**29.1±1.1**	**61±4**	NR	NR
	4/12/95	**33.9±1.3**	**55±2**	-20±40	ND
	10/6/95	**24.8±1.0**	**54±2**	NR	NR
71	4/22/92	**10.8±0.4**	2.7±1.6	-20±30	ND
	10/15/92	**9.7±0.4**	-2±2	NR	NR

Table 2. Concentrations of tritium, strontium-90, cesium-137, and other radionuclides in perched ground water from selected wells, Test Reactor Area, 1992-95—Continued

Well identifier	Date sampled (m/d/y)	Tritium (pCi/mL)	Strontium-90 (pCi/L)	Cesium-137 (pCi/L)	Other radionuclides (pCi/L)
71-cont.	4/13/93	**8.3±0.4**	-.5±1.7	0±20	ND
	10/12/93	**7.1±0.4**	-3±2	NR	NR
	4/19/94	**6.9±0.4**	-3±3	8±15	ND
	10/31/94	**5.7±0.4**	0±2	NR	NR
	4/13/95	**5.3±0.3**	-.8±0.7	30±30	ND
	10/6/95	**4.9±0.3**	0±0.8	NR	NR
72	4/10/92	-.16±0.18	3±2	10±30	ND
	10/29/92	0±0.2	1.3±2.0	NR	NR
	4/5/93	0±0.2	.3±1.6	0±30	ND
	10/28/93	-.1±0.2	-1±2	NR	NR
	7/6/94	0±0.2	0±2	NR	NR
	7/11/95	-.16±0.16	.6±0.8	NR	NR
73	4/13/92	**149±3**	2.8±1.5	-8±13	ND
	10/28/92	**118±2**	1±2	NR	NR
	4/19/93	**128±2**	3±2	-10±30	ND
	10/18/93	**296±10**	1.5±1.5	NR	NR
	5/3/94	**150±5**	-1±2	10±20	Co-60, **110±20**
	10/21/94	**148±5**	0±2	NR	NR
	4/27/95	**119±4**	1.9±0.8	10±20	ND
	10/19/95	**83.4±2.9**	.9±0.7	NR	NR
74	4/22/92	**93.1±1.7**	-1.9±1.3	10±20	ND
78	7/13/95	-.06±0.17	.9±0.8	NR	NR

Table 3. Concentrations of selected dissolved ions in perched ground water from selected wells, Test Reactor Area, 1992-95

[Analyses were performed by the National Water Quality Laboratory. Abbreviations: (m/d/y), month/day/year; µg/L, microgram per liter; mg/L, milligram per liter. Symbols: <, less than; NR indicates analysis not requested]

Well identifier	Date (m/d/y)	Chromium (µg/L)	Hexavalent chromium (µg/L)	Sodium (mg/L)	Chloride (mg/L)	Sulfate (mg/L)
CWP-1	9/29/92	<1	<1	NR	11	NR
	5/5/93	3	<1	NR	12	NR
	10/14/93	3	1	NR	11	NR
	7/19/94	2.6	<1	NR	11	NR
	7/13/95	<5	<1	NR	23	310
CWP-2	5/5/93	<1	<1	NR	11	NR
	10/14/93	<1	<1	NR	12	NR
	7/20/94	<1	<1	NR	14	NR
	7/13/95	<5	2	NR	5.7	21
CWP-3	9/29/92	4	<1	NR	11	NR
	5/5/93	4	<1	NR	11	NR
	10/14/93	3	1	NR	11	NR
	7/20/94	3.9	<1	NR	11	NR
	7/14/95	<5	1	NR	22	260
CWP-4	9/29/92	<1	<1	NR	13	NR
	5/5/93	<1	<1	NR	11	NR
	10/14/93	2	1	NR	11	NR
	7/20/94	<1	<1	NR	17	NR
	7/14/95	<5	<1	NR	8	15
CWP-5	5/5/93	<1	<1	NR	11	NR
	10/14/93	3	1	NR	11	NR
	7/20/94	<1	<1	NR	11	NR
	7/14/95	<5	<1	NR	21	230
CWP-7	5/5/93	2	<1	NR	11	NR
	10/15/93	3	1	NR	11	NR
CWP-8	5/5/93	1	<1	NR	8.8	NR
	10/15/93	1	1	NR	11	NR
	7/20/94	<1	<1	NR	14	NR
	7/14/95	<5	<1	NR	15	97
PW-7	1/17/92	3	<1	NR	20	NR
	4/21/92	<1	<1	NR	19	NR

Table 3. Concentrations of selected dissolved ions in perched ground water from selected wells, Test Reactor Area, 1992-95—Continued

Well identifier	Date (m/d/y)	Chromium (µg/L)	Hexavalent chromium (µg/L)	Sodium (mg/L)	Chloride (mg/L)	Sulfate (mg/L)
PW-7-cont.	7/13/92	<1	<1	NR	19	NR
	10/28/92	<1	<1	9.8	15	NR
	4/24/93	<1	<1	NR	15	NR
	7/17/93	<1	<1	NR	14	NR
	10/22/93	<1	<1	9.6	14	NR
	4/29/94	<1	<1	NR	14	NR
PW-8	1/10/92	30	30	NR	17	NR
	4/7/92	40	22	NR	16	NR
	7/13/92	30	8	NR	17	NR
	10/13/92	17	<1	14	13	NR
	4/6/93	17	12	NR	13	NR
	7/17/93	14	12	NR	12	NR
	10/7/93	12	10	12	12	NR
	1/20/94	13	6	NR	18	NR
	4/8/94	10	<1	NR	17	NR
	7/13/94	6.4	<1	NR	13	NR
	9/29/94	11	4	12	14	NR
	1/18/95	9.7	4	NR	20	NR
	4/10/95	12	<1	NR	20	NR
	7/12/95	6	5	NR	21	250
	10/3/95	8	6	17	23	270
PW-9	1/21/92	40	26	NR	30	NR
	4/21/92	100	<1	NR	31	NR
	7/13/92	81	76	NR	29	NR
	10/15/92	100	100	22	25	NR
	2/4/93	130	110	NR	27	NR
	4/6/93	150	150	NR	25	NR
	7/20/93	9	160	NR	27	NR
	10/8/94	180	150	22	27	NR
	1/14/94	240	170	NR	26	NR
	4/25/94	220	210	NR	24	NR
	7/12/94	220	180	NR	22	NR

Table 3. Concentrations of selected dissolved ions in perched ground water from selected wells, Test Reactor Area, 1992-95—Continued

Well identifier	Date (m/d/y)	Chromium (µg/L)	Hexavalent chromium (µg/L)	Sodium (mg/L)	Chloride (mg/L)	Sulfate (mg/L)
PW-9-cont.	10/24/94	220	200	21	23	NR
	1/18/95	210	210	NR	23	NR
	4/7/95	190	130	NR	23	NR
	7/11/95	180	190	NR	23	78
	10/6/95	180	260	21	23	80
TRA A-13	7/19/93	<1	<1	NR	18	NR
	10/13/93	<1	<1	19	17	NR
	4/29/94	<1	<1	NR	18	NR
	10/31/94	<1	<1	15	24	NR
	4/27/95	<5	<1	NR	35	NR
	10/4/95	<5	<1	22	33	270
TRA A-77	1/17/92	20	<1	NR	1.4	NR
	4/10/92	11	<2	NR	1.8	NR
	7/21/92	7	<1	NR	3.8	NR
	10/29/92	4	<1	1	.7	NR
	2/5/93	10	<1	NR	.5	NR
	4/5/93	5	<1	NR	.4	NR
	7/20/93	10	<1	NR	.4	NR
	10/28/93	NR	NR	NR	.7	NR
	4/28/94	5	<1	NR	.7	NR
	10/26/94	15	<1	1.3	.7	NR
	4/25/95	9	<1	NR	1.1	NR
	10/17/95	NR	NR	NR	NR	NR
53	10/28/92	<1	92	9.0	7.2	NR
	4/19/93	170	180	NR	5.7	NR
	10/15/93	33	<10	12	12	NR
	4/18/94	250	170	NR	20	NR
	10/25/94	82	65	13	17	NR
	4/7/95	540	500	NR	32	NR
	10/4/95	590	630	19	35	200
54	1/22/92	60	27	NR	16	NR
	8/3/92	48	19	NR	11	NR

Table 3. Concentrations of selected dissolved ions in perched ground water from selected wells, Test Reactor Area, 1992-95—Continued

Well identifier	Date (m/d/y)	Chromium (µg/L)	Hexavalent chromium (µg/L)	Sodium (mg/L)	Chloride (mg/L)	Sulfate (mg/L)
54-cont.	10/16/92	66	36	12	9.4	NR
	4/19/93	24	19	NR	12	NR
	7/21/93	6	<1	NR	12	NR
	10/13/93	7	5	12	11	NR
	4/19/94	7.1	<1	NR	14	NR
	7/11/94	6.1	<1	NR	12	NR
	10/25/94	7.8	11	13	17	NR
	1/4/95	11	10	NR	21	NR
	4/7/95	10	<1	NR	19	NR
	7/12/95	6	3	NR	24	300
	10/4/95	6	4	18	21	230
55	10/16/92	20	<2	6.4	23	NR
	5/4/93	17	6	NR	24	NR
	4/18/94	53	17	NR	30	NR
	10/25/94	74	40	24	28	NR
	4/10/95	40	10	NR	22	NR
	10/4/95	53	54	22	24	35
56	4/29/93	67	54	NR	7.2	NR
	4/25/94	120	10	NR	27	NR
	10/26/94	58	50	250	22	NR
	4/18/95	81	45	NR	18	NR
	10/4/95	190	270	57	32	150
60	1/10/92	20	17	NR	110	NR
	4/7/92	20	10	NR	16	NR
	7/13/92	20	11	NR	19	NR
	9/29/92	12	<1	13	13	NR
	4/1/93	8	5	NR	13	NR
	7/17/93	7	<1	NR	12	NR
	10/7/93	4	4	11	12	NR
	4/6/94	6.5	<1	NR	16	NR
	9/29/94	8.7	3	12	14	NR
	4/10/95	9	<1	NR	21	NR

Table 3. Concentrations of selected dissolved ions in perched ground water from selected wells, Test Reactor Area, 1992-95—Continued

Well identifier	Date (m/d/y)	Chromium (µg/L)	Hexavalent chromium (µg/L)	Sodium (mg/L)	Chloride (mg/L)	Sulfate (mg/L)
60-cont.	10/3/95	7	5	17	24	280
61	4/8/92	30	14	NR	24	NR
	10/13/92	33	<1	14	17	NR
	4/12/93	35	21	NR	16	NR
	10/6/93	15	9	17	14	NR
	4/28/94	17	7	NR	14	NR
	10/27/94	22	24	12	14	NR
	4/12/95	32	7	NR	15	NR
	10/3/95	27	19	13	16	130
62	4/9/92	15	3	NR	23	NR
	10/13/92	50	10	15	14	NR
	4/12/93	70	60	NR	13	NR
	9/30/93	70	60	12	12	NR
	4/25/94	33	11	NR	18	NR
	10/24/94	22	26	13	14	NR
	4/12/95	18	<1	NR	19	NR
	10/3/95	10	6	15	20	230
63	4/9/92	70	52	NR	25	NR
	10/14/92	180	<1	15	14	NR
	4/6/93	130	9	NR	13	NR
	10/13/93	120	110	12	11	NR
	4/25/94	80	3	NR	17	NR
	10/27/94	51	50	13	17	NR
	4/7/95	33	15	NR	20	NR
	10/4/95	21	19	16	22	250
66	4/29/92	16	<1	NR	23	NR
	10/28/92	<1	<1	14	20	NR
	4/24/93	1	<1	NR	18	NR
	10/22/93	49	<10	15	14	NR
	7/28/94	100	60	15	14	NR
	7/17/95	49	30	15	15	110

Table 3. Concentrations of selected dissolved ions in perched ground water from selected wells, Test Reactor Area, 1992-95—Continued

Well identifier	Date (m/d/y)	Chromium (µg/L)	Hexavalent chromium (µg/L)	Sodium (mg/L)	Chloride (mg/L)	Sulfate (mg/L)
68	1/17/92	10	<1	NR	52	NR
	4/10/92	13	<1	NR	75	NR
	7/21/92	7	1	NR	45	NR
	10/29/92	2	<1	1,100	36	NR
	2/5/93	6	<1	NR	36	NR
	4/29/93	5	<1	NR	37	NR
	7/20/93	5	<1	NR	64	NR
	10/28/93	3	<1	1,000	36	NR
	4/29/94	5.9	<1	NR	38	NR
	10/26/94	8.5	8	890	31	NR
	4/25/95	<15	<1	NR	35	NR
	10/17/95	6	1	1,200	31	3,900
69	4/9/92	1	<1	NR	28	NR
	10/14/92	2	<1	11	19	NR
	4/13/93	3	<1	NR	17	NR
	10/12/93	3	<1	9.6	14	NR
	7/11/94	1.2	1	11	16	NR
	7/6/95	<5	2	11	16	96
70	4/9/92	60	36	NR	31	NR
	10/14/92	28	9	21	26	NR
	4/12/93	30	23	NR	19	NR
	10/7/93	29	26	13	13	NR
	4/20/94	25	15	NR	16	NR
	10/27/94	28	23	14	17	NR
	4/12/95	30	12	NR	20	NR
	10/6/95	31	22	18	20	120
71	4/22/92	53	27	NR	23	NR
	10/15/92	40	8	13	19	NR
	4/13/93	40	26	NR	19	NR
	10/12/93	50	40	12	19	NR
	4/19/94	53	28	NR	17	NR
	10/31/94	72	55	11	17	NR

Table 3. Concentrations of selected dissolved ions in perched ground water from selected wells, Test Reactor Area, 1992-95—Continued

Well identifier	Date (m/d/y)	Chromium (µg/L)	Hexavalent chromium (µg/L)	Sodium (mg/L)	Chloride (mg/L)	Sulfate (mg/L)
71-cont.	4/13/95	71	35	NR	17	NR
	10/6/95	75	56	13	16	140
72	4/10/92	2	<1	NR	26	NR
	10/29/92	3	<1	28	14	NR
	4/5/93	<1	<1	NR	17	NR
	10/28/93	<1	<1	34	16	NR
	7/6/94	2.1	<1	23	14	NR
	7/11/95	<5	1	30	14	38
73	4/13/92	71	56	NR	50	NR
	10/28/92	30	4	15	47	NR
	4/19/93	57	9	NR	68	NR
	10/18/93	95	70	19	24	NR
	5/3/94	100	10	NR	39	NR
	10/21/94	100	80	17	33	NR
	4/27/95	85	45	NR	48	NR
	10/19/95	78	23	14	32	43
74	4/22/92	82	60	NR	28	NR
78	7/13/95	<5	1	7.1	3.6	18

Table 4. Concentrations of tritium, strontium-90, and cesium-137 in perched ground water from selected wells, Idaho Chemical Processing Plant, 1992-95

[Analyses were performed by the Radiological and Environmental Sciences Laboratory. Analytical uncertainties are reported as 1s. Concentrations that are equal to or greater than the reporting level of 3 times the 1s value are shown in boldface type. Abbreviations: (m/d/y), month/day/year; pCi/mL, picocurie per milliliter; pCi/L, picocurie per liter. Symbol: NR indicates analysis not requested]

Well identifier	Date (m/d/y)	Tritium (pCi/mL)	Strontium-90 (pCi/L)	Cesium-137 (pCi/L)
PW-1	1/16/92	0.2±0.2	**12±2**	NR
	4/13/92	**2.4±0.3**	**17±2**	40±30
	8/7/92	.4±0.2	**7±2**	NR
	10/19/92	.5±0.2	**9±2**	NR
	4/28/93	0±0.2	3±2	-20±30
	7/19/93	.25±0.17	2.6±1.6	NR
	10/25/93	.14±0.18	-1±2	NR
	1/24/94	.1±0.2	2±2	NR
	4/22/94	.2±0.2	3±2	NR
	7/15/94	**.6±0.2**	**11±2**	NR
	10/21/94	.5±0.2	2±2	NR
	1/25/95	**.7±0.2**	**3.2±0.9**	NR
	4/3/95	.5±0.2	3.3±1.2	-30±40
	7/17/95	**1.0±0.2**	**5.5±0.9**	NR
	10/19/95	**.8±0.2**	1.6±0.8	NR
PW-2	1/13/92	**1.0±0.2**	6±3	NR
	4/16/92	**1.6±0.2**	**8±2**	11±29
	8/7/92	**.6±0.2**	**6±2**	NR
	10/19/92	**.8±0.2**	4±2	NR
	5/6/93	**.9±0.2**	**6±2**	20±20
	7/21/93	**1.0±0.2**	5±2	NR
	10/25/93	**.7±0.2**	0±2	NR
	4/22/94	**.6±0.2**	**5.0±1.5**	NR
	10/21/94	**1.1±0.2**	1±2	NR
	4/3/95	.5±0.2	3.2±1.2	16±17
	10/19/95	**.8±0.2**	1.3±0.9	NR
PW-3	1/16/92	.4±0.2	**14±3**	NR
	4/17/92	**1.2±0.2**	**8±2**	30±30
	7/20/92	.3±0.2	**6±2**	NR
	10/21/92	.3±0.2	**8±2**	NR
	5/5/93	.15±0.18	3±2	10±20

Table 4. Concentrations of tritium, strontium-90, and cesium-137 in perched ground water from selected wells, Idaho Chemical Processing Plant, 1992-95—Continued

Well identifier	Date (m/d/y)	Tritium (pCi/mL)	Strontium-90 (pCi/L)	Cesium-137 (pCi/L)
PW-3-cont.	7/19/93	.3±0.2	4.4±1.7	NR
	10/25/93	.4±0.2	5±2	NR
	4/29/94	.4±0.2	2±2	NR
	10/21/94	**1.9±0.2**	**8±2**	NR
	4/6/95	**.9±0.2**	**4.1±0.8**	-13±23
	10/19/95	**1.0±0.2**	1.3±1.1	NR
PW-4	1/13/92	**2.8±0.3**	**9±2**	NR
	4/16/92	**3.2±0.3**	**7±2**	0±20
	8/6/92	**1.6±0.2**	**8±2**	NR
	10/22/92	**1.7±0.2**	**8±2**	NR
	5/6/93	**1.5±0.2**	**8±2**	15±28
	7/20/93	**1.9±0.2**	**6±2**	NR
	10/20/93	**1.7±0.2**	-1.2±2.4	NR
	1/14/94	**1.1±0.2**	3±2	NR
	4/22/94	**1.2±0.2**	**7±2**	-30±20
	7/14/94	.5±0.2	4±2	NR
	10/24/94	.3±0.2	**8±2**	NR
	1/23/95	.2±0.2	**3.1±0.9**	NR
	4/19/95	.3±0.2	**5.5±0.8**	0±20
	7/17/95	.3±0.2	**5.0±0.9**	NR
	10/17/95	.2±0.2	1.6±0.9	NR
PW-5	1/21/92	.3±0.2	**10±2**	NR
	4/14/92	**2.4±0.3**	5±2	40±30
	8/12/92	.4±0.2	**7±2**	NR
	10/20/92	**.6±0.2**	**9±2**	NR
	4/27/93	.4±0.2	**6±2**	-30±20
	8/20/93	**.7±0.2**	4±2	NR
	9/28/93	.1±0.2	**6±2**	NR
	4/21/94	.14±0.18	4±2	-10±30
	10/20/94	.4±0.2	**6±2**	NR
	4/14/95	.5±0.2	**3.8±1.2**	30±30
	10/24/95	.4±0.2	1.5±1.1	NR

Table 4. Concentrations of tritium, strontium-90, and cesium-137 in perched ground water from selected wells, Idaho Chemical Processing Plant, 1992-95—Continued

Well identifier	Date (m/d/y)	Tritium (pCi/mL)	Strontium-90 (pCi/L)	Cesium-137 (pCi/L)
PW-6	1/17/92	**31.4±0.8**	3±2	NR
	4/21/92	**23±0.7**	.9±1.5	0±20
	7/17/92	**28.5±0.7**	.1±1.4	NR
	10/21/92	**31.3±0.8**	1.1±2.0	NR
	4/9/93	**30.3±0.8**	2±2	-30±30
	7/19/93	**20.8±0.6**	2±2	NR
	10/25/93	**24.1±1.0**	1±2	NR
	1/24/94	**21.5±0.9**	-1.1±1.9	NR
	4/29/94	**24.5±1.0**	-1.1±1.9	NR
	7/25/94	**23.5±0.9**	0±2	NR
	10/21/94	**24±1.0**	1.1±1.7	NR
	1/25/95	**24.5±1.0**	-.2±0.8	NR
SWP-8	7/25/94	.13±0.17	**9±2**	50±20
	7/12/95	**.8±0.2**	**5.7±1.0**	0±70
50	1/23/92	**82.5±1.6**	**195±8**	50±20
	4/29/92	**76.6±1.5**	**207±8**	-30±16
	7/23/92	**72.9±1.4**	**223±9**	30±30
	10/21/92	**72.2±1.4**	**166±7**	-11±28
	1/25/93	**74.9±1.4**	**183±8**	-16±17
	4/30/93	**74.1±1.4**	**206±8**	-20±20
	7/28/93	**69.8±1.4**	**223±9**	0±20
	10/26/93	**62.6±2.2**	**239±10**	-20±20
	4/22/94	**67.7±2.4**	**216±9**	20±30
	11/1/94	**60.6±2.1**	**217±9**	-20±30
	4/13/95	**58.4±2.1**	**164±5**	10±30
	10/16/95	**51.1±1.8**	**233±8**	0±20

Table 5. Concentrations of selected dissolved ions in perched ground water from selected wells, Idaho Chemical Processing Plant, 1992-95

[Analyses were performed by the National Water Quality Laboratory. Analytical results in milligrams per liter. Abbreviations: (m/d/y), month/day/year. Symbols: <, less than; NR indicates analysis not requested]

Well identifier	Date (m/d/y)	Sodium	Chloride	Sulfate	Nitrite plus nitrate (as nitrogen)
PW-1	1/16/92	NR	330	NR	NR
	4/13/92	NR	270	NR	NR
	8/7/92	NR	300	NR	NR
	10/19/92	190	340	NR	NR
	4/28/93	NR	260	NR	NR
	7/19/93	NR	260	NR	NR
	10/25/93	180	300	NR	NR
	1/24/94	NR	260	NR	NR
	4/22/94	NR	270	NR	NR
	7/15/94	NR	270	NR	NR
	10/21/94	160	260	NR	NR
	1/25/95	NR	260	NR	NR
	4/3/95	NR	250	NR	NR
	7/17/95	NR	280	NR	NR
	10/19/95	170	280	25	NR
PW-2	1/13/92	NR	260	NR	NR
	4/16/92	NR	230	NR	NR
	8/7/92	NR	270	NR	NR
	10/19/92	160	260	NR	NR
	5/6/93	NR	250	NR	NR
	7/21/93	NR	280	NR	NR
	10/25/93	180	290	NR	NR
	4/22/94	NR	260	NR	NR
	10/21/94	160	250	NR	NR
	4/3/95	NR	260	NR	NR
	10/19/95	170	260	25	NR
PW-3	1/16/92	NR	300	NR	NR
	4/17/92	NR	250	NR	NR
	7/20/92	NR	280	NR	NR
	10/21/92	160	270	NR	NR
	5/5/93	NR	300	NR	NR

Table 5. Concentrations of selected dissolved ions in perched ground water from selected wells, Idaho Chemical Processing Plant, 1992-95—Continued

Well identifier	Date (m/d/y)	Sodium	Chloride	Sulfate	Nitrite plus nitrate (as nitrogen)
PW-3-cont.	7/19/93	NR	290	NR	NR
	10/25/93	180	320	NR	NR
	4/29/94	NR	290	NR	NR
	10/21/94	170	270	NR	NR
	4/6/95	NR	280	NR	NR
	10/19/95	170	270	28	NR
PW-4	1/13/92	NR	270	NR	NR
	4/16/92	NR	220	NR	NR
	8/6/92	NR	310	NR	NR
	10/22/92	170	290	NR	NR
	5/6/93	NR	280	NR	NR
	7/20/93	NR	320	NR	NR
	10/20/93	180	310	NR	NR
	1/14/94	NR	280	NR	NR
	4/22/94	NR	270	NR	NR
	7/14/94	NR	270	NR	NR
	10/24/94	170	260	NR	NR
	1/23/95	NR	290	NR	NR
	4/19/95	NR	280	NR	NR
	7/17/95	NR	300	NR	NR
	10/17/95	170	270	27	NR
PW-5	1/21/92	NR	220	NR	NR
	4/14/92	NR	210	35	1.5
	8/12/92	NR	250	NR	NR
	10/20/92	160	300	NR	NR
	4/27/93	NR	270	NR	NR
	8/20/93	NR	350	NR	NR
	9/28/93	190	330	NR	NR
	4/21/94	NR	270	NR	NR
	10/20/94	160	240	NR	NR
	4/14/95	NR	290	NR	NR
	10/24/95	170	260	28	NR

Table 5. Concentrations of selected dissolved ions in perched ground water from selected wells, Idaho Chemical Processing Plant, 1992-95—Continued

Well identifier	Date (m/d/y)	Sodium	Chloride	Sulfate	Nitrite plus nitrate (as nitrogen)
PW-6	1/17/92	NR	89	NR	NR
	4/21/92	NR	170	NR	NR
	7/17/92	NR	160	NR	NR
	10/21/92	94	150	NR	NR
	4/9/93	NR	190	NR	NR
	7/19/93	NR	210	NR	NR
	10/25/93	95	200	NR	NR
	1/24/94	NR	220	NR	NR
	4/29/94	NR	200	NR	NR
	7/25/94	NR	210	NR	NR
	10/21/94	90	200	NR	NR
	1/25/95	NR	170	NR	NR
SWP-8	7/25/94	190	280	NR	1.6
	7/12/95	200	330	47	5.4
50	1/23/92	NR	73	NR	NR
	4/29/92	NR	69	NR	NR
	7/23/92	NR	72	NR	NR
	10/21/92	65	67	NR	34
	1/25/93	NR	69	NR	NR
	4/30/93	NR	71	NR	NR
	7/28/93	NR	69	NR	NR
	10/26/93	67	68	NR	61
	4/22/94	NR	68	NR	NR
	11/1/94	62	67	NR	35
	4/13/95	NR	68	NR	NR
	10/16/95	63	60	42	34

Table 6. Concentrations of tritium, strontium-90, cesium-137, selected transuranic elements, and dissolved chloride in perched ground water from a well at the Radioactive Waste Management Complex, 1992-94

[Analyses were performed by the Radiological and Environmental Sciences Laboratory and the National Water Quality Laboratory. Analytical uncertainties are reported as 1s. Concentrations that meet or exceed the reporting level of 3 times the 1s value are shown in boldface type. Abbreviations: (m/d/y), month/day/year; pCi/mL, picocuries per milliliter; pCi/L, picocuries per liter; mg/L, milligram per liter. Symbol: NW indicates not enough water for analysis]

Well identifier	Date (m/d/y)	Tritium (pCi/mL)	Strontium-90 (pCi/L)	Cesium-137 (pCi/L)	Plutonium-238 (pCi/L)	Plutonium-239, 240 (undivided) (pCi/L)	Americium-241 (pCi/L)	Chloride (mg/L)
USGS 92	4/27/92	0.4±0.2	-1±2	10±30	-0.012±0.026	0.001±0.017	0.03±0.03	89
	10/27/92	.2±0.2	NW	0±20	-.01±0.03	.015±0.016	**.14±0.04**	NW
	11/1/94	0±0.2	.3±1.6	10±30	**.39±0.05**	-.01±0.02	.01±0.03	86