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Monitoring System and Installation Plan for Operable Unit 3-13, Group 4, Perched Water Well Installation

IDAHO NATIONAL ENGINEERING & ENVIRONMENTAL LABORATORY

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ACRONYMS

AA	alternative action
amsl	above mean sea level
ARAR	applicable or relevant and appropriate requirements
BBWI	Bechtel BWXT Idaho, LLC
bgs	below ground surface
BLR	Big Lost River
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulation
COC	contaminant of concern
CPP	(Idaho) Chemical Processing Plant
DOE	U.S. Department of Energy
DOE-ID	U.S. Department of Energy Idaho Operations Office
DQO	Data Quality Objective
DR	decision rule
DS	decision statement
EPA	Environmental Protection Agency
ESD	experiment specification document
FFA/CO	Federal Facilities Agreement and Consent Order
FSP	Field Sampling Plan
FY	fiscal year
HASP	Health and Safety Plan

HI	hazard index
IDAPA	Idaho Air Pollution Act
IDEQ	Idaho Department of Environmental Quality
INEEL	Idaho National Engineering and Environmental Laboratory
INTEC	Idaho Nuclear Technology and Engineering Center
LSIT	Large Scale Infiltration Test
MCL	maximum contaminant level
MDL	method detection limit
MSIP	Monitoring System and Installation Plan
MW	Monitoring Well
OU	Operable Unit
OUL	Ozark Underground Laboratory
PSQ	principal study question
PW	Perched Water
QAPjP	Quality Assurance Project Plan
RAO	Remedial Action Objective
RD/RA	Remedial Design/Remedial Action
RG	remedial goal
RI/BRA	Remedial Investigation/Baseline Risk Assessment
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
SOW	Statement of Work
SRPA	Snake River Plain Aquifer
TBC	to be considered
TRA	Test Reactor Area
USGS	United States Geological Survey

WAG	Waste Area Group

Monitoring System and Installation Plan for Operable Unit 3-13, Group 4, Perched Water Well Installation

1. INTRODUCTION

The Idaho National Engineering and Environmental Laboratory (INEEL) is divided into 10 waste area groups (WAGs) to better manage environmental operations mandated under a Federal Facility Agreement and Consent Order (FFA/CO) (Department of Energy-Idaho Operations Office [DOE-ID] 1991). The Idaho Nuclear Technology and Engineering Center (INTEC), formerly the Idaho Chemical Processing Plant (CPP), is designated as WAG 3. Operable Unit (OU) 3-13 encompasses the entire INTEC facility.

Operable Unit 3-13 was investigated to identify potential contaminant releases and exposure pathways to the environment from individual sites as well as the cumulative effects of related sites. Ninety-nine release sites were identified in the OU 3-13 Remedial Investigation/Feasibility Study (RI/FS), of which, 46 were shown to have a potential risk to human health or the environment (DOE-ID 1997a). A new operable unit, OU 3-14, was created specifically to address activities at the Tank Farm area where special actions will be required. The 46 sites were divided into seven groups based on similar media, contaminants of concern (COC), accessibility, or geographic proximity. The OU 3-13 Record of Decision (ROD) (DOE-ID 1999) identifies remedial design/remedial action (RD/RA) objectives for each of the seven groups. The seven groups include:

- Tank Farm Soils (Group 1)
- Soils Under Buildings and Structures (Group 2)
- Other Surface Soils (Group 3)
- Perched Water (Group 4)
- Snake River Plain Aquifer (Group 5)
- Buried Gas Cylinders (Group 6)
- SFE-20 Hot Waste Tank System (Group 7).

The final ROD for OU 3-13 was signed in October 1999 (DOE-ID 1999). This comprehensive ROD presents the selected remedial actions for the seven groups, including Group 4 perched water instrumentation to assess the perched water drain-out and potential contaminant flux into the Snake River Plain Aquifer (SRPA).

This Monitoring System and Installation Plan (MSIP) identifies and describes in detail the work elements required to implement the selected remedies presented in the ROD, and provides a detailed project budget and work schedule, including FFA/CO enforceable milestones. The Monitoring Report/Decision Summary Report, a primary document, will be produced using data from Phase I and II activities to document the data, rationale, and justification for decisions concerning whether a third phase of contingent remedial actions is needed subsequent to the completion of Phase II activities. An updated Long-Term Monitoring Plan will be included as a part of this report. This report will function as the Remedial Action Report for Group 4 activities.

1.1 Regulatory Background

Under the FFA/CO, the U.S. Environmental Protection Agency (EPA), the Idaho Department of Environmental Quality (IDEQ), and the U.S. Department of Energy (DOE) (collectively known as the Agencies) are directing cleanup activities to reduce human health and environmental risks to acceptable levels at INTEC. Per the FFA/CO, INTEC is designated as WAG 3. In order to facilitate remediation of the INTEC, WAG 3 was further divided into OUs comprised of individual contaminant release sites.

Several phases of investigation have been performed at the WAG 3 OUs. A comprehensive RI/FS (DOE-ID 1997a, 1997b, 1998) was conducted for OU 3-13 to determine the nature and extent of contamination and corresponding potential risk to human health and the environment under various exposure pathways and scenarios. Based on the RI/FS results, INTEC release sites were further segregated into seven groups based on contaminants of concern, accessibility, or geographic proximity, to allow development of remedial action alternatives. The INTEC Perched Water was designated as Group 4 by the OU 3-13 ROD.

The INTEC Perched Water does not currently pose a direct human health and/or environmental threat. This perched water exists primarily as a result of INTEC water usage. The effect of the several potential sources are being evaluated as part of this plan, including the percolation ponds, the sewage treatment lagoons and the Big Lost River (BLR). The perched water is not used as a source of drinking water and is expected to disappear when INTEC operations cease. However, perched water does pose a threat as a contaminant transport pathway to the SRPA. The perched water zone may impact SRPA groundwater quality because it is a contaminant transport pathway between contaminated surface soils and the SRPA. Although a future water supply well screened in the perched water is not capable of providing sufficient water for domestic use purposes, restrictions will be required to prevent any future attempts to use perched water after 2095 when INEEL-wide institutional controls are projected to end. The Remedial Action Objectives (RAOs) for perched water, as stated in the ROD (DOE-ID 1999) are:

a. "Prevent migration of radionuclides from perched water in concentrations that would cause SRPA groundwater outside the INTEC security fence to exceed a cumulative carcinogenic risk of 1×10^{-4}, a total hazard index (HI) of 1, or applicable State of Idaho groundwater quality standards such as maximum contaminant levels (MCLs) in 2095 and beyond.

b. Prevent excavations into and drilling through the contaminated earth materials remaining after the desaturation of the perched water, to prevent exposing the public to a cumulative carcinogenic risk of 1×10^{-4}, a total HI of 1, and protection of the SRPA to meet Objective 3a listed above."

A response action is necessary to minimize or eliminate the leaching and transport of contaminants from the perched water to the SRPA and to prevent future perched water use.

1.2 Selected Remedy

The selected remedy for the Group 4, Perched Water is institutional controls with aquifer recharge control. As described and defined by the OU 3-13 ROD, this remedy includes:

1. "Implement institutional controls (to include a DOE-ID Directive limiting access) to prevent perched water use while INTEC operations continue and to prevent future drilling into or through the perched zone (through noticing this restriction to local county governments,

Sho-Ban Tribal Council, General Services Administration, Bureau of Land Management, and other agencies as necessary)."

Implementation: This remedy is being implemented through Institutional Controls Projects identified and described in the OU 3-13 RD/RA Statement of Work (SOW).

2. "Implement remedies to control surface water recharge to perched water beneath INTEC by specifically taking the existing INTEC percolation ponds, which are estimated to contribute ~ 70% of the perched water recharge, out of service. Limiting infiltration to the perched water will minimize potential releases to the SRPA by reducing the volume of water available for contaminant transport. Design, construct, and operate replacement ponds outside of the INTEC perched water area following the removal of the existing INTEC percolation ponds from service. The replacement percolation ponds will be sited ~ 3,048 m (10,000 ft) southwest of the INTEC and will be operational on or before December 2003."

   Implementation: This remedy is being implemented through the INTEC Service Wastewater Discharge Facility Project (INEEL/EXT-99-00904).

3. "In addition, minimize recharge to the perched water from lawn irrigation, and lining the Big Lost River segment contributing to the INTEC perched water zones, if additional infiltration controls are necessary. Implement additional infiltration controls if the recession of the Perched Water zone does not occur as predicted by the RI/FS vadose zone model within five years of removing the percolation ponds. If implementation of the additional infiltration controls is necessary, implement as a second phase to the Group 4 remedy."

   Implementation: A decision on whether this remedy is needed will be based on data collected during the five years of monitoring following the relocation of the percolation ponds. This remedy may require an Explanation of Significant Difference to the OU 3-13 ROD and is not included in the RD/RA SOW.

4. "Measure moisture content and COC concentration(s) in the perched water zones to determine if water contents and contaminant fluxes are decreasing as predicted. Also use these data to verify the OU 3-13 vadose zone model and determine potential impacts to the SRPA."

   Implementation: This MSIP describes and defines the activities intended to meet item number 4 of the remedy for Group 4. The MSIP will measure moisture content and COC concentrations in the perched water to determine if water contents and contaminant fluxes are decreasing as predicted by the OU 3-13 vadose zone model and to provide aquifer recharge control from the INTEC perched water bodies. These data will then be used to determine potential impacts to the SRPA. Data collected and analyzed will be used to determine the need for additional infiltration controls beyond the scope of this MSIP.

1.3 Scope

1.3.1 Project Description

The Group 4 remedial action requires relocation of the INTEC percolation ponds. Contingent recharge controls may also be implemented if the relocation of the percolation ponds is determined insufficient to meet the Group 4 RAOs. The OU 3-13 ROD further requires that five years after relocation of the percolation ponds, a decision will be made whether to apply the contingent recharge controls based upon the analysis of the five years of monitoring and predictions of the perched water drain-out until 2095. Results of the current remedial action and any contingent remedial actions, if applied, will be re-evaluated every five years in the Comprehensive Environmental Response, and Compensation, and Liability Act (CERCLA) five-year review process, for a minimum of 15 additional years.

Group 4 Phases I and II, as described in this work plan and associated monitoring plans, will take this project to the point of the initial decision regarding contingent remedial action. This initial decision will be made five years after the percolation pond relocation. This work plan describes well installation, tracer study, and sampling and analysis activities associated with Phase I and the first five years of Phase II of the Group 4 remedy. Following the initial five years of monitoring the effects of percolation pond relocation, a Monitoring Report/Decision Summary will be prepared that documents monitoring data, rationale, and justification for the decision about whether there is a need for contingent remedial action.

The scope for these phases is described in greater detail in Sections 4 and 5 of this report and the attached Phase I and Phase II sampling plans. A logic diagram which describes the flow of activities for Phases I and II is presented in Figure 1-1.

1.3.2 Other Projects Implementing Remedy Scope

There are other remedial action elements related to Group 4 that are being addressed as projects separate from the SOW of this project. The specific tasks and the projects where they are being handled are shown below:

Implementation of institutional controls— This work scope is intended to prevent perched water use while INTEC operations continue and to prevent future drilling into or through the perched water zone. This project is being addressed as a part of the Group 8 Institutional Controls Plan.

Implementation of remedies to control surface water recharge— This work scope is intended to reduce the perched water beneath INTEC specifically by taking the existing INTEC percolation ponds out of service. The design, construction, and operation of replacement ponds outside of the INTEC perched water area is being addressed by the OU 3-13 Service Waste Water Discharge Facility project.

OU 3-13, Group 5, SRPA Outside the INTEC Security Fence Remedial Action— The Group 5 activities related to Group 4's RAOs include monitoring of COC flux across and outside the INTEC security fence in the SRPA, as well as measuring COC concentrations both above and below the HI interbed. These data will be used in conjunction with the Group 4 data in determining if the Group 4 RAOs are being met and if further action is necessary.

OU 3-14, Tank Farm Soil and Groundwater RI/FS— The purpose of the OU 3-14 RI/FS is to gather additional information to support risk management decisions about contaminated soils in the tank farm at INTEC and groundwater within the INTEC security fence.

The data from the above projects will be evaluated along with the data generated during the Group 4 monitoring activities. All these data will be analyzed together to determine the best possible path forward for the remediation of the INTEC vadose zone and groundwater.

1.4 MSIP Work Plan Organization

This MSIP was prepared following the methodology outlined in the Remedial Design and Remedial Action Guidance for the Idaho National Engineering and Environmental Laboratory (DOE-ID 1994) and the requirements outlined in the Guidance on Expediting Remedial Design and Remedial Action (EPA/540/G-90/006). The information developed and presented in this MSIP builds on the decisions made and documented in the OU 3-13 ROD and the RD/RA SOW for Waste Area Group 3, Operable Unit 3-13. The organization of the remainder of this MSIP is as follows:

- Section 2—Site Description and Background—Provides a description of the site geology, hydrology, and nature and extent of contamination

- Section 3—Design Criteria—Provides a description of the project and the design requirements and provisions

- Section 4—Design Basis—Provides a status of the OU 3-13 ROD assumptions, a discussion of the modeling of the perched water and aquifer, and an evaluation of how the project applicable or relevant and appropriate requirements (ARARs) will be met

- Section 5—Remedial Design—Provides a discussion of the Phases I, Phase II, and Tracer Study design elements

- Section 6—Remedial Action Work Plan—Provides an overview of the remedial action elements, any changes to the RD/RA SOW, an evaluation of performance measures, and a summation of the key guidance documents

- Section 7—Reporting—These reviews include CERCLA five-year reviews and the assessment of the drain-out of the perched water bodies five years after the percolation pond relocation.

- Section 8—References—Key documents that will be used to guide and direct the execution of the project tasks.

2. SITE DESCRIPTION AND BACKGROUND

2.1 Site Background

The INEEL is a U.S. Government-owned facility managed by the U.S. DOE. The eastern boundary of the INEEL is located 52 km (32 mi) west of Idaho Falls, Idaho. The INEEL site occupies approximately 2,305 km^2 (890 mi^2) of the northwestern portion of the Eastern Snake River Plain in southeast Idaho. The INTEC facility covers an area of approximately 0.39 km^2 (0.15 mi^2), and is located approximately 72.5 km (45 mi) from Idaho Falls, in the south-central area of the INEEL as shown in Figure 2-1.

The INTEC has been in operation since 1952. The plant's original mission was to reprocess uranium from defense-related projects, and research and store spent nuclear fuel. The DOE phased out the reprocessing operations in 1992 and redirected the plant's mission to (1) receipt and temporary storage of spent nuclear fuel and other radioactive wastes for future disposition, (2) management of current and past wastes, and (3) performance of remedial actions.

The liquid waste generated from the past reprocessing activities is stored in an underground Tank Farm. The INTEC Tank Farm consists of eleven 1,135,624 L (300,000 gal) tanks, four 113,562 L (30,000 gal) tanks, four 68,137 L (18,000 gal) tanks, and associated equipment for the monitoring and control of waste transfers and tank parameters. One of the 1,135,624 L (300,000 gal) tanks serves as a spare tank and is always kept empty in the event of an emergency. The majority of wastes stored in the Tank Farm are raffinates generated during the first-, second-, and third-cycle fuel extraction processes. These wastes include high-level wastes that are composed of first- and second-cycle raffinates and intermediate-level wastes that are composed of third-cycle raffinates blended with concentrated bottoms from the process equipment waste evaporator. This liquid waste continues to be treated by a calcining process to convert the waste into a more stable form and to reduce the waste volume.

Numerous CERCLA sites are located in the area of the Tank Farm and adjacent to the process equipment waste evaporator. Contaminants found in the interstitial soils of the Tank Farm are the result of accidental releases and leaks from process piping, valve boxes, sumps, and cross-contamination from operations and maintenance excavations. No evidence has been found to indicate that the waste tanks themselves have leaked. The contaminated soils at the Tank Farm comprise about 95% of the known contaminant inventory at INTEC. The final comprehensive RI/FS for OU 3-13 (DOE-ID 1997b) contains a complete discussion of the nature and extent of contamination.

The formulation of the perched water zone is a result of natural flows from the BLR and operations of the percolation ponds. The percolation ponds have come on line in a staggered manner. The pond directly south of the plant (Pond 1) began receiving service waste in 1984. The southeastern pond (Pond 2) came on line in 1986. The ponds have received all plant service wastewater since use of the injection well was discontinued in 1984. The ponds are filled on an annual alternating schedule. The two ponds received Resource Conservation and Recovery Act clean-closure equivalency for metals contamination in 1994 and 1995. This means that only the remaining radionuclides need to be addressed under CERCLA. Construction of new ponds to the west of the present facility are part of Group 4, Phase 1 activities under the 1999 ROD, but are outside the scope of this Field Sampling Plan (FSP).

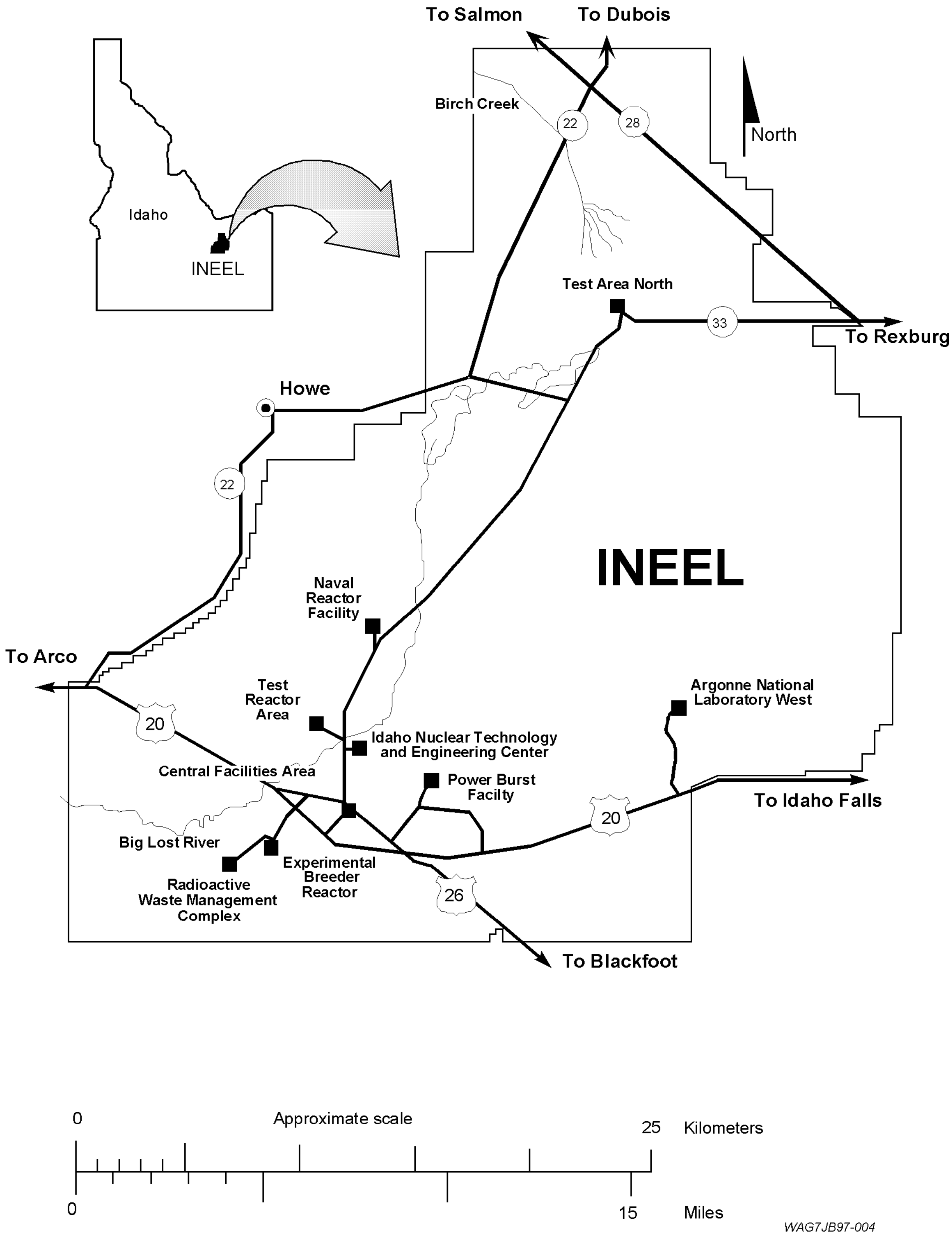

Figure 2-1. Map showing location of the INTEC at the INEEL.

2.2 Conceptual Model

2.2.1 Geological Setting

The geology of the site includes about 13.7 m (45 ft) of surficial alluvium deposited by the BLR. The BLR is an intermittent stream, and flow is lost by infiltration through the riverbed. Underneath the alluvium are several thousand feet of relatively thin fractured basalt flows. Interspersed between some of the basalt flows are sedimentary interbeds ranging in thickness from a few inches to a few feet. Some of the interbeds are fairly continuous, others are not. The SRPA is located at about 137 m (450 ft) below ground surface (bgs) at the INTEC site.

2.2.2 Hydrologic Setting

Several sources of water contribute to moisture movement and the development of perched water in the INTEC subsurface. The two major recharge sources are the percolation ponds (bottom center, Figure 2-2) and the BLR (upper left, Figure 2-2). An average of 4.39 million liters (1.16 million gallons) of wastewater is discharged to the percolation ponds each day. Depending on the snowpack and precipitation that occurs in a particular year, the BLR may flow all year or cease to flow entirely for several months or years. The mean annual flow in the BLR at a point near the INTEC site is 42,467,544 m^3/month (34,429 acre-ft/month). Together, these two sources are thought to supply about 90% of the recharge. The wastewater treatment lagoons (upper right, Figure 2-2), operational activities, and precipitation account for the remaining recharge. Average annual discharge to the wastewater treatment lagoons is 52,617 m^3/yr (13.9 M gallons/yr). Operational losses are variable and not well quantified. The mean annual precipitation at the INEEL is approximately 21.5 cm/yr (8.5 in./yr). Usually, less than half of this occurs as snowfall. The collection of precipitation in local basins can supply substantial amounts of focused infiltration.

As the wetting front moves downward through the surficial sediments, it may move through contaminated sediments where the contaminants may be mobilized and transported. The water continues its downward movement until it encounters an underlying fractured basalt flow where it is likely to collect and move laterally along the sediment/basalt interface until it encounters preferential pathways that may be associated with a fracture network or permeable rubble zones between basalt flows. In the basalt, the majority of water is believed to flow as a saturated front through high permeability systems consisting of fractures and permeable interflow zones. This results in rapid water movement through the entire fractured basalt portion of the subsurface.

If the infiltrating water encounters sedimentary interbeds, the water may spread laterally moving downgradient. A permeability contrast between the interbed, the fractures, and the basalt matrix causes the water to pond and spread. One result of this contrast is the development of perched water in association with the interbeds. The perching may occur either on the interbeds or dense basalt. However, most of the perched water at INTEC appears to be associated with the interbeds.

The extent to which water moves horizontally while vertically transiting the fractured basalts is uncertain. Water has been shown to move laterally several miles in the subsurface when sufficient water was available to support long lateral spread. Eventually, water infiltrating at the surface of the INTEC will reach the underlying SRPA.

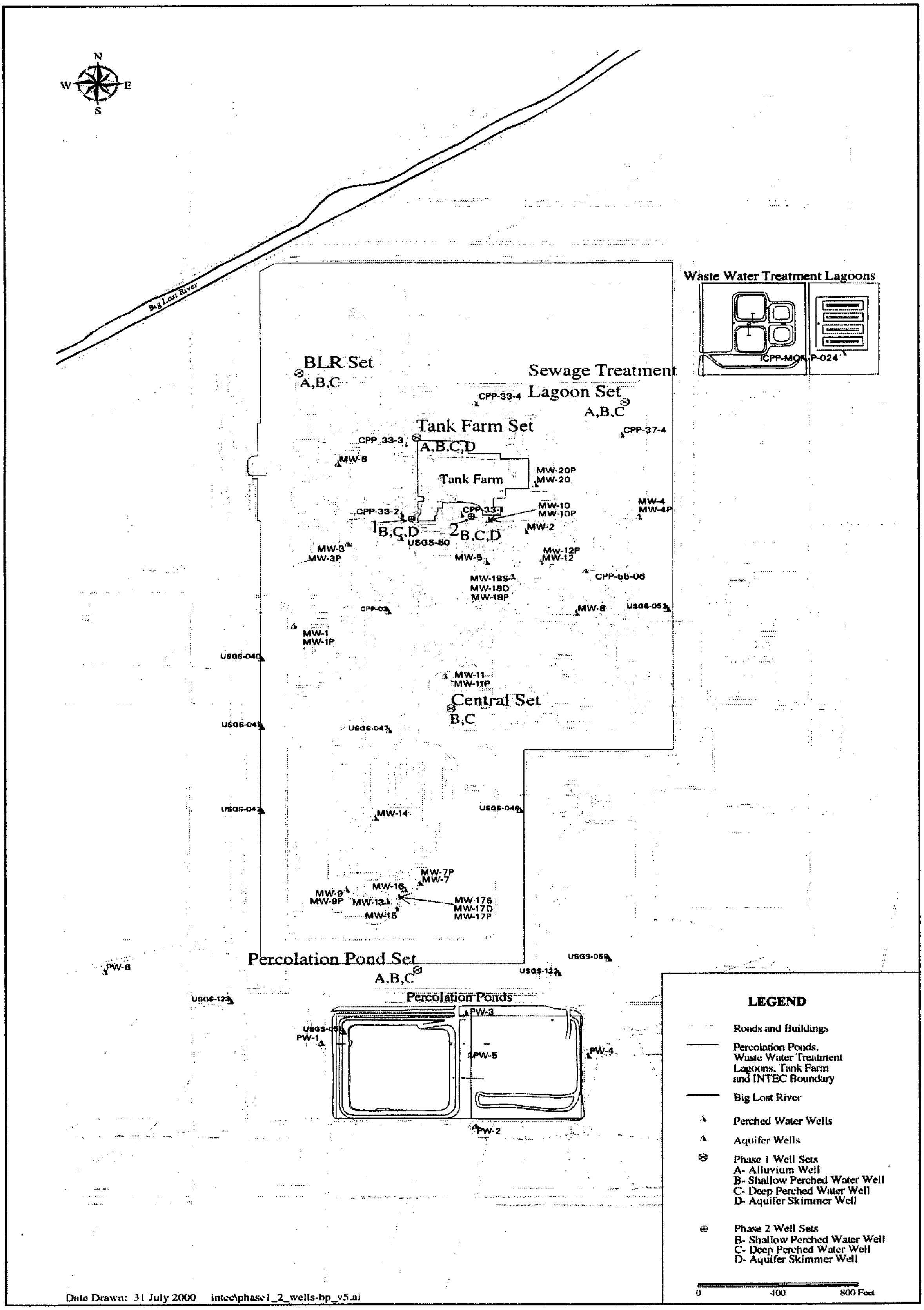

Figure 2-2. Map of INTEC showing existing and proposed wells.

2.3 Perched Water

Perched water bodies are significant because they increase the opportunity for contaminants to move both laterally and vertically in the vadose zone. This lateral water and contaminant movement in the vadose zone results in vertical migration rates that are spatially nonuniform beneath the INTEC. Infiltration from the surface is assumed to move vertically through the basalt to an interbed. The water and contaminants migrate along the interbed and accumulate at interbed low points because the interbeds are sloped. This results in greater than average vertical water and contaminant fluxes in water accumulation areas and less than average vertical water and contaminant fluxes in the elevated portions of the interbed. Perched water bodies increase the complexity of flow and transport through the vadose zone.

Several zones of perched water have developed in the vadose zone as a result of site operations and natural recharge sources. The perched water bodies have been found in three zones in the subsurface:

- The interface between the surface alluvium and the shallowest basalt flow.
- An upper zone associated with the CD and DE3 interbeds at depths between 34 and 53 m (113 ft and 170 ft) bgs. This shallow zone is further subdivided into an upper shallow zone and a lower shallow zone.
- A lower zone associated with the DE6 and DE8 interbeds at a depth of about 97 to 128 m (320 to 420 ft) bgs.

Figure 2-3 shows a geologic cross-section running from north to south through the INTEC. The names of the basalt flows and interbeds are shown in the figure. Also depicted are locations where perched water is thought to exist. The perched water has varying degrees of radionuclide concentrations, with the northern upper perched zone showing the highest concentration levels.

2.3.1 Perched Water in Surficial Alluvium

In places with a concentrated source of surface recharge, a perched water zone can develop in the surficial alluvium on top of the first basalt flow. Perched water has been identified in the alluvium at the INTEC beneath surface disposal ponds (the Percolation Ponds and the sewage treatment pond). A small perched water table in alluvium was encountered west of CPP-603. The source for the perched water was assumed to be wastewater that was discharged to a shallow seepage pit (Robertson et al. 1974).

Perched water in the surficial alluvium requires a concentrated source of recharge that exceeds the normal recharge provided by precipitation. Perched water has not been widely measured at the sediment-basalt interface.

2.3.2 Upper Perched Water Zone

As shown in Figure 2-3, the upper portion of the shallow upper perched water body is present above the CD and D interbeds, and the lower portion of the upper perched water body has been identified on the DE3 interbed. The CD interbed occurs at depths between 34 and 36 m (113 and 119 ft) bgs, the D interbed occurs at depths between 39 and 41 m (128 and 135 ft) bgs, and the DE3 interbed occurs at depths between 50 and 52 m (163 and 170 ft) bgs.

The upper perched water zone is frequently divided into the northern and southern zones because it appears to be two discrete water bodies. Figure 2-4, taken from the ROD, shows an interpretation of the approximate extent of the upper perched water zones. The actual extent of the perched water bodies could be quite different because the perched water boundaries are not well defined. Even within the upper zones, the zones appear to occur as fragmented rather than continuous perched water bodies. The connections between the perched water bodies are not well understood.

Based on the upper perched water configuration, it appears that multiple water sources are providing recharge to the upper perched water body in the northern portion of the INTEC. These sources may include recharge from the BLR, the wastewater treatment lagoons, and operational releases. The wastewater treatment lagoons, located northeast of the facility, provide approximately 4.73×10^6 L (1.25×10^6 gal) per month of recharge to the eastern side of this perched water body. This recharge has resulted in a water table elevation of approximately 1,477 m (4,845 ft) above mean sea level (amsl) in the well (CPP-MON-P-024) (see Figure 2-2, upper right) completed near the sewage treatment ponds. In the western portion of the perched water body and beneath the main portion of the facility, recharge from an unknown source has produced a water table elevation of 1,467.7 m (4,815.2 ft) amsl in Well CPP-33-2. Between the eastern and western portions of the upper perched water body, the groundwater elevation is 1,465.7 m (4,808.8 ft) amsl in Well CPP-37-4. Fluctuations in water levels in the upper perched water zone that are observed in response to flow in the river indicate a connection between the northern upper perched water and the river.

Perched water has been identified beneath two areas of the southern INTEC. A small perched water body has been identified in the vicinity of building CPP-603 and a larger perched water body has developed from the discharge of wastewater to the percolation ponds. The southern upper perched zone is thought to be primarily recharged by the percolation ponds. The water elevations in the southern perched water zone range between 1,442.4 to 1,460.0 m (4,732.4 to 4,790.2 ft) amsl north of the Percolation Ponds near Building CPP-603, and between 1,461.9 to 1,477.9 m (4,796.2 to 4,848.9 ft) amsl near the Percolation Ponds. Only two upper perched water wells (see Figure 2-2) are located between the northern and southern perched water bodies (Monitoring Well [MW]-11 and MW-14), and neither indicates perched water in these areas.

2.3.2.1 Northern Perched Water Contamination. The highest perched water radioactive contamination occurs beneath the northern portion of the INTEC, particularly associated with MW-2, MW-5, and CPP 55-06 (see Figure 2-2). The maximum gross alpha and gross beta activities measured in the upper perched groundwater were 1,140±220 pCi/L and 589,000±2,600 pCi/L respectively, in well MW-2. At a depth of approximately 42 m (140 ft), the maximum gross alpha and gross beta concentrations measured in the perched water were 137±9 pCi/L and 65,300±600 pCi/L in wells MW-10 and MW-20.

The most significant radionuclides in the upper perched water body are Sr-90 and Tc-99. Low levels of H-3 were also detected in the upper perched water zone. The low H-3 concentrations in the upper perched water zone is a significant contrast to the waste stream that was directed to the INTEC disposal well where the vast majority of the associated radioactivity consisted of H-3. Strontium-90 was detected in all wells completed in the northern area of the upper perched water zone. The maximum Sr-90 concentration detected was 320,000±3,000 pCi/L (well MW-2) followed by 104,000±1,000 pCi/L (well MW-5) and 66,300±600 pCi/L (well CPP 55-06). The only other fission product detected in the upper perched groundwater is Tc-99. Tc-99 has been detected in all wells except CPP 33-4 and MW-6. The maximum Tc-99 concentration detected in the upper perched groundwater zone was 38000±500 pCi/L in well MW-10.

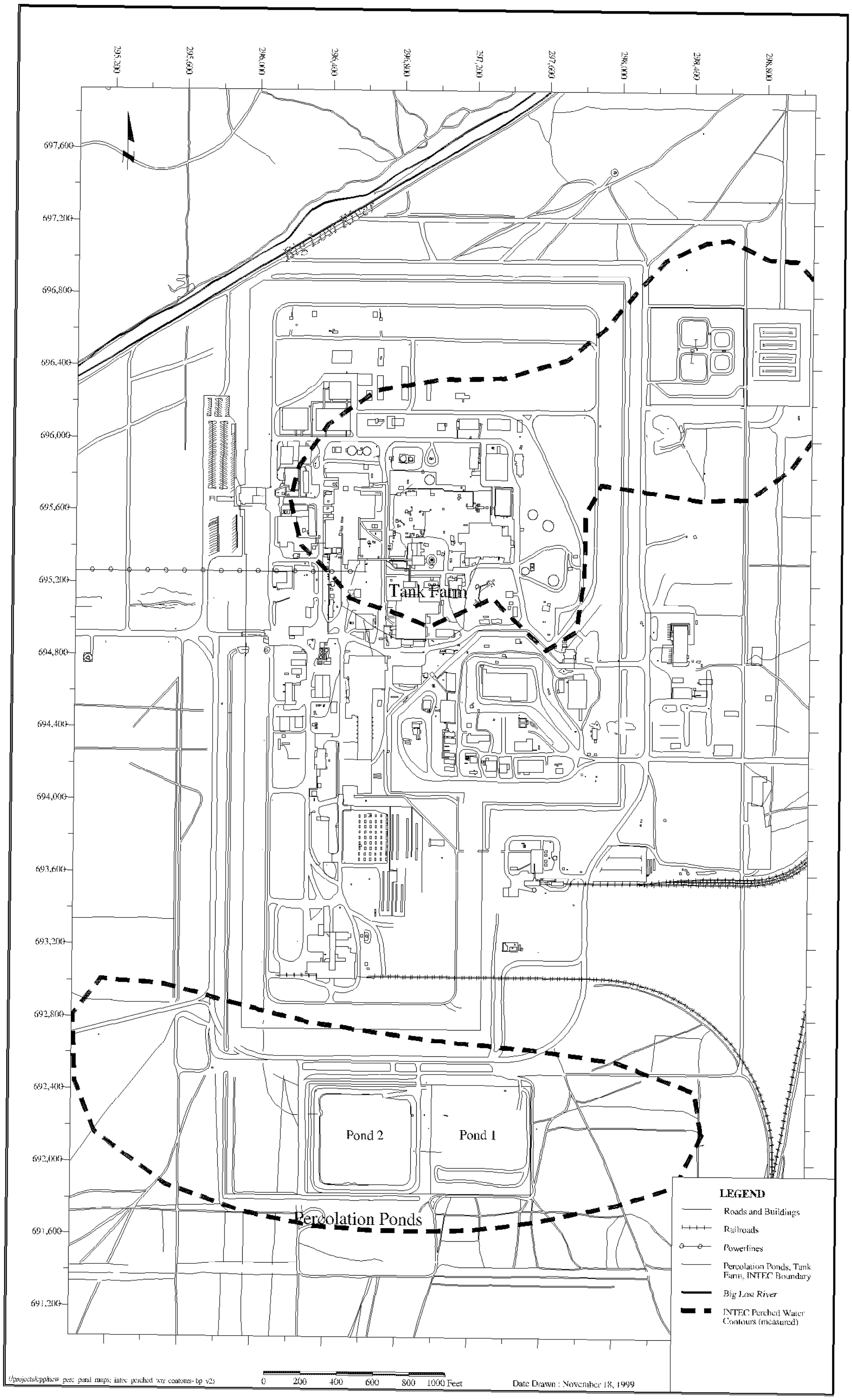

Figure 2-4. Approximate extent of the shallow Perched Water at the INTEC.

Two wells (MW-10 and MW-20) are completed in water-bearing zones at depths of approximately 42 m (140 ft). The maximum concentrations for H-3, Sr-90, and Tc-99 from these wells are 38,000±50 pCi/L, 25,800±30 pCi/L, and 127±2 pCi/L respectively. A comparison of the water quality from the wells completed in the upper perched groundwater body (at approximately 33 m [110 ft]) to this deeper zone indicates an increase in both H-3 and Tc-99 concentrations and a decrease in the Sr-90 concentrations.

2.3.2.2 Southern Perched Water Contamination. Wells that monitor the perched water quality in the upper southern perched water zone around CPP-603 include MW-7, MW-9, MW-13, MW-14, MW-15, MW-16, and MW-17. From the inorganic analysis, only nitrate/nitrite was detected at a concentration exceeding the MCL at well MW-15 (14.7 mg/L). The radionuclides detected in the perched water include H-3 (3,360±176 to 25,700±400 pCi/L) and Tc-99 (6.4±0.6 to 23.7±0.6 pCi/L). In addition, Sr-90 and U-234 were detected in MW-15 at concentrations of 17,200±200 pCi/L and 11.8±1 pCi/L, respectively.

Perched water in the percolation pond area is monitored by six wells, designated as perched water (PW)-1 through PW-6, which monitor the upper-most perched water body associated with wastewater discharge to the percolation ponds. These wells have been monitored by the United States Geological Survey (USGS) since 1987. Wells PW-1, PW-2, PW-4, and PW-5 have been sampled on a quarterly basis as part of the INTEC groundwater-monitoring program since 1991 (INEEL 1995).

Most of the historical radioactivity present in the PW-series wells is from H-3, with Sr-90 providing a secondary activity contribution. According to the USGS monitoring, activities from both H-3 and Sr-90 have remained relatively stable with the exception of an increased H-3 activity period in mid-1988. Average H-3 concentrations range from 1,334±421 to 4,681±567 pCi/L with Sr-90 concentrations averaging 3.7±3.4 pCi/L.

2.3.3 Lower Perched Water Zone

A deep perched water zone has been identified in the basalt between 98 and 128 m (320 and 420 ft) bgs. This one was first discovered in 1956 when perched groundwater was encountered at a depth of 106 m (348 ft) while drilling well USGS-40 (Robertson et al. 1974). Since then, perched water has been encountered in this zone during the drilling of wells USGS-41, USGS-43, USGS-44, USGS-50, USGS-52, MW-1, MW-17, and MW-18. Borehole neutron logs run from wells USGS-40, USGS-43, USGS-46, USGS-51, and USGS-52 indicate that in 1993 perched water may still have been present in this zone.

Only four wells are completed in the deep perched water zone. Wells MW-1, MW-18, and USGS-50 are completed in the northern portion of the facility, and water has been encountered at approximately 85, 107.5, and 101 m (322, 407, and 383 ft) bgs, respectively. In the southern portion of the INTEC facility, only well MW-17D is completed in the lower perched water zone in which water is encountered at a depth of approximately 96 m (364 ft) bgs (see Figure 2-2).

Similar to the upper perched water zone, it is thought that the lower perched water zone is formed by decreased permeability associated with sedimentary interbed layers. It appears that the lower perched water has formed primarily on the DE7 interbed (see Figure 2-3). The top of this interbed occurs beneath the INTEC at depths ranging from 101 to 112.5 m (383 to 426 ft) bgs in the western portion of the INTEC facility. However, the DE6 interbed is responsible for creating perched water associated with Wells USGS-40 and USGS-43. The lower perched water zone is not continuous beneath the entire facility and may actually consist of several individual perched water bodies. Recharge to the southern perched water body is from service wastewater discharged to the percolation ponds. The source of recharge to the western portion of the northern perched water body is unknown, though the BLR and facility water leaks are likely contributors.

Water levels in the lower perched water zone have been monitored since the early 1960s in Well USGS-50. The water level in this well has been fairly consistent, ranging between 1,381 and 1,384 m (4,530 and 4,540 ft) amsl. In the late 1960s and 1970s, however, the water level increased by approximately 27.4 m (90 ft) in response to failure of the INTEC injection well, Site CPP-23. During this period, wastewater was discharged directly to the vadose zone from the INTEC injection well at a reported depth of 69 m (226 ft) bgs (Fromm et al. 1994). Measurements made in 1966 showed that the well was intact. Therefore, most of the collapse took place in 1967 or early 1968. The period when the INTEC injection well was plugged and discharged directly into the vadose zone has resulted in a thick zone of contamination underlying INTEC. This zone serves as a possible source of contamination to the deep perched water zone and complicates any interpretation of contamination in the subsurface.

In September 1970, a drilling contractor began to redrill and reline the injection well to its original depth. By October, deepening had progressed to about 152.4 m (500 ft) and the water level in the well had resumed its normal depth at about 138.7 m (455 ft). During the well repair, wastewater was disposed of to USGS-50. The injection well collapsed again and had to be reopened to the water table in late 1982. At this time, a high-density polyethylene liner 25.4 cm (10 in.) in diameter was placed in the well from ground level to the bottom of the well. The liner was perforated from 137 m (450 ft) bgs (approximately 2.4 m [8 ft] above the water table) to the bottom of the well. On February 7, 1984, the injection well was taken out of routine service, and wastewater is now pumped to percolation ponds 1 and 2.

2.3.3.1 Lower Perched Water Contamination. Contamination in the lower portion of the vadose zone is different in composition from the upper perched zone. The lower vadose zone perched water contamination results from the two INTEC injection well (Site CPP-23) collapses where service wastewater was released into the vadose zone above the lower sediment and the migration of upper perched water toward the SRPA. Lower perched water is monitored at the INTEC by wells MW-1, MW-17, MW-18, and USGS-50 that are completed in water-bearing zones occurring at depths between 99.4 to 102.4 m (326 to 336 ft), 109.7 to 116.1 m (360 to 381 ft), 120.1 to 126.2 m (394 to 414 ft), and 109.7 to 123.4 m (360 to 405 ft) respectively. Historically, two rounds of perched water samples have been collected from MW-1, one round of perched water samples has been collected from MW-17 and MW-18, and a substantial database concerning radioactive contaminants is available for the water quality from USGS-50. Results from these water-sampling events are described in the WAG 3 RI/FS Work Plan (INEEL 1995).

Well MW-1 is located in the northern INTEC. Nitrate/nitrite was detected at a concentration of 69.6 mg/L. The radionuclides detected in water samples from well MW-1 include Sr-90 (4.5±0.4 pCi/L) and H-3 (24,700±400 pCi/L). Of these contaminants, only H-3 was measured above the federal primary MCL of 20,000 pCi/L. Since H-3 concentrations in the deep perched water zone are higher than the H-3 concentrations in the overlying perched water bodies, the source of this contamination is either a historical release where the contaminants have moved through the system, or wastewater disposal to the ICPP injection well.

Well MW-18 is completed in the deeper perched water zone near the eastern boundary of the INTEC. From the June 1995 sampling event, only nitrate/nitrite concentration at 34.4 mg/L exceeded either a federal primary or secondary MCL. The radionuclides detected in the deep perched groundwater at this location include H-3 (73,000±700 pCi/L), Sr-90 (207±2 pCi/L), and Tc-99 (736±6J pCi/L). The H-3 and Tc-99 concentrations from this well are some of the highest concentrations measured in the perched water beneath the ICPP.

USGS-50 was originally intended to be completed in the SRPA, but was ultimately drilled to a total depth of 123 m (405 ft) to monitor a lower perched water zone. This well is located in the north central portion of the facility. The highest concentrations of H-3 and Sr-90 occurred in 1969 and 1970. These elevated concentrations were attributed to the failure of the ICPP disposal well where the wastewater was injected into the vadose zone rather than directly to the aquifer.

From the May 1995 water sampling of USGS-50, the concentrations of all chemical contaminants except nitrate/nitrite were below federal primary or secondary MCLs. Nitrate/nitrite concentration was measured at 31.3 mg/L, compared to the federal primary MCL of 10 mg/L. Radionuclides in the perched water that were detected include H-3 (61,900±700 pCi/L), Sr-90 (151±2 pCi/L), and Tc-99 (63±1J pCi/L). The concentrations for H-3 and Sr-90 are within the expected values based on the historical sampling conducted by the USGS.

Well MW-17 is the only deep perched water monitoring well located in the southern portion of the INTEC. This well has been constructed to monitor three perched water bodies: an upper zone from 55.4 to 58.4 m (181.7 to 191.7 ft) bgs, a middle zone from 80.4 to 83.5 m (263.8 to 273.8 ft) bgs, and a lower zone from 110 to 116 m (360 to 381 ft) bgs. During the May 1995 sampling event, water was only present in the upper and lower zones. None of the chemical constituents detected in the perched water exceeded either a federal primary or secondary MCL. Only two radionuclides (H-3 and Tc-99) were detected in perched water samples collected from MW-17. The concentrations of these two radionuclides were similar between the upper and lower perched water zones. H-3 concentrations varied from 25,100±400 to 25,700±400 pCi/L, and Tc-99 concentrations varied from 5.9±0.6 to 6.4±0.6 pCi/L.

2.4 Contaminants of Concern

The COCs identified in the OU 3-13 WAG 3 baseline risk assessment are primarily radionuclides. The perched water COCs are strontium-90 and tritium (H-3), cesium-137, iodine-129, plutonium isotopes (Pu-238, -239, -240, and -241), uranium isotopes (U-234, -235, and -238), Np-237, Am-241, and Tc-99. In addition, mercury (Hg) was identified as a COC. Contamination in the upper perched water results from contaminants being leached from surface sources while contamination in the lower perched water resulted from a combination of injection well failures and contaminant migration. By Agency request, hazardous volatile organic compounds to be included with the COC analyses are 1,1,1-trichloroethane (TCA), carbon tetrachloride, trichloroethylene (TCE), tetrachloroethylene (PCE), benzene, toluene, carbon disulfide, and pyridine. The volatile organic compounds sampling will be discontinued if they are not detected at concentrations above MCLs in the initial sampling. Geochemical sampling will include cations and anions.