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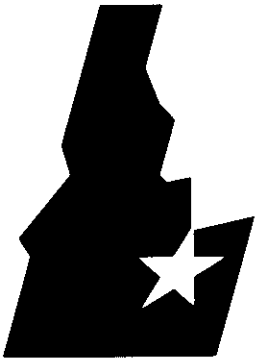
Comprehensive RI/FS for the Idaho Chemical Processing Plant OU 3-13 at the INEEL—Part A, RI/BRA Report (Final)

Binder 1 of 3



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Comprehensive RI/FS for the Idaho Chemical Processing Plant OU 3-13 at the INEEL—Part A, RI/BRA Report (Final)

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Comprehensive RI/FS for the Idaho Chemical Processing Plant OU 3-13 at the INEEL—Part A, RI/BRA Report (Final)

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SUMMARY

The Idaho National Engineering and Environmental Laboratory (INEEL) was listed on the National Priorities List of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980 in November 1989. In response to this listing, the U.S. Department of Energy (DOE), the U.S. Environmental Protection Agency (EPA), and the State of Idaho negotiated a Federal Facility Agreement/Consent Order (FFA/CO) and Action Plan. This agreement described how the DOE, the EPA, and the State of Idaho would implement CERCLA activities at the INEEL release sites. The FFA/CO and Action Plan require the DOE to implement a remedial investigation/feasibility study (RI/FS) to characterize the nature and extent of the contamination and to evaluate and implement possible response actions.

The Idaho Chemical Processing Plant (ICPP) is included as Waste Area Group (WAG) 3 of the ten INEEL WAGs identified in the FFA/CO. Operable Unit (OU) 3-13 is listed as the "WAG 3 Comprehensive RI/FS" in the FFA/CO. This RI/BRA is tasked to assemble the investigations previously conducted for WAG 3 and to thoroughly investigate the sites not previously evaluated determine the overall risk posed by the WAG. The scope of the OU 3-13 RI/FS is defined in the *WAG 3 Comprehensive RI/FS Work Plan,* (LITCO, 1995).

The WAG 3 contains 95 release sites that are classified by the following categories (except the wind-blown area): Track 2 Sites, Track 1 Sites, No Action Sites, or Newly Identified Sites (i.e., those sites not listed in the FFA/CO). With the exception of 10 sites that were originally included in the FFA/CO as No Action, the remaining 85 sites have been organized into 13 Operable Units. The OU 3-13 Comprehensive RI and Baseline Risk Assessment (BRA) relies on documents from previously conducted WAG 3 investigations (i.e., Track 1, Track 2, and Remedial Investigation documents). The previous investigations evaluated for OU 3-13 include contaminated pits, French drains, perched and aquifer water, percolation ponds, rubble piles, spills, storage areas, tanks, and injection wells. Historical disposal points for wastes include the old sewage treatment plant, the new sewage treatment plant, the percolation ponds, the CPP-603 basin water filtration system, and the injection well. Historical discharges included large quantities of plant service wastewater and sewage water that contained trace quantities of metals and radionuclides that were discharged into the percolation ponds and old sewage ponds, respectively. Treated basin water was routinely discharged through disposal wells in the former filtration system. Significant quantities of tritium were injected from a disposal well into the Snake River Plain Aquifer. Current discharges include treated sewage from the new treatment plant and service wastewater that is diverted to the percolation ponds because it contains no hazardous substances.

The final sampling phase to support the RI/BRA process was conducted during the summer of 1995. The data were collected to fill data gaps identified during the RI/FS scoping period and to investigate four newly identified release sites. To this end, soil samples were collected from 14 sites and groundwater samples were collected from perched and aquifer wells. A number of tests, which included water level, pumping, and tracer tests, were conducted on the perched water zones and aquifer to collect data useful during the groundwater fate and transport modeling.

The BRA was conducted to document the magnitude and primary causes of risk at a site, determine whether additional response actions are necessary at any release site, and to help support selection of remedial alternatives that may include No Action. Therefore, note that the BRA results represent conditions

at a site caused by hazardous substance releases in the absence of any actions to control or mitigate these releases. In order to focus the BRA on those sites having the greatest potential to adversely affect human health and the environment, all 95 sites underwent a screening process, and subsequently the chemicals measured within these sites were screened to further focus the evaluation on those chemicals of greatest concern. Ultimately, a total of 48 release sites were evaluated quantitatively in the BRA. To facilitate the analysis of the 48 release sites they were combined into five groups that were defined by Agency consensus. The potential adverse health effects associated with exposure to site-related chemicals were estimated with scenario evaluations. Many exposure assumptions were necessary to conduct this evaluation under three different land use conditions; current: occupational, 100-year future occupational, and 100-year future residential.

The results of the BRA under the various land use assumptions indicate that there are a number of groups and sites that present a high potential to adversely affect human health and the environment. Specifically, under future residential exposure assumptions, the increased cancer incidence at several of these sites were found to exceed the 1E-04 to 1E-06 target risk range (one in ten-thousand to one in a million excess cancer risk) or the noncarcinogenic hazard index of one, established by the National Contingency Plan (NCP). The four groups that fall within this category are Tank Farm (CPP-20, -25, -26, -28, -31, -32E/W, and -79), Tank Farm South (CPP-15, -27/33, -58W/E), Waste Calcine Facility (CPP-35, -36/91, -85), the Old Storage Pool (CPP-01/04/05, -08/09, -10, -11), and site CPP-03 from the Storage Yard East Group. The individual release sites outside of groups that fall within this category are CPP-67, -34, -13, -19, and -93. The sites within the group of Exclusive Groundwater Concern (CPP-02, -23, -65, -69, -80, -83, -87, and -89) do not contribute to surface exposure but were evaluated in the groundwater model as a source of contamination and/or recharge to the aquifer. Site CPP-92, which consists of the boxes that contain contaminated soil, was not evaluated quantitatively in the BRA, but is recommended for further evaluation of disposal options for the soil in the 3-13 Feasibility Study. Three additional contaminated soil sites pose a potential risk solely to ecological receptors (CPP-14, -44, -55).

The results of the groundwater model predict chromium, mercury, tritium, I-129, Np-237, and Sr-90 to exceed their MCL before the year 2095. After 2095, mercury, Sr-90, I-129, and total plutonium concentrations are expected to exceed the MCLs. Total plutonium is predicted to exceed the MCL beginning in the year 2850. These four are most likely to be the contaminants of concern that would require further evaluation in the Feasibility Study. From an interpretation of the model results, most of the I-129 and mercury source is due to the injection well. For Sr-90 and total plutonium, the injection well contributes to most of the pre-2095 source, but thereafter most of the Sr-90 and plutonium comes from the vadose zone.

The risk management decisions produced by the OU 3-13 RI/BRA, based on the nature of the contaminant and extent of evaluations, the site and chemical screening evaluations, the human health risk assessment described for each group and site in Sections 8 through 26, and the ecological risk assessment described in Section 28, identified 40 sites that require further evaluation in the Feasibility Study. In addition, sites CPP-84 and -94 will be evaluated in the Feasibility Study as special case sites even though they were eliminated early in a screening process because there is no evidence of release from the abandoned gas cylinders to the environment. Therefore, this brings the total to 42 sites to be evaluated in the Feasibility Study.

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ACRONYMS

ABS	absorption fraction
AEC	U.S. Atomic Energy Commission
AFs	adjustment factors
ARARs	applicable or relevant and appropriate requirement
ARDC	Administrative Record and Document Control
ASTM	American Society for Testing and Materials
BAF	bioaccumulation factor
bgs	below ground surface
BLM	Bureau of Land Management
BRA	Baseline Risk Assessment
C2	Category 2
CDL	contact detection limit
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CF	concentration factor
CFA	Central Facilities Area
CFR	Code of Federal Regulations
Ci	Curies
CLP	Contract Laboratory Program
cm	centimeter
COC	contaminant of concern
COC	chain-of-custody
COCA	Consent Order and Compliance Agreement
COC	contaminants of concern
COPC	contaminants of potential concern
cpm	counts per minute
CPP	Chemical Processing Plant
CRAVE	Carcinogen Risk Assessment Verification Endeavor
CSM	conceptual site model
CSSF	Calcine Solid Storage Facilities
D-D	Dempster-Dumpster
D&D	decontamination and decommissioning
DCG	Derived Concentration Guide
DEQ	Division of Environmental Quality
DMS	Data Management System
DOE	Department of Energy
DOE-ID	Department of Energy Idaho Operations Office
DOT	Department of Transportation
DQOs	data quality objectives

EBR-II	Experimental Breeder Reactor No. 2
EBSLs	ecologically-based screening levels
EC	Environmental Checklist
ECA	Environmentally Controlled Area
ED	exposure duration
EP	extraction procedure
EPA	Environmental Protection Agency
ER	Environmental Restoration
ERA	ecological risk assessment
ERIS	Environmental Restoration Information System
ESSW	East Side Service Waste
FAST	Fluroinel Dissolution Process and Fuel Storage
FECF	Fuel Element Cutting Facility
FFA/CO	Federal Facility Agreement and Consent Order
FR	Federal Regulations
FRSF	Fuel Receiving and Storage Facility
FS	feasibility study
ft	feet
ft^2	square feet
FTL	field team leader
g	gram
gal	gallon
GM	Gieger Muller
gpd	gallons per day
GPR	ground-penetrating radar
GSF	Graphite Storage Facility
HASP	Health and Safety Plan
HDPE	high-density polyethylene
HEAST	Health Effects Assessment Summary Tables
HEPA	high-efficiency particulate air
HF	hydrofluoric acid
HHRA	human health risk assessment
HI	hazard indices
HLLW	high-level liquid waste
HLLWTF	High-level Liquid Waste Tank Farm
HP	health physics
HPIL	Health Physics Instrument Laboratory
HPP	Headend Process Plant
HQ	hazard quotients

I/P	infiltration/percolation
I.D.	inside diameter
IAEA	International Atomic Energy Agency
ICP	inductively coupled plasma
ICPP	Idaho Chemical Processing Plant
IDHW	Idaho Department of Health and Welfare
IDL	instrument detection limit
IDW	investigation-derived waste
IFSF	Irradiated Fuel Storage Facility
IH	industrial hygiene
ILW	incidental liquid waste
in.	inch
INEEL	Idaho National Engineering and Environmental Laboratory
INPS	Idaho Native Plant Society
IRIS	Integrated Risk Information System
kg	kilogram
L	liter
L&V	Limitations and Validation
LET&D	Liquid Effluent Treatment and Disposal Process
LET&D	Liquid Effluent Treatment and Disposal Facility
LOAEL	lowest-observed-adverse-effect-level
m	meter
m^2	square meter
m^3	cubic meter
MCL	maximum contaminant level
MD	mean difference
mg	milligram
MHC	Mechanical Handling Cave
MK	Morrison Knudsen
mrem/hr	millirem/hr
μg	microgram
MS/MSDs	matrix spikes/matrix spike duplicates
NCP	National Contingency Plan
NEPA	National Environmental Policy Act
NOAA	National Oceanic and Atmospheric Administration
NOAL	no-observed-adverse-effect-level
NPL	National Priorities List
NRF	Naval Reactor Facility
NRTS	National Reactor Testing Station
NWCF	New Waste Calcining Facility

OU	operable unit
PCB	polychlorinated biphenyl
pCi	picocurie
PD	program directive
PEW	process equipment waste
ppb	parts per billion
PPE	personal protective equipment
ppm	parts per million
PRG	preliminary remediation goal
psi	per square inch
PSP	Preliminary Scoping Package
PUF	plant uptake factor
PVC	polyvinyl chloride
PWL	process waste liquid
QA	quality assurance
QAPjP	Quality Assurance Project Plan
QC	quality control
QCELs	quantified critical exposure levels
R/hr	rem/hour
RAGS	Risk Assessment Guidance for Superfund
RAL	Remote Analytical Laboratory
RaLa	Radioactive Lanthanum
RBC	risk-based concentration
RCRA	Resource Conservation and Recovery Act
RCT	radiological control technician
RESL	Radiological and Environmental Services Laboratory
RfCs	Reference Concentrations
RfD	Reference Dose
RI/FS	remedial investigation/feasibility study
RI/BRA	remedial investigation/Baseline Risk Assessment
RI	remedial investigation
R_j	risk factor
RME	reasonable maximum exposure
RML	Radiation Measurements Laboratory
ROD	Record of Decision
ROVER	Space Nuclear Propulsion Program
RPD	relative percentage difference
RPMs	Remedial Project Managers
RWMC	Radioactive Waste Management Complex

SAP	Sampling and Analysis Plan
SDGs	Sample Delivery Groups
SDGA	screening and data gap analysis
sec	second
SFs	slope factors
SLERA	screening level ecological risk assessment
SMO	Sample Management Office
SNF	Spent Nuclear Fuel
SOP	standard operating procedure
SOW	Statement of Work
SRPA	Snake River Plain Aquifer
STP	Sewage Treatment Plant
SUFs	site use factors
SVOC	semivolatile organic compounds
SWL	static water level
TAL	target analytical list
TBP	tributyl phosphate
TCC	typic calciorthids
TCLP	toxicity characterization leaching procedure
TDEM	time domain electromagnetic
TLD	thermo-luminescent detector
TRA	Test Reactor Area
TRU	transuranic
TRVs	toxicity reference values
TTF	typic torrifluvents
TSDFs	Treatment, Storage, and Disposal Facilities
UCL	upper confidence limit
UREP	Utilities Replacement and Expansion Project
USGS	United States Geologic Survey
UTL	upper tolerance limit
VOA	volatile-organic analysis
VOC	volatile organic compound
VOG	vessel off-gas
WAG	waste area group
WCF	Waste Calcining Facility
WERA	WAG Ecological Risk Assessment
WINCO	Westinghouse Idaho Nuclear Company
WM	wide mouth
WSSW	West Side Service Waste

yd^3	cubic yards
yr	year

Chapter 1

Comprehensive RI/FS for the Idaho Chemical Processing Plant OU 3-13 at the INEEL—Part A, RI/BRA Report (Final)

1. INTRODUCTION

This Remedial Investigation/Baseline Risk Assessment (RI/BRA) report describes the nature and extent of contamination, including a BRA for soil and groundwater contamination identified at the Idaho Chemical Processing Plant (ICPP) at the Idaho National Engineering and Environmental Laboratory (INEEL). The INEEL is located in southeastern Idaho, with an eastern boundary located approximately 51.5-km (32-mi) west of Idaho Falls, Idaho. The ICPP is located approximately 12.9-km (8.0-mi) north of the southern INEEL boundary, and covers an area of approximately 0.39 km^2 (0.15 mi^2). Figure 1-1 presents a map of the INEEL and the location of the ICPP facility in relation to the INEEL.

1.1 Purpose and Scope

The Department of Energy (DOE), Environmental Protection Agency (EPA), and the Idaho Department of Health and Welfare (IDHW) have a common goal to ensure that releases or threatened releases of hazardous substances at the INEEL are thoroughly investigated in accordance with the National Contingency Plan (NCP) and that appropriate response actions are undertaken and completed as necessary to protect human health and the environment. The framework for the response actions at the INEEL is described in the Federal Facility Agreement and Consent Order (FFA/CO) and Action Plan. This document identified 10 waste area groups (WAGs) at the INEEL, of which, the ICPP has been designated as WAG 3.

The Action Plan identified 83 release sites within WAG 3, and 12 additional release sites that include the OU 10-06 windblown area, have been subsequently added (Figure 1-2). To expedite evaluation, these 95 sites were combined into 13 operable units (OUs) based on similar waste streams and projected remedial actions. This document is the mechanism for presenting the available data for WAG 3 concerning site conditions and the nature and extent of contamination, and assessing the potential risk to human health and the environment. A companion document, the feasibility study (FS), serves as the mechanism for the development, screening, and detailed evolution of various remedial actions to address the contamination identified in the RI/BRA.

1.2 Report Organization

The overall report format is designed to provide all of the necessary background information, summarize the technical approach and procedures used during the RI/BRA, and present the results on a site-by-site basis. The report then summarizes the conclusions and recommendations. Several appendices are included in a separate volume to support the body of this report.

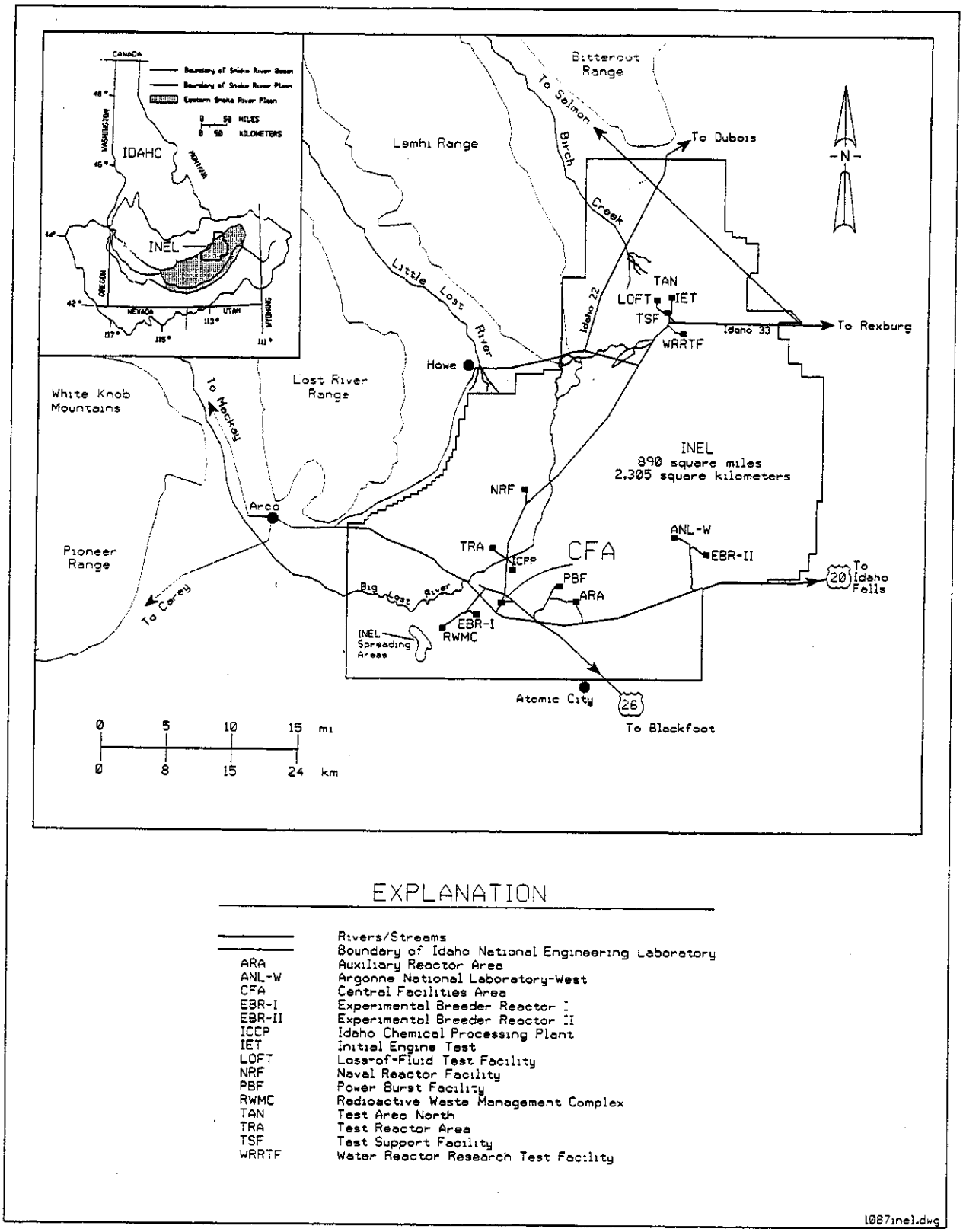

Figure 1-1. Location of the INEEL and ICPP.

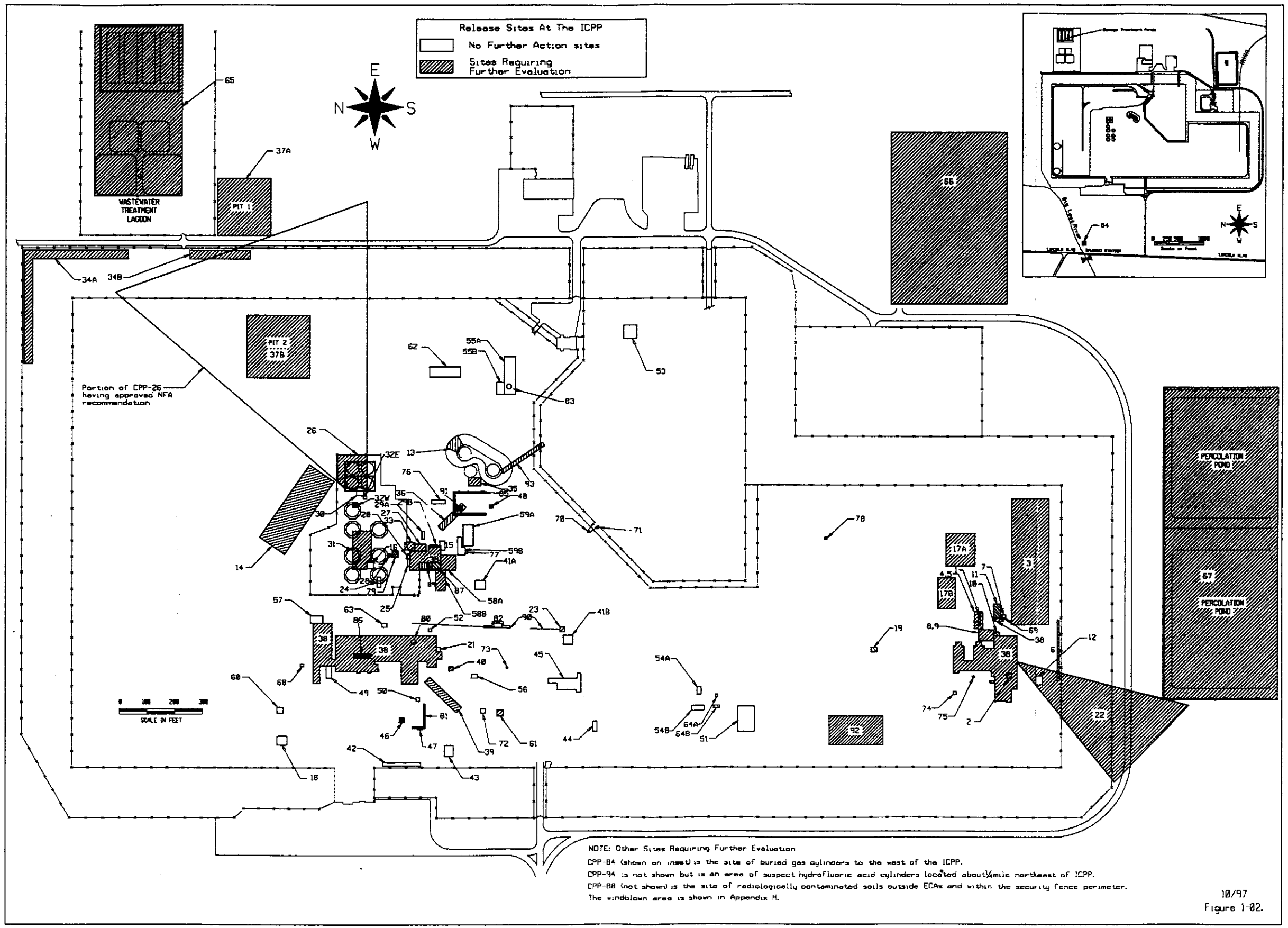

Figure 1-2. Release sites identified at the ICPP.

1.3 ICPP Background

The following sections provide background information on the ICPP.

1.3.1 ICPP Facility Description, Operation, and History

The INEEL is a Federal facility operated by the DOE. The facility was previously known as the National Reactor Testing Station (NRTS) and was established by the U.S. Atomic Energy Commission (AEC) in 1949 to provide a place to build, operate, and test nuclear reactors, fuel processing plants, and support facilities. Since its establishment, 52 reactors have been constructed at the INEEL. The INEEL has also supported other Government-sponsored projects and programs, including energy, defense, and environmental and ecological research.

The ICPP has been in operation since 1954 and has historically been a uranium reprocessing facility for defense projects and for research and storage of spent nuclear fuel (SNF). Irradiated defense nuclear fuels were reprocessed to recover unused uranium. After fuel dissolution and extraction, the liquid wastes were calcined and the resultant granular solids subsequently stored in stainless steel bins. Depending on the type of fuel reprocessing used, several types of high-level, radioactive liquid wastes have been produced at ICPP.

In 1992, DOE announced the reprocessing part of the ICPP mission would be phased out. This decision led to the phaseout of all fuel dissolution, solvent extraction, product denitration, and other processes at the ICPP (WINCO, 1994). The ICPP mission now will be to receive and temporarily store SNF and radioactive wastes for future disposition.

Over the past decades, inadvertent and operational releases of radioactivity and other contaminants from the ICPP processing plants and support systems have been released to the environment. Accidental releases were either noticed immediately or identified years later. Some past practices, which were then recognized as acceptable, included direct disposal to the subsurface environment through an injection well, including the Snake River Plain Aquifer (SRPA).

A plot map of the ICPP showing the locations of the various facilities described in the following sections is provided in Figure 1-3. Also, Figure 1-4 was added to graphically depict the processes of spent fuel storage, dissolution, calcination, and storage of raffinates. These processes are described in Sections 1.3.1.1 through 1.3.1.4.

1.3.1.1 Spent Nuclear Fuel Storage. Expended, highly enriched fuels were shipped to the ICPP from test and research reactors at the INEEL, reactors in various parts of the world, and U.S. Navy ship propulsion reactors. The fuels were stored in several facilities at the ICPP until enough fuel of a particular type accumulated to make a processing run economical.

Dry storage of irradiated fuels at the ICPP is in the CPP-749 underground dry wells and the dry storage area of CPP-603 [Irradiated Fuel Storage Facility (IFSF)] for storage of irradiated graphite fuels. The IFSF was built as an addition to the fuel storage basin and consists of 636 steel canisters stored in an enclosed storage rack. The decay heat from the fuel is removed by a forced flow, single pass air system capable of supplying a cooling airflow (WINCO, 1986).

The unirradiated Fuel Storage Facility (CPP-651) provides interim storage for recovered uranium products and a variety of unirradiated nuclear materials from other Federal facilities.

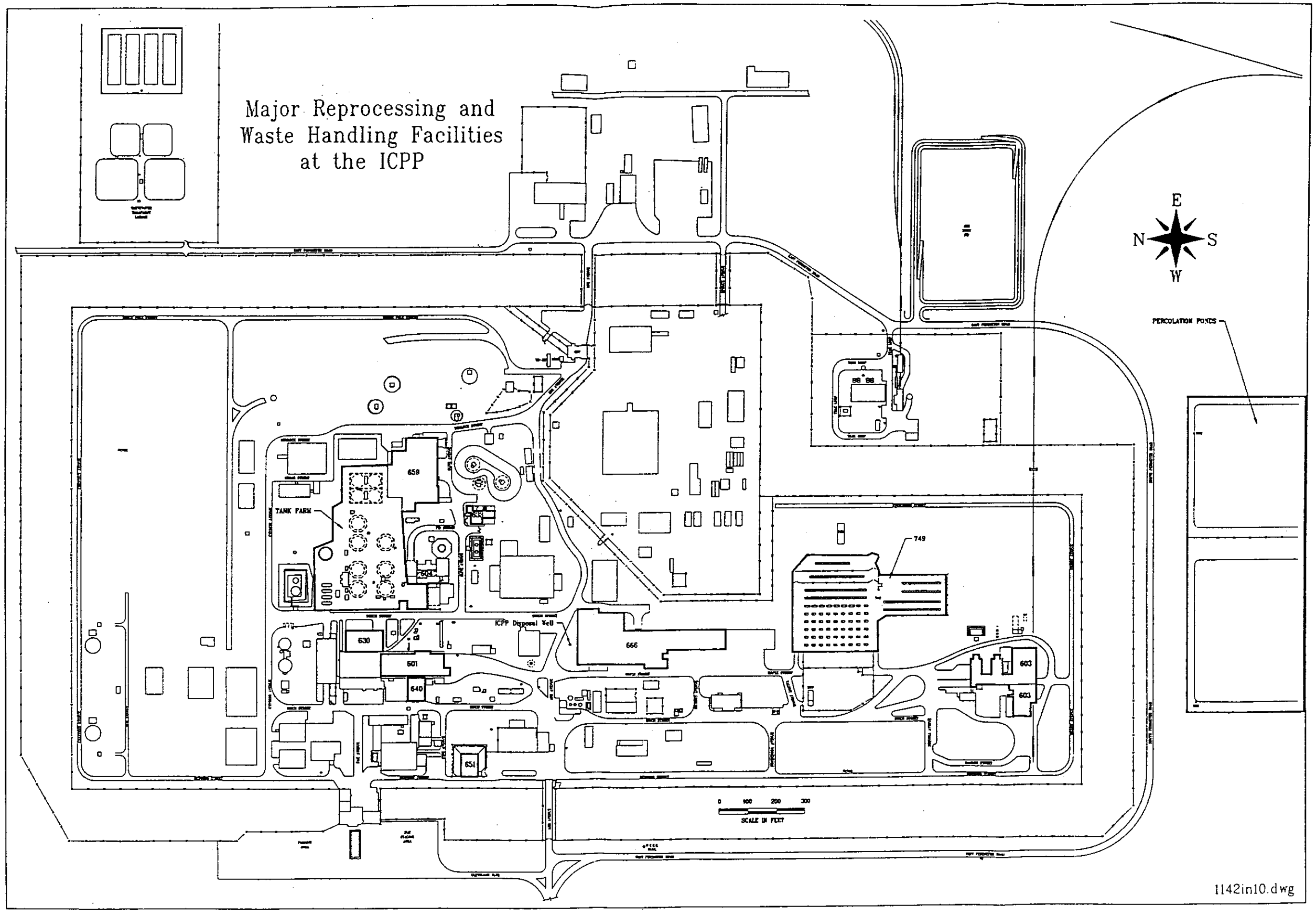

Figure 1-3. Plot map of the ICPP.

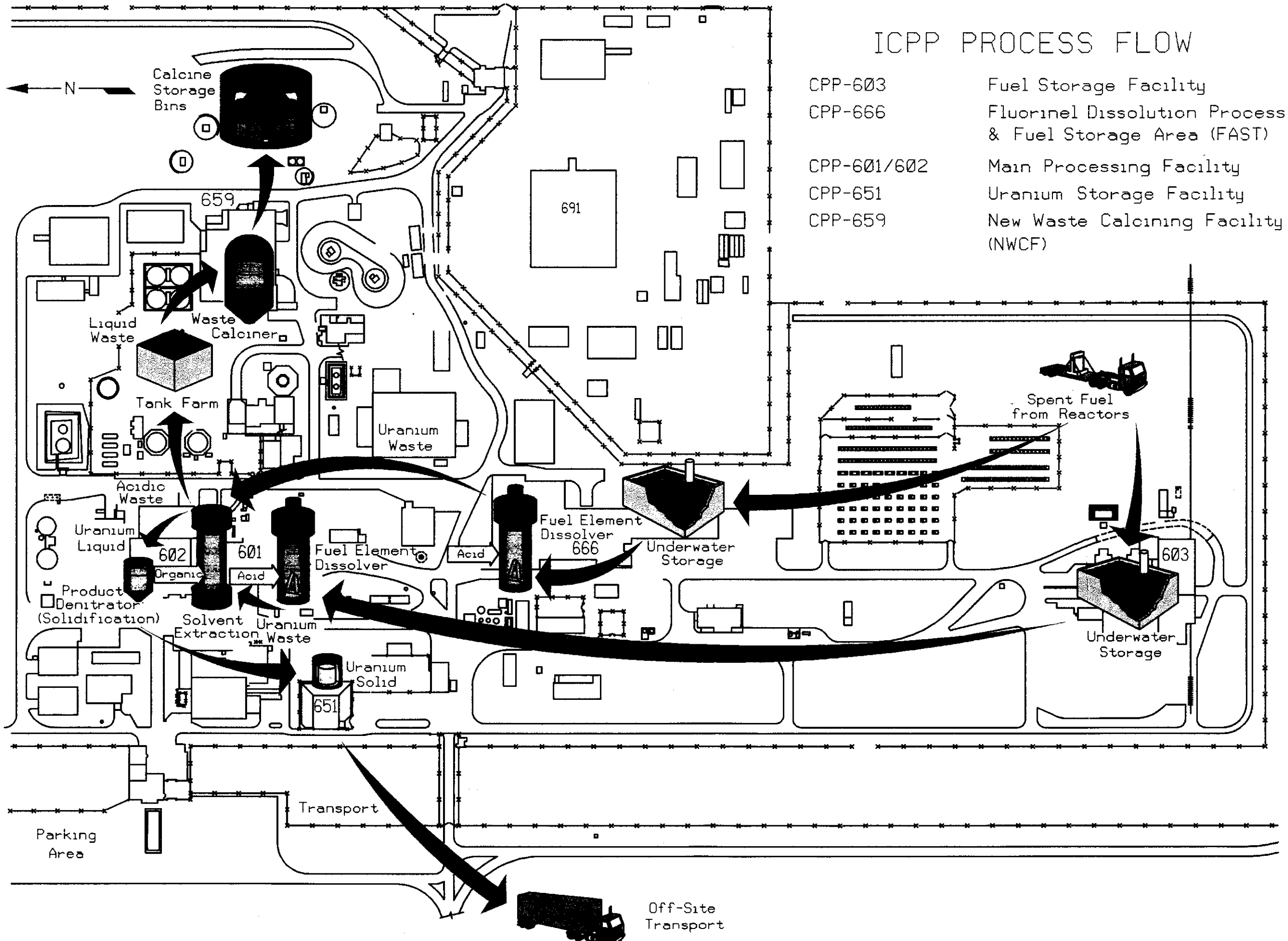

Figure 1-4. Graphical depiction of the spent fuel mangement process.

Most of the spent fuel received at the ICPP has been stored underwater at either the CPP-603 or CPP-666 fuel storage facilities. The underwater storage provides natural convective cooling of the fuel as well as shielding of beta and gamma radiation emitted from the decay of fission products in the fuel. CPP-603 is the oldest facility and has capacity for dry and wet storage. CPP-603 contains three older, concrete pools for underwater fuel storage. The pools are interconnected by a transfer canal. CPP-603 no longer receives new fuels for storage and the underwater portion of the facility is scheduled to be shut down. CPP-666 fuel storage area is the primary underwater storage facility for new fuel receipts and contains stainless steel, lined holding pools. CPP-666 recently underwent fuel storage rack reconfiguration to support continued receipt of spent fuel of different sizes than originally projected. Fuels from CPP-603 underwater storage are being transferred to CPP-666.

1.3.1.2 Fuel Dissolution Processes. The ICPP fuel dissolution processes produced a solution of uranyl nitrate for solvent extraction. Virtually any type of waste that has been present at the ICPP is likely to have passed through CPP-601, which is the main processing facility. Most fuel dissolution processes are located in one processing complex (CPP-601, -640, and -630). The fluorinel dissolution process is housed in the Fluorinel Dissolution Process and Fuel Storage (FAST) building (CPP-666). Following reprocessing, the wastes were directed from CPP-601 to either the percolation ponds, high-level liquid waste (HLLW) Tank Farm, or process equipment waste (PEW) Evaporator Facility.

The aluminum dissolution process, located in CPP-601, dissolved aluminum fuel assemblies containing highly enriched uranium in the form of uranium-aluminum alloy clad. These fuel assemblies were dissolved in a nitric acid solution in the presence of a mercuric nitrate catalyst.

The fluorinel dissolution process facility provided for dissolution of zirconium-clad fuels and occupies a section of the FAST facility (CPP-666); zirconium-based fuels were dissolved in hydrofluoric and nitric acids.

The electrolytic dissolution process was housed in the Headend Processing Plant (CPP-640). Stainless steel fuels were dissolved in nitric acid while a direct electrical current passed through the fuel and nitric acid solution, which caused the fuel to dissolve. Also housed in CPP-640 was the Space Nuclear Propulsion Program (ROVER) dissolution process where graphite fuels were first burned in oxygen to remove the graphite; then the uranium materials were dissolved in hydrofluoric and nitric acids. The solution was then sent to solvent extraction for uranium recovery.

Custom processing was housed in CPP-627 where other fuels were processed in specially designed pilot-plant-type equipment with specific dissolvents for the type of fuel. CPP-627 was not a production-scale dissolution system; therefore, only small quantities of spent reactor fuel could be accommodated.

The separation of uranium from nonnuclear components and fission products in fuels was accomplished in three cycles of solvent extraction. The liquid, uranium-bearing product stream from any of the fuel dissolution processes required preparation for the solvent extraction processes. The solvent extraction processing separated uranium from the cladding and fission products. Feed preparation consisted of a combination of the following:

- Clarification to remove particulates
- Adjustment of chemical composition by adding nitric acid to improve uranium extractability

- Suppression of emulsions by adding gelatin.

The first-cycle solvent extraction process preferentially separated uranium from fission products, whereas subsequent extraction cycles separated the transuranics. In this process, tributyl phosphate (TBP) in a hydrocarbon diluent was used to effect the separation.

The second- and third-cycle extraction processes used the solvent methyl isobutyl ketone to purify the uranium product from first-cycle extraction. The purposes of the processes were to separate the uranium from the residual fission products and transuranic (TRU) elements, recover most of the uranium as product, and after reducing its volume, transfer the waste material to storage.

The greatest amount of fission-product waste at the ICPP is contained in the liquid radioactive waste streams from the extraction process. The wastes include (a) zirconium-fluoride wastes generated from dissolution of zirconium-clad spent fuels in hydrofluoric acid, (b) aluminum-nitrate wastes generated from dissolution of aluminum-clad spent fuels in nitric-acid, and (c) sodium-bearing wastes that are typically generated from sodium-bearing decontamination solutions used in the PEW Evaporator Facility.

Processed wastes were collected and transferred to either the HLLW Tank Farm or PEW Evaporator Facility. All unconcentrated low- and intermediate-level wastes were sent to be concentrated in the PEW Evaporator located in CPP-604. Waste was fed to an evaporator until a predetermined specific gravity was reached or the supply tank was empty. The concentrated "bottoms" solution from the PEW was sent to the Tank Farm as incidental liquid waste (ILW) and the "overhead" condensate was sent to the Liquid Effluent Treatment and Disposal Process (LET&D) for further treatment. The LET&D fractionated the PEW overhead condensate into overhead gaseous steam and a concentrated nitric acid bottoms stream. The nitric acid was then sent to the Tank Farm or used in place of fresh acid for various plant operations. The overhead gaseous stream was superheated, filtered, and discharged through the ICPP stack.

1.3.1.3 Tank Farm Operations. The HLLW Tank Farm has also been in service (receiving liquid waste until it can be solidified) since 1954. The Tank Farm at the ICPP consists of 11 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 waste transfer, monitoring, and control. One of the 1,135,624-L (300,000-gal) tanks is designated as the spare tank and is always maintained empty in the event of an emergency.

The 1,135,624-L (300,000-gal) tanks are constructed of stainless steel and housed in underground concrete vaults. The concrete vaults sit on bedrock about 13.7 m (45 ft) belowgrade with the top of the vaults about 3.0 m (10 ft) belowgrade. This distance includes approximately 15.5 cm (0.6 ft) of soil over a synthetic membrane. The 113,562-L (30,000-gal) tanks are constructed of stainless steel, set on concrete pads, and covered with about 3.0 m (10 ft) of soil. Because these tanks are directly buried in the ground without secondary containment, they have been emptied and flushed of all hazardous waste and are out of service. The 68,220-L (18,000-gal) tanks are also constructed of stainless steel and are housed inside stainless steel, lined concrete vaults located in the bottom of the Waste Treatment Building, CPP-604.

The majority of liquid waste stored in the Tank Farm was generated during the first-, second-, and third-cycle extraction processes. These raffinates 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 PEW Evaporator. Additional wastes stored in the Tank Farm include fluoride and cadmium-bearing wastes from the fluorinel process, decontamination wastes containing fluoride from

waste calcining, process salvage streams from J-Cell after extraction, and occasional transfers from WL-104 and WL-105, which are part of westside service waste disposal system.

Incidental liquid waste (ILW) is not HLLW but has similar radioactivity levels, TRU levels, and hazardous components. This waste is also stored in the Tank Farm for interim storage until it can be transferred to the New Waste Calcining Facility (NWCF) for solidification. The ILW is segregated from HLLW to facilitate present and future processing.

Liquid wastes are transferred to the Tank Farm from various ICPP plant areas through underground stainless steel lines. These buried lines and associated equipment constitute both a system for the transfer of high-level, liquid radioactive waste and one for the transfer of less radioactive intermediate-level, liquid waste. All the transfer lines are piped and valved separately throughout the Tank Farm area so the integrity of the various waste types is maintained.

Most of the nonradioactive, liquid discharge originates from the ICPP utilities areas in CPP-606, CPP-644, and the coal fired steam-generating facility. Cooling water for the secondary heat transfer system for the ICPP liquid waste Tank Farm is routed directly to service waste without monitoring for radioactivity because the primary systems are monitored. Potentially radioactive, liquid effluents at the ICPP are associated with heating- or cooling-water streams from various processes throughout the plant.

1.3.1.4 Waste Calcining Facilities. CPP-633, the Waste Calcining Facility (WCF), operated on a plant scale from 1963 to 1981, converting HLLW to a noncorrosive, less mobile, solid form. The NWCF, CPP-659, started operating in 1982 and was the first production scale facility for converting highly radioactive waste solutions to a solid form requiring only about one-eighth as much space as stored liquids. The highly radioactive waste generated from the fuel reprocessing at the ICPP contains nuclear fission products. Fluidized-bed calcination was developed to convert radioactive waste solutions to solids. In the calcination process, liquid radioactive wastes are evaporated and the dissolved metals and fission products are converted to salts and oxides. The key step in the calcination process is evaporation and solidification of the liquid radioactive wastes in a heated bed of fluidized particles. Feed is atomized by air and sprayed into a heated bed of spherical particles. Dissolved metals and fission products oxidize to solids as they coat the surfaces of bed particles. Combustion and solid products build up in layers on the bed particles while the gaseous products are swept from the vessel with the fluidizing gases. Most solids remaining in the gas after leaving the primary cyclone are removed in the gas scrubbing system. Before being released to the atmosphere, this stream is decontaminated in a series of devices including a cyclone, spray quench tower, scrubber, associated separators, and silica gel absorbers. After filtering, the decontaminated offgas is transferred to the 76.2-m (250-ft) high ICPP stack. The spray quench tower removes particulates from the off-gas; additional particulate is removed through the nitric acid scrubbing system. Liquid drops from the scrubber are removed to the deentrainment separator and mist eliminator then drained to the scrub tank and recycled as calciner feed by transferring it to the waste holding tanks.

Conversion of HLLW to a solid reduces the volume of waste by a ratio of about 7 to 1 and provides a less corrosive waste form. Up to 11,356 L/day (3,000 gal/day) can be processed through the NWCF. The calcined solids are in the form of particles 0.2 to 0.6 mm in diameter and made up of aluminum and zirconium oxides. Other metallic oxides and fission product oxides are withdrawn continuously from the bottom of the calciner and are air-conveyed (pneumatically) to underground storage bins. The calciner product removed from the bed and the fines removed from the offgas in the cyclone are combined and pneumatically transferred to the Calcine Solid Storage Facilities (CSSF). The CSSF provides containment of

radioactive solids. The CSSF consists of seven, separate, self-contained units referred to as bin sets. The bin sets are numbered sequentially, one through seven, in order of their past use or intended usage. Each bin set consists of a reinforced concrete vault containing from three to seven stainless steel storage bins. The stainless steel bins and concrete vaults are intended to provide primary and secondary containment for the stored calcined solids (DOE-ID, 1994). Bin Sets 1 through 3 store calcine produced by the WCF. These units have been filled to design capacity and isolated from all other processes.

1.3.1.5 Miscellaneous Support Facilities.

1.3.1.5.1 Hot Waste Tank—The SFE-20 Hot Waste Tank is a 2,423-L (640-gal), stainless steel tank with a 1.1-m (3.5-ft) inside diameter. The hot waste tank, in conjunction with a concrete vault and associated piping and equipment were constructed in 1957 to collect low-level, radioactive liquid wastes from the Fuel Element Cutting Facility (FECF) addition of the CPP-603 Fuel Receiving and Storage Facility. The function of the FECF was to receive, store, and cut aluminum-clad fuel from the test reactor program at the Savannah River Site. The fuel-cutting operation in the FECF began in 1959 and was completed in 1962. Floor drains in the receiving area, the decontamination pad, and the FECF collected decontamination solutions, liquids from the shipping casks, and other hot waste liquids. Liquid wastes flowed by gravity through underground lines to the SFE-20 tank and were eventually pumped to the PEW Evaporator.

The tank was also used from 1966 to 1976 for interim storage of wastes associated with CPP-603. The supernatant from the shielding water in the filter system of the settling system at the CPP-603 basins was steam jetted to the SFE-20 and eventually pumped to the PEW Evaporator. In 1976, the inlet pipe was disconnected and the tank was taken out of service.

1.3.1.5.2 Percolation Ponds—The service waste system collects, monitors, and samples wastewater used in various plant activities and transfers it to one of the two percolation ponds located south of the ICPP for disposal. This wastewater contains trace amounts of radioactive and inorganic constituents. Percolation Ponds 1 and 2 are located outside the ICPP southern security fence, southeast of CPP-603. The percolation ponds are unlined ponds that were excavated from the surficial alluvium in 1982 and 1985. Percolation Pond 1 began receiving flow in 1984, but an inadequate percolation rate made it necessary to build Pond 2. The two ponds have been used alternately since then, receiving approximately [5.7 to 9.5 M L/day (1.5 to 2.5M gal/day)] of service wastewater. The liquid wastes consisted primarily of water and condensed steam generated by various ICPP operations. Sampling efforts have indicated radioactive, inorganic, and organic contaminants in the pond sediments. Resource Conservation and Recovery Act (RCRA) closure of the ponds was initiated in 1993 and completed in April 1994 and May 1995 for Ponds 1 and 2, respectively. The scope of the RCRA closure activities was limited to the inorganic and organic contaminants and the evaluation of the radioactive contaminants and the perched water was deferred to the comprehensive RI/FS. The ponds continue to receive plant discharges regulated under the Idaho Wastewater Land Application Permit process.

1.3.1.5.3 Old Sewer System—The old sewage treatment plant (CPP-14) processed sanitary wastes from nine ICPP facilities. Digested sludge from the sewer treatment system (i.e., Imhoff tanks and chlorine contact basin) was transferred to the sludge drying beds, and liquid effluent from the trickling filter was chlorinated and discharged to the drain field. The Sewage Treatment Plant (STP) was demolished in September, 1983. This demolition consisted of removing the wastewater treatment facility and equipment to a depth of 1.5 m (5 ft) belowgrade, removal and disposal of all remaining sludge in the drying beds, and removal of buried piping with the exception of sludge in the drying beds. The excavated area was then

backfilled and graded to match the surrounding surface. Lower portions of the influent personnel access hole, ejector pit, Imhoff tanks, final tank, and chlorine tank remain.

The STP was not designed to receive or process hazardous or radioactive wastes. However, during removal and disposal of sludge during the demolition project, the sludges were found to have low levels of radioactivity. Sampling efforts detected metals, organics, and radionuclide contained in the general treatment plant.

1.3.1.5.4 Sewage Treatment Plant—The ICPP STP treats sanitary sewage from 31 permanent facilities at the ICPP, which primarily consists of wastewater from restrooms and cafeterias. All sanitary waste from the 31 permanent facilities is collected by gravity-flow lines and piped via lift stations to the STP for treatment. In addition, sanitary waste from nine ICPP buildings is collected and treated separately from the main STP.

The STP facility is located to the northeast of the enclosed ICPP plant area. It consists of two aerated lagoons, two quiescent facultative stabilization lagoons, four infiltration/percolation (I/P) trenches, and six weir boxes. The aerated lagoons are arranged in series and drain into facultative lagoons; the overflow drains to the I/P trenches. The weir boxes route the wastewater through the lagoons and trenches. Maximum plant capacity is 454,200 Lpd (120,000 gpd), with an average flow of 159,000 Lpd (42,000 gpd).

The aerated lagoons each have a floor area of 607 m^2 (6,530 ft^2), a water surface area of 1,821 m^2 (19,430 ft^2), and volume of 3,342 m^3 (118,000 ft^3). The two facultative lagoons each have floor areas of 162 m^2 (1,743 ft^2), a maximum water surface area of approximately 852 m^2 (9,060 ft^2), and maximum volume of approximately 1,280 m^3 (45,200 ft^3). All lagoons are lined with geotextile liners (Chevron impermeable liner, 80 mils, over scrim polypropylene fabric mat, 3.1 oz/yd^2) and are surrounded by dikes. The four I/P trenches are each approximately 890 m^2 in size. Only one trench is used at a time with trench rotation occurring every 2 to 12 weeks.

1.3.1.5.5 ICPP Disposal Well, CPP-23—Since 1952, ICPP processes have generated large volumes of plant cooling waters and condensates. These service wastewaters contained very small quantities of radioactive and inorganic contaminants. The ICPP injection well (MEH-FE-PL-304), located north of building CPP-666, was used to discharge these low-level radioactive and chemical wastes (trace quantities) to the aquifer from 1952 to February, 1984. The ICPP disposal well was drilled in 1950 to a depth of 64.6 m (212 ft) and deepened in 1951 to 182 m (597 ft). A 61-cm (24-in.) diameter borehole was drilled and cased using 41-cm (16-in.) nominal diameter carbon steel casing. The annular space between the borehole and casing was filled with gravel. The well casing was perforated from 125.6 to 137.8 m (412 to 452 ft) and 149.4 to 180.7 m (490 to 593 ft) below land surface (bgs). The average discharge to the well during this period was about 1.4B L/yr (363M gal/yr) or about 3.8M L/day (1M gal/day).

On February 7, 1984, the injection well was taken out of routine service and since then wastewater has been pumped from two parallel collection vaults to Percolation Ponds 1 and 2. The injection well also served as an emergency overflow protection for buildings CPP-709, -734, and -797, which contain the vaults from which the service wastewater is monitored and pumped. The overflow protection was only required on a temporary basis if the operating and standby pumps from one of the parallel streams failed simultaneously. All the lines have been plugged and can no longer be used to route service wastewater overflow from the vaults in the buildings.

In October and November 1989, the injection well was sealed by perforating the casing throughout and pumping in cement. The well was sealed from the basalt silt layer [145 m (475 ft) bgs] to land surface to prevent hydraulic communication between the land surface, perched water, and SRPA.

1.3.2 Regulatory Process at the ICPP

On July 14, 1989, the INEEL was proposed to be added to the EPA National Priorities List (NPL) [54 Federal Register (FR) 29820]. This listing was proposed using Hazard Ranking System procedures found in the National Contingency Plan (NCP). The INEEL received a score of 51.91. Data supporting listing the INEEL as an NPL site are found in the Federal Facilities Docket, EPA Headquarters, Washington D. C. As a Federal facility, the INEEL is eligible for the NPL pursuant to the requirements of the NCP [40 Code of Federal Regulations (CFR) 300.66(c)(2)]. After considering public input during a 60-day comment period, the INEEL was placed on the NPL and became subject to the provisions of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) on November 15, 1989. Contaminated sites at the ICPP contributed to listing the INEEL on the NPL. As a result of listing on the NPL, the DOE, EPA Region 10, and IDHW negotiated an FFA/CO and Action Plan. To facilitate environmental cleanup, the FFA/CO divided the INEEL into 10 WAGs. The ICPP was designated as WAG 3.

The DOE, EPA, and State of Idaho determined the ICPP should be remediated through the CERCLA-driven RI/FS process because CERCLA Section 120:

- Addresses radioactive and chemical contaminants, while the RCRA addresses only chemical contaminants
- Includes actions generally more site-specific than RCRA actions
- Includes actions that allow joining or separating facilities or problems into OUs for timely and effective remedial action
- Includes guidance documents establishing accepted procedures for risk-based decisions.

The Action Plan identified 83 release sites within WAG 3 and 12 additional sites that include the 10-06 windblown area, that have been subsequently added (Table 1-1 and Figure 1-2). These sites were combined into 13 OUs based on similar waste streams and projected remedial actions. Following procedures identified in the Action Plan, preliminary scoping Track 1 and/or 2 investigations have been completed for all the release sites except the 10 no action sites, the windblown area, and the latest site to be added, CPP-94. These preliminary scoping investigations evaluated existing information and, if necessary, collected additional information on the nature and extent of contamination to better quantify risks. A no action determination was made for 10 sites before the FFA/CO based on Summary Assessments completed under the RCRA Consent Order and Compliance Agreement (COCA).

In addition to release sites identified in the FFA/CO and the additional new sites, the WAG 3 comprehensive RI/BRA qualitatively evaluated 285 ICPP facilities that are operating, no longer operating and are undergoing decontamination and decommissioning (D&D), or are in transition from operating to D&D. This evaluation consisted of a screening process to identify the facilities most likely to impact

Table 1-1. WAG 3 sites.

Site	Operable unit	Description	CERCLA process[a]
CPP-43	None	Grease pit south of CPP-637	None
CPP-52	None	Pickling shed east of CPP-631	None
CPP-70	None	Septic tank east of CPP-655	None
CPP-71	None	Seepage pits west of CPP-656	None
CPP-72	None	CPP-758 Cesspool east of CPP-651	None
CPP-73	None	Leaching cesspool east of CPP T-15	None
CPP-74	None	Seepage pit and septic tank west of CPP-626	None
CPP-75	None	Septic tank and cesspool west of CPP-603	None
CPP-76	None	Septic tank and cesspool west of CPP-659	None
CPP-77	None	Seepage pit and cesspool north of CPP-662	None
CPP-49	OU 3-01	PCB transformer yard (CPP-705)	Track 1
CPP-50	OU 3-01	PCB transformer yard (CPP-731)	Track 1
CPP-51	OU 3-01	PCB staging area west of CPP-660	Track 1
CPP-61	OU 3-01	PCB spill in CPP-718 Transformer Yard	Track 1
CPP-07	OU 3-02	Soil contamination northwest of CPP-642	Track 1
CPP-12	OU 3-02	Contaminated paint chips and pad south of CPP-603	Track 1
CPP-18	OU 3-02	Gas Storage Building, current location of CPP-668	Track 1
CPP-21	OU 3-02	Solid Waste Storage Bin south of CPP-601	Track 1
CPP-41	OU 3-02	Fire Training Pits between CPP-666 and CPP-663	Track 1
CPP-53	OU 3-02	Paint and Paint Solvent Area south of CPP-697	Track 1
CPP-54	OU 3-02	Drum storage area west of CPP-660	Track 1
CPP-55	OU 3-02	Mercury-contaminated area south of CPP T-15	Track 1
CPP-57	OU 3-02	Sulfuric acid spills east of CPP-606	Track 1
CPP-59	OU 3-02	Kerosene tank overflow west of CPP-633	Track 1
CPP-60	OU 3-02	Paint shop at present location of CPP-645	Track 1
CPP-62	OU 3-02	Mercury-contaminated area near CPP TB-4	Track 1
CPP-63	OU 3-02	Hexone spill by CPP-710	Track 1
CPP-64	OU 3-02	Hexone spill west of CPP-660	Track 1
CPP-68	OU 3-02	Abandoned Gasoline Tank CPP VES-UTI-652	Track 1
CPP-23	OU 3-02	CPP Injection Well (MAH-FE-PL-304)	Track 2

Table 1-1. (continued).

Site	Operable unit	Description	CERCLA process[a]
CPP-37	OU 3-02	CPP Gravel Pits #1 and #2	Track 2
CPP-65	OU 3-02	CPP Sewage Treatment Plant Lagoons	Track 1
CPP-66	OU 3-02	CPP Coal Fired Steam Generation Facility Fly Ash Pit	Track 1
CPP-67	OU 3-03	CPP Percolation Ponds #1 and #2	Track 1
CPP-38	OU 3-04	Friable transite on CPP-601 through 606, 640, 644, and 648	Track 1
CPP-14	OU 3-05	Old Sewage Treatment Plant west of CPP-664	Track 2
CPP-47	OU 3-06	Pilot Plant Storage Area west of CPP-620	Track 1
CPP-33	OU 3-06	Contaminated soil in the Tank Farm Area near WL-102, northeast of CPP-604	Track 1
CPP-34	OU 3-06	Soil Storage Area in the northeast corner of the ICPP	Track 1
CPP-40	OU 3-06	Lime pit at the base of the CPP-601 Berm and French drain	Track 2
CPP-16	OU 3-07	Contaminated soil from leak in-line from CPP WM-181 to PEW	Track 2
CPP-20	OU 3-07	CPP-604 Radioactive Waste Unloading Area	Track 2
CPP-24	OU 3-07	CPP Tank Farm Area bucket spill	Track 2
CPP-25	OU 3-07	Contaminated soil in the Tank Farm Area north of CPP-604	Track 2
CPP-30	OU 3-07	Contaminated soil in the Tank Farm Area near Valve Box B-9	Track 2
CPP-32 (east and west)	OU 3-07	Contaminated soil in the Tank Farm Area southwest and northwest of Valve Box B-4	Track 2
CPP-26	OU 3-07	Contaminated soil in the Tank Farm Area from steam flushing	Track 2
CPP-28	OU 3-07	Contaminated soil in the Tank Farm Area south of WM-181 by Valve Box A-6	Track 2
CPP-31	OU 3-07	Contaminated soil in the Tank Farm Area south of Tank WM-183	Track 2
CPP-79	OU 3-07	Tank Farm release near Valve Box A-2	Track 2
CPP-83	OU 3-07	Well 55-06 (radioactive contamination in perched water)	Track 2
CPP-15	OU 3-08	Solvent burner east of CPP-605	Track 2
CPP-29	OU 3-08	Contaminated soil north and west of the Main Stack (CPP-708)	Track 2
CPP-13	OU 3-08	Pressurization of solid storage cyclone northeast of CPP-633	Track 2
CPP-27	OU 3-08	Contaminated soil in the Tank Farm Area east of CPP-604	Track 2
CPP-35	OU 3-08	CPP-633 decontamination spill	Track 2

Table 1-1. (continued).

Site	Operable unit	Description	CERCLA process[a]
CPP-36	OU 3-08	Transfer line leak from CPP-633 to WL-102	Track 2
CPP-01	OU 3-09	Concrete settling basins and dry wells east of CPP-603	Track 2
CPP-02	OU 3-09	French drain west of CPP-603	Track 2
CPP-03	OU 3-09	Temporary storage area southeast of CPP-603	Track 2
CPP-04	OU 3-09	Contaminated soil area around CPP-603 Settling Tank	Track 2
CPP-05	OU 3-09	Contaminated soil around CPP-603 Settling Basin	Track 2
CPP-06	OU 3-09	Trench east of CPP-603 Fuel Storage Basin	Track 2
CPP-08	OU 3-09	CPP-603 Basin Filter System line failure	Track 2
CPP-09	OU 3-09	Soil contamination northeast corner of CPP-603 South Basin	Track 2
CPP-10	OU 3-09	CPP-603 plastic pipeline break	Track 2
CPP-11	OU 3-09	CPP-603 sludge and water release	Track 2
CPP-17	OU 3-09	Soil storage area south of CPP Peach Bottom Fuel Storage Area	Track 2
CPP-19	OU 3-09	CPP-603 to CPP-604 line leak	Track 2
CPP-22	OU 3-09	Particulate air release south of CPP-603	Track 2
CPP-69	OU 3-09	Abandoned Liquid Radioactive Waste Storage Tank CPP VES-SFE-20	Track 2
CPP-78	OU 3-09	Contaminated soil west of CPP-693, east of Dry Fuel Storage Area	Track 2
CPP-42	OU 3-10	Drainage ditch west of CPP-637	Track 2
CPP-44	OU 3-10	Grease pit south of CPP-608	Track 2
CPP-56	OU 3-10	Nitric acid contamination south of CPP-734	Track 2
CPP-46	OU 3-10	CPP-637 Courtyard Pilot Plant release	Track 1
CPP-45	OU 3-11	CPP-621 Chemical Storage Area spills	Track 2
CPP-58	OU 3-11	CPP PEW Evaporator overhead pipeline spills	Track 2
CPP-81	OU 3-12	Abandoned CPP-637/CPP-601 VOG line	Track 1
CPP-82	OU 3-12	Abandoned line (1.5 in.) PLA-766 west of Beech Street	Track 1
CPP-80	OU 3-12	CPP-601 Vent Tunnel Drain leak	Track 2
CPP-39	OU 3-13	CPP HF Storage Tank (YDB-105) and dry well	Track 2
CPP-48	OU 3-13	French drain south of CPP-633	Track 2
CPP-84	OU 3-13	Gas canisters (buried gas cylinders)	Track 1

Table 1-1. (continued).

Site	Operable unit	Description	CERCLA process[a]
CPP-85	OU 3-13	Waste Calcining Facility Hot Cell Blower Corridor	Track 1
CPP-86	OU 3-13	CPP-602 Waste Trench Sump	Track 1
CPP-87	OU 3-13	CPP-604 VOG Blower Core	Track 1
CPP-88	OU 3-13	Radiologically-contaminated soil	Track 1
CPP-89	OU 3-13	CPP-604/-605 Tunnel excavation	Track 1
CPP-90	OU 3-13	CPP-709 ruthenium detection	Track 1
CPP-91	OU 3-13	CPP-633 Blower Pit Drain	Track 1
CPP-92	OU 3-13	Soil boxes west of CPP-1617	Track 1
CPP-93	OU 3-13	Simulated Calcine Trench	Track 1
CPP-94	OU 3-13	Buried Cylinders East of ICPP	RI/FS
—	OU 3-13 (OU 10-06)	CPP Windblown Area	RI/FS

a. The CERCLA process indicates the "track" or level of investigation performed for each site as defined in the Action Plan.

cumulative risk at WAG 3. This evaluation and the results are in Appendix M of this report. This evaluation identified the 79 facilities most likely to impact future risk at WAG 3.

1.3.2.1 National Environmental Policy Act (NEPA)/CERCLA Integration. As of June 1994, the DOE relies on the CERCLA process to address the environmental aspects of CERCLA projects. National Environmental Policy Act of 1969 (NEPA) "values" are to be addressed in CERCLA documents only to the extent that NEPA aspects are significantly impacted by the project.

To ensure all environmental aspects will be reviewed during the planning phases of a CERCLA project, it has been proposed that a Department of Energy, Idaho Operations Office (DOE-ID) environmental checklist (EC) with attachments be prepared. Any significant environmental issues discovered in the EC review would be addressed in the RI/FS. Additionally, the completed EC with attachments would be submitted as background to and concurrent with the appropriate CERCLA project document, but not as an integral part of that document.

1.3.2.2 RCRA Status of ICPP Facilities. ICPP facilities currently operating under RCRA interim status include the PEW Evaporators, Tank Farm, Percolation Ponds 1 and 2, WCF, NWCF, and Calcine Storage Facility. A RCRA Part B permit application will be submitted to the Idaho Division of Environmental Quality (DEQ) at an undetermined future date. The NWCF will be addressed in the permit application. At present, there are no plans to include the CPP-603 basin in the permit application.

The State of Idaho has issued a Consent Order concerning the operation of the Tank Farm. The Consent Order allows a portion of the Tank Farm to operate until the year 2015. At that time, all the radioactive waste storage tanks must "cease use." Under the Consent Order, a phased closure will be implemented at the Tank Farm. The stipulated deadline for the first five tanks to cease use is year 2009 and the tanks will be emptied to the heel at that time. The remaining tanks may continue to operate until year 2015. Resource Conservation and Recovery Act (RCRA) closure activities will be implemented after the tanks cease use in 2015. The closure activities will address the HLLW tanks, the concrete vaults surrounding the tanks, and associated pipelines. The Consent Order also includes stipulations and deadlines for various upgrades and modifications to the Tank Farm and associated ancillary systems. A closure plan and schedule for the Tank Farm has not been developed.

The two ICPP percolation ponds have been used for discharge of the ICPP service wastewater since 1984. The use of the ponds is generally alternated to allow maintenance of the ponds if need. Both ponds are unlined and continue to be used. The wastewaters contain trace levels of heavy metals and radionuclides. Both ponds are listed on the INEEL RCRA Part A Permit application and subject to the closure requirements for interim status treatment, storage, and disposal facilities (TSDFs). The RCRA Closure Plan for the ICPP Percolation Ponds 1 and 2 was approved by the DEQ in December, 1992. All closure activities for both ponds have been completed. Professional Engineer certifications were achieved in April, 1994 and March, 1995 for Ponds 1 and 2, respectively. The DOE has petitioned the DEQ for an "equivalency determination" that these clean closures completed under interim status are as stringent as those closure requirements for RCRA-permitted units. This petition is anticipated to be successful and therefore, future regulation of these units will be under the purview of the Wastewater Land Application Permit. The radioactive contaminants in the bottom sediments of both ponds, and potential subsurface contamination associated with the ponds were evaluated in this RI/BRA Report as CPP-67 in OU 3-03.

The WCF at the ICPP is a multilevel structure of masonry, reinforced concrete, and steel construction. The WCF successfully demonstrated the fluidized bed calcination process for the conversion of HLLW into granular solids that are less corrosive, less mobile, and occupy less storage space. The WCF was taken out of service in 1981 after the successful completion of the ninth processing campaign. The WCF contains six units that are included in the INEEL RCRA Part A Permit Application and are subject to the closure requirements for interim status TSDFs. These units include four storage vessels, the WCF evaporator, and the high-efficiency particulate air (HEPA) filter storage area. During the 18 years of operation, there have been several surface and subsurface releases of radioactively-contaminated solutions in the vicinity of the WCF. The investigation of these releases was conducted as part of OU 3-08 and will continue to be evaluated during the WAG 3 Comprehensive RI/FS. It should be noted that the WCF is not included in the FFA/CO; therefore, the removal and disposal of the six RCRA-regulated units and associated ancillaries and structures will be conducted in accordance with an approved RCRA Closure Plan for this facility. The WCF RCRA Closure Plan was finalized in June 1996. Generally the proposed scope of the closure activity consists of grouting in place the six RCRA units followed by collapsing the aboveground structures into the WCF lower levels and filling voids with grout. Finally, a concrete cap that extends approximately five feet beyond the WCF perimeter will be installed. At the time of this writing, the work was under way and is expected to be finished by September 1998.

1.3.2.3 RCRA Listed Waste Issue. At the time that the RCRA Part A Permit was prepared for the ICPP units, it was submitted with an inventory of chemicals that included 23 characteristic and 105 listed waste codes. This raised a concern over the potential presence of listed constituents in the past releases that have occurred during liquid waste transfers between permitted units. If these waste codes were present then

the associated contaminated soil and groundwater would require to be managed as RCRA listed waste at the time of remediation. A strategy to address this issue is described in Appendix G of the FS report.

1.3.2.4 Settlement Agreement. On October 15, 1995, an agreement was reached between the State of Idaho, the Department of Energy, and the U.S. Navy on several strategic waste management issues at the INEEL. With regard to the high-level wastes residing within WAG 3, the decision was made that the high-level waste evaporator would operate in such a manner as to reduce the total liquid waste volume by no less than 330,000 gallons by December 31, 1997. It was also agreed that DOE would complete calcination of all nonsodium and sodium bearing liquid wastes by June 30, 1998 and December 31, 2012, respectively.

1.4 Summary of Known Releases

This section includes a brief description of each release site and the D&D facilities included in the WAG 3 Comprehensive RI/FS. The sites are organized by OU and decisions that have been made regarding the CERCLA process for each site are identified. Contaminants present at each site and an evaluation of the associated risks for each site are discussed in subsequent sections of this document. This section will also describe a process that was conducted on the list of ICPP facilities to identify the smaller subset of facilities most likely to impact future cumulative risk at the WAG 3.

1.4.1 No Action Sites

Ten release sites were determined to require no further action in Summary Assessments prepared under the COCA. When evaluated under the FFA/CO, these sites were identified to follow a no action process track. A short description of each site is provided in the following paragraphs.

The grease pit south of CPP-637 (site CPP-43) was used for disposing of an unknown quantity of oil and grease. The site occupies an area of 141 m^2 (1,520 ft^2). The site was filled, and a building (CPP-651) was constructed on the site in the mid-1970s. A no action documentation package was submitted for the Administrative Record in September 1991.

CPP-52 was a pickling shed used to treat piping and other structural materials with mineral acids during the original construction of the ICPP. The site involved an area of 13.4 m^2 (144 ft^2). The building was a temporary structure located east of CPP-631. Spent pickling solutions were disposed of in liquid waste storage tanks; there are no records of spills or leaks. The building was demolished in 1954. A no action decision document package was placed in the Administrative Record in September 1991.

CPP-70 is a septic tank located east of CPP-655. This septic tank was used to treat sanitary waste generated at the craft shop and warehouse building. Operations in the building include equipment maintenance and repair, welding, and carpentry. There are no drains located in the work areas and there is no evidence hazardous constituents were disposed of into the septic system. A no action decision document package was submitted to the Administrative Record in September 1991.

The seepage pits west of CPP-656 (CPP-71) were used in conjunction with the septic tank located east of CPP-655 (CPP-70). There are no records of hazardous constituents entering the system. A no action decision document package was submitted for inclusion into the Administrative Record in September 1991.

The CPP-758 cesspool east of CPP-651 (CPP-72) was used to treat sanitary sewage from temporary office trailers. The trailers have been disconnected and the system is no longer in use. Because the septic system was only connected to office restrooms, it is unlikely hazardous constituents were disposed of into the system. A no action decision document package was submitted to the Administrative Record in September 1991.

CPP-73 is a cesspool located east of and connected to temporary building CPP-T-5, which was used as a lunch/break room by a construction contractor. No hazardous materials have been stored at this location, and no hazardous wastes are reported to have been disposed into the unit. A no action decision document package was placed in the Administrative Record in September 1991.

CPP-74 is a seepage pit and septic tank located west of CPP-626. This septic system was constructed in the early 1970s and is used to treat sanitary waste from the fuel receiving and storage building and storage basin change room. The building contains a cafeteria, restroom facilities, showers, and office space. No operations involving hazardous materials are known to have occurred in the building and it is unlikely hazardous wastes have entered the system. The Summary Assessment recommending no further action for this site was approved in 1988. A no action decision document package was placed in the Administrative Record in September 1991.

The septic tank west of CPP-603 (CPP-75) was built in the early 1950s and received sanitary wastes before operation of CPP-74. The system was connected to a restroom facility, which was physically isolated from hazardous materials operations. The primary hazardous materials used in operations that might have been associated with this unit were mineral acids. The Summary Assessment recommending no further action for this site was approved in 1988. A no further action decision document package was placed in the Administrative Record in September 1991.

The septic tank and cesspool west of CPP-659 (CPP-76) was used to treat sanitary wastewater from the old calcining facility, which was built in 1960. There are no records of hazardous wastes entering the system. The septic tanks are in the process of being removed in support of the NO_x Abatement Facility construction. The Summary Assessment recommending no further action for this site was approved in 1988. A no action documentation package was placed in the Administrative Record in September 1991.

CPP-77 is a seepage pit and cesspool located north of CPP-662. There are no known records that indicate hazardous materials ever entered this system. The Summary Assessment recommending no further action for this site was approved in 1988. A no further action documentation package for this site was placed in the Administrative Record in September 1991.

1.4.2 Operable Unit 3-01

OU 3-01 includes four release sites (CPP-49, -50, -51, and -61) potentially contaminated with polychlorinated biphenyls (PCBs). Transformers were temporarily relocated to these sites after being removed from service as part of the utilities replacement projects. All four sites have undergone Track 1 investigations and no further action recommendations were approved for three of the sites. Radiological contamination was discovered at site CPP-61 and as a result, this site was further evaluated during the WAG 3 Comprehensive RI/FS.

CPP-49 and -50 consist of PCB transformer yards (CPP-705 and -731, respectively). CPP-49 consists of a 98.1 m^2 (1,056 ft^2) area located at the southwest corner of CPP-606 and contained three transformers from the CPP-705 yard. These transformers contained PCBs up to 330 parts per million (ppm) and leakage was observed on some of the transformers. It was estimated that less than 3.8 L (1 gal) of PCB oil may have leaked. CPP-50 consists of a 19.3-m^2 (208-ft^2) area (PCB Transformer Yard CPP-731) located at the southeast corner of building CPP-637. One transformer from the CPP-731 yard was removed from service and contained approximately 874 L (231 gal) of PCBs at 400 ppm. Leakage was noted and appeared to be confined to the concrete pad, with no soil contamination in the 19.3 m^2 (208 ft^2) site. Less than 3.8 L (1 gal) was estimated to have leaked, and the transformer was removed and shipped to a commercial disposal facility on August 30, 1985. These sites have undergone a Track 1 investigation, which recommended no further action. The recommendations for these sites were approved in April 1992.

The PCB staging area west of CPP-660 (CPP-51) is a 604 m^2 (6,500 ft^2) area where transformers that were removed from service were stored before shipment to a commercial disposal facility. Some of the transformers leaked oil into the soil. PCB spill cleanup debris was also stored at the staging area. The PCB concentrations were 400 ppm for the oil, 134 ppm for the concrete pad, and 31 ppm for the cleanup debris. The transformers and barrels of soil were shipped to a commercial disposal facility in 1985. A Track 1 investigation recommending no further action was approved in January 1993.

CPP-61 addresses a PCB spill in the CPP-718 transformer yard. The transformer leaked approximately 1,514 L (400 gal) of liquid containing PCBs at 179 ppm to the soil, which contaminated an area of approximately 58 m^2 (625 ft^2). The transformer, contaminated soil, and concrete pad were removed and shipped to a commercial disposal facility. Approximately 40 drums of soil and debris were removed. A new transformer and concrete pad have been installed. A Track 1 investigation resulted in a recommendation for no further action for the PCBs, which was approved in January, 1993. The radiological contamination discovered in the soil at this site was further evaluated during the WAG 3 Comprehensive RI/FS.

1.4.3 Operable Unit 3-02

OU 3-02 consists of 19 sites that were proposed for Track 1 investigations in the FFA/CO. These investigations resulted in no further action determinations for 14 of these sites. Track 1 investigations recommended further evaluation in the WAG 3 Comprehensive RI/FS for two of the sites. Track 2 preliminary scoping packages were prepared addressing sites CPP-23 (injection well), CPP-37 (gravel pits used for discharge and disposal of miscellaneous materials and equipment decontamination), and CPP-59 (kerosene tank overflows). These Track 2 scoping packages recommended further analysis of sites CPP-23 and CPP-37 in the WAG 3 Comprehensive RI/FS. The Track 2 analysis recommended no further action at site CPP-59.

CPP-07 is approximately 23 m^2 (252 ft^2) of contaminated soil located northwest of CPP-642. The soil was contaminated on September 10, 1972, by steam condensing from a vent line connected to the floor drain waste collection tank. Radiation readings of 200 mR/hr beta and gamma were detected on the soil directly beneath the vent line. Contaminated soil was removed to a depth of approximately 7.6 cm (3 in.) and replaced with clean soil. The Track 1 decision document for this site was submitted on August 17, 1992 and a no further action recommendation was approved in January 1993.

Radioactively-contaminated paint chips from a concrete storage pad south of CPP-603 (CPP-12) were discovered in May, 1984. It was estimated that an area of approximately 81 m^2 (875 ft^2) was contaminated.

The contaminated paint chips and any contaminated soil beneath the pad were removed. The Track 1 decision document for this site was submitted on August 17, 1992, and the no further action recommendation was approved in January 1993.

CPP-18 addresses an open-sided building that was used to store radioactively-contaminated gas cylinders from the early-1950s through mid-1970s. Gas cylinders stored at this location were decontaminated and shipped offsite. Radioactive contamination has been cleaned up and the site is presently at the location of building CPP-668. The Track 1 decision document was submitted on June 9, 1992, and the no further action recommendation was approved on September 14, 1992.

CPP-21 is a solid waste storage bin located south of CPP-601. Solid waste including paper, rags, and contaminated metal was collected in the bin before transfer to the Radioactive Waste Management Complex (RWMC). A 27.9 m^2 (300 ft^2) area around the bin was discovered to have been radioactively contaminated. The radioactive waste in the bin has been removed and the area around the bin has been cleaned up. The Track 1 decision document was submitted on October 1, 1992, and the no further action determination was approved in April 1993.

CPP-23 is the CPP Injection Well (MAH-FE-304), which was used from 1952 to 1984 to dispose service wastewater, including cooling water and condensate. The primary contaminants in the wastewater were radionuclides [estimated total activity at 21,302 curies (Ci), of which 94.5% was tritium (H-3), in 4.2E+10 L (1.1E+10 gal) of water]. The majority of these radionuclides have decayed due to their relatively short half-life. The water also contained chemicals at concentrations below drinking water standards. Several accidental releases of radioactive contaminants are known to have occurred over the operational life of the well. Track 1 and 2 investigations have been completed and this site was further evaluated in the WAG 3 Comprehensive RI/FS.

CPP-37 is two gravel pits used for discharge and disposal of miscellaneous materials and as an equipment decontamination area. Pit 1 occupies approximately 5,574 m^2 (60,000 ft^2), and Pit 2 occupies approximately 5,806 m^2 (62,500 ft^2). Sanitary waste, service waste, construction debris, and possibly chemical wastes were discharged to, disposed of, or decontaminated in the pits. Sampling and drilling activities were conducted in the pits in 1991 under the COCA. The Track 1 investigation resulted in preparation of a Track 2 scoping package. This site was further evaluated during the WAG 3 Comprehensive RI/FS.

CPP-41 is the fire training pits between CPP-666 and -663. These two small depressions [130 and 149 m^2 (1,400 ft^2 and 1,600 ft^2)] were used to burn organic material to train firefighters. The former locations of these pits have been covered with buildings CPP-663 and -666. A Track 1 investigation was submitted on April 30, 1992, and the no further action recommendation was approved in January 1993.

CPP-53 is a paint and paint solvent storage area south of CPP-697. This 232 m^2 (2,500 ft^2) area was used by a painting subcontractor to store between 30 and 40 drums of paint and paint solvents on pallets during construction of the FAST building. Some of the drums may have leaked to the ground before shipment to a commercial disposal facility in 1983, potentially contaminating the area with metals (mercury, chromium, and lead) and paint solvents. The area was characterized in 1986 and no contamination was identified. The Track 1 decision document package was submitted on August 17, 1992, and the no further action recommendation was approved in January 1993.

Site CPP-54 is a drum storage area consisting of two small areas [47.4 and 92.9 m^2 (510 and 1,000 ft^2)] used to store 30 to 40 drums of organic solvents (including Hexone) and used waste oil on pallets. These drums could potentially have leaked and contaminated the underlying soil. The drums were shipped to a commercial disposal facility in late 1985. Characterization of the site did not indicate hazardous constituents were present. The Track 1 decision document package was completed, and the no further action recommendation was approved in January 1993.

CPP-55 consists of a 766 m^2 (8,250 ft^2) area where carpenters and painters were observed discarding used paint solvents to the soil in 1984. Contaminants of concern at the site were mercury, chromium, and lead. Analyses of seven soil samples collected in August 1985 indicated mercury levels ranging from 48 to 236 parts per billion (ppb). All RCRA hazardous constituents were present at levels below regulatory limits. The Track 1 decision document package was completed, and the no further action recommendation was approved in April 1993.

CPP-57 is a 139 m^2 (1,500 ft^2) area east of CPP-606 that was contaminated by two sulfuric acid spills. In October 1984, a tank was overfilled and 189 L (50 gal) of sulfuric acid was discharged to the soil. In 1985, the tank developed a leak and 17,034 L (4,500 gal) of acid spilled onto the soil. The soil was subsequently removed, neutralized, and packaged. Cleanup of the area has been completed and a new tank has been installed. The Track 1 decision document package was completed, and the no further action recommendation was approved in January 1993.

Overflows from a kerosene tank located west of CPP-633 comprise site CPP-59. In 1983, kerosene being transferred to the NWCF overflowed from the building storage tank and kerosene from the foam fire protection line drained out of a vent at the same time. It was estimated that approximately 760 L (200 gal) of kerosene overflowed and contaminated a 228 m^2 (2,456 ft^2) area. In a separate incident in 1983, 227.1 L (60 gal) of kerosene overflowed and contaminated a 195 m^2 (2,100 ft^2) area. A 1990 RCRA closure plan recommended this site be closed without a removal action. A subsequent Track 1 investigation and Track 2 scoping analysis recommended no further action be taken at this site. The recommendation was approved.

CPP-60 is an old paint shop north of CPP-637 where paint and paint solvents may have been discharged to the soil. Potential contaminants of concern include paint solvents, mercury, chromium, and lead. The paint shop was removed and the site is the present location of building CPP-645. The Track 1 decision document was completed, and the no further action recommendation was approved in January 1993.

Site CPP-62 is a mercury-contaminated area near CPP-TB-4. This 446 m^2 (4,800 ft^2) site was contaminated by paint and paint solvents most likely containing mercury, chromium, and lead. During characterization, mercury levels up to 2,825 ppb were identified in the soil. In 1985, 25 drums of the contaminated soil were removed from the site and disposed of at a commercial facility. Calcine Bin Set #6 was erected over the location and no contaminated source remains. The Track 1 decision document was completed, and the no further action recommendation was approved in September 1992.

CPP-63 is a Hexone spill located adjacent to building CPP-710. A leak in the CPP-601 Hexone line was discovered during installation of cathodic protection. The Hexone tank was removed in January 1992, but contaminated soil was left in place. The site was sampled during November, 1992 and a qualitative risk assessment performed. The Track 1 decision document was completed, and the no further action recommendation was approved in April 1993.

CPP-64 is a Hexone spill west of CPP-660. The spill occurred when a drum was punctured allowing 208 L (55 gal) of Hexone to spill onto the asphalt and soil. Vermiculite was used to absorb some of the Hexone and then disposed of to an approved facility. The Track 1 decision document was completed, and the no further action recommendation approved in September 1992.

The four ICPP sewage treatment plant lagoons occupy 22,111 m^2 (238,000 ft^2) and have been identified as site CPP-65. No hazardous constituents are known to be present at this site. Monthly monitoring has detected extremely small amounts of radioactive contamination in the wastewater discharge, possibly caused by a decontamination shower in CPP-602. The liners to the lagoons currently leak and it is estimated large volumes of liquids may be escaping. A project to upgrade or replace the liners has been proposed. This site has been further evaluated in the WAG 3 Comprehensive RI/FS.

CPP-66 is the coal-fired steam generation facility fly ash pit. The pit contains 16,990 m^3 (22,222 yd^3) of fly ash in a 29,060 m^2 (312,800 ft^2) area. The Track 1 decision document was completed in April 1994 and the recommendations for no further action was approved. It should be noted that this decision is to be revisited during the Record of Decision (ROD) to review the impact of updates in the solid waste regulations.

Site CPP-68 is an abandoned gasoline tank that was taken out of service in 1983 and removed in 1986. There were no records of spills and the tank did not appear to leak. Two soil samples were collected at the site. Sample analysis indicated only trace amounts of gasoline constituents at concentrations within acceptable levels. The Track 1 decision document was completed, and the no further action recommendation was approved in April 1993.

1.4.4 Operable Unit 3-03

OU 3-03 consists of the two ICPP percolation ponds (site CPP-67) located to the south of the facility. These ponds occupy 59,654 m^2 (642,114 ft^2) and have been used only for discharge of the ICPP service wastewater since 1984 when the injection well was taken out of service. The service wastewater is monitored for gamma radiation, other radionuclides, total dissolved solids, heavy metals, and pH. Discharged water is below established limits. The Track 1 investigation has been completed and it was recommended that the radiologically-contaminated pond soils be further evaluated in the WAG 3 Comprehensive RI/FS. The ponds are in the process of being closed under RCRA. Closure certifications and an equivalence determination have been submitted to the DEQ. Following RCRA closure, the percolation ponds will be used for disposal of wastewater that does not contain RCRA-regulated hazardous constituents. The percolation ponds represent a significant recharge source, which has been included in the fate and transport modeling in this RI.

1.4.5 Operable Unit 3-04

OU 3-04 consists of asbestos-containing friable Transite on the outside walls of buildings CPP-601, -602, -603, -604, -605, -606, -640, -644, and -648 (site CPP-38). Transite is composed of 40% asbestos and 60% Portland cement. The Track 1 decision document was completed, and the no further action recommendation was approved in June 1993. Asbestos abatement is currently being undertaken by ICPP maintenance outside the FFA/CO to remediate the problem.

1.4.6 Operable Unit 3-05

OU 3-05 comprises the old sewage treatment plant at the ICPP (site CPP-14). This treatment plant serviced most of the ICPP buildings from 1951 to 1982. Radioactive decontamination showers drained into the plant and then to an outfall pit. The plant was decommissioned in 1982 and the sludge from the drying beds was sent to the RWMC. Drain tiles and the outfall line were left in place. The 3,902 m^2 (42,000 ft^2) area was sampled in 1991 and a risk analysis was performed using the Track 2 methodology. Based on this evaluation, the primary risk driver was determined to be the presence of PCBs (arochlor) in the Imhoff tank sludge. This site was further evaluated in the WAG 3 Comprehensive RI/FS.

1.4.7 Operable Unit 3-06

OU 3-06 consists of four sites (CPP-33, -34, -40, and -47) that have been identified as land disposal units.

CPP-33 consists of contaminated soil in the Tank Farm area near WL-102, located northeast of building CPP-604. The contaminated soil was discovered in the vicinity of a 31-cm (12-in.) pressure relief line drain and the process tie-ins to the stack drain. The pipe was fixed and approximately 191 m^3 (250 yd^3) of radioactively-contaminated soils were excavated and sent to the RWMC. The total amount of leakage is unknown. In 1983, contaminated soil was encountered again near tank WL-102, and 10,704 m^3 (14,000 yd^3) of soil was removed. Approximately 1,529 m^3 (2,000 yd^3) of soil with radioactivity in excess of 30 mR/hr were sent to the RWMC. The remainder of the soil [9,175 m^3 (12,000 yd^3)] with activity less than 30 mR/hr was stored east of CPP-603 and disposed of in a trench in the northeast corner of the ICPP. Some contaminated soil was left in place. The Track 1 investigation recommended this site to be included as part of the Track 2 investigation for site CPP-27 (discussed below under OU 3-08).

Site CPP-34 is the soil storage area in the northeast corner of the ICPP. In 1984, radioactively-contaminated soil at levels up to 30 mR/hr was removed from a pile located east of CPP-603 and disposed of to the trench. The soil was originally excavated out of an area east of CPP-604 (see Site CPP-33). The contamination consisted predominantly of nitric acid and radionuclides, including cesium (Cs)-137, uranium (U)-234 and -238, neptunium (Np)-237, strontium (Sr)-90, and plutonium (Pu)-238. Results of radionuclide sample analyses indicate Cs-137 and Sr-90 are the principal radionuclides in this 4,366 m^2 (47,000 ft^2) area. Lead, mercury, and silver were also detected at levels in excess of background and Bis (2-ethylhexyl) phthalate was also present in two samples. The Track 1 investigation recommended a Track 2 treatability study be conducted for this site. This site was further evaluated in the WAG 3 Comprehensive RI/FS.

Site CPP-40 is the lime pit located at the base of the CPP-601 berm and French drain. The pit was used to dispose of an unknown volume of hydrofluoric acid. The hydrofluoric acid drain line from the southwest corner of CPP-601 to the lime pit was removed in December 1991. Samples taken below the holes indicate no hazardous wastes were present at concentrations above acceptable levels. However, radioactive contamination was encountered in the soil below the line. The source for this radioactive contamination is unknown. Since the sampling, the lime pit has been decontaminated and abandoned in place. The Track 1 decision document was completed, and recommended no further action for the chemical contaminants because the concentrations were below risk-based concentrations. This no further action decision for the chemical contaminants was approved in June 1994. The radioactive contamination identified at this site was further evaluated in the WAG 3 Comprehensive RI/FS.

CPP-47, located west of CPP-620, is a 18.6 m^2 (200 ft^2) area used to store hydrofluoric acid for pilot plant operations. A small spill of an unknown quantity of hydrofluoric acid is known to have occurred in 1984. A bed of dolomite for neutralization of spills was installed below the pallets, but it is uncertain whether the 1984 spill occurred before the installation of the dolomite bed. It is estimated a maximum of 27.9 m^2 (300 ft^2) of soil may have been contaminated during the 1984 spill. The Track 1 decision document was completed, and the no further action recommendation was approved in September 1992.

1.4.8 Operable Unit 3-07

OU 3-07 includes 10 soil contamination sites within the Tank Farm and the perched groundwater identified by well CPP 55-06.

CPP-16 is contaminated soil from a leak in the line from CPP-WM-181 to PEW tank WL-102. Approximately 7.0 m^2 (75 ft^2) of soil became radioactively contaminated in January 1976 when the leak occurred during the transfer of service waste. Soil samples were taken and indicated the contamination did not penetrate the soil beneath the valve to depths greater than 0.9 m (3 ft). The contaminated soil was left in place and the site was later excavated during construction of a new valve box. The Track 2 investigation recommended no further action at this site. The recommendation was approved.

CPP-20 is the CPP-604 radioactive waste unloading area. The site consists of a 20.9-m^2 (225-ft^2) area north of CPP-604, where occasional small spills occurred during the transfer of liquid wastes into the storage tank. Spills were reportedly corrected at the time of occurrence and the resulting contaminated soils were removed. Records are not available to document the types, quantities, and location of the spills or verify the effectiveness of the cleanup. In the early 1980s, the entire site was excavated as part of the fuel processing facility upgrade project. Approximately 200 m^3 (7,053 ft^3) of soil was removed as part of the project. The area was subsequently backfilled. The Track 2 investigation recommended no further action at this site. The risks associated with radioactively-contaminated soil that was used as backfill were evaluated in the WAG 3 Comprehensive RI/FS.

Site CPP-24 is contaminated soil in the Tank Farm area resulting from an accidental dumping of a bucket [approximately 3.8 L (1 gal)] of liquid waste from inside Tank WM-180 in 1954. The liquid would have contained mercuric nitrate, nitric acid, and radionuclides. Contamination from the spill was reportedly cleaned up. Surface radiation readings have not detected contamination at the site. The Track 2 investigation recommended no further action at this site because the source has been removed.

CPP-25 is the contaminated soil in the Tank Farm area north of CPP-604. In 1960, a ruptured transfer line released an unknown quantity of liquid waste onto the soil adjacent to CPP-604. The release occurred during the transfer of waste from WC-119 to WL-102. The waste consisted of mercuric nitrate, nitric acid, and radionuclides. Approximately 7 m^3 (9 yd^3) of contaminated soil was removed from the site and the building was washed to acceptable radiation levels. The entire site was excavated as part of the fuel processing facility upgrade project and subsequently backfilled with low-level, radioactively-contaminated soil. The Track 2 investigation recommended no further action at this site because the source has been removed. The radioactively-contaminated soil that was used as backfill was evaluated in the WAG 3 Comprehensive RI/FS.

CPP-26 consists of contaminated soil in the Tank Farm area from steam flushing operations. Contaminated fluid and steam containing mercuric nitrate, nitric acid, and radionuclides was dispersed over

approximately 13 acres northeast of the northeast corner of the tank farm during a steam flushing operation in 1964. Approximately 3 acres of land outside the ICPP fence was contaminated during this incident. A significant amount of construction has occurred within the release site since 1964. The site was evaluated in a Track 2 investigation that recommended no further action would be needed for the area outside the Tank Farm, and the area within the Tank Farm should be evaluated further. The recommendation was approved; therefore, only the site area within the Tank Farm was evaluated in the WAG 3 Comprehensive RI/FS.

CPP-28 comprises contaminated soil in the Tank Farm area south of WM-181 by Valve Box A-2. A subsurface release of radioactively-contaminated liquid resulted from holes drilled into a transfer line during installation in 1955. It is estimated 13,600 L (3,600 gal) of first-cycle raffinate waste containing 32,000 Ci of gross radioactivity was released from the pipe between 1955 and 1974. Soil containing an estimated 3,000 Ci was reportedly excavated from the area. The failed line has been removed from service. The Track 2 investigation has been completed and recommended further evaluation of this site in the WAG 3 Comprehensive RI/FS.

CPP-30 is contaminated soil in the vicinity of Valve Box B-9. In 1975, a 6.1- × 6.1-m (20- × 20-ft) area of soil was contaminated up to levels of 1 R/hr when maintenance personnel working inside a contaminated valve box inadvertently placed radioactively-contaminated equipment and clothing on the ground. The contaminated surface soil was removed, packaged into four 208-L (55-gal) drums, and shipped to the RWMC for disposal. Subsequent surface radiation surveys in the area have not shown radiation levels above background. The Track 2 investigation has been completed and recommended no further action because the source has been removed. The recommendation was approved.

CPP-31 is contaminated soil located south of tank WM-183. The soil was contaminated by a release of 53,000 L (14,000 gal) of liquid waste from a corroded carbon steel line in the radioactive liquid waste transfer system. The liquid waste contained mercuric nitrate, nitric acid, and radionuclides. Contaminated soil [612 m^3 (800 yd^3)] was left in place and is monitored by subsurface access ports that extend to a depth of 7.6 m (25 ft). Maximum readings of 10 R/hr were recorded between 4.0 and 6.1 m (13 and 20 ft) belowgrade. The estimated volume of contaminated soil is 153 m^3 (200 yd^3) in a 10 R/hr range and 306 m^3 (400 yd^3) in the 1 R/hr range. The Track 2 investigation has been completed and recommended further evaluation in the WAG 3 Comprehensive RI/FS.

CPP-32 is two areas of contaminated soil near Valve Box B-4 that were contaminated by separate pipe leaks. CPP-32E is an area of contaminated soil located southwest of Valve Box B-4. The contamination at this site is suspected to have originated as a surface release of condensate originating from a vent tube in the valve box. The area of contamination was identified as 1 m^2 (8 ft^2) and extended to a depth of 31 cm (12 in.) bgs. The soil was left in place and has been covered with approximately 0.6 m (2 ft) of soil, the Tank Farm membrane, and an additional 15 cm (6 in.) of soil. The Track 2 investigation has been completed and recommended no further action for site CPP-32E because the maximum concentration detected at the point of release overestimates the risk and a more reasonable estimation of the source term would result in an acceptable risk. Contamination at CPP-32W is believed to have originated from a 5-cm (2-in.) aboveground transfer line that released radioactive liquids approximately 15.2-m (50-ft) northwest of the valve box. The release covered an area approximately 0.9 × 0.6 m (3 × 2 ft), having radiation levels as high as 2 R/hr. The Track 2 investigation has been completed and recommended further evaluation in the WAG 3 Comprehensive RI/FS.

CPP-79 is a release of radioactively-contaminated liquid in the Tank Farm near Valve Box A-2. Approximately 9,460 L (2,500 gal) of low-level, radioactively-contaminated condensate was released during transfer operations from the WCF to the PEW feed tank in July or August, 1976. The transfer line and valve box were located 3.0 m (10 ft) bgs and sampling has indicated the presence of low levels of radioactivity above 11.0 m (36 ft) bgs. Samples collected from 12.2 to 12.8 m (40 to 42 ft) bgs contain significantly higher levels of radioactive contamination and based on the difference in concentration and isotopes present, it was determined the lower contamination was the result of a separate release. The Track 2 investigation has been completed and recommended further evaluation in the WAG 3 Comprehensive RI/FS.

CPP-83 is the perched groundwater beneath the Tank Farm in the northern portion of the plant being monitored by well CPP 55-06. This well was installed as part of the characterization for Site CPP-55. Quarterly sampling has been performed on perched water from this well, commencing in August 1990. Analytical results indicate radionuclides are the contaminants of primary concern. The Track 2 investigation has been completed and recommended further evaluation in the WAG 3 Comprehensive RI/FS.

1.4.9 Operable Unit 3-08

OU 3-08 is named Tank Farm Area II and consists of six release sites.

CPP-13 resulted from the pressurization of the solid storage cyclone northeast of CPP-633 where calcined high-level waste was released to the air in 1976. The contamination covered a 27.9 m^2 (300 ft^2) area on the berm covering Bin Sets 1 through 3. The bin sets contain high-level waste and, as a result, contamination in the area is masked by the high levels of radiation in the area. As detailed in Chapter 19, sampling was performed during the OU 3-13 RI/FS field program. These results are evaluated in the WAG 3 Comprehensive RI/FS.

CPP-15 is the soil contaminated by liquid that leaked from a flange on top of the solvent burner holding tank (LE-102) east of CPP-605 release. Maximum radiation levels in the contaminated soil were 3 R/hr and the area of the release was estimated to be 65 m^2 (700 ft^2). Additional contamination resulted from continual leakage of combustion products from the solvent burner flue when the system was in operation. The contaminated soil was removed and placed in drums. The excavated area was backfilled with uncontaminated soil. In 1985, CPP-629 was dismantled and the solvent burner and holding tank were removed. The Track 2 investigation was completed and recommended no further action because the source was believed to have been removed. The recommendation was approved. In September 1995 during an electrical upgrade project, radionuclide-contaminated soil was encountered within the site boundary. As a result, the radionuclide contamination at this site is being reevaluated. More details about the newly discovered contamination are found in Section 11 of this report.

Site CPP-27 is contaminated soil in the Tank Farm area east of CPP-604. This 117 m^2 (1,260 ft^2) site was contaminated after acidic condensate leaked and corroded two 2.1- to 2.4-m (7- to 8-ft) sections of a pressure relief line. The site was discovered in 1964 and it was determined that approximately 1,140 L (300 gal) of radioactive waste containing 1,000 Ci of activity may have leaked from the line between 1961 and 1974. Cleanup efforts in 1974 removed approximately 229 m^3 (300 yd^3) of contaminated soil. Additional contaminated soil was later discovered while excavating tank WL-102, which is located northeast of CPP-604. In 1983, approximately 10,700 m^3 (14,000 yd^3) of contaminated soil was removed from the site. In 1992, boreholes were drilled and soil samples collected. These results indicate hotspots are present at several depths throughout the site. Furthermore, it was determined Sites CPP-27 and -33 (discussed above)

were likely to have resulted from the same source and therefore, should be addressed as a single release site. Therefore, the Track 2 investigation combined sites CPP-27 and -33 and recommended further evaluation in the WAG 3 Comprehensive RI/FS.

CPP-29 comprises the contaminated soil north and west of the main stack (CPP-708). The site consists of 28 m^2 (300 ft^2) areas of contaminated soil at two locations, north and west of the stack. The sites were contaminated when a solution containing 0.6 μCi/mL mercuric nitrate and nitric acid seeped through two areas at the base of the main stack. Contaminated soil at both sites was excavated and removed. The Track 2 investigation was completed and recommended no further action because the source of contamination has been removed. The recommendation was approved.

CPP-35 is the CPP-633 decontamination spill where during decontamination efforts on the WCF calcine vessel WC-102, decontamination solution entered the air transport system and was released to the soil. It is estimated this release contaminated an area of 111 m^2 (1,200 ft^2) with approximately 38 L (10 gal) of solution containing nitric acid, mercuric nitrate, heavy metals, fluoride, and nitrates and as much as 10 Ci of radioactivity. Contaminated soil and gravel were removed and disposed of at the RWMC. Sampling in the area has indicated the presence of radioactive contamination. The Track 2 investigation was completed and recommended further evaluation in the WAG 3 Comprehensive RI/FS.

CPP-36 resulted from a leak in a transfer line between CPP-633 and WL-102 that contaminated 302 m^2 (3,250 ft^2) of soil. This leak of decontamination solution contained radionuclides, nitric acid, mercuric nitrate, volatile organic compounds (VOCs), and heavy metals. Excavations indicated contamination to a depth of 3.7 m (12 ft). Four different areas within the site, representing four possible releases, have been sampled since 1974. Radioactive fields of 10 and 20 R/hr have been reported during these sampling activities. Sampling has indicated the presence of contamination at this site. The Track 2 investigation was completed and recommended further evaluation in the WAG 3 Comprehensive RI/FS.

1.4.10 Operable Unit 3-09

OU 3-09 consists of 15 release sites in the vicinity of CPP-603.

CPP-01 is a 46.5 m^2 (500 ft^2) site consisting of a concrete settling basin, vault, and dry wells east of CPP-603. The basin and wells were used for discharge of radioactively-contaminated fuel storage basin water. In 1968, operation of the horizontal settling basin ceased and the basin was covered with soil. The settling pit was later reactivated, but the supernatant was drained to a hot waste tank instead of the dry wells. Use of the settling facilities terminated in 1977 after installation of a pressurized sand filter system. This site was sampled via boreholes CPP-01-1, CPP-01-2, and CPP-01-3 with contamination located in samples from each borehole. The Track 2 investigation has been completed and recommended further evaluation in the WAG 3 Comprehensive RI/FS.

An old French drain used in the 1960s before the graphite fuel storage building was constructed is site CPP-02. The drain helped to reduce chloride and nitrate ion concentrations in the basin water by using a "bleed and feed" system. Discharge was discontinued in 1966 and the drain was decommissioned, boxed, and sent to the RWMC when the graphite fuel storage building was built. Low-level contaminated soil associated with the drain was either backfilled in place or buried near the dry fuel storage area. No sampling of the site has been conducted because the location of the French drain is underneath the graphite fuel storage building. The Track 2 investigation was completed and recommended further evaluation in the WAG 3

Comprehensive RI/FS. The site is considered to be exclusive groundwater concern. Assumptions regarding influence to groundwater are described in Chapter 9.

CPP-03 is a 45.7 × 152 m (150 × 500 ft) temporary storage area southeast of CPP-603 that was used to store old and abandoned equipment, most of which was radioactively contaminated. The storage area was decommissioned in the late 1970s. All stored material was boxed and sent to the RWMC. Contaminated soil was removed, boxed, and taken to the RWMC and the area was covered with 28 cm (11 in.) of "cold" soil. Subsequently, 9,175 m^3 (12,000 yd^3) of contaminated soil excavated from the Tank Farm was stockpiled at this location before burial in three trenches located in the northeast corner of the ICPP. Radiological surveys in the area have indicated activity levels above background, and sampling was conducted from three boreholes in the area. The Track 2 investigation has been completed and recommended further evaluation in the WAG 3 Comprehensive RI/FS.

Sites CPP-04 and -05 were combined for analysis because these sites were determined to be the result of the same source of contamination. These sites consist of 205 m^2 (2,211 ft^2) of contaminated soil around the CPP-603 settling tank. These areas were discovered to be contaminated in 1953 and 1954, respectively, and some contaminated soil was subsequently removed. The Track 2 investigation has been completed and recommended further evaluation in the WAG 3 Comprehensive RI/FS.

The trench east of the CPP-603 fuel storage basin is site CPP-06. This 116 m^2 (1,250 ft^2) trench was used for the discharge of basin water while maintenance was conducted on the basin. The basin water contained low levels of radioactivity and chloride ions at 50 ppm. Approximately 1,892,700 L (500,000 gal) of water was pumped across Willow Avenue into the ditch on the south side of the road. This trench was abandoned in place and has been sampled in one borehole. The Track 2 investigation has been completed and recommended further evaluation in the WAG 3 Comprehensive RI/FS.

Sites CPP-08 and -09 were combined for analysis because contamination was determined to be from the same source. These sites consist of contamination from the basin filter system line failure and the soil contamination discovered near the northeast corner of the CPP-603 basin, respectively. The underground carbon steel recirculation line from the basin failed due to corrosion and contaminated approximately 251 m^2 (2,700 ft^2) of soil with 79,494 L (21,000 gal) of radioactively-contaminated liquid from CPP-603. The exact location of the leak was not identified. The Track 2 investigation has been completed and recommended further evaluation in the WAG 3 Comprehensive RI/FS.

Site CPP-10 resulted from the release of 3,000 L (800 gal) of radioactively-contaminated basin water that drained onto the CPP-603 shielded area floor as a result of a break in a polyvinyl chloride (PVC) line. A small area [34.0 m^2 (366 ft^2)] of asphalt and soil outside the building was contaminated and has been designated as site CPP-10. The area of the spill was decontaminated, but sampling in one borehole at the site has indicated the presence of radionuclides. The Track 2 investigation has been completed and recommended further evaluation in the WAG 3 Comprehensive RI/FS.

Site CPP-11 is the result of a release of waste-containing sludge and water from CPP-603 in February 1978. The release involved 1,136 to 1,893 L (300 to 500 gal) of sludge and water and covered an area of 8.5 × 17.1 m (28 × 56 ft). The initial spill was cleaned up and areas having radiation levels greater than 1 R/hr were removed. The remainder of the area was roped off. The tanks are still used for contamination suspected to be from small spills associated with removal activities. The 94,600-L (25,000-gal) SFE-106 tank is located 1.8 m (6 ft) bgs at the site and is still in service. The tank is known to contain radionuclide-

contaminated waste. There is no evidence the tank is leaking. Because the tank is still in use and there is a possibility of a future release, the Track 2 investigation recommended further evaluation in the WAG 3 Comprehensive RI/FS.

Site CPP-17 consists of two areas east of building CPP-603 and south of the CPP Peach Bottom Fuel Storage Area. Area 17a measures approximately 34.7 × 39.6 m (114 × 130 ft) and Area 17b is approximately 38.1 × 21.3 m (125 × 70 ft). These areas were once used for storing piles of soil, asphalt, concrete, metal debris, and other items during a period of at least 5 years. The stored material reportedly came from a variety of construction and maintenance activities within the ICPP perimeter fence. It has been reported that before these sites were used for storing construction soil and debris, sludge/liquids generated during CPP-603 fuel storage basin maintenance activities may have been deposited at these areas, resulting in contamination of the underlying soils. The areas were classified as radioactive Zone 1 and roped off to prevent entry.

The soil at CPP-17 has been containerized into 640 standard radioactive waste boxes, each measuring 0.6 × 1.2 by 2.4 m (2 × 4 × 8 ft). The soil was monitored during removal using an RO-2A survey meter; however, no radiological contamination was detected during the project using this survey method. Results of gamma spectroscopy analyses indicated low levels of Cs-137 were present. The volume of contaminated soil is approximately 1,160 m^3 (40,960 ft^3). During containerization of the soil, four composite grab samples were collected and analyzed for toxicity characterization leaching procedure (TCLP) metals and radioactive constituents. The results indicated the soil samples did not exhibit the toxicity characteristic for heavy metals (D004-D011) in accordance with 40 CFR 261, and low levels of Cs-137, Sr-90, Eu-152, Eu-154, Pu-238, and Pu-239 were present. After the contaminated soil was removed from site CPP-17, the area was leveled to grade. The Track 2 investigation has been completed and recommended further evaluation in the WAG 3 Comprehensive RI/FS.

CPP-19 is soil contaminated by a 1978 release of 7,570 L (2,000 gal) of radioactively-contaminated liquid that leaked from an underground waste transfer line between CPP-603 and WL-102 in CPP-604. Approximately 80.0 m^3 (2,825 ft^3) of soil was removed from the most highly contaminated areas and the remaining surface contamination was scraped off to a depth of 15 to 20 cm (6 to 8 in.). The entire 46.5 m^2 (500 ft^2) area was then backfilled with clean soil to radiation levels less than 0.5 mR/hr. Sampling of two boreholes indicated the presence of contamination. The Track 2 investigation has been completed and recommended further evaluation in the WAG 3 Comprehensive RI/FS.

CPP-22 is a radioactive particulate release that occurred when cell ventilation filters failed in October 1958 contaminating an area to the south of CPP-603. At the time of the release, approximately 12,170 m^2 (131,000 ft^2) of land adjacent to the building was contaminated. The contamination was reportedly cleaned up. The Track 2 investigation has been completed and recommended further evaluation in the WAG 3 Comprehensive RI/FS.

CPP-69 consists of an abandoned liquid radioactive waste storage tank (V.S.-SFE-20) and its contents that was taken out of service in 1977. The tank contains approximately 1,514 L (400 gal) of low-level, radioactive liquid waste. The Track 2 investigation has been completed and the site was evaluated further in the WAG 3 Comprehensive RI/FS because it represents a potential future release.

CPP-78 is a small area of contaminated soil to the west of CPP-693 and east of the dry fuel storage area. Radioactively-contaminated soil was encountered in a 2.3 m^2 (25 ft^2) area during excavation for a dry

fuel storage area trench in 1987. The trench was backfilled with the soil. No soil samples were collected to quantify the contamination at this site. A surface radiation survey in 1993 indicated no surface radiological contamination. The Track 2 investigation has been completed and recommended further evaluation in the WAG 3 Comprehensive RI/FS.

1.4.11 Operable Unit 3-10

Four sites classified as chemical spills are included in OU 3-10.

CPP-42 is an 167 m^2 (1,800 ft^2) drainage ditch west of CPP-637 that was possibly used for disposal of laboratory and nonradioactive pilot plant chemicals, including miscellaneous acids. Concentrations of contaminants have been estimated using the results from 1988 Extraction Procedure (EP) toxicity tests on three soil samples collected from the ditch. The Track 2 investigation has been completed and recommended no further action for this site. The recommendation was approved.

CPP-44 is a 63.2 m^2 (680 ft^2) grease pit south of CPP-608 that was used for discharge of oils and greases from the plant vehicle service. The pit has been filled with soil and is no longer in use. The pit is close to an acid storage area and some acids may have been dumped into the pit after the fill material was added. Sampling results from the pit were used to determine risk-based soil concentrations and as a result, the Track 2 investigation has been completed and recommended this site for no further action. The recommendation was approved.

CPP-46 resulted from a release of about 1,703 L (450 gal) of nonradioactive simulated zirconium-dissolved product from a storage tank in the CPP-637 courtyard. The release occurred in 1978 when a 37 m^2 (400 ft^2) area was potentially contaminated with zirconium, hydrofluoric acid, fluorides, and nitric acid. The solution was neutralized and most contaminated soil removed. Sampling indicated no contamination remains at the site. The Track 2 investigation has been completed and recommended no further action for this site. The recommendation for inorganic contamination was approved; however, the potential radionuclide contamination was investigated as part of the WAG 3 comprehensive RI/FS.

Nitric acid contamination south of CPP-734 has been designated as site CPP-56. In 1968, waste from the westside nonradioactive liquid waste holdup tank (WL-103) located to the west of CPP-734 was pumped to the westside monitoring station where the line developed a leak. The quantity of nitric acid discharged is unknown, and the affected area is estimated to be 32.5 m^2 (350 ft^2). The Track 2 investigation has been completed and recommended no further action based on cleanup activities subsequent to the release. The recommendation was approved.

1.4.12 Operable Unit 3-11

OU 3-11 consists of two acid spill sites (CPP-45 and -58) in the vicinity of CPP-621.

CPP-621 chemical storage area spills have been designated as site CPP-45. The storage chemical area occupies 906 m^2 (9,750 ft^2) and consists of eight tanks, two open bottom limestone pits, and six French drains. The French drains are no longer in use. Various acids and aluminum nitrate solution are stored in large metal and fiberglass tanks. Some acids have overflowed and spilled in this area. Acids, mercury, and lead were detected in small amounts in soil samples collected in 1986. The total volume of spills is estimated to be less than 37,850 L (10,000 gal). The contaminated soil from a 4,542 L (1,200 gal) nitric acid spill in

1982 was cleaned up. A Track 2 investigation has been completed and recommended no further action because the concentrations of existing contaminants pose no significant hazards. The recommendation was approved.

Site CPP-58 is the result of pipeline spills associated with the PEW Evaporator. The site consists of two areas: CPP-58E [334 m^2 (3,600 ft^2)] and CPP-58W [297 m^2 (3,200 ft^2)]. CPP-58W resulted from a subsurface release [1.8 to 2.4 m (6 to 8 ft) bgs] of low-level contaminated liquid from an underground transfer line between the PEW Evaporator and the monitoring station in CPP-709. The release occurred in 1954 and subsequently, building CPP-649 has been constructed on top of the release site. Minimum excavation for the building was 3.7 m (12 ft) bgs. The size and amount of the spill is unknown, but is contained underneath the building. No field investigations have been performed on this site due to the presence of the building. For purpose of the RI/FS, results from CPP-58E were assumed representative of CPP-58W. The Track 2 investigation has been completed and recommended further evaluation in the WAG 3 Comprehensive RI/FS. CPP-58E consists of spills from the PEW overhead pipeline. The area was sampled in 1992 as part of a Track 2 investigation. For the purposes of the RI/BRA, results from CPP-58E were assumed representative of CPP-58W. The Track 2 investigation has been completed and recommended further evaluation in the WAG 3 Comprehensive RI/FS.

1.4.13 Operable Unit 3-12

The three sites (CPP-80, -81, and -82) addressed by OU 3-12 consist of abandoned pipelines.

CPP-80 resulted from a leak in the CPP-601 Vent Tunnel Drain (VT-300). The leak in the south vent tunnel floor drain line was discovered in 1989. In 1982 or 1983, off-gas condensate was incorrectly routed into this line, causing corrosion and subsequent leakage. Approximately 399,400 L (105,500 gal) of hazardous, radioactive liquid condensate was released to the soil between 1983 and 1989. A Track 1 investigation completed in 1993 recommended further investigation to better characterize the risk associated with this site. A Track 2 investigation was not performed and, therefore, this site was evaluated in the WAG 3 Comprehensive RI/FS.

CPP-81 is an abandoned vessel offgas (VOG) line (CPP-637/CPP-601 VOG line) that became plugged with simulated calcine material in 1986. No release to the environment is believed to have occurred and the line has been removed. The Track 1 investigation has been completed and recommended no further action because the source of contamination was removed by a removal action. The no further action decision was approved in June 1994.

CPP-82 is an abandoned pipeline (1.5 in.-PLA-776) located west of Beach Street. Four lines carrying liquid nonhazardous, low-level radioactive waste were struck by a backhoe during construction activities releasing contamination to the soil. The contamination was removed after the release. The Track 1 investigation has been completed and the no further action recommendation was approved in May 1993.

1.4.14 Operable Unit 3-13

OU 3-13 includes Track 2 PSP Sites CPP-39 and -48 and the WAG 3 Comprehensive RI/FS. In addition, 11 new units and a windblown contamination area have been identified at the ICPP and are also included in this OU. These release sites have been discovered since the finalization of the FFA/CO Action Plan and may include previously unknown release sites or new information at previously evaluated sites.

With the exception of CPP-94, Track 1 investigations have been prepared for these sites but were never submitted to the regulatory agencies for review and approval. Instead, these documents are included as part of this report in Appendix A. Data needs were identified during the preparation of the Track 1s for several of these sites and are discussed in Section 4 of the WAG 3 Comprehensive RI/FS Work Plan. If field work was required, the data collection is described in the WAG 3 Comprehensive RI/FS Sampling and Analysis Plan (SAP).

CPP-39 consists of a hydrofluoric acid storage tank (YDB-105) and dry well. This 488 m^2 (5,250 ft^2) site contained hydrofluoric acid used for the process makeup. Any tank overflow was drained to a limestone neutralization pit beneath the tank and is estimated to have received 3,028 L/yr (800 gal/yr). The neutralized solution then drained to a dry well located south of CPP-637. The tank and line from the neutralization vault to the dry well have been removed. The soil in the area was characterized in 1993. The Track 2 Preliminary Scoping Package was submitted to the regulatory agencies in early 1995 and recommended no further action for this site.

CPP-48 is a French drain located south of CPP-633 that was used for disposal of nitric acid and other chemicals consisting primarily of aluminum nitrate and calcium nitrate. No records are available regarding the quantities of disposed chemicals, but the volume is estimated to be 3,790 L (1,000 gal). The drain has been taken out of service. Soil sampling was conducted around the French drain in 1986 and no hazardous wastes/constituents were detected. The 3.7-m (12-ft) deep, 1.5-m (5-ft) diameter stainless steel tank was removed in August 1993 and underlying soils were characterized. The Track 2 Preliminary Scoping Package was submitted to the agencies in early 1995 and recommended no further action for this site.

CPP-84 is a discarded gas canister site located to the northwest of the ICPP. After initial construction of the ICPP, several gas cylinders were placed in a 6.1- × 9.1- × 1.5-m (20- × 30- × 5-ft) trench and covered with soil. Some cylinders were damaged with bent or frozen valves and others were empty or nearly empty. The contents of the cylinders are believed to be primarily welding gases (oxygen, acetylene, etc.). The trench is located outside the ICPP fence approximately 46 m (150 ft) north of the last power pole before the bridge (Lincoln Blvd. over the Big Lost River) and 15.2 to 18.3 m (50 to 60 ft) from the river channel on the east side. The scoping package recommended this site for no further action. This site was not evaluated in the RI/BRA. However, because of the nature of the hazard at this site (i.e., explosion), alternatives to mitigate this threat along with cost estimates may be found in Appendix F of the FS report.

CPP-85 is the blower corridor for the CPP-633 cells. This corridor runs around the outside perimeter of building CPP-633. The corridor was used to transfer unfiltered air from several hot cells in CPP-633 to -649, where the air is exhausted into a HEPA filter system. The corridor is made of clay tile and was not designed to contain liquids. The corridor was recently inspected using a remote video camera and water marks were observed. Contaminated water may have entered the corridor during steam and water decontamination of the hot cells. The scoping package recommended this site be evaluated further during the WAG 3 RI/FS.

CPP-86 is the CPP-602 waste trench sump. Mercury was found in the soil beneath the waste trench sump during construction of the PEW collection system. Sample analysis indicated that small amounts of contamination leaked through cracks in the concrete into the soil before installation of a stainless steel liner. The scoping package recommended this site for no further action.

CPP-87 is the CPP-604 VOG blower core. Analysis of a soil sample below a severely deteriorated portion of the concrete in the blower cell indicated the presence of low concentrations of hazardous constituents. The results of the sample analysis indicate contaminant concentrations are below EP Toxicity limits. The scoping package recommended this site for no further action.

CPP-88 is designated as the radiologically-contaminated soils that have been identified within the security perimeter fence at the ICPP that have not been attributed to a release site identified in the FFA/CO. During construction activities at the ICPP, primarily digging and excavations, radiological contamination has been periodically discovered in the soils. This contamination is measured by radiological control technicians (RCTs) using field instruments and reported in Health Physics Survey Reports. These measurements are not isotope-specific (usually reported as total beta-gamma activity) and only provide a qualitative estimate of the radioactivity, reported as counts per minute (cpm) or millirem/hour (mrem/hr). CPP-88 includes only the measurements made on soil between December 1988 and March 1994 and excludes contamination associated with buildings, structures, and concrete or asphalt pads. This site was further evaluated during the WAG 3 Comprehensive RI/FS.

CPP-89 is the CPP-604/-605 tunnel excavation. This tunnel was excavated under the CPP-604 off-gas building as part of the fire protection program to provide a second egress route. Contaminated soil was encountered during excavation and it was determined the contamination resulted from abandoned drain lines running to the PEW system. Contaminated soil was boxed and removed and segments of the corroded carbon steel lines were removed. Contamination was also encountered on the outside south facing basement wall of CPP-604 and is believed to be the result of a leaking concrete sump above the wall in CPP-604. The concentration of contamination at this site is below the concentration in soils that were historically used as backfill throughout the plant. This site was evaluated during the WAG 3 Comprehensive RI/FS.

CPP-90 deals with detection of trace amounts of ruthenium [7E-06 μci/mL ruthenium (Ru)-106] in the ICPP production wells in May 1959. The contamination was determined to be the result of a deteriorated service waste line washing contaminated soil into the ICPP disposal well. The explanation for contamination of the upgradient production wells was that a larger than usual volume of water was released to the injection well for several months during the prescribed time period. Reports indicate that a 152-m (500-ft) segment of concrete pipe disintegrated and leaked in several locations. The pipe, which was replaced in 1960, exited monitoring station CPP-709 and inputted to the injection well. This site was evaluated during the WAG 3 Comprehensive RI/FS.

The CPP-633 blower pit drain has been designated as site CPP-91. The blower pit is located on the northwest corner of the WCF (CPP-633), and a floor drain in the pit was used to remove any water that accumulated in the pit. Original blue prints indicate the drain was not piped into a plant service waste line and effluent from the drain line discharged directly to the soil. The hatch covering the pit was not watertight and rain and snowmelt could potentially have entered the pit. Cleanup activities were initiated on the pit in February 1992. Debris and sludge were removed from the pit and the drain was sealed off. The hatch was covered and made watertight. Samples of soils and sludge indicated contaminants of concern were Cs-134, Cs-137, and Eu-154. This site was evaluated during the WAG 3 Comprehensive RI/FS.

CPP-92 is a group of soil boxes located west of CPP-1617. This site consists of approximately 1,500 boxes containing soil with low levels of radioactive contamination. The 1.2- × 1.2- × 2.4-m (4- × 4- × 8-ft) boxes are constructed of 1.9-cm (0.75-in.) plywood and are lined with a polyethylene membrane liner. The waste was generated as a result of a variety of ICPP activities, including the Tank Farm Upgrade,

CERCLA remedial projects, CPP-603 cleanup, and miscellaneous excavations throughout the plant. Most of the boxes contain soil with contaminant levels so low the RWMC will not accept the waste, and shipment of the boxes to the RWMC would severely diminish the remaining capacity of the facility. The site was evaluated during the WAG 3 Comprehensive RI/FS.

CPP-93 is a trench located near the WCF that was used to dispose of nonradioactive calcine. Excavation took place in the early to mid-1960s. The trench, now buried, was approximately 9.1 × 107 m (30 × 350 ft) and used to dispose of simulated calcine before hot startup of the CPP-633, WCF. Ten test batches of solution were calcined and disposed of in the trench. Nine batches used solutions consisting of aluminum nitrate, nitric acid, sodium nitrate, and boric acid. The tenth batch used a solution of aluminum nitrate, nitric acid, sodium nitrate, mercuric nitrate, and boric acid. No radioactive material was disposed of in the trench. However, Test Batch 10 contained mercuric nitrate, and it is assumed the soil in the vicinity of the trench could be contaminated with mercury in concentrations above regulatory limits. This site was evaluated during the WAG 3 Comprehensive RI/FS.

CPP-94 was discovered in December 1996 and is located about 1/2 mile northeast of the ICPP. The site contains three compressed gas bottles that are visible and may contain a fourth bottle that is buried. It is believed that the bottles were placed in their current location sometime in the early 1960s. The visible portions of the bottles appear to be structurally sound with paint partially intact and some surficial rust. The bottles are 15 in. × 52 in., have a volume of 4.46 ft^3, weigh about 160 lbs empty, and were rated for 240 psi. Four metal tags found near the bottles are stamped with the words "hydrofluoric acid." The fourth tag provides some evidence that there is at least one more bottle below ground surface. At this time, there is no information on the actual contents of the bottles or the number of subsurface bottles at the site. Soil sampling, nondestructive tests, and geophysical surveys planned for the summer of 1997 will attempt to resolve these unknowns. A fence and caution signs have been placed around the site to control access. This site was not evaluated in the RI/BRA however, because of the nature of the threat, removal alternatives are provided in Appendix F of the FS report.

1.4.15 Idaho Chemical Processing Plant Windblown Area

An area of radionuclide-contaminated soils has been identified outside the ICPP perimeter fence and within the outermost 1990 aerial survey isopleth. This area of contamination is being addressed as part of OU 10-06 "Radionuclide-Contaminated Soils RI/FS for the Idaho Chemical Processing Plant." A copy of the relevant sections from this document are included in Appendix A. The soil in this area is considered potentially contaminated as a result of atmospheric dispersion of radionuclides from ICPP operations. The elongated contaminant isopleths trending in the predominant southwest and northeast wind directions from the ICPP are indicative of windblown contamination, possibly from stack release(s). The area of potential windblown radionuclide-contaminated soil at the ICPP was originally based on the ionizing radiation isopleths produced by the EG&G Measurements, Inc., (EMI) 1990 aerial survey. The 1990 EMI isopleths in the vicinity of the ICPP were identified by EMI to result from gamma rays emitted by Cs-137 in the northeastern and southwestern portion of the ICPP Windblown Area. Cesium-137 was detected at elevated levels in OU 10-06 Phase I and Radiological and Environmental Sciences Laboratory (RESL) samples collected in these areas, indicating the EMI isopleth is a result of gamma rays emitted by Cs-137 contained in surface soils.

To determine the nature and extent of radionuclide-contaminated soils in the ICPP Windblown Area, samples were collected during Phase I of OU 10-06. The vertical extent of radionuclide-contaminated soils in

the ICPP Windblown Area is believed to be restricted to the upper 10 cm (4 in.) of soil (see Appendix A). An evaluation of the Phase I and RESL data sets was performed to determine the horizontal extent of radionuclide-contaminated soils. In the ICPP Windblown Area, the majority of the elevated Cs-137 concentrations observed occur in the vicinity of the facility and primary wind directions. Contaminant concentrations generally decrease with increasing distance from the facility. These observations are indicative of windblown contamination, possibly from a stack release. The kriging results generated using the Phase I and RESL data sets bounds the horizontal extent of Cs-137 contamination to 5 pCi/g or greater within the kriging contour.

1.4.16 Decontamination and Decommissioning Activities

There is an active D&D program that deals with the cleanup or remediation of contaminated facilities at the INEEL, including the ICPP. These activities are in addition to remediation performed pursuant to CERCLA under the FFA/CO. As might be expected by the nature of the activities at the ICPP, there are numerous facilities that are, or have been, involved in processing hazardous and/or radioactive substances and have thus become contaminated. Such facilities would not appear on the FFA/CO listing if there were no reason to suspect an actual or threatened release of these substances to the environment. The D&D program charter is to perform or manage the decommissioning of contaminated facilities to minimize present and future impacts on the work force and the environment. These efforts may range from totally dismantling a facility that is of no further value, to decontaminating a facility (or portion thereof) with a goal of allowing unrestricted future use. During negotiations for the FFA/CO, it was agreed and is now consistent with the structure of the agreement, that any releases to the environment discovered or otherwise encountered during D&D activities would become subject to the FFA/CO and CERCLA process.

When the D&D program is called on to decommission and dismantle a facility, actions are planned under the premise that contamination will be removed to the maximum extent possible. Waste and process products are removed and subjected to all applicable regulatory requirements for ultimate treatment and/or disposition. Facility components, structural elements, etc. removed are also subject to these regulatory standards. It is generally the D&D planning assumption that aboveground portions of facilities will be removed as will contaminated components from belowground portions of the facility. Table 1-2 identifies facilities, or portions of facilities, at the ICPP that are currently inactive or which have begun transition actions to move toward an inactive or shutdown status. The locations of these facilities are shown in Figure 1-5.

1.4.17 ICPP Comprehensive Facility Closure Evaluation (formerly known as Co-Located Facility Evaluation)

Within the WAG 3 there are 95 known past releases and about 285 facilities, some of these are contaminated. The scope of this CERCLA evaluation is limited to the known past releases. However, this evaluation would not be complete until some discussion or level of closure is reached regarding the other sources of contamination within WAG 3, namely those within many of the 285 facilities. To this end, the Comprehensive Facility Closure Evaluation was prepared and included as Appendix M of this report. The purpose of this evaluation is to identify the subset of the contaminated facilities most likely to impact future cumulative risk within WAG 3.

Table 1-2. Decommissioning and decontamination facilities and transition facilities in shutdown or standby status.

Facility	Background information
ICPP-601 Fuel Processing Building	The facility contains systems for recovering uranium from various types of spent fuel. The entire CPP-601 complex is scheduled for decommissioning beginning in 1997 when the new Fuel Processing Facility construction is completed. Currently, the majority of the facility is used to support uranium recovery and purification processes. Some of the CPP-601 systems, however, have been shut down for several years and are surplus to future programmatic needs.
ICPP-607 Storage Building	This building was removed in 1994. Health physics (HP) and industrial hygiene (IH) coverage were not required during the removal of this facility. Because HP or IH coverage was not required, it is inferred that this facility contained no radioactive or hazardous materials. Therefore, no additional investigations are required for this facility.
ICPP-625 Rectifier Bldg for Electrolytic Dissolver	Electrical power for CPP-640 is still routed through this building (and will be until the phase out of CPP-640). However, the rectifier that once supplied the electrolytic process is not active. Existing information does not indicate hazardous substances or process fluids were ever present. Also, the potential for having PCBs in electrical equipment would have been considered under an earlier, Site-wide PCB-free project. There is no apparent evidence of past weeps, leaks, or spills from the facility.
ICPP-631 RALA Process "L" Cell Off-Gas Blower Room	The offgas from the Radioactive Lanthanum (RaLa) recovery system in CPP-601 was transferred to CPP-631 where it was processed through specialized equipment before being released to the ICPP main exhaust stack. The CPP-601 portion of the RaLa system was decommissioned in FY 1983 with operating funds and the CPP-631 equipment was removed using D&D program funding in FY 1986. The remaining facility (abovegrade entry to a subsurface cell, 10 × 14 × 9-ft high) includes approximately 125 ft of contaminated pipe chase (2 ft^2) with abandoned capped piping. The CPP-631 RaLa Cell is highly contaminated and has been associated with a "potential" ground contamination incident. The facility surfaces contain radiation hotspots up to 350 mR/hr beta+gamma. This facility has been characterized sufficiently to allow for D&D to conduct the design/planning for decontamination of this facility. Contained in the D&D information is analytical data for both radionuclides and metals inside and outside the facility.
ICPP-633 Waste Calcine Facility	WCF was the world's first plant-scale facility built to achieve safe, efficient disposal of high-activity radioactive wastes resulting from reprocessing of nuclear fuels. The WCF converted high-level radioactive liquid wastes into granular solids, which were less corrosive, more immobile, and occupied less storage volume. First-cycle solvent-extraction wastes from reprocessing spent nuclear fuels was sprayed into a hot, air-fluidized bed of granular solids where water flashed off and the metallic salts were converted to their corresponding oxides and fluorides. The WCF was designed for direct maintenance of equipment during periodic shutdowns. Operations of the WCF with the radioactive wastes began in 1963 and terminated in 1981. During that time over 4,000,000 gallons of aqueous waste was calcinated producing approximately 77,000 ft^3 of solids. Because of its deteriorated condition, the WCF was replaced by the NWCF, which was completed shortly after WCF was shutdown. The facility is a multilevel structure of masonry, reinforced concrete, and structural steel with approximately 20,000 ft^2 of floor space. The processing cells lie underground in two banks with the service corridors lying between them. Nonradioactive service areas for the facility are located in the concrete block structure abovegrade. The WCF contains a silica-gel adsorber media (~25 m^3) and several RCRA-regulated wastes. The silica-gel media is an absorber of highly radioactive offgas byproducts and is a high radiation source. The RCRA-regulated wastes include acid residues contaminated with heavy metals, elemental lead (Pb), and asbestos. The major radionuclide waste includes cesium and ruthenium.

Table 1-2. (continued).

Facility	Background information
	An asbestos removal project was recently completed (FY-93) to reduce release/exposure potential. Functional lead shielding is throughout the building; some is being removed as cleaning is performed. A tank 18,927 L (5,000 gal) in a vault at the bottom of the facility is still used to collect condensate from throughout the building. Although a problem to access (hatched manways, exposure problems, etc.), level indicators and radiation alarms are checked daily and any fluid accumulating in the tank is pumped to the Tank Farm. It has been in this condition since about 1981, but a remote camera inspection in FY-94 indicated the tank and vault appear to be in reasonable condition. There are also four tanks in place that contain a silica-gel once used to remove specific isotopes.
ICPP-640 CRP Headend Process Plant (HPP)	The HPP facility with approximately 1,394 m^2 (15,000 ft^2) of floor space, which housed two unique fuel reprocessing headend systems and liquid waste handling system. One of the HPP headends, the ROVER rocket fuel headend, has been shutdown since 1984. The other HPP headend, the electrolytic dissolution headend for stainless steel-clad fuel, has been shut down since 1981. Although much of the original chemical and radionuclide inventory has been removed from the headend systems, neither system has been fully decontaminated. In fact, part of the ROVER system still contains significant quantities of fissile material. HPP Liquid Waste System: CPP-640 was equipped with its own waste collection system consisting of three 1,893-L (500-gal) tanks located in two cells at the lowest level of the building beneath the basement floor. The tank vaults are constructed of reinforced concrete and are accessible only through hatches in the floor of the waste tank control room above the vaults. The tanks were included in the RCRA Part A permit but the transfer lines from the tanks do not meet secondary containment requirements. The tanks and vault are to be closed under interim status and decommissioned. ROVER Headend: The ROVER headend process was divided into two parts: 1. Combustion of the graphite rocket fuel in the "dry side." 2. Dissolution of the ash in the "wet side." The dry side was housed in the Mechanical Handling Cave (MHC), Cells 3 and 4. The wet side was housed in Cell 2. The ROVER process used two stages of fluidized-bed burning to burn the graphite from the fuel. ROVER fuel elements were periodically charged to the burner system and the resulting uranium-containing ash was collected, weighed, and transferred to the dissolver in the wet side (Cell 2) for dissolution. The solution was then transferred to an adjacent facility (CPP-601) where the uranium was further purified and converted back to an oxide. Electrolytic Headend: The electrolytic dissolution system was located in Cell 5 of the HPP. Stainless steel-clad fuel assemblies or cans were transported in a bottom-opening cask from the fuel storage basin and dropped through a charging port to a table in the Electrolytic Cell. An operator used remotely-operated manipulators to load the fuel into the open top of a trough-shaped titanium dissolver. The dissolver product solution, essentially a metal nitrate-nitric acid solution containing nuclear poison, circulated continuously to a surge tank from which it was pumped through a flowmeter, heat exchanger, conductivity meter, and control valve before being returned to the dissolver. Fresh dissolvent was added as product was transferred to the CPP-601 facility for further processing. The electrolytic system was shut down in 1981 following the failure of several pieces of key equipment.
ICPP-641 West Side Waste Holdup Tank Pumphouse	This facility contains three waste holding tanks (cold, warm, and hot) that were used for the neutralization of solutions before being disposed of in the waste disposal system. During the construction of CPP-796, an area 6-ft deep, 8-feet wide, and 30 to 40-feet long was excavated. This excavation removed some or all of the soil identified as site CPP-56. Because of the proximity of the site CPP-56 to this facility and its active status, there is no reason to suspect that additional releases to the environment have occurred.

Table 1-2. (continued).

Facility	Background information
ICPP-685 Data Acquisition Shelter	This is a data acquisition shelter in which computer equipment is contained. Being a computer equipment building, it is not expected that hazardous or radioactive material would have been present.
ICPP-689 Coal Fired Plant Gate House	This facility is a gate house on the road leading up to site CPP-66. Being a gate house, no hazardous or radioactive material would have been present.
ICPP-691 Fuel Processing Restoration (FPR) Building	This facility was originally being constructed to conduct the separation operations at the ICPP. The construction of the FPR project was stopped before final construction and systems testing. As the FPR project was not completed, and no hazardous or radioactive material was used for the FPR project, no hazardous or radioactive material would have been present.
ICPP-1609 Guardhouse #3	This is a guardhouse on the east side of ICPP leading to the MK area behind the ICPP. Being a guardhouse, no hazardous or radioactive material would have been present.
ICPP-1614 Fast Acid Transfer Pumphouse	This facility is contained in the ICPP Environmentally Controlled Area CPP-45. A Track 2 investigation was conducted on site CPP-45. Contained within site CPP-45 were five documented releases. One of the areas contained in CPP-45 was a release of 86 L (23 gal) of sulfuric acid (H_2SO_4) in 1986. In the OU 3-11 Track 2, this area is addressed in Subunit #1, Acid Storage Vaults. Because this facility has already been investigated under the OU 3-11 Track 2, no further investigation is required.
ICPP-1636 FPR Contractor Warehouse	This is a warehouse that was used to store equipment for the FPR project during construction of the FPR facility. As the FPR project was not completed and no hazardous or radioactive material was used for the FPR project, no hazardous or radioactive material would have been present.
ICPP-1637 FPR Weld Fab Shop	This is a building that was used to fabricate parts through welding and cutting operations during the construction of the FPR facility. As such no hazardous or radioactive material was used for the FPR project, no hazardous or radioactive material would have been present.
ICPP-1638 FPR Parts Warehouse	This is a building that was used to store parts and supplies during the construction of the FPR facility. As the FPR project was not completed and no hazardous or radioactive material were used for the FPR project, no hazardous or radioactive material would have been present.
ICPP-1653 Warehouse	This is a warehouse to the east of the ICPP area. Since this is an unguarded warehouse and outside of the ICPP security fences, the probability of this warehouse containing hazardous or radioactive material is very low.

Table 1-2. (continued).

Facility	Background information
ICPP-709 Service Waste Monitoring Station	The original service waste diversion system was designed to prevent the accidental release of high-level radioactive solution to the environment. The East Side Service Waste (ESSW) monitor in CPP-709 and the West Side Service Waste (WSSW) monitor in CPP-734 were equipped with NaI crystal gamma monitoring instruments. These instruments provided actuation signals to automatic valves, which diverted service waste flow to a 300,000-gal hold tank (WM-191) if the stream(s) were excessively contaminated. Recent upgrades to the plant service waste system have rendered this system obsolete. The contamination level in these systems is considered to be relatively low. The ESSW monitoring system is housed in subsurface rooms (15 × 9 × 9-ft high) with abovegrade entries. The ESSW monitoring system and facility are slightly radiologically contaminated. The ESSW monitoring system building, CPP-709, was constructed in 1951-1952 to house the ESSW monitoring equipment. It is located about 75 feet east of CPP-601. Wastewater from floor drains, steam condensate lines, equipment cooling jackets, and the PEW Evaporator was routed through the basin of CPP-709 and pumped to an injection well, which was later replaced by percolation ponds. Gravity-feed maintained the flow through CPP-709 in case of pumping system failure. Upon detection of radiological constituents in the wastewater stream in CPP-709, an alarm signaled ICPP plant operators to immediately stop or divert the contaminated wastewater flow. The CPP-709 wastewater stream with the greatest potential for contamination was condensate from the PEW system. In-flow of the PEW condensate wastewater in CPP-709 was terminated on January 9, 1990. The flow of uncontaminated wastewater in CPP-709 continued into January 11, 1990. During the 2-day time period, approximately 5,000,000 gal of uncontaminated wastewater flowed through CPP-709. The 5,000,000-gal flow is believed to have flushed the CPP-709 of contamination before terminating the wastewater flow.
ICPP-710 Solvent Storage Building	This small, empty hut/building was used in the past to store containers of solvents. Operators indicate there were never any spills or leaks in the building and that it presents no contamination issues.
ICPP-727 HF Acid Storage: *VES-CS-169*	This facility is contained in the ICPP Environmentally Controlled Area, CPP-45. A Track 2 investigation was conducted on site CPP-45. Contained within site CPP-45 were five documented releases. One of the areas contained in CPP-45 was a release of 25 L of hydrofluoric acid in 1988 and an additional 25 L of hydrofluoric acid later that year. In the OU 3-11 Track 2, this area is addressed in Subunit #1, Acid Storage Vaults. Because this facility has already been investigated under the OU 3-11 Track 2, no further investigation is required.

Table 1-2. (continued).

Facility	Background information
ICPP-734 Service Waste Monitoring Station for West Side	The original service waste diversion system was designed to prevent the accidental release of high-level radioactive solution to the environment. The ESSW monitor in CPP-709 and the WSSW monitor in CPP-734 were equipped with NaI crystal gamma monitoring instruments. These instruments provided actuation signals to automatic valves, which diverted service waste flow to a 300,000-gal hold tank (WM-191) if the stream(s) were excessively contaminated. Recent upgrades to the plant service waste system have rendered this system obsolete. The contamination level in these systems is considered to be relatively low. The WSSW monitoring system is housed in subsurface rooms (15 × 9 × 9-ft high) with abovegrade entries. The WSSW monitoring system and facility are slightly radiologically contaminated. The WSSW monitoring system building, CPP-734, was constructed in 1959–1960 to house the WSSW monitoring equipment. It is located about 150 feet southwest of CPP-601. The normally uncontaminated waste from steam condensate lines and equipment cooling lines was routed to the basin of CPP-734 for monitoring and then flowed by gravity to an injection well. In 1984, pumps were added to CPP-734 to transfer the service waste to the percolation ponds as the injection well was taken out of service. The WSSW equipment was configured to send an alarm if radiological contamination was detected in the waste stream. Upon detection of radiological constituents in the wastewater flow through CPP-734, an alarm signaled ICPP plant operators to immediately stop or divert the contaminated wastewater flow. In May 1981, an inadvertent transfer of very low-level radioactive contaminants tripped the alarm. It was determined that approximately 25 millicuries of mixed fission products were discharged through CPP-734 in approximately 1,250 gal of water. Discharge limits to the injection well were exceeded. Between May 1981 and late 1989 when CPP-734 was replaced by CPP-796, no other incidents of radiological contaminants passing through CPP-734 occurred. The building has been posted as a potential contamination source because of the small amount of contamination contained in the water transferred through CPP-734 in 1981. However, no contamination has been found by the characterization surveys and sample analysis.
ICPP-740 Settling Basin & Dry Well *Near CPP-603*	The area containing this facility was investigated under the OU 3-09 Track 2 investigation as site CPP-01.
ICPP-745 HF Acid Storage *VES-YDB-105*	This facility is contained in the ICPP Environmentally Controlled Area, CPP-39, and was investigated as part of the CPP-39 investigation. In the bottom of the containment vault, five boreholes were jackhammered through the concrete and samples were collected at depths below the concrete (deepest borehole 5.7-ft below concrete vault floor). The sample collected at 5.7-ft below the concrete vault floor corresponds to a total depth of 10.5 ft. There were no contaminants at this site that exceeded risk-based levels.
ICPP-757 Fluoboric Acid Storage Tank *VES-CS-113*	This facility is contained in the ICPP Environmentally Controlled Area, CPP-45, where five documented releases were investigated. One of the areas contained in CPP-45 was a release of 1,136 L (300 gal) of sulfuric acid (H_2SO_4) in 1986. In the OU 3-11 Track 2, this area is addressed under Subunit #1 Acid Storage Vaults.
ICPP-758 Leaching Cesspool for TR-11	This facility was previously investigated as Environmentally Controlled Area, CPP-72. This septic system was used to treat sanitary sewage from temporary office trailer TR-1 through TR-9. The trailers have subsequently been disconnected from the system, which is no longer in use. As this septic system was only connected to office bathrooms, it is unlikely that hazardous or radioactive constituents were disposed of into the system. A no action decision document package was compiled and submitted to the Administrative Record in 1991.

Table 1-2. (continued).

Facility	Background information
ICPP-759 Leaching Cesspool for MK Bldgs. T-1 & T-5	This facility was previously investigated as Environmentally Controlled Area, CPP-73. It is reported that this septic system is connected to temporary building CPP-T-5, which is used as a lunch/break room by a construction contractor. No hazardous or radioactive materials are reported to have been stored at this location. A no action decision document package was compiled and submitted to the Administrative Record in 1991.
ICPP-766 Seepage Pit for CPP-662 Sanitary Waste	This facility was previous investigated as Environmentally Controlled Area, CPP-77. The septic system was removed from the list of potentially hazardous units. Based on the information gathered, no evidence could be found to suggest that hazardous or radioactive materials ever entered the system. A no action decision document package was compiled and submitted to the Administrative Record in 1991.
ICPP-798 HF Acid Storage *VES-YDC-101*	This facility is similar to the facility ICPP-727. The OU 3-11 Track 2 investigation dealt with the releases at facility ICPP-727 in the Environmentally Controlled Area, CPP-45. This facility was included in the OU 3-11 Track 2 investigation.
ICPP-1753 Cesspool for VES-VM-101	The vessel is gone and this cesspool is inactive. Historical use of the cesspool is unknown by the D&D organization. There are currently plans to have it pumped. Any waste removed will be trucked to the sanitary wastewater pond and the cesspool backfilled.

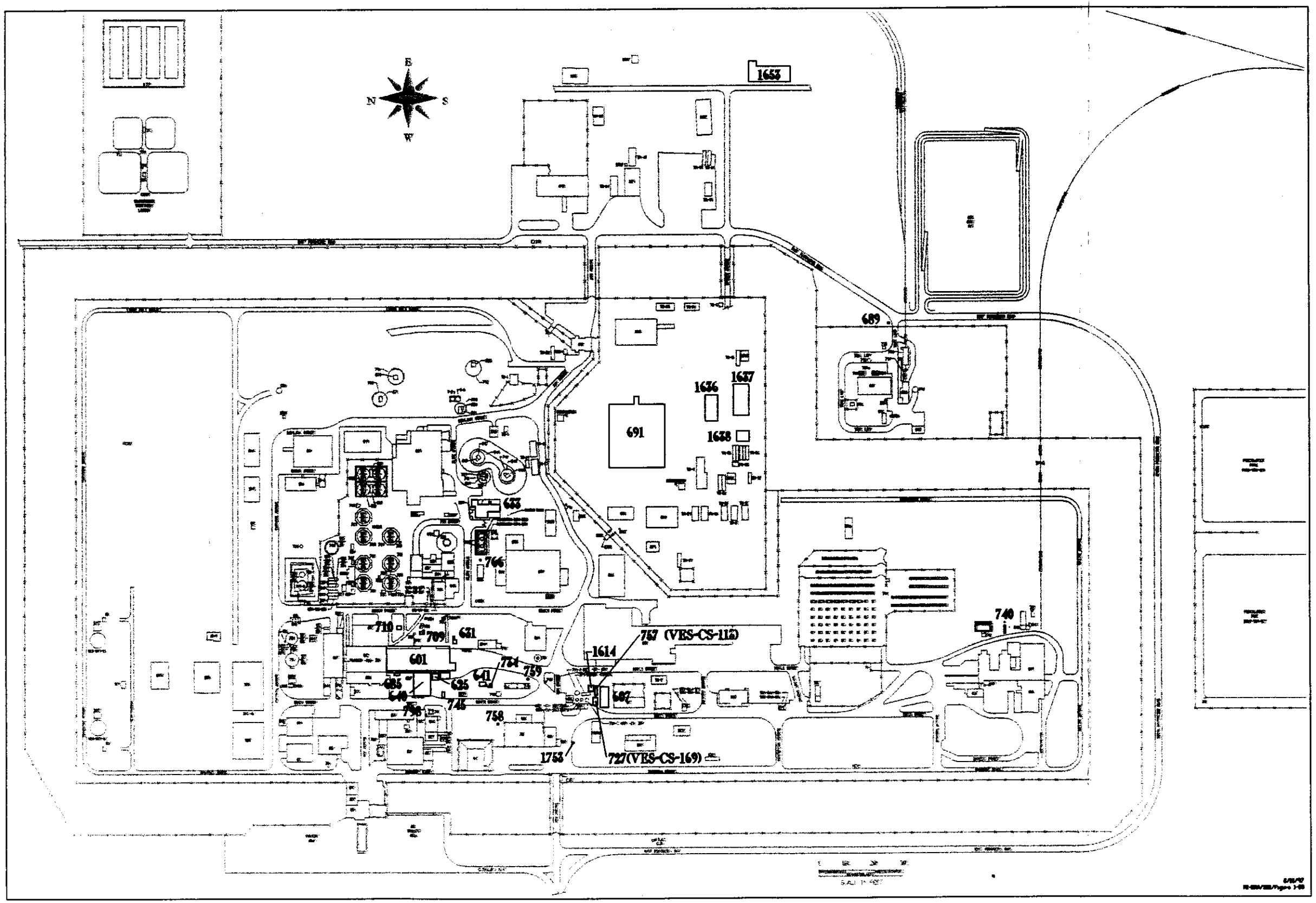

Figure 1-5. Facilities proposed for D&D at the ICPP.

1.5 Previous Investigations

According to the procedure identified in the Action Plan, all sites have completed preliminary scoping Track 1 and/or 2 investigations except for the 10 release sites identified for no action. These investigations were performed in a phased approach in order to collect environmental data concerning the risk posed to human health and the environment for each site. If additional data needs were identified following the scoping investigation, those data were collected during the WAG 3 Comprehensive RI/FS, as identified in the SAP (LITCO, 1995).

Track 1 investigations were performed on the low probability hazardous sites at the INEEL to provide qualitative estimates of risk. These investigations usually did not involve collecting additional field data, and evaluated existing information against established decision criteria to determine the qualitative risk and uncertainty. For most sites, existing data resulted in a medium to high uncertainty in the estimated consequence or threat. These medium to high uncertainties in the data may be acceptable in many cases because conservative parameters were used to calculate the risks associated with each site. The Track 1 investigation served as the mechanism for collecting background information and establishing data quality objectives (DQOs) for subsequent investigations if the Remedial Project Managers (RPMs) determined the qualitative risk or uncertainty was unacceptable.

Track 2 investigations were performed on sites lacking sufficient data to make a decision concerning the level of risk or select and/or design a remedy. Track 2 investigations generally followed the Track 1 investigations where the risk posed by the site could not be determined from existing data or were designated as Track 2 in the FFA/CO. These investigations typically required collection of new environmental data. Track 2 investigations resulted in a summary report with a decision that (a) no significant data gaps exist and there is no unacceptable risk associated with the site, so no further action, (b) the site poses unacceptable risk and data are sufficient to support selection of a remedy carried out as an interim action, or (c) a more detailed analysis of risk or remedy selection is needed and the site should be included in an RI/FS. It should be noted that data collected during Track 2 investigations were used during the preparation of the RI/BRA Report along with additional data collected during the summer of 1995 to evaluate the more significant release sites. In some cases, data collected outside of the a CERCLA framework were also used qualitatively or quantitatively to help define the nature and extent of contamination and associated risk accordingly where they were used, in Sections 8 through 26.

The conclusions from the preliminary scoping investigations for WAG 3 resulted in recommendations of either no further action or additional evaluation in an RI/FS for each release site. No further action determinations were made only if there was no justification to further address the site. If a clear no further action determination could not be made, the site was designated for further investigation in the RI/FS.

1.6 References

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Chapter 2

2. ENVIRONMENTAL SETTING OF THE ICPP

The INEEL occupies 2,305 km^2 (890 mi^2) on the northern portion of the Eastern Snake River Plain (ESRP) in southeastern Idaho (Figure 1-1). The eastern boundary of the INEEL is located approximately 51 km (32 mi) west of Idaho Falls. The INEEL is bounded on the northwest by the Lost River, Lemhi, and Beaverhead mountain ranges. The remainder of the INEEL is bounded by the ESRP.

The INEEL is located in a topographically closed drainage basin. Three intermittent streams, the Big Lost River, Little Lost River, and Birch Creek flow onto the INEEL. These streams originate in local mountain drainages and much of the water is diverted or stored upstream of the INEEL for use in irrigation. The Big Lost River is the principal surface water feature on the INEEL. Several storage and diversion systems exist on the Big Lost River. The Mackay Reservoir is located about 48-km (30-mi) upstream from Arco, Idaho, and has a storage capacity of 44,500 acre-ft (Van Haaften et al., 1984). A flood diversion system was constructed on the INEEL in 1958 to protect INEEL facilities from potential flooding of the Big Lost River. The system uses a low dam to divert river flow into a series of spreading areas located in the southwestern portion of the INEEL. The capacity of the diversion system was expanded in 1984, and the system is capable of accommodating flows of up to 263 m^3/sec (9,300 ft^3/sec) (Bennett, 1986).

Except for evapotranspiration, most of the water in the Big Lost River, Little Lost River, and Birch Creek is recharged to the ground through irrigation or infiltration. Water from the Big Lost River infiltrates into the material beneath the river and into the SRPA. The volume of this infiltration is significant during wet years. Zones of perched water have been identified along the Big Lost River when it contains water. The extent and volume of these perched water zones is not completely known.

The Snake River Plain Aquifer (SRPA) underlies the INEEL and is a valuable regional resource in southeastern Idaho, extending approximately 320 km (200 mi) from Ashton, Idaho, in the northeast to Hagerman, Idaho, on the southwest. The aquifer consists of a series of basalt flows with interbedded sedimentary deposits and pyroclastic materials. INEEL-wide water-level data compiled in July 1985 indicated the general direction of groundwater flow across the INEEL was toward the south-southwest at an average gradient of about 0.8 m/km (4 ft/mi)(Bartholomay et al., 1997). Horizontal groundwater flow rates in the SRPA have been estimated to vary from 0.3 to 7.6 m/day (1 to 25 ft/day) (Kaminsky et al., 1994; Robertson et al., 1974). The SRPA was designated as a sole source aquifer by the EPA (56 FR 50634, October 7, 1991) because it is the only viable source of drinking water for many communities on the ESRP. The aquifer is the source of all water used at the INEEL.

2.1 Surface Features

The land surface of the INEEL is characterized as rolling to broken, typical of basalt terrain. The predominant relief on the INEEL is the result of volcanic buttes and unevenly surfaced and fissured basalt flows. Elevations on the INEEL range from 1,585 m (5,200 ft) in the northeast to 1,448 m (4,750 ft) in the southwest with the average being approximately 1,520 m (5,000 ft). A broad ridge on the ESRP extends through the Big Southern, Middle, and East Buttes on the southern portion of the INEEL, effectively separating drainage from the mountains in the north from that of the Snake River to the south. The Big Lost River flows onto the INEEL in the southwest and turns north, culminating in a series of playa lakes where it infiltrates, recharging the SRPA. The majority of the land within the boundaries of the INEEL is relatively undisturbed and covered with sagebrush. Three public highways traverse the INEEL.

The ICPP is located in the south-central portion of the INEEL. Elevation at the ICPP is 1,498 m (4,917 ft), and the facility's northwest corner is actually truncated by the current channel of the Big Lost River. Gravelly, medium-to-coarse textured soils derived from alluvial deposits occur in the vicinity of the ICPP. The underlying basalt is covered with as much as 18.2 m (60 ft) of these soils and the land surface is flat and covered with sagebrush.

2.2 Demographic and Land Use

2.2.1 Demography (On-Site and Off-Site Populations)

The nearest INEEL boundaries are 51 km (32 mi) west of Idaho Falls, 37-km (23-mi) northwest of Blackfoot, 71 km (44 mi) northwest of Pocatello, and 11 km (7 mi) east of Arco, Idaho. With a population of approximately 1100, Arco is the largest boundary community in the area surrounding the Site. Approximately 121,500 people reside within a radius of 80 km (50 mi) of the Site's operational center, which is the TRA-ICPP area. There are no residents within 16 km (10 mi) of that center with Atomic City (population 25) being the closest boundary community.

2.2.2 Land Use (Current and Future)

As with virtually all of the sites in the DOE complex, the INEEL is making major changes in the use of its land. Until recent years, land use planning was driven by nuclear energy research and defense-related projects. Presently, however, the shutdown of facilities and environmental restoration of the land play important roles in land use planning.

The primary use of INEEL lands is to support facility operations and act as buffer and safety zones around the facilities. Virtually all of the work at the INEEL is performed within the site's primary facility areas [i.e., Central Facilities Area (CFA), Test Reactor Area (TRA), ICPP]. These areas, however, occupy only about 2% of the total INEEL land area. Other land uses include environmental research, ecological preservation, and socio-cultural preservation. INEEL land is also used for grazing, recreation, and connecting infrastructure, with the remaining land being essentially undisturbed.

Currently the ICPP has a total land area of 200 acres and 106,070 m^2 (1,141,711 ft^2) of facilities. Land at ICPP is used to store spent nuclear fuels and radioactive wastes for the DOE. Other uses include a coal-fired generating plant, Tank Farm waste storage facility, and wastewater treatment/disposal facilities. Before April 1992, spent nuclear fuels were reprocessed at the plant. With the DOE's decision to cease reprocessing operations, however, the need to store greater quantities of these fuels increased.

As the shutdown of INEEL facilities and the environmental restoration of INEEL land play greater roles, environmental studies are increasingly important elements in land use planning. These studies provide INEEL scientists, engineers, and planners with information about how nuclear reactor research has affected the environment and the extent of remediation necessary to restore the land.

To facilitate decisions about environmental restoration activities at the INEEL, DOE-ID conducted analyses in 1994 to project reasonable land use scenarios at the INEEL for the next 100 years. These analyses, conducted with extensive public involvement, resulted in the development of specific issues, assumptions, and constraints that guided the generation of facility and land use scenarios for the next 25, 50,

75, and 100 years, as published in the *Long-Term Land Use Future Scenarios for the Idaho National Engineering Laboratory* (DOE-ID, 1995). Refer to that document for a listing of participating individuals/organizations, comments received, and an explanation of the process for producing future land use scenarios. The INEEL Site Specific Advisory Board reviewed and provided input to the creation of the future use scenarios. EPA and IDHW did not review or comment on the document.

The planning assumptions for the future use scenarios include:

- The INEEL will remain under DOE management and control for at least the next 100 years.

- Advances in DOE and private-sector research will result in the obsolescence of existing facilities. It is further assumed that new facilities will need to be constructed in response to the need to provide state-of-the-art research facilities. Other programs, however, will be discontinued after the facilities become obsolete.

- New construction may include structures in existing facility areas; other new construction may require the development of new facility areas.

- As facilities become obsolete, decontamination and decommissioning will likely be required. Similarly, contaminated areas will require remediation.

- To the extent practical, new development will be encouraged in developed facility areas to take advantage of existing physical and service infrastructures. Such redevelopment will reduce environmental degradation associated with construction activities in previously undeveloped areas.

- The CFA will remain the focal area for support and infrastructure activities.

- The life expectancy of current and new facilities is expected to range between 30 and 50 years. The decontamination and decommissioning process will commence after closure of a facility, assuming no new missions for a facility are articulated.

- Environmental restoration and waste management activities will continue. Cleanup of hazardous, mixed, and low-level waste sites is expected to be completed within 10 years after completion of a record of decision for the activities mandated under Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

- Research and development facilities will be expanded to accommodate "new frontier research" such as fusion, transportation, space exploration, nuclear propulsion, alternative fuels, and advanced cleanup technologies.

- Research at the INEEL will focus increasingly on advances in nuclear medical research and the production of isotopes used in medicine, research, and industry. In addition, other specific research initiatives (i.e., alternative fuels, advanced environmental restoration and waste management technology, transportation) will gain importance at the INEEL. To support such efforts, cooperative partnerships between the public and private sectors will be developed to

achieve mutual goals. This could result in the reuse of INEEL facilities by private sector interests, supplemented with technology support by INEEL personnel.

- The INEEL will continually be prepared to support defense-related operations (i.e., manufacturing, testing, support) in response to the ever-changing military climate throughout the world. Although the INEEL will continue to be used for defense-related research, other nuclear research will receive an increasing emphasis in years to come.

- Regional development trends will be closely related to activities at the INEEL. For example, new housing development will be generated by increases in onsite employment because the INEEL is a major regional employer. Conversely, a major decrease in onsite employment will hamper the regional housing market.

- No residential development (i.e., housing) will occur within INEEL boundaries; however, grazing will be allowed to continue in the buffer area.

- No new, major, private developments (residential or nonresidential) are expected in areas adjacent to the INEEL site. There is uncertainty about the applicability of this assumption to privately held land. Beyond 25 to 50 years, there is less certainty about this assumption.

- An 890 mi^2 site dedicated to nuclear research, development, testing, and evaluation is irreplaceable. It was therefore assumed that it is extremely unlikely that a similar DOE facility could be sited at any other location.

The ICPP was one of the facilities that had a future use scenario projected. The scenarios are broken down into the present situation, as well as for the next 25, 50, 75, and 100 years.

Present: Interim storage of SNFs; disposition of fuels; managing waste and improving waste and water management techniques.

25-Year: Continue use as industrial area; planned new waste treatment facility.

50-Year: Approaching end of useful life if no new mission identified; D&D with all or selected areas for restricted industrial use.

75-Year: Standby mode for restricted industrial use; reuse permitted, but no new development outside existing fence line.

100-Year: Continuation as a restricted industrial area.

These planning assumptions and the constraints just described were used to project the most likely INEEL configuration. Over time, the planning assumptions and resulting long-term scenarios may need to be revised due to unforeseen developments.

2.3 Surface Water Recharge

Surface water recharge to the groundwater beneath the ICPP is provided through natural precipitation, human made sources (i.e., surface percolation ponds, lawn watering, steam injection wells, leaking water pipes), and occasionally during wet years from the Big Lost River. These water sources have resulted in the formation of several perched water zones beneath the ICPP at depths ranging from 12.2 to 115 m (40 to 377 ft) (Thomas, 1988; Chipman, 1989).

2.3.1 Climatology and Meteorology

The INEEL is located on the Snake River Plain, which is a large flat valley surrounded by mountains. Air masses cross this mountain barrier before entering the Snake River Plain. Most of the moisture is lost in crossing the mountain barrier; thus, the INEEL has little annual rainfall and is classified as semiarid.

The arid climate permits intense solar heating of the ground surface during the day and rapid cooling at night, especially during the summer months. In general, the INEEL has a large diurnal variation in temperature at ground level.

Mountain ranges to the north block many of the shallow, intensely cold, air masses moving out of Canada in the winter months. The climate in eastern Idaho is a more moderate climate than the climate in areas at similar latitudes east of the continental divide. The mountains can also serve as a barrier and cold air masses that do enter the valley are frequently held in place for a week or longer.

The surrounding mountains tend to channel the winds in the region. The prevailing winds on the Snake River Plain are from the southwest and windspeeds are frequently greater than 8 km/hr (5 mi/hr). The second most frequent winds are from the northeast.

Meteorological data have been collected at over 40 locations on or near the INEEL since 1949. The weather station at the CFA was the first onsite station and appears on National Climatic Center records as Idaho Falls 46 W. There are 27 active meteorological stations in operation on or near the INEEL. Most of the meteorological monitoring within 80 km (50 mi) of the INEEL is conducted by the National Oceanic and Atmospheric Administration (NOAA) Air Resources Laboratories. A large database has been compiled and analyzed by NOAA (Clawson et al., 1989).

An overview of climatological data is available from summaries of temperatures, precipitation, snowfall and snow depth, windspeed and direction, and moisture content of the air. Much of the summary information comes from the monitoring station at CFA, which is located approximately 5 km (3 mi) south of the ICPP. Differences in climate between the facilities would be small local variations.

Temperatures at the INEEL vary widely over the course of the year. Records for CFA indicate that the highest daily maximum temperature occurring between 1950 and 1988 was 38°C (101°F) and the lowest temperature recorded at CFA was -44°C (-47°F). The highest daily average temperature over the course of a month was 28°C (83°F) and the lowest daily average was -33°C (-28°F). Temperatures also vary greatly over the course of the day and, on average, span a 17°C (30°F) range. The maximum temperature range in 1 day at CFA spanned 50°C (90°F).

Average annual precipitation at the CFA (1950 to 1988 inclusive) is 22.1 cm (8.7 in.). The highest annual precipitation was 36.6 cm (14.4 in.) and the lowest was 11.4 cm (4.5 in.). Over the years, the wettest months have been May and June. However, recorded precipitation amounts of less than 0.3 cm (0.1 in.) have occurred in all months. Individual months have had as much as 11.2 cm (4.4 in.) of precipitation or as little as no precipitation. The greatest amount of precipitation at the CFA in a 1-hr period or a 24-hr period, is 1.3 cm (0.5 in.) and 4.1 cm (1.6 in.), respectively, occurred in June. The monthly precipitation totals for CFA from March 1950 through November, 1995 are provided in Table 2-1.

From 1950 to 1988, the CFA averaged 70.1 cm (27.6 in.) of snow per year. The maximum snowfall in a year was 151.6 cm (59.7 in.). Maximum snowfall occurs in December and January. Little snow falls from May through October. June, July, and August are the only months with no recorded snowfall between 1950 and 1988. The maximum snowfall in a 24-hr period was 21.8 cm (8.6 in.), which occurred in March. A snowfall of 21.6 cm (8.5 in.) in a 24-hr period is recorded for January. The lowest annual snowfall at the CFA was 17.3 cm (6.8 in.). All months have gone without snowfall in at least 1 year during the recording period.

January and February have the highest average maximum snow depth at 10.4 cm (4.1 in.). The highest recorded maximum snow depth was 51 cm (20 in.) and occurred in March. December, January, and February also have had snow depths greater than 28 cm (11 in.).

Average relative humidities at the CFA range from 30 to 70%. Relative humidities typically are higher during the colder months (November through March). The relationship between relative humidity and temperature makes high relative humidities possible from small amounts of moisture when the temperature is low. Consequently, winter months may have high relative humidities from very low moisture contents. Relative humidities on summer afternoons are frequently lower than 15% and can be lower than 5%. Maximum absolute humidities reach 100% in all months except July. Average minimum absolute humidities are below 16% in all months and below 10% from April through October.

From 1955 through 1961, the average air temperature in January (the coldest month) was -8.6°C (16.5°F) and the average dewpoint was -13.7°C (7.4°F). During July, the warmest month, the temperature averaged 20.6°C (69.0°F) and the dewpoint averaged 0.8°C (33.5°F). The annual average temperature was 5.9°C (42.6°F) and the dewpoint was -6.4°C (20.4°F). Low dewpoints and relative humidities indicate the environment at the INEEL is quite arid.

The most frequent winds at the ICPP are southwesterly. Other significant components are westerly and northeasterly. Most windspeeds are less than 5.0 m/sec (11 mph). The peak wind gust at the CFA [6.1 m (20 ft) level] was 126 km/hr (78 mph), which occurred in January. All months have seen wind gusts of 97 km/hr (60 mph) or greater. At 76.2 m (250 ft), the peak wind gust at CFA was 135 km/hr (84 mph) and occurred in March.

Severe weather on the INEEL consists of thunderstorms, tornadoes, and funnel clouds. On the average, two to three thunderstorms occur during each of the summer months. Small hail may accompany the thunderstorms but hail damage has not been reported at the INEEL. Occasionally, rain in excess of the average monthly total precipitation may be recorded at a monitoring station on the INEEL as a result of a single thunderstorm. Nevertheless, precipitation from thunderstorms on the INEEL is generally light and may evaporate before reaching the ground.

Table 2-1. CFA precipitation totals for March 1950 through November 1995 (NOAA database).

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1950	—	—	1.05	0.14	0.28	0.98	0.10	1.08	0.28	0.16	0.30	0.55	(4.92)
1951	0.76	0.58	0.60	0.30	0.56	0.15	0.58	2.17	0.00	0.69	0.33	0.72	7.44
1952	0.61	1.04	0.41	0.03	0.80	0.91	0.38	0.29	0.12	0.00	0.37	0.67	5.63
1953	0.45	0.25	0.40	0.64	1.78	0.80	0.00	0.18	0.01	0.41	0.08	0.25	5.25
1954	0.51	0.87	0.55	0.46	0.45	2.74	0.16	0.39	0.15	0.07	0.65	0.40	7.40
1955	0.47	0.21	0.20	0.49	0.81	1.03	0.65	0.19	0.21	0.20	0.24	2.06	6.76
1956	0.80	0.31	0.27	0.35	1.63	0.02	0.17	0.02	0.28	1.53	0.28	0.15	5.81
1957	1.15	1.12	0.82	1.43	4.42	0.83	0.47	0.11	0.06	1.03	0.39	0.47	12.30
1958	0.85	0.87	0.93	1.45	0.79	0.48	0.45	0.20	0.66	0.00	0.43	0.23	7.34
1959	0.52	0.49	0.16	0.04	1.82	1.45	0.05	1.52	0.74	0.05	0.00	1.13	7.97
1960	0.66	1.33	0.71	0.45	0.70	1.38	0.07	1.20	0.29	0.23	1.02	0.12	8.16
1961	0.00	0.80	0.12	0.54	1.55	0.54	0.20	0.96	3.52	0.96	0.31	0.54	10.04
1962	0.80	2.40	0.58	0.23	1.91	1.77	0.72	0.03	1.21	0.29	0.11	0.25	10.30
1963	1.04	0.84	0.74	2.50	2.30	2.84	0.00	0.89	1.39	0.36	0.98	0.52	14.40
1964	0.47	0.22	0.81	1.17	1.05	2.23	0.49	0.26	0.00	0.74	1.53	3.43	12.40
1965	1.56	0.15	0.07	1.54	1.32	1.86	0.07	0.54	0.20	0.03	1.25	0.36	8.95
1966	0.14	0.63	0.24	0.30	0.84	0.12	0.25	0.11	0.47	0.23	0.29	0.88	4.50
1967	1.39	0.01	0.54	0.86	0.69	2.58	0.56	0.18	0.03	0.52	0.37	0.63	8.36
1968	0.55	0.20	0.33	0.11	1.49	3.89	0.05	3.27	0.85	0.34	0.94	1.23	13.25
1969	2.56	0.93	0.08	0.08	0.07	2.39	0.02	0.00	0.29	0.20	1.02	0.50	8.14
1970	0.62	0.05	0.83	1.26	1.28	0.96	0.51	0.50	0.53	0.35	1.53	0.97	9.39
1971	0.56	0.71	0.70	0.43	1.48	1.05	0.11	0.43	2.08	1.07	0.78	1.54	10.94
1972	0.48	0.09	0.25	0.35	0.66	1.41	0.34	0.78	0.48	0.75	0.76	1.08	7.43
1973	0.69	0.76	0.75	0.41	0.50	1.04	1.70	0.15	1.09	0.62	1.30	1.18	10.19
1974	0.66	0.36	1.44	0.35	0.72	0.49	0.03	0.71	0.01	1.34	0.42	1.19	7.72
1975	0.76	0.94	1.20	1.99	0.98	0.89	0.61	0.14	0.00	1.16	0.50	0.16	9.33
1976	0.45	0.88	0.50	1.66	1.00	0.79	0.18	0.82	0.96	0.51	0.00	0.05	7.80
1977	0.60	0.16	0.32	0.00	1.55	1.07	0.45	0.25	0.31	0.00	0.70	0.97	6.38
1978	1.00	1.05	0.66	1.32	0.74	0.26	0.31	0.17	0.96	0.09	0.48	0.44	7.48
1979	0.92	0.80	0.79	0.06	1.41	0.39	1.33	0.90	0.06	0.65	0.60	0.18	8.09

Table 2-1. (continued).

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1980	0.91	0.84	0.24	0.48	2.24	1.26	0.59	0.35	1.52	0.52	0.20	0.73	9.88
1981	0.61	0.69	0.94	1.83	1.81	0.25	0.17	0.07	0.14	0.93	1.34	0.67	9.45
1982	0.53	0.28	1.25	0.42	1.03	0.71	0.51	0.76	0.92	0.95	0.66	1.88	9.90
1983	0.20	0.19	1.08	0.42	0.40	1.75	1.31	0.88	1.07	1.67	1.18	0.81	10.96
1984	0.03	0.58	0.75	1.45	0.71	2.86	2.09	0.43	0.25	0.44	1.43	0.26	11.28
1985	0.98	0.50	0.76	0.06	0.91	0.40	2.29	0.02	1.67	0.28	1.07	0.63	9.57
1986	0.31	2.36	1.22	1.25	1.46	0.74	0.48	1.11	1.50	0.67	0.17	0.02	11.29
1987	0.65	0.38	0.18	0.40	1.96	0.76	2.16	0.21	0.00	0.11	0.72	0.42	7.95
1988	0.50	0.00	0.08	1.28	0.56	0.13	0.04	0.04	0.23	0.01	1.74	0.80	5.41
1989	0.31	0.38	0.62	0.31	0.75	1.21	0.32	0.41	1.86	0.29	0.45	0.04	6.95
1990	1.05	0.15	0.19	0.97	1.28	0.86	0.59	0.68	0.05	0.25	0.18	0.23	6.48
1991	0.05	0.00	1.18	0.51	2.03	1.15	0.53	0.78	1.08	0.51	0.73	0.00	8.55
1992	0.01	0.45	0.28	0.06	0.31	1.53	0.25	0.07	0.58	0.33	0.47	1.16	5.50
1993	1.15	1.44	0.57	1.20	1.99	2.73	0.08	0.73	0.12	0.92	0.48	0.21	11.62
1994	0.17	0.72	0.00	1.00	0.80	0.00	0.06	0.33	1.11	0.44	0.69	0.85	6.17
1995	1.03	0.28	2.03	0.72	2.34	4.64	0.59	0.05	0.52	0.07	0.22	—	(12.49)

( )—indicates incomplete record.

Since 1949, three small tornadoes, which caused no damage, have occurred within the boundaries of the INEEL. Additionally, 10 confirmed and three unconfirmed funnel clouds have been observed since 1954 (NOAA and Morrison Knudsen, 1983). NOAA records indicate a total of five funnel clouds and no tornadoes on the INEEL since 1950 (Clawson et al., 1989). Discrepancies in these records may be related to different methods of reporting and confirming tornadoes. No INEEL facilities have ever been damaged by a tornado.

Dust devils are also common in the region and can entrain dust and pebbles and transport them over short distances. Dust devils usually occur on warm sunny days with little or no wind. The dust cloud may be several hundred meters (yards) in diameter and extend several hundred meters (feet) in the air.

Vertical temperature and humidity profiles in the atmosphere determine atmospheric stability. Stable atmospheres are characterized by low levels of turbulence and less vertical mixing. Stability parameters at the INEEL range from stable to unstable. Stable conditions occur mostly at night during strong radiational cooling. Unstable conditions can occur during the day when there is strong solar heating of the surface layer or whenever a synoptic scale disturbance passes over the region.

2.3.1.1 Air Quality Monitoring. Air quality monitoring at the INEEL consists of two networks of stations designed to monitor atmospheric transport of radionuclides on particulate matter and ambient concentrations of total suspended particulates. Although the air quality monitoring networks are designed to monitor emissions from the entire INEEL, select low-volume particulate samplers in the vicinity of the ICPP provide detailed data on ambient concentrations of radionuclides and particulates.

Historically, one network has been operated by the contractor and the other network has been operated independently by the DOE. The contractor network consists of low-volume air samplers that operate at 0.14 m^3/min (5 ft^3/min). Particulate matter is collected on a membrane filter. The air filters are collected and analyzed every 2 weeks for gross alpha and gross beta activity. Filters are also analyzed monthly for selected gamma-emitting radionuclides. Gross beta analyses of the air filters are evaluated to determine if any increases in the sample radioactivity may require more immediate and/or more in-depth analysis by gamma spectrometry or radiochemistry.

The DOE network consists of 23 monitoring stations on and around the INEEL. Each low-volume air sampler contains two filters: a membrane prefilter and charcoal-impregnated paper filter. Filters are collected and analyzed weekly. Gross beta activity for each filter is determined weekly as a screening technique to give timely information in the event of site releases. If unusually high gross beta activity is detected on the filters, gamma spectrometry is conducted to obtain more detailed information. Composites of the membrane prefilters for each location are analyzed for specific radionuclides on a quarterly basis.

2.3.2 Humanmade Surface Water Features

Human made surface water features in the vicinity of the ICPP consist of two percolation ponds used for disposal of water in the service waste system (formerly injected into the aquifer via the ICPP injection well) and sewage treatment lagoons for treated water. In addition, several landscaped areas at the ICPP have historically been watered during the summer months and a network of ditches are used to channel runoff from the plant after precipitation events. Historically, precipitation runoff has been channeled to an old gravel pit (Site CPP-37-1) and both this pit and the unlined ditches may contribute recharge to the perched water bodies at the ICPP. Perched water bodies are known to exist beneath the percolation ponds and the sewage

treatment ponds. In addition, perched water bodies are known to exist beneath the ICPP plant facilities, including the high-level liquid waste (HLLW) Tank Farm and the CPP-603 facility.

The presence of the perched water bodies with no identifiable surface water source, and discrepancies between the reported volume of water pumped from the SRPA and the volume of water disposed at the ICPP, suggest water is being lost from the plant water distribution system and/or the liquid waste collection system. Leaks in municipal water systems are not unusual; however, concerns that this water source could leach and transport contaminants that have been released over the years at the ICPP led to a Water Inventory Study (Richards, 1994).

2.3.2.1 ICPP Water Inventory Study. The Water Inventory Study (Richards, 1994) was undertaken to determine if water was leaking from plant water supply systems and wastewater systems in sufficient quantities to account for seepage into the Tank Farm vaults and support the perched water beneath the plant (which have no readily apparent source, such as the surface infiltration ponds). The study involved a number of tasks and was designed to:

- Evaluate water budget measurements and calculations for plant water systems
- Upgrade plant water metering as necessary to quantify the plant water budget
- Leak-test the plant water supply and wastewater systems in the northern portion of the ICPP
- Estimate natural recharge
- Identify sources of water seeping into the Tank Farm vaults.

The ICPP uses approximately 7.9M L (2.1M gal) of water per day. Water is supplied by two raw water wells and one potable water well. The water is used for process cooling, equipment cooling, steam production, process solutions, decontamination, fuel storage basin makeup, chemical laboratory use, regeneration of ion exchange units, fire protection, and human uses. Piping systems external to facility buildings are either buried or enclosed in utility tunnels. The ICPP water systems that were considered relevant to the water inventory study included the raw water, fire water, treated (softened) water, demineralized water, steam condensate, landscape watering, potable water, service waste (industrial wastewater), and sanitary waste systems. Criteria of low volume, secondary containment, distinct radiological or chemical signature, and close monitoring or visibility were used to eliminate the steam distribution system, HLLW process lines, and pipes used to distribute cooling water to the HLLW storage tanks in the Tank Farm from leak testing during the Water Inventory Study.

The primary water systems at the ICPP include the raw water system, fire water system, water softeners (treated water system), and demineralizer (demineralized water system). The raw water system piping has an approximate length of 1,905 m (6,250 ft) and an average flow of 1,473 L/min (389 gal/min). Raw water is pumped from the aquifer from two production wells to the fire water storage tanks. The raw water feed tanks supply water to three distribution pumps. The fire water piping system has a length of 8.0 km (5 mi), with an average flow of 170 L/min (45 gal/min). This flow in the system is water used for watering lawns, safety showers, cooling of waste tanks and sump pump bearings, and flushing radiation monitor bowls. The treated (softened) water system has a length of 1,219 m (4,000 ft) and an average flow of 3,407 L/min (900 gal/min). Treated water is used for chemical process makeup and in heat exchangers. The

demineralized water system has a length of 1,280 m (4,200 ft) and an average flow of 5.7 L/min (1.5 gal/min). Demineralized water is used for process cooling, steam, and in fuel storage basins.

The steam condensate piping system has a length of 1,280 m (4,200 ft) and an average flow of 280 L/min (74 gal/min) between September and April. Primary steam use occurs between the months of September and March due to seasonal demands such as heating and freeze protection. Most of the steam is condensed and recycled or routed to the service waste system. Approximately 10% of the steam is either released to the atmosphere or discharged to the ground.

The potable water system has a length of 3.2 km (2 mi) with an average flow of 231 L/min (61 gal/min) (Figure 2-1). Potable water is supplied from two wells completed in the SRPA. Water is pumped to a storage tank, and three distribution pumps in building CPP-606 are used to supply potable water to ICPP facilities. The potable water system includes a chlorination system.

The service waste piping system has a length of 3.9 km (2.4 mi) and an average flow of 4,997 L/min (1,320 gal/min) (Figure 2-2). Raw water, treated water, demineralized water, and steam condensate are discharged to the service waste system. Waste streams that might be contaminated with radioactive materials are monitored before discharge to the service waste system, and the water is diverted to a holding tank for processing in the process equipment waste (PEW) Evaporator if contamination is detected. Water in the service waste system is discharged to two percolation ponds located on the south end of the facility.

The sanitary sewer piping system is 2.4 km (1.5 mi) long and has an average flow rate of 110 L/min (29 gal/min) (Figure 2-3). Potable water and sanitary waste from ICPP facilities are discharged to the sanitary sewer system and gravity drained to lift stations, where the waste is pumped to the ICPP Sewage Treatment Plant (STP). The waste is transferred to a series of treatment lagoons located at the northeast corner of the ICPP.

The seven landscape watering systems are all located in the northern ICPP and historically covered a total area of 1.5 acres (Figure 2-4). Approximately 75,710 L/day (20,000 gal/day) from the raw water, fire water, and potable water systems has been used to maintain lawns and landscaping at the ICPP during the summer months. A total volume of 8.90M L (2.35M gal) was used to water ICPP lawns each year. Consumptive use was calculated to require 2,967,760 L (784,000 gal) per growing season. Subtracting the consumption and evapotranspiration from the supplied water yields a net volume of 5.94M L (1.57M gal) available for infiltration and recharge of the perched water bodies.

2.3.2.1.1 Leak Testing—Leak testing was performed as part of the Water Inventory Study and indicated the fire water and potable water systems were leaking. The fire water system was found to have a year-round leak of 15.1 L/min (4 gal/min) and an additional leak of 45.4 L/min (12 gal/min) in a branch connection that is only used periodically. The potential loss from the fire water system was determined to be 14.8M L/yr (3.9M gal/yr). The potable water system was found to have a small leak of 0.57 L/min (0.15 gal/min), which would provide 299,050 L/yr (79,000 gal/yr) of potential recharge. These leaks have been repaired, but have historically provided nearly 15.1M L/yr (4M gal/yr) of potential recharge to the perched water bodies below the ICPP facilities and Tank Farm.

2.3.2.1.2 Tank Farm Vaults—Another purpose of the water inventory study (Richards, 1994) was identification of the source of water infiltrating into the Tank Farm vaults. Seepage into the vaults is a concern because the water could be leaching contaminants released to the soil in the vicinity of the Tank Farm

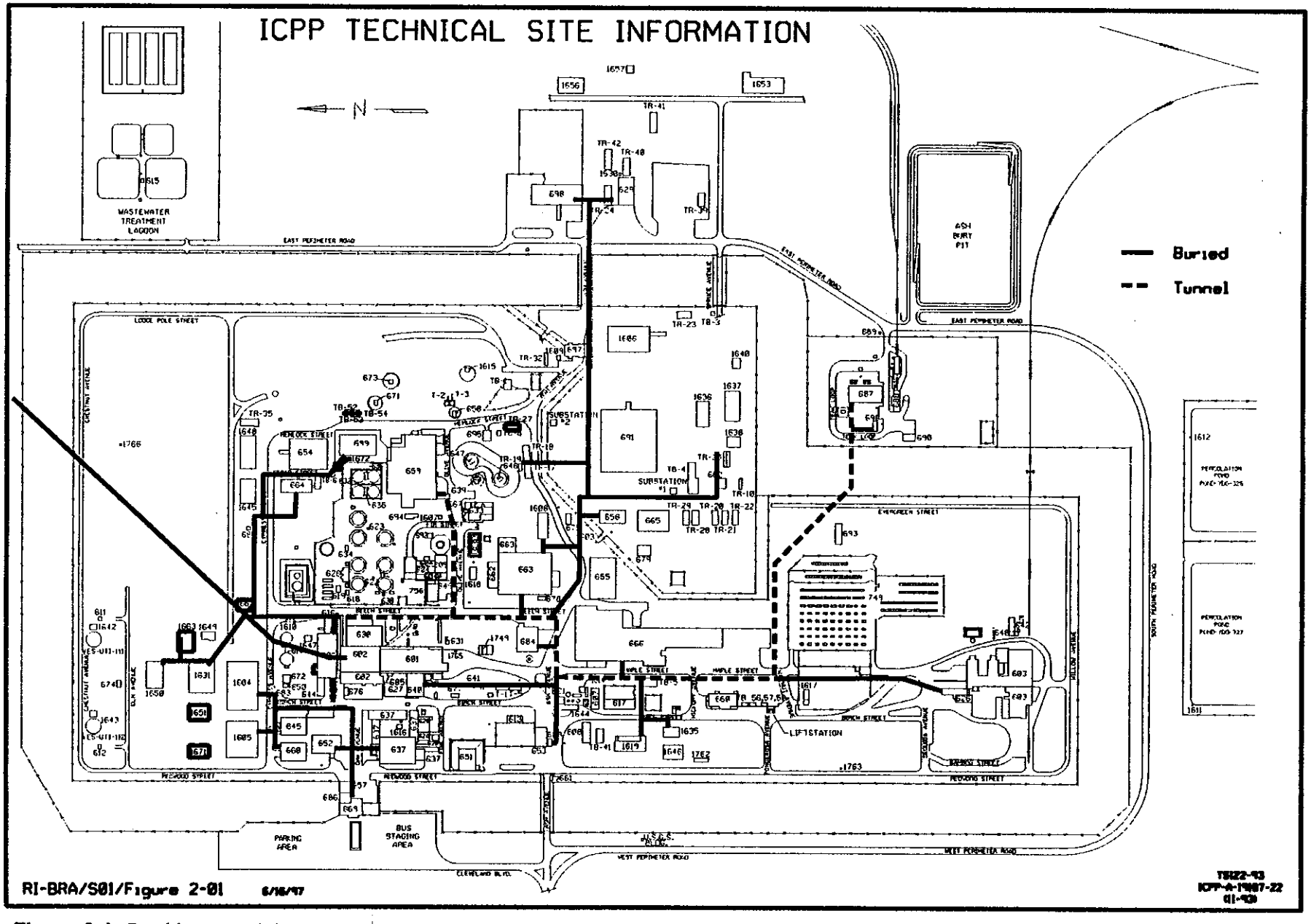


Figure 2-1. Potable water piping system.

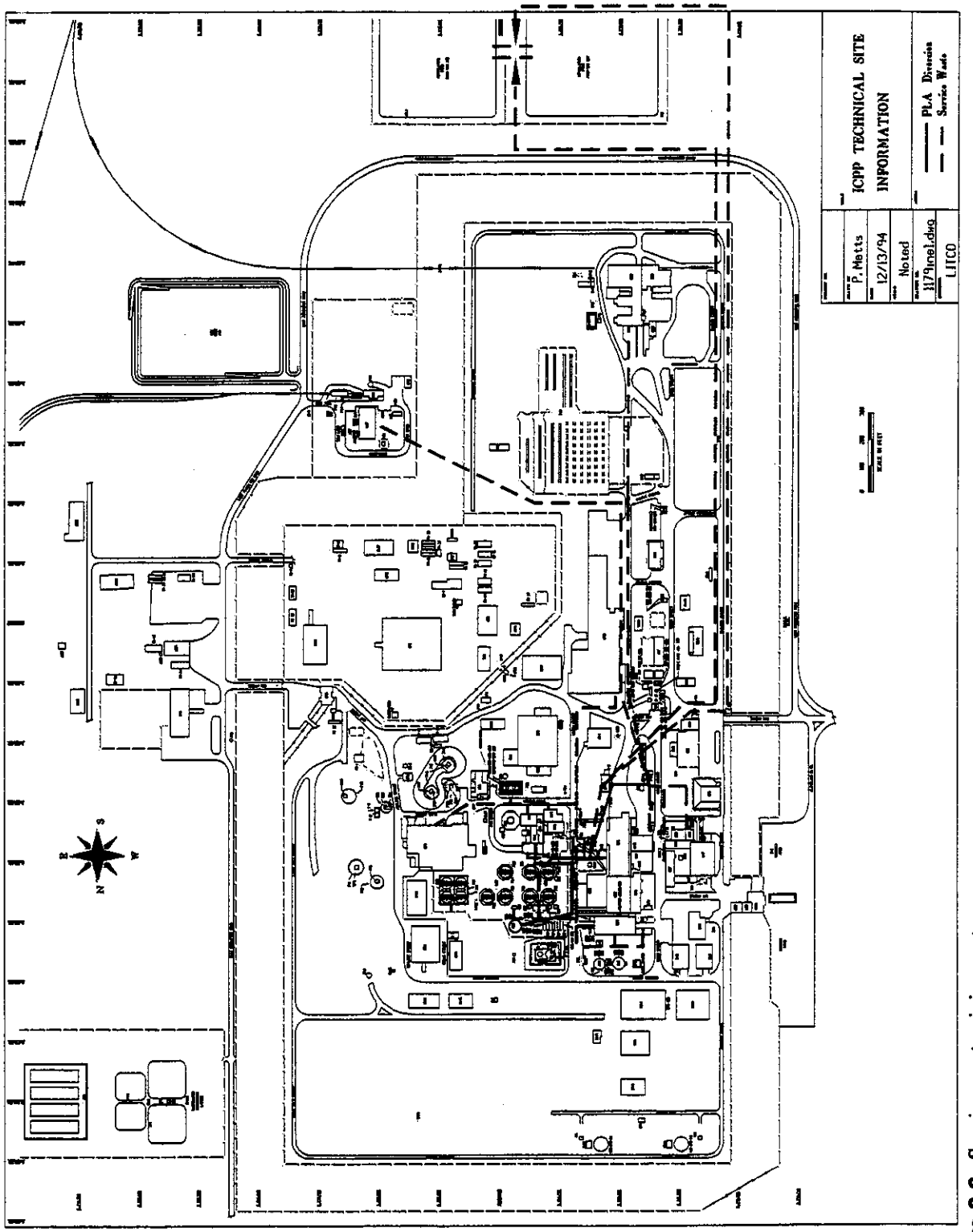


Figure 2-2. Service waste piping system.

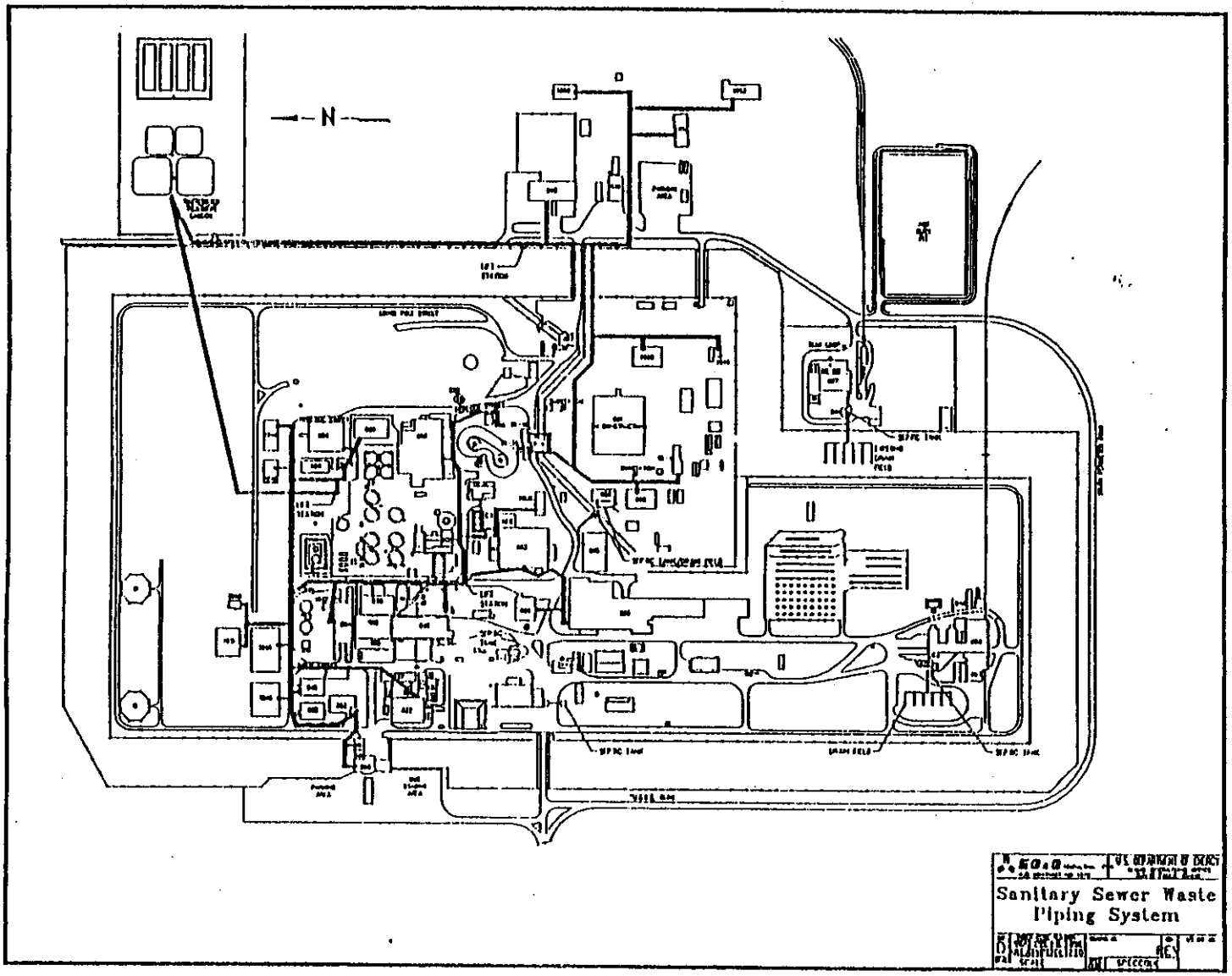


Figure 2-3. Sanitary sewer piping system.

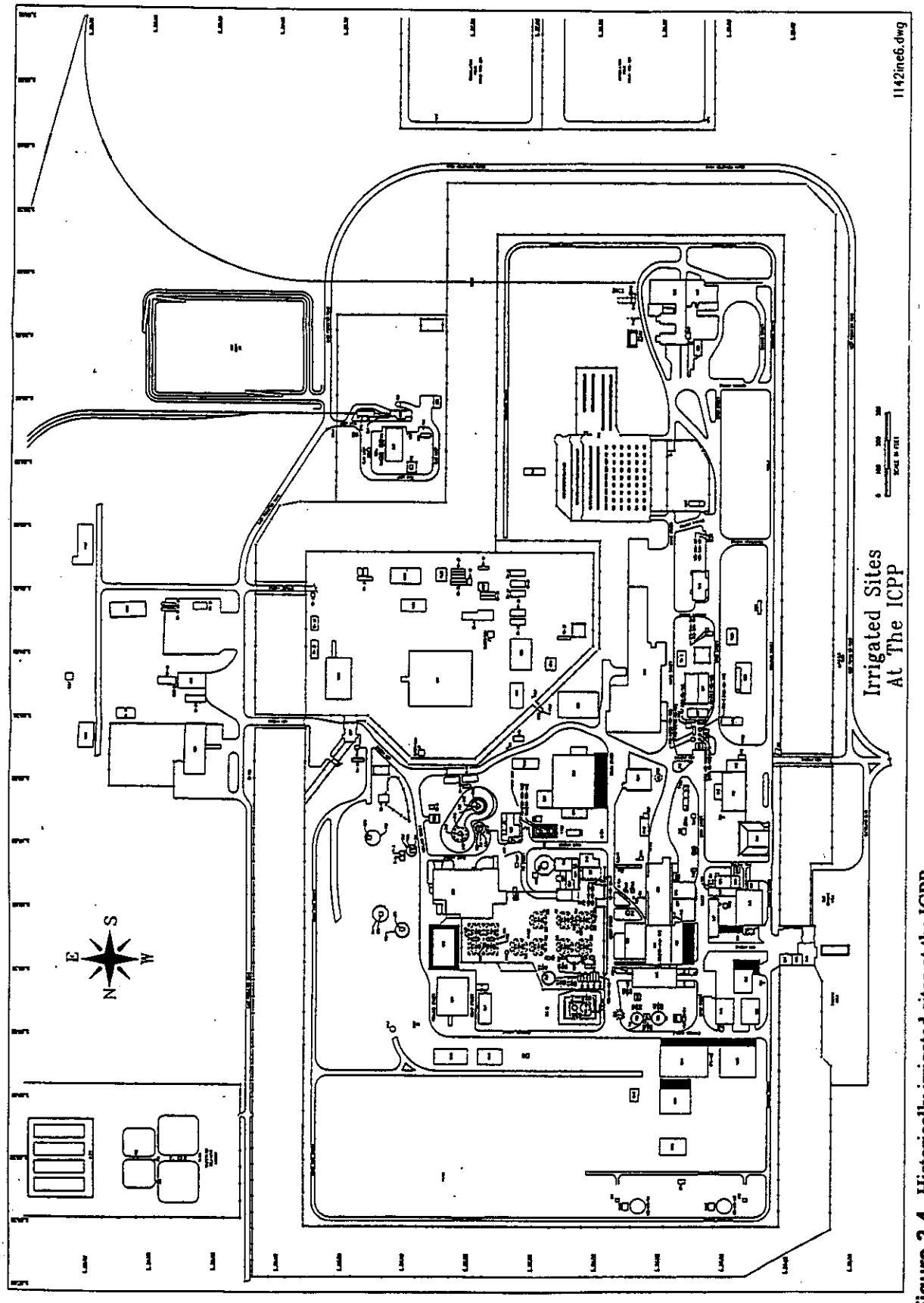


Figure 2-4. Historically irrigated sites at the ICPP.

and transporting those contaminants to the aquifer. The rate of seepage into the vaults is approximately 109,780 L/yr (29,000 gal/yr). Sources of this water were evaluated based on the pattern (constant, precipitation related, seasonal, or random) of seepage, chemistry of the water, location of the sources, and volume of water available for seepage from a particular source. The two most important sources of water for seepage were determined to be infiltration of precipitation and watering the lawn to the west of building CPP-699.

Infiltration of precipitation is a source of seepage for every vault except 781, which showed no seepage during the study period. The volume of water falling on the Tank Farm as precipitation is more than sufficient to provide the necessary volume of water, and the most likely pathway for the water to enter the vaults is seepage through the existing membrane at perforations made for pipes, risers, and valve boxes. Approximately 41% of the water seeping into the vaults comes from this source. The second most important source of seepage for the Tank Farm is watering the lawn. The volume of water from this source is slightly greater than that from precipitation, providing 47% of the seepage. However, this water only affects Vault 713. The pathway for movement of this water was not clearly identified by Richards (1994) because 9.1 to 12.2 m (30 to 40 ft) of lateral movement with only 0.9 to 1.2 m (3 to 4 ft) of vertical movement would be required. Movement of this landscape irrigation water along pipe encasements and drain lines is possible. The remaining 12% of seepage, or 13,476 L/yr (3,560 gal/yr), is from miscellaneous sources, such as leaky steam valves or leaks from valve seals in waste transfer lines. These small sources are not major contributors, but do contribute to seepage periodically.

2.3.2.2 ICPP Steam Condensate System. Subsequent to the Water Inventory Study, a perched groundwater investigation was undertaken in fiscal year (FY)-94. This study was intended to provide additional information about the northern perched groundwater system, including water chemistry and temperature, dissolved contaminant concentrations, depth, and saturated thickness. Temperature measurements in the perched groundwater ranged from 22.2°C (72.1°F) in Well MW-5 to 10.8°C (51.5°F) in Well MW-4. The elevated temperatures in the perched groundwater suggest that hot water sources may be contributing to the perched water system in some areas at the ICPP. Steam condensate drains located throughout the facility (Figure 2-5) are one of the major sources of hot water at the ICPP.

The ICPP steam system consists of two boiler plants (CPP-606 and -687), which supply steam to various buildings and installations throughout the ICPP. Steam condensate traps are located at low portions of the steam lines and these traps allow condensate water to exit the system. The volume of condensate at each trap depends on the length of the steam line the vent services and the heat loss in the steam line. A large portion of this steam distribution system is located in a utility tunnel housing a 30.5-cm (12-in.) steam line connecting CPP-606 to the coal powered generating plant (CPP-687). A total of 48 steam vent condensate drains are located in the utility tunnel. Condensate water drains to the subsurface. Generally, the steam is used in steam heater units, which are used to heat a majority of the buildings onsite. Steam usage is greatest during the heating season beginning in September and ending in April when an average flow rate of 280 L/min (74 gal/min) occurs in the system. Volumes of condensate water generated in the system depend on the heat load of the system, and estimates of the volume of condensate originating at steam heater units were based on 150 days at an ambient temperature of -7°C (20°F). The main steam line in the utility tunnel is active all year and condensate calculations for the steam condensate traps along this line were adjusted to reflect 365 days/yr of operation.

The volume of condensate from the steam heater units and the steam traps were estimated (Table 2-2). The largest contributors of waste steam condensate water to the ground are the steam heater units located in

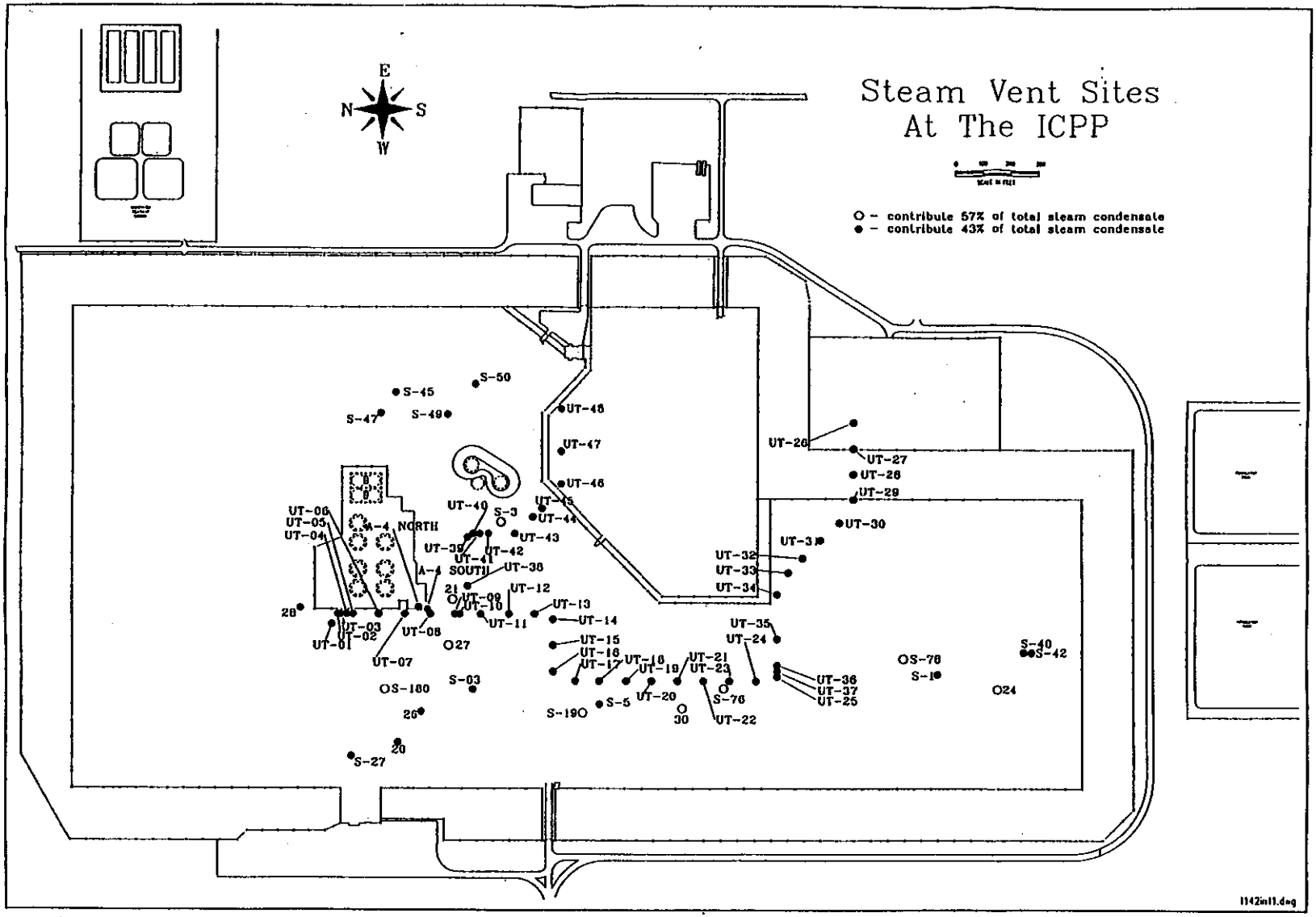


Figure 2-5. Steam condensate drains at the ICPP.

Table 2-2. Approximate discharge from the ICPP condensate drains.

STEAM VENT IDENTIFICATION	NORTHING COORDINATE	EASTING COORDINATE	VOLUME OF WATER IN GALLONS PER DAY	YEARLY VOLUME IN GALLONS
S-1	693405	296474	6	900
S-3	695098	297063	2160	324000
S-5	694707	296359	0	0
S-19	694774	296325	1344	201600
S-27	695682	296160	0	0
S-40	693067	296557	28	4200
S-42	693037	296557	5	750
S-45	695511	297568	8	1200
S-47	695568	297487	8	1200
S-49	695308	297482	8	1200
S-51	695200	297600	8	1200
S-63	695209	296416	15	2250
S-76	694229	296419	288	43200
S-78	693537	296533	144	21600
S-180	695551	296416	432	64800
20	695502	296213	28	4200
21	695286	296761	144	21600
24	693170	296417	1008	151200
26	695411	296330	28	4200
27	695302	296583	144	21600
28	695877	296728	28	4200
30	694389	296342	432	64800
A-4 NORTH	695419	296731	0	0
A-4 SOUTH	695385	296722	0	0
UT-01	695757	296665	35	12775
UT-02	695733	296704	23	8395
UT-03	695723	296704	8	2920
UT-04	695699	296704	10	3650
UT-05	695674	296704	26	9490
UT-06	695574.5	296704	43	15695
UT-07	695474	296704	43	15695
UT-08	695373	296704	42	15330
UT-09	695277.5	296704	25	9125
UT-10	695259	296704	43	15695
UT-11	695178.5	296704	42	15330
UT-12	695066	296704	46	16790
TU-13	694966	296704	42	15330
UT-14	694895	296683	42	15330
UT-15	694895	296584	43	15695
UT-16	694895	296484	47	17155
UT-17	694804	296448	46	16790
UT-18	694708	296448	43	15695
UT-19	694604	296448	44	16060
UT-20	694506	296448	45	16425
UT-21	694406.5	296448	45	16425
UT-22	694307	296448	43	15695
UT-23	694207	296448	43	15695
UT-24	694107	296448	44	16060
UT-25	694025	296466	30	10950
UT-26	693729	297452	52	18980
UT-27	693729	297352	43	15695
UT-28	693729	297252	43	15695
UT-29	693729	297152	43	15695
UT-30	693781	297061	43	15695
UT-31	693854	296992	43	15695
UT-32	693924	296921	39	14235
UT-33	693981	296865	39	14235

Table 2-2. (continued).

STEAM VENT IDENTIFICATION	NORTHING COORDINATE	EASTING COORDINATE	VOLUME OF WATER IN GALLONS PER DAY	YEARLY VOLUME IN GALLONS
UT-34	694025	296782	59	21535
UT-35	694025	296608	59	21535
UT-36	694025	296508	43	15695
UT-37	694025	296485	30	10950
UT-38	695229	296813	51	18615
UT-39	695229	297004	51	18615
UT-40	695208	297017.5	58	21170
UT-41	695181.5	297017.5	16	5840
UT-42	695148	297017.5	33	12045
UT-43	695042.5	297017.5	44	16060
UT-44	694973	297082	31	11315
UT-45	694938	297115	32	11680
UT-46	694863	297212	53	19345
UT-47	694863	297341	61	22265
UT-48	694863	297504	104	37960
TOTALS:			8279	1674645

some of the buildings around the site. These units produce a 3.8-L/min (1-gal/min) flow of condensate water for every 600,000 British thermal units (BTUs) of heat energy generated. The amount of condensate water generated at each steam condensate trap along the line in the utility tunnel is relatively low compared to the volumes generated by the steam heater units, but the number of these traps and drains make this a significant source of steam condensate that is discharged to the subsurface. The total annual volume of steam condensate discharged to the ground was estimated to be 6.32M L (1.67M gal). Of this volume, approximately 4.92M L (1.3M gal) are discharged in an area where the condensate could contribute to the northern perched water body.

2.3.2.3 CPP-603 Basins. CPP-603 consists of three reinforced concrete fuel storage basins connected by a transfer channel. The walls of the basins are 0.6-m (2-ft) thick and the floor is 1.5-m (5-ft) thick. The pools are 6.1-m (20-ft) deep and the water inventory is maintained at approximately 5.7M L (1.5M gal). The basin water treatment system consists of sand filters, a selective cation exchange system, and an ultraviolet sterilizer. Demineralized makeup water is provided from a reverse osmosis unit. The basin water contains a variety of soluble radionuclides and stable constituents. The radionuclides are removed by the basin water treatment system and the primary nonradioactive soluble ions that have accumulated in the basin water are sodium, calcium, chloride, and nitrate. Inspection of the accessible walls and floor of the basin do not indicate any cracking or other physical damage. The basin is unlined and several studies have been undertaken to estimate the quantity of water that may be leaking from the basin. These studies have estimated losses due to evaporation and have evaluated the basin water inventory.

Various methods of estimating water loss from the basin were evaluated. Measurement of the dilution of dissolved solids was used to estimate the basin water inventory because the method is direct and reasonably reliable. This method involves measurement of the dilution of a dissolved solid in the basin water as water is added to the basin to maintain the water level. The dissolved solid selected for measurement must not be removed by the basin ion exchanges system, the filter, or by contact with the basin walls and piping. Chloride was selected as the best candidate dissolved solid for monitoring. Cation concentrations can be affected by the basin ion exchange system and are not useful for determining the basin leak rate. Nitrate is also not useful because the ion is a known nutrient for basin microorganisms. Chloride is not a nutrient and is not affected by the basin water treatment systems. However, small amounts of chloride may be lost from corrosion of aluminum. The sludges on the basin floor are also known to contain undissolved chloride, but chloride in the sludges is likely to be in equilibrium with the water.

Dilution of chloride has been used in two basin water inventory studies. The first study was conducted from July 28, 1986, through August 3, 1987. In this study, the chloride concentration in the makeup water was assumed to be 10 parts per million (ppm) based on measurements of the concentration in ICPP well water. A loss rate of 379 L/day (100 gal/day) in excess of measured losses was estimated. The estimate was determined to have an error of approximately 100%. The second study calculated basin water inventory based on dilution of chloride during the period from May 3, 1993 to October 3, 1993. In this inventory, the total loss rate from the basin was determined to be 874 L/day (231 gal/day). Measured losses were determined to be 363 L/day (96 gal/day), leaving a discrepancy of 511 L/ day (135 gal/day) (estimated error has not been calculated). The evaporation rate from the pond was estimated to be 1,173 L/day (310 gal/day), which is consistent with a previous laboratory study estimate of 1,211 L/day (320 gal/day). The 511 L/day (135 gal/day) loss rate can be attributed to permeation through microcracks along the basin surface. Based on the two studies the best estimate for the loss rate is between 500–700 L/day. This loss rate is very small for a simple concrete structure as large as CPP-603 and is an indication the basin surfaces are in excellent condition.

2.3.2.4 Sewage Treatment and Percolation Ponds. The ICPP STP treats sanitary sewage from 31 permanent facilities at the ICPP, primarily consisting of wastewater from restrooms and cafeterias. All sanitary waste from the 31 permanent facilities is collected by gravity-flow lines and piped via lift stations to the STP for treatment. In addition, sanitary waste from nine ICPP buildings is collected and treated separately from the main STP.

The STP facility is located to the northeast of the enclosed ICPP plant area. It consists of two aerated lagoons, two quiescent facultative stabilization lagoons, four infiltration/percolation (I/P) trenches, and six weir boxes. The aerated lagoons are arranged in series and drain into facultative lagoons, which then overflow into the I/P trenches. The weir boxes route the wastewater through the lagoons and trenches. Maximum plant capacity is 454,200 L/day (120,000 gal/day), with an average flow of 159,000 L/day (42,000 gal/day). From 1984 to present, the monthly discharge to the sewage treatment ponds is provided in Table 2-3.

The service waste system collects, monitors, and samples nonradioactive, nonhazardous wastewater used in various plant activities and transfers it to one of the two percolation ponds located south of the ICPP for disposal. Percolation Ponds 1 and 2 are located outside the ICPP southern security fence, southeast of CPP-603. The percolation ponds are unlined ponds that were excavated from the surficial alluvium in 1982 and 1985. Percolation Pond 1 began receiving flow in 1984, but an inadequate percolation rate made it necessary to build Pond 2. The two ponds have been used alternately since then, receiving approximately [5.7 to 9.5M L/day (1.5 to 2.5M gal/day)] of service wastewater. From 1984 to present, the monthly discharge to the percolation ponds is provided in Table 2-4.

2.3.3 Big Lost River

The Big Lost River flows southeast from the Mackay Dam, through the Big Lost River Basin, past Arco, Idaho, and onto the Snake River Plain. The river flows onto the INEEL near the southwest boundary, curves to the northeast, and flows northward to its termination in the Big Lost River playas (Figure 1-1).

The Big Lost River basin includes parts of Custer and Butte Counties in south-central Idaho (Bennett, 1990). The drainage area of the river upstream of the INEEL is approximately 3,626 km^2 (1,400 mi^2). Of the 2,305 km^2 (890 mi^2) within the boundaries of the INEEL, only 181 to 207 km^2 (70 to 80 mi^2) contribute surface runoff of any significance to the Big Lost River. Noncontributing areas of the Big Lost River basin within the INEEL consist of small topographically closed basins 2.6 to 26 km^2 (1 to 10 mi^2) in area. Land surface altitudes of the drainage area range from 1,457 m (4,780 ft) above sea level at the terminal playas to 3,858 m (12,656 ft) at Borah Peak in the Lost River Range. The channel of the Big Lost River is incised about 18.3 m (60 ft) into the basalt of the Snake River Plain at a point 1.6 to 3.2 km (1 to 2 mi) downstream from the gauging station near Arco. After reaching the western boundary of the INEEL, the river emerges from the narrow, 61- to 91-m (200- to 300-ft) wide, canyon into a broad plain where it is incised less than 6.1 m (20 ft). The river is incised less than 3 m (10 ft) near Highway 20 and downstream from the highway, the river enters a broad floodplain that ranges in width from 1.6 to 6.4 km (1 to 4 mi). This floodplain is characterized by remnants of old meander channels. Ultimately, the main channel branches into many small channels and flow spreads across several ponding areas, or playas, known as the Big Lost River Sinks. Playas 1 and 2 have an elevation of 1,459 m (4,788 ft) and surface areas of about 350 and 110 acres, respectively. Playas 3 and 4 are at an altitude of 1,457 m (4,780 ft) and have surface areas of 1,000 and 1,350 acres, respectively.

Table 2-3. Monthly discharge of the sewage treatment ponds (RWMIS database).

	Jan.	Feb.	March	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1984	0.7	0.6	0.5	0.6	0.7	0.5	0.6	0.6	0.6	0.5	0.6	0.6	7.1
1985	0.6	0.6	0.7	0.6	0.6	0.6	0.6	0.5	0.6	0.6	0.6	0.1	6.5
1986	0.8	0.8	0.9	0.9	0.8	0.7	0.9	0.8	0.8	0.7	0.8	0.8	9.6
1987	0.8	0.8	0.8	0.8	0.8	0.7	0.7	0.7	0.6	0.7	0.8	0.8	9.0
1988	0.9	0.8	0.8	0.8	0.8	0.7	0.7	0.7	0.8	0.7	0.7	0.8	9.2
1989	0.8	0.9	0.9	0.8	0.8	0.8	0.7	0.7	0.7	0.9	0.8	0.9	9.7
1990	0.8	1.0	0.9	0.8	0.9	0.9	1.0	1.1	1.1	0.9	0.9	0.9	11.3
1991	1.2	1.1	0.8	0.9	0.8	0.8	0.9	0.7	0.8	0.7	0.9	1.2	10.8
1992	0.9	1.5	1.6	1.5	1.5	1.3	1.3	1.6	1.7	2.0	2.2	1.7	18.7
1993	1.1	1.2	1.1	1.2	1.1	1.2	1.4	0.6	0.8	1.2	1.2	1.1	13.1
1994	3.1	1.4	ND	1.9	4.4	5.9	3.2	2.0	1.4	1.0	1.6	2.0	(27.92)
1995	2.5	1.3	2.3	2.2	3.1	1.3	0.1	1.8	1.3	ND	ND	ND	(15.75)

( ) - indicates incomplete record.
Discharge in millions of gallons.

Table 2-4. Monthly discharge to percolation ponds (RWMIS database).

	Jan.	Feb.	March	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1984	ND	ND	42.1	45.4	52.5	53.1	45.0	47.2	41.8	41.3	37.6	38.9	(444.9)
1985	29.9	36.7	36.4	0.6	31.5	41.9	39.3	43.4	60.0	58.5	17.4	57.6	453.23
1986	54.1	46.7	40.8	50.1	45.0	47.3	50.2	50.6	43.7	49.7	49.3	48.1	575.56
1987	51.9	50.7	47.9	50.4	51.8	52.1	51.4	50.8	49.5	49.7	46.6	47.1	599.90
1988	53.3	49.4	47.1	51.4	47.4	50.3	48.2	48.3	42.5	44.9	41.2	41.5	565.50
1989	36.2	40.2	39.0	36.9	29.8	35.9	33.0	33.2	37.9	36.7	37.6	43.4	439.80
1990	46.7	45.1	38.7	51.5	59.9	62.4	57.3	55.7	62.5	50.9	47.4	44.3	622.40
1991	45.6	44.4	38.0	44.6	45.6	44.0	49.3	48.1	52.7	48.6	49.2	46.3	556.43
1992	55.5	58.7	52.6	57.5	48.1	43.6	47.5	54.2	57.8	54.6	58.8	53.6	642.50
1993	58.2	57.1	62.9	60.2	56.1	59.2	53.1	53.9	50.9	48.6	49.8	54.8	664.80
1994	55.5	40.8	54.9	49.6	48.7	40.0	35.2	37.8	40.2	37.3	40.1	39.1	519.20
1995	39.5	40.8	38.0	58.0	46.1	35.9	35.6	45.3	3.8	ND	ND	ND	(342.98)

() - indicates incomplete records.
Discharge in millions of gallons.

Storage and diversion systems on the Big Lost River include the Mackay Dam, several irrigation diversions, and the INEEL flood diversion dam. The Mackay Dam is a 435.9-m (1,430-ft) long, 24.1-m (79-ft) high earthfill dam built for the Big Lost River Irrigation District. The dam was completed in 1918 and is located 6.4-km (4-mi) northwest of the town Mackay. The dam has a storage capacity of 5.49 $\times 10^7$ m^3 (4.45 $\times 10^4$ acre-ft) of water. The dam is used to impound water for irrigation in the Big Lost River Irrigation District. Water from the Big Lost River is used to irrigate about 57,500 acres of land downstream from the Mackay Reservoir and another 10,200 acres of land are subirrigated upstream from the reservoir (Harenberg et al., 1987).

The INEEL flood diversion system, located approximately 10.5-km (6.5-mi) downstream from the western INEEL boundary, was built in 1958 to divert high flows on the Big Lost River away from INEEL facilities. During the winter months, most of the flow in the river is diverted to avoid accumulation of ice in the channel, thus reducing the possibility of flooding at downstream INEEL facilities. The system consists of a small earthen diversion dam and headgate that diverts water from the main channel, through a connecting channel, and into a series of four natural depressions, called spreading areas. The capacity of the spreading areas is about 7.2 $\times 10^7$ m^3 (5.8 $\times 10^4$ acre-ft) at an elevation of 1,539 m (5,050 ft) mean sea level. An overflow weir in Spreading Area D allows water to drain southwest off the INEEL. Runoff from the Big Lost River has never been sufficient to exceed the capacity of the areas and overflow the weir.

Carrigan (1972) modeled the capacity of the INEEL flood diversion system as it existed in 1972 and concluded the system was inadequate for long period floods. The diversion system was upgraded in 1984 in response to a flood risk that occurred in late 1983 and early 1984 (McKinney, 1985). The present diversion system has a total diversion channel capacity of up to 263.3 m^3/s (9,300 ft^3/s). The existing diversion channel can carry 203.9 m^3/s (7,200 ft^3/s). The ICPP area has not been flooded since construction of the diversion system.

Gauging stations are located upstream and downstream of the Mackay Reservoir to monitor discharge. Additional stream gauging stations are maintained on the Big Lost River by the U.S. Geologic Survey (USGS), including a station where the river is crossed by Lincoln Boulevard on the INEEL. Flow in the river is highly variable with peak flows occurring in June and July due to snowmelt (Table 2-5). Generally, there is no flow in the river during the winter months.

The Big Lost River flow is perennial upstream from a point a few miles southeast of Arco. Downstream, the flow is lost by infiltration through the river bottom, and the point where flow ceases depends on discharge and the infiltration conditions of the channel. Infiltration rates are greatest when the channel is initially wetted and the hydraulic head is at a maximum. Flow in the river may not reach the western boundary of the INEEL or may continue as far north as Playa 4. Losses in streamflow also result from evaporation and transpiration. These losses are small by comparison to losses due to infiltration. The intermittent flow of the river does not encourage growth of vegetation along the periphery, which minimizes transpiration. Annual net evaporation from large water surfaces in the ESRP is 84 cm/yr (33 in./yr) (Stearns et al., 1938). Using this evaporation rate, Harenberg et al. (1987) calculated the maximum possible evaporation for the 71-km (44-mi) stretch from Arco to the playas would be less than 900 acre-ft/yr. The river is also generally dry during periods of peak evaporation so actual losses are lower. During the period from 1965 to 1987, losses due to evapotranspiration and infiltration in the 18-km (11-mi) stretch between the INEEL diversion dam and Lincoln Boulevard averaged 9,820 acre-ft/yr. During this period there was no flow 28% of the time at the diversion dam and 49% of the time at Lincoln Boulevard. Since 1987, the Big Lost

Table 2-5. Monthly discharge of the Big Lost River at Lincoln Boulevard near the ICPP (acre-feet).

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1965[a]	0	0	2,380	10,300	15,400	29,600	31,100	16,900	10,900	0	0	0	116,580
1966	0	0	0	3,660	981	0	0	0	0	0	0	0	4,641
1967	0	0	0	0	2,030	20,180	18,376	4,400	9,050	8,740	0	0	62,776
1968	0	0	2,280	3,390	16	524	0	1,053	1,130	3,290	4,500	0	16,183
1969	0	0	0	3,960	33,000	33,500	21,800	4,780	9,840	6,710	3,290	0	116,880
1970	0	0	501	1,650	793	13,800	17,700	1,510	6,080	5,280	4,750	8	52,072
1971	0	0	0	10,600	12,300	17,200	20,800	7,760	13,400	14,400	13,100	0	109,560
1972	0	0	1,540	4,920	504	1,710	861	84	2,990	3,520	3,099	0	19,228
1973	0	0	0	2,830	405	0	0	0	0	0	0	0	3,235
1974	0	0	3,240	5,520	6,940	16,200	9,390	1,170	1,160	3,760	4,200	0	51,580
1975	0	0	0	3,180	12,000	12,100	18,700	3,560	6,520	8,210	7,990	0	72,260
1976	0	0	333	1,450	1,660	1,120	0	0	300	620	1,100	76	6,659
1977	0	0	0	0	0	0	0	0	0	0	0	0	0
1978	0	0	0	0	0	0	0	0	0	0	0	0	0
1979	0	0	0	0	0	0	0	0	0	0	0	0	0
1980	0	0	0	0	0	0	1,140	0	0	0	0	0	1,140
1981	0	0	0	1,300	5,092	7,560	0	0	0	0	0	0	13,952
1982	0	0	0	5,930	17,200	13,400	15,100	4,820	8,190	10,500	5,740	600	81,480
1983	600	600	900	12,800	15,800	18,900	18,200	9,780	7,320	6,200	5,660	1,200	97,960
1984	1,200	1,200	1,200	2,200	2,320	4,550	3,950	5,790	5,140	5,980	8,710	2,120	44,360
1985	3	0	0	7,170	6,430	0	0	0	9,950	10,707	1,275	0	35,535
1986	0	96	537	8,370	14,825	20,315	2,900	1,016	14,753	8,220	1,190	2	72,224
1987	0	0	531	491	0	0	0	0	0	0	0	0	1,022
1988[b]	0	0	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 2-5. (continued).

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1992	0	0	0	0	0	0	0	0	0	0	0	0	0
1993	0	0	0	0	0	5,116	0	0	0	0	0	0	5,116
1994	0	0	0	0	0	0	0	0	0	0	0	0	0
1995	0	11	0	0	0	16,010	22,310	955	0	NA	NA	NA	—

a. Monthly discharge volume for 1965 to 1988 from Bennett 1990, Streamflow Losses and Ground Water Level Changes Along the Big Lost River at the Idaho National Engineering Laboratory, Idaho. USGS Water-Resources Investigations Report 90-4067.

b. Monthly discharge data for 1988 to 1994 from the USGS.

NA—Not available.

River has been dry on the INEEL with the exception of brief periods in 1993, 1995, and 1996. Flows have reached Playa 1 in 24 of the 77 years since the construction of the Mackay Reservoir in 1917.

The ICPP is located on the alluvial plain approximately 61.0 m (200 ft) from the Big Lost River channel near the point where the channel intersects with Lincoln Boulevard on the INEEL. The elevation of the Big Lost River channel immediately northwest of the ICPP is 1,495 m (4,908 ft), and the elevation of the river bank or berm is 1,497.1 m (4,912 ft). The average elevation of the ICPP is 1,498.7 m (4,917 ft).

The INEEL diversion system diverts water from the Big Lost River during periods of high flow. The diversion dam across the Big Lost River permits the passage of less than 900 cubic feet per second during floods (Bennett, 1986), and the river channel near ICPP can accommodate this flow. The maximum diversion capacity of the INEEL diversion system is up to 9,300 cubic feet per second, well above the 100-year flood stage (Bennett, 1986). The Big Lost River poses no flood threat to the ICPP as it flows northeast to its termination in the playas.

2.3.3.1 Aquifer Recharge from the Big Lost River. In 1985, flow in the SRPA at the INEEL was to the southwest and the gradient was about 0.8 m/km (4 ft/mi) (Bartholomay et al., 1997). The direction of flow is locally affected by recharge and discharge. Recharge at the INEEL is primarily the result of underflow from the northeastern part of the plain and the Big Lost River. During periods of high flow, local groundwater levels and the direction of groundwater flow can be temporarily altered by recharge from the river. In periods of low flow in the Big Lost River, local gradients reflect regional flow directions.

The altitude of water levels and configuration of the water table in the SRPA vary in response to changes in the volume and source of recharge. Water levels peaked in the early 1970s during a prolonged period of above average precipitation and high flows in the Big Lost River beginning in 1965. Water levels subsequently declined during a period of average or below average precipitation and stream flow beginning in 1976 and continuing through the early 1980s. No flows were recorded at Lincoln Boulevard on the INEEL during the period from 1977 through 1979 and small flows were recorded in 1 month of 1980 and 3 months of 1981. Measured water levels in USGS monitoring wells rose during the period from 1981 through 1985, corresponding with a period of flow in the Big Lost River Channel.

During the period from 1972 to 1978, water levels declined as much as 3.0 m (10 ft) near the Radioactive Waste Management Complex (RWMC) spreading areas and north of the Naval Reactors Facility (NRF). During the same period, water levels in the eastern part of the INEEL, where water levels are probably influenced least by flows in the Big Lost River and other surface water recharge sources, declined about 1.5 m (5 ft). The net increase in the regional water table during the period from 1981 to 1985 reflected a change in the volume of water available for recharge during a comparatively wet period following 3 years of no flow in the river. The water table in the vicinity of the RWMC rose as much as 4.9 m (16 ft) in response to recharge from water diverted to the spreading areas. Water levels rose as much as 3.7 m (12 ft) in the vicinity of the NRF and about 1.5 m (5 ft) in the eastern INEEL. Water levels at the Test Area North (TAN) declined less than 0.3 m (1 ft) during the first period, but rose as much as 1.2 m (4 ft) during the period of high flow. Between the period 1989 to 1991, water levels declined because there was no stream flow in the Big Lost River below Arco and because of a general decline in recharge to the aquifer. From 1991 to 1995, water levels generally decline throughout the INEEL because of drought conditions that began in 1987. Water level declines ranged from about 8.5 ft in wells in the west-central part of the INEEL to about 2.5 ft. in wells in the southern part. The water level decline in the west-central part of the INEEL is attributed to lack of recharge from the Big Lost River.

Changes in water levels in wells in the vicinity of the Big Lost River sinks correlate with flows that were recorded at the gauging station at Lincoln Boulevard. Groundwater levels rose rapidly during periods of high stream flow and declined during periods of decreased or no flow. Groundwater levels in the areas southwest of the RWMC and north of the NRF are significantly affected by recharge from the Big Lost River. These areas correspond with the spreading areas and sinks.

From 1964 through 1994, water levels in USGS monitoring wells near the ICPP rose in response to periods of flow on the Big Lost River (Figure 2-6). Periods of high flow on the river correspond to periods of rising water levels in the monitoring wells. Peak water levels in the wells occurred approximately 1 year after each period of high flow in the river. Although infiltration of precipitation would contribute to water levels in the wells and river flows would be expected to be greater in years with higher precipitation, infiltration of water from the Big Lost River channel appears to be the major cause of increased water table elevation along the channel during periods of high flow.

2.3.4 Summary of Surface Water Recharge

The ICPP uses approximately 7.9M L (2.1M gal) of water per day. Water is supplied by two raw water wells and two potable water wells located in the northern portion of the facility. The primary water systems at the ICPP include raw water, fire water, treated (softened) water, demineralized water, steam condensate, landscape watering, potable water, service waste (industrial wastewater), and sanitary waste systems (Table 2-6). Piping systems external to facility buildings are either buried or enclosed in utility tunnels. Based on the primary water systems, approximately 2.9B L (767M gal) of water are distributed throughout 23 km (14 mi) of piping annually at the ICPP.

A Water Inventory Study (Richards, 1994) was performed at the ICPP to determine whether water was leaking from the plant's water supply and wastewater systems in sufficient quantities to support the perched water bodies beneath the plant (which have no readily apparent source). A thorough evaluation of the primary piping systems was performed and leaks were discovered on the fire water and potable water systems. The fire water system was found to have a year-round leak of 15 L/min (4 gal/min) and an additional leak of 45.4 L/min (12 gal/min) in a branch connection that was only used periodically. The potential loss from the fire water systems was determined to be 14.8M L/yr (3.9M gal/yr). The potable water system was found to have a small leak of 0.57 L/min (0.15 gal/min), which would provide approximately 299,000 L/yr (79,000 gal/yr) of potential recharge to the perched water systems. These leaks have been repaired, but historically provided nearly 15.1M L/yr (4M gal/yr) of potential recharge to the perched water bodies. A potential exists that other unknown leaks are present in the 23 km (14 mi) of piping. For example, even if the metering could measure the flow throughout the plant to a 5% accuracy, an annual loss of 145M L (38.4M gal) could go undetected.

Another source of recharge to the perched water bodies is the subsurface injection of waste steam condensate. The steam condensate piping system has a length of 1,280 m (4,200 ft) and an average flow of 280 L/min (74 gal/min.) between September and April. Primary steam use occurs between these months due to seasonal demands such as heating and freeze protection. The total annual volume of steam condensate discharged to the ground was estimated to be 6.4M L (1.7M gal). Of this volume, it is estimated that 4.9M L (1.3M gal) are discharged in an area where the condensate could contribute to the northern perched water body.

The seven landscape watering systems are all located in the northern ICPP and cover a total area of approximately 1.5 acres. It is estimated 75,710 L/day (20,000 gal/day) of water are used to maintain lawns

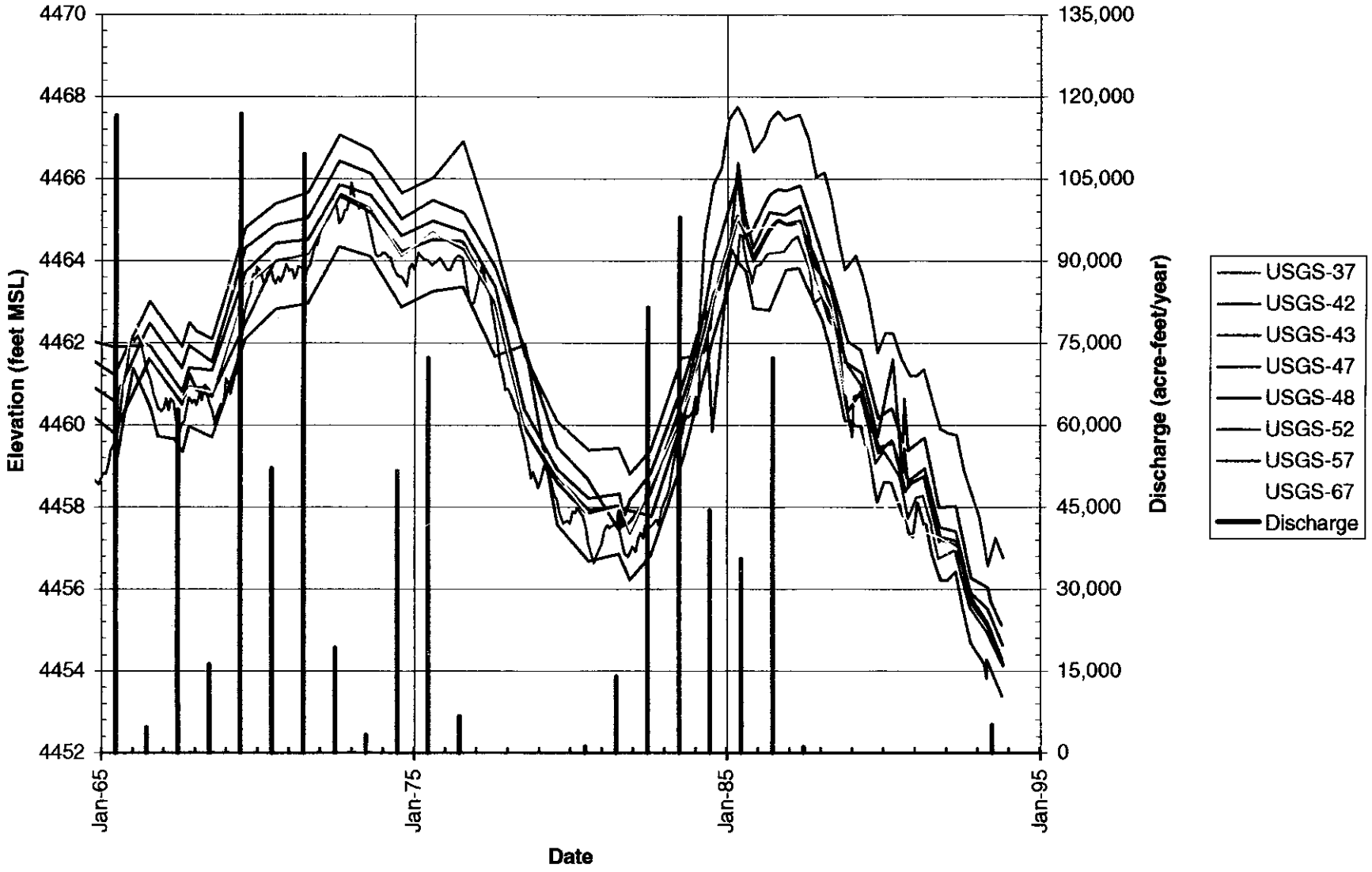


Figure 2-6. SRPA water level response to flows in the Big Lost River (1964 to 1994 USGS records).

Table 2-6. Primary water systems at ICPP.

System	Estimated annual flow (gallons)	Length of piping
Raw	200,000,000	1,905 m (6,250 ft)
Fire	24,000,000	8,049 m (26,400 ft)
Treated (softened)	470,000,000	1,219 m (4,000 ft)
Demineralized	790,000	1,280 m (4,200 ft)
Steam condensate	39,000,000	1,280 m (4,200 ft)
Potable	32,000,000	3,220 m (10,560 ft)
Service	690,000,000	3,863 m (12,670 ft)
Sanitary	15,000,000	2,415 m (7,920 ft)
Total	1,470,000,000[a]	20,132 m (76,200 ft) (14.4 mi)

a. Annual flow is approximately twice the estimated 7.9M L (2.1M gal) of water used daily because the annual flow is based on both the process end and the waste disposal (i.e., service and sanitary wastewater).

and landscaping at the ICPP during the summer months. Annually, a total volume of 8.9M L (2.35M gal) is used to water ICPP lawns. Consumptive use was calculated to require 2,967,760 L/growing season (784,000 gal/growing season). Subtracting the consumption and evapotranspiration from the supplied water yields a net volume of approximately 5.94M L (1.57M gal) available for infiltration and recharge of the perched water bodies.

Natural recharge from precipitation is also available to support perched water bodies. Long-term average annual precipitation at the INEEL is 22.1 cm (8.7 in.) and pan evaporation is on the order of 109 cm/yr (43 in./yr). Nevertheless, water from snowmelt or heavy rains may infiltrate to a depth where it cannot be evaporated. Furthermore, many areas within the ICPP are impervious and precipitation runs off to drainage ditches. The ditches are unlined and a significant fraction of infiltration is likely to occur along the ditches. Estimates of net recharge from precipitation range from 2.5 to 10.2 cm (1 to 4 in.) (Miller et al., 1990), with 4.1 cm/yr (1.6 in./yr) being considered to be the best estimate for net infiltration to be used at the ICPP. Infiltration may actually be greater due to the impervious areas, drainage ditches, and infiltration ponds used to collect runoff. Using a net infiltration rate of 4.1 cm/yr (1.6 in./yr) and assuming the recharge area for the entire ICPP to be approximately 184 acres provides an estimate of 30M L (8M gal) of water available for recharge from natural precipitation. For the northern perched water bodies, approximately 14.3M L (3.8M gal) of recharge is available due to precipitation using an area of 87 acres. Approximately 15M gal/yr are discharged into the infiltration galleries of the new sewage treatment plant in the northeastern corner of the facility. Finally, the largest source of recharge to the southern portion of the facility is due to approximately 690M gal/yr of service waste water discharge to the 2 service waste percolation ponds.

A summary of the amount of water available to recharge the perched water bodies at the ICPP is provided in Table 2-7. Historically, approximately 2.73 billion L/yr (720M gal/yr) are known to be providing recharge at the ICPP. This does not include an additional 145M L (38.4M gal) that could be leaking through the facility piping and go undetected by the current metering system.

Table 2-7. Estimated volume of water recharging the perched water bodies at ICPP.

Source	Northern ICPP Volume (gal/yr)	Northern ICPP Percent	Facility-wide Volume (gal/yr)	Facility-wide Percent
Service wastewater	None	0	690,000,000	95.8
Sewage treatment ponds	15,000,000	58	15,000,000	2.1
Water system leaks[a]	3,980,000	16	3,980,000	0.6
Landscape irrigation[a]	1,568,000	6	1,568,000	0.2
Precipitation infiltration	3,800,000	15	8,000,000	1.1
Steam condensate	1,300,000	5	1,700,000	0.2
CPP-603 Basins	None 0.00	0.0	49,275	<0.1
Total	25,648,000	100	720,297,275	100

a. Estimate based on past leaks and irrigation practices. Actual loss from piping leaks is unknown.

2.4 Geology

The following geologic description is summarized from *Lithology and Stratigraphy at the Idaho Chemical Processing Plant* [Attachment 2 of LITCO (1995)]. This technical memorandum includes the data used for the interpretation, an explanation of interpretive methods, and lithologic descriptions of each geologic unit.

2.4.1 Regional Geology

The INEEL is located in south-central Idaho on the Snake River Plain. The Snake River Plain is commonly divided into two regions: a western region, which is a northwest trending depositional basin, and an eastern region, which is a northeast trending volcanic plain (Malde, 1991). The INEEL is located in the eastern region of the Snake River Plain. This volcanic plain is comprised of approximately 914 m (3,000 ft) of layered late Cenozoic basalt flows over a rhyolitic basement that is approximately 3,048 m (10,000 ft) deep (Malde, 1991).

The ESRP is approximately 322-km (200-mi) long and ranges between 80 and 113 km (50 and 70 mi) in width (Anderson, 1991). It is bounded on the west by the north flowing reach of the Snake River through the Hagerman Valley and on the east by the Island Park rhyolite deposits. The northern and southern boundaries consist of the basin and range mountains of south central Idaho (Malde, 1991).

2.4.1.1 Origin of the Snake River Plain Volcanics. The crustal structure of the Snake River Plain volcanics, although not completely understood, is believed to include the entire thickness of the crust (Malde, 1991). It is believed the crust beneath the plain was modified by a hotspot (Malde, 1991). This theory is supported by numerous geophysical studies (Malde, 1991).

The geophysical studies suggest the crust beneath the plain is approximately 3.1-km (1.9-mi) thick as opposed to the crust surrounding the plain, which is approximately 20.0 km (12.4-mi) thick (Malde, 1991). There is geophysical evidence that a shallow source of heat exists at approximately 12.1 km (7.5 mi) below the surface (Malde, 1991). Heat flow measurements and volcanic activity suggest either the hotspot has progressed in a northeast direction or the crust has moved in a southwest direction resulting in the hotspot being presently associated with Yellowstone National Park (Malde, 1991). The absence of Paleozoic rocks within the ESRP is explained by Malde (1991), who suggests the hotspot produced mafic intrusions causing the granitic crust to melt from below, which resulted in a thinning of the crust and the formation of silicic magma bodies. These silicic magma bodies would have resulted in the formation of granitic batholiths, which would effectively displace any Paleozoic rock, leaving only the silicic magma and the underlying mafic intrusion as the only source materials for the formation of the ESRP. As the silicic magma erupted to the surface, the rhyolitic rocks found beneath the basalt were deposited. The violent silicic eruptions would have opened passage ways for the mafic magma to move through, eventually resulting in the basalt flows that now make up the ESRP.

2.4.1.2 Basalt Flow Structure. Greeley (1982) proposed the term "basalt plain" to describe the basaltic region of the ESRP. According to Greeley, a basalt plain combines elements of shield volcanoes and flood basalt plateaus.

The ESRP is composed of multiple thin flows erupted from vents aligned on volcanic rift zones. Two types of basalt are commonly erupted on the ESRP: a form known as *pahoehoe*, which is a very fluid, low-viscosity magma that produces thin tongues and lobes, and *aa*, which is a high-viscosity magma that results in blocky angular flows. A third "hybrid" type of basalt is also found among the lava flows of the ESRP. It is suggested it was formed by magma interacting with crustal rocks at depths of about 31 km (19 mi) (Malde, 1991).

As suggested by Greeley (1982), pahoehoe is the dominant type of basalt that erupted on the Snake River Plain, which forms the long, low angle flanks of the low shield volcanoes. The eruption of an aa lava produces the higher angle slopes surrounding the vents. As the eruption of the basalt continued over time, several low shield volcanoes formed, their flanks overlapping, to produce the complex stratigraphy found within the Snake River Plain.

2.4.1.3 Flows, Flow Units, Flow Groups. A lava flow is generally defined as a solidified body of rock that has been extruded out horizontally across the earth's surface from a fissure or vent. A lava flow may be described as a flow, which refers to the overall body of rock; a lava flow may also be described as a flow unit that is defined as a separate distinct lobe that issues out from a flow, or a lava flow may be described as a flow group, which is a sequence of petrographically similar flows that erupted from the same magma chamber (Anderson and Lewis, 1989). Between lava flows there is a contact that represents a cooling surface between flows. The cooling surface is typically marked by an increase in the number of vesicles and fractures in the rock as well as a significant amount of oxidation. There may also be a layer of sediments between flows. Commonly these sediments are referred to as interbeds.

The sediment or interbed sources may be other volcanic activity or alluvial, lacustrine, and eolian types of sediments. The sediment thickness depends on the location of the deposition, time between eruptions, and type of sediments.

2.4.1.4 Volcanic Features Near the INEEL. Several volcanic features exist on the Snake River Plain in the vicinity of the INEEL; these features make up a series of volcanic rift zones. To the west of the INEEL is the Arco Volcanic Rift Zone, to the south is an arc of volcanic vents and rhyolitic domes, the largest of which is Big Southern Butte, which is dated at about 300,000 years ago (Spear and King, 1982). This arc of volcanic features is called the Axial Volcanic Zone. To the east of the INEEL is the Hells Half Acre Rift Zone, which trends northwest to southeast. These volcanic zones are thought to be the sources of much of the basalt that has flowed out onto the Snake River Plain.

2.4.1.5 Surficial Sediments. A summary of Kuntz et al. (1990) of the surficial sediments deposited on the surface of the Snake River Plain follows:

> "The surficial sediments deposited on the surface of the plain in the vicinity of the INEEL are composed of alluvial, lacustrine, and eolian deposits. During the Pleistocene times, streams originating in the mountains north of the plain carried large volumes of sediments and deposited them in the mouths of the stream valleys as huge alluvial fans. Some sediments were carried out into the basins below the mountain ranges to form broad gravel plains. In addition to the sediments deposited by the regular workings of the mountain streams, some sediments were distributed through large floods that moved across the plain. There was also a large lake that formed during the Pleistocene time that covered much of the northeast portion of the INEEL. The lake has been named Lake Terreton. Sediment was also carried out over the plain by strong winds which deposited fine grained sands and silts."

2.4.2 Subsurface Geology of the ICPP

The subsurface of the ICPP has been extensively drilled and sampled by the USGS in an effort to understand and monitor the movement of groundwater and contaminants beneath the ICPP. The geologic data acquired during the drilling of the wells at the ICPP were used to make the geologic interpretation of the subsurface at the ICPP.

To date, 41 wells have been drilled at and around the ICPP to depths that exceed the upper limits of the SRPA (36 USGS monitoring wells, four production wells, and ICPP monitoring well); 32 wells have been drilled and are completed in the various perched water bodies beneath the ICPP; and numerous holes have been drilled at the ICPP in the surficial sediments to the top of the basalt. Two of the deep aquifer wells and 11 of the shallow perched wells were cored. A significant number of the wells completed in the perched groundwater and SRPA have geophysical logs including natural-gamma, neutron, gamma-gamma, and caliper. In addition, borehole video logs are available for each well. Figure 2-7 is a map of the ICPP showing well locations.

The subsurface geologic interpretation is divided into a section in which the lithology of the basalt flows is discussed and a section in which the basalt flow stratigraphy is discussed. The reason the geologic interpretation is being presented in this manner is because the complex lithology (i.e., fracturing, vesicles, and weathering surfaces) is not continuous within a single flow unit and, therefore, the lithology cannot be correlated between boreholes. However, the stratigraphic relationship of the basalt flows can be correlated

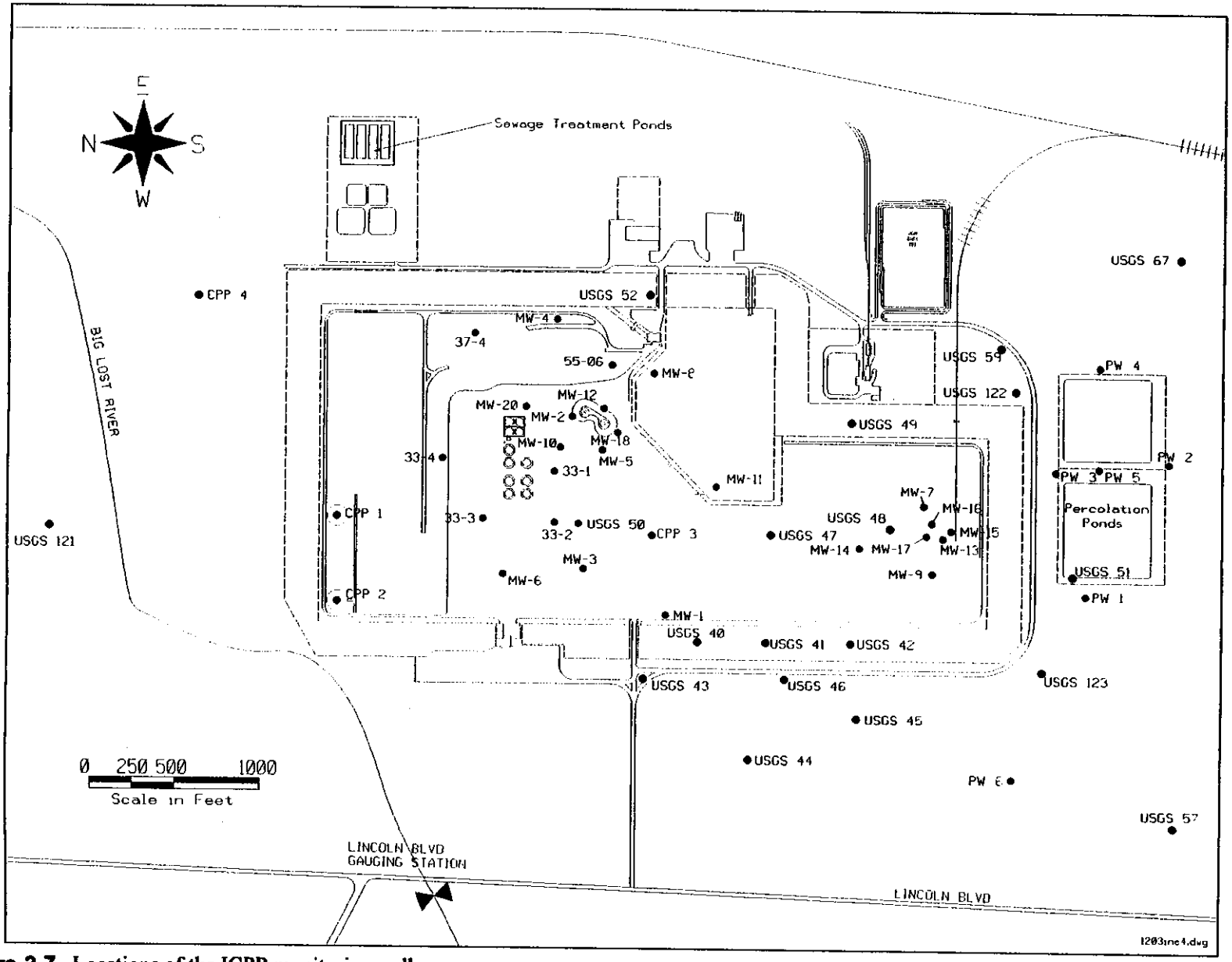


Figure 2-7. Locations of the ICPP monitoring wells.

between boreholes using the stratigraphic position of the flows as indicated by similar geophysical responses measured within the boreholes. This correlation is difficult due to the high degree of similarity between basalt flows.

2.4.2.1 Lithology. Figure 2-8 is a generalized lithologic column showing the basalt flows and sedimentary interbeds beneath the ICPP and the geophysical response associated with each different geologic material as determined by careful examination of core from the ICPP.

The generalized lithologic column (Figure 2-8) shows three typical lithologic sequences found in basalt flows beneath the ICPP. The upper portion of the column indicates a massive dry basalt grading downward into a moist vesicular basalt. The base of the flow rests on a saturated layer of sediments. The sediments cover a weathered fractured vesicular basalt in which the vesicles and fractures have been filled to some extent with sediments from above. A set of horizontal sediment-filled fractures are shown below the upper weathered zone. These horizontal fractures overlay a dry massive basalt, which grades into a saturated basalt vesicular basalt. The bottom of this flow unit overlies a tight, moist sediment layer. The sediments then overlay a moist to dry layer of vesicular fractured basalt, which grades to a massive dry basalt. Below the massive basalt is a basalt vesicular zone followed by a fractured weathered vesicular zone. This is typical of a contact between two flows in which there are no sediments present. There may be some measurable amount of moisture due to the fracturing and vesicular nature of the basalt near the edge of flows. The basalt then grades to a massive dry basalt.

The geophysical logs provided on the generalized column show typical responses to the different lithologies. The gamma log shows a typical low gamma radiation count for the massive portions of the basalt with increasing gamma counts related to zones of increased sediment percentages. The largest gamma counts correspond to those portions of the lithologic column that are entirely sediment. The sediment-filled horizontal fracture produces a small gamma anomaly. The actual gamma count from the sediment may be equal to that of the thicker sediment layer above, but because the fracture is very small, the radiation is attenuated causing a smaller response.

The neutron log indicates a response to moisture in the formation. The dry basalt causes very limited neutron thermalization and, therefore, the neutron count for these zones is much higher than the zones where moisture is present. Zones of either limited porosity or moisture tend to produce a moderate number of neutron collisions, thereby causing the neutron count to decrease slightly. Saturated zones produce the most neutron collisions, which is reflected by the low neutron counts.

The generalized natural-gamma and neutron logs show perching units versus nonperching units and zones where groundwater occurs. A perching unit will have a neutron low above it and exhibit a neutron high. If the perching layer is composed of sediments, there will be a natural-gamma anomaly associated with it. Fractures and other zones of water are indicated by low neutron counts.

2.4.2.2 Lithology of Corehole USGS-121. The lithologic column for Corehole USGS-121 was selected to show the lithology from the ground surface to the SRPA. This corehole penetrates lithology that is typical of the ICPP subsurface, however, the lithology may vary significantly between boreholes at the ICPP.

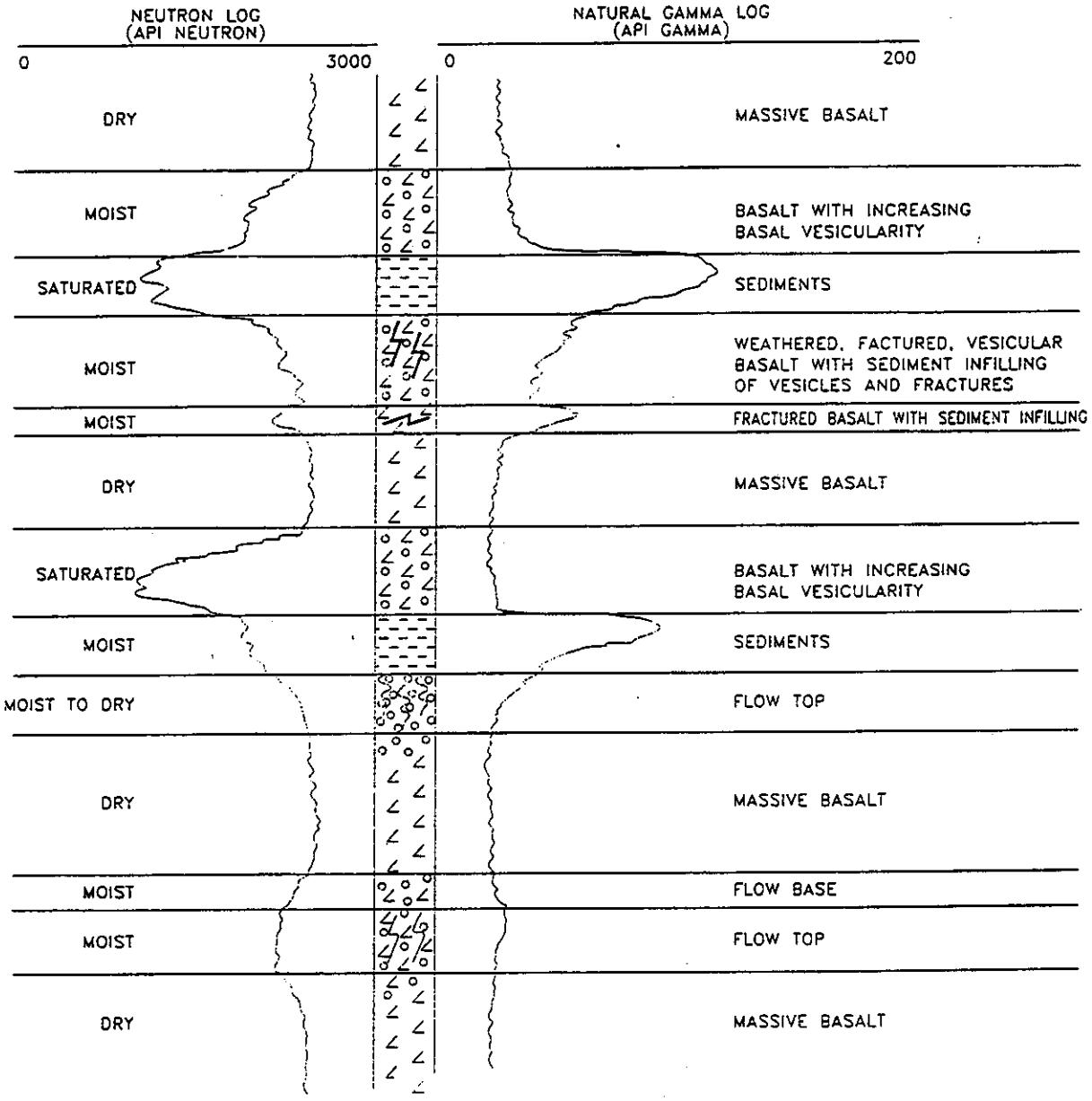


Figure 2-8. Generalized lithologic column and associated geophysical response.

Corehole USGS-121 is located north of the ICPP (Figure 2-7); the total depth of the corehole is 227 m (745.8 ft) below ground surface (bgs). The corehole was drilled in 1989 and 1990 as a monitoring well. Static water level in the SRPA is approximately 139 m (455 ft) bgs. The hole was overreamed to 30.18 cm (11.88 in.) and cased to 131.7 m (432 ft) bgs with a 20-cm (8-in.) carbon steel casing. Stainless steel casing was hung from 125.8 to 136 m (412.6 to 449 ft) bgs having 7.9 m (26 ft) of 0.02 slot stainless screen and an additional 1.5 m (5 ft) of stainless steel casing to a depth of 146 m (480 ft) bgs. A silica sand pack was placed from 146 to 148 m (480 to 485 ft) bgs over a Volclay bentonite plug, which was installed from 148 to 151 m (485 to 495 ft) bgs.

Digital natural-gamma and neutron logs were recorded for Corehole USGS-121 in June, 1993 to a depth of 146 m (480 ft) bgs, which is the top of the silica sand pack. Before the 1993 logging effort, the hole was geophysically logged using an analog natural-gamma, neutron, and gamma-gamma logging system in 1989 and again in 1990. For the lithologic evaluation of the hole, the digital log recorded in 1993 was used. The effects of well construction and the static water level on the neutron log are seen in the interval from 131 to 140 m (430 to 460 ft) bgs.

A detailed lithologic column for Corehole USGS-121 was derived from the core log description and geophysical logs contained in Attachment 2 of LITCO (1995). Top and bottom depths of the lithologic units and descriptions of the lithologic units are also provided in LITCO (1995). Significant lithologic sequences penetrated by Corehole USGS-121 are described as follows:

- The base of the surficial sediments at 10.4 m (34 ft) bgs are indicated by a sharp decrease in the natural gamma count. The neutron log does not show a significant change until the basalt becomes more competent and less fractured and/or vesicular. This delay in the neutron log response was confirmed by inspection of the core.

- A basalt sequence of an unusually high natural gamma radiation is found between 35.4 and 39.6 m (116 and 130 ft) bgs. This was confirmed as a basalt from inspection of the core. It appears to be a single unit with a thin sediment layer above and below, as indicated by the neutron log. The neutron log shows a significant decrease between 34.7 and 35.4 m (114 and 116 ft) bgs and again at 39.6 and 40.5 m (130 and 133 ft) bgs. Core loss in these zones prevented a detailed description of the materials from these intervals, but silty sediments were found on the core above and below these intervals.

- Moist silt is possibly indicated by the natural gamma and neutron logs between 42.7 and 44.2 m (140 and 145 ft) bgs. Inspection of the core from above and below this interval revealed traces of silt, thus supporting the interpretation of the geophysical logs.

- The interval between 79.2 and 85.3 m (260 and 280 ft) bgs is a slightly weathered to fresh dusky red basalt that is highly fractured, as indicated by the neutron log. It overlies a 9.8-m (32-ft) thick interval [85.3 to 95.1 m (280 to 312 ft) bgs] of fresh, minutely vesicular basalt that is relatively unfractured. This interval is characterized by a higher neutron log count than the overlying basalt, while the natural gamma log remains essentially the same. Below this interval is a highly weathered vesicular basalt, which is possibly a pyroclastic flow [97.8 to 98.4 m (321 to 323 ft) bgs]. The neutron log shows a significant decrease in the count rate between 95.7 and 97.5 m (314 and 320 ft) bgs, whereas, the natural gamma log does not show any significant change between this interval and the one above.

- The interval from 122.2 to 125.3 m (401 to 411 ft) bgs is a series of sands, silts, and clays. The sediment descriptions were obtained by inspection of the core. The geophysical responses of the sediments are used to confirm the intervals in which the sediments exist and aid in the identification of the type of sediments.

  The sediments between 122.2 and 122.5 m (401 and 402 ft) bgs are described in the core log as silt with basalt gravel. The natural gamma count is beginning to increase in this interval and the neutron log shows a significant low.

  From 122.5 to 123.4 m (402 to 405 ft) bgs a reddish brown, massive silty clay is described. The natural gamma count has significantly increased from the interval above and the neutron log also increased in this interval, indicating a decrease in the moisture content in these sediments.

  From 123.4 to 124.7 m (405 to 409 ft) bgs there was a significant amount of core loss, but no indication the lithology changed from sediments to basalt. The geophysical data suggest a sand. This is based on the low natural gamma count combined with a decrease in the neutron count indicating the clay mineral content of the sediments decreased and the porosity increased, which is typical of a sand.

  From 124.7 to 125.0 m (409 to 410 ft) bgs a pale yellow brown moist silt is described in the core log. This geologic material type is accompanied by a high natural gamma count and an increase in the neutron count.

  Based on the above observations, it appears water may be perching on the fine clay like sediments from 122.5 to 123.4 m (402 to 405 ft) bgs. The sediments above this zone may contain some water based on the neutron response while the sediments below appear to be relatively dry.

2.4.2.3 Stratigraphy. Several stratigraphic units based on similar lithology and stratigraphic position have been identified beneath the ICPP. A generalized stratigraphic column is presented in LITCO (1995). This figure shows the stratigraphic units and gives a general description of the units. The unit thicknesses provided on the stratigraphic column are average thicknesses from the wells used to make the stratigraphic interpretation. A complete table of the unit thicknesses are provided in *Lithology and Stratigraphy at the Idaho Chemical Processing Plant* [Attachment 2 of LITCO (1995)]. The names given the stratigraphic units are based on the nomenclature used by Anderson (1991). An attempt was made to stratigraphically associate the sediments found between the basalt flows and as a result, the names of the sediment units are based on their stratigraphic association (i.e., "DE2" Basalt and "DE2" Sands).

South-north and west-east cross sections have been prepared from the available data. A complete description of these cross sections is presented in *Lithology and Stratigraphy at the Idaho Chemical Processing Plant* [Attachment 2 of LITCO (1995)]. The cross sections extend from the ground surface [approximately 1,494 m (4,900 ft) above median sea level (amsl)] to 1,341 m (4,400 ft) amsl. The top of the SRPA is approximately 1,356 m (4,450 ft) amsl in the vicinity of the ICPP. Figure 2-9 shows the location of the east-west cross section and the wells used for correlation. The east-west cross section of the ICPP may be found in Section 2.6.1.2.1 of this report, and additional cross sections are provided in Plate 3 of the Final Work Plan. The wells used for the west-east section include USGS-043, MW-001, CPP-03 (Injection Well), MW-018 (the location of MW-018 is approximate; it was not surveyed in at the time of this Work Plan), MW-008, and USGS-052. MW-001, MW-008, and MW-018 were drilled using an air rotary drill rig with a

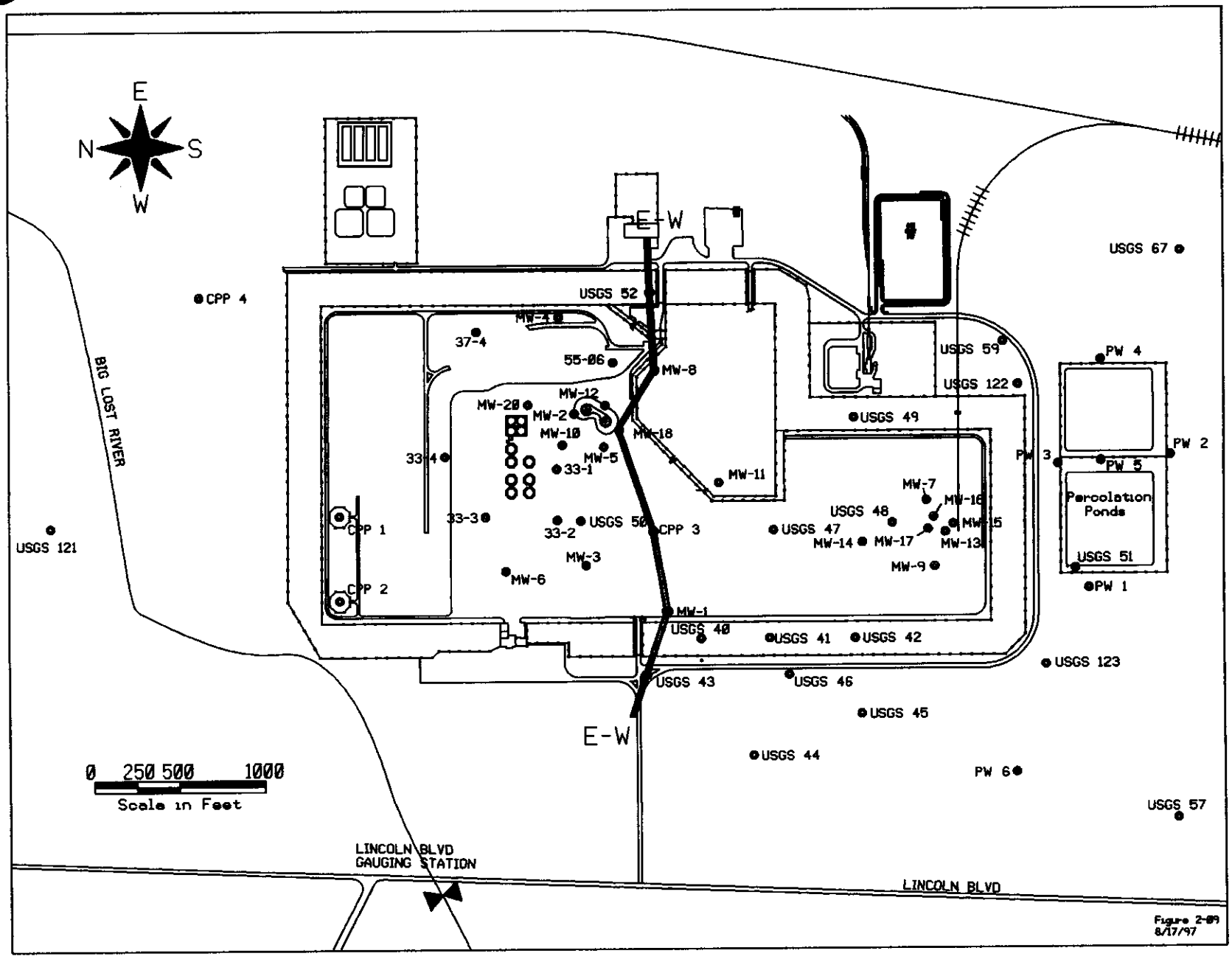


Figure 2-9. Map showing locations of the east-west section lines.

tri-cone bit between 1992 and 1994. The remaining wells were drilled using a cable tool rig in the early 1950s and 1960s.

The USGS wells were drilled as monitoring wells for the SRPA. The MW series of wells were drilled to monitor the perched water zones beneath the ICPP. Well CPP-3 was drilled as a deep injection well for the ICPP (it has since been abandoned), and Well CPP-2 was drilled as a production well for the ICPP water supply.

The stratigraphic relations shown on the cross section depict the typical subsurface stratigraphy beneath the ICPP. The basalt flows are characterized as overlapping lobes of basalt intermixed with larger basalt flows of relatively uniform thickness beneath the ICPP. The sediments found between the basalt flows are often discontinuous and characterized by sequences of sands, silt, and clays. These changes in the sediment lithology are distinguished by the geologist records from drilling and/or the responses of the sediments on the geophysical logs.

The basalt flows, as interpreted, appear to be relatively uniform in thickness beneath the ICPP. Significant changes in the flow thickness are often related to changes in the lithology of the flow or are caused by the flow margins in which the flow appears as a lobe of basalt. The lithologic changes that may cause a change in the flow thickness are the existence of pyroclastic deposits on or within a flow, or a flow being very vesicular, and thus, more susceptible to the effects of erosion.

Stratigraphically significant basalt flows beneath the ICPP include the "CD" flow, "DE3" flow, and "DE4" and "DE5" flows. The "CD" flow appears to be a very hard, nonporous flow that is not continuous over the entire ICPP. This could potentially affect the movement of groundwater in the vadose zone. The "DE3" flow is typically uniform in thickness and appears to be relatively flat lying; it is most likely a porous to semiporous basalt. It provides a lower boundary for the thick sediments associated with the "D" and "DE2" stratigraphic units. The "DE4" and "DE5" basalt flow units are often characterized as massive and unfractured, however, portions of the flows are described as pyroclastic cinder-type deposits in which the basalt is highly vesicular and fractured. The boundary between these flows is not clearly defined; there does not appear to be any major sedimentary units separating these basalt flows.

The sediments, as interpreted, appear to be primarily made up of sands and silts with some small clay lenses. The majority of the sediments are thin [0.3- to 1.5-m (1- to 5-ft) thick] layers of silt between the major basalt flows. Sediments were most likely deposited in eolian or fluvial type environments. Two major sediment sequences are shown on the cross sections: the upper sequence associated with the "CD," the thick "D" and "DE2" sands and silts; and the lower sediments associated with the "DE6," "DE7," and "DE8" stratigraphic units.

The cross sections show a very thick sequence of sediments, particularly in the northern end of the south-north section, which are stratigraphically shown as the "CD", "D," and "DE2" units. These sediments appear to be a thick sequence of sands over and underlain by silts and clays. Structure contour maps of the top of the "CD" and "D" interbeds are provided in Figures 2-10 and 2-11, respectively.

The sediments associated with the "DE6," "DE7," and "DE8"stratigraphic units appear to be made up of gravels, silts, and clays. These sediments were most likely deposited in a fluvial environment and may indicate a braided stream deposit. This is the last major sediment deposit above the SRPA. Structure contour map of the top of the "DE8" interbed is provided in Figure 2-12.

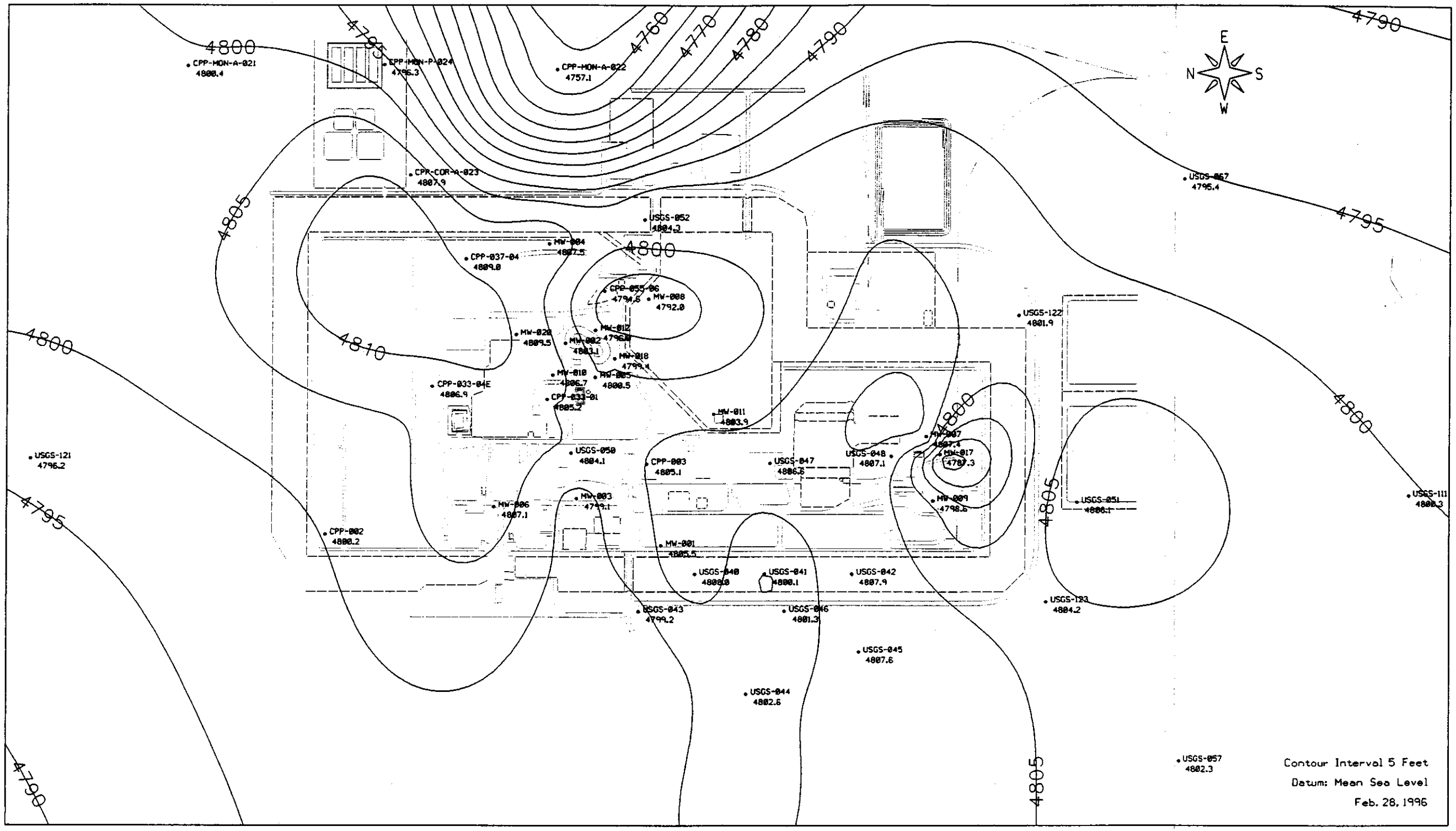


Figure 2-10. Structure contour map of the top of the "CD" interbed.

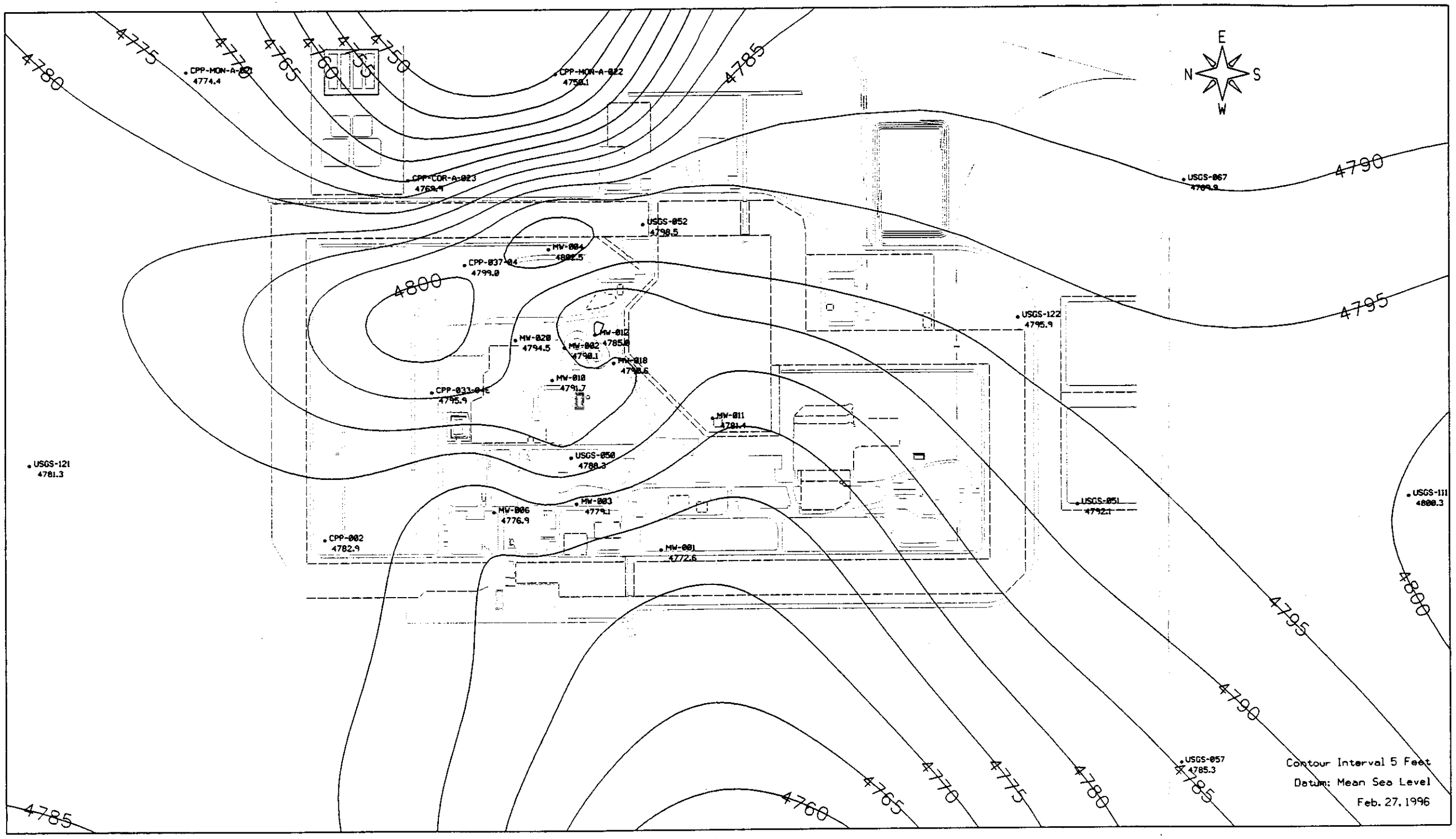


Figure 2-11. Structure contour map of the top of the "D" interbed.

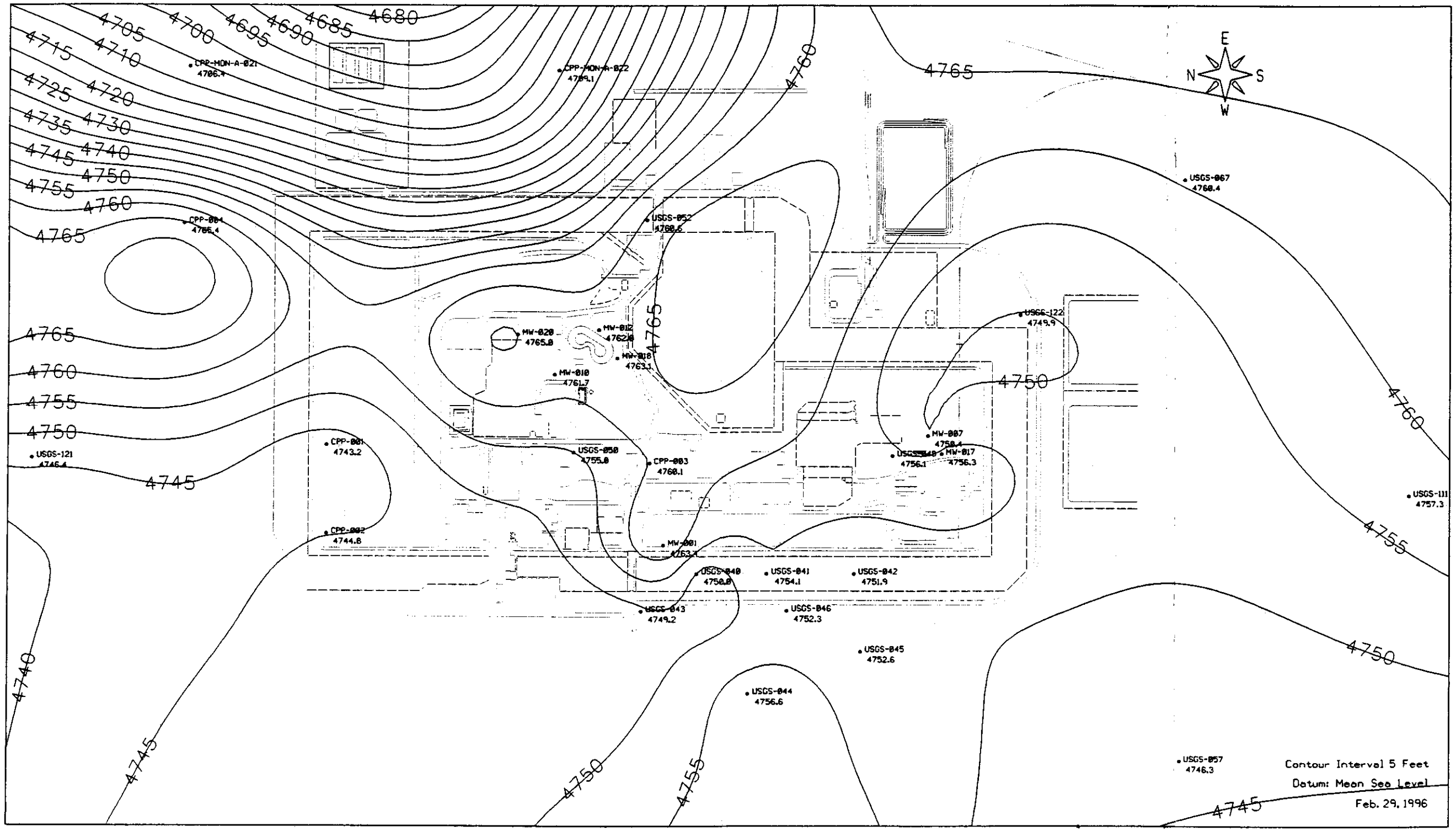


Figure 2-12. Structure contour map of the top of the "DE8" interbed.

2.5 Regional Hydrogeology

The SRPA flows beneath the INEEL and is about 322 km (200 mi) long and 89- to 113-km (55- to 70-mi) wide. It extends from Ashton and the Big Bend Ridge on the northeast to Hagerman on the southwest (Figure 2-13) and covers about 25,900 km^2 (10,000 mi^2). The aquifer consists of a series of basalt flows with interbedded sedimentary deposits and pyroclastic materials. The boundaries are formed by the contacts of the aquifer with less permeable rock at the margins of the plain (Mundorff et al., 1964). Robertson et al. (1974) estimated as much as 2B acre-ft of water may be in storage in the aquifer, of which about 500M acre-ft are recoverable.

Groundwater in the SRPA generally occurs under unconfined conditions, but locally may be quasi-artesian or artesian (Nace et al., 1959). The quasi-artesian or artesian conditions are caused by layers of dense, massive basalt or sediments with relatively low permeability. Nace et al. (1959) described quasi-artesian as the situation in which the groundwater level is first recognized in a borehole during drilling at a depth below the regional water table, and then the level rises significantly [1.5 to 15.2 m (5 to 50 ft)] to the level of the water table. This rise of the water level simulates artesian pressure, but the conditions are not truly artesian. Nace et al. (1959) also noted water levels in some wells in the SRPA respond to fluctuations in barometric pressure similar to wells in confined aquifers, indicating tight zones in the basalt may impede pressure equalization. True artesian or flowing artesian conditions in the SRPA were identified at Rupert, in parts of the Mud Lake Basin, and north of the American Falls Reservoir (Nace et al., 1959).

Recharge to the aquifer is primarily by valley underflow from the mountains to the north and northeast of the plain and from infiltration of irrigation water. A small amount of recharge occurs directly from precipitation. Recharge to the aquifer within INEEL boundaries is primarily by underflow from the northeastern part of the plain and the Big Lost River (Bennett, 1990). Significant amounts of recharge from the Big Lost River have caused water levels in some wells at the INEEL to rise as much as 1.8 m (6 ft) in a few months after high flows in the river (Barraclough et al., 1982). Locally, the direction of groundwater flow is temporarily changed by recharge from the Big Lost River (Bennett, 1990).

Estimates of the effective thickness of the SRPA at the INEEL are variable. A 3,159-m (10,365-ft) deep geothermal test well (INEL-1) was drilled about 7.2-km (4.5-mi) north of the ICPP in 1979. Subsurface geologic information from INEL-1 indicates at least 610 m (2,000 ft) of basalt underlie the INEEL (Prestwich and Bowman, 1980). Hydrological data from INEL-1 were interpreted by Mann (1986) to indicate the effective base of the aquifer is 259 to 372 m (850 to 1,220 ft) bgs. The depth to water at INEL-1 is about 122 m (400 ft) bgs, which suggests an effective aquifer thickness of 137 to 250 m (450 to 820 ft). In earlier studies by Robertson et al. (1974), the effective portion of the SRPA at the Test Reactor Area (TRA) was assumed to be the upper 76 m (250 ft) of the saturated zone based on lithology and water quality. The aquifer's thickness varies at different areas, and the aquifer becomes less productive with depth due to decreasing hydraulic conductivity (Hull, 1989). Hydraulic conductivity of the basalt in the upper 244 m (800 ft) of the aquifer generally is 0.3 to 30.5 m/day (1 to 100 ft/day); whereas, the hydraulic conductivity of underlying rocks is several orders of magnitude smaller (Orr and Cecil, 1991). Fracture filling from sediments and secondary mineralization are the principal reasons for the decreased hydraulic conductivity.

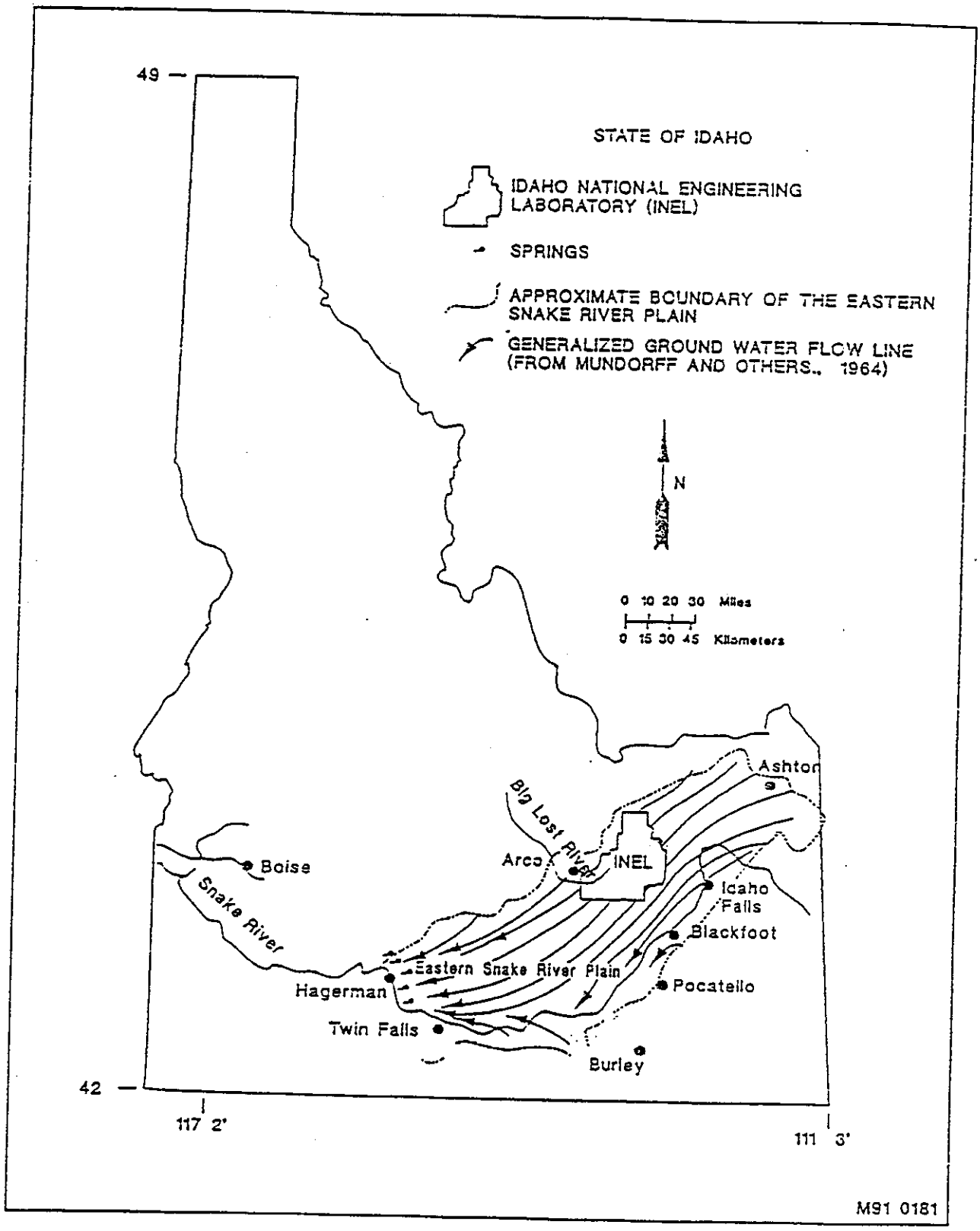


Figure 2-13. Map of Idaho showing location of the INEEL, Snake River Plain, and generalized groundwater flow of the SRPA (Hull, 1989).

Perched groundwater zones occur when downward flow to the aquifer is impeded by fine sediments or dense basalt flows with relatively low permeability. At the INEEL, perched groundwater has been documented beneath the Big Lost River system, and at the NRF, TRA, and ICPP (Morris et al., 1965; Robertson et al. 1974; and Pittman et al., 1988). The occurrence of perched groundwater at the ICPP will be discussed later in this section.

2.5.1 Depth to Water and Groundwater Flow

The water table contour map shows the configuration of the water table and general lateral direction of groundwater flow across the INEEL in July, 1988 (Figure 2-14). The water level elevations ranged from 1,399 m (4,590 ft) amsl in the northern part of the INEEL to about 1,347 m (4,420 ft) amsl south of the INEEL; the depth to the water table varied from about 61.0 m (200 ft) bgs in the northern part of the INEEL to about 274-m (900-ft) bgs in the southern part. The general direction of groundwater flow was to the south-southwest, and the average gradient was about 0.8 m/km (4 ft/mi) (Orr and Cecil, 1991). Locally, however, the hydraulic gradient varies significantly and ranges from about 0.2 m/km (1 ft/mi) in the northern part of the INEEL to a maximum of 2.8 m/km (15 ft/mi).

The elevation of the water table and direction of groundwater flow are affected by recharge and groundwater withdrawal. From July 1985 to July 1988, Orr and Cecil (1991) reported water level changes in INEEL wells ranging from a 7.9-m (26-ft) decline near the RWMC to a 1.2-m (4-ft) rise north of TAN. Water levels generally declined in the southern two-thirds of the INEEL during that time and rose in the northern one-third.

The Big Lost River flows intermittently on the INEEL. When flowing, the water infiltrates from the river and percolates downward toward the SRPA. Layers of sediment and massive basalt in the vadose zone having relatively low permeability may impede the downward percolation of water and sometimes form perched water bodies beneath the river. A hydrograph of Well USGS-78 located west of the ICPP and corresponding discharge measurements from the Big Lost River at the Lincoln Boulevard Bridge near the ICPP are shown in Figure 2-15. Well USGS-78 is 71.6 m (235 ft) from the river and 61.9 m (203 ft) deep, and is completed approximately 79.2 m (260 ft) above the SRPA.

The water level in Well USGS-78 begins an abrupt rise about 4½ days after flow starts in the Big Lost River. The water level may rise as much as 30.5 m (100 ft) within a few months. The water level in the well is very sensitive to river stage, and as stream flow declines or ceases, the perched water level declines abruptly. Declines of 18.3 to 27.4 m (60 to 90 ft) have been measured within 3 or 4 months (Barraclough and Jensen, 1976). Well USGS-78 is an open borehole from 20.1 to 61.9 m (66- to 203-ft) bgs, and as a result, the transmissive zone cannot be determined to provide an estimate for the vertical flow velocity. The horizontal groundwater velocity from the Big Lost River to Well USGS-78 appears to be as high as 0.9 m/hr (3 ft/hr).

2.5.2 Aquifer Properties

Aquifer permeability is controlled primarily by fractures, fissures, and voids along the upper and lower contacts of basalt flows, interstitial large voids, and intergranular pore spaces. Vesicles contribute little to permeability because most are isolated and do not transmit much water. Locally, the direction of groundwater flow may vary due to the variability of the hydraulic characteristics of the aquifer within a small area.

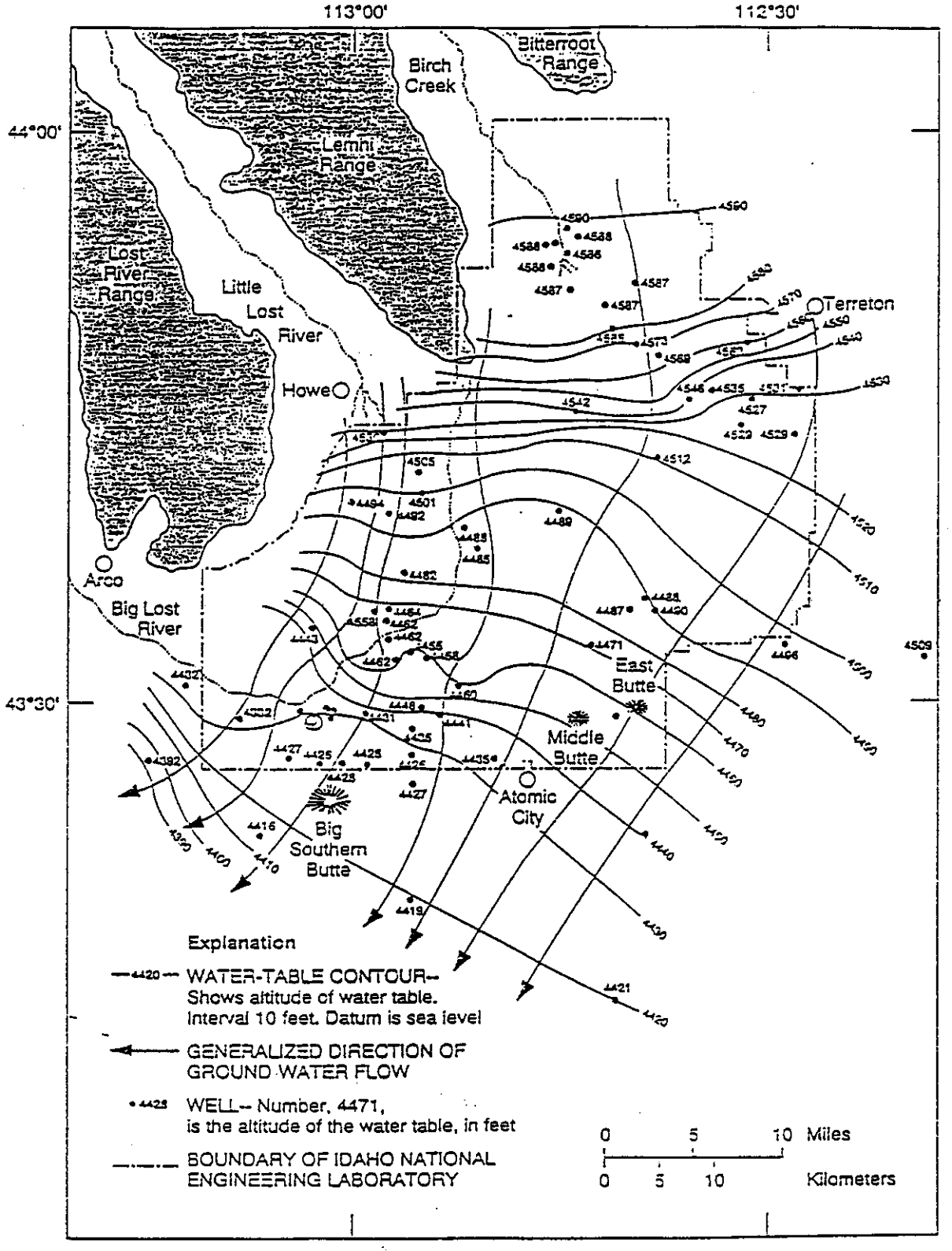


Figure 2-14. Water table elevation and generalized direction of groundwater flow for the SRPA, July 1988 (Orr and Cecil, 1991).

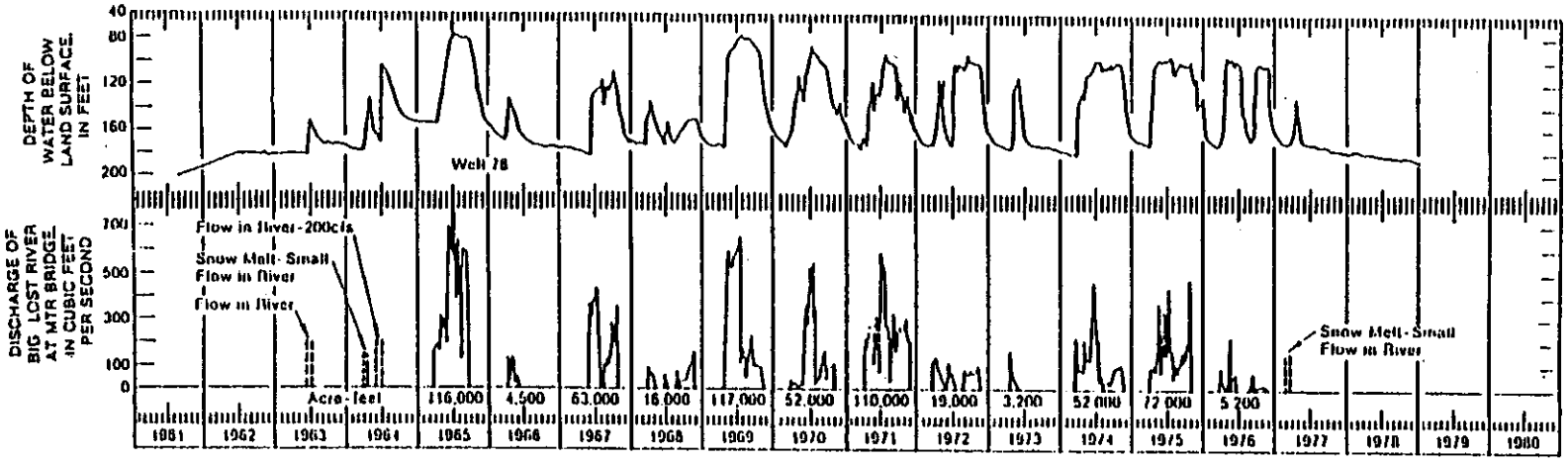


Figure 2-15. USGS-78 water level response vs. Big Lost River discharge at Lincoln Boulevard (Barraclough et al., 1982).

Hydraulic properties of the SRPA have been determined by pumping tests. According to Robertson et al. (1974), transmissivities range from 1.24×10^4 to 1.24×10^6 m^2/day (1.34×10^5 to 1.3×10^7 ft^2/day) with 6.2×10^4 m^2/day (6.7×10^5 ft^2/day) considered normal. Table 2-8 summarizes transmissivity and storage coefficients calculated from tests conducted at the INEEL. Transmissivities range from 3.7×10^2 to 2.2×10^4 m^2/day (4.0×10^4 to 2.4×10^6 ft^2/day), with the lowest at TAN and highest at TRA. By calculating the geometric mean of transmissivity values, Hull (1989) estimated regional aquifer transmissivity for the southern INEEL to be 27,000 m^2/day (294,000 ft^2/day). Estimates of the storage coefficients range from 0.01 to 0.06 and effective porosity from 5 to 15%, with 10% being historically the most accepted value (Robertson et al., 1974), though more recent information indicates that a lower value may be appropriate.

2.6 ICPP Hydrogeology

Sixty-eight wells have been installed at the ICPP to monitor perched water bodies and the SRPA. This monitoring well network consists of 32 wells completed in the perched water zones and 36 wells completed in the SRPA. Several of the perched water monitoring wells are completed in multiple water bearing zones. The location of the wells completed in the perched water zones are shown in Figure 2-16, with the construction specifications provided in Table 2-9.

2.6.1 Perched Water Zones

The uppermost perched water zone identified at the ICPP occurred within the Big Lost River alluvium above the basalt. This shallow perched water was first investigated near the fuel element cutting and storage facility (CPP-603) in the early 1960's. The perched water was primarily attributed to the discharges of wastewater to the shallow seepage pit (CPP-2) located on the west side of the building. This shallow perched water body was investigated by installing 27 observation wells in the alluvium above the basalt. A small zone of perched water was encountered at a depth of 6.7-m (22-ft) bgs, and a larger zone was encountered directly on the basalt surface at a depth of 9.8-m (32-ft) bgs. This perched water body has not been monitored since 1970 and is believed to have dissipated since the construction of the Irradiated Fuel Storage Facility (IFSF) on the western portion of CPP-603 over the seepage pit in the early 1970's. Other than the shallow perched water bodies beneath surface discharge ponds, no other extensive alluvial perched water bodies have been identified at the ICPP.

The upper basalt perched water zone was initially discovered in the late 1950s where Wells USGS-50 and USGS-52 encountered perched water at 38.4 and 53.0 m (126 and 174 ft) bgs, respectively. The occurrence of this perched water was attributed to operational practices based on the presence of radioactive and chemical contaminants. Since then, numerous monitoring wells have been installed in the upper perched water zone to identify the source of recharge, delineate the perched water bodies, and determine the nature and extent of contamination. A discussion of this perched water zone is provided in Section 2.6.1.2.

A lower perched water zone was also identified in the basalt at depths between 104 and 122 m (340 and 400 ft) bgs (Robertson et al., 1974). This water was first discovered in 1956 while drilling Well USGS-40 where perched water was encountered at a depth of 106 m (348 ft). An analysis of this perched water

Table 2-8. Results of aquifer tests conducted to determine transmissivity and storage properties of the SRPA (Walton, 1958 and Walker, 1960).

Well number	Test date	Transmissivity (ft^2/day)	Storage coefficient	Penetration of well below water table (ft)
CFA-2	27-FEB-51	2.1×10^4	—	209
TRA-1	22-JUL-57	1.9×10^6	0.02	114
MTR-TEST	07-JUN-57	2.4×10^6	0.06	134
Fire Station Well	03-NOV-58	4.1×10^5	—	96
SPERT	11-JAN-56	1.6×10^4	—	196
GCRE	20-MAY-59	3.9×10^5	—	747
4N 30E 7ad	29-AUG-50	2.3×10^5	—	367
CPP-1	11-NOV-51	4.4×10^5	0.06	136
STR-1	17-NOV-50	2.0×10^5	—	172
NRF-1	12-NOV-53	1.1×10^4	0.03	157
STR-2	03-AUG-50	4.9×10^5	—	163
NRF-2	19-FEB-57	5.7×10^5	—	
ALW	24-AUG-56	1.5×10^5	—	180
NRF-3	25-MAR-57	6.4×10^4	—	
ANP-1	16-APR-53	9.4×10^4	0.01	157
ANP-2	30-APR-53	1.3×10^4	—	133
ANP-3	20-JUL-53	8.6×10^4	—	112
FET Prod 1	17-APR-58	4.4×10^4	—	139
FET Prod 2	03-MAY-58	9.1×10^4	—	259
LPTF Disposal	20-JUN-57	4.0×10^3	—	109

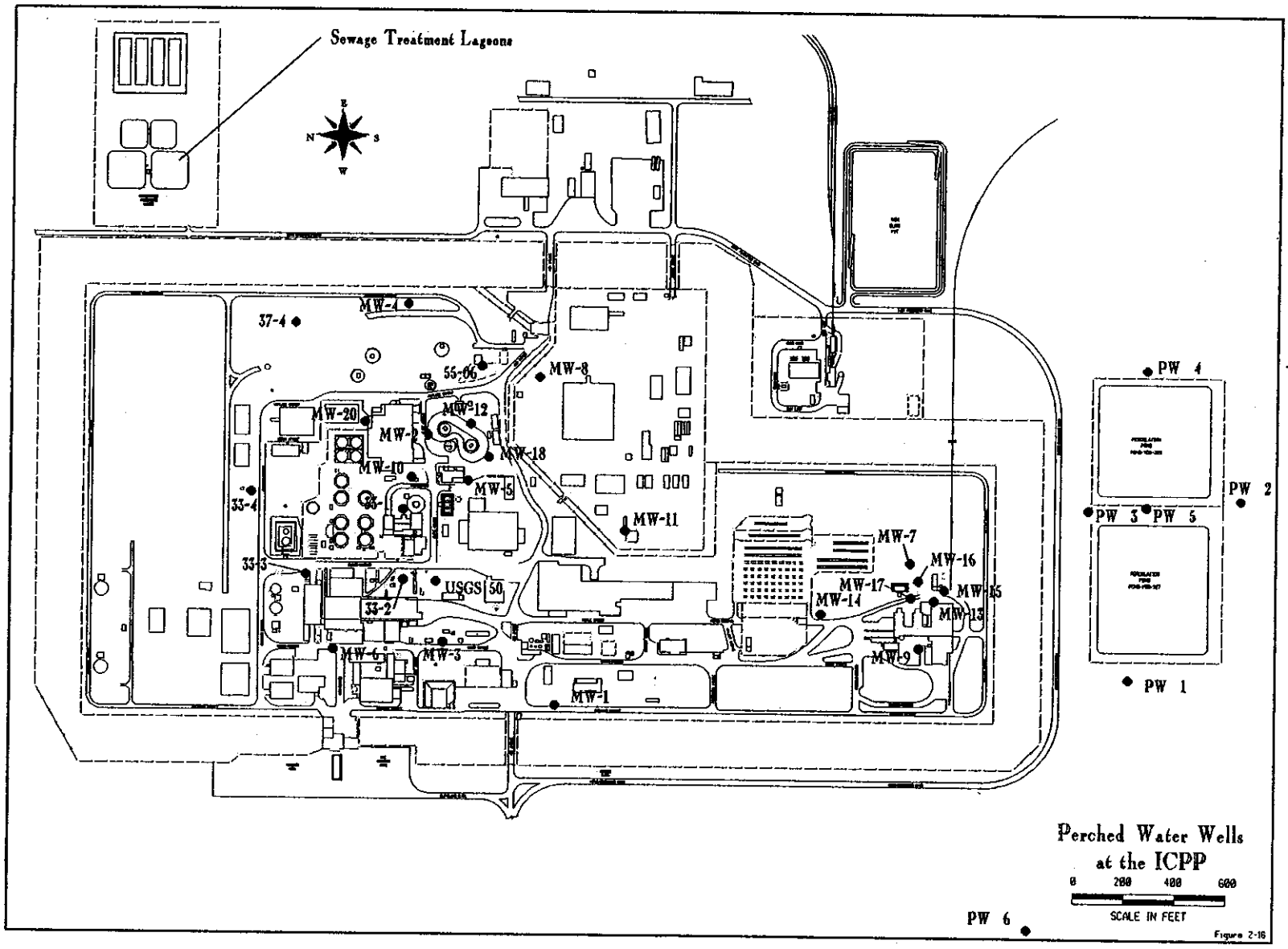


Figure 2-16. Locations of the perched water wells as the ICPP.

Table 2-9. Specifications of the perched water wells.

Well	Type	Northing	Easting	Land Surface Elevation	Measuring Point Elevation	Total Depth Drilled Footage	Total Depth Drilled Elevation	Well Screen (footage) Top	Well Screen (footage) Bottom	Well Screen (elevation) Top	Well Screen (elevation) Bottom
CPP 33-1	2-in. SS Well	695392	296939	4915.2	4917.38	113.6	4801.6	89.0	99.0	4826.2	4816.2
CPP 33-2	2-in. SS Well	695385	296639	4914.2	4915.42	114.7	4799.5	85.8	105.8	4828.4	4808.4
CPP 33-3	2-in. SS Well	695806	296659	4913.7	4916.23	126.4	4787.3	111.8	121.8	4801.9	4791.9
CPP 33-4	2-in. SS Well	696049	297011	4911.9	4914.01	124.0	4787.9	98.2	118.2	4813.7	4793.7
CPP 37-4	2-in. SS Well	695861	297743	4911.0	4912.66	129.3	4781.7	99.9	109.9	4811.1	4801.1
CPP 55-06	2-in. SS Well	695057	297563	4911.6	4913.21	122.9	4788.7	93.1	113.1	4818.5	4798.5
PW-1	6-in. Steel Well	692270	296234	4917.8	4919.13	120.0	4797.8	100.0	120.0	4817.8	4797.8
PW-2	6-in. Steel Well	691791	297010	4917.0	4918.54	131.0	4786.0	111.0	131.0	4806.0	4786.0
PW-3	6-in. Steel Well	692447	296961	4916.7	4918.12	123.0	4793.7	103.0	123.0	4813.7	4793.7
PW-4	6-in. Steel Well	692197	297572	4914.8	4916.30	150.0	4764.8	110.0	150.0	4804.8	4764.8
PW-5	6-in. Steel Well	692196	296978	4916.4	4918.40	131.0	4785.4	109.0	129.0	4807.4	4787.4
PW-6	6-in. Steel Well	692696	295150	4920.5	4922.34	135.0	4785.5	105.0	125.0	4815.5	4795.5
MW-1	4-in. PVC Well	694731	296099	4916.5	4919.25	395.0	4521.5	326.0	336.0	4590.5	4580.5
MW-1	1-in. PVC Piezo.	694731	296099	4916.5	4919.00	395.0	4521.5	359.0	369.0	4557.5	4547.5
MW-2	2-in. PVC Well	695285	297262	4913.1	4916.09	127.0	4786.1	102.0	112.0	4811.1	4801.1
MW-3	2-in. PVC Well	695215	296369	4916.0	4918.50	151.3	4764.7	128.0	138.0	4788.0	4778.0
MW-3	1-in. PVC Piezo.	695215	296369	4916.0	4918.50	151.3	4764.7	116.3	118.0	4799.7	4798.0
MW-4	2-in. PVC Well	695376	297828	4911.4	4914.21	131.0	4780.4	100.6	110.6	4810.8	4800.8
MW-4	1-in. PVC Piezo.	695376	297828	4911.4	4913.77	131.0	4780.4	128.0	129.7	4783.4	4781.7
MW-5	2-in. PVC Well	695110	297064	4916.4	4919.27	141.0	4775.4	106.5	126.5	4809.9	4789.9
MW-6	2-in. PVC Well	695690	296320	4916.5	4919.26	161.0	4755.5	117.0	137.0	4799.5	4779.5
MW-7	2-in. PVC Well	693209	296726	4917.4	4920.13	177.0	4740.4	132.0	142.0	4785.4	4775.4
MW-7	1-in. PVC Piezo.	693209	296726	4917.4	4920.13	177.0	4740.4	102.3	104.0	4815.1	4813.4
MW-8	2-in. PVC Well	694806	297514	4911.7	4914.37	141.0	4770.7	115.0	125.0	4796.7	4786.7
MW-9	2-in. PVC Well	693168	296357	4919.6	4922.33	158.0	4761.6	120.0	130.0	4799.6	4789.6
MW-9	1-in. PVC Piezo.	693168	296357	4919.6	4922.33	158.0	4761.6	104.2	105.7	4815.4	4813.9
MW-10	2-in. PVC Well	695356	297078	4914.7	4917.41	181.0	4733.7	141.0	151.0	4773.7	4763.7
MW-10	1-in. PVC Piezo.	695356	297078	4914.7	4917.41	181.0	4733.7	76.5	78.0	4838.2	4836.7
MW-11	2-in. PVC Well	694435	296854	4914.9	4917.72	150.5	4764.4	131.0	136.0	4783.9	4778.9
MW-11	1-in. PVC Piezo.	694435	296854	4914.9	4917.72	150.5	4764.4	112.0	113.5	4802.9	4801.4
MW-12	2-in. PVC Well	695107	297336	4913.0	4915.99	153.0	4760.0	109.0	119.0	4804.0	4794.0
MW-12	1-in. PVC Piezo.	695107	297336	4913.0	4915.99	153.0	4760.0	148.6	150.3	4764.4	4762.7

Table 2-9. (continued).

Well	Type	Northing	Easting	Land Surface Elevation	Measuring Point Elevation	Total Depth Drilled Footage	Total Depth Drilled Elevation	Well Screen (footage) Top	Well Screen (footage) Bottom	Well Screen (elevation) Top	Well Screen (elevation) Bottom
MW-13	2-in. PVC Well	693106	296561	4919.9	4921.99	128.0	4791.9	100.0	105.0	4819.9	4814.9
MW-14	2-in. PVC Well	693594	296503	4919.1	4921.60	138.0	4781.1	94.0	104.0	4825.1	4815.1
MW-15	2-in. PVC Well	693059	296608	4918.9	4921.25	143.0	4775.9	111.3	131.3	4807.6	4787.6
MW-16	2-in. PVC Well	693173	296648	4919.1	4921.65	126.0	4793.1	97.0	107.0	4822.1	4812.1
MW-17	2-in. PVC Well	693129	296622	4918.3	4921.11	381.0	4537.3	181.7	191.7	4736.6	4726.6
MW-17	1-in. PVC Piezo.	693129	296622	4918.3	4921.11	381.0	4537.3	263.8	273.8	4654.5	4644.5
MW-17	4-in. Steel Well	693129	296622	4918.3	4921.11	381.0	4537.3	360.0	381.0	4558.3	4537.3
MW-18	2-in. PVC Well	695020	297193	4914.0	4917.32	494.0	4420.0	113.5	123.5	4800.5	4790.5
MW-18	1-in. PVC Well	695020	297193	4914.0	4917.33	494.0	4420.0	394.0	414.0	4520.0	4500.0
MW-18	4-in. PVC Well	695020	297193	4914.0	4917.31	494.0	4420.0	458.5	478.5	4455.5	4435.5
MW-20	2-in. PVC Well	695568	297309	4915.0	4918.00	151.5	4763.5	133.2	148.4	4781.8	4766.6
MW-20	1-in. PVC Piezo.	695568	297309	4915.0	4918.00	151.5	4763.5	96.0	106.0	4819.0	4809.0
USGS-50	4-in. Steel Well	695247	296633	4913.5	4918.31	405.0	4508.5	356.0	405.0	4557.5	4508.5

Notes: SS = stainless steel
Piezo. = piezometer.

detected abnormally high total dissolved solids (303 mg/L), sodium (25 mg/L), and chloride (81 mg/L) indicating the water is of waste origin (Olmsted, 1962). According to Robertson et al. (1974), this was a reasonable level for the perched groundwater due to the presence of a clay bed "aquitard" at 113 m (370 ft) bgs.

In the late 1950s, only wells drilled in the northern ICPP encountered the lower perched groundwater zone. Since 1984, a lower perched groundwater zone has also formed in the southern ICPP due to disposal of process waste through the percolation ponds. The location of this lower perched water zone is indicated by Well MW-17 and borehole neutron logs from Well USGS-51. A discussion of the lower basalt perched water zone is described in Section 2.6.1.3.

2.6.1.1 Alluvium Perched Water. The only extensive perched water identified in the alluvium at the ICPP, other than beneath surface disposal ponds (i.e., percolation pond and sewage treatment pond), was encountered west of CPP-603. The source for the perched water was thought to be wastewater discharged to the shallow seepage pit (CPP-02). This disposal pit was in operation from 1952 to 1966 (Robertson et al., 1974). In 1963, 27 observation wells were installed in the alluvium to monitor this perched water body.

From 1962 to 1963, the volume of liquid wastes discharged to the pit averaged 37,850 L/day (10,000 gal/day). Morris et al. (1965) calculated that approximately 37,850 L (10,000 gal) of liquid waste were contained in the alluvium near the pit. Therefore, the shallow perched water body contained approximately 1 day's discharge of waste. Under these conditions, the perched water should quickly reflect short-term variations in the discharge rates or compositions. A comparison of the Sr-90 concentrations on the discharge to the Sr-90 concentration in the perched water confirms the short-term variations in the water quality (Morris et al., 1965).

If the source of recharge to the shallow alluvium perched water was solely due to the discharge pit, cessation in discharge to the pit should result in a dramatic decrease in the shallow perched water. Use of the pit was discontinued in October 1966, however, the shallow perched water body had not reflected the corresponding response by 1970 (Robertson et al., 1974). The configuration of the post-1966 perched water body is very similar to that of the pre-1966 period (Figure 2-17).

Robertson et al. (1974) made a comparison of the Sr-90 and H-3 concentrations in the shallow perched groundwater for 1963 and 1970 (Figure 2-18). The high Sr-90 concentrations in the 1963 perched water were the result of large Sr-90 releases to the disposal pit when more than 33 Ci were discharged. The 1970 concentrations in the perched water were attributed to either continued minor discharges or desorption from sediments of previously discharged and sorbed Sr-90. Tritium concentrations in the perched water indicate a significant decrease during the period from 1963 to 1970. The high concentrations in 1963 reflect the relatively high volumes of waste discharged to the pit during 1962 and 1963. The decline in H-3 concentrations from 1963 to 1970 is too great to be caused solely by radioactive decay. This information, combined with an increase in water levels from 1966 to 1970, indicates a nonradioactive source may have been percolating down and recharging the shallow perched water body, thus diluting the H-3 concentrations.

According to Morris et al. (1965), sewage wastes (nonradioactive) from CPP-603 were discharged to the pit from a nearby septic tank. It is unknown how the volume of sewage discharge compared to the volume

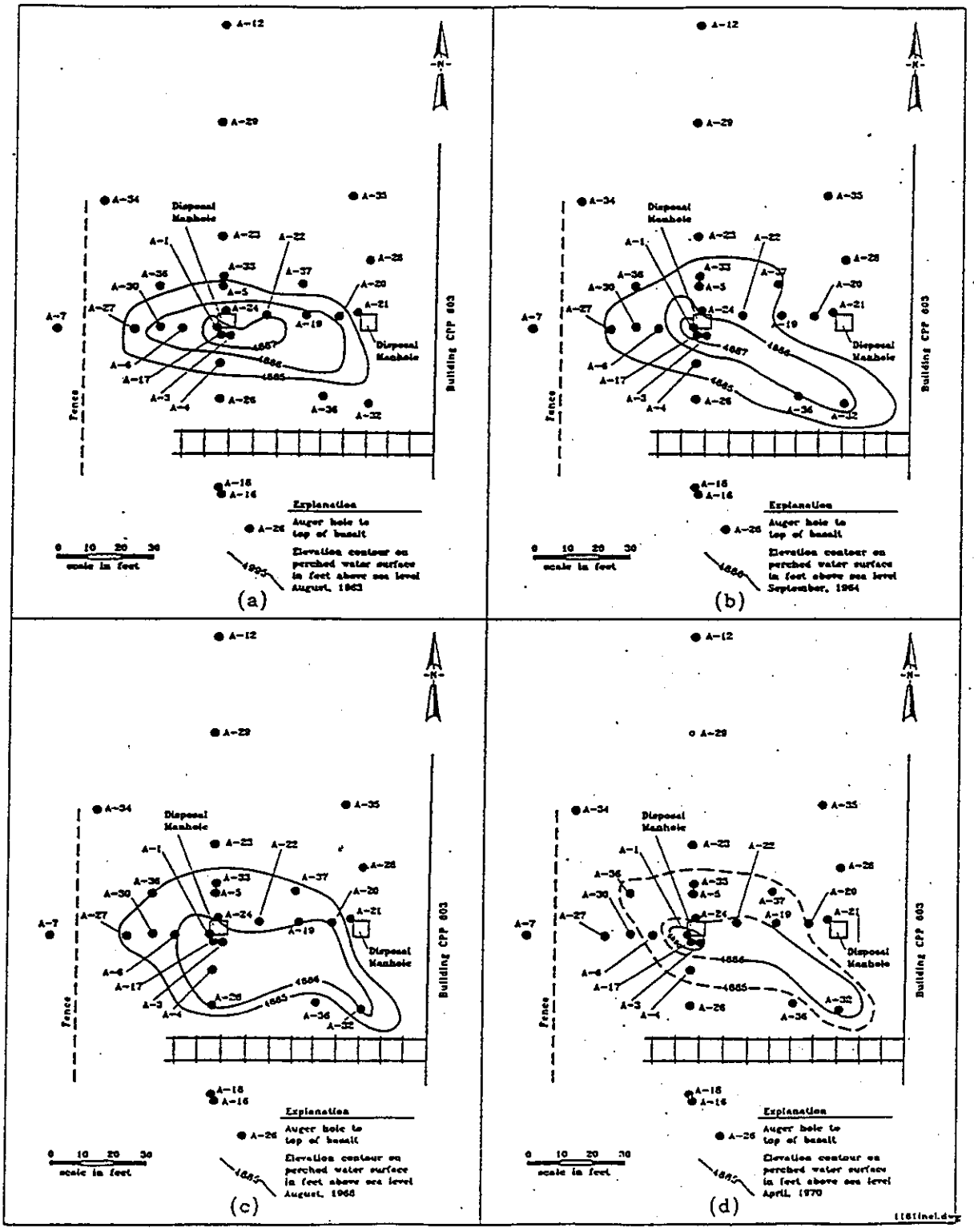


Figure 2-17. Water level contours on the alluvial perched water at the ICPP for 1963, 1966, 1968, and 1970 (Robertson et al., 1974).

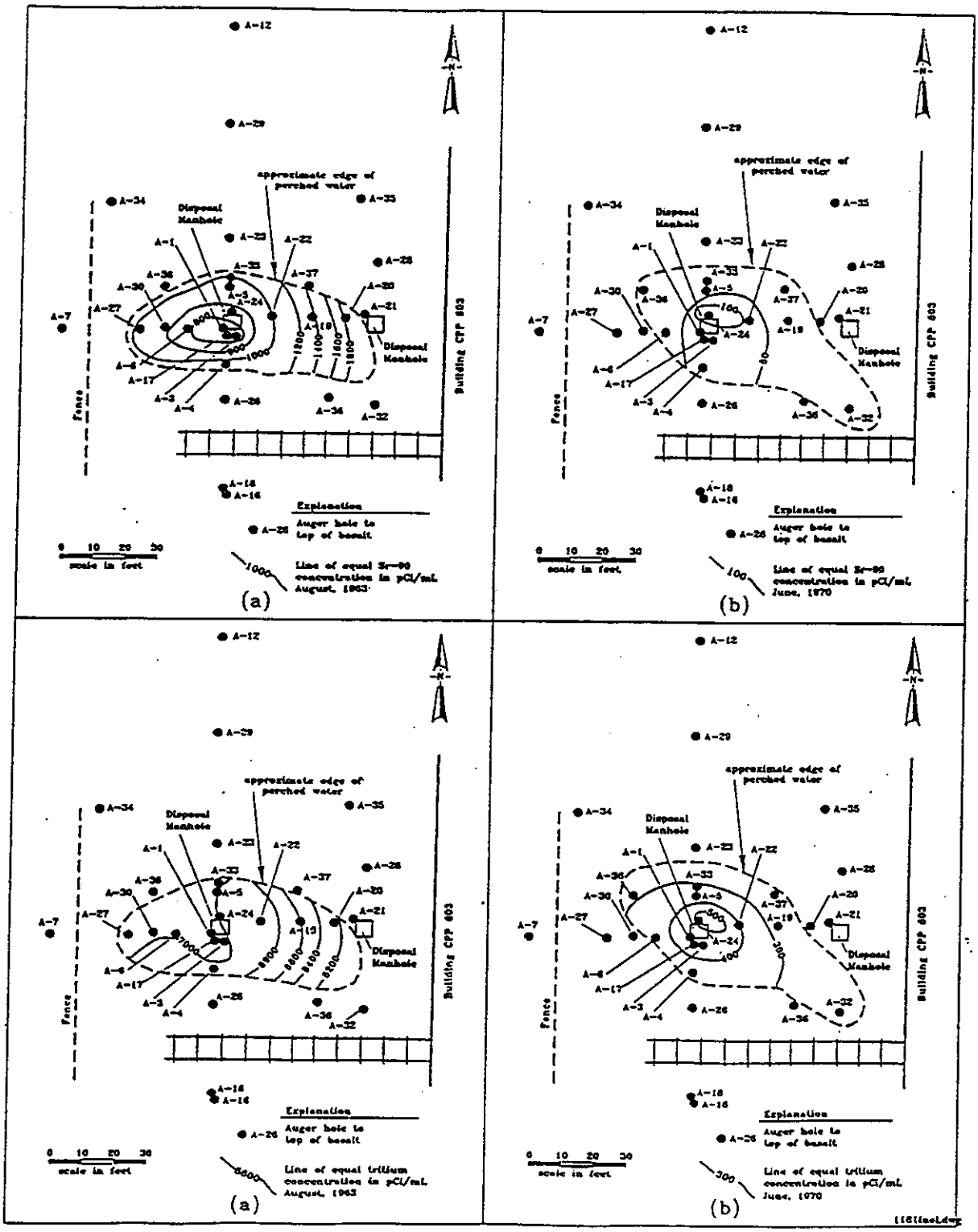


Figure 2-18. Distribution of Sr-90 and H-3 in the alluvial perched groundwater for 1963 and 1970 (Robertson et al., 1974).

of radioactive wastes discharged to the seepage pit. It was postulated that the sewage discharge may be at least partially responsible for the existence of the shallow perched water body in 1970. It was also speculated that piping leaks of nonradioactive water may also be contributing to the perched water body in 1970. Since the construction of the IRFS in 1973, the shallow perched water body has not been monitored and is believed to have dissipated. From the soil borings and monitoring wells installed during 1993 and 1994, only Well MW-13 encountered perched water in the alluvium. The water encountered by Well MW-13 is not believed to be related to the historical perched water body because (a) the well is located to the east of the facility and the historical perched water body was to the west and (b) discharge from the disposal pit ceased in 1966.

2.6.1.2 Upper Basalt Perched Water Zone. Stratigraphy controls the hydrogeologic characteristics of the subsurface at the ICPP, particularly in the formation and movement of perched groundwater. The formation of perched groundwater can be attributed to lithologic features contributing to contrasts in the vertical hydraulic conductivity of basalt layers and sedimentary interbeds in the unsaturated zone. Cecil et al. (1991) attributed four lithologic features to the formation of perched groundwater at the ICPP. Perched groundwater can form where (a) a sedimentary interbed with a reduced vertical hydraulic conductivity underlies a more conductive basalt layer, (b) altered baked zones between two basalt flows reduce the hydraulic conductivity, (c) the presence of dense unfractured basalt having low vertical hydraulic conductivity, and (d) sedimentary and chemical filling of fractures near the upper contact of a basalt flow reduce the vertical hydraulic conductivity.

Based on the perched water data, it appears the upper perched groundwater bodies are formed by the relatively low vertical hydraulic conductivity in the sedimentary interbeds. Of particular importance to the formation of perched groundwater are the "CD," "D," and "DE3" interbeds. Figure 2-19 shows the location of the upper basalt perched water zone that occurs between depths of 30.5 and 58 m (100 to 190 ft).

2.6.1.2.1 Northern ICPP—Twenty-three monitoring wells (including multiple completion wells) have been installed in the northern ICPP to monitor the upper perched groundwater (i.e., groundwater that occurs less than 58 m (190 ft) bgs. Two perched groundwater bodies have been identified in the northern ICPP. The upper perched groundwater body is present above the "CD" and "D" interbeds and the lower perched groundwater body has been identified on the "DE3" interbed. According to the lithology, 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. Based on available information, it appears that the perched groundwater between the "CD" and "D" interbeds is continuous over much of the northern ICPP since these interbeds are only separated by 9 ft. The perched water body and monitoring well completed above the associated interbed are as follows:

"CD" Interbed	"D" Interbed	"DE3" Interbed
CPP-33-1	CPP-33-3	MW-10 (2-in.)
CPP-33-2	CPP-33-4	MW-12 (1-in.)
CPP-37-4	CPP-37-4	MW-20 (2-in.)
CPP-55-06	MW-3 (2-in.)	
MW-2 (2-in.)	MW-4 (2-in.)	
MW-3 (1-in.)	MW-5 (2-in.)	
MW-8 (2-in.)	MW-6 (2-in.)	
MW-11 (1-in.)	MW-11 (2-in.)	
MW-12 (2-in.)	MW-18 (1-in.)	
MW-20 (1-in.)		

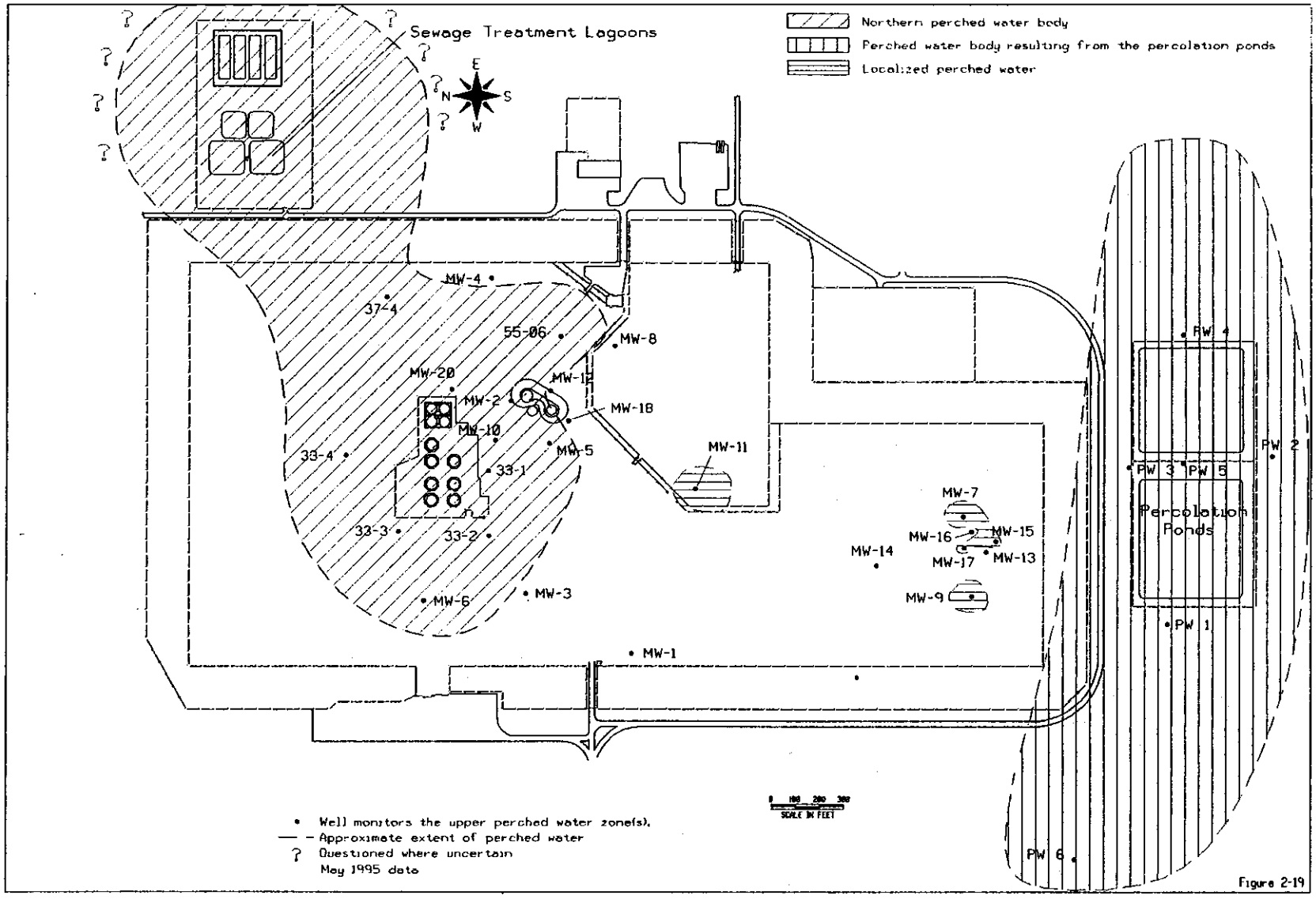


Figure 2-19. Approximate extent of the upper basalt perched water bodies at the ICPP.

In addition to these wells, well MW-4 (1 in.) is completed at the bottom of the "D" interbed and Well MW-10 (1 in.) is completed in a fracture zone associated with the "BC" interbed. Historically, both of these wells have been dry.

The extent of the upper basalt perched groundwater body is provided in Figure 2-19. These elevations range from 1,462.2 to 1,476.8 m (4,797.3 to 4,845.3 ft) and represent the average water table level throughout the monitoring period as discussed in Section 2.6.1.4. The extent of the perched water above the "CD" and "D" interbeds are illustrated in this figure. Perched groundwater is not known to occur above these interbeds outside the areas illustrated on the map. Where the perched water bodies overlap (i.e., in the vicinity of wells CPP-33-4, CPP-33-1, MW-5), the entire region between the "CD" and "D" interbeds is likely to be saturated. Otherwise, perched groundwater is only present above the associated interbed. The height of the perched groundwater above the "CD" and "D" interbeds is provided in Figures 2-20 and 2-21, respectively. Based upon the input parameters used in the Tetrad groundwater model, and assuming 100% water saturation, it is estimated that the upper perched water zone contains 25.7×10^9 L (6.8×10^9 gal) of water.

An east-west cross section is provided in Figure 2-22 to illustrate the occurrence of the interbeds and the associated perched groundwater. In the eastern part of the section (i.e., in the vicinity of wells MW-4 and CPP 55-06), the "CD" and "D" interbeds form a single stratigraphic unit because the "CD" basalt flow is not present. These interbeds separate toward the west forming two layers to impede the downward migration of water. The average separation between these two interbed is approximately 2.7 m (9 ft).

Based on the water table configuration, it appears that multiple water sources are providing recharge to the upper basalt perched water body in the northern ICPP. The sewage treatment ponds, located east of the facility, provide approximately 4.73×10^6 L (1.25×10^6 gal) per month of recharge to this perched water body. This recharge has resulted in a water table elevation of 1,476.8 m (4,845 ft) in the well (CPP-MON-P-024) 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(s) has produced a maximum water table elevation of 1,468.4 m (4,817.5 ft) in well CPP-33-2. Between the eastern and western portions of the upper perched water body, the average groundwater elevation is 1,465.8 m (4,809.2) ft in Well CPP-37-4. This water table configuration indicates separate sources of water providing recharge to the eastern and western portions of the upper-most perched water body and that the sewage treatment ponds have minimal, if any, impact upon the western portion of this perched water body.

Occurring beneath the upper perched groundwater body, a deeper perched groundwater body has been identified at a depth of approximately 140 ft bgs. This groundwater appears to be the result of the "DE3" interbed, which occurs between 163 and 169 ft bgs in the northern ICPP. Only three wells [MW-10 (2-in.), MW-12 (1-in.), and MW-20 (2-in.)] are completed in this perched groundwater body. Based upon monitoring data, the water table elevation within this perched water zone varies from 1,453.6 to 1,456.6 m (4,769 to 4,779 ft). The estimated extent and water table elevation for this perched water body is provided in Figure 2-23. Based on the input parameters for the Tetrad groundwater model, and assuming 100% water saturation, it is estimated that the middle perched water zone contains 14.8×10^9 L (3.9×10^9 gal) of water.

2.6.1.2.2 Southern ICPP—The upper perched water bodies identified in the southern ICPP are shown in Figure 2-19. The largest perched water body is the result of discharge to the percolation ponds and monitored by wells PW-1 through PW-6. In the vicinity of CPP-603, six wells (MW-7, MW-9, and MW-13

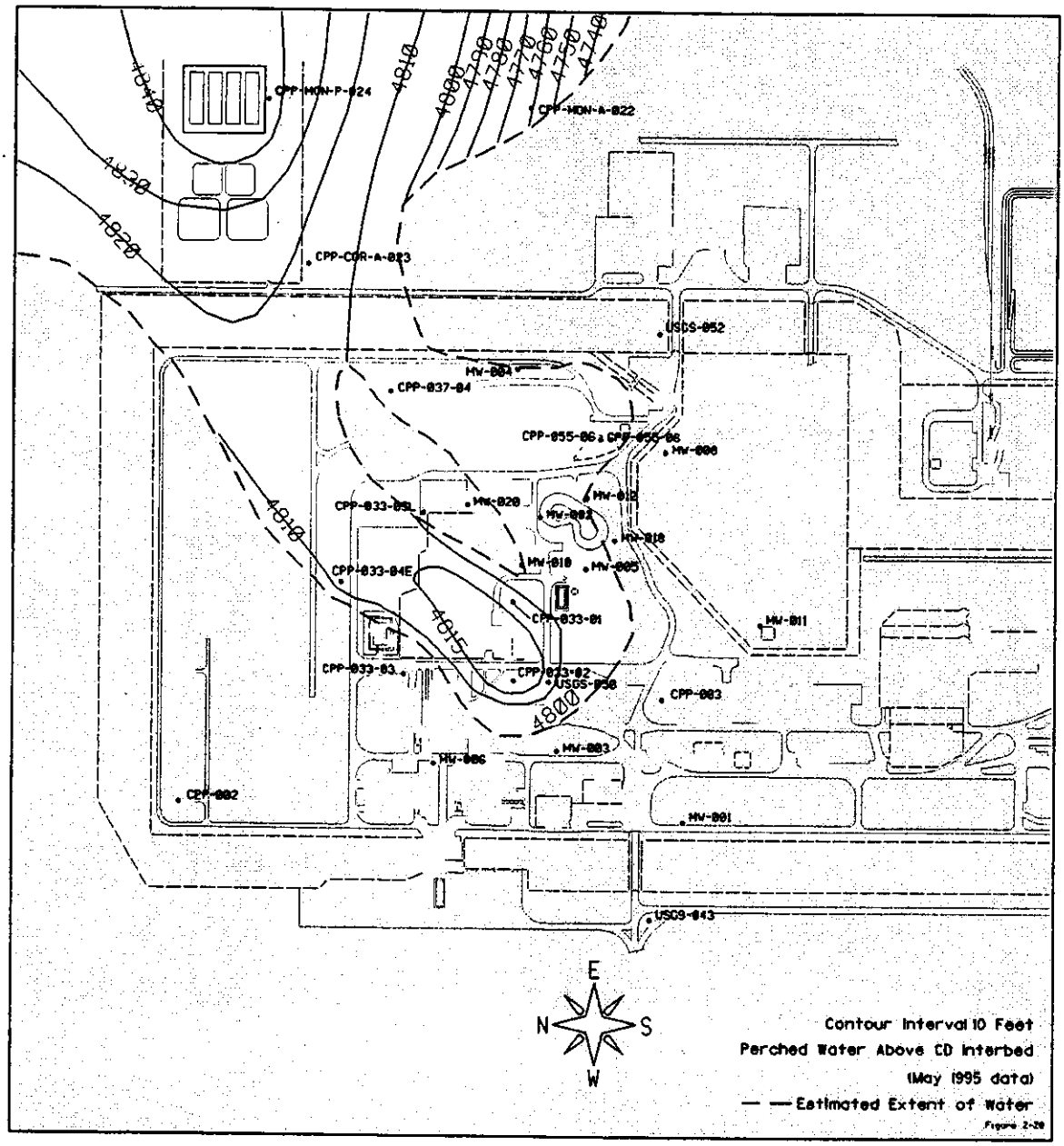


Figure 2-20. Elevation of water above the "CD" interbed in the northern ICPP.

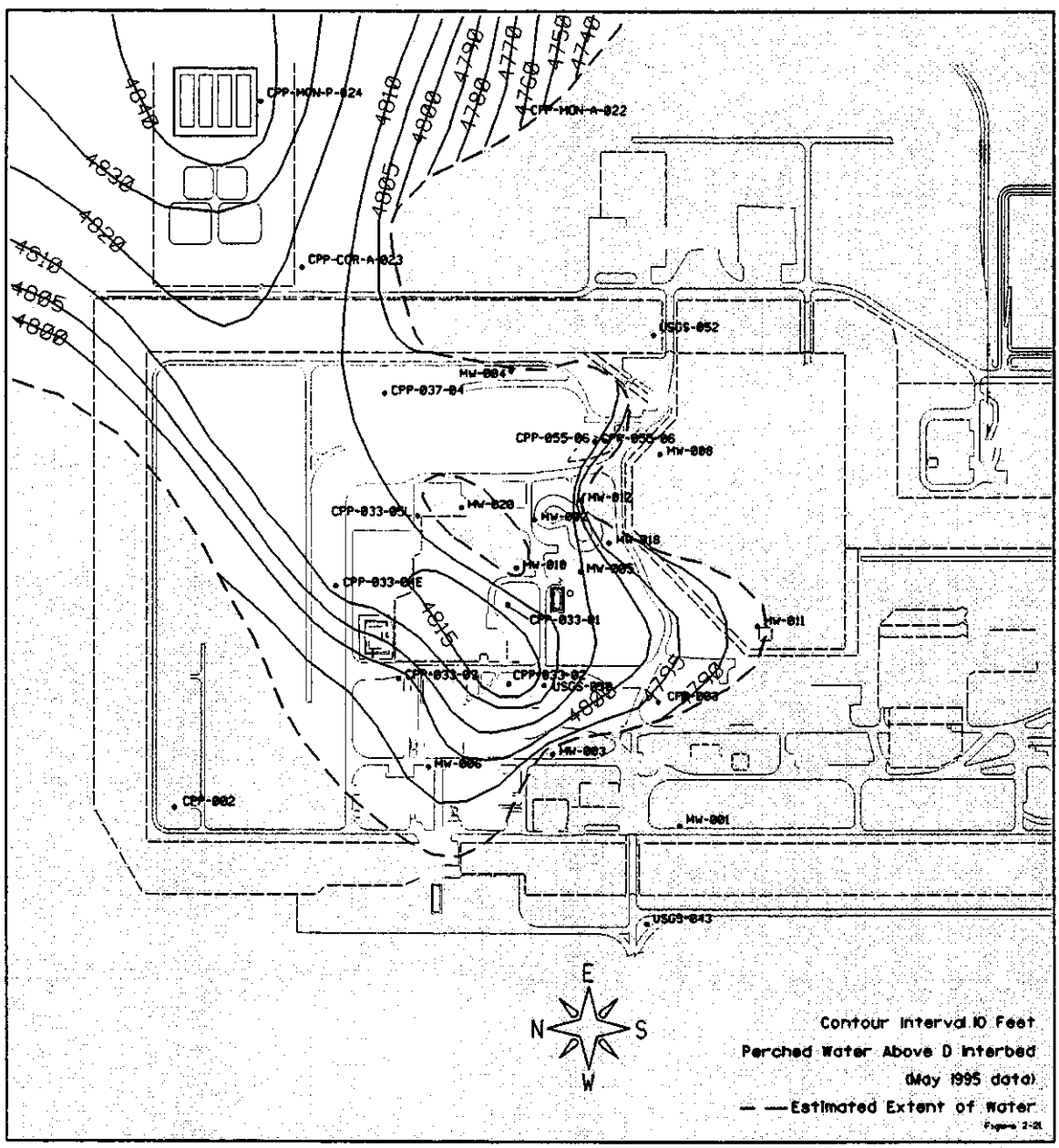


Figure 2-21. Elevation of water above the "D" interbed in the northern ICPP.

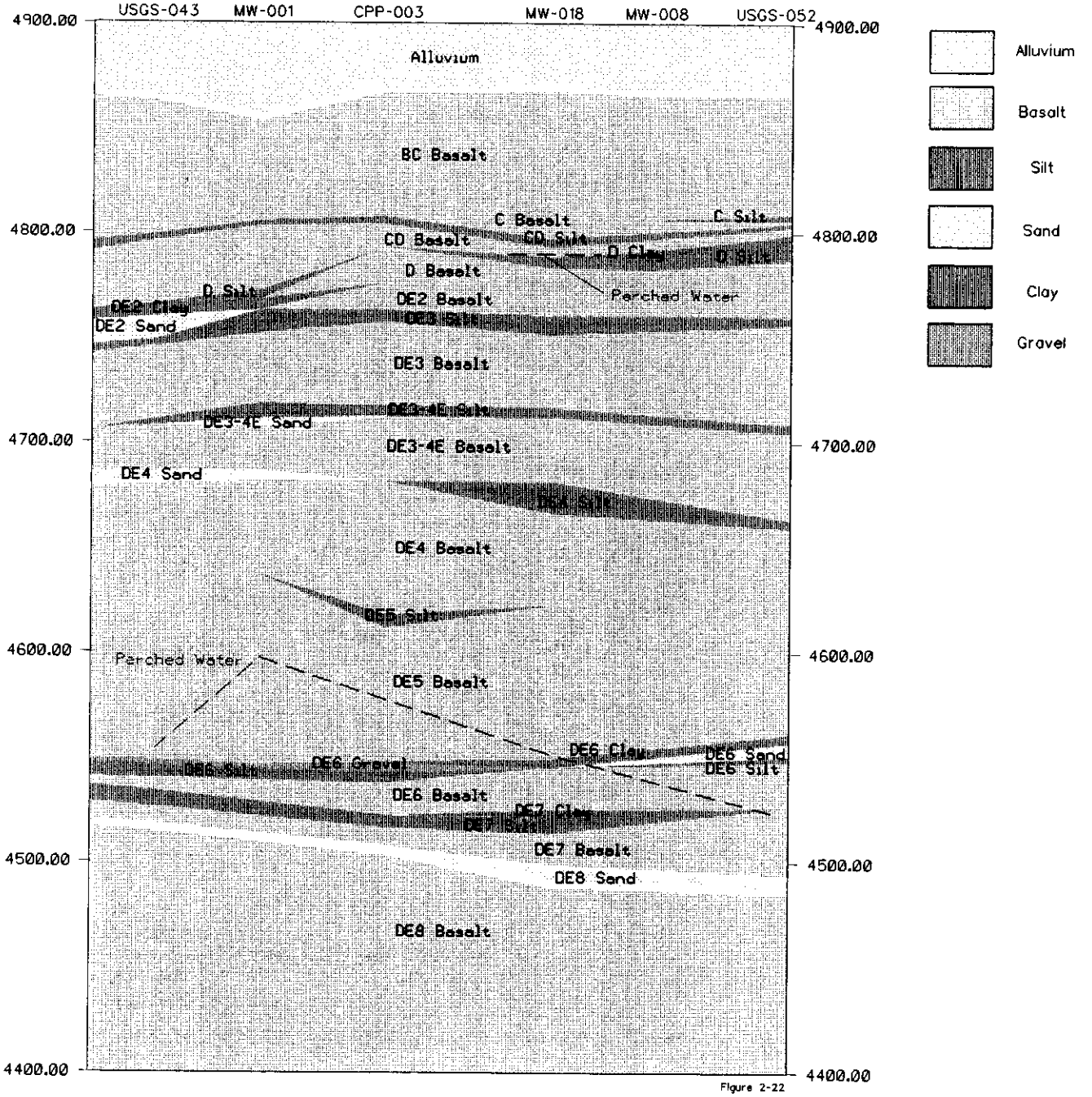


Figure 2-22. East-west cross section of the upper basalt perched water zone in the northern ICPP.

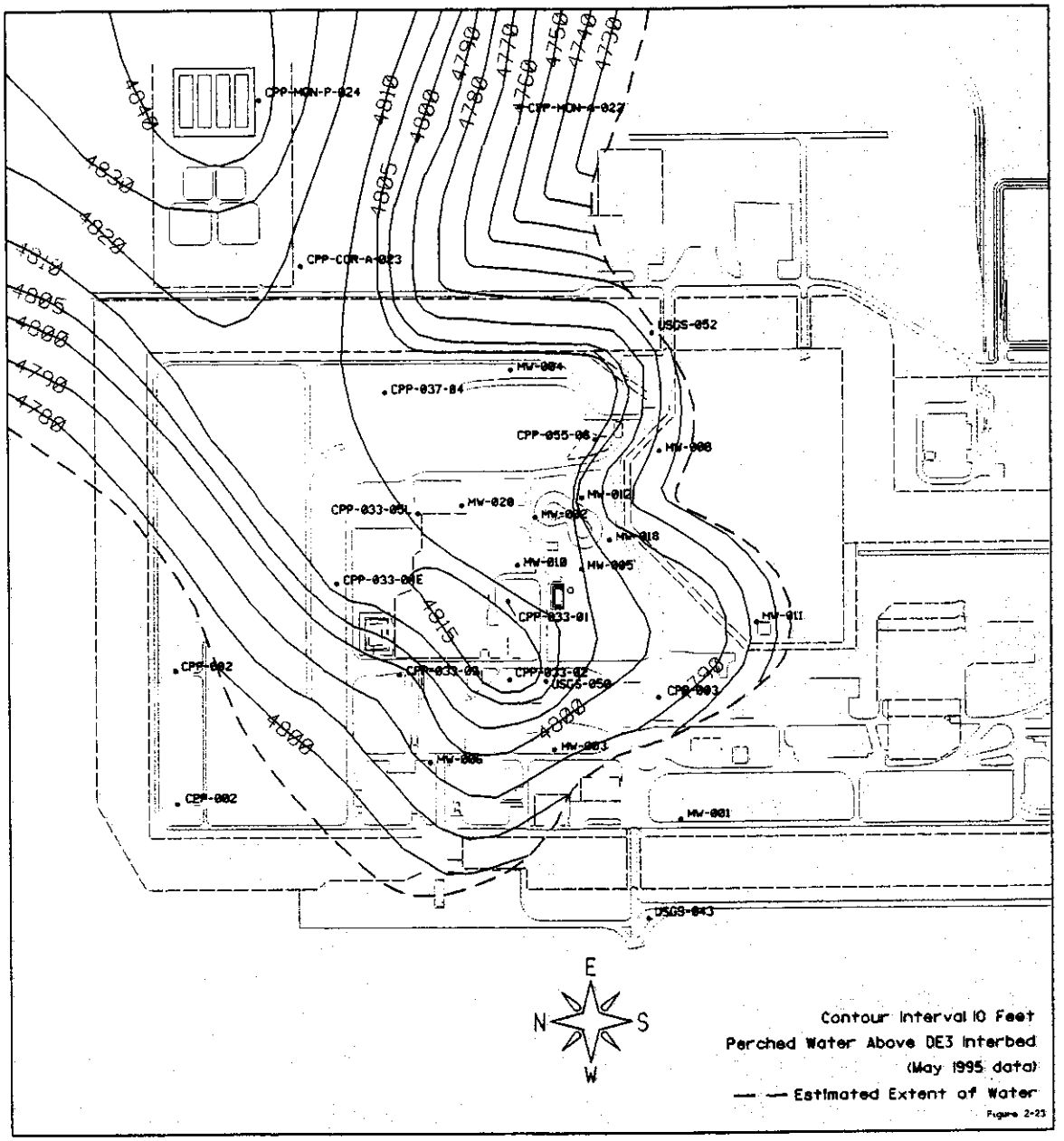


Figure 2-23. Approximate extent of the perched groundwater above the "DE3" interbed.

through MW-16) were installed to monitor perched water on the upper interbed that is present between 33.5- and 39.6-m (110- and 130-ft) bgs. One triple completion well (MW-17) was installed to monitor for perched water on a deeper interbed occurring approximately 57.9 m (190 ft) bgs.

An extensive perched water body on the upper interbed has not been identified in the vicinity of CPP-603. Only three wells (MW-7, MW-9, and MW-15) have detected water on the upper interbed, and the remaining three wells (MW-13, MW-14, and MW-16) are dry. Other than MW-15, only minimal water has been encountered with the height of water above the interbed less than 1.2 m (4 ft) during every measuring event.

Wells PW-1 through PW-6 were installed adjacent to the percolation ponds to monitor the perched groundwater beneath the ponds. Figure 2-24 provides the hydrographs for these wells during the period from September 1986 through early 1994. As shown in this figure, a similar fluctuation in the water level is observed for Wells PW-1, PW-3, and PW-6 indicating these wells are effective in monitoring infiltration from the western percolation pond. The water level fluctuation in Well PW-4 is opposite to the response observed in Wells PW-1, PW-3, and PW-6, indicating this well monitors infiltration from the eastern percolation pond. The water level fluctuations in Wells PW-2 and PW-5 are fairly consistent indicating these wells are influenced by discharge to either pond.

2.6.1.3 Lower Basalt Perched Water Zone. A lower perched groundwater zone has been identified to occur in the basalt between 97.5- and 128-m (320- and 420-ft) bgs. This water was first discovered in 1956 while drilling Well USGS-40 where perched groundwater was encountered at a depth of 106 m (348 ft) (Robertson et al., 1974). Since then, groundwater 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. Table 2-10 summarizes the available data from the USGS wells concerning the deep perched groundwater zone. Borehole neutron logs ran in 1993 indicate perched water may still be present in this zone from Wells USGS-40, USGS-43, USGS-46, USGS-51, and USGS-52.

Only four wells are completed in the lower perched water zone that presently monitor water level changes. Wells MW-1, MW-18, and USGS-50 are completed in the northern portion of the facility having encountered water at approximately 85, 107.5, and 101 m (322, 407, and 383-ft) bgs, respectively. In the southern portion of the facility, only Well MW-17 is completed in the lower perched water zone where water is encountered at a depth of approximately 96-m (364-ft) bgs. Based upon water quality information, the deep perched groundwater encountered by Well MW-17 is the result of discharge to the percolation ponds.

Similar to the upper basalt perched water zone, the lower perched water zone is thought to be formed by decreased permeability associated with sedimentary interbed layers. It appears that the lower perched groundwater has formed primarily on the "DE8" interbed. The top of this interbed occurs beneath the ICPP at depths ranging from 101 to 112.5 m (383 to 426 ft) bgs. In the western portion of the facility, however, the "DE6' interbed is responsible for creating perched groundwater associated with Wells USGS-40 and USGS-43. Table 2-11 provides a summary of the perching layer, depth to water, and water table elevation for the wells that encountered lower perched groundwater. The extent of the lower perched groundwater and approximate elevation of the water table is shown in Figure 2-25. It should be noted that these data contain a high degree of uncertainty since they consist of a combination of original drillers logs (some dating back 40 years), geophysical borehole logs, and monitoring wells that are completed in this zone.

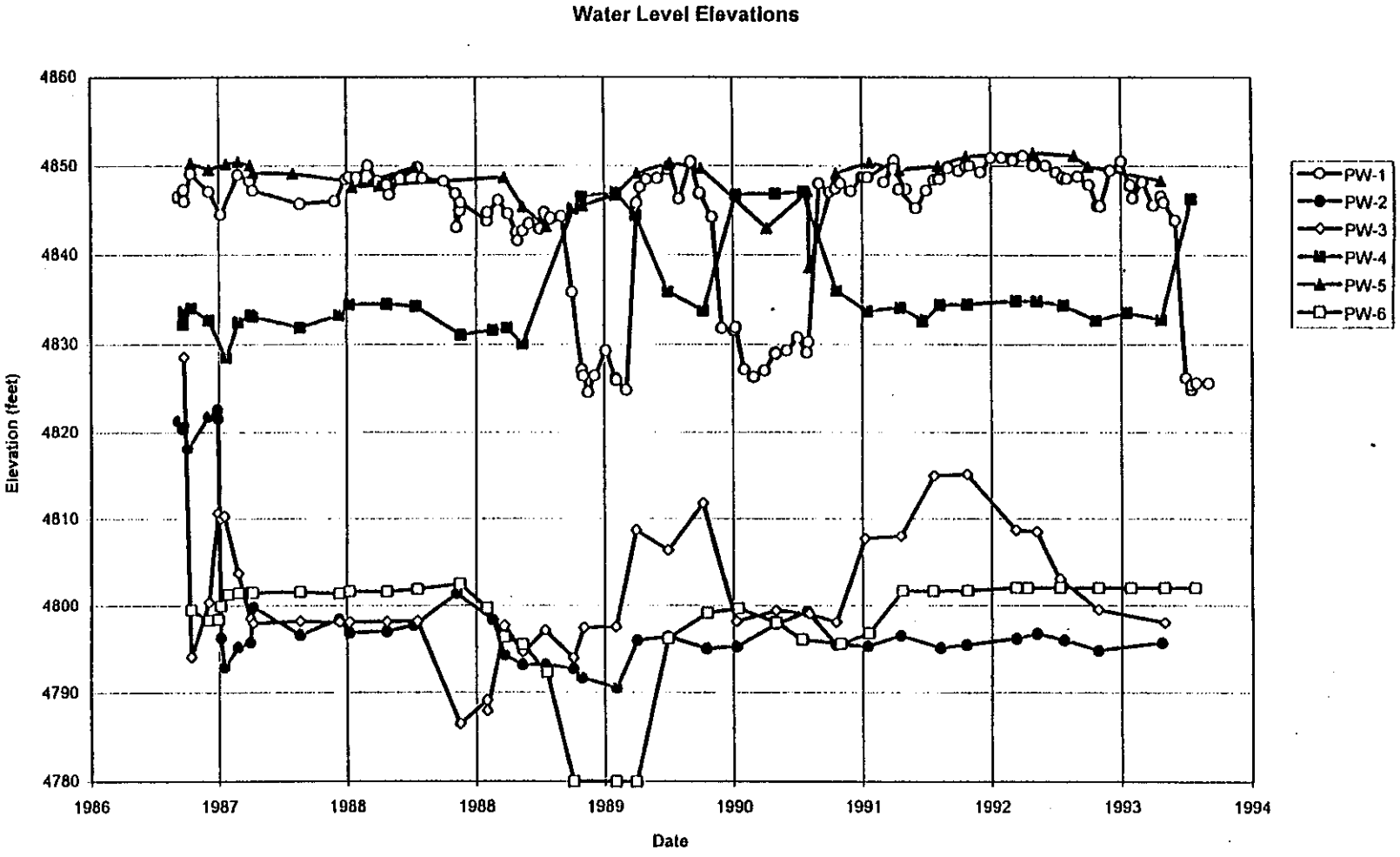


Figure 2-24. Hydrographs for the PW-series wells.

Table 2-10. Depth of perched water zones encountered during the drilling of wells around the ICPP (Robertson et al., 1974).

Well number	Date drilled	Depths to perched water (ft)	Characteristics of the water	Depth of perching clay layer (ft)
USGS-40	September, 1956	348 (rose to 340)	high Na^+, Cl^-	370
USGS-41	December, 1956	396 (rose to 384)	high Cl^-	Unknown
USGS-43	March, 1957	367 (rose to 362)	background groundwater composition	370
USGS-44	September, 1957	385	background groundwater composition	Unknown
USGS-50	September, 1959	84		110 ?
		126	high sodium, β activity, Ru-106, Rh-106 present	135
	Deepened to 405 ft October, 1962	390	high H-3	392
USGS-52	December, 1959	174	slightly high Na^+, high β and γ activity, I-131, Ru-106, Rh-106 present	195
	Deepened to 650 ft October, 1960	320		345
		385	slightly high Na^+, high β activity, Ru-106 present	410

Table 2-11. Perched layer, depth to water, and water table elevation for the wells encountering water in the lower perched water zone.

Well	Water Level		Perching Layer		Water Table Elevation
	ft bls	Year	Interbed	Depth	(ft AMSL)
USGS-40	340	1956	DE6	368-383	4,576
USGS-41	384	1956	DE8	406-430	4,533
USGS-43	362	1957	DE6	368-376	4,554
USGS-44	385	1957	DE8	410	4,534
USGS-50	383	1995	DE8	396-405	4,535
USGS-51	270	1986	DE6	384-400	4,686
USGS-52	385	1960	DE8	416-425	4,525
MW-1	322	1995	Unknown	Unknown	4,597
MW-17	364	1995	DE8	>381	4,557
MW-18	407	1995	DE8	412.7-423.2	4,553

As shown in Figure 2-25, the lower perched water zone is probably not continuous beneath the entire facility, and may actually consist of several individual perched water bodies. The north-south separation of the lower perched water bodies is based on the lack of perched groundwater (either through drilling or subsequent neutron logging) identified in Wells USGS-42, -45, -47, -48, and -49. Based on input parameters used in the Tetrad groundwater model, and assuming 100% water saturation, it is estimated that the deep perched water zone contains 20.4×10^9 L (5.4×10^9 gal) of water. Recharge to the southern perched water body is from wastewater discharged to the percolation ponds. The source of recharge to the western portion of the northern perched water body is unknown.

Water levels in this lower perched water zone have been monitored since the early 1960's in Well USGS-50 (Figure 2-26). Other than during the late 1960's and early 1970's, the water level in this well has been fairly consistent. The water level during this period generally ranged between 1,381 and 1,384 m (4,530 and 4,540 ft) amsl. In the late 1960's/early 1970's; however, the water level increased by approximately 27.4 m (90 ft) in response to failure of the ICPP injection well. During this period, wastewater was discharged directly to the vadose zone from the ICPP injection well at a reported depth of 68.9 m (226 ft) bgs.

The presence of a deep perched groundwater zone beneath the percolation ponds is indicated by the borehole neutron response from Wells USGS-51 and MW-17. Figure 2-27 shows the natural gamma log, stratigraphy, and epithermal neutron logs ran in 1984, 1985, and 1986 for Well USGS-51. Deflections of the neutron log to the left indicate increases in moisture content. As shown in this figure, two zones illustrate significantly increasing moisture content since the percolation ponds were placed into service on February 1984. These two zones occur from 44.2 to 54.3 m (145 to 178 ft) and 83.5 to 101 m (274- to 332-ft) bgs. The upper perched water zone is currently being monitored by the PW-series wells. Well MW-17 (4-in.) is completed in the lower perched water zone.

2.6.1.4 Water Level Fluctuation. Thirty-two wells have been installed to monitor the water level fluctuations in the perched groundwater beneath the ICPP. Several piezometers have been completed in conjunction with the perched water wells, resulting in 44 different monitoring intervals. If water was present in the well following completion, the well was usually equipped with a pressure transducer and data logger to automatically monitor changes in the water level. Table 2-12 describes the well, monitoring period, number of measurements, and general statistics concerning the water level elevation for the wells being monitored. Concurrent with the automatic monitoring of selected wells, complete rounds of water level measurements have been recorded for all the perched water wells. A summary of the water level data from these measuring events is provided in Table 2-13.

Hydrographs for the nine perched water wells completed in the northern ICPP are provided in Figure 2-28. Figure 2-29 shows the same well hydrographs grouped according to similar water level patterns. Data presented in these hydrographs were collected between January 1993 and October 1995 and represent the majority of perched water monitoring at the ICPP. Individual hydrographs for each of these wells are presented in Appendix B. Several water-level fluctuation patterns are shown in the hydrographs presented in Figure 2-29 and are discussed below:

- Wells CPP-33-4, CPP-37-4, and MW-4 show similar water-level fluctuation patterns. During 1994, water level elevations were highest in March, and decreased during the summer and remained relatively constant for the remainder of the year. Well CPP-33-4 showed a rise in water level during the November and December of 1994. Water levels increased from January 1995 to

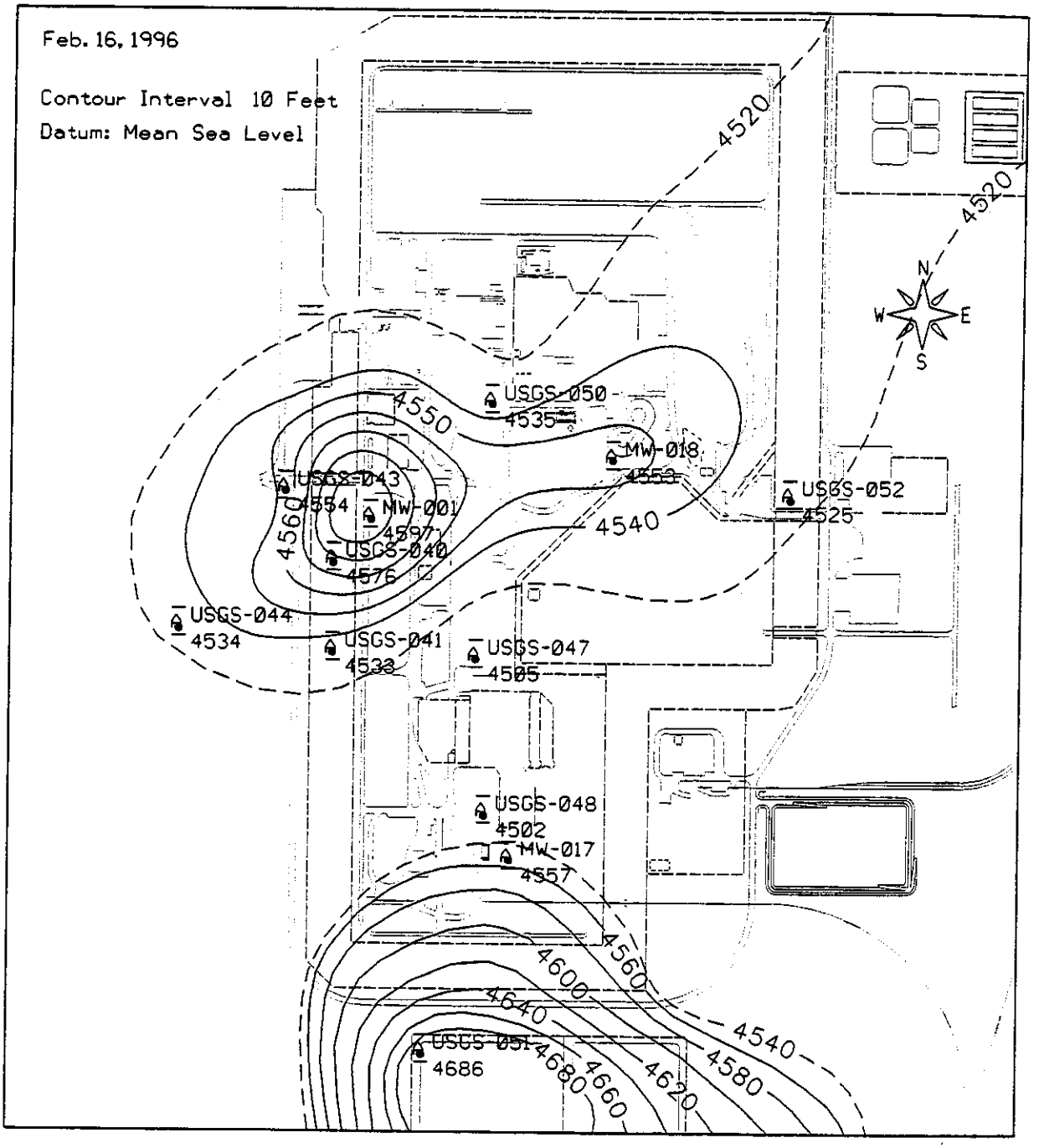


Figure 2-25. Approximate extent of the lower perched groundwater zone.

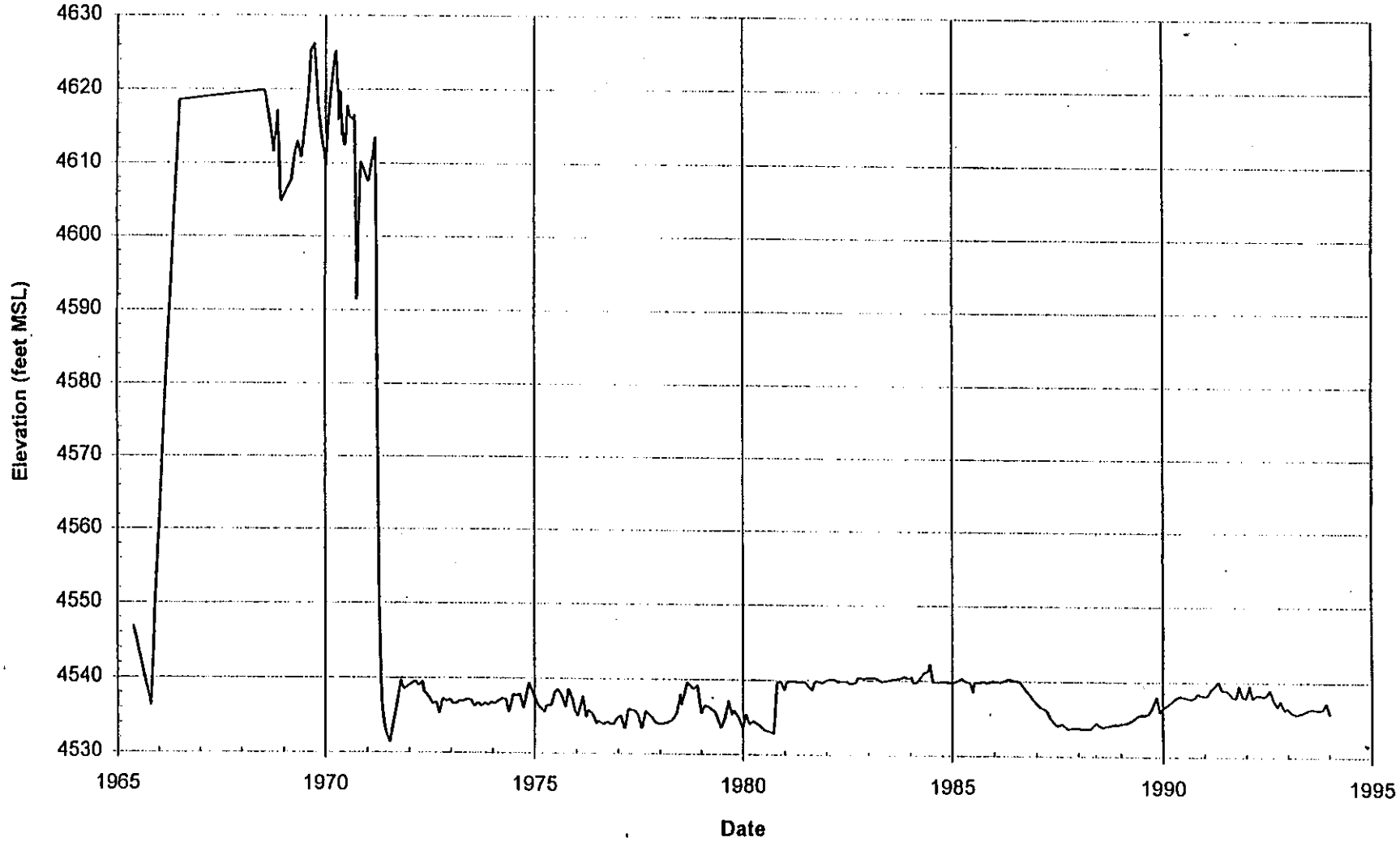


Figure 2-26. Hydrograph for Well USGS-50 (USGS records).

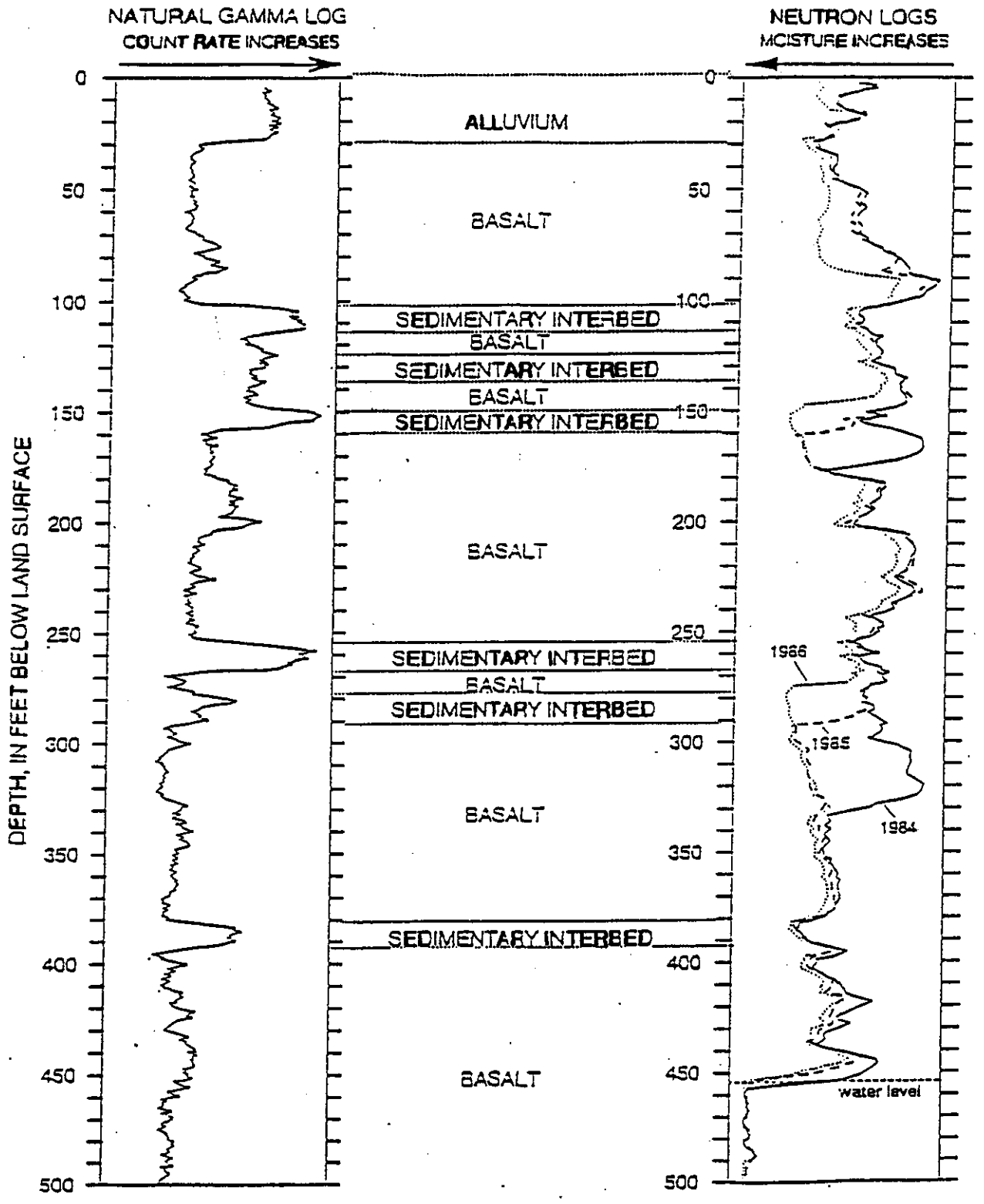


Figure 2-27. Natural gamma log, stratigraphy, and neutron logs for Well USGS-51 (Cecil et al., 1991).

Table 2-12. Summary of the water level monitoring data from the perched water wells equipped with data loggers.

Well	Period of record	Number of measurements	Minimum water level (ft amsl)	Maximum water level (ft amsl)	Average water level (ft amsl)
CPP 33-2	12/92–10/95	973	4,811.14	4,820.68	4,817.53
CPP 33-3	1/93–10/95	962	4,794.02	4,802.25	4,799.05
CPP 33-4	1/93–10/95	672	4,800.11	4,815.51	4,810.83
CPP 37-4	9/92–10/95	481	4,806.52	4,812.82	4,809.21
CPP 55-06	10/92–10/95	1,000	4,802.10	4,810.52	4,806.61
MW-1	6/95–11/95	942	4,595.07	4,602.89	4,598.97
MW-2	2/94–10/95	588	4,804.72	4,809.85	4,807.14
MW-4	2/94–10/95	606	4,804.64	4,810.04	4,806.65
MW-5	3/94–9/95	559	4,803.34	4,808.98	4,805.61
MW-6	2/94–10/95	608	4,792.14	4,804.79	4,797.32
MW-20	6/95–9/95	539	4,779.56	4,781.44	4,780.53
USGS-50	6/95–11/95	943	4,524.02	4,534.80	4,533.05

Table 2-13. Summary of water level data from the perched water wells.

Designation	Construction	January 1994			May 1994			August 1994			Sept 1994 - Jan 1995			May 1995		
		Ft bls	Elevation	Ft in Well	Ft bls	Elevation	Ft in Well	Ft bls	Elevation	Ft in Well	Ft bls	Elevation	Ft in Well	Ft bls	Elevation	Ft in Well
CPP 33-1	2-in. SS Well	Dry(1)	NA	NA	Dry(1)	NA	NA	Dry(1)	NA	NA	Dry	NA	NA	99.91	4817.47	1.27
CPP 33-2	2-in. SS Well	101.55	4813.87	5.47	98.90	4816.52	8.12	98.67	4816.75	8.35	98.85	4816.57	8.17	97.50	4817.92	9.52
CPP 33-3	2-in. SS Well	117.95	4798.28	6.38	117.92	4798.31	6.41	117.85	4798.38	6.48	115.11	4801.12	9.22	118.33	4797.90	6.00
CPP 33-4	2-in. SS Well	104.88	4809.13	15.43	102.56	4811.45	17.75	106.60	4807.41	13.71	106.83	4807.18	13.48	102.85	4811.16	17.46
CPP 37-4	2-in. SS Well	104.66	4808.00	6.90	105.60	4807.06	5.96	106.21	4806.45	5.35	106.60	4806.06	4.96	103.80	4808.86	7.76
CPP 55-06	2-in. SS Well	106.42	4806.79	8.29	108.58	4804.63	6.13	110.48	4802.73	4.23	106.93	4806.28	7.78	106.25	4806.96	8.46
MW-1	4-in. PVC Well	318.12	4601.13	20.63	322.00	4597.25	16.75	324.23	4595.02	14.52	323.25	4596.00	15.50	322.28	4596.97	16.47
MW-1	1-in. PVC Piezo.	NR	NA	NA	Dry	NA	NA	Dry	NA	NA	Dry	NA	NA	Dry	NA	NA
MW-2	2-in. PVC Well	107.87	4808.22	7.12	109.88	4806.21	5.11	Dry	NA	NA	107.70	4808.39	7.29	107.49	4808.60	7.50
MW-3	2-in. PVC Well	Dry	NA	NA	Dry	NA	NA	Dry	NA	NA	Dry	NA	NA	Dry	NA	NA
MW-3	1-in. PVC Piezo.	NR	NA	NA	Dry	NA	NA	Dry	NA	NA	Dry	NA	NA	Dry	NA	NA
MW-4	2-in. PVC Well	Dry	NA	NA	Dry	NA	NA	Dry	NA	NA	Dry	NA	NA	105.85	4808.36	7.56
MW-4	1-in. PVC Piezo.	NR	NA	NA	NR	NA	NA	Dry	NA	NA	Dry	NA	NA	131.10	4782.67	0.97
MW-5	2-in. PVC Well	111.92	4807.35	17.45	113.25	4806.02	16.12	115.12	4804.15	14.25	115.36	4803.91	14.01	112.30	4806.97	17.07
MW-6	2-in. PVC Well	126.34	4792.92	13.42	127.25	4792.01	12.51	116.77	4802.49	22.99	116.60	4802.66	23.16	122.70	4796.56	17.06
MW-7	2-in. PVC Well	141.85	4778.28	2.88	140.75	4779.38	3.98	140.75	4779.38	3.98	134.31	4785.82	10.42	Dry	NA	NA
MW-7	1-in. PVC Piezo.	NR	NA	NA	NR	NA	NA	Dry(1)	NA	NA	Dry	NA	NA	Dry	NA	NA
MW-8	2-in. PVC Well	Dry	NA	NA	Dry	NA	NA	Dry	NA	NA	Dry	NA	NA	Dry	NA	NA
MW-9	2-in. PVC Well	129.81	4792.52	2.92	Dry(1)	NA	NA	132.35	4789.98	0.38	131.87	4790.46	0.86	Dry	NA	NA
MW-9	1-in. PVC Piezo.	NR	NA	NA	NR	NA	NA	Dry	NA	NA	Dry	NA	NA	Dry	NA	NA
MW-10	2-in. PVC Well	Dry	NA	NA	NA	NA	NA	147.29	4770.12	6.42	141.47	4775.94	12.24	148.12	4769.29	5.59
MW-10	1-in. PVC Piezo.	NR	NR	NR	NR	NA	NA	Dry	NA	NA	Dry	NA	NA	79.12	4838.29	1.59
MW-11	2-in. PVC Well	138.46	4779.44	0.54	137.72	4780.18	1.28	138.62	4779.28	0.38	Dry	NA	NA	Dry	NA	NA
MW-11	1-in. PVC Piezo.	NR	NR	NR	NR	NA	NA	Dry	NA	NA	Dry	NA	NA	Dry	NA	NA
MW-12	2-in. PVC Well	Dry	NA	NA	Dry	NA	NA	Dry	NA	NA	Dry	NA	NA	Dry	NA	NA
MW-12	1-in. PVC Piezo.	NR	NR	NR	NR	NA	NA	Dry	NA	NA	Dry	NA	NA	153.00	4762.99	0.29
MW-13	2-in. PVC Well	NR	NR	NR	NR	NR	NR	NR	NR	NR	Dry	NA	NA	Dry	NA	NA
MW-14	2-in. PVC Well	NR	NR	NR	NR	NR	NR	NR	NR	NR	Dry	NA	NA	Dry	NA	NA
MW-15	2-in. PVC Well	NR	NR	NR	NR	NR	NR	NR	NR	NR	122.50	4798.75	11.15	122.85	4798.40	10.80
MW-16	2-in. PVC Well	NR	NR	NR	NR	NR	NR	NR	NR	NR	Dry	NA	NA	Dry	NA	NA
MW-17	2-in. PVC Well	NR	NR	NR	NR	NR	NR	NR	NR	NR	190.50	4730.61	4.01	190.37	4730.74	4.14
MW-17	1-in. PVC Piezo.	NR	NR	NR	NR	NR	NR	NR	NR	NR	Dry	NA	NA	Dry	NA	NA
MW-17	4-in. Steel Well	NR	NR	NR	NR	NR	NR	NR	NR	NR	364.30	4556.81	19.51	364.80	4556.31	19.01
MW-18	2-in. PVC Well	NR	NR	NR	NR	NR	NR	NR	NR	NR	Dry	NA	NA	124.35	4792.97	2.47
MW-18	1-in. PVC Well										407.25	4510.08	10.08	407.63	4509.70	9.70
MW-18	4-in. PVC Well	NR	NR	NR	NR	NR	NR	NR	NR	NR	462.95	4454.36	18.86	464.19	4453.12	17.62
MW-20	2-in. PVC Well	NR	NR	NR	NR	NR	NR	NR	NR	NR	139.60	4778.40	11.80	137.33	4780.67	14.07
MW-20	1-in. PVC Piezo.	NR	NR	NR	NR	NR	NR	NR	NR	NR	Dry	NA	NA	109.34	4808.66	0.00

NR - not reported.
NA - not available.

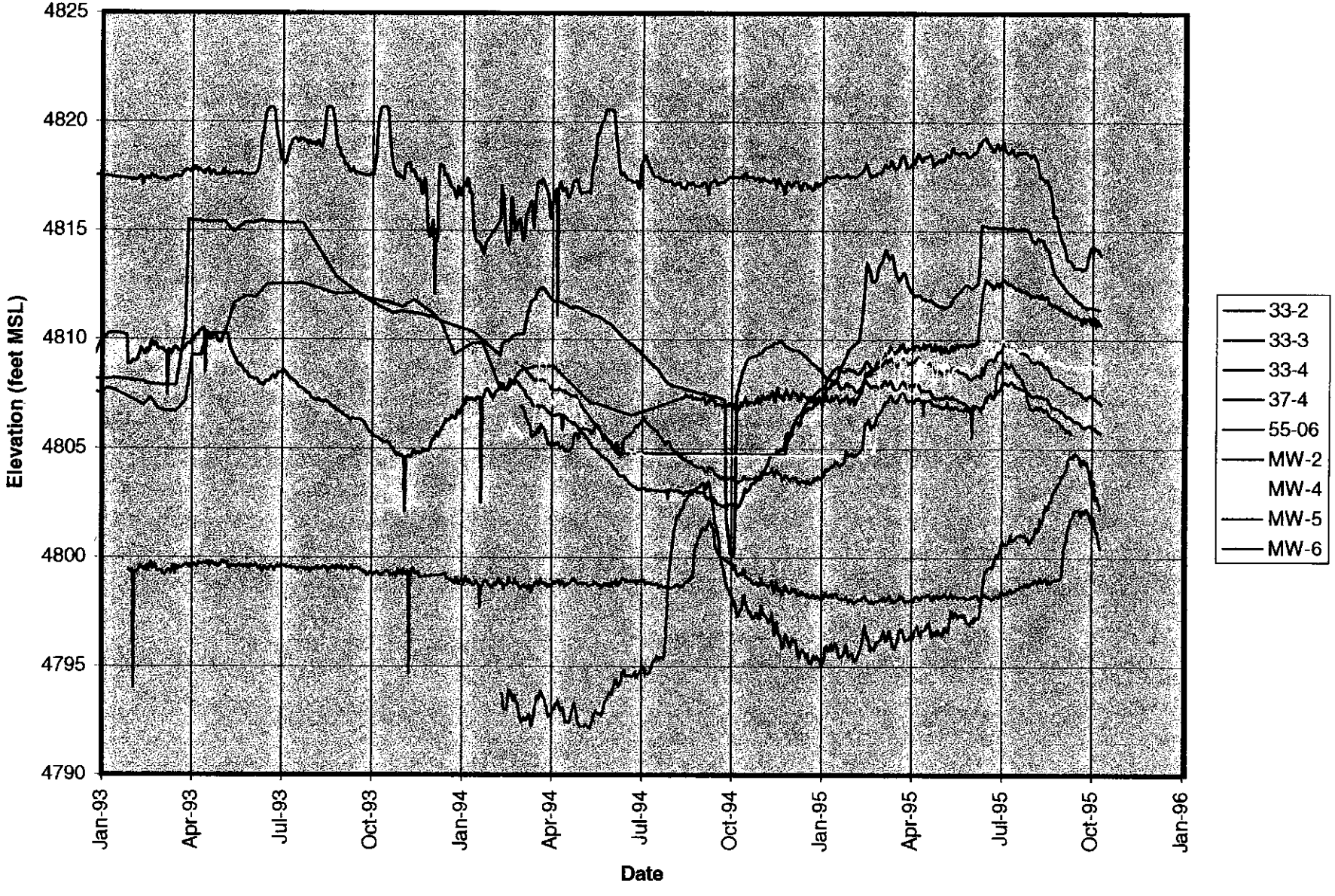
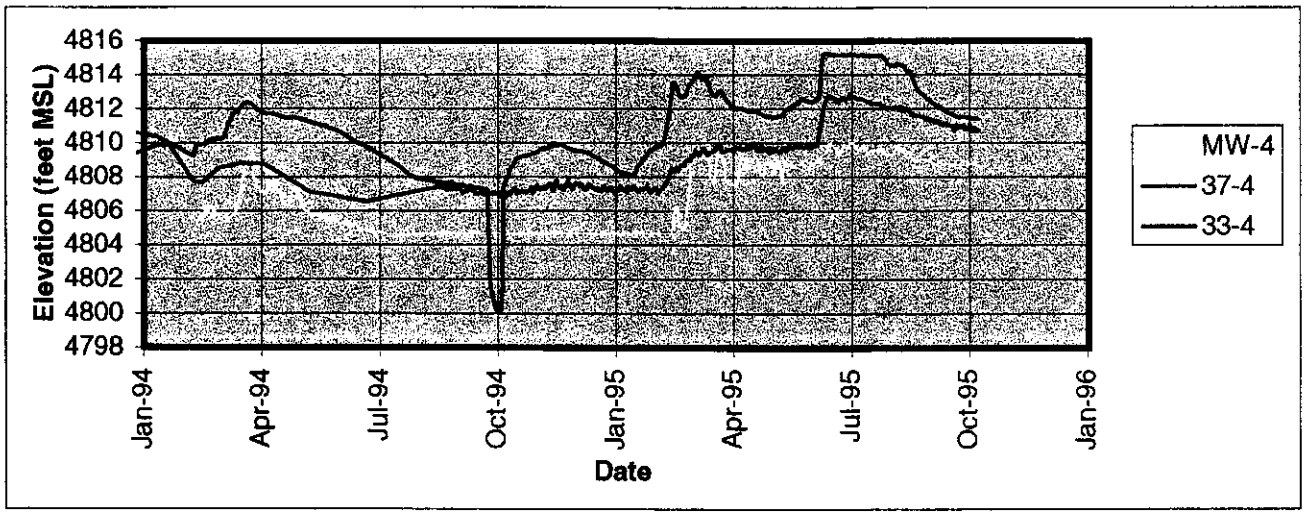
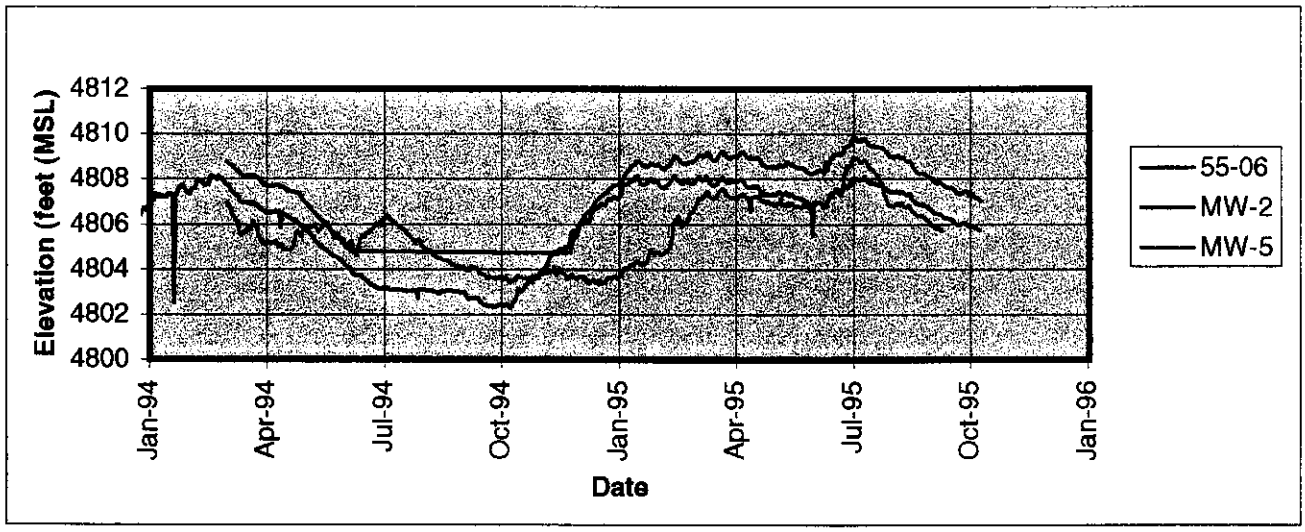


Figure 2-28. Hydrographs for the perched water wells equipped with data loggers.





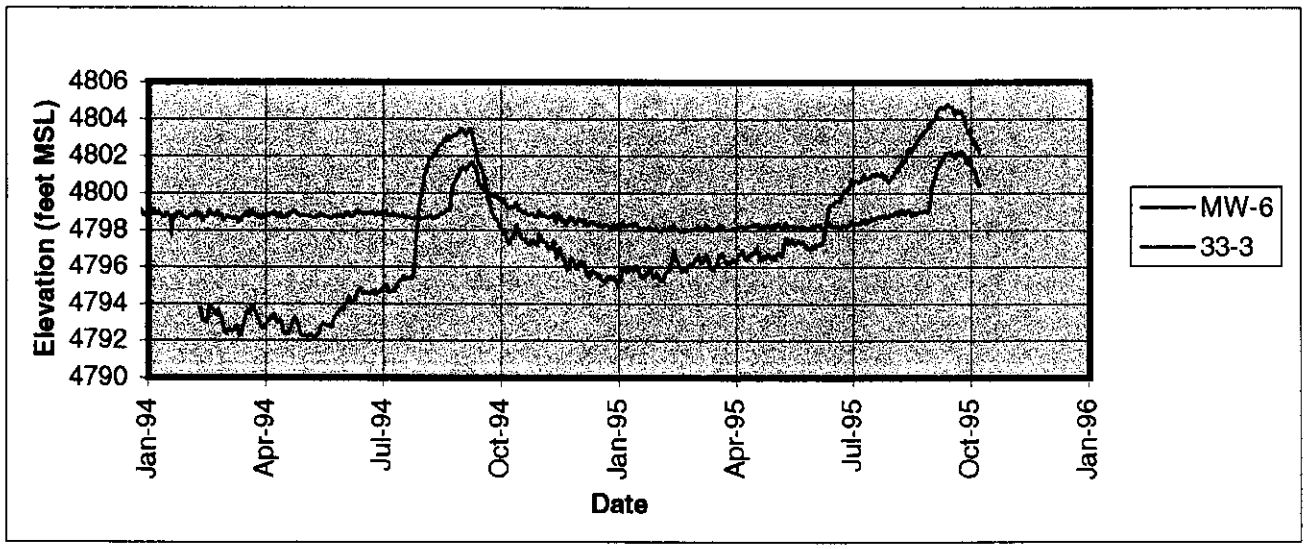


Figure 2-29. Hydrographs for perched water wells from 1994 to October 1995.

the highest level during May 1995. The water level fluctuations at these wells appear to be caused by recharge from both spring snowmelt and increased runoff in the Big Lost River as indicated by the June water level increases. The hydrograph for well MW-2 shows the water-level elevation of about 4805 ft msl between July 1994 and February 1995, which was caused by the water level falling below the transducer.

- Similar water-level responses are shown by wells 55-06, MW-2, and MW-5. Water levels generally are lower during the summer months and increase during the fall, winter, and spring months. These water-level patterns are largely attributed to the steam injection vents, where excess steam is discharged to the subsurface. The hydrograph for well MW-2 shows the water-level elevation of 4,805 ft msl between May and November 1994 which was caused by the water level falling below the transducer.

- Wells MW-6 and CPP-33-3 also exhibit similar water-level fluctuations. Both wells show an apparent seasonal water-level increase and decrease between July and October for each of the years monitored. The water level increase during this period is about 8 feet for well MW-6 and 3 feet for well 33-3. These apparent seasonal responses can not be attributed to any known plant operations. The water-level fluctuations may suggest a local lag in groundwater recharge, resulting from spring snowmelt, to the area where these wells are completed. The permeability of the C interbed at well MW-6 is about two orders of magnitude less than the C-interbed at the adjacent well MW-3 which might account for the apparent lag.

- Water-levels in well CPP 33-2 are not similar to most of the other perched water wells. This well exhibits relatively rapid responses to recharge events as shown in the hydrograph presented in Figure 2-28. The hydrograph presented in Appendix B is difficult to evaluate but appears to show a general pattern of higher water levels during the spring and lower or more constant water levels during the winter. The highest water levels occurred during late spring and summer of 1993 which was a much wetter period than average. About 6 inches of precipitation (Table 2-1) occurred between April and June 1993. The lowest measured water levels occurred during late September 1995, which was also during a period of much lower than average precipitation.

Correlation between pairs of water level data was also performed using the Pearson product-moment test. This procedure is used to calculate the strength of a linear relationship between two variables on a scale of -1 to +1. These coefficients correspond to a perfect negative correlation for -1 and a perfect positive correlation for +1. A coefficient near 0 indicates no linear relationship between the variables. The equation used to calculate the coefficients is as follows:

$$r = \frac{S_{xy}}{\sqrt{S_{xx} * S_{yy}}} \qquad (2\text{-}1)$$

where

r = correlation coefficient

x = variable 1

y = variable 2

S_{xy} = sum of column x multiplied by the sum of column y squared

S_{xx} = sum of column x multiplied by the sum of column x squared

S_{yy} = sum of column y multiplied by the sum of column y squared.

The results of the Pearson product-moment correlation for the perched water wells in the northern ICPP is provided in Table 2-14. The best positive correlation is observed between Wells CPP 55-06 and MW-2 (0.96), followed by Wells CPP 37-4 and MW-4 (0.93). Good positive correlation is also observed between Wells CPP 37-4 and MW-5 (0.88), Wells CPP 33-4 and CPP 37-4 (0.84), Wells CPP 33-4 and MW-4 (0.81), and Wells CPP 33-4 and MW-5 (0.80). These wells are located in the northeastern portion of the facility indicating a similar source of recharge to these wells. Poor correlation is observed from the wells located in the western portion of the facility (CPP 33-2, CPP 33-3, and MW-6) to the wells located to the east. This variation in the water level response indicates two separate sources of recharge to the northern perched water body: one water source providing recharge to the western portion (i.e., in the vicinity of Wells CPP 33-2, CPP 33-3, and MW-6) and the other source providing recharge to the eastern portion (i.e., in the vicinity of Wells CPP 33-4, CPP 37-4, CPP 55-06, MW-2, MW-4, and MW-6).

2.6.1.4.1 Barometric Pressure Effects—Barometric efficiency, which is the response in water level change to change in barometric pressure, was examined in the perched water monitoring wells at ICPP. Barometric efficiency may be as high as 80% (*Ground Water Manual*), and is estimated using the relationship B=dH/dpA, where B is the barometric efficiency, dH is the change in water elevation in a monitoring well, and dpA is the change in air pressure expressed as equivalent feet of water. Daily water level and barometric pressure readings in April 1994 were used because the general trend for water levels in each perched water monitoring well was relatively uneventful and appeared to be less affected by influences other than barometric pressure.

Water level fluctuations in several of the wells exhibited good correlation with changes in barometric pressure, while other wells were either insensitive to air pressure variation or the response was masked by other influences. Well CPP 33-3 exhibited an excellent correlation between water fluid level and barometric pressure, indicating local confinement in this area. Water level fluctuations from Well MW-5 displayed good correlation with barometric changes throughout the first several weeks of April, implying some local confinement for the perched water in this area. There was a significant rise in water level during the fourth week of April in Well MW-5 in excess of that due to barometric pressure alone. Well CPP 55-06 also had good correlation during the first several weeks of April, whereas the last 2 weeks of water level fluctuations were not as correlatable to barometric pressure. Wells CPP 33-2 and MW-6 demonstrated significant changes in water levels, frequently in excess of 100% efficiency, indicating something other than barometric pressure may be influencing the local fluid level behavior. Wells CPP 33-4 and MW-2 exhibited considerably lower barometric efficiency than did Wells CPP 33-3 and MW-5, however, the data are in the range normally observed in confined water aquifer systems, suggesting confinement of perched water may also be occurring in the vicinity of these wells.

Figures 2 through 8 in Appendix B display water levels in perched water wells and also barometric pressure expressed in equivalent feet of head. Table 2-15 provides a summary of the estimates of barometric efficiency for the perched water monitoring wells.

Table 2-14. Pearson correlation coefficient for the perched water wells.

	33-2	33-3	33-4	37-4	55-06	MW-2	MW-4	MW-5	MW-6
33-2	X	-0.65	0.15	0.02	0.07	0.08	0.02	0.36	-0.35
33-3	-0.65	X	-0.25	0.04	-0.42	-0.34	0.000	-0.34	0.60
33-4	0.15	-0.25	X	0.84	0.71	0.74	0.81	0.80	0.07
37-4	0.02	0.04	0.84	X	0.54	0.69	0.93	0.88	0.46
55-06	0.07	-0.42	0.71	0.54	X	0.96	0.64	0.57	-0.10
MW-2	0.08	-0.34	0.74	0.69	0.96	X	0.75	0.70	0.02
MW-4	0.02	0.00	0.81	0.93	0.64	0.75	X	0.84	0.32
MW-5	0.36	-0.34	0.80	0.88	0.57	0.70	0.84	X	0.10
MW-6	-0.35	0.60	0.07	0.46	-0.10	0.02	0.32	0.10	X

2.6.1.5 Big Lost River Effects. The Big Lost River is located directly to the north of the ICPP. Surface water flow from the Big Lost River is monitored near the ICPP at the Lincoln Boulevard gauging station located adjacent to the bridge. Typically, no flow is observed in the Big Lost River near the ICPP. During the past 5 years, however, flow was observed at the Lincoln Boulevard gauging station twice. The first time occurred during June, 1993 where flow in the Big Lost River lasted for approximately 3 weeks. No response was observed in any of the upper basalt perched water wells resulting from the 1993 stream flow in the Big Lost River (Figure 2-30).

Flow in the Big Lost River was again observed at the Lincoln Boulevard gauging station from June 6 to August 9, 1995, which is a span of 64 days. During this period flows were 16,010 acre/ft (June), 22,310 acre/ft (July) and 955 acre/ft (August). An evaluation of the water level response in the perched groundwater to the Big Lost River flow is therefore based on the duration of flow rather than the flow measurements at the gauging station. Figure 2-31 provides hydrographs for wells completed in the upper perched water zone and flow duration for the Big Lost River at the Lincoln Boulevard gauging station.

Of the nine wells completed in the upper perched groundwater zone in the northern ICPP, response to flows in the Big Lost River was observed in seven wells (CPP 33-4, CPP 37-4, CPP 55-06, MW-2, MW-4, MW-5, and MW-6). According to the monitoring data, changes in water level were observed to occur between 3 and 9 days following flow in Big Lost River. The average response time was 5.2 days. The maximum increase in water level was observed in Well CPP 33-4 at 0.6 m (2.4 ft). An average increase in the water level for all wells was 0.3 m (1.2 ft). An estimated travel time for the water to move from the Big Lost River to the upper perched groundwater was calculated based upon the distance between the well and the river and the amount of time elapsed until a response was observed in the well. The estimated travel time from the Big Lost River to the upper perched water zone varied between 64.5 to 220 m/day (244 to 834 ft/day) with an average of 121 m/day (459 ft/day). Table 2-16 provides a summary of the water level response attributed to the Big Lost River.

The effects of the Big Lost River were monitored in the lower perched groundwater zone as shown in Figure 2-32. Wells MW-1 and USGS-50 are completed in lower perched groundwater zones at depths of approximately 85 and 100 m (322 and 380 ft), respectively. The water level increased throughout the

Table 2-15. Barometric efficiency estimates for selected perched water monitoring wells at the ICPP.

Change in barometric pressure			Change in water level (ft)						
Interval	dpA, Hg (in.)	dpA, H_2O (ft)	Well 55-06 dH	Well 33-2 dH	Well 33-3 dH	Well 33-4 dH	Well MW-2 dH	Well MW-5 dH	Well MW-6 dH
A-B	0.280	0.317	0.027	0.157	0.202	0.037	0.007	0.178	0.398
B-C	0.110	0.125	0.034	0.532	0.088	0.026	0.013	0.112	0.031
C-D	0.240	0.272	0.101	0.309	0.180	0.000	0.043	0.140	0.360
D-E	0.420	0.476	0.080	0.389	0.272	0.003	0.074	0.295	0.448
E-F	0.280	0.317	0.021	0.469	0.203	0.060	0.009	0.120	0.121
F-G	0.350	0.397	0.132	0.361	0.254	0.067	0.125	0.241	0.585
G-H	0.620	0.703	0.221	0.842	0.367	0.159	0.137	0.834	0.790
H-I	0.480	0.544	0.269	0.393	0.269	0.006	0.223	0.265	0.844
			Barometric efficiency						
			Well 55-06 B	Well 33-2 B	Well 33-3 B	Well 33-4 B	Well MW-2 B	Well MW-5 B	Well MW-6 B
A-B			8.51%	49.46%	63.63%	11.66%	2.21%	56.07%	125.37%[a]
B-C			27.26%	426.57%*	70.56%	20.85%	10.42%	89.80%	24.86%
C-D			37.12%	113.56%	66.15%	0.00%	15.80%	51.45%	132.30%[a]
D-E			16.80%	81.69%	57.12%	0.63%	15.54%	61.95%	94.08%
E-F			6.61%	147.74%	63.94%	18.90%	2.84%	37.80%	38.12%
F-G			33.26%	90.97%*	64.01%	16.88%	31.50%	60.73%	147.42%[a]
G-H			31.44%	119.78%	52.21%	22.62%	19.49%	118.64%	112.38%
H-I			49.43%	72.21%	49.43%	1.10%	40.98%	48.69%	155.09%[a]
	Average		26.3%	87.9%	60.9%	11.6%	17.4%	66.0%	67.4%
	Std Dev		13.8%	26.3%	6.8%	9.0%	12.5%	26.0%	42.4%

a. If the barometric efficiency was greater than 120%, it was not included in Average and Standard Deviation calculations.

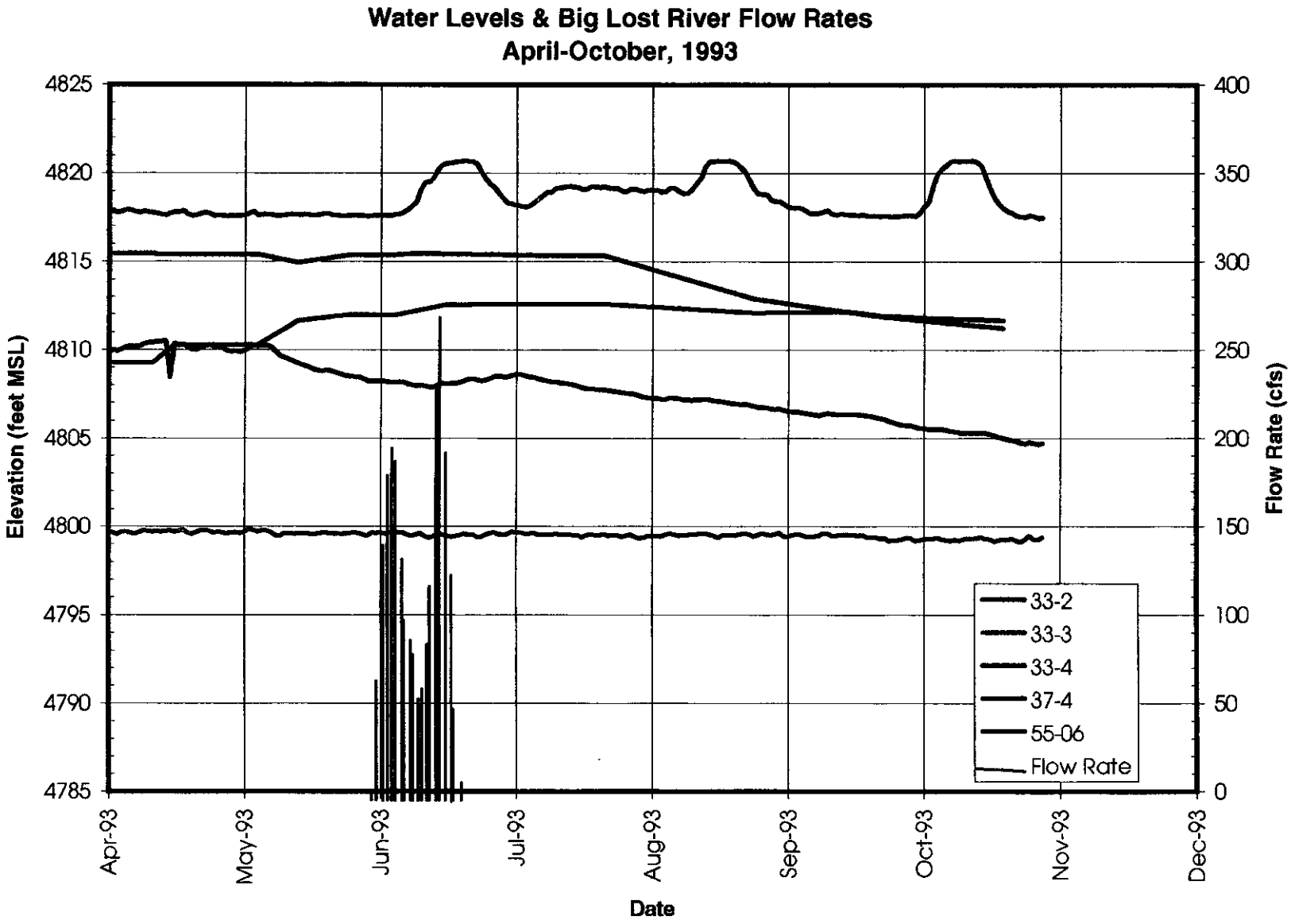


Figure 2-30. Big Lost River discharge vs. upper perched ground water levels (1993).

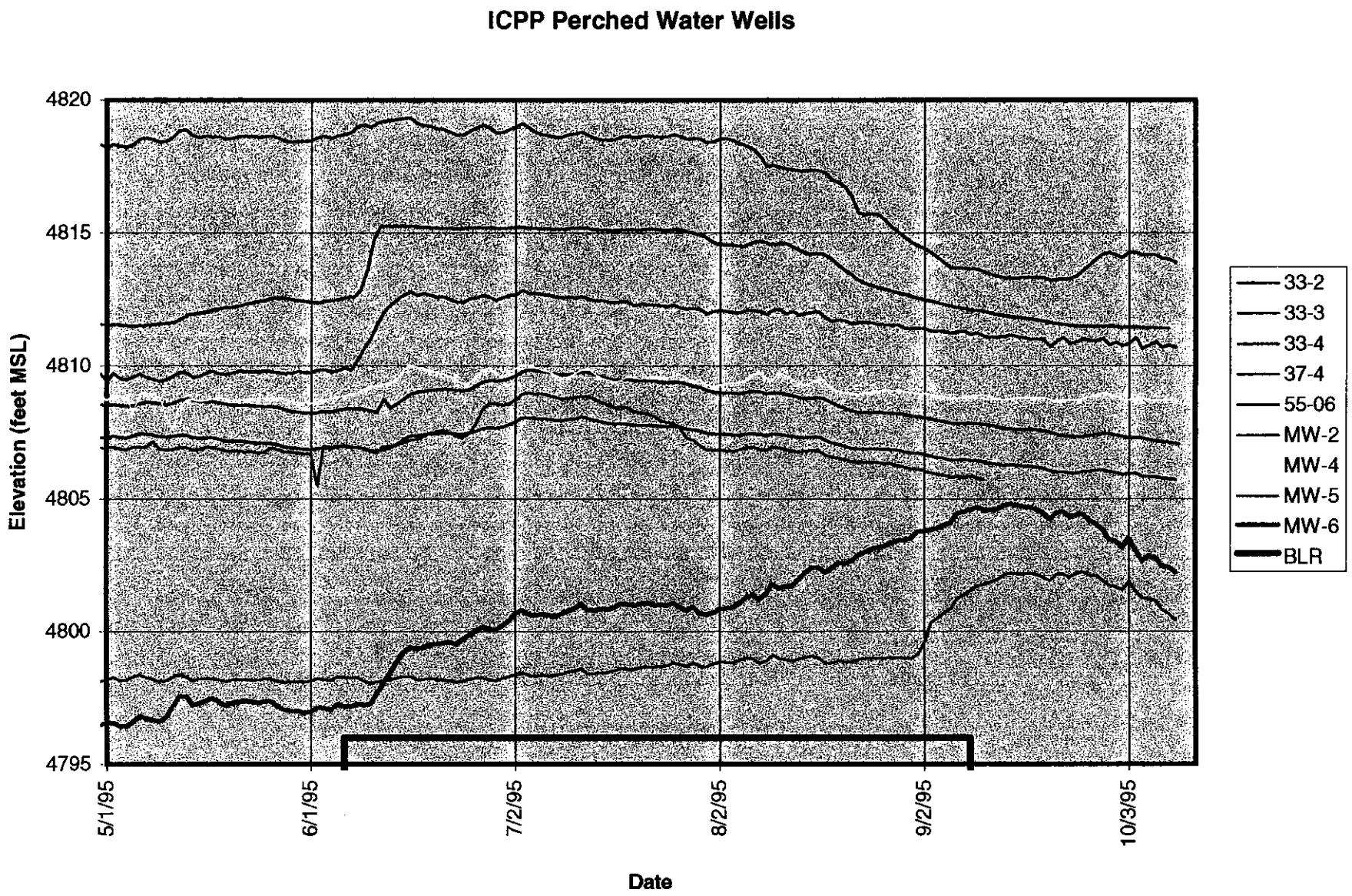


Figure 2-31. Big Lost River discharge vs. upper perched ground water levels (1995).

Table 2-16. Summary of upper perched groundwater level response to discharge in the Big Lost River.

Well	Well distance to BLR (feet)	Depth to water (ft bgs)	Water level increase (feet)	Water level response (days)	Estimated travel[a] (ft/day)
CPP 33-4	1,429	99	2.4	3	477
CPP 37-4	2,286	101	2.3	3	763
CPP 55-06	2,500	104	0.3	9	278
MW-2	2,143	104	0.4	6	358
MW-4	2,500	102	0.9	3	834
MW-5	2,071	109	0.5	8	259
MW-6	1,214	119	1.9	5	244
Average					459

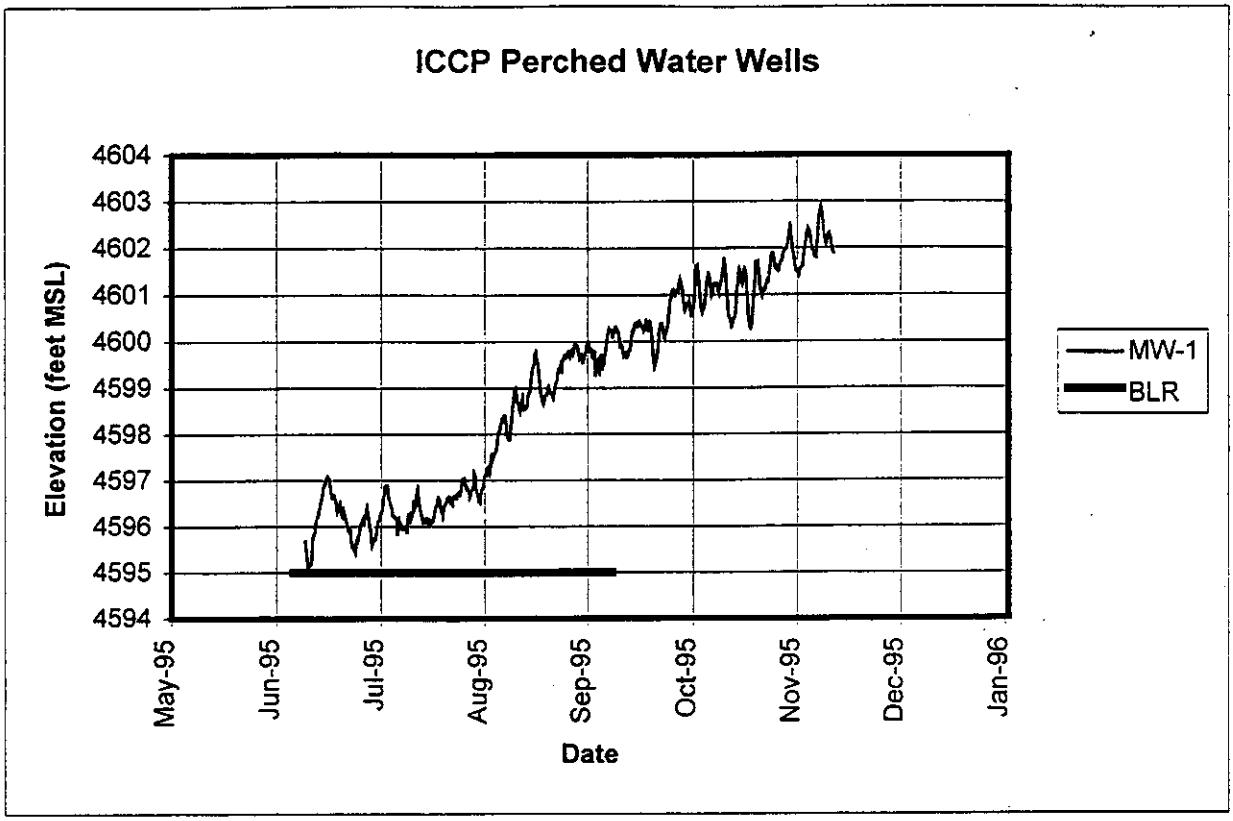
a. Rate assuming straight line.

monitoring period for both of these wells. Since historical data are not available, it is uncertain whether this increase in water level is attributable to the Big Lost River or some other factor.

2.6.1.6 Physical and Hydrologic Properties (Perched Water Zone). Aquifer tests have been performed on nine wells completed in the upper perched water zone. Single well pumping tests using the drawdown and recovery data were performed on Wells CPP 33-2, CPP 33-3, CPP 33-4, and CPP 55-06. Saturated zone hydraulic conductivities were calculated using the Cooper-Jacob analytical technique (Hubbell, 1992 and Bishop, 1992). Slug tests were performed on Wells MW-1, MW-2, MW-4, MW-5, and MW-6. These data were also evaluated using the Cooper-Jacob analytical technique to determine the saturated zone hydraulic conductivities. A 22-hr pumping test was also performed on Well MW-5 to determine the saturated zone hydraulic conductivity and the response from surrounding wells completed in the upper perched groundwater zone.

Field aquifer tests were performed to determine the hydraulic conductivities for both basalts and sedimentary interbeds (Table 2-17). Hydraulic conductivities determined in the field were fairly consistent, varying only over two orders of magnitude. Field hydraulic conductivities ranged from 3.9×10^{-5} to 2.9×10^{-3} cm/s (0.11 to 8.3 ft/day) with an average of 1.2×10^{-3} cm/s (3.3 ft/day). As shown in Table 2-17, significant differences in hydraulic conductivities were not observed between tests performed on basalts versus tests performed on sedimentary interbeds.

Laboratory testing of the interbed samples was performed to determine the physical properties of the various interbeds. During the drilling operation, interbed samples were obtained from Wells MW-3, MW-4, MW-5, MW-6, MW-7, MW-8, MW-9, and MW-10 (Table 2-18). This table presents a summary of the field data and laboratory results including depth, soil type (from logbooks), moisture content, density, porosity, and saturated hydraulic conductivity. Additionally, this information is grouped by depth into three different



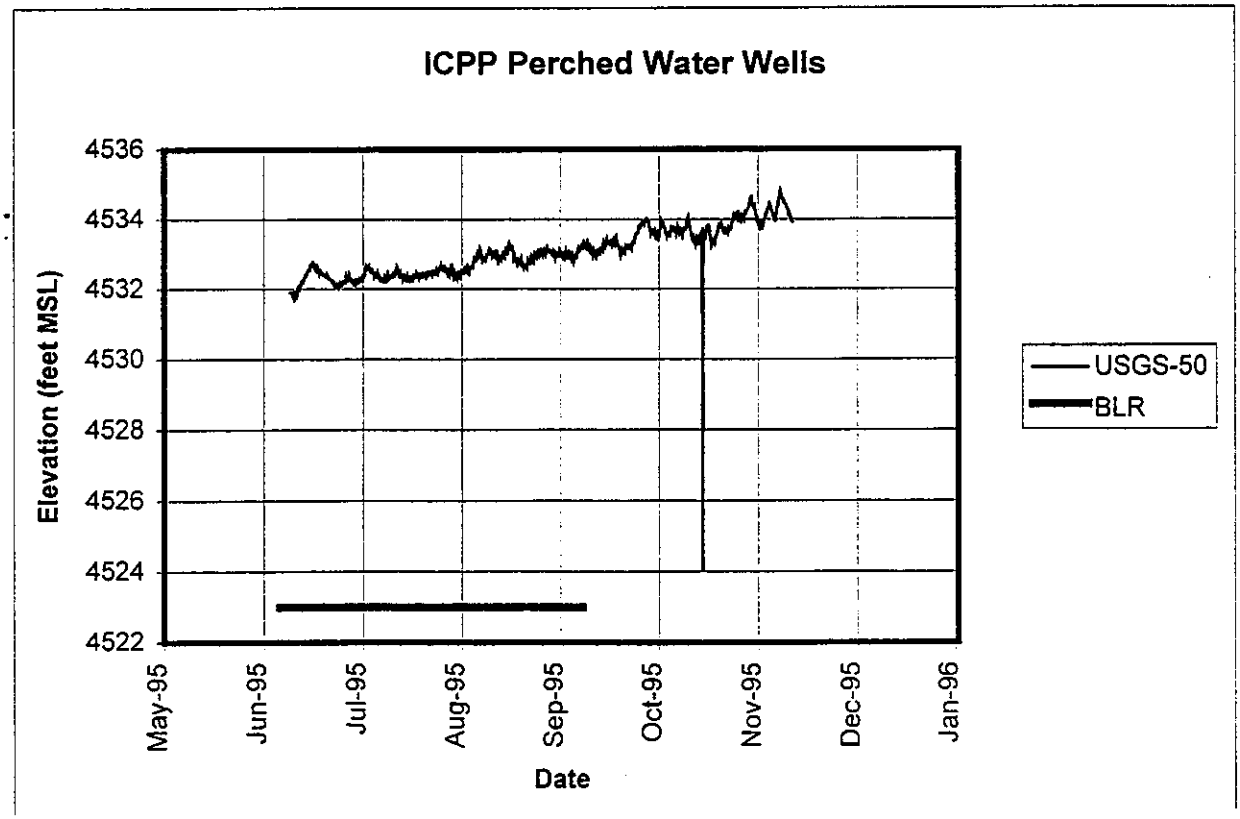


Figure 2-32. Big Lost River discharge vs. lower perched groundwater levels (1995).

Table 2-17. Results of perched water aquifer tests at the ICPP.

Well	Test zone (ft bgs)	Test type	Material	Hydraulic conductivity cm/sec	Hydraulic conductivity ft/day
CPP 33-2	97.8–105.8	Pumping/Recovery	Basalt	1.3×10^{-3}	5.0
CPP 33-3	111.2–121.8	Pumping/Recovery	Basalt	9.5×10^{-4}	2.7
CPP 33-4	103.7–118.2	Pumping/Recovery	Basalt	2.9×10^{-3} (average)	6.9 (average)
CPP 55-06	105.2–113.1	Pumping/Recovery	Basalt	4.2×10^{-4}	1.2
MW-1	326–336	Slug	Basalt	2×10^{-4}	0.57
MW-2	107.9–112	Slug	Sandy clay interbed	1.8×10^{-3} (average)	5.1 (average)
MW-4	104.6–110.6	Slug	Silty sand and gravel interbed	3.9×10^{-5}	0.11
MW-5	115–126.5	Slug	Basalt with small sandy clay interbeds	1.1×10^{-3}	3.1
MW-5	110.8–126.5	22-hr Pumping Test	Basalt with small sandy clay interbeds	1.3×10^{-3}	3.6
MW-6	140–151	Slug	Silty sand, fine grained interbed	1.3×10^{-3} (average)	3.7 (average)
			Average (basalts)[a]	1.2×10^{-3}	3.5
			Average (interbeds)[b]	1.0×10^{-3}	3.0
			Average (all tests)	1.3×10^{-3}	3.3

a. Average is based on Wells CPP 33-2, CPP 33-3, CPP 33-4, CPP 55-06, MW-1, and MW-5.

b. Average is based on Wells MW-2, MW-4, and MW-6.

Table 2-18. Laboratory testing results for the ICPP interbed samples.

Well	Depth (feet)	Interbed	Soil type (logbooks)	Initial moisture content		Dry bulk density (g/cc)	Calculated porosity (%)	Ksat (cm/sec)
				Gravimetric (%,g/g)	Volumetric (%,cc/cc)			
MW-3	117-119.3	CD	silty clay	32.8	42.5	1.29	52.5	8.9E-05
MW-4	108 -109.3	CD	silty sand and gravel	35.9	49.2	1.37	50.2	1.6E-05
MW-7	113.5-114.5	CD	silt with fine gravel	22.7	32.5	1.44	47.0	1.3E-03
MW-8	122.3-123.7	CD	clay with silt	28.0	42.2	1.51	45.0	1.1E-05
MW-10	110.3-111	CD	sandy silt	39.5	50.2	1.27	54.0	1.0E-05
MW-11	113.7-115.3	CD	silty sand	29.5	43.7	1.48	45.9	1.2E-05
MW-4	105.1-105.6	CD	silt	43.8	51.4	1.18	57.6	3.2E-05
MW-4	105.6-106.8	CD	silt	50.8	56.8	1.12	60.9	6.7E-05
MW-6	110-111	CD	clay	33.4	48.3	1.45	47.8	3.0E-07
MW-9	111.6-112.5	CD	clay with silt	28.8	30.1	1.05	61.4	21.E-03
	Average			34.5	44.7	1.33	50.9	3.6E-04
MW-11	135.4-136	D	clay	18.1	33.2	1.83	33.6	5.2E-08
MW-3	138-139	D	silty clay	21.6	30.9	1.43	47.2	8.3E-04
MW-6	142-143	D	silty clay	22.4	30.6	1.36	49.5	2.2E-03
MW-9	148.7-149.4	DE 2	silt with clay	9.5	12.7	1.34	50.3	3.4E-03
	Average			17.9	26.9	1.48	44.6	1.6E-03
MW-1	231.7-232.3	DE 4	sand with silt	15.7	24.8	1.59	41.3	3.3E-04

classes (i.e., interbeds "CD," "D," and "DE2"). The depths are approximately 33.5, 42.7, and 70.1 m (110-, 140-, and 230-ft) bgs. A complete discussion of the sample collection and laboratory data package is described in *Interim Data Results From the FY 93/94 Perched Ground Water Investigation* (February 18, 1994).

The range of hydraulic conductivities determined from the field aquifer tests are within the range of hydraulic conductivities measured in the laboratory. The average hydraulic conductivity determined from the field tests is 1.2×10^{-3} cm/s (3.3 ft/day) compared to an average of 6.9×10^{-4} cm/s (1.96 ft/day) determined from the laboratory tests. Some of the difference between the two hydraulic conductivities may be attributed to the fact that the field tests measured horizontal hydraulic conductivity whereas the laboratory tests measured vertical hydraulic conductivity. Typically, horizontal hydraulic conductivities are higher than the corresponding vertical hydraulic conductivities.

Good correlation in the hydraulic conductivity values occurred from the boreholes where both field and laboratory measurements were performed. From the same zone in Well MW-4, the average hydraulic conductivity determined in the laboratory was 3.81×10^{-5} cm/s (0.1 ft/day) compared to the field determined value of 3.9×10^{-5} cm/s (0.11 ft/day). Similarly in Well MW-6, the hydraulic conductivity determined in the laboratory was 2.2×10^{-3} cm/s (6.2 ft/day) compared to the field determined value of 1.3×10^{-3} cm/s (3.7 ft/day). These two wells are the only locations where both field and laboratory measurements were performed.

The physical property data collected from the interbeds at the ICPP were compared to similar data collected at other INEEL facilities (Table 2-19). This table provides minimum, maximum, and average values of saturated hydraulic conductivity, density, porosity, and Van Genuchten parameters for the three ICPP interbeds and interbeds at the TRA and RWMC. A significant range of values is apparent in this table, however, the physical properties data collected on the ICPP interbeds are in good agreement with the data collected at other INEEL facilities.

2.6.1.6.1 MW-5 Pumping Test Results—A constant rate pumping test was performed on Well MW-5, which is completed in the upper perched groundwater zone. The well was pumped at a rate of 11.4 L/min (3 gpm) for 22 hr after which, the pump was turned off and the water level recovery data monitored. Figure 2-33 provides the drawdown and recovery data for the test. In addition to monitoring the pumping well, water levels in wells MW-2, MW-4, MW-6, CPP 33-2, CPP 33-3, CPP 33-4, CPP 37-4, and CPP 55-06 were recorded at 1-min intervals throughout the duration of the test.

For the first 400 min into the test, drawdown in Well MW-5 was similar to an expected "Theis-type" curve where the rate of drawdown decreases exponentially. An increase in drawdown was noted for the next 100 minutes where a maximum drawdown of approximately 3 m (10 ft) was recorded at 500 min into the test. The additional 2 feet of drawdown observed at approximately 500 minutes into the test probably represents a local boundary condition caused by a much lower permeability stratum of interbed material which could not provide sufficient recharge to the well at the constant discharge rate. Water levels in Well MW-5 increased for the next 100 minutes to a drawdown of 2.4 m (8 ft). This level corresponds to the level that would have been expected if the water level response were to follow a "Theis-type" response. Drawdown in the latter portion of the test (600 to 1,300 min) increased more that what would be expected assuming a "Theis-type" response. The increased drawdown in the middle portion of the test may be the result of local boundary effects caused by heterogenous sedimentary interbed material. The well recovered to approximately 0.2 m (0.5 ft) of the prepumping levels and maintained the constant level for several days.

Table 2-19. Comparison of the physical properties data for the interbeds from ICPP, TRA, and RWMC.

Interbed or INEEL facility	Approx depth (ft)	Ksat (cm/sec)	Dry bulk density (g/cc)	Porosity	Van Genuchten Parameters				
					Sat. water content	Res. water content	alpha	n	r-squared
"CD" interbed	110	3.7E-05	1.33	50.9	0.50 0.0	0.00	0.0025	1.43	0.96
(range of values)		(3.0E-07 to 1.3E-03)	(1.05 to 1.51)	(45.0 to 61.4)	(0.43 to 0.64) 0		(0.00012 to 0.25)	(1.12 to 2.70)	(0.88 to 1.00)
D interbed	140	1.3E-04	1.48	44.6	0.46	0.0036	0.24	1.63	0.97
(range of values)		(5.2E-08 to 3.4E-03)	(1.34 to 1.83)	(33.6 to 50.3)	(0.36 to 0.55)	(0.00 to 0.82)	(0.0021 to 0.078)	(1.20 to 2.71)	(0.95 to 0.99)
deep interbed	230	3.3E-04	1.59	41.3	0.43	0.041	0.052	1.29	0.99
(range of values)		—	—	—	—	—	—	—	—
TRA	—[a]	1.4E-06	1.66	38.4	0.42	—	—	—	—
(range of values)		(1.7E-08 to 1.4E-03)	(1.24 to 2.13)	(20.4 to 54.8)	(0.31 to 0.57)	—	—	—	—
RWMC	—	7.6E-05	—	—	—	—	—	—	—
(range of values)		—	—	—	—	—	—	—	—

a. — = no value.

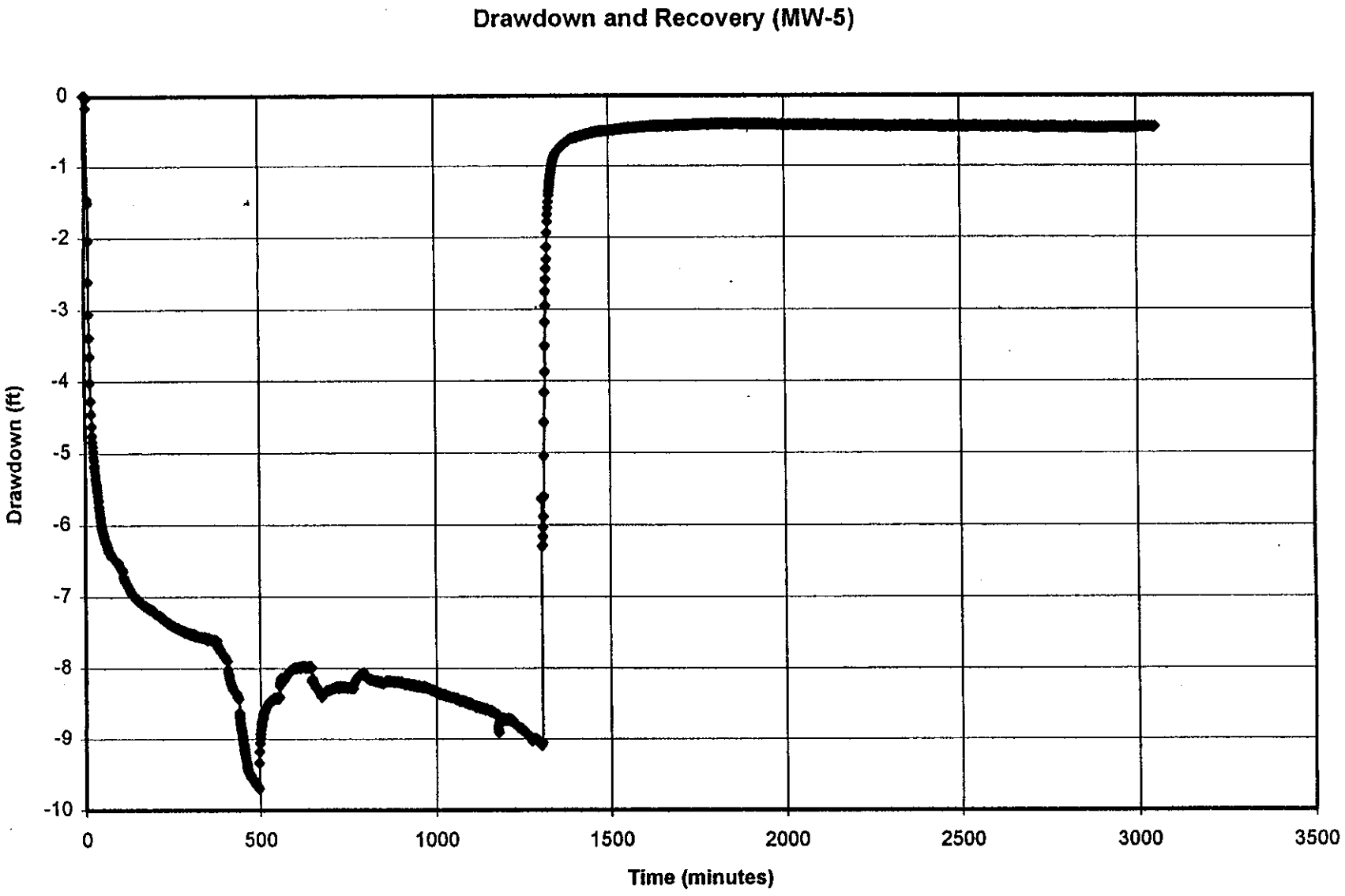


Figure 2-33. Drawdown and recovery data for the Well MW-5 pumping test.

As stated earlier, the water level in eight wells completed in the upper perched groundwater were monitored at 1-minute intervals throughout the duration of the test. The groundwater elevations in these observation wells did not respond to discharge from Well MW-5 as shown in Figure 2-34. Overall, water elevations in the observation wells increased (i.e., negative drawdown) during the first half of the test and then decreased for the remainder of the monitoring period with no correlation to the pumping test.

The drawdown data from the pumping well (MW-5) was evaluated using the Jacob straight line method (Figure 2-35) (Fetter, 1980). The early time data (i.e., under 10 min) were not used in the calculation because of water stored in the casing. Schafer (1978) suggests that in many instances the early pumping test data may not fit Jacob's modification of the nonequilibrium theory, and that calculations based on the early drawdown data will be erroneous. When pumping begins, water in the casing is removed first. As the water level in the casing falls, water begins to enter the well from the surrounding formation. Gradually, a greater percentage of the well's yield will be from the aquifer. Based on the height of water in the well at the time of the test, approximately 79 L (21 gal) of water is contained in the well casing and surrounding sand pack. It would take approximately 7 min to purge this volume of water from the well using a pumping rate of 11.4 L/min (3 gpm). Therefore, it is reasonable to ignore the early time data from this test and base the transmissivity calculation solely on the late-time data.

Transmissivity and hydraulic conductivity were calculated using the following equations:

$$T = \frac{264Q}{\Delta s} \qquad (2\text{-}2)$$

$$K = T/b \qquad (2\text{-}3)$$

where

T = transmissivity (gpd/ft)

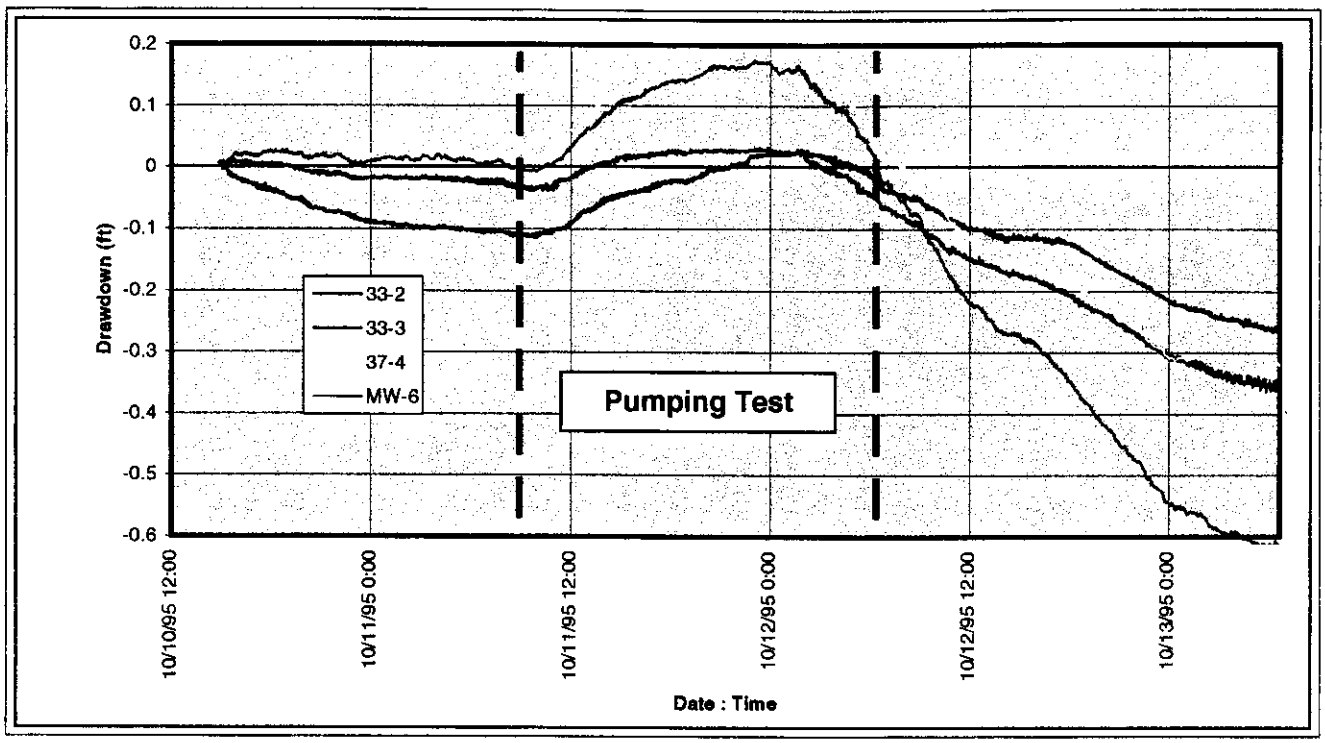
Q = discharge (gpm)

s = drawdown (ft)

K = hydraulic conductivity (gpd/ft^2)

b = saturated thickness (ft).

Based on these equations and a saturated thickness of 4.8 m (15.7 ft), the transmissivity and hydraulic conductivity are 419.6 gpd/ft and 1.3×10^{-3} cm/s (3.6 ft/day), respectively. The hydraulic conductivity determined from the pumping test correlates very well with the hydraulic conductivity of 1.1×10^{-3} cm/s (3.1 ft/day) determined from the slug test.



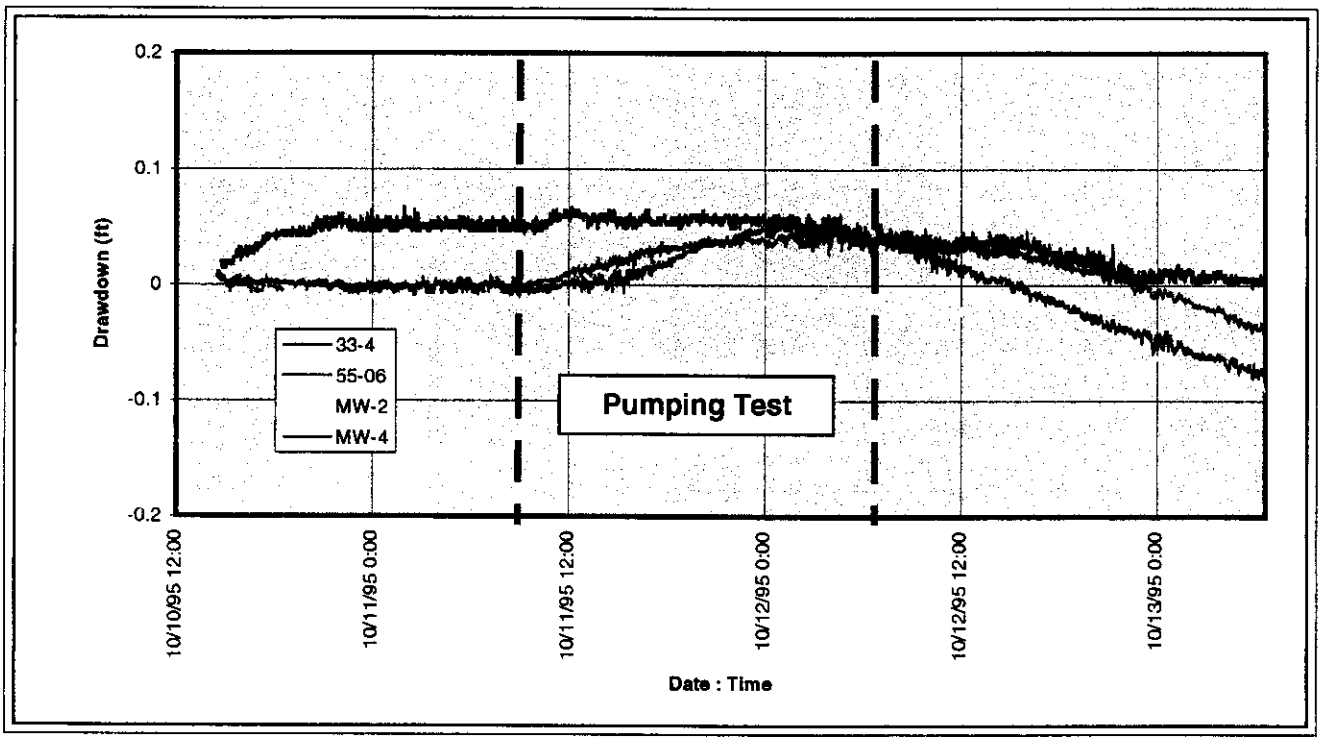


Figure 2-34. Water level response in the perched water wells monitored during the pumping test.

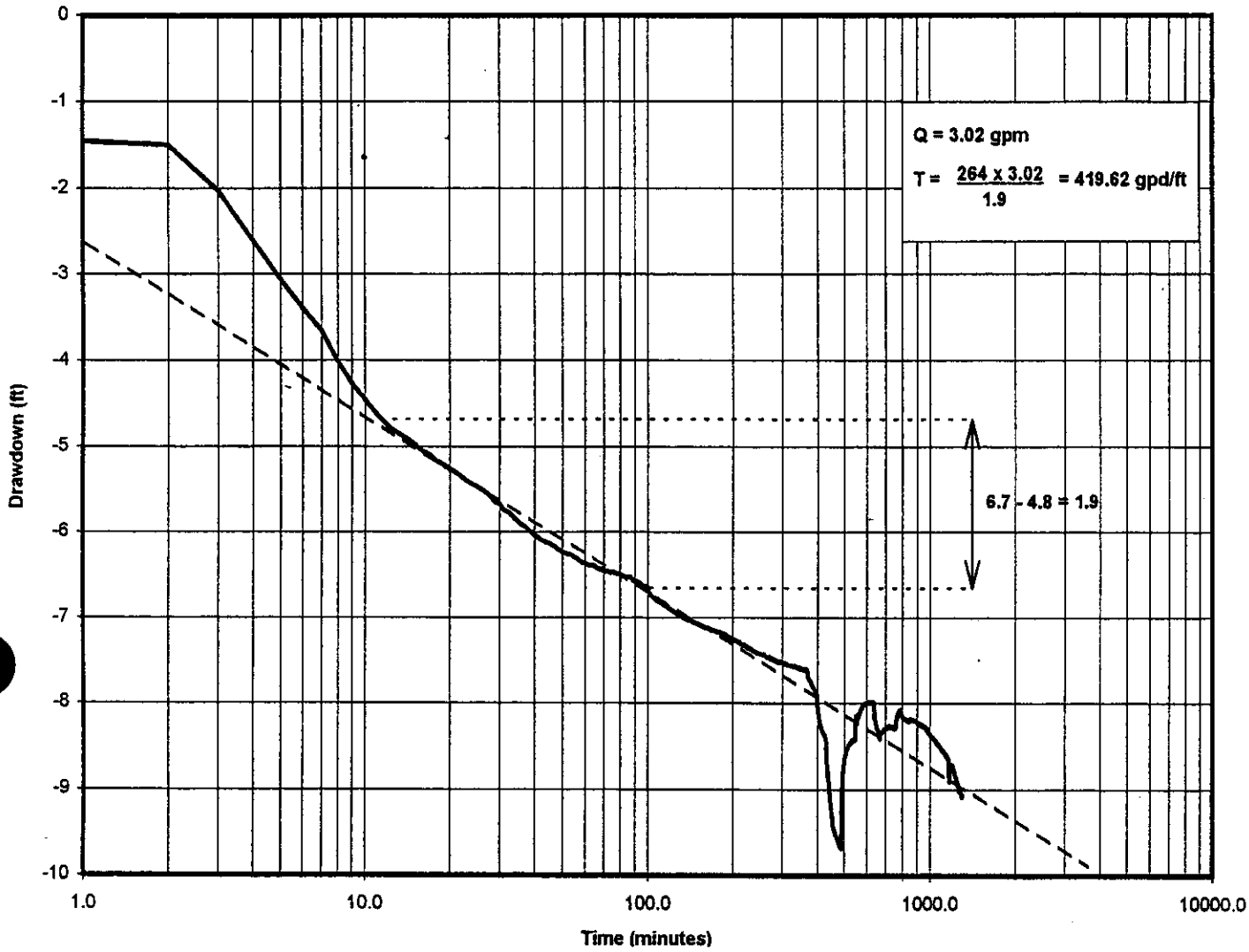


Figure 2-35. Drawdown data from the Well MW-5 pumping test.

2.6.2 Snake River Plain Aquifer

Thirty-three monitoring wells have been installed by the USGS around the ICPP to characterize the occurrence, movement, and quality of water in the SRPA. The monitoring well network was designed to determine hydraulic-gradient changes that influence the rate and direction of groundwater and waste-constituent movement in the SRPA, identify sources of recharge to the aquifer, and measure the effect of recharge (Orr and Cecil, 1991). The location of the observation wells, frequency of water-level measurements, and frequency of water sample collection are shown in Figure 2-36.

2.6.2.1 Groundwater Flow. As part of the WAG 3 RI, a complete round of water level measurements was recorded for the wells completed in the SRPA (Table 2-20). This table includes the measured water depth, borehole deviation information (if available), and a corrected depth to water based upon the borehole deviation. Subsequently, the water level elevations listed in Table 2-20 are corrected for borehole deviation and use the most recent INEEL well survey data. Based on these measurements, the groundwater flow down gradient of the ICPP during May, 1995 is shown in Figure 2-37. Overall, the local groundwater flow is to the south-southwest, consistent with the regional groundwater flow as discussed in Section 2.5.1.

The water level elevations indicate two separate sources of local recharge to the SRPA. One source for recharge is apparently from the percolation ponds as indicated by elevated water levels measured in Wells USGS-51, -112, -113, -114, -115, and -116. Water level response to recharge from these ponds is indicated by a 0.6 m (2 ft) increase in Well USGS-113 and a 0.3 m (1 ft) increase in Well USGS-51. The water table in the SRPA down gradient from the percolation ponds has a bimodal shape, indicating a preferred flow direction toward the southwest with a secondary flow component to the southeast. Directly south of the ponds, water levels in Wells USGS-77 and USGS-111 are significantly lower than what would be expected based on the water levels in the adjacent wells. The reason(s) for the anomalously low water levels in these two wells is not attributed to erroneous wellhead elevations or borehole deviation, but rather to local variations in the water-bearing characteristics of the SRPA (see Section 2.6.2.2, Hydraulic Characteristics).

A second possible source of recharge to the SRPA may be indicated by anomalously high water levels measured in Well USGS-47. The water levels measured in Well USGS-47 are consistently 0.3 to 0.6 m (1 to 2 ft) higher than corresponding water levels measured from the surrounding wells. The possible causes of the anomalously high water levels include local recharge, local pumping, vertical hydraulic gradient (i.e., increasing hydraulic head with depth), and/or well completion characteristics.

The local groundwater flow appears complex and is apparently affected by local recharge, variations in hydraulic conductivity, local pumping, and possibly vertical hydraulic gradients. Groundwater directly beneath the ICPP generally flows to the southwest and southeast, with a minor flow component to the south. The local flow pattern likely results from local recharge (i.e., percolation ponds and sewage ponds) that creates the mounding in the water table and possibly from pumpage of the production wells. As the groundwater progresses beyond the influence of the ICPP, it flows toward the southwest. The local hydraulic gradient is low, only 0.2 m/km (1.2 ft/mi) compared to the regional gradient of 0.8 m/km (4 ft/mi).

2.6.2.2 Hydraulic Characteristics. Hydraulic characteristics of the SRPA have been determined from 16 aquifer tests conducted in the vicinity of the ICPP (Ackerman, 1991). Transmissivity is the rate at which water is transmitted through a unit width of an aquifer under a unit gradient. Since transmissivity is the rate

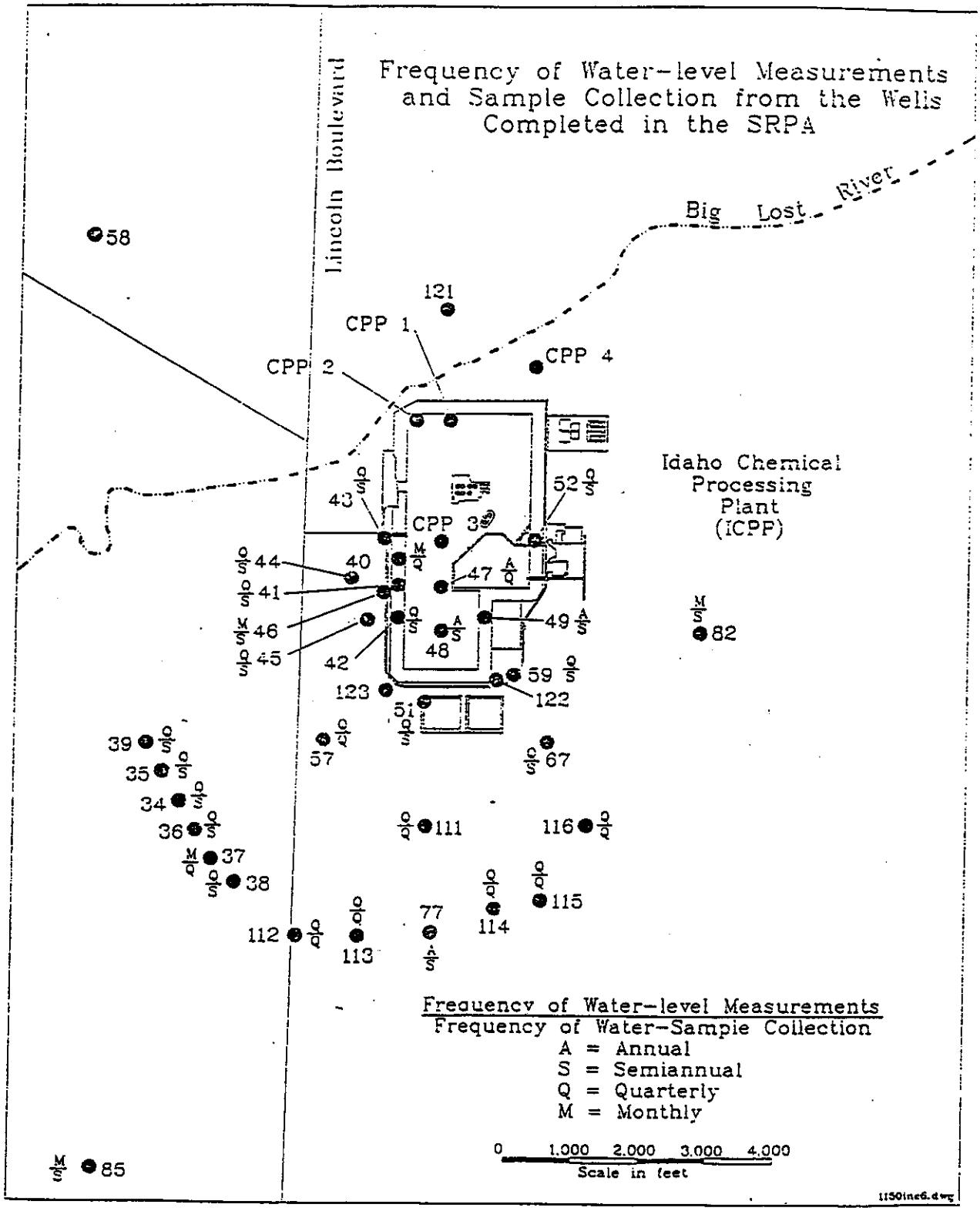


Figure 2-36. Location and frequency of water level measurements, and frequency of water sample collection for the wells completed in the SRPA (USGS).

Table 2-20. Water level measurements in the SRPA (May 1995).

Well	Drilled Depth (ft)	Actual Vertical Depth - Well (ft)	Measured Vertical Depth - Well (ft)	Measured Water Depth (ft)	Actual Water Depth (ft)	Water Level Elevation (ft)
MW-18	479.0	471.96	472.4	464.19	463.75	4453.56
USGS 34	700.0	564.90	565.0	477.33	477.25	4453.02
USGS 35	578.5	479.71	480.0	477.76	477.47	4453.73
USGS 36	567.1	539.94	540.0	477.48	477.42	4453.01
USGS 37	573.0	550.00	550.0	477.61	477.54	4453.07
USGS 38	729.0	599.94	600.0	478.03	477.98	4453.08
USGS 39	571.9	479.89	480.0	479.16	479.05	4453.13
USGS 40	679.0	No borehole deviation survey.		463.58	463.58	4453.67
USGS 41	674.4	No borehole deviation survey.		464.53	464.53	4453.87
USGS 42	678.5	No borehole deviation survey.		464.83	464.83	4453.89
USGS 43	676.0	No borehole deviation survey.		465.58	465.58	4451.25
USGS 44	650.0	No borehole deviation survey.		465.58	465.58	4453.79
USGS 45	651.2	No borehole deviation survey.		467.41	467.41	4452.40
USGS 46	650.9	No borehole deviation survey.		468.10	468.10	4449.53
USGS 47	652.0	Deviation noted as insignificant.		461.34	461.34	4455.11
USGS 48	750.0	No borehole deviation survey.		464.16	464.16	4453.99
USGS 49	656.0	No borehole deviation survey.		NA	NA	NA
USGS 51	659.0	No borehole deviation survey.		466.77	466.77	4454.10
USGS 52	650.0	No borehole deviation survey.		457.75	457.75	4453.92
USGS 57	732.0	No borehole deviation survey.		471.80	471.80	4452.64
USGS 59	657.0	No borehole deviation survey.		461.44	461.44	4453.45
USGS 67	698.0	No borehole deviation survey.		462.34	462.34	4453.42
USGS 77	610.0	No borehole deviation survey.		471.26	471.26	4452.75
USGS 82	700.0	No borehole deviation survey.		454.94	454.94	4453.66
USGS 84	505.0	No borehole deviation survey.		486.56	486.56	4453.03
USGS 85	637.0	No borehole deviation survey.		489.07	489.07	4452.45
USGS 111	595.0	512.75	520.0	475.98	469.35	4453.40
USGS 112	563.0	546.04	550.0	479.67	476.22	4453.91
USGS 113	564.0	541.39	550.0	480.31	472.79	4454.88
USGS 114	562.0	533.70	540.0	474.02	468.49	4453.85
USGS 115	581.0	546.33	550.0	470.27	467.13	4454.00
USGS 116	580.0	559.47	560.0	464.71	464.27	4454.33
USGS 121	745.8	456.49	458.0	459.12	457.61	4453.86
USGS 122	482.8	478.79	479.3	462.62	462.13	4453.57
USGS 123	744.2	480.10	480.2	468.39	468.29	4453.02
LF2-08	495.0	477.04	480.0	485.79	482.80	4450.34
LF2-09	497.0	479.12	485.0	486.30	480.40	4453.06
LF2-10	765.0	707.52	710.0	484.74	483.05	4450.59
LF2-11	499.0	484.90	485.0	477.60	477.50	4452.67
LF2-12	483.0	474.89	475.0	481.85	481.73	4452.53
LF3-08	510.0	489.96	495.0	494.16	489.13	4452.45
LF3-09	500.0	489.87	490.0	490.59	490.46	4452.31
LF3-10	501.0	489.99	490.0	492.14	492.13	4452.49
LF3-11	492.2	479.97	480.0	NA	NA	NA

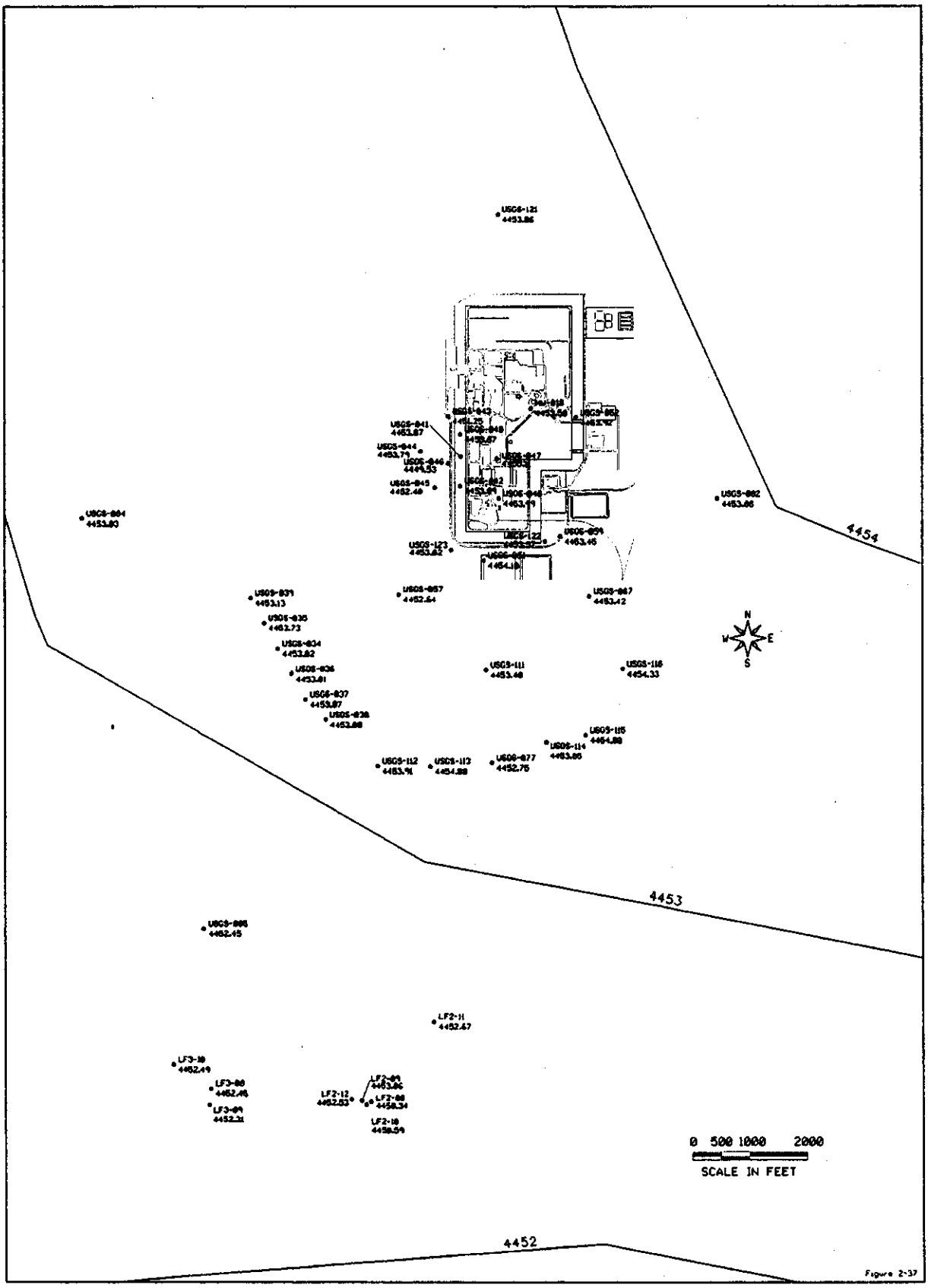


Figure 2-37. Groundwater flow in the SRPA (May 1995).

at which water will be transmitted through a unit width of an aquifer under a unit hydraulic gradient, the values are directly comparable from well to well. The transmissivity values at the ICPP range five orders of magnitude with a maximum transmissivity of 7.0×10^4 m^2/day (7.5×10^5 ft^2/day) at well CPP-3 and a minimum transmissivity of 0.93 m^2/day (10 ft^2/day) at well USGS-114 (Table 2-21). The average transmissivity for the SRPA in the vicinity of the ICPP is $8.8 \times 10^3 \pm 1.8 \times 10^4$ m^2/day ($9.5 \times 10^4 \pm 1.9 \times 10^5$ ft^2/day).

A plot of the SRPA transmissivities at the ICPP is shown in Figure 2-38. This figure indicates two zones of higher transmissivity extend to the southwest and east-southeast of the ICPP Disposal Well. Directly to the south of the ICPP is a region of relative low transmissivities [<93 m^2/day (<1,000 ft^2/day)], indicating lower flow rates through this area. This transmissivity pattern apparently has a big impact on the groundwater flow direction from the ICPP as shown in contaminant distribution maps.

Hydraulic conductivity describes the rate at which water can move through permeable medium. Aquifer hydraulic conductivity is estimated by including the aquifer thickness using the following relationship:

$$K = T/b \qquad (2\text{-}4)$$

where

K = hydraulic conductivity (ft/day)

T = transmissivity (ft^2/day)

b = aquifer thickness (ft).

One problem with estimating hydraulic conductivity by dividing the transmissivity by aquifer thickness for a well in fractured rock aquifers is the hydraulic conductivity could range over several orders of magnitude depending on whether a 0.3-m (1-ft) zone is highly fractured to dense and unfractured. At local scales, the velocity of groundwater movement or the movement of a pollutant is governed by the maximum hydraulic conductivity that would be representative of a fracture or set of fractures in a zone open to a well. Therefore, a calculated velocity using an average hydraulic conductivity can be misleading.

The hydraulic conductivity of the SRPA in the vicinity of the ICPP was estimated using the transmissivity values reported by Ackerman (1991) and the saturated thickness of the open interval of the well (Table 2-21). The estimation of hydraulic conductivity assumes the wells fully penetrate the saturated thickness of the aquifer. Hydraulic conductivities range five orders of magnitude with a maximum hydraulic conductivity of 3.0×10^3 m/day (1.0×10^4 ft/day) at Well CPP-3 and a minimum hydraulic conductivity of 3.0×10^{-2} m/day (1.0×10^{-1} ft/day) at Well USGS-114. The average hydraulic conductivity within the immediate vicinity of the ICPP is $4.0 \times 10^2 \pm 7.9 \times 10^2$ m/day ($1.3 \times 10^3 \pm 2.6 \times 10^3$ ft/day). Using the average hydraulic conductivity, a hydraulic gradient of 1.2 m/km (6.3 ft/mi) (Orr and Cecil, 1991), and an effective porosity of 10%, the calculated seepage velocity in the vicinity of the ICPP is approximately 3 m/day (10 ft/day).

2.6.2.3 Local Flow Velocity. Tritium from the ICPP wastes has been used extensively in tracing groundwater flow velocities and directions (Morris et al., 1964; Hawkins and Schmalz, 1965; and

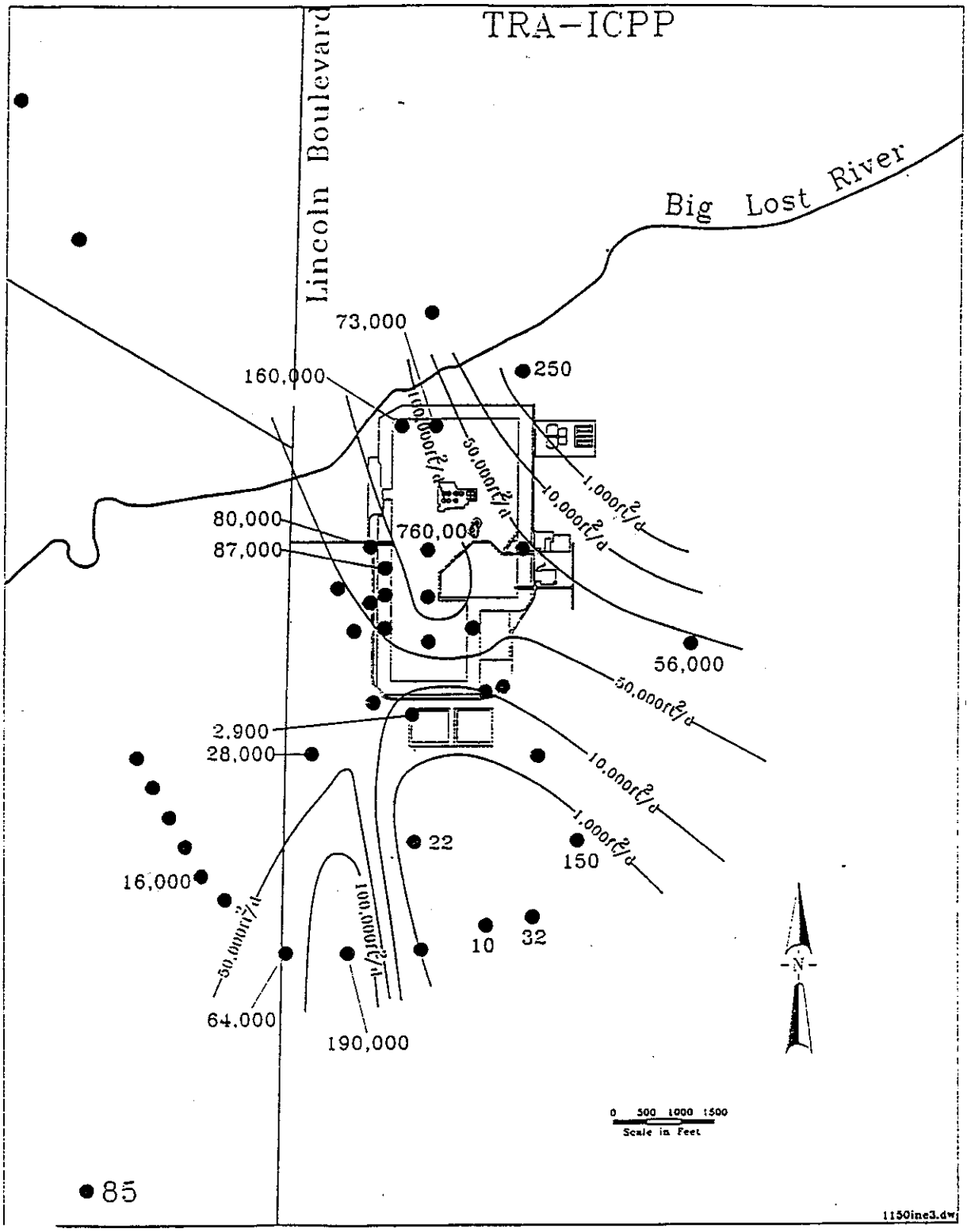


Figure 2-38. Plot of transmissivities in the SRPA near the ICPP.

Table 2-21. Transmissivities in the SRPA near the ICPP (Ackerman, 1991) and estimates of hydraulic conductivity.

Well identifier	Transmissivity (ft^2/day)	Saturated thickness (ft)[a]	Hydraulic conductivity (ft/day)
CPP-1	7.3×10^4	150	4.9×10^2
CPP-2	1.6×10^5	75	2.1×10^3
CPP-3	7.6×10^5	74	1.0×10^4
CPP-4	2.5×10^2	255	9.8×10^{-1}
USGS-37	1.6×10^4	65	2.5×10^2
USGS-40	8.7×10^4	27	3.2×10^3
USGS-43	8.0×10^4	225	3.6×10^2
USGS-51	2.9×10^3	184	1.6×10^1
USGS-57	2.8×10^4	255	1.1×10^2
USGS-82	5.6×10^4	100	5.6×10^2
USGS-111	2.2×10^1	137	1.6×10^{-1}
USGS-112	6.4×10^4	96	6.7×10^2
USGS-113	1.9×10^5	97	2.0×10^3
USGS-114	1.0×10^1	100	1.0×10^{-1}
USGS-115	3.2×10^1	123	2.6×10^{-1}
USGS-116	1.5×10^2	127	1.2×10^0
Maximum	7.6×10^5		1.0×10^4
Minimum	1.0×10^1		1.0×10^{-1}
Average±standard deviation (SD)	9.5×10^4 $\pm 1.9 \times 10^5$		1.3×10^3 $\pm 2.6 \times 10^3$

a. Saturated thickness values are the total saturated portion of the open well intervals.

Barraclough et al., 1967). Peaks of high H-3 discharge to the disposal well have been particularly useful in determining the local flow characteristics in the SRPA. One of the most studied "peak" discharges of H-3 occurred in December 1961 because it was preceded and followed by relatively long periods of low H-3 discharge.

The concentration of the H-3 peak as it passed each observation well provides an indication of the amount of dispersion the slug has undergone. Wells along the most direct line of flow should show the least attenuation in peak concentration. This effect is illustrated in Figure 2-39 where the maximum concentration of the peak from the December, 1961 release was plotted and contoured (Barraclough et al., 1967). The most prominent features are the zones of least attenuation to the southwest (Wells USGS-42, USGS-57, USGS-38, and USGS-85) and a second lobe of higher peak concentrations to the southeast. These lobes indicate two preferred flow paths from the disposal well probably exist; the predominant one to the southwest and a less clearly defined path to the southeast. Some of the explanation for this phenomenon is provided in the plot of the transmissivity values for the ICPP where a zone of low transmissivity is located directly to the south. This zone of low transmissivity to the south apparently acts as a barrier to impede the local groundwater flow.

According to Figure 2-39, the most prominent flow path from the disposal well is to the southwest along Wells USGS-42, USGS-57, USGS-38, and USGS-85. Barraclough et al. (1967) studied the movement of the December 1961 peak down this line of wells and calculated the groundwater flow velocity from the ICPP. Figure 2-40 shows the H-3 concentration with time for these wells. The December 1961 peak is apparent through Well USGS-57, but becomes obscured in Wells USGS-38 and USGS-85. The arrow on the figure indicates the time of arrival for the December 1961 peak (Barraclough et al., 1967).

The behavior of the peak is shown in the following tabulation (Barraclough et al., 1967):

Well	Distance from disposal well (ft)	Groundwater velocity (ft/day)
47	705	25
42	1,340	11.5
48	1,400	12.5
57	3,500	20
38	6,300	12
85	10,400	10

The anomously high value for Well USGS-57 apparently indicates very rapid flow from Wells USGS-42 and USGS-48. The groundwater velocity between Well USGS-47 and Well USGS-42 or USGS-48 would have to be approximately 2.3 m/day (7.5 ft/day), while the average groundwater flow velocity between Well USGS-42 or USGS-48 and Well USGS-57 would have to be approximately 18.3 m/day (60 ft/day). One possible explanation for the extremely high groundwater flow velocity is Wells USGS-42 and USGS-48 are not in the most direct flow path from the disposal well. In this case, the preferred groundwater flow path from the disposal well would occur as a thin band between these two wells.

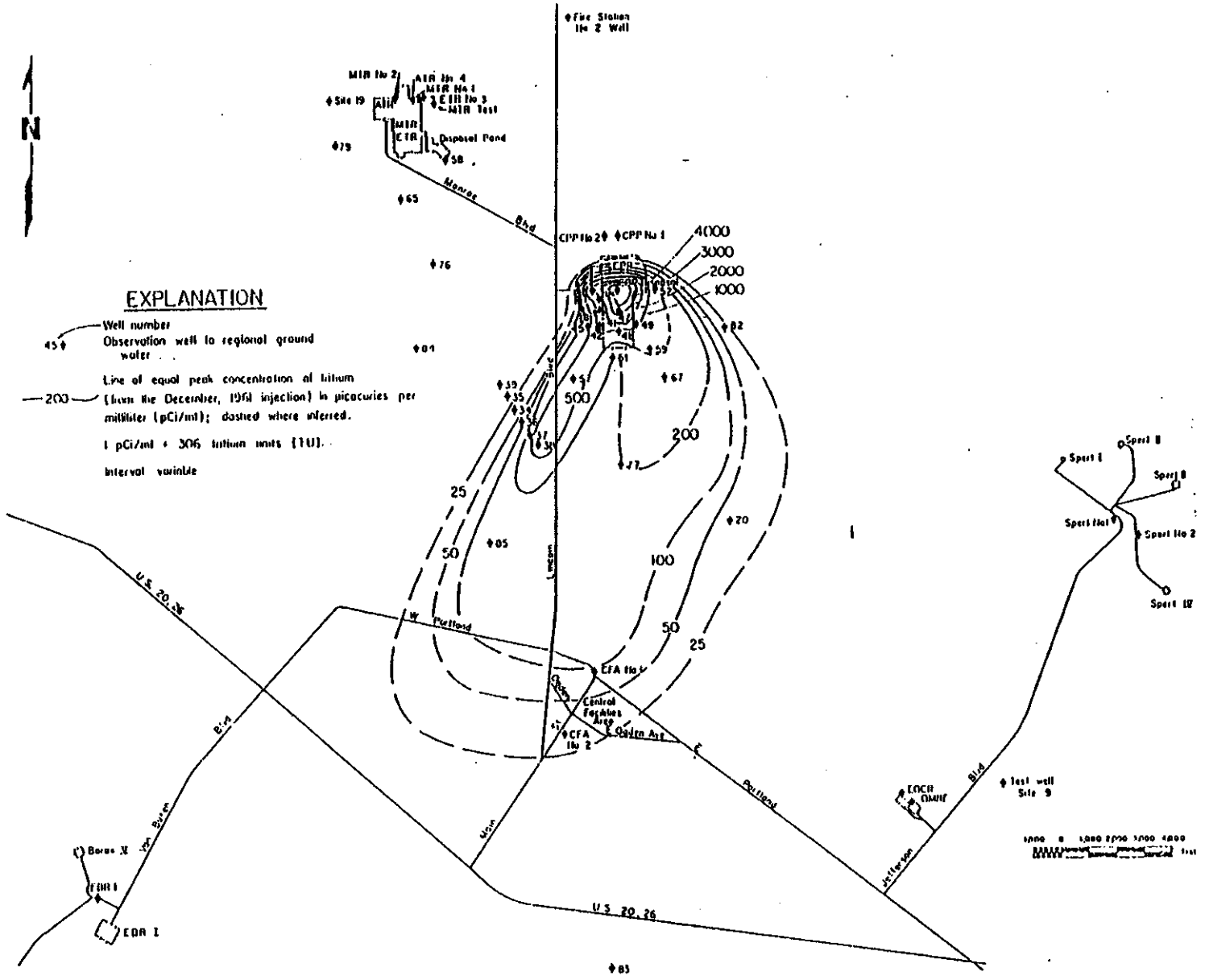


Figure 2-39. Maximum tritium concentrations in the SRPA from the December 1961 release (Barraclough et al., 1967).

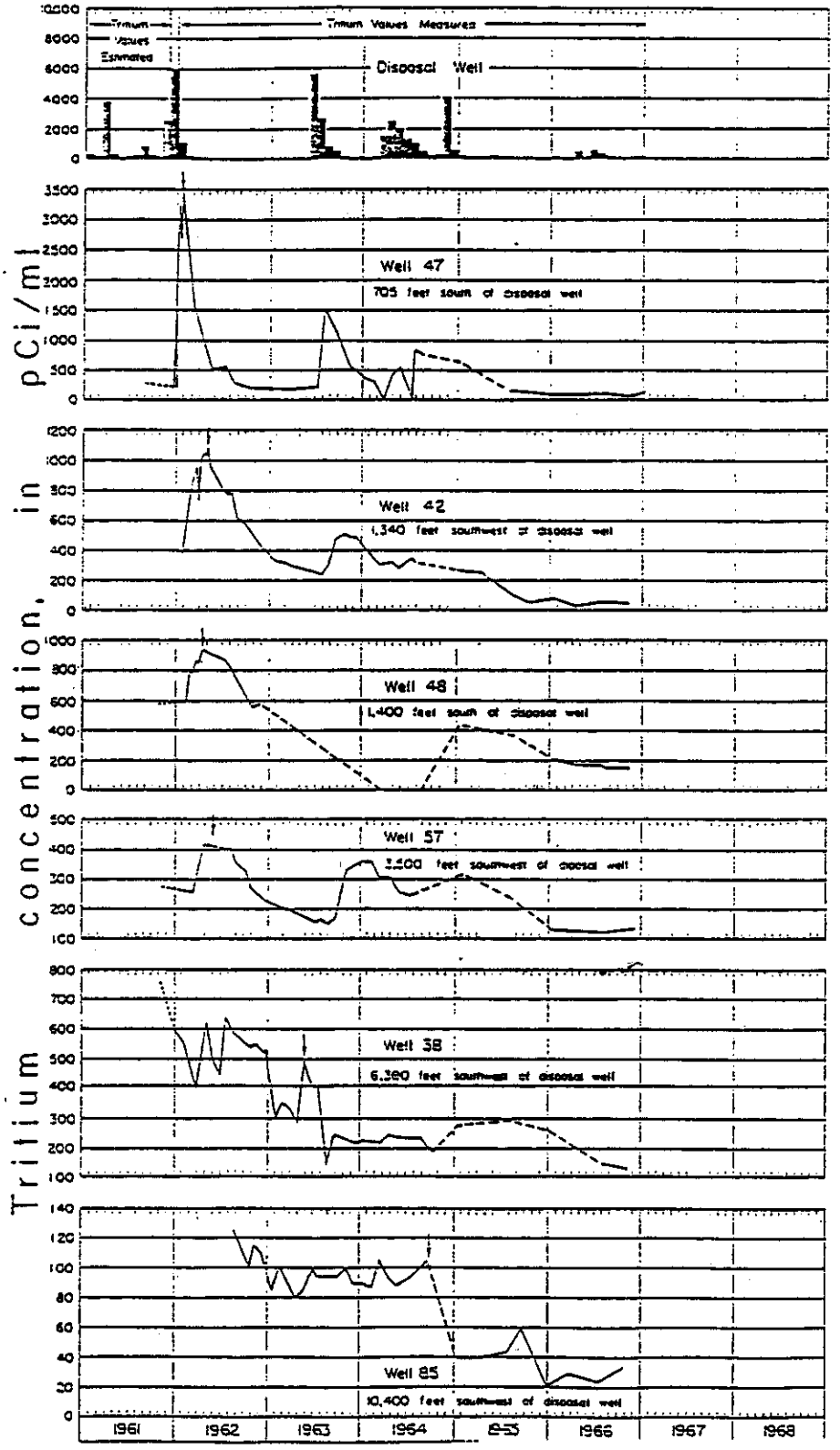


Figure 2-40. Graphs of tritium concentrations in the SRPA Wells USGS-47, -42, -57, -38, and -85 from 1961 through 1966 (Barraclough et al., 1967).

The relatively poor response of Well USGS-38 to the December 1961 peak is probably due to either the well not being located on the most direct flow path or the well being completed in a different portion of the aquifer than the other wells along the line. Most of the other wells are perforated in the upper 76.2 m (250 ft) of the aquifer, whereas, Well USGS-38 is completed in a 15.5-m (51-ft) wide zone between 64 and 79 m (210 and 260 ft) below the water table. This may indicate the majority of the H-3 is being transported in the upper 61 m (200 ft) of the aquifer.

Well USGS-85 also shows a poor response to the December 1961 H-3 peak. It was postulated by Barraclough et al. (1967) that this poor response may be a result of the well not being in the direct flow path and also due to its greater distance from the disposal well.

2.6.2.4 Pumping Effects. The ICPP uses approximately 7.9M L (2.1M gal) of water per day. This water is supplied by two raw water wells (CPP-1 and CPP-2) and two potable water wells (CPP-4 and new well) located in the northern portion of the facility. As part of the WAG 3 RI, the effect of groundwater pumpage from these wells upon the local water table was investigated during July and August 1995. This investigation involved continuous water level monitoring of several aquifer wells completed in the northern ICPP while metering the pump usage in Production Well CPP-2.

Water level fluctuations in six aquifer wells (MW-18, USGS-40, -43, -47, -52, and -121) were monitored at 5-min intervals using pressure transducers and data loggers. Barometric pressure changes were recorded at 5-min intervals by NOAA at the CFA weather station, which is located approximately 5 km (3 mi) from the test site. Pump usage for Well CPP-2 was continuously monitored based on amperage requirements. Plots of the water level fluctuation versus pump usage for this test are provided in Figures 2-41 and 2-42. During the 11 days of the test, the production well pump turned on 17 times with each pump cycle lasting for approximately 9 hr.

The water levels in all aquifer wells exhibited a similar response. Daily fluctuations, generally less than 3 cm (1 in.), were observed in all aquifer wells corresponding with pump usage of the production well. The change in water level for each pump cycle is provided in Table 2-22. In almost all pump cycles, the corresponding water levels in the aquifer wells decreased by an average of 1.9 cm (0.75 in.). Only Pump Cycle #11 demonstrated an increase in water levels throughout the pump duration for all wells except Well USGS-40. This water level increase during this pump cycle may be the result of a local or regional trend and not related to groundwater pumpage. Other than Pump Cycle #11, the water levels decreased during the pump cycle in Wells MW-18, USGS-40, -43, and -52 throughout the test.

The SRPA has been described as "quasi-artesian" by Nace et al. (1959) and therefore, the water levels may be affected by changes in barometric pressure. Plots of the change in barometric pressure versus change in water level (standardized to feet of water) for the six aquifer wells are provided in Figure 2-43. The barometric pressure efficiency for each well was then calculated based upon the linear regression line shown in the figure. The barometric pressure efficiency for Wells MW-18, USGS-40, -47, and -121 were calculated to be 54, 77, 66, and 48%, respectively. For two of the wells (USGS-43 and -52), the linear regression line did not intercept the 0-0 point and as a result, the barometric pressure efficiency could not be calculated for these wells.

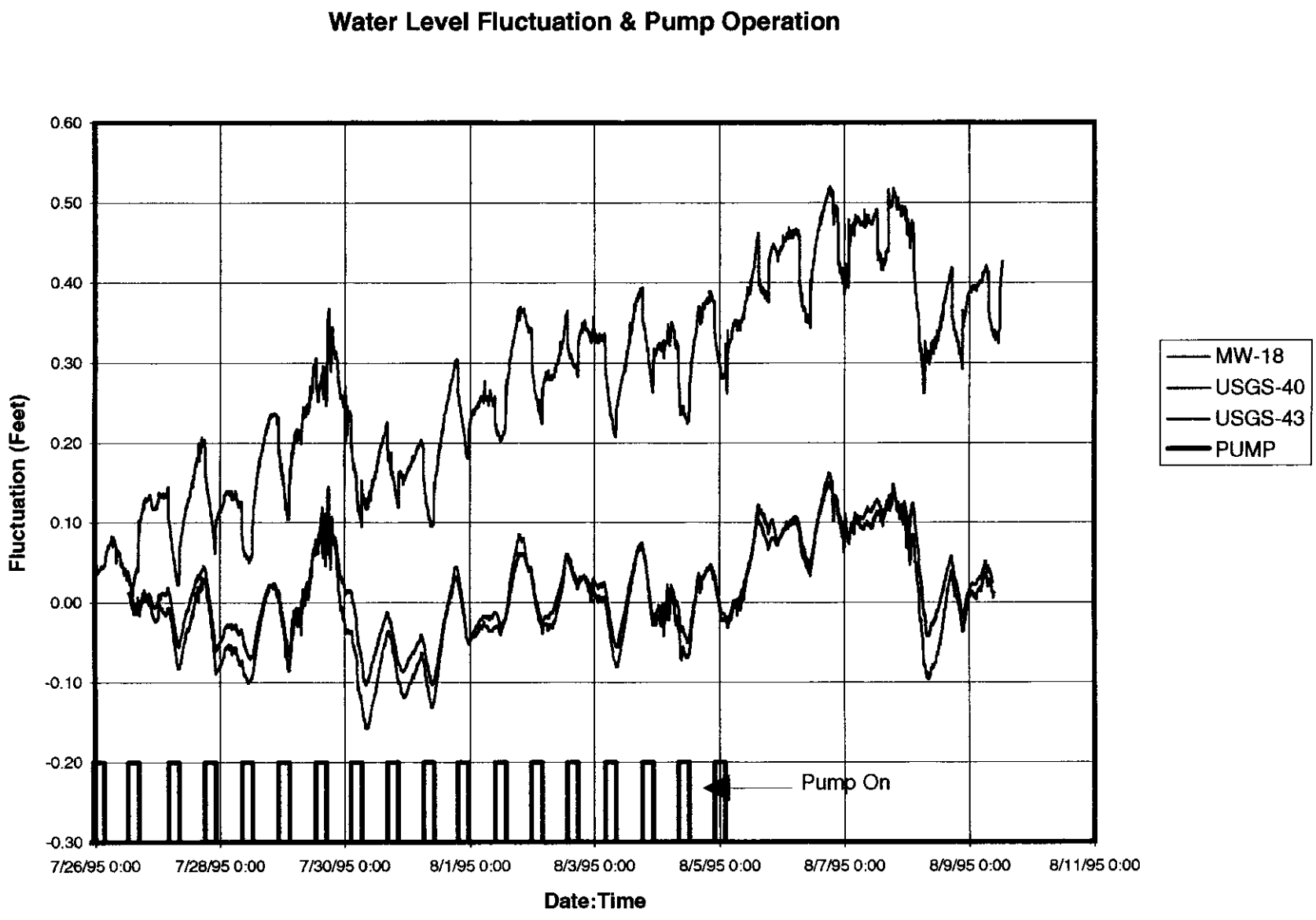


Figure 2-41. Water level response vs. CPP-2 pump usage for Wells MW-18, USGS-42, and -43.

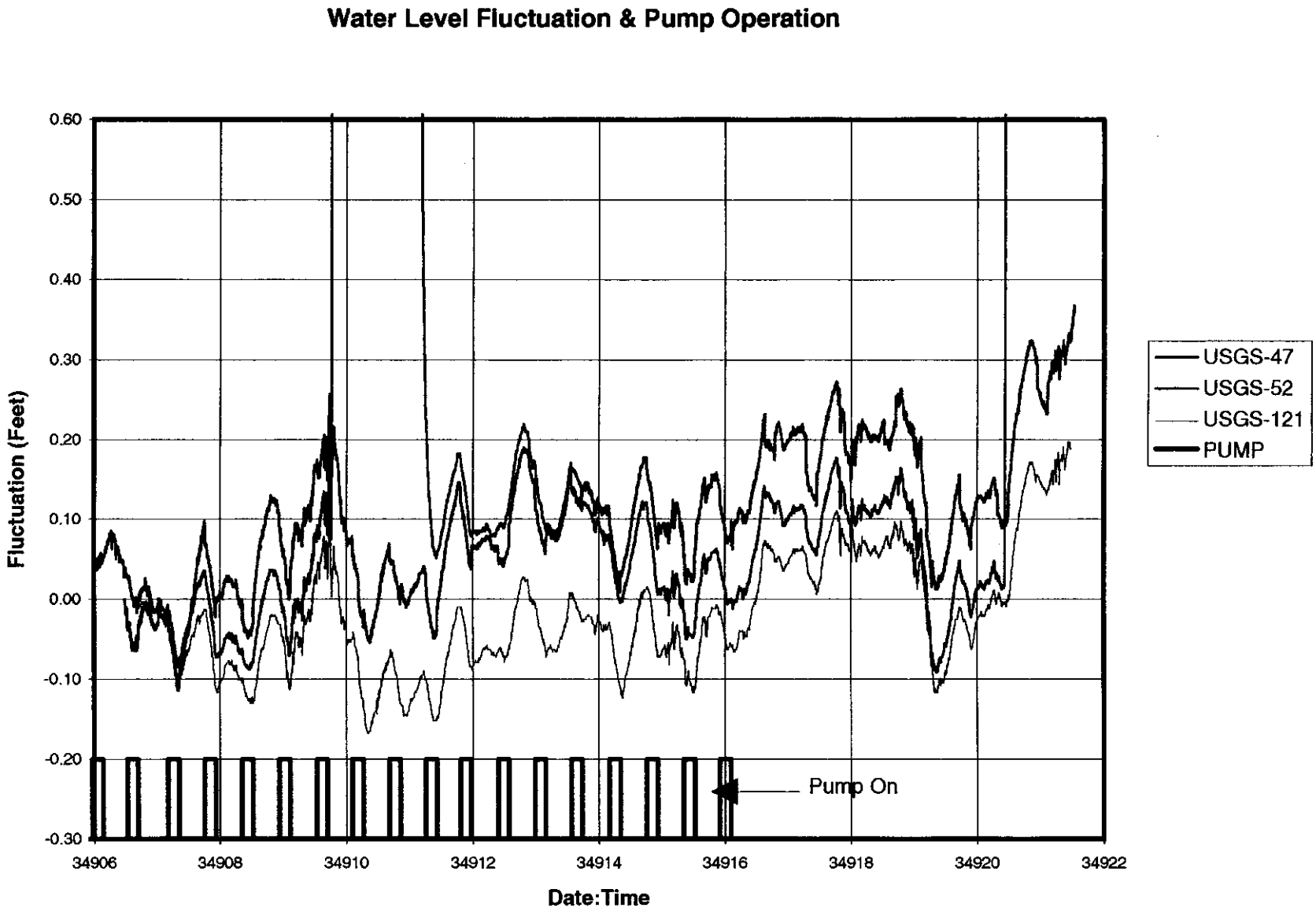


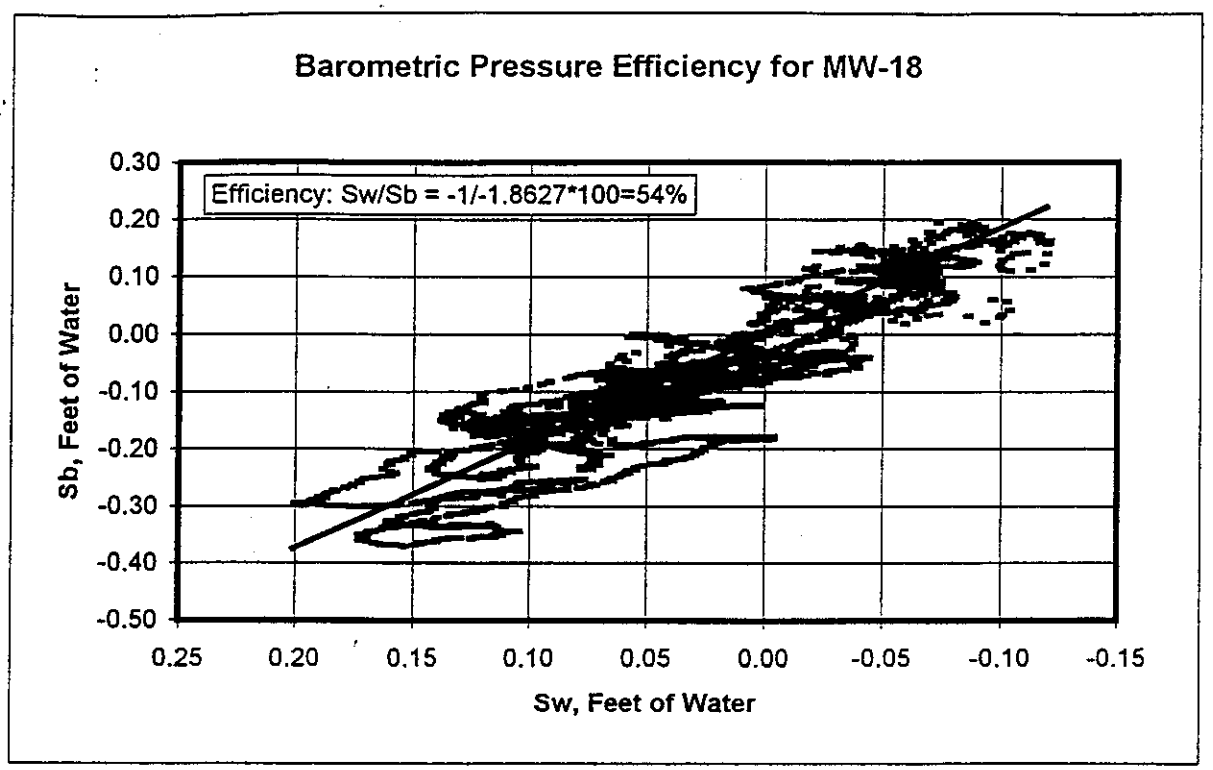
Figure 2-42. Water level responce vs. CPP-2 pump usage for Wells USGS-47, -52, and -121.

Table 2-22. Summary of water level fluctuation for each pump cycle.

	Water Level Fluctuation (including barometric pressure effects)					
Pump Cycle	MW-18	USGS-40	USGS-43	USGS-47	USGS-52	USGS-121
1	-0.02	NA	NA	-0.27	NA	NA
2	-0.08	-0.07	-0.12	-0.07	-0.07	-0.08
3	-0.12	-0.10	-0.11	-0.11	-0.10	-0.10
4	-0.02	-0.03	-0.06	-0.01	-0.01	0.01
5	-0.09	-0.08	-0.08	-0.08	-0.09	-0.08
6	0.00	-0.01	-0.05	0.00	-0.02	0.00
7	-0.10	-0.09	-0.08	-0.14	-0.08	-0.09
8	-0.06	-0.06	-0.11	0.00	-0.05	-0.06
9	-0.05	-0.05	-0.05	-0.15	-0.03	-0.05
10	-0.09	-0.08	-0.01	-0.10	-0.11	-0.08
11	0.01	-0.01	0.00	0.04	0.02	0.01
12	-0.07	-0.07	-0.11	-0.08	-0.06	-0.06
13	-0.03	-0.04	-0.08	-0.05	-0.02	-0.03
14	-0.09	-0.08	-0.12	-0.08	-0.06	-0.08
15	-0.10	-0.07	-0.13	-0.11	-0.09	-0.08
16	-0.03	-0.04	-0.05	-0.02	0.00	-0.04
17	-0.05	-0.05	-0.09	-0.05	-0.06	-0.04
Maximum	0.01	-0.01	0.00	0.04	0.02	0.01
Minimum	-0.12	-0.10	-0.13	-0.27	-0.11	-0.10
Average	-0.06	-0.06	-0.08	-0.08	-0.05	-0.05

	Water Level Fluctuation (without barometric pressure effects)					
Pump Cycle	MW-18	USGS-40	USGS-43	USGS-47	USGS-52	USGS-121
1	-0.02	0.00	NA	-0.27	NA	0.00
2	-0.10	-0.10	NA	-0.10	NA	-0.10
3	-0.15	-0.16	NA	-0.15	NA	-0.13
4	0.00	0.00	NA	0.02	NA	0.01
5	-0.09	-0.08	NA	-0.08	NA	-0.80
6	-0.07	-0.10	NA	-0.08	NA	-0.05
7	-0.15	-0.17	NA	-0.21	NA	-0.14
8	0.06	0.11	NA	0.15	NA	0.05
9	-0.04	-0.04	NA	-0.14	NA	-0.37
10	-0.10	-0.09	NA	-0.10	NA	-0.08
11	0.06	0.06	NA	0.09	NA	0.05
12	-0.08	-0.82	NA	-0.09	NA	-0.08
13	-0.01	-0.02	NA	-0.03	NA	-0.02
14	-0.11	-0.12	NA	-0.11	NA	-0.10
15	-0.13	-0.11	NA	-0.14	NA	-0.10
16	0.00	0.00	NA	0.17	NA	-0.01
17	-0.05	-0.05	NA	-0.05	NA	-0.04
Maximum	0.06	0.11	NA	0.17	NA	0.05
Minimum	-0.15	-0.82	NA	-0.27	NA	-0.80
Average	-0.06	-0.10	NA	-0.07	NA	-0.11

NA denotes not available



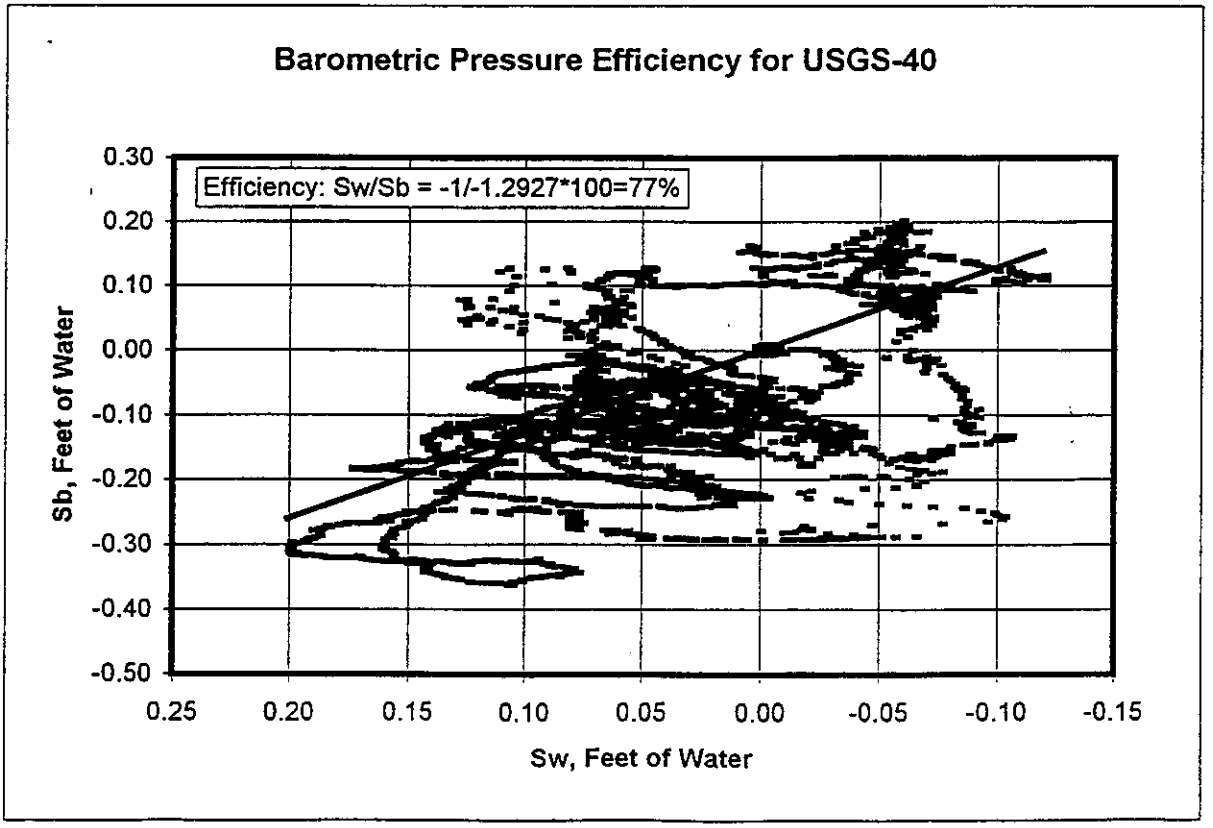
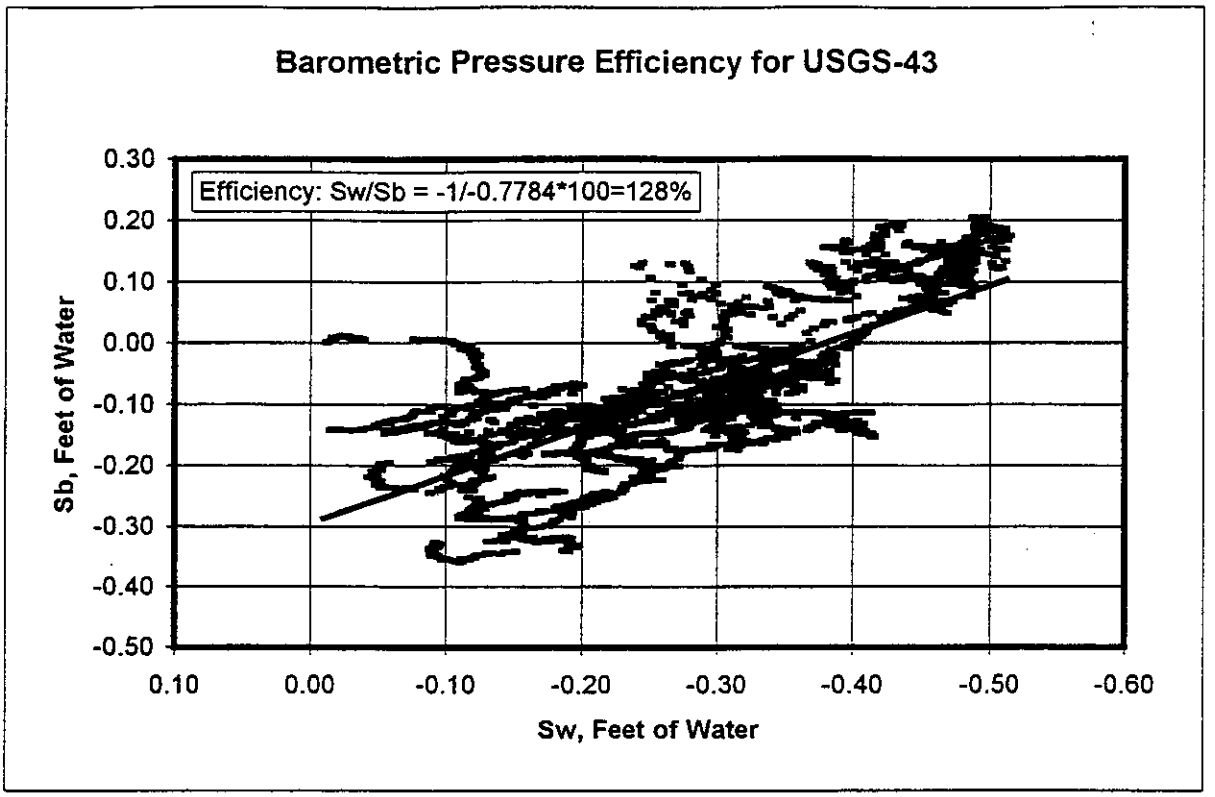


Figure 2-43. Barometric pressure vs. water level fluctuation for Wells MW-18, USGS-40, -43, -47, -52, and -121.



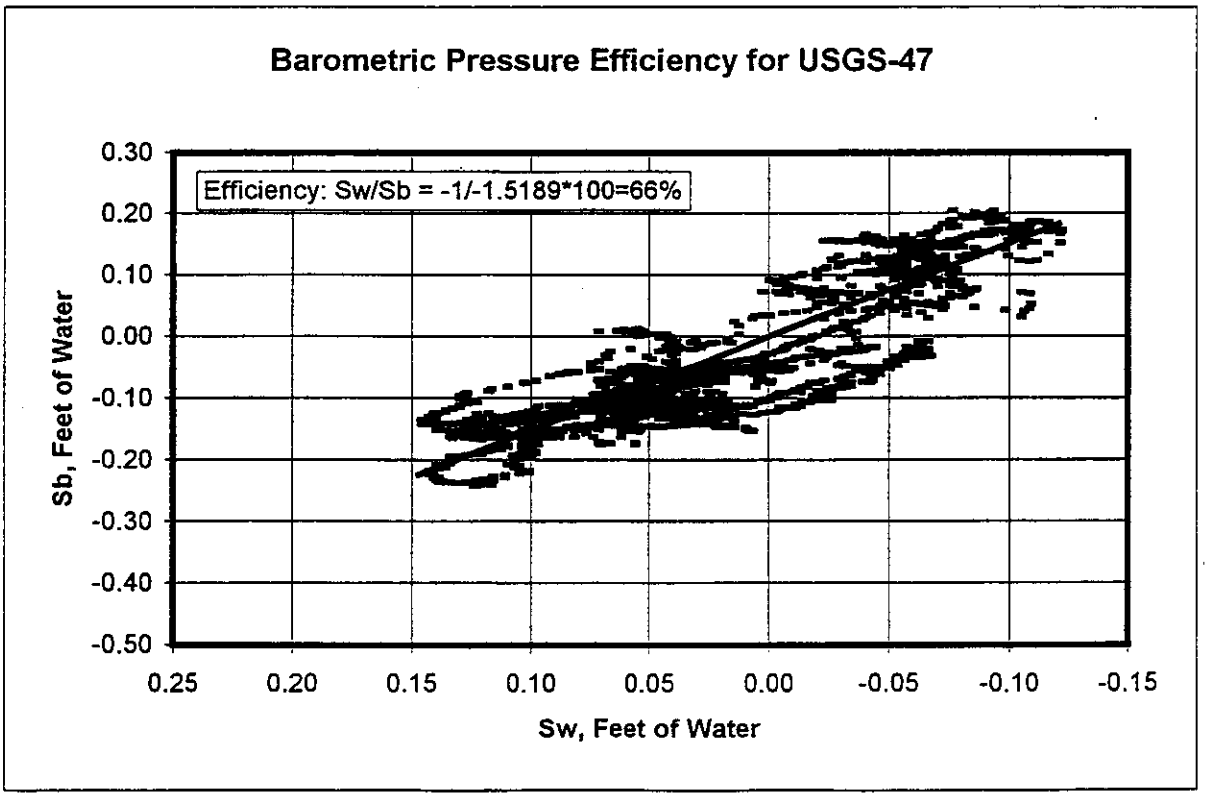
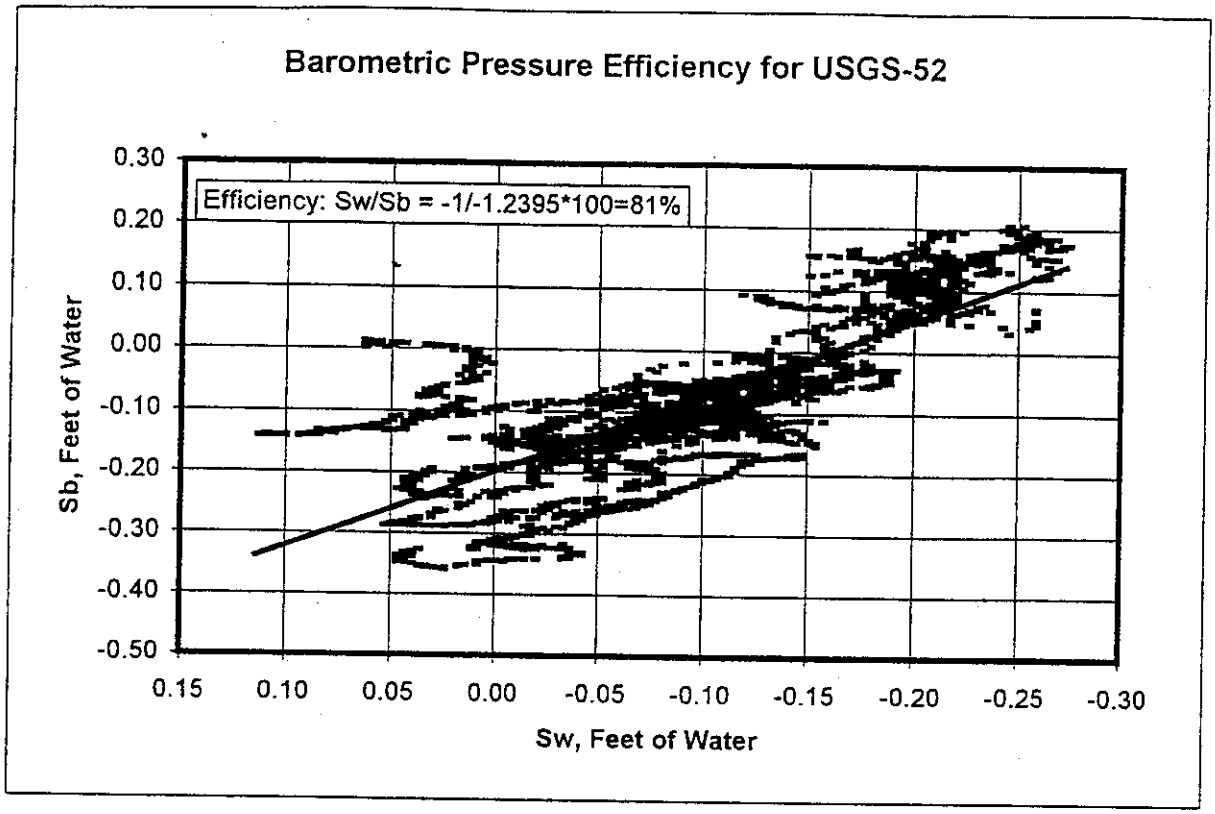


Figure 2-43. (continued).



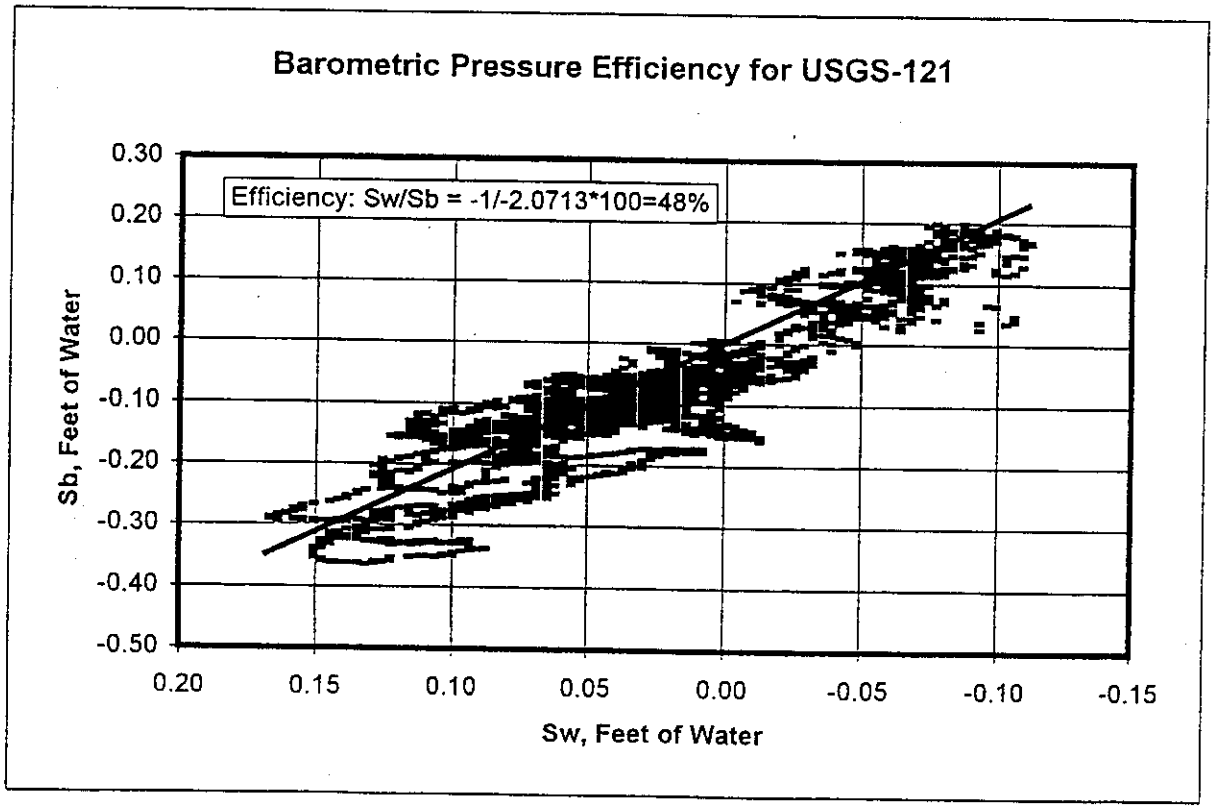


Figure 2-43. (continued).

The effects of barometric pressure upon the water level were eliminated by combining the barometric pressure change during the pump cycle with the barometric pressure efficiency calculated in Figure 2-43. The water level fluctuations without barometric pressure effects for each pump cycle are also provided in Table 2-22. By eliminating barometric pressure effects, water levels in the SRPA decreased during 13 pump cycles, increased during three pump cycles, and demonstrated a mixed response in one pump cycle. Overall, the water level in the SRPA decreased an average of 2.5 cm (1 in.) during each pump cycle.

As shown by this test, water levels in the SRPA are affected by groundwater pumpage from the production well. Minimal responses [<2.5 cm (<1 in.)] were observed in these six monitoring wells, however, the wells are located approximately 610 m (2,000 ft) from the production well. Increased drawdown would be expected closer to the production well that could affect the local groundwater flow direction in the northern ICPP.

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Chapter 3

3. CONTAMINANT ASSESSMENT METHODOLOGY

During the waste area group (WAG) 3 remedial investigation/feasibility study (RI/FS) Work Plan scoping process, U.S. Department of Energy Idaho Operations Office (DOE-ID), Environmental Protection Agency (EPA) Region 10, Idaho Department of Health and Welfare (IDHW)-DEQ, and Lockheed Martin Idaho Technologies Company (LMITCO) WAG 3 project scientists (risk assessors, process engineers, statisticians, etc.) reviewed available information regarding process knowledge, contaminant types and concentrations, site conditions, and potential exposure pathways, and determined that several data gaps existed at some of the operable units (OUs) within WAG 3 that required further investigation and data collection. As part of the RI/FS investigation, additional data collection for the OUs within WAG 3 was performed under the guidance of the *Sampling and Analysis Plan for the Waste Area Group 3 Comprehensive Remedial Investigation/Feasibility Study*. Section 3.1 describes the overall sampling and analysis program implemented to support the RI/FS sampling conducted during the summer of 1995. Sections 3.2 and 3.3 describe the groundwater and soil investigations in more detail and any deviations from the Work Plan are discussed in Section 3.4. The data quality assessment is provided in Section 3.5. It should be noted that all soil field sampling results are summarized separately for each site in Sections 8 though 26 and the groundwater monitoring results are summarized in Section 4. This section of the report does not address the useability of data collected before 1995 by INEEL personnel or other Agencies (i.e., USGS). These data were assumed to have been collected using approved protocol of that time.

3.1 Sampling And Analysis Program

The sampling and analysis program implemented for the WAG 3 RI was detailed in the Sampling and Analysis Plan (SAP) and Quality Assurance Project Plan (QAPjP). Environmental monitoring requirements conducted during the field investigations are described in the Health and Safety Plan (HASP). These documents were included as attachments to the Work Plan. The objective of the program was to obtain sufficient, valid, field data to fill the data gaps identified during the scoping process for the WAG 3 Work Plan. Tables 3-1, 3-2, and 3-3 summarize sampling and analysis performed for the groundwater and soil investigations. The LMITCO Sample Management Office (SMO) procured offsite laboratory services for the WAG 3 sampling and analysis program in accordance with the QAPjP. The chemical analysis program, summarized in Table 3-4, implemented EPA Contract Laboratory Program (CLP) and SW-846 analytical methods and deliverables for nonradioactive chemicals, and *Statement of Work of Radiological Analyses Performed for the Environmental Restoration Department at the INEL (ER-SOW-33)* (EG&G Idaho, 1991) methods and deliverables for radionuclides. The sampling and analysis program consisted of standardized procedures for sample collection, sample handling, analytical methods, data reporting, and quality control. These main features of the program will be described in Sections 3.1.1 through 3.1.5.

3.1.1 Sample Collection Procedures

The following sections describe the general procedures used by field personnel to screen and collect soil and groundwater samples.

3.1.1.1 Field Measurements. All samples were screened in the field using portable instruments for radioactivity. Results from the field screening activities were used to select the soil samples with the highest radioactivity for laboratory analyses. An ambient radiation level was established and used for all soil samples

Table 3-1. Sampling and analysis summary for the perched water wells.

Project: WAG 3 RI/FS INVESTIGATION - PERCHED GROUND WATER						ANALYSIS TYPES														
WELL	SAMPLE DATE	SAMPLE ID	LABORATORY ID	SAMPLE TYPE	DEPTH RANGE	A4	AB	BA	EA	F3	JN	N2	NK	NP	R4	R7	R8	R9	RB	RI
CPP 33-2	17-May-95	31320201	95212916	REG	97.5-105.8	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
CPP 33-4	17-May-95	31320401	9521267	REG	102.85-118.2	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
CPP 37-4	25-May-95	31320501	9523167	REG	103.8-109.9	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
CPP 55-06	7-Jun-95	31320601	95237917	REG	106.25-113.1	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
MW-1	31-May-95	31320701	9506L17401	REG	322.28-336	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
MW-2	5-Jun-95	31320901	95229513	REG	107.49-112	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
MW-4	8-Jun-95	31321201	9524197	REG	105.85-110.6	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
MW-5	2-Jun-95	31321401	9522953	REG	112.5-126.5	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
MW-6	18-May-95	31321501	9521597	REG	122.7-137	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
MW-10	22-Jun-95	31322101	9525335	REG	148.12-151	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
MW-15	9-Jun-95	31322901	9523795	REG	122.85-131.3	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
MW-17	22-May-95	31323101	9521557	REG	190.18-195.2	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
MW-17	31-May-95	31323301	95231816	REG	364.8-381	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
MW-18	15-Jun-95	31323501	9524773	REG	407.63-414	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
MW-20	1-Jun-95	31323601	9523147	REG	137.33-148.4	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
USGS-50	30-May-95	31323801	9523397	REG	384-405	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
MW-5	11-Oct-95	31323901	9536001	REG	START														x	
MW-5	11-Oct-95	31324001	9536002	REG	MIDDLE														x	
MW-5	12-Oct-95	31324101	9536004	REG	END														x	
MW-5	11-Oct-95	31324201	9536003	QC	MIDDLE														x	
USGS-50	30-May-95	31324301	95233716	QC	384-405	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
CPP 33-4	17-May-95	31324401	95215816	QC	102.85-118.2	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
QC	2-Jun-95	31324501	95231616	QC	N/A	x	x		x		x			x	x	x	x	x	x	x
QC	2-Jun-95	31324601	9523357	QC	N/A	x	x		x		x			x	x	x	x	x	x	x

A4: Am-241
AB: Gross Alpha/Beta
BA: Carbonate/Bicarbonate/Total Alkalinity - Unfiltered
EA: Tc-99
F3: Chloride/Fluoride/Sulfate
JN: CLP Metals + Zirconium
N2: Nitrate/Nitrite
NK: Total Kjeldahl Nitrogen/Ammonia
NP: Np-237
R4: Gamma Spectroscopy
R7: Plutonium Isotopic
R8: Tritium
R9: Uranium Isotopic
RB: Strontium-90
RI: Iodine-129

Table 3-2. Sampling and analysis summary for the aquifer wells.

Project: WAG 3 RI/FS INVESTIGATION - SNAKE RIVER PLAIN AQUIFER						ANALYSIS TYPES											
WELL	SAMPLE DATE	SAMPLE ID	LABORATORY ID	SAMPLE TYPE	DEPTH RANGE	A4	AB	EA	JN	NP	R4	R7	R8	R9	RB	RI	GA
MW-18	5-Jun-95	31330101	06L177-008	REG	464.19-479	x	x	x	x	x	x	x	x	x	x	x	
USGS 34	10-May-95	31330201	95204714	REG	477.33-700	x	x	x	x	x	x	x	x	x	x	x	
USGS 35	5-May-95	31330301	95204814	REG	477.76-580.5	x	x	x	x	x	x	x	x	x	x	x	
USGS 36	12-May-95	31330401	9521297	REG	477.48-567.1	x	x	x	x	x	x	x	x	x	x	x	
USGS 37	12-May-95	31330501	95213016	REG	477.61-573	x	x	x	x	x	x	x	x	x	x	x	
USGS 38	16-May-95	31330601	9521307	REG	478.03-729	x	x	x	x	x	x	x	x	x	x	x	
USGS 39	4-May-95	31330701	9520505	REG	479.16-573.9	x	x	x	x	x	x	x	x	x	x	x	
USGS 40	10-May-95	31330801	95212816	REG	463.58-679	x	x	x	x	x	x	x	x	x	x	x	
USGS 41	11-May-95	31330901	9521327	REG	646.53-674.4	x	x	x	x	x	x	x	x	x	x	x	
USGS 44	9-May-95	31331101	9520475	REG	465.58-650	x	x	x	x	x	x	x	x	x	x	x	
USGS 45	19-May-95	31331201	9521607	REG	467.41-651.2	x	x	x	x	x	x	x	x	x	x	x	
USGS 46	31-May-95	31331301	95231714	REG	468.1-654.9	x	x	x	x	x	x	x	x	x	x	x	
USGS 48	9-May-95	31331401	9520491	REG	464.16-752	x	x	x	x	x	x	x	x	x	x	x	
USGS 51	16-May-95	31331601	9521287	REG	466.77-659	x	x	x	x	x	x	x	x	x	x	x	
USGS 52	12-May-95	31331701	95213118	REG	457.75-650	x	x	x	x	x	x	x	x	x	x	x	
USGS 57	17-May-95	31331801	95212316	REG	471.8-732	x	x	x	x	x	x	x	x	x	x	x	
USGS 59	18-May-95	31331901	9521577	REG	470-657	x	x	x	x	x	x	x	x	x	x	x	
USGS 67	18-May-95	31332001	95215516	REG	462-699	x	x	x	x	x	x	x	x	x	x	x	
USGS 77	16-May-95	31332101	95212516	REG	471.26-610	x	x	x	x	x	x	x	x	x	x	x	
USGS 82	9-May-95	31332201	9520485	REG	454.94-700	x	x	x	x	x	x	x	x	x	x	x	
USGS 85	22-May-95	31332301	95215716	REG	489.07-637	x	x	x	x	x	x	x	x	x	x	x	
USGS 111	8-May-95	31332401	95204914	REG	475.98-597	x	x	x	x	x	x	x	x	x	x	x	
USGS 112	19-May-95	31332501	95215616	REG	479.67-563	x	x	x	x	x	x	x	x	x	x	x	
USGS 113	17-May-95	31332601	9521257	REG	480.31-564	x	x	x	x	x	x	x	x	x	x	x	
USGS 114	17-May-95	31332701	9521247	REG	474.02-564	x	x	x	x	x	x	x	x	x	x	x	
USGS 115	15-May-95	31332801	95212717	REG	470.27-581	x	x	x	x	x	x	x	x	x	x	x	
USGS 116	10-May-95	31332901	95213212	REG	464.71-580	x	x	x	x	x	x	x	x	x	x	x	
USGS 121	22-May-95	31333001	95215916	REG	459.12-475	x	x	x	x	x	x	x	x	x	x	x	
USGS 122	31-May-95	31333101	95233516	REG	465-476	x	x	x	x	x	x	x	x	x	x	x	
USGS 123	23-May-95	31333201	9523387	REG	468.39-475	x	x	x	x	x	x	x	x	x	x	x	
LF2-08	25-May-95	31333301	95231416	REG	495	x	x	x	x	x	x	x	x	x	x	x	
LF2-10	11-May-95	31333501	95233816	REG	765	x	x	x	x	x	x	x	x	x	x	x	
LF2-11	3-Aug-95	31333601	9529537	REG	499	x	x	x	x	x	x	x	x	x	x	x	
LF2-12	5-Jun-95	31333701	9523187	REG	489	x	x	x	x	x	x	x	x	x	x	x	
LF3-08	25-May-95	31333801	9523377	REG	510	x	x	x	x	x	x	x	x	x	x	x	
LF3-09	25-May-95	31333901	9523197	REG	500	x	x	x	x	x	x	x	x	x	x	x	
LF3-10	2-Aug-95	31334001	95295316	REG	501	x	x	x	x	x	x	x	x	x	x	x	
USGS-84	12-May-95	31334201	95212614	REG	486.56-505	x	x	x	x	x	x	x	x	x	x	x	
USGS-42	15-May-95	31334301	9521272	REG	464.83-678.5	x	x	x	x	x	x	x	x	x	x	x	
USGS-47	26-Jun-95	31334401	9525214	REG	460.35-652	x	x	x	x	x	x	x	x	x	x	x	
CPP-1	5-Jun-95	31334501	95233916	REG	595	x	x	x	x	x	x	x	x	x	x	x	
CPP-2	5-Jun-95	31334601	95231916	REG	595	x	x	x	x	x	x	x	x	x	x	x	

Table 3-2. (continued).

USGS 47	22-Jun-95	31340601	9525229	REG	462-470.8			x					x		x	x	x
USGS 47	22-Jun-95	31340701	9525235	REG	483-491.8			x					x		x	x	x
USGS 47	23-Jun-95	31340801	95252415	REG	511.5-520.8			x					x		x	x	x
USGS 47	23-Jun-95	31340901	95252410	REG	558-566.8			x					x		x	x	x
USGS 47	23-Jun-95	31341001	95252220	REG	576-584.8			x					x		x	x	x
USGS 47	23-Jun-95	31341401	95252215	REG	596-604.8			x					x		x	x	x
USGS 36	12-May-95	31334801	95212410	QC	477.48-567.1	x	x	x	x	x	x	x	x	x	x	x	
USGS 121	22-May-95	31334901	9521567	QC	459.12-475	x	x	x	x	x	x	x	x	x	x	x	
USGS-67	18-May-95	31335001	9521587	QC	462.34-698	x	x	x	x	x	x	x	x	x	x	x	
QC	24-May-95	31335101	9523177	QC	N/A	x	x	x	x	x	x	x	x	x	x	x	
QC	15-May-95	31335201	9521311	QC	N/A	x	x	x	x	x	x	x	x	x	x	x	
QC	23-Jun-95	31341201	9525245	QC	N/A			x					x		x	x	x
QC	22-Jun-95	31341301	9525225	QC	N/A			x					x		x	x	x
USGS-47	22-Jun-95	31341101	95252310	QC	483-491.8			x					x		x	x	x

A4: Am-241
AB: Gross Alpha/Beta
EA: Tc-99
JN: CLP Metals + Zirconium
NP: Np-237
R4: Gamma Spectroscopy
GA: Gross Alpha
R7: Plutonium Isotopic
R8: Tritium
R9: Uranium Isotopic
RB: Strontium-90
RI: Iodine-129

Table 3-3. Sampling and analysis summary for soils.

Project: WAG 3 RI/FS INVESTIGATION - SOILS						ANALYSIS TYPES							
BOREHOLE	SAMPLE DATE	SAMPLE ID	LAB ID	SAMPLE TYPE	DEPTH RANGE	C1	EH	F7	JN	LM	N2	SV	VG
CPP-11-1	5-Jun-95	31100101	06L246-001	BOREHOLE	0-0.5	x	x						
CPP-11-1	5-Jun-95	31100201	06L246-002	BOREHOLE	0.5-2.5	x	x						
CPP-11-1	5-Jun-95	31100301	06L246-003	BOREHOLE	7.5-10	x	x						
CPP-11-1	25-Jun-95	31100302	06L246-004	BOREHOLE	10-12.5	x	x						
CPP-11-2	6-Jun-95	31100401	06L246-005	BOREHOLE	0-0.5	x	x						
CPP-11-2	6-Jun-95	31100501	06L246-006	BOREHOLE	0.5-2.5	x	x						
CPP-11-2	6-Jun-95	31100601	06L246-007	BOREHOLE	7.5-10	x	x						
CPP-11-3	5-Jun-95	31100701	06L245-001	BOREHOLE	0-0.5	x	x						
CPP-11-3	5-Jun-95	31100801	06L245-002	BOREHOLE	2.5-5	x	x						
CPP-11-3	5-Jun-95	31100901	06L245-003	BOREHOLE	5-7.5	x	x						
CPP-11-3	5-Jun-95	31101001	06L245-004	BOREHOLE	22.5-25	x	x						
CPP-13-1	31-May-95	31350101	06L128-001	BOREHOLE	0.5-1		x		x				
CPP-13-1	31-May-95	31350201	06L128-002	BOREHOLE	1-2.5		x		x				
CPP-13-1	31-May-95	31350301	06L128-003	BOREHOLE	7.5-10		x		x				
CPP-13-2	15-May-95	31350601	05L045-001	BOREHOLE	0.5-1		x		x				
CPP-13-2	15-May-95	31350701	05L045-002	BOREHOLE	2.5-4		x		x				
CPP-13-3	15-May-95	31350801	05L045-003	BOREHOLE	0.5-1		x		x				
CPP-13-3	15-May-95	31350901	05L045-004	BOREHOLE	2.5-4		x		x				
CPP-19-3	13-Jun-95	31900101	06L245-005	BOREHOLE	0-0.5	x	x						
CPP-19-3	13-Jun-95	31900201	06L245-006	BOREHOLE	2.5-5	x	x						
CPP-19-3	13-Jun-95	31900301	06L245-007	BOREHOLE	5-7.5	x	x						
CPP-19-3	13-Jun-95	31900401	06L245-008	BOREHOLE	27.5-30	x	x						
CPP-19-3	13-Jun-95	31900501	06L245-009	BOREHOLE	31.5	x	x						
CPP-19-4	15-Jun-95	31900601	06L322-023	BOREHOLE	0.5-2.5	x	x						
CPP-19-4	15-Jun-95	31900701	06L322-024	BOREHOLE	2.5-5	x	x						
CPP-19-4	15-Jun-95	31900801	06L322-026	BOREHOLE	7.5-10	x	x						
CPP-19-4	15-Jun-95	31900901	06L322-027	BOREHOLE	22.5-25	x	x						
CPP-19-4	15-Jun-95	31901001	06L322-028	BOREHOLE	31.4	x	x						
CPP-22-1	6-Jul-95	32200101	9526307	BOREHOLE	0-0.5		x						
CPP-22-1	6-Jul-95	32200201	9526308	BOREHOLE	0.5-3		x						
CPP-22-1	6-Jul-95	32200102	95263010	BOREHOLE	3-7		x						
CPP-22-2	6-Jul-95	32200401	9526304	BOREHOLE	0-0.5		x						
CPP-22-2	6-Jul-95	32200501	9526305	BOREHOLE	0.5-2.5		x						
CPP-22-2	6-Jul-95	32200601	9526306	BOREHOLE	7-10		x						
CPP-22-3	6-Jul-95	32200701	9526301	BOREHOLE	0-0.5		x						
CPP-22-3	6-Jul-95	32200801	9526302	BOREHOLE	0.5-3		x						
CPP-22-3	6-Jul-95	32200901	9526303	BOREHOLE	8-10		x						
CPP-40-1	1-Jun-95	34000101	9522582	BOREHOLE	0-0.5		x						
CPP-40-1	1-Jun-95	34000201	9522583	BOREHOLE	2.5-5		x						
CPP-40-1	1-Jun-95	34000301	9522584	BOREHOLE	7.5-10		x						
CPP-46-1	9-May-95	34600101	95213310	BOREHOLE	0-0.5		x						
CPP-46-1	9-May-95	34600201	95213311	BOREHOLE	2-4		x						
CPP-46-1	9-May-95	34600301	95213312	BOREHOLE	8-10		x						
CPP-61-1	10-May-95	36100101	95213314	BOREHOLE	0-0.5		x						
CPP-61-1	10-May-95	36100201	95213315	BOREHOLE	2-4		x						
CPP-61-1	10-May-95	36100301	95213316	BOREHOLE	8-10		x						
CPP-61-2	29-Jun-95	36100601	95263011	BOREHOLE	0-0.5		x						
CPP-61-2	29-Jun-95	36100701	95263012	BOREHOLE	4-4.5		x						
CPP-61-3	29-Jun-95	36100801	95263013	BOREHOLE	0-0.5		x						

C1: CLP Metals
EH: Gamma Sec/Gross A-B/Am/Np/Pu/U/Sr/Tc
F7: Gamma Spectroscopy/Sr-90
JN: CLP Metals + Zirconium
LM: CLP Metals (TAL)
N2: Nitrate/Nitrite
SV: SVOCs (8270)
VG: VOCs by GC/MS (8260)

Table 3-3. (continued).

Project: WAG 3 RI/FS INVESTIGATION - SOILS						ANALYSIS TYPES							
BOREHOLE	SAMPLE DATE	SAMPLE ID	LAB ID	SAMPLE TYPE	DEPTH RANGE	C1	EH	F7	JN	LM	N2	SV	VG
CPP-61-3	29-Jun-95	36100901	95263014	BOREHOLE	0.5-1		x						
CPP-61-4	29-Jun-95	36101001	95263015	BOREHOLE	0-0.5		x						
CPP-61-4	29-Jun-95	36101101	95263016	BOREHOLE	1-1.5		x						
CPP-603-1	31-May-95	36300101	06L128-005	BOREHOLE	0-0.5	x	x						
CPP-603-1	31-May-95	36300201	06L128-006	BOREHOLE	2.5-5	x	x						
CPP-603-1	31-May-95	36300301	06L128-007	BOREHOLE	5-7.5	x	x						
CPP-603-1	31-May-95	36300401	06L128-008	BOREHOLE	22.5-24.5	x	x						
CPP-603-1	31-May-95	36300501	06L128-009	BOREHOLE	31.5-32	x	x						
CPP-603-2	25-May-95	36300601	05L103-001	BOREHOLE	0-0.5	x	x						
CPP-603-2	25-May-95	36300701	05L103-002	BOREHOLE	2.5-5	x	x						
CPP-603-2	25-May-95	36300801	05L103-003	BOREHOLE	7.5-10	x	x						
CPP-603-2	30-May-95	36300901	06L128-010	BOREHOLE	22.5-25	x	x						
CPP-603-2	30-May-95	36301001	06L128-011	BOREHOLE	31.5-32	x	x						
CPP-78-1	26-May-95	37800101	9522191	BOREHOLE	0-0.5		x						
CPP-78-1	26-May-95	37800201	9522193	BOREHOLE	2.5-5		x						
CPP-78-1	26-May-95	37800301	9522194	BOREHOLE	7.5-10		x						
CPP-78-2	26-May-95	37800601	9522195	BOREHOLE	0-0.5		x						
CPP-78-2	26-May-95	37800701	9522196	BOREHOLE	2.5-5		x						
CPP-78-2	26-May-95	37800801	9522197	BOREHOLE	7.5-10		x						
CPP-88-1-1	1-Jun-95	38800101	9522588	GRID 72	0-0.5			x					
CPP-88-1-1	1-Jun-95	38800601	06L128-012	GRID 72	2.5-5	x		x					
CPP-88-1-1	1-Jun-95	38800301	95225810	GRID 72	7.5-10			x					
CPP-88-2-1	22-May-95	38800701	9522204	GRID 57	0-0.5			x					
CPP-88-2-1	22-May-95	38801201	05L103-004	GRID 57	2.5-5	x		x					
CPP-88-2-1	22-May-95	38800902	9522206	GRID 57	5-7.5			x					
CPP-88-3-1	19-May-95	38801301	9521354	GRID 150	0-0.5			x					
CPP-88-3-1	19-May-95	38801801	05L985-001	GRID 150	2.5-5	x		x					
CPP-88-3-1	19-May-95	38801501	9521356	GRID 150	7.5-10			x					
CPP-88-4-1	19-May-95	38801901	9521359	GRID 84	0-0.5			x					
CPP-88-4-1	19-May-95	38802001	95213510	GRID 84	2.5-5	x		x					
CPP-88-4-1	19-May-95	38802101	95213511	GRID 84	7.5-10			x					
CPP-88-5-1	19-May-95	38802501	9522201	GRID 94	0-0.5			x					
CPP-88-5-1	22-May-95	38802601	9522202	GRID 94	2.5-5			x					
CPP-88-5-1	22-May-95	38803001	05L103-005	GRID 94	5.0-7.5	x							
CPP-88-5-1	22-May-95	38802701	9522203	GRID 94	7.5-10			x					
CPP-88-6-1	10-May-95	38803101	95213318	GRID 38	0-0.5			x					
CPP-88-6-1	10-May-95	38803201	95213319	GRID 38	0.5-2			x					
CPP-88-6-1	10-May-95	38803301	95213320	GRID 38	4-6			x					
CPP-88-7-1	22-May-95	38803702	9522209	GRID 85	0-0.5			x					
CPP-88-7-1	22-May-95	38804201	05L103-006	GRID 85	0.5-2.5	x		x					
CPP-88-7-1	22-May-95	38803901	95222011	GRID 85	7.5-10			x					
CPP-88-8-1	18-May-95	38804301	9521351	GRID 134	0-0.5			x					
CPP-88-8-1	18-May-95	38804401	9521352	GRID 134	2.5-4			x					
CPP-88-8-1	19-May-95	38804501	9521353	GRID 134	7.5-10	x		x					
CPP-88-9-1	22-May-95	38804901	95222014	GRID 28	0-0.5			x					
CPP-88-9-1	22-May-95	38805401	05L103-007	GRID 28	2.5-5	x		x					
CPP-88-9-1	22-May-95	38805101	95222013	GRID 28	7.5-10			x					
CPP-88-9-2	26-May-95	38805501	95222015	BOREHOLE 2	0-0.5			x					

C1: CLP Metals
EH: Gamma Sec/Gross A-B/Am/Np/Pu/U/Sr/Tc
F7: Gamma Spectroscopy/Sr-90
JN: CLP Metals + Zirconium
LM: CLP Metals (TAL)
N2: Nitrate/Nitrite
SV: SVOCs (8270)
VG: VOCs by GC/MS (8260)

CPP-88-9-2	26-May-95	38806001	05L103-008	BOREHOLE 2	0.5-2.5	x		x					
CPP-88-9-2	26-May-95	38805701	95222017	BOREHOLE 2	7.5-10			x					

Table 3-3. (continued).

Project: WAG 3 RI/FS INVESTIGATION - SOILS						ANALYSIS TYPES							
BOREHOLE	SAMPLE DATE	SAMPLE ID	LAB ID	SAMPLE TYPE	DEPTH RANGE	C1	EH	F7	JN	LM	N2	SV	VG
CPP-88-10-1	17-May-95	38806101	9521331	GRID 88	0-0.5			x					
CPP-88-10-1	18-May-95	38806201	9521332	GRID 88	2.5-4			x					
CPP-88-10-1	18-May-95	38806301	9521333	GRID 88	7.5-10			x					
CPP-88-11-1	18-May-95	38806701	9521337	GRID 192	0-0.5			x					
CPP-88-11-1	18-May-95	38806801	9521338	GRID 192	2.5-4			x					
CPP-88-11-1	18-May-95	38806901	9521339	GRID 192	7.5-10			x					
CPP-88-12-1	18-May-95	38807301	9521334	GRID 100	0-0.5			x					
CPP-88-12-1	18-May-95	38807401	9521335	GRID 100	0.5-2.5			x					
CPP-88-12-1	18-May-95	38807501	9521336	GRID 100	7.5-10			x					
CPP-88-13-1	17-May-95	38807901	9521344	GRID 64	0-0.5			x					
CPP-88-13-1	17-May-95	38808001	9521345	GRID 64	0.5-2.5			x					
CPP-88-13-1	17-May-95	38808101	9521347	GRID 64	7.5-10			x					
CPP-88-14-1	17-May-95	38808501	9521341	GRID 144	0-0.5			x					
CPP-88-14-1	17-May-95	38808601	9521342	GRID 144	0.5-2			x					
CPP-88-14-1	17-May-95	38808701	9521343	GRID 144	7.5-10			x					
CPP-88-15-1	7-Jul-95	38809101	95263017	GRID 179	0-0.5	x		x					
CPP-88-15-1	7-Jul-95	38809201	95263018	GRID 179	0.5-4	x		x					
CPP-88-15-1	7-Jul-95	38809301	95263020	GRID 179	7-11	x		x					
CPP-90-1	14-Jun-95	39000101	06L322-001	DISP WELL HEAD	0-2.5	x	x					x	x
CPP-90-1	14-Jun-95	39000201	06L322-003	DISP WELL HEAD	2.5-5	x	x					x	x
CPP-90-1	14-Jun-95	39000301	06L322-005	DISP WELL HEAD	7.5-10	x	x					x	x
CPP-90-1	14-Jun-95	39000401	06L322-007	DISP WELL HEAD	27.5-30	x	x					x	x
CPP-90-1	14-Jun-95	39000501	06L322-009	DISP WELL HEAD	40-42	x	x					x	x
CPP-90-2	14-Jun-95	39000601	06L322-011	WASTE DISP LINE	0-0.5	x	x					x	x
CPP-90-2	14-Jun-95	39000701	06L322-013	WASTE DISP LINE	2.5-5	x	x					x	x
CPP-90-2	14-Jun-95	39000801	06L322-015	WASTE DISP LINE	7.5-10	x	x					x	x
CPP-90-2	14-Jun-95	39000901	06L322-017	WASTE DISP LINE	32.5-35	x	x					x	x
CPP-90-2	14-Jun-95	39001001	06L322-021	WASTE DISP LINE	48.1	x	x					x	x
CPP-90-3	14-Jun-95	39001101	06L319-001	709 PUMPHOUSE	0-2.5	x	x					x	x
CPP-90-3	14-Jun-95	39001201	06L319-004	709 PUMPHOUSE	2.5-5	x	x					x	x
CPP-90-3	14-Jun-95	39001301	06L319-007	709 PUMPHOUSE	10-12.5	x	x					x	x
CPP-90-3	14-Jun-95	39001401	06L319-010	709 PUMPHOUSE	22.5-25	x	x					x	x
CPP-90-3	14-Jun-95	39001501	06L319-013	709 PUMPHOUSE	40-41.8	x	x					x	x
CPP-91-1	8-Jun-95	39100101	06L246-008	BOREHOLE	0-0.5	x	x						
CPP-91-1	8-Jun-95	39100201	06L246-009	BOREHOLE	2.5-5	x	x						
CPP-91-1	8-Jun-95	39100301	06L246-010	BOREHOLE	7.5-10	x	x						
CPP-91-1	8-Jun-95	39100401	06L246-011	BOREHOLE	17.5-20	x	x						
CPP-91-1	8-Jun-95	39100501	06L246-012	BOREHOLE	46-46.5	x	x						
CPP-91-2	12-Jun-95	39100601	06L268-001	BOREHOLE	0-0.5	x	x						
CPP-91-2	12-Jun-95	39100701	06L268-002	BOREHOLE	0.5-2.5	x	x						
CPP-91-2	12-Jun-95	39100801	06L268-003	BOREHOLE	5-7.5	x	x						
CPP-91-2	12-Jun-95	39101002	06L268-006	BOREHOLE	32.5-35	x	x					x	x
CPP-91-2	12-Jun-95	39100901	06L268-004	BOREHOLE	37.5-40	x	x						
CPP-91-2	12-Jun-95	39101001	06L268-005	BOREHOLE	42-42.5	x	x						
CPP-93-1	7-Jul-95	39300101	9507L61301	BOREHOLE	2.5-4					x	x		
CPP-93-1	7-Jul-95	39300201	9507L61303	BOREHOLE	12					x	x		
CPP-93-2	7-Jul-95	39300301	9507L61307	BOREHOLE	2.5-3					x	x		

C1: CLP Metals
EH: Gamma Sec/Gross A-B/Am/Np/Pu/U/Sr/Tc
F7: Gamma Spectroscopy/Sr-90
JN: CLP Metals + Zirconium
LM: CLP Metals (TAL)
N2: Nitrate/Nitrite
SV: SVOCs (8270)
VG: VOCs by GC/MS (8260)

CPP-93-2	7-Jul-95	39300401	9507L61309	BOREHOLE	12					x	x		
CPP-93-3	14-Jul-95	39300501	9507L61311	BOREHOLE	2.5-3					x	x		
CPP-93-3	14-Jul-95	39300601	9507L61313	BOREHOLE	11.5-12					x	x		

Table 3-3. (continued).

Project: WAG 3 RI/FS INVESTIGATION - SOILS						ANALYSIS TYPES							
BOREHOLE	SAMPLE DATE	SAMPLE ID	LAB ID	SAMPLE TYPE	DEPTH RANGE	C1	EH	F7	JN	LM	N2	SV	VG
CPP-93-4	17-Jul-95	39300701	9507L61315	BOREHOLE	6.5-7					x	x		
CPP-93-4	17-Jul-95	39300801	9507L61317	BOREHOLE	11.5-12					x	x		
CPP-93-7	18-Jul-95	39301301	9507L61322	BOREHOLE	6.5-7					x	x		
CPP-93-8	18-Jul-95	39301401	9507L61324	BOREHOLE	6.5-7					x	x		
CPP-93-9	18-Jul-95	39301501	9507L61326	BOREHOLE	6.5-7					x	x		
CPP-93-10	18-Jul-95	39301601	9507L61328	BOREHOLE	6.5-7					x	x		
CPP-93-11	18-Jul-95	39301701	9507L61330	BOREHOLE	6.5-7					x	x		
CPP-93-12	18-Jul-95	39301801	9507L61332	BOREHOLE	6.5-7					x	x		
LOCATION #1	28-Jun-95	3CS00101	07L509-001	CONT. SOIL PILE	1-1.5	x	x						
LOCATION #2	28-Jun-95	3CS00201	07L509-002	CONT. SOIL PILE	1-1.5	x	x						
LOCATION #3	28-Jun-95	3CS00301	07L509-003	CONT. SOIL PILE	1-1.5	x	x						
LOCATION #4	28-Jun-95	3CS00401	07L509-004	CONT. SOIL PILE	1-1.5	x	x						
LOCATION #5	28-Jun-95	3CS00501	07L509-005	CONT. SOIL PILE	1-1.5	x	x						
LOCATION #6	28-Jun-95	3CS00601	07L509-006	CONT. SOIL PILE	1-1.5	x	x						
LOCATION #7	28-Jun-95	3CS00701	07L509-007	CONT. SOIL PILE	1-1.5	x	x						
LOCATION #8	28-Jun-95	3CS00801	07L509-008	CONT. SOIL PILE	1-1.5	x	x						
LOCATION #9	28-Jun-95	3CS00901	07L509-009	CONT. SOIL PILE	1-1.5	x	x						
LOCATION #10	28-Jun-95	3CS01001	07L509-010	CONT. SOIL PILE	1-1.5	x	x						
LOC #11 - COMP	28-Jun-95	3CS01101	07L509-011	CONT. SOIL PILE	1-1.5	x	x						
QC	19-May-95	3XF00101	05L985-004	FIELD BLANK	N/A	x							
QC	10-May-95	3XF00101	95213317	FIELD BLANK	N/A		x						
QC	17-May-95	3XF00101	9521349	FIELD BLANK	N/A			x					
QC	15-May-95	3XF00101	05L045-005	FIELD BLANK	N/A				x				
QC	14-Jun-95	3XF00101	9506L32001	FIELD BLANK	N/A								x
QC	19-May-95	3XF00102	05L985-006	FIELD BLANK	N/A	x							
QC	15-May-95	3XF00102	9521616	FIELD BLANK	N/A		x						
QC	19-May-95	3XF00102	9521358	FIELD BLANK	N/A			x					
QC	25-May-95	3XF00103	05L103-010	FIELD BLANK	N/A	x							
QC	25-May-95	3XF00103	95221914	FIELD BLANK	N/A		x						
QC	19-May-95	3XF00103	95213513	FIELD BLANK	N/A			x					
QC	7-Jul-95	3XF00104	07L527-003	FIELD BLANK	N/A	x							
QC	26-May-95	3XF00104	9522199	FIELD BLANK	N/A		x						
QC	1-Jun-95	3XF00104	95225811	FIELD BLANK	N/A			x					
QC	17-Jul-95	3XF00105	9507L61319	FIELD BLANK	N/A	x							
QC	1-Jun-95	3XF00105	9522586	FIELD BLANK	N/A		x						
QC	7-Jul-95	3XF00105	95263022	FIELD BLANK	N/A			x					
QC	8-Jun-95	3XF00106	95238814	FIELD BLANK	N/A		x						
QC	19-May-95	3XR00101	05L985-005	RINSATE	N/A	x							
QC	9-May-95	3XR00101	95213313	RINSATE	N/A		x						
QC	17-May-95	3XR00101	9521348	RINSATE	N/A			x					
QC	15-May-95	3XR00101	05L045-006	RINSATE	N/A				x				
QC	17-Jul-95	3XR00101	9507L61321	RINSATE	N/A						x		
QC	20-Jun-95	3XR00101	9506L31916	RINSATE	N/A							x	
QC	14-Jun-95	3XR00101	9506L32002	RINSATE	N/A								x
QC	19-May-95	3XR00102	05L985-007	RINSATE	N/A	x							
QC	15-May-95	3XR00102	9521615	RINSATE	N/A		x						

C1: CLP Metals
EH: Gamma Sec/Gross A-B/Am/Np/Pu/U/Sr/Tc
F7: Gamma Spectroscopy/Sr-90
JN: CLP Metals + Zirconium
LM: CLP Metals (TAL)
N2: Nitrate/Nitrite
SV: SVOCs (8270)
VG: VOCs by GC/MS (8260)

QC	19-May-95	3XR00102	9521357	RINSATE	N/A			x					
QC	25-May-95	3XR00103	05L103-011	RINSATE	N/A	x							
QC	25-May-95	3XR00103	95221910	RINSATE	N/A		x						
QC	19-May-95	3XR00103	95213512	RINSATE	N/A			x					

Table 3-3. (continued).

Project: WAG 3 RI/FS INVESTIGATION - SOILS						ANALYSIS TYPES							
BOREHOLE	SAMPLE DATE	SAMPLE ID	LAB ID	SAMPLE TYPE	DEPTH RANGE	C1	EH	F7	JN	LM	N2	SV	VG
QC	7-Jul-95	3XR00104	07L527-004	RINSATE	N/A	x							
QC	26-May-95	3XR00104	9522198	RINSATE	N/A		x						
QC	1-Jun-95	3XR00104	9522587	RINSATE	N/A			x					
QC	17-Jul-95	3XR00105	9507L61320	RINSATE	N/A	x							
QC	1-Jun-95	3XR00105	9522581	RINSATE	N/A		x						
QC	7-Jul-95	3XR00105	95263021	RINSATE	N/A			x					
QC	8-Jun-95	3XR00106	95238813	RINSATE	N/A		x						
QC	8-Jun-95	3XR00106	95302430	RINSATE	N/A		x						
QC	14-Jun-95	3XV00101	9506L32003	TRIP BLANK	N/A								x

C1: CLP Metals
EH: Gamma Sec/Gross A-B/Am/Np/Pu/U/Sr/Tc
F7: Gamma Spectroscopy/Sr-90
JN: CLP Metals + Zirconium
LM: CLP Metals (TAL)
N2: Nitrate/Nitrite
SV: SVOCs (8270)
VG: VOCs by GC/MS (8260)

Table 3-4. Analytical parameters and methods and associated sample containers, preservative, and holding time requirements.

Analytical parameter and method	Container size	Container type	Preservative	Holding time	Min. sample volume
Aqueous Samples					
CLP Target Analyte List (TAL) metals[a] + Zirconium	1,000 mL	high-density polyethylene (HDPE)	HNO_3 to pH <2	6 months; 28 days for Hg	500 mL
Carbonate/bicarbonate/alkalinity[b]	500 mL	HDPE	4° C	14 days	300 mL
Sulfate/chloride/fluoride[b]	500 mL	HDPE	4° C	28 days	400 mL
Nitrate/Nitrite[b]	250 mL	HDPE	H_2SO_4 to pH <2 4° C	28 days	250 mL
Gross alpha/beta[c,d]	2-1,000 mL	HDPE	HNO_3 to pH <2	6 months	2,000 mL
Gamma spectroscopy[c]	540 mL	HDPE	HNO_3 to pH <2	6 months	540 mL
Uranium and Plutonium isotopes[c,d]	1 gal	Cubitainer	HNO_3 to pH <2	6 months	1 gal
Americium-241, Neptunium-237[c,d]	1 gal	Cubitainer	HNO_3 to pH <2	6 months	1 gal
Strontium-90, Technetium-99[c,d]	1 gal	Cubitainer	HNO_3 to pH <2	6 months	1 gal
Iodine-129[c]	2-1,000 mL	Amber glass jug	None	6 months	1,000 mL
Tritium[c]	1,000 mL	HDPE	None	6 months	1,000 mL
Solid samples					
Gamma spectroscopy[c]	16 ounce (oz) squat jar	HDPE	NA	6 months	16 oz
Gross alpha/beta[c,d]	16 oz squat jar	HDPE	NA	6 months	16 oz
CLP TAL metals[a]	250 mL	wide mouth (WM) glass jar	4° C	6 months	250 mL

Table 3-4. (continued).

Analytical parameter and method	Container size	Container type	Preservative	Holding time	Min. sample volume
Volatile Organic Compounds (VOCs) (8240)[b]	125 mL	WM glass jar Teflon lined cap	4° C	14 days	125 mL
Semivolatile Organic Compounds (SVOCs) (8270)[e]	250 mL	WM glass jar Teflon lined cap	4° C	14 days until extraction, 40 days to analysis	250 mL

a. Statement of Work for Inorganic-Multi-Media, Multi-Concentration (EPA, 1993).

b. Methods for the Chemical Analysis of Water and Wastes (EPA, 1983).

c. *Statement of Work of Radiological Analyses Performed for the Environmental Restoration Department at the INEL* (ER-SOW-33) (EG&G Idaho, 1991).

d. Samples were reanalyzed for Strontium-90 and Technetium-99 if gross beta activity is greater than 30 pCi/g; and Americium-241, Neptunium-237, Plutonium-isotopes, and Uranium-isotopes if gross alpha activity is greater than 20 pCi/g.

e. Test Methods for Evaluating Solid Waste, Physical and Chemical Methods, SW-846 (EPA, 1986).

retrieved from the borehole. As such, the location for radiation screening was constant throughout the drilling operation at each borehole.

To maintain monitoring consistency, the detector was held as close as possible to the sample and moved along the entire length of the sampler. The screening information was also used to determine the appropriate level of health and safety and sample shipping requirements. Samples collected during the investigation were screened for radiological contamination by the project radiological control technician (RCT) before any samples were released from a radiologically controlled zone.

All field equipment was calibrated before use. Copies of the instrument manuals were made available to the field team leader (FTL) and equipment operator. A record of field calibration for analytical instruments used by the field sampling team was maintained in the field instrument calibration/standardization logbook or the sample logbook by field personnel. In addition, any notes on unusual results, battery charging, operation and maintenance, etc., were included in the logbook. Calibration of health physics instruments was performed every 6 months by INEEL Health Physics Instrument Laboratory (HPIL) personnel following approved procedures. The RCT performed a source check weekly and an operational check before each use and recorded these checks in the RCT instrument calibration logbook.

Maintenance responsibilities for field equipment were coordinated through an instrument technician whose primary duty was ensuring available equipment and instrumentation were ready for use and returned equipment is checked out, serviced, and returned to available inventory in a timely manner. Maintenance during use was the responsibility of the project FTL. RCTs performed minor repairs and general maintenance of radiological screening instruments. For more laborious repairs, RCT field instruments were returned to the HPIL or the manufacturer for repairs and/or recalibration.

During the WAG 3 RI, it was the responsibility of the project manager and sampling team members to ensure all procedures were followed as specified and measurement data met the prescribed acceptance criteria. In the event a problem occurred, it was imperative that prompt action be taken to correct the problem. Corrective action is discussed in the Quality Program Plan for ER&WM, QPP-149, Section 15, "Corrective Action" and Section 10, "Corrective Action," of the QAPjP (INEL, 1995).

3.1.1.2 Soil Sample Collection. The locations for the proposed soil borings were identified during preparation of the SAP. Before drilling, walkovers of the proposed soil boring locations were performed to verify the location and site condition of sources and facilities shown on the site map. The locations of utilities, structures, surface features, and radiation zones and markers that could affect the movement of equipment or activities of field investigation personnel, was noted in the appropriate logbooks. The walkovers were not an exhaustive survey of all surface structures and features, but if previously unidentified structures were observed during the walkover, they were incorporated into the figures. The area walkovers also evaluated access for drilling equipment and located surface utilities and sources near proposed drilling sites. In addition to the area walkovers, a ground-penetrating radar (GPR) survey was performed over the sites where subsurface sample collection occurred. The GPR survey was performed in accordance with the environmental restoration (ER) standard operating procedure (SOP) 11.24 "Ground Penetrating Radar Survey." The results from the GPR survey helped identify underground metallic objects (e.g., underground lines) that could be affected by drilling operations. Unless specific approval from facility operations was obtained, boreholes were not drilled within a minimum of 1.5 m (5 ft) from any underground piping or lines. Soil samples were collected using hand augers or a split-spoon sampler following the ER SOP 11.12, "Soil

Sampling." After retrieval, the split-spoon sampler was opened and screened for radioactivity using hand-held instruments. Radiological contamination in soils was determined by screening a portion of the sample material. Results from the radiological field surveys were used to determine which depth interval would have samples sent for laboratory analyses.

To maintain monitoring consistency, instruments were held within 15-cm (6-in.) of the sample and moved along the entire length of the sampler at a specified rate. The screening information was also used to determine the appropriate level of health and safety and sample shipping requirements. If sufficient sample volume for all requested analyses was not obtained, a second split-spoon sample was collected. The actual sample source depth, field radiation measurement, and collection method used were stated in the field logbook. The split-spoon sampler (including soil) from each interval was stored at the drilling location until the total borehole depth had been reached. A new split-spoon sampler was then attached to the auger and advanced to the next depth. The sample with the highest radiation reading in the target depths was then prepared for sample collection as described below. The field radiation screening measurements and depths for all split-spoon samples were recorded in the sample logbook.

Soil samples from the split-spoon sampler were a composite of material that had been placed into a stainless steel, aluminum, or glass mixing pan, thoroughly mixed with a stainless steel spoon, surveyed with radiological survey instruments, and placed into the appropriate sample containers. All samples were contained in precleaned and certified bottles (I-Chem or equivalent) prepared in accordance with EPA bottle-washing procedures. Table 3-4 outlines specific requirements for containers, sample volumes, preservation methods, and holding times for solid and liquid samples, as identified in EPA guidance documents. Sample bottles for organic analysis (if required) were filled with minimal headspace. Volatile organic analysis (VOA) vials 125-mL (1.4-oz) for liquids [if volatile-organic compounds (VOCs) were sampled for] were filled completely, with absolutely no headspace or air bubbles.

3.1.1.2.1 Equipment Decontamination—To prevent contamination of samples, sample collection and drilling equipment were thoroughly decontaminated before initial use and after each subsequent use. Decontaminated sampling equipment inside the ICPP was surveyed for radiological contamination before collecting any samples, including rinsates. The sampling team used only new or previously decontaminated equipment; decontamination was performed as equipment was used and clean equipment supplies were depleted. The field sampling team was responsible for properly decontaminating the sampling equipment.

Sampling equipment decontamination solutions collected inside the ICPP were containerized in 19-L (5-gal) plastic carboys. Equipment blank samples (rinsates) were collected at minimum frequency described in the SAP or as deemed necessary by the FTL. Upon project completion, the decontamination solutions were disposed of to the process equipment waste (PEW) Evaporator.

Procedures for decontaminating sample equipment used to collect soil and water samples followed those presented in ER SOP 11.5, "Field Decontamination of Sample Equipment," with one exception: isopropanol was not used during equipment decontamination so as to minimize waste generation at the site. ER SOP 11.5 was posted at the decontamination area during the field activities.

Procedures for decontaminating power auger equipment used to reach the desired sampling depths followed those presented in ER SOP 11.4, "Field Decontamination of Heavy Equipment, Drill Rigs, and

Drilling Equipment." The power auger equipment was steam cleaned after each borehole to prevent the spread of contamination to "clean" areas. To prevent airborne dispersion of contaminants, the equipment was thoroughly wetted before steam cleaning or temporary containment walls were used.

Procedures for decontaminating the drill rigs and ancillary equipment were presented in ER SOP 11.4. The methods generally used were steam cleaning or washing with water under high pressure and/or scrubbing accessible parts with a nonphosphate detergent and water solution under pressure. An RCT obtained a smear (swipe) from the equipment for a radiation contamination check.

3.1.2 Sample Documentation, Custody, Handling, and Transportation

The FTL was responsible for controlling and maintaining all field documents and records and ensuring all required documents were submitted to Administrative Record and Document Control (ARDC) at the conclusion of the project. Sample documentation and custody procedures for this project were based on EPA-recommended procedures that emphasized careful documentation of sample collection and sample transfer. To ensure all the important information pertaining to each sample was properly recorded, the following sections describe documentation procedures, sample packaging, and sample transportation requirements for sample shipment to the analytical laboratories.

3.1.2.1 Field Logbooks. All information pertinent to field screening or sampling was recorded in the field logbook in accordance with ER Program Directive (PD) 4.2, "Logbooks." Logbooks were supplied by the ARDC and consisted of FTL daily logbooks, sample collection, and sample shipping logbooks. Logbooks were waterproof, bound books with consecutively numbered pages. In addition, the project RCT documented all personal/area monitoring and associated relevant data on form EG&G-737 and in the LMITCO Data Management System (DMS)-80. All logbooks were quality control (QC) checked for accuracy and completeness by the FTL or an appointed designee. The person responsible for QC checks initialed their name in the appropriate space, indicating the above information to be true and correct.

The FTL's Daily Logbook contained a daily summary of the personnel onsite, all the team activities, weather conditions, sampling locations, problems encountered, deviations from the SAP, visitor log, and list of site contacts. This logbook was used to record information necessary to interpret analytical data and include all field information pertaining to sampling team activities. Entries were dated and signed by the individual making the entry.

Sample logbooks were used by the field sampling team to maintain a chronological record of the team's daily activities. This logbook contained logsheets to record field changes/deviations from the SAP, description of specific sample locations, date and time of collection, sample matrix and type, observations, depths, analysis types, sample jars and preservation methods used, and any changes in sampling method. All quality assurance (QA) samples [field duplicates, equipment rinsate blanks, trip blanks, matrix spikes/matrix spike duplicates (MS/MSDs), and field blanks] were recorded in the sample logbook. A record of decontamination activities was also included in this logbook.

Sample shipping logbooks were used to record the sample identification number, collection date, cooler identification number, destination, date shipped, chain of custody (COC) number, sample shipping classification, name of shipper, and QA check.

3.1.2.2 Chain of Custody. To maintain and document sample possession, COC procedures discussed in ER PD 5.7, "Chain of Custody, Sample Handling, Packaging, and Shipment," were followed. The purpose of COC is to document the identity of a sample and its handling from the point of collection until laboratory analysis is complete and the sample is disposed of. The custody record was completed by the individual designated by the project manager as being responsible for sample shipment and was completed at the sampling site. The COC record is a multiple-copy form that served as a written record of the handling of the sample. The completed original COC form was returned to the ARDC by the laboratory personnel upon initial receipt of the samples and completion of the form. The original form is a permanent part of the project records. COC procedures began immediately after sample collection. The secureness of the lids on the containers was checked before shipping the container to the analytical laboratory. The completed COC forms were placed inside the coolers (if needed), and the coolers (if needed), were taped shut. At least two custody seals were placed on the coolers (if needed). Clear plastic tape was placed over the seals to ensure the seals were not accidentally broken during shipment.

3.1.2.3 Sample Handling, Packaging, and Shipping. Preservation of samples is required to retain integrity. The most common preservation techniques include pH adjustment and temperature control. Field personnel followed EPA and analytical laboratory-recommended preservation techniques and holding times for the parameters of concern. Sample bottles contained the required types and amounts of preservatives before sample collection commenced. Specific preservation methods that were employed during sampling activities are presented in Table 3-4. Ice chests (coolers) containing frozen Blue Ice were used to chill samples, if required, in the field immediately after sample collection.

All samples were packaged in accordance with the EG&G Idaho Company Procedures Manual (EG&G Idaho, 1993a), the EG&G Idaho Hazardous Materials Transportation Manual (EG&G Idaho, 1993b), and EPA-recommended procedures. Packaging procedures varied depending on the suspected sample concentrations and Department of Transportation (DOT) hazard class. At a minimum, samples were packaged in a manner that protected the integrity of the samples, as well as protected them against detrimental effects from possible leakage. All samples were screened for radionuclide activity and classified before they were packaged and transported.

All samples were packaged carefully to avoid breakage or contamination and shipped to the laboratory at proper temperatures. The following sample packaging requirements were followed:

- Sample bottle lids were not mixed; all sample lids stayed with the original containers.
- Sample containers were packaged in insulated and shock-resistant coolers; individual sample bottles were wrapped in bubble pack or other protective material before their placement in plastic bags to minimize the potential for contamination and breakage during shipment. The coolers were also filled with Blue Ice, if necessary.
- Empty space in the coolers was filled with inert packing material. Under no circumstances was locally obtained material (sawdust, sand, etc.) used.
- All samples were cooled unless "no cooling" was specified.

- The COC record was placed in a plastic bag and taped to the bottom of the cooler lid.

- All shipping containers were taped and custody sealed for shipment to the laboratory, filament tape was wrapped around the cooler at least twice and signed and dated, custody seals were applied to the front and back of the cooler, and clear cellophane tape was placed over the custody seal to prevent accidental damage to the seal. Appropriate labels (e.g., analytical laboratory and return address, this side up, fragile, and environmental samples) were placed on the outside of the cooler and all extraneous labels were removed to avoid confusion.

- The FTL notified the laboratory before shipment to alert them of any shipments and confirm personnel were available to receive and process the samples. The FTL also called after the expected receipt of samples to check on their condition, holding times, cooling, etc.

The temperature of each batch of coolers (i.e., those arriving at the same time) was checked upon receipt by the analytical laboratory. One cooler per batch was opened, a thermometer was placed inside and allowed to equilibrate, and the temperature was recorded in a logbook by personnel at the analytical laboratory. The laboratory communicated these temperatures to the FTL to ensure adequate coolant was used to cool the samples during shipment.

3.1.2.3.1 Transportation of Samples—All samples were transported in accordance with the EG&G Idaho Company Procedures Manual (EG&G Idaho, 1993a); the EG&G Idaho Hazardous Materials Transportation Manual (EG&G Idaho, 1993b); regulations issued by the DOT (49 CFR 171 through 178); and EPA sample handling, packaging, and shipping methods (40 CFR 261.4). All samples for offsite analysis were transported "priority one/overnight" via commercial air transport delivery services. The discussion below describes the general classification and shipping procedures for radioactive samples.

A radiation screening survey for shipping purposes was performed in the field by a certified RCT. Screening helped determine whether the sample must be shipped as a radioactive shipment, how it should be packaged, and to which laboratory it can be shipped to for analysis. The RCT first measured the external surface contact radiation level of the sample material in the homogenization pan or directly from the sample equipment for beta and gamma radiation using direct reading instrumentation. The RCT also surveyed each packaged sample before shipment. A contact, beta-gamma survey was performed on the outside of the sample container, with readings taken on all sides. Samples with detectable radioactivity greater than 100 cpm beta/gamma activity above background were sent to an onsite laboratory for analysis of gamma-emitting radionuclides by gamma spectroscopy (20-minute screen). According to DOT regulations, a radioactive sample is one that contains a specific activity greater than 2 nCi/g (2,000 pCi/g) or 2×10^6 pCi/L (assumes a density of 1.0 g/cm^3). Based on the radiological screening results for alpha-, beta-, and gamma-emitting radionuclides, any samples exceeding either of these values were packaged in accordance with 49 CFR Parts 173.401 through 173.478. The sections that applied vary according to the radioactive isotopes involved, quantity of each isotope, type of sample, etc. Samples were packaged in steel-belted coolers (if needed) and checked by the RCT to ensure less than 0.5 mR/hr on contact with the outside of the package. Limited quantity radioactive material is defined as any material whose activity per package does not exceed the limits specified in 49 CFR 173.423, using the appropriate A2 value for the sample from 49 CFR 173.435. If the identity of the radionuclides could not be determined, the A2 value of 0.002 Ci (or 0.4 Ci when alpha-emitters are known to be absent) (49 CFR 173.433) was used. Most radioactive samples met the

definition of limited quantity radioactive material and are, therefore, exempt from the more stringent DOT requirements for greater activities of radioactive material.

3.1.3 Analytical Methods

Each laboratory used for the WAG 3 chemical analysis program was audited, and approved by the SMO. The audit evaluated the laboratories analytical procedures, equipment calibration, and QA/QC Program. These audits and approvals were performed according to the procedures in PDs 5.5, "Obtaining Laboratory Services," and 5.6, "Conducting Audits of Analytical Laboratories." As indicated on Table 3-4, samples were analyzed for nonradioactive parameters using EPA-approved methods (i.e., CLP or SW-846) or radioactive parameters as described in the *Statement of Work of Radiological Analyses Performed for the Environmental Restoration Department at the INEL* (ER-SOW-33) (EG&G Idaho, 1991), prepared by the SMO. The following EPA methods were used:

- Test Methods for Evaluating Solid Waste, Physical and Chemical Methods, SW-846 (EPA, 1986)
- Methods for the Chemical Analysis of Water and Wastes (EPA, 1983)
- Statement of Work for Inorganic-Multi-Media, Multi-Concentration (EPA, 1993).

Calibration of laboratory analytical instruments were conducted in accordance with the SMO SOP 12.2.1, "Initial Analytical Laboratory Approval Procedure." The contract laboratory instruments were calibrated according to the manufacturer's recommendations, and as specified in the laboratory methods and/or Scope of Works (SOWs). The SOW defines calibration frequency and acceptance criteria. Laboratory instrument calibrations were documented on applicable instrument calibration forms. Calibration was verified as part of the data validation process.

3.1.4 Data Reporting

Data collection, transfer, storage, recovery, and processing steps, including laboratory and field QC and the use of logbooks and chain-of-custody forms followed the procedures of PDs 3.7, "Characterization Process in Environmental Restoration," 4.2, "Logbooks," and 5.7, "Chain-of Custody, Sample Handling, and Packaging." Field data reporting was coordinated by the FTL. Field records were controlled and maintained. All documents were submitted to ARDC at the conclusion of the project. Data reduction and reporting of raw laboratory data were performed by the laboratory in accordance with guidelines reviewed and approved by the LMITCO SMO. Data storage requirements for the laboratory are addressed in the laboratory SOW.

3.1.5 Quality Control

Internal QC checks were established and implemented for the sampling and analysis program as documented in the SAP and QAPjP. Field QC checks were established by submitting QA samples to the analytical laboratory. The field and laboratory QC checks are briefly described in the following sections. Section 3.5 presents a Data Quality Assessment of both the field and laboratory QC programs.

3.1.5.1 Field Quality Control. Several types of QC checks were performed in parallel with field sampling activities to ensure that the established data quality objectives (DQOs) were met (see Section 3.5). As defined in the SAP, the QC checks included duplicate samples, field blanks, equipment rinsate blanks, and trip blanks. The frequency and type of QC sample collection was dictated by the plan tables in the SAP. Detailed descriptions of the sample type, purpose, and collection frequencies are provided in Section 3.5.

3.1.5.2 Laboratory Quality Control. Laboratory QC checks, including the type and frequency of QC samples and calculation of data quality indicators, are described in the laboratory SOW prepared by the SMO and verified through data validation. As previously stated, all laboratory services were obtained following ER-approved procedures as outlined in PDs 5.5, "Obtaining Laboratory Services," and 5.6, "Conducting Audits of Analytical Laboratories."

3.2 Groundwater Investigation

In general, the RI/FS groundwater investigation consisted of the following activities:

- One round of groundwater samples were collected from the perched groundwater and aquifer wells in the vicinity of the ICPP.
- Borehole geophysical logging and impeller flowmeter tests were performed in well USGS-47 to identify groundwater flow zones. Following the flowmeter testing, six individual zones were isolated using straddle packers and water samples collected to help determine the vertical contaminant profiles of selected radionuclides.
- A step-drawdown and long duration (24 hr) pumping tests were performed on the 110-ft perched groundwater zone.
- A pumping test was performed on well MW-18 to determine the local aquifer transmissivity and the degree of interconnectedness of this well to the Snake River Plain Aquifer (SRPA).
- Detailed water level measurements were performed on wells MW-18, USGS-52, -47, -40, -43, and -121 to determine the impact of the local groundwater due to pumping high volumes of water from the ICPP production wells.
- Surface electromagnetic geophysical surveys were performed to better define the lateral extent of the perched groundwater outside the ICPP and, if possible, resolve the thickness of the deeper perched groundwater zone.

3.2.1 Groundwater Sampling

One complete round of groundwater samples was collected from the perched water and aquifer wells at the ICPP during May and June 1995. The wells included during this sampling event are shown in Figure 3-1. The aquifer wells selected for sampling bound the contaminant plumes from the ICPP and provide a baseline contaminant distribution for the groundwater modeling. All perched water wells that had sufficient water for sampling were sampled; however, many were dry.

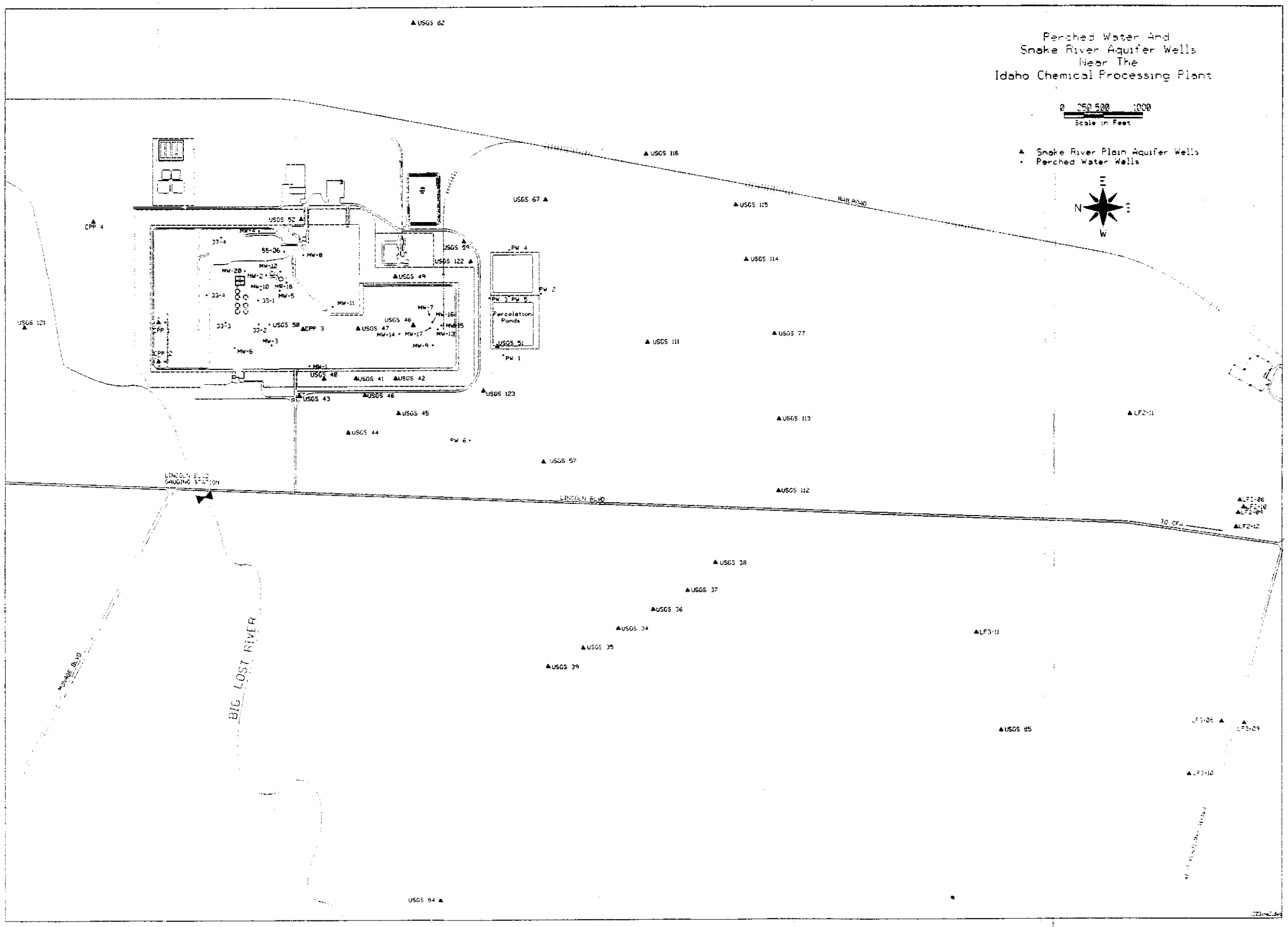


Figure 3-1. Locations of SRPA and perched water wells to be sampled.

Several aquifer wells originally planned to be sampled during the WAG 3 RI were not sampled due to problems with the wells. Landfill well LF2-9 was not sampled because the inoperable submersible pump was stuck in the well. LF3-11 was not sampled because it is a crooked hole and was abandoned during drilling. The surface casing of USGS-49 was damaged in 1977 during construction activities and consequently, this well was not sampled. Finally, production well CPP-4 has not been in operation for several years and therefore, was not sampled.

Water samples collected from the perched water wells were analyzed to help identify the source of water and to determine the nature of contamination. To satisfy the first objective, water from these wells was analyzed for carbonate, bicarbonate, alkalinity, chloride, fluoride, sulfate, total Kjeldahl nitrogen, ammonia, and nitrate/nitrite. To determine the nature of contamination, water samples were analyzed for gross alpha, gross beta, gamma spectroscopy, tritium, Sr-90, Tc-99, iodine-129 (I-129), CLP metals, and zirconium. If the gross alpha concentration exceeded 15 pCi/L (40 CFR 141), then the water sample was further analyzed for Am-241, Np-237, Pu-isotopes, and U-isotopes. A summary of the sampling and analysis for the perched water wells is provided in Table 3-1. At the time of sampling many perched water wells were found to be dry. These wells were sampled during previous field investigations and thus, it was not critical they be sampled. The only exception was USGS 50 and it was sampled.

Water samples collected from the aquifer wells were analyzed to assist in determining the nature and extent of contamination. These water samples were analyzed for gross alpha, gross beta, gamma spectroscopy, tritium, Sr-90, Tc-99, I-129, CLP metals, and zirconium. For the wells not in the direct flow path from the ICPP injection well, the water samples were further analyzed for Am-241, Np-237, Pu-isotopes, and U-isotopes only if the gross alpha concentration exceeded 15 pCi/L. For the wells in the direct flow path from the ICPP injection well (wells MW-18, USGS-42, -47, -48, -57, -112, and -121), the water samples were further analyzed for Am-241, Np-237, Pu-isotopes, and U-isotopes regardless of the gross alpha concentration. The SAP table for the aquifer wells is provided in Table 3-2.

3.2.1.1 Water Level Measurements. Water level elevations were measured in all wells before and following the groundwater sampling operation. The water levels were recorded using an electronic measuring device following the procedures described in ER SOP 11.9, "Measurement of Ground Water Levels." These data were collected in as short a time as possible to provide a "snap shot" of the groundwater flow directions in both the perched groundwater and the SRPA. Water level elevations were recorded for the perched and aquifer wells in May 1995.

3.2.1.2 Temperature, pH, and Specific Conductance. Temperature, pH, and specific conductance were measured in the field during purging, before sample collection, and following sample collection using calibrated field instruments. The measurements and calibration frequency were in accordance with the manufacturer's recommendations. All field measurements were recorded in the sample logbook.

3.2.1.3 Well Purging. All wells were purged before sample collection. A minimum of three well bore volumes of water were removed before sample collection. If the well was purged dry, samples were collected as soon as sufficient water was available to fill the required sample bottles. Purging was performed using the dedicated sampling pumps or a bailer. During the purging operation, specific conductance, pH, and temperature of the groundwater were measured initially and at least once during every well volume removed.

When three consecutive measurements were within the limits listed below and at least three well bore volumes were removed, a sample for water quality analysis was collected.

- pH—± 0.1 standard units
- Temperature—± 0.5 °C
- Specific conductance—± 10 µS/cm
- Color—no visually discernible difference.

If the parameters did not stabilize after three well bore volumes of water were removed, the purging operation continued until a minimum of five well bore volumes of water were evacuated from the well. Groundwater samples were then collected and the appropriate notations recorded in the field logbook. The investigation-derived waste (IDW) purge water generated from the aquifer wells that was discharged to the soil provided historical records that indicate the absence of chemicals above maximum contaminant levels (MCLs). The IDW purge water generated from the perched water wells was containerized and staged for subsequent disposal to the PEW Evaporator.

3.2.1.4 Water Sample Collection. Groundwater samples were collected and analyzed for inorganic and radionuclide contaminants. All bottles were filled to approximately 90% of capacity to allow for possible content expansion. Both filtered and unfiltered samples were collected in the field, with a summary of the sample collection provided as follows:

Unfiltered Samples

One 250-mL (8.45-oz) unfiltered sample was collected for nitrate/nitrite analyses and preserved with sulfuric (H_2SO_4) to a pH <2. Two 500-mL (16.9-oz) unfiltered samples were collected with one sample analyzed for carbonate/bicarbonate/alkalinity and the other sample analyzed for sulfate/chloride/fluoride. One 1,000-mL (33.8-oz) unfiltered sample was collected and analyzed for tritium. One 3.785-L (1-gal) unfiltered sample was collected and analyzed for Sr-90 and Tc-99. Finally, one 540-mL (18.25-oz) unfiltered sample was collected and analyzed by gamma spectroscopic techniques.

Filtered Samples

A 1-L (.264-gal) sample was collected for metal analyses, filtered using a 0.45-µm Millipore® filter, and acidified to a pH <2 using nitric acid. Two 1,000-mL (33.8-oz) samples were collected for gross alpha and gross beta analyses; one 3.785-L (1-gal) sample was collected for uranium and plutonium analyses and one 3.785-L (1-gal) sample was collected for americium and neptunium analyses. All these samples were filtered in the field using a 0.45-µm Millipore® filter and acidified to a pH <2 using nitric acid. Two 1,000-mL (33.8-oz) samples were collected for iodine-129 analyses and filtered using a 0.45-µm Millipore® filter in the field.

All procedures for sample collection were in accordance with the ER PD 5.7, "Chain of Custody, Sample Handling, Packaging, and Shipment."

Samples were not analyzed for U- and Pu-isotopes, Np-237, and Am-241 if the gross alpha activity was less than 15 pCi/L (based on Safe Drinking Water Act MCL). If insufficient water was available to complete all sample requirements, samples were collected in the following priority: Sr-90, gamma spectroscopy, gross beta, gross alpha, CLP metals, Tc-99, tritium, I-129, U- and Pu-isotopes, Np-237 and Am-241, and nitrate/nitrite, chloride/fluoride/sulfate, and carbonate/bicarbonate/alkalinity.

Given the low amount of water available from well MW-10, sample bottles were filled in the following priority: U- and Pu-isotopes, Sr-90 and Tc-99, gamma spectroscopy, gross beta, gross alpha, CLP metals, tritium, I-129, Np-237 and Am-241, nitrate/nitrite, chloride/fluoride/sulfate, and carbonate/bicarbonate/ alkalinity. This change in sample collection priority for well MW-10 was to help identify the isotopic breakdown for the gross alpha contamination that was identified in the well during previous sampling events.

3.2.2 Vertical Contaminant Profile Sampling (USGS-47)

Vertical contaminant sampling was performed for the saturated zone of well USGS-47 to better understand the groundwater flow conditions and distribution of contaminants in the SRPA downgradient from the ICPP injection well. Historically, this well has consistently higher [0.3 to 0.6 m (1 to 2 ft)] water level elevations than observed in the surrounding wells. The elevated water levels from this well may be the result of the overlying perched groundwater. The construction diagram for USGS-47 indicates a 15.87-cm (6.25-in.) inside diameter (I.D.) casing from the land surface to 140 m [460 ft below ground surface (bgs)] and a 15-cm (6-in.) diameter open hole down to the total depth of 198.5-m (651.3-ft) bgs. Before the sampling operation, the water level in USGS-47 was measured at 137.9-m (452.5-ft) bgs.

Flow zones within USGS-47 were identified using down hole geophysical logging tools and an impeller flowmeter. A Century Geophysical Model 9710 impeller flowmeter was run in conjunction with a natural gamma, caliper, and video log on the open hole interval of the well. The impeller flowmeter detected changes in water velocity to several ft/sec and these data were used with the geophysical and video logs to identify active flow zones for the well.

Following the geophysical well logging and flowmeter testing, five active flow zones were identified and sampled for water quality. Samples were also collected at the water table for analyses. The six zones tested involved the following intervals: (1) 140–143.4 m (462–470.8 ft) bgs, (2) 147–149.9 m (483–491.8 ft) bgs, (3) 155.9–158.5-m (511.5–520.3-ft) bgs, (4) 170–172.7-m (558–566.8-ft) bgs, (5) 175–178.2-m (576–584.8-ft) bgs, and (6) 181–184.3-m (596–604.8-ft) bgs.

The samples were collected using a straddle-packer assembly to isolate the individual flow zones. The straddle-packer was set at each zone in accordance with ER SOP 11.7.1, "Aquifer Testing Using the Straddle-Packer Method." The straddle-packer assembly had an upper and lower packer that isolated the target zone and used a submersible pump attached to steel tubing, which extends to land surface. Before sampling, the sample interval was purged of three straddle packed interval well bore volumes. Once the required water samples were collected from a zone, the straddle-packer assembly was deflated and set up on the next zone. The samples collected were analyzed for gross alpha, tritium, Sr-90, Tc-99, and I-129.

Tritium and Sr-90 are the only constituents detected in the SRPA in concentrations above the MCL. A summary of the sample and analysis for the vertical contaminant profile sampling is provided in Table 3-2.

3.2.3 Perched Water Aquifer Tests

Pumping tests were performed on the perched groundwater beneath the ICPP as described in the *Technical Work Plan for the Idaho Chemical Processing Plan Perched Ground Water Tracer and Pumping Tests*. The tests were intended to collect site-specific data on the nature, occurrence, and movement of perched groundwater beneath the ICPP. Specifically, the objectives were to:

- Assist in determining the contribution of steam injection.
- Determine whether sustained pumping is feasible for the pump and treat remedial alternative.
- Determine the hydraulic connectedness of the perched groundwater bodies. The interconnectedness of the perched water bodies is relevant to evaluating potential remedial options.
- Collect parameters to help determine the fate and downward transport of contaminants to the SRPA.
- Provide information (i.e., seepage velocity, and effective porosity) to assist in the calibration of the unsaturated flow model.

The perched water pumping tests consisted of a step-drawdown test, constant rate pumping test coupled with the drift and pumpback tracer test, and a vertical tracer test. The vertical tracer test was performed during the "winter heating season" when steam condensate was being generated by heating the Waste Calcining Facility (WCF) (CPP-633). The step-drawdown pumping test was conducted during late summer after water in the Big Lost River was no longer flowing near the ICPP. The constant rate pumping test was performed within a few weeks of the step-drawdown test to check the feasibility of a sustained pumping event.

MW-5 was designated as the primary test well because it is one of the best water producing wells in the upper perched zone at the ICPP and has significant levels of contamination. MW-5 has a dedicated Grundfos Redi-Flo 2 submersible pump that is capable of pumping up to 19 L/min (5 gpm) from the depth it is installed. Control of the pump discharge rate was through the use of a controller box. All water collected from well MW-5 was containerized in a "Frac" tank and staged for subsequent disposal to the PEW Evaporator.

3.2.3.1 Step Drawdown Test (MW-5). A step-drawdown test was performed at MW-5 on September 29, 1995 before the tracer and constant discharge pumping test. During the step-drawdown test, well MW-5 was pumped at four successively higher rates and the drawdown for each step recorded in the logbook. This test determined the range of sustainable pumping rates that the perched aquifer will yield, assuming the volume of water within the perched zone is adequate to sustain a continuous withdrawal for a 24-hr or longer duration, and determined the optimum pumping rate for the constant discharge test.

Four pumping steps were used during the step-drawdown test [1.58 L/min, 8.3 L/min, 13.6 L/min, and 19 L/min (0.42 gpm, 2.2 gpm, 3.6 gpm, and 5.2 gpm)]. These discharge rates were based upon the maximum discharge from the 5.1-cm (2-in.) submersible pump installed in MW-5. The maximum pumping rate of 19.6 L/min (5.2 gpm) caused the water level in the well to decline below the transducer and no measurements were recorded. Since data were no longer being recorded at the maximum pumping rate, the test was terminated 2 min into this step.

The procedure followed for the step-drawdown test of MW-5 was:

1. The surface equipment including poly tank, discharge hose, and flowmeter were set up. The system was then checked for leaks before the start of the test.

2. The static water level (SWL) in MW-5 was recorded in the field logbook based upon the value recorded from the dedicated data logger and transducer. The data logger was then programmed to take measurements every minute.

3. The pump was turned on and adjusted to the desired flow rate on the flowmeter as soon as possible.

4. Water level readings were automatically recorded at 1-min intervals in the pumping well by the dedicated data logger and transducer.

5. The barometric pressure was recorded at the monitoring station at Central Facilities Area (CFA) every 5 min.

6. Pumping continued at specific flow rate for a given time duration. The pumping rates and associated duration were as follows: 1.58 L/min (0.42 gpm) for 30 min, 8.3 L/min (2.2 gpm) for 60 min, 13.6 L/min (3.6 gpm) for 62 min, 19.6 L/min (5.2 gpm) for 2 min. At the final step, the water level within the well was decreased below the level of the transducer and the test was terminated.

7. The pump was shut off and water level recovery data were recorded at 1-min intervals until the well recovered almost totally to the prepumping levels.

3.2.3.2 Single-Well Tracer Test. The estimation of regional advective groundwater velocity (seepage velocity) is important to understand rates of contaminant migration. In some cases, this aquifer parameter can be calculated by dual-well tracer tests if two wells exist along the line of flow. However, a tracer test known as a drift and pumpback test can be a more economical method for obtaining seepage velocity.

The drift and pumpback test consists of injecting a tracer into a well and allowing it to move away from the well under ambient flow conditions. As the tracer begins to move away from the well under advective conditions, mechanical dispersion and molecular diffusion tend to distort the tracer front. After the tracer drifts for a sufficient length of time, pumping at the well begins and the tracer is recovered in the pumped water. As the well is pumped, tracer concentration readings are taken at predetermined time intervals. When the tracer is pumped back toward the well, an increase in tracer concentration should be observed, followed

by a decrease. A plot of tracer concentration versus time during the pumpback portion of the test will generate a skewed, bell-like curve. The vertical line dividing the area under the curve into two equal pieces represents the center of the tracer mass. In other words, the center of mass is defined as that point in time at which half of the injected tracer is recovered through pumping. The analytical equations for this test requires the drift time and time required to recover the tracer's center of mass.

3.2.3.2.1 Tracer Selection—Sodium iodide was identified as a suitable ionic tracer for the drift and pumpback test, which is considered to be conservative in that it is largely unaffected by sorptive processes. Generally, short-term tracer experiments in permeable material will be affected almost exclusively by hydrodynamic dispersion. Therefore, when studying the tracer concentration and its direct relation to the moving groundwater beneath the ICPP, only hydrodynamic dispersion need be considered.

This tracer is easy to detect with a commercially available ion-selective electrode having detection limits of 0.4 to 79,900 mg/L. These solid-state electrodes are used jointly with a reference electrode and require an ion meter with a resolution of 0.1 millivolts. Based on historical sampling results, natural background concentrations of iodide in the perched water bodies at the ICPP are less than 1 mg/L.

3.2.3.2.2 Procedure—The procedures followed for the drift and pumpback test were:

1. Before the drift and pumpback test, the water level in MW-5 was measured and recorded. This information was used to determine the tracer amount to be injected in the well.

2. To achieve an estimated initial iodide concentration in the well of 1,000 mg/L, approximately 12.3 grams of sodium iodide were mixed in 1-L (0.3-gal) of water. The amount of sodium iodide required for an initial 1,000 mg/L iodide solution [using 1-L (0.3-gal) of water to dissolve the sodium iodide] was calculated using the following equation:

$$Z = \frac{C(X+1)}{0.847}$$

where

Z = mg of sodium iodide

C = initial iodine tracer concentration to be introduced into the well

X = liters of water in well (approximately 9.7 L)

0.847 = fraction of iodide in 1 mg of sodium iodide.

3. The 12.3 g of sodium iodide were mixed with 1 L (0.3 gal) of deionized water and poured into the 2.5-cm (1-in.) diameter stainless steel pump casing through 1.3-cm (0.5-in.) diameter plastic tubing. Nitrogen gas was then introduced into the plastic tubing to force the sodium iodide solution out of the tubing and into the pump column. Once the solution was inside the pump column, nitrogen gas was introduced into the pump column to force the sodium iodide solution out of the pump column and into the well casing. Once the sodium iodide solution was forced out

of the pump column and into the well casing, the time was recorded in the field logbook and marked the beginning of the drift interval.

4. The tracer was allowed to drift away from the well for 14 days before the pumping test. This length of time was selected to ensure that the iodide's center of mass drifted a sufficient distance away from the well bore and would provide meaningful data. Estimated seepage velocities in this perched aquifer are low, on the order of 2 to 4 cm/day (0.6 to 1.6 in./day). This is due, in part, to a probable low hydraulic gradient derived from water level information for MW-2 and MW-5. Therefore, it was estimated in the Work Plan that the drift portion of the test would take from 1 to several weeks to achieve adequate drift of the iodide.

5. Once the drift portion of the test was complete, the pumpback portion of the test was initiated in conjunction with the pumping test. The pumping rate corresponded to the optimum rate determined from the step-drawdown test.

6. Samples were collected from the initial water and at every 30 min thereafter for the duration of the test. The samples were collected in 40-mL (1.3-oz) high-density polyethylene (HDPE) bottles with teflon-lined lids and placed directly in a cooler. These water samples were later tested for iodide concentration in the laboratory using an iodide selective electrode combined with the appropriate millivolt meter.

3.2.3.2.3 Results—During the constant rate pumping test, water samples were collected at 30-minute intervals for iodide analysis. Iodide concentrations in the groundwater were later measured in a laboratory under a constant temperature using a iodide selective electrode. The results for the pumpback portion of the test are plotted in Figure 3-2. As shown in this figure, none of the tracer injected into the well was recovered during the pumpback portion of the test. Apparently, the tracer drifted beyond the influence of the pumping test and was not subsequently recovered. Therefore, estimates of effective velocity are not possible from these data.

3.2.3.3 Constant Rate Pumping Test (MW-5). A constant rate pumping test was performed during October 11 and 12, 1995 at well MW-5. This test corresponded to the beginning of the pumpback portion of the drift and pumpback tracer test as discussed in Section 3.2.3.2. The pumping test was performed for approximately 22 hr with water level measurements recorded at 1-min intervals using a dedicated pressure transducer and data logger. Following completion of the pumping test, the water level in the well was allowed to fully recover during the monitoring period.

Before conducting the pumping tests, water level measurements were made in 14 perched water monitoring wells to determine whether they could be used as observation wells during the constant rate pumping test. These wells include MW-2, MW-4, MW-6, MW-8, MW-10, MW-12, MW-18, MW-20, CPP 33-1, CPP 33-2, CPP 33-3, CPP 33-4, CPP 37-4, and CPP 55-06. Of these wells, sufficient water was available in wells MW-2, MW-4, MW-6, MW-20, CPP 33-2, CPP 33-3, CPP 33-4, CPP 37-4, and CPP 55-06 for monitoring. These wells were selected as observation wells because they are completed at elevations similar to that of MW-5 and may be impacted during the pumping test. During the pumping test, these wells were monitored at 1-min intervals using pressure transducers and data loggers. Barometric pressure readings were also recorded during this period at 5-min intervals from the CFA weather station.

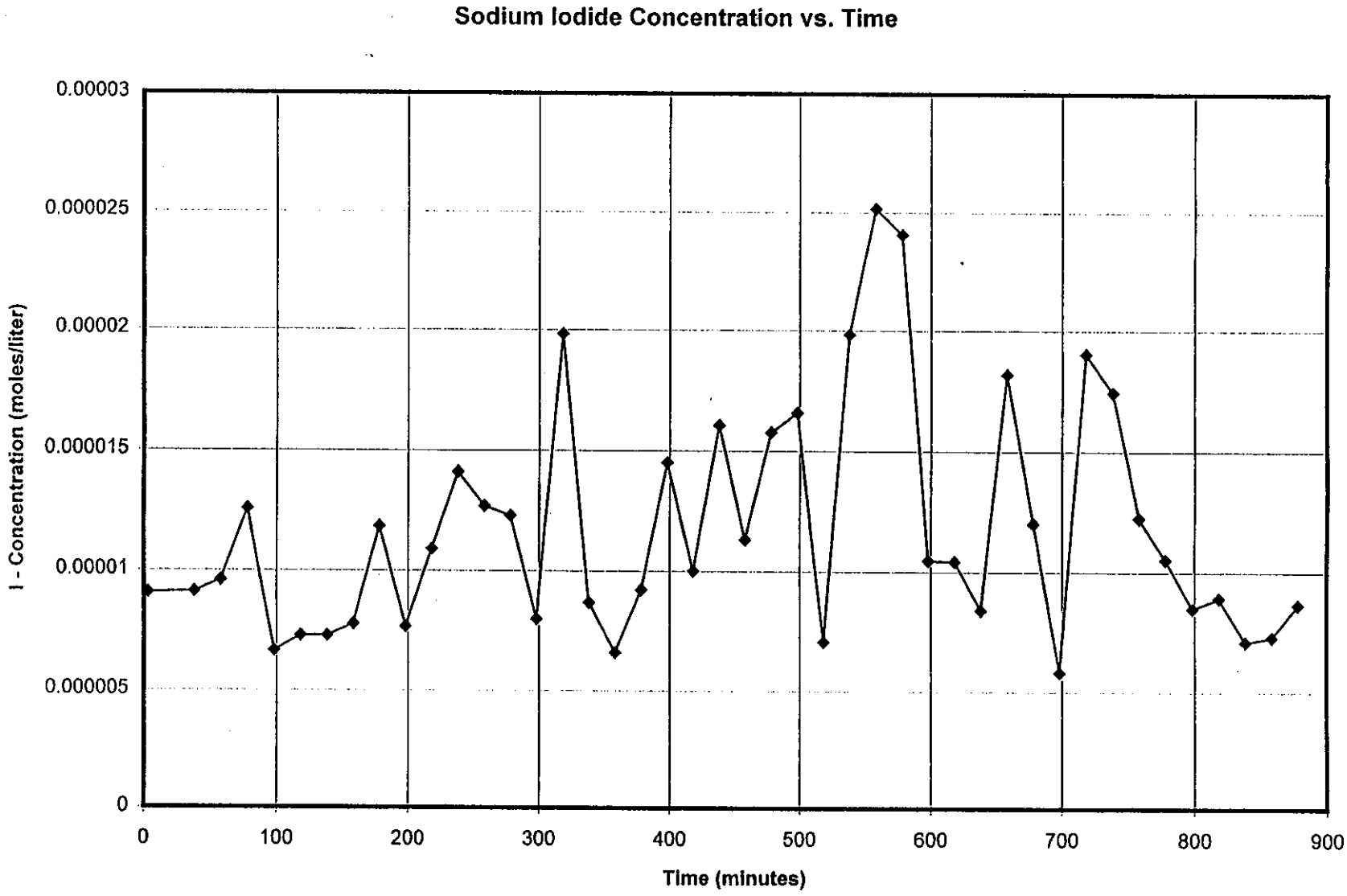


Figure 3-2. Iodide concentrations for well MW-5 pumpback test.

During the constant rate pumping test, water samples were collected for Sr-90 analysis. One sample was collected within the first 10 min of pumping to determine initial Sr-90 concentrations in the perched groundwater. Additional samples were collected at the approximate midpoint of the test and the final sample was collected immediately before the pump was shut-off to end the pumping portion of the test. One QA/QC duplicate sample was collected in conjunction with the midpoint sample to check laboratory integrity. A summary of the sample and analysis for the MW-5 pumping test is listed in Table 3-1.

The discharge rate was maintained at approximately 11 L/min (3 gpm). This rate was kept as constant as possible throughout the test by adjusting an in-line gate valve and monitoring the discharge using a flowmeter. Flowmeter measurements were recorded in the field logbook at 30-min intervals. Any changes in the discharge rate were recorded in the field logbook and the flow adjusted accordingly. The discharge rate was maintained within ±0.7 L/min (0.2 gpm) throughout the duration of the test.

At the end of the 22-hr pumping test, the pump was turned off, and the time and recovery data were recorded. The data loggers (including the pumping and all observation wells) recorded the recovery of water levels at 1-min intervals. The recovery portion of the pumping test continued until water levels in MW-5 were within 90% of the prepumping level. An SOP for the constant rate pumping test is provided in Appendix B of the SAP.

3.2.3.4 Vertical Tracer Test. A vertical tracer test was performed near the WCF to assist in determining the vertical travel time for water introduced at the surface to travel downward to the upper perched water zone. A known volume and concentration of sodium bromide tracer solution was introduced into a steam condensate drain located to the southwest of the WCF. The surrounding monitoring wells (MW-2 and MW-5) that were completed in the upper perched zone were monitored for tracer breakthrough. Bromide concentrations were measured in the field using ion-selective electrodes.

The steam condensate drain selected for the vertical tracer test is located approximately 7.6-m (25-ft) south of MW-5. The steam condensate originates from the heating of the old WCF. The steam vent is only active during the heating season, which is generally October through April of each year. The volume of steam condensate varies on a daily basis, depending on the heat demand of the building. During high heat demand, it has been calculated by operating engineers that approximately 45 gal/per day (gpd) of steam condensate are generated and directed to the drain. During groundwater sampling events, it has been noted that the temperature of MW-5 purge water was around 21°C (70°F), indicating the steam vent may be actively recharging the upper perched zone.

3.2.3.4.1 Tracer Preparation—The initial starting concentration of the bromide tracer was 388 g/L. This solution was made by adding 500 g of sodium bromide crystals to 1-L (0.3-gal) of water (bromide concentration is 77.6% of the total in sodium bromide). This initial concentration is above the upper limit of the ion-selective electrode for the measurement of bromide, however, it allows for six orders of magnitude dilution factor before the tracer is unmeasurable.

The procedures for preparing the bromide solution for injection are described as follows:

1. Begin with the total volume of water [1-L (0.3-gal)] to be mixed with the tracer and add 500 g of sodium bromide crystals. Because the tracer will be added to a steam condensate drain, the

amount of water standing in the drain will be unknown and therefore, will not be included in the total volume. The tracer slug volume to be added to the steam vent will be 1-L (0.3-gal).

2. Thoroughly mix the 500 g of sodium bromide with 1-L (0.3-gal) of tap water before injection. The bromide solution will then be injected into the steam drain by pouring directly into the drain. The day and time of injection is then recorded in the field logbook.

3.2.3.4.2 Monitoring Procedure—Monitoring for tracer breakthrough in wells MW-2 and MW-5 continued for approximately 3½ months. The procedures followed during this monitoring period were as follows:

1. Groundwater samples for bromide measurements were collected from MW-5 and MW-2 using the dedicated submersible pumps installed in each well. Because of the conservative nature of the tracer, only small quantities of water were pumped from the well during each sampling event. For each sampling event, only one well bore volume of water was purged before sample collection, which was approximately 9.4-L (2.5-gal). All purge water was containerized in 208-L (55-gal) drums for eventual disposal at the PEW Evaporator. Water level measurements were recorded throughout the test by the dedicated pressure transducers and data loggers.

2. Bromide measurements were taken by collecting the sample water in a beaker and quickly placing the bromide ion-selective electrode into the beaker and recording the measurement in millivolts. The electrode was rinsed after each reading to avoid cross-contamination. All water level and bromide readings were recorded in a single bound logbook.

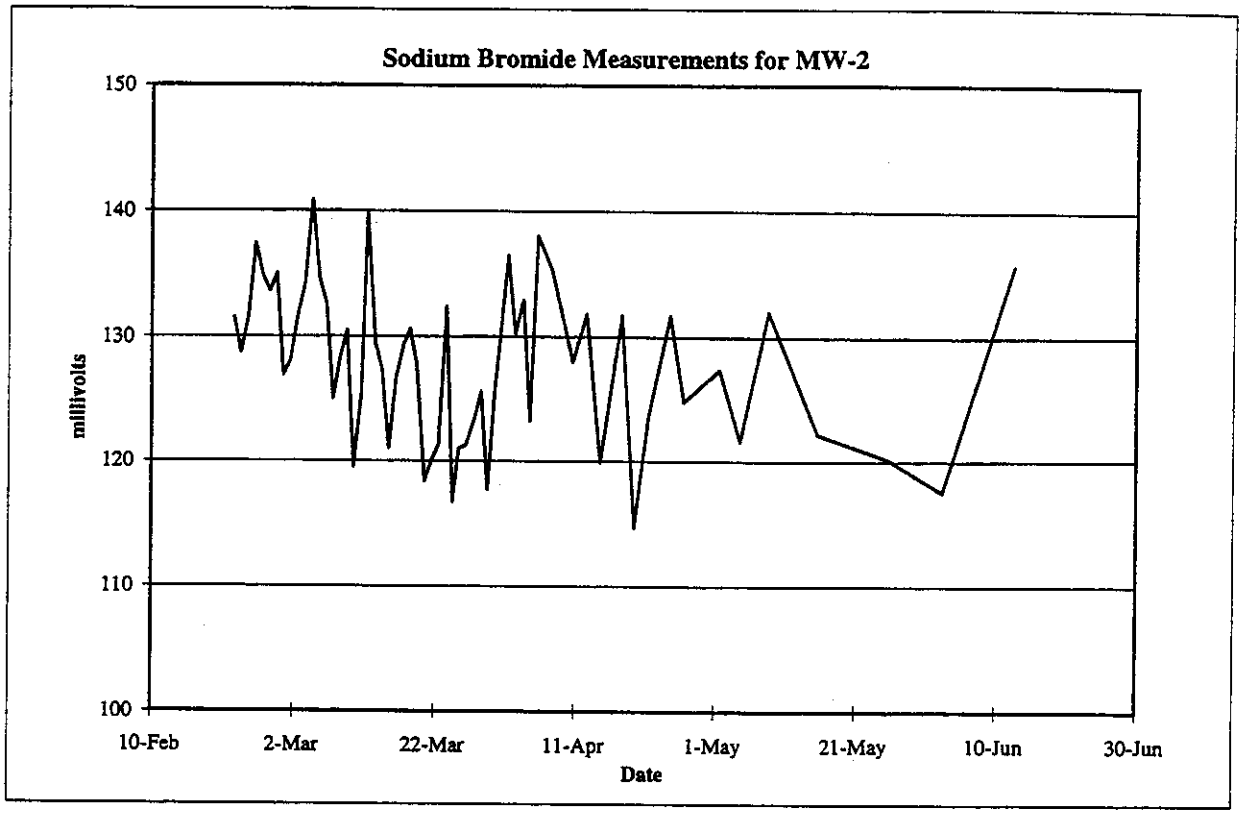
3. Sampling began the day after injection of the tracer into the steam vent and continued for 44 days on a daily monitoring basis. Sampling continued for an additional 2 months at a rate of approximately 2 to 3 measurements per week. The sampling of wells MW-2 and MW-5 continued until June 12, 1995.

3.2.3.4.3 Results—The solution containing the sodium bromide tracer was injected in the steam vent on February 17, 1995. Monitoring for tracer breakthrough was then performed using the bromide selective electrode in wells MW-2 and MW-5 on a daily basis until April 5, 1995. After 44 days of monitoring, the sample frequency was adjusted to a rate of approximately two to three measurements per week and monitoring for the tracer continued until June 12, 1995. Since tracer breakthrough was not observed after 115 days of monitoring, the vertical tracer test was terminated on June 12, 1995. Figure 3-3 provides the monitoring data for the vertical tracer test.

3.2.4 Snake River Plain Aquifer Tests

Two aquifer tests were performed to better understand the local groundwater flow. The first test consisted of a pumping test of MW-18 to determine the local hydraulic conductivity. The second test was performed to determine the effects of the production wells upon the SRPA.

3.2.4.1 Pumping Test (MW-18). A pumping test was performed on well MW-18 for the 10.16-cm (4-in.) diameter casing completed in the SRPA. During previous groundwater sampling activities, the flow rate in well MW-18 was measured at 2.2 L/min (0.6 gpm). It is uncertain whether this low flow rate was a



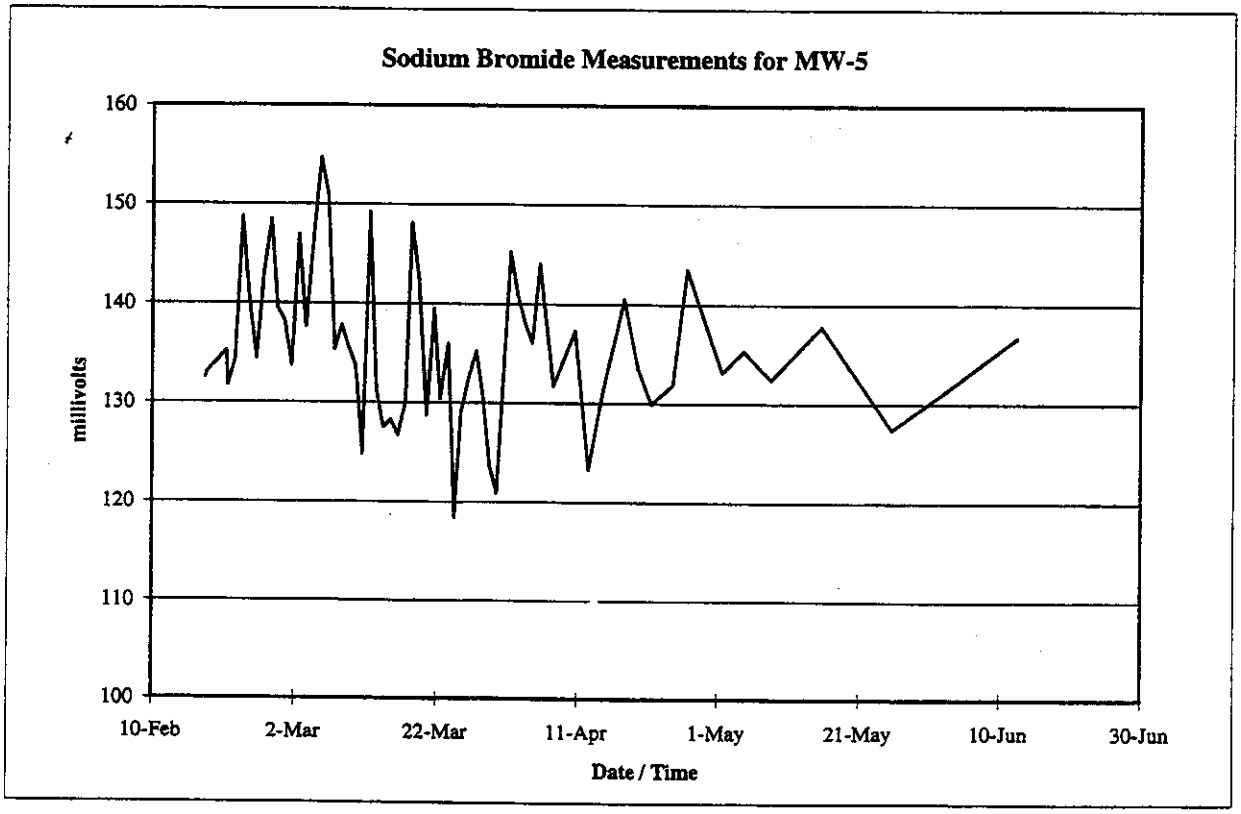


Figure 3-3. Monitoring data for the vertical tracer test.

function of the aquifer hydraulics or due to the limitations of the dedicated submersible pump. Information gathered from the pumping test was intended to be used to determine the transmissivity of the aquifer in well MW-18 and the degree of communication with the SRPA.

The constant rate pumping test was conducted at well MW-18 by pumping the maximum discharge rate and recording changes in the water level or drawdown using an In-situ® transducer and data logger. The maximum discharge achieved during the pumping test was 2.6 L/min (0.7 gpm) and as a result, no noticeable drawdown was observed in the well. Therefore, it appears that the discharge limitation from MW-18 is mechanical and not a function of the aquifer. Since negligible drawdown was observed in the well during the test, no useable data were obtained to determine the hydraulic conductivity or the degree of communication with the SRPA.

3.2.4.2 SRPA Water Level Study. Water levels were monitored in six wells completed in the SRPA using In-situ® transducers and data loggers to provide information on the transient effects on the aquifer from pumping high volumes of water from aquifer production wells CPP-1 and -2. The objectives of this effort were to collect information that will assist in determining the effects on the SRPA from the overlying perched groundwater in the central portion of the ICPP, and to confirm or deny whether water releases to the ICPP percolation ponds are adding sufficient hydraulic head to create a localized change in water direction in the northern area of the ICPP.

A maximum of 20 psi rated transducers were placed 1 to 3 m (5 to 10 ft) below the groundwater in wells MW-18, USGS-52, -47, -40, -43, and -121. Transducers could not be placed in the two operational production wells (CPP-1 and -2) due to small access ports at the wellhead. The data loggers were set to record the water level at 1-min intervals and the wells were monitored for a minimum of 2 weeks. The pump usage from the production wells was also monitored so that information could be correlated to fluctuations in the water level.

3.2.5 Time Domain Electromagnetic (TDEM) Survey

To provide better definition of the perched or saturated zones in and around the ICPP boundaries, surface geophysical surveys were performed from September 11–15, 1995. The surface geophysical logging was performed by Blackhawk Geosciences using time domain electromagnetic (TDEM) techniques. The geoelectric sections derived from the TDEM surface measurements were correlated with available lithologic and geophysical logs before performing interwell interpretation. The presence of buried utilities at the ICPP interfered with the TDEM measurements and impacted the effectiveness of the survey.

All data were collected with the Geoonics EM47 TDEM system. For the most part, data were collected using 40 × 40-m nongrounded transmitter loops. Three soundings were measured using 80 × 80-m transmitter loops. The 40 × 40-m loops used a current of 3 A and a turnoff time of 2.5 μs. The 80 × 80 m transmitter loops used a current of 2.5 amperes with a turnoff time of 4.5 μs.

The nongrounded transmitter loops were positioned as much as possible away from cultural features such as fences, power lines, and other utilities in the area, which degrade the TDEM data quality. Measurements of the z (vertical) component field were usually made at the center of the loop and at locations 20 m outside of the transmitter loop on two opposite sides. In some locations, the horizontal (x) field data were collected at the external measurement location.

A report describing the procedures and results of the Phase 1 TDEM geophysical survey is provided in Appendix C. In summary, the three areas investigated show that the TDEM data can detect fine grained zones identified in the stratigraphic logs between 100 and 175-ft bgs. In one case (near USGS-67), TDEM data detected an individual, thick, clay layer that was also identified in the well log. In the other comparisons, TDEM data detected a broader, low resistivity zone, which appears to correlate to a combination of several fine grained zones, with varying amounts of clay. Also, some soundings detected the regional water table. In these comparisons, there is no indication of the deep perched groundwater zone or fine grained zones that may create it.

3.3 Surface and Subsurface Soil Investigation

The sampling design for the surface and subsurface investigation was selected to meet the project DQOs identified in the SAP. Activities conducted during the RI/FS field investigation included the following:

- Surface radioactivity screening was performed at three sites (CPP-61, CPP-13, and CPP-22) using field instruments. Areas of elevated radiation (>100 cpm above background) were then targeted for the collection of soil samples.

- Surface and subsurface soil samples were collected from sites CPP-61, -40, -13, -11, -19, -78, -46, -88, -90, -91, and -93 to determine the degree of contamination from past releases at each of the sites. In addition, two boreholes were drilled in the area east of building CPP-603 to bound the extent of subsurface contamination.

- Samples were collected from soil removed from the Tank Farm area during an upgrade project, to help evaluate nearby release sites in the risk assessment. It should be noted that this soil is not a CERCLA site.

3.3.1 Sample Collection and Field Observations

The general sample collection strategy for the surface and subsurface soil samples was the same for each site. A soil sample was collected from the land surface to a depth of 0.1 m (0.5 ft) and sent to the laboratory for analysis. The sample was also analyzed for Sr-90 and Tc-99 if gross beta was greater than 30 pCi/g; and Am-241, Np-237, and U- and -Pu isotopes if gross alpha activity was greater than 20 pCi/g. The gross beta and alpha levels are considered background levels in soil at the INEEL (see Attachment 6 Section 2.3.22, Sample Analysis Plan, of WAG 3 Comprehensive RI/FS Work Plan). A sample was also collected from the interval having the highest radiation measured between 0.2 and 1.2 m (0.5 ft and 4 ft) bgs and sent for analysis. These samples 0 to 0.2 m (0 to 0.5 ft) and 0.2 to 1.2 m (0.5 to 4 ft) bgs helped to determine if contamination present was from windblown contamination or the result of a larger release that may have contaminated soils at greater depths. Finally, a sample was collected from the interval having the highest radiation measured between 1.2- and 3-m (4- and 10-ft) bgs and sent for analysis.

All screening levels measured in the field were recorded in the sample logbooks. If elevated levels of radioactivity (i.e., greater than 100 cpm over background) were measured in the borehole soil at 3-m (10-ft) bgs by the portable survey equipment, the borehole was advanced until soil radiation readings were at or near background levels or down to the soil/basalt interface. If the borehole was advanced below 3-m (10-ft) bgs, split-spoon samples were taken every 2 m (5 ft) and screened for radioactivity. A sample was then collected

from the interval having the highest radioactivity between 3-m (10-ft) bgs and the total depth of the borehole and sent for laboratory analyses. If the borehole extended to the soil/basalt interface, a sample for analysis was also taken at the interface.

At a minimum, all soil samples were submitted to the laboratory and analyzed for gross alpha/beta and gamma spectroscopy. The sample was also analyzed for Sr-90 and Tc-99 if gross beta was greater than 30 pCi/g; and Am-241, Np-237, and U- and -Pu isotopes if gross alpha activity was greater than 20 pCi/g. Depending on the type of contaminants that were expected to be present, the samples may have been analyzed for various inorganic contaminants. Table 3-3 provides the sampling and analysis requirements for the soil investigation at each release site.

3.3.1.1 Site CPP-61 (OU 3-01). Four boreholes (CPP-61-1, -2, -3, and -4) were hand augered to depths of 3-, 1.4-, 0.3-, and 0.5-m (10-, 4.5-, 1-, and 1.5-ft) bgs, respectively (Figure 3-4). Before drilling, the locations of the boreholes were approved by ICPP Facility Management personnel before any hand augering due to the presence of subsurface electrical conduits in the area.

One borehole (CPP-61-1) was drilled to 3-m (10-ft) bgs at a location as close as possible to the original polychlorinated biphenyl (PCB) spill and the 1,000 and 1,500 cpm hotspots detected during the 1985 surface radiation reading. Soil samples for laboratory analysis were collected from 0 to 0.2 m, 0.6 to 1.2 m, and 2.4 to 3 m (0- to 0.5-ft, 2- to 4-ft, and 8- to 10-ft) bgs. The maximum radiation level measured in the borehole was less than 100 cpm (at all depths). For borehole CPP-61-2, soil samples for laboratory analyses were collected at depths of 0–0.2 m and 1.2–1.4 m (0–0.5 ft and 4–4.5 ft) bgs. The maximum radiation level measured in the borehole was less than 150 cpm (at all depths). Borehole CPP-61-3 had soil samples collected at depths of 0–0.2 m, and 0.2–0.3 m (0–0.5 ft, and 0.5–1 ft) bgs. The maximum radiation level measured in this borehole was 130 cpm (at all depths). Borehole CPP-61-4 had soil samples collected at depths of 0-0.2 m, and 0.3– 0.5 m (0–0.5 ft, and 1–1.5 ft) bgs. The maximum radiation level measured in this borehole was 120 cpm [0.3–0.5 m (1–1.5 ft)].

3.3.1.2 Site CPP-40 (OU 3-06). One borehole was hand augered to 3 m (10 ft) bgs at a location 1.5-m (5-ft) northeast of the midpoint along the former location of the underground pipes (Figure 3-5). Before drilling, a site walkover was performed and the borehole was placed as close as physically possible to the location of the former lines. Locating the borehole near the highest Cs-137 detection, combined with the low mobility of Cs-137 in soils, increased the probability of collecting samples near the source. Soil samples for laboratory analysis were collected from 0 to 0.2 m, 0.8 to 1.5 m, and 2.3 to 3 m (0 to 0.5 ft, 2.5 to 5 ft, and 7.5 to 10 ft) bgs. The maximum radiation level measured in the borehole was less than 100 cpm (at all depths).

3.3.1.3 Site CPP-13 (OU 3-08). One borehole (CPP-13-1) was drilled to a total depth of 3 m (10 ft) bgs at the location along the bottom of the berm having the highest radioactivity (Figure 3-6). This borehole was positioned at the bottom of the berm because any surface precipitation along the upper portions of the berm would infiltrate into the soil and most likely migrate toward the base. According to the incident report following the release, approximately 15 cm (6 in.) of "clean" soil was placed over the earthen berm after the release. Therefore, a sample was collected between 13 and 31 cm (6 in. and 1 ft) rather than 0 and 13 cm (0 and 6 in.) and sent for laboratory analysis. The remaining sample samples were collected from 0.2 to 0.3 m, 0.3 to 0.8 m, and 2.3 to 3 m (0.5 to 1 ft, 1 to 2.5 ft, and 7.5 to 10 ft) bgs and sent to the laboratory for analyses. In addition to the radiological analyses, the samples were also analyzed for CLP metals and

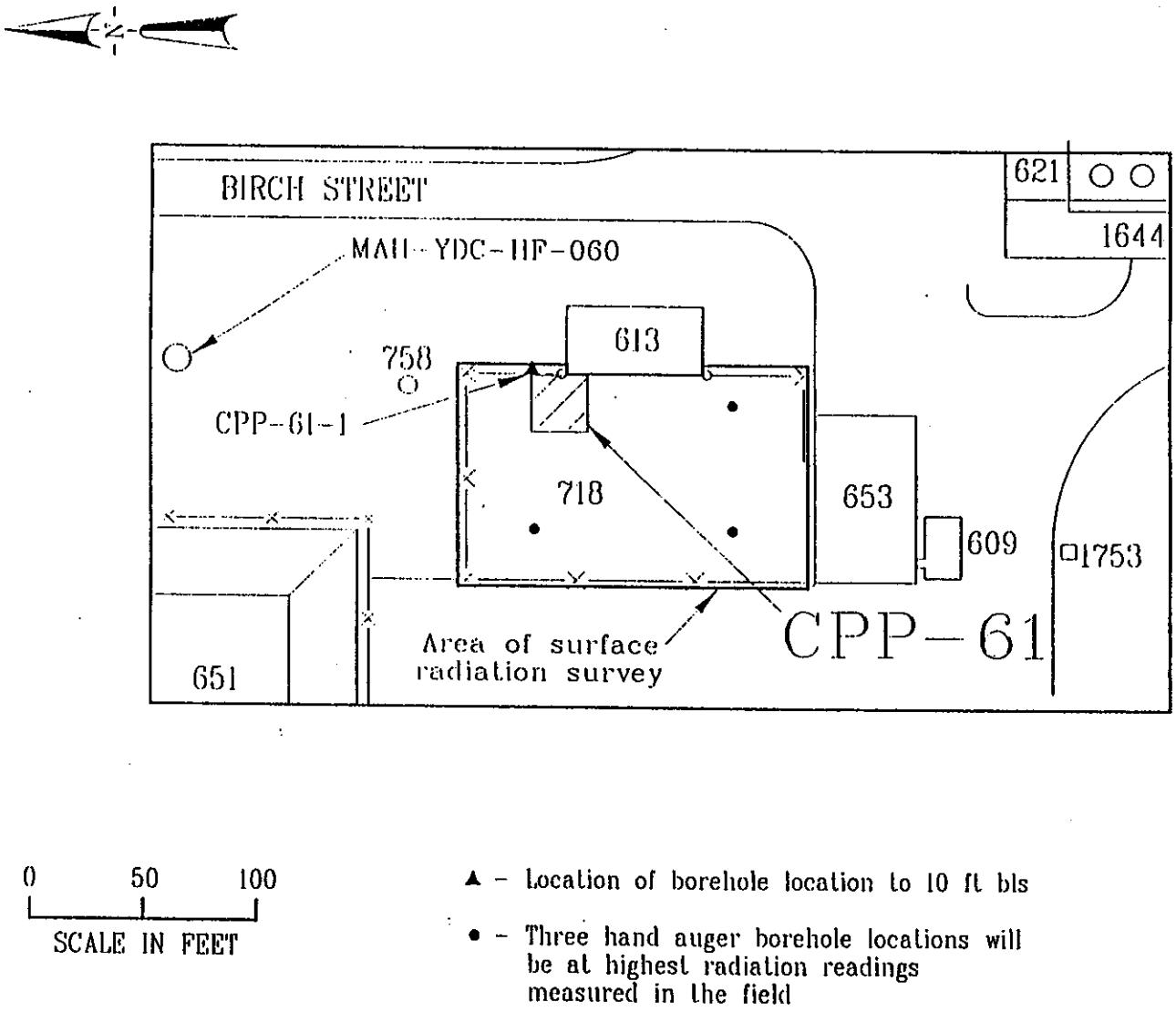
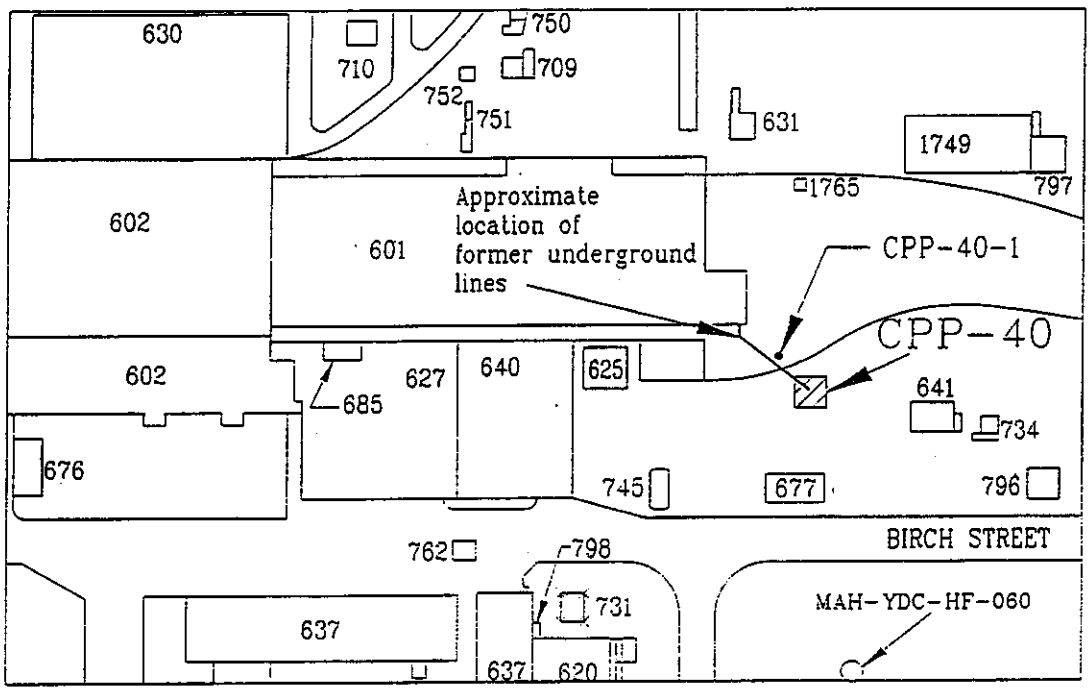


Figure 3-4. Plot plan and borehole locations for site CPP-61.



• – Approximate location of borehole CPP-40-1

0 50 100
SCALE IN FEET

Figure 3-5. Plot plan and borehole locations for site CPP-40.

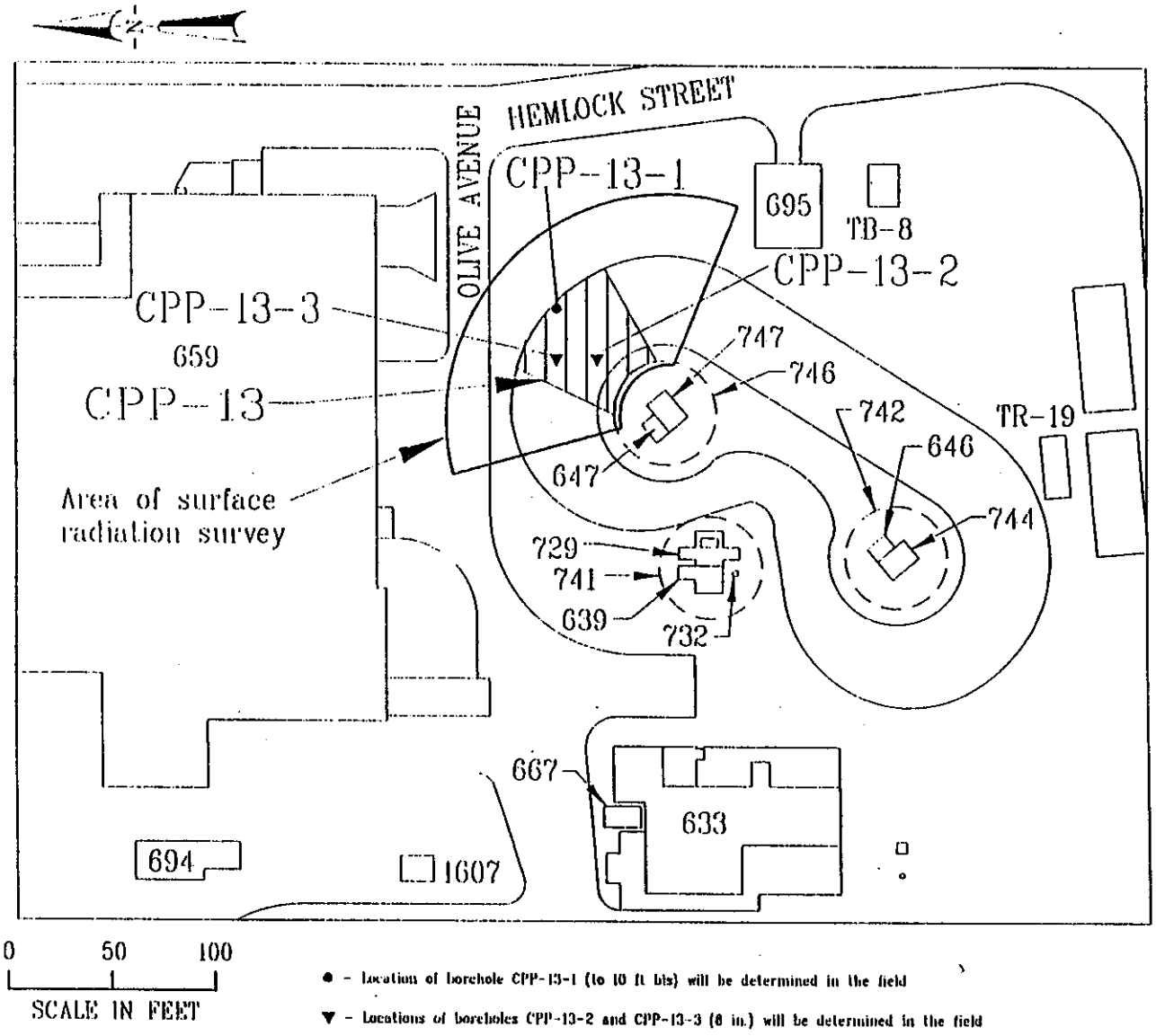


Figure 3-6. Plot plan and borehole locations for site CPP-13.

zirconium. The maximum radiation level encountered in the borehole was less than 150 cpm (at all depths) above a background level of 300 cpm.

Soil samples were also collected at two locations (CPP-13-2 and -3) identified during the field survey as having elevated radiation levels. Two soil samples were collected from each borehole 0.2 to 0.3 m and 0.8 to 1.2 m (0.5 to 1 ft and 2.5 to 4 ft) using hand augers, and screened in the field using portable instruments. The samples having the highest measured radiation were then sent for the same laboratory analyses listed above. The maximum radiation levels encountered in the two boreholes were 500 cpm [0.2 to 0.3 m (0.5 to 1 ft)] and 0.8 mR [0.8 to 1.2 m (0.5 to 1 ft)], respectively.

3.3.1.4 Site CPP-15 (OU 3-08). Site CPP-15 was the location of two previous facilities, the stack preheater and the solvent burner. The function of the preheater was to generate heat in the stack causing it to draw before calciner startup. Later the preheater was removed and a facility was constructed to burn contaminated solvents. The solvent burner performed a dual role by preheating the stack and volatilizing contaminated solvents. Historical records note that an accidental release of contaminated solvent into the soil had occurred during past operation of the facility. In 1985, the D&D program removed the solvent burner structure, a tank beneath the structure, and the contaminated soil in the vicinity. The D&D closure document confirmed that the contaminated soil was excavated and disposed of.

The OU 3-08 Track 2 decision document recommended no further action for site CPP-15. The decision was based on the D&D report and interviews conducted during the Track 2 investigation. Knowledgeable personnel stated that contaminated soils had been removed from the site. However, no verification sampling was conducted at site CPP-15.

In September, 1995, LITCO construction personnel encountered elevated radiological readings while performing an excavation through site CPP-15. The excavation took place in preparation for an electrical duct bank and transformer pad installation. The footprint of the pad was to extend over part of site CPP-15. During the excavation, at a depth of 0.6 m (2 ft) bgs, contaminated soil was unearthed. Beneath the soil was a concrete footing with a hotspot reading of 1.5 R/hr. The footing was a remnant of the old stack preheater. Five samples were collected from the site: one from a soil stockpile in a dump truck, one 46 cm (18 in.) away from the footing, one directly below the footing, one 1.2 m (4 ft) below the footing, and one duplicate from directly below the footing (Figure 3-7). The radiological analysis ranged from 0.0 to 1,090 pCi/g gross alpha and from 44.5 to 43,300 pCi/g gross beta. The source of the contamination is unknown. LMITCO construction personnel agreed to remove the footing and the contaminated soils that were located beneath the footprint of the transformer pad and duct bank. Contaminated soil was removed to a depth of 3 m (10 ft) below the pad. Contaminated soil beneath the duct bank was removed to a depth of 1.8 m (6 ft). At the 3- and 1.8-m (10- and 6-ft) depths, the radiological analysis indicated that contaminant concentrations diminished significantly.

3.3.1.5 Site CPP-11 (OU 3-09). To assess contamination above the tank, two soil borings (CPP-11-1 and -2) were drilled to depths of 3.8 and 3 m (12.5 and 10 ft) bgs, respectively, which corresponds to the top of the SFE-106 tank (Figure 3-8). A containment structure is located directly above the tank and the boreholes were placed as close as physically possible to the structure. These borings were located near each end of the structure to help characterize any contamination present in the soil above the tank. Consistent with

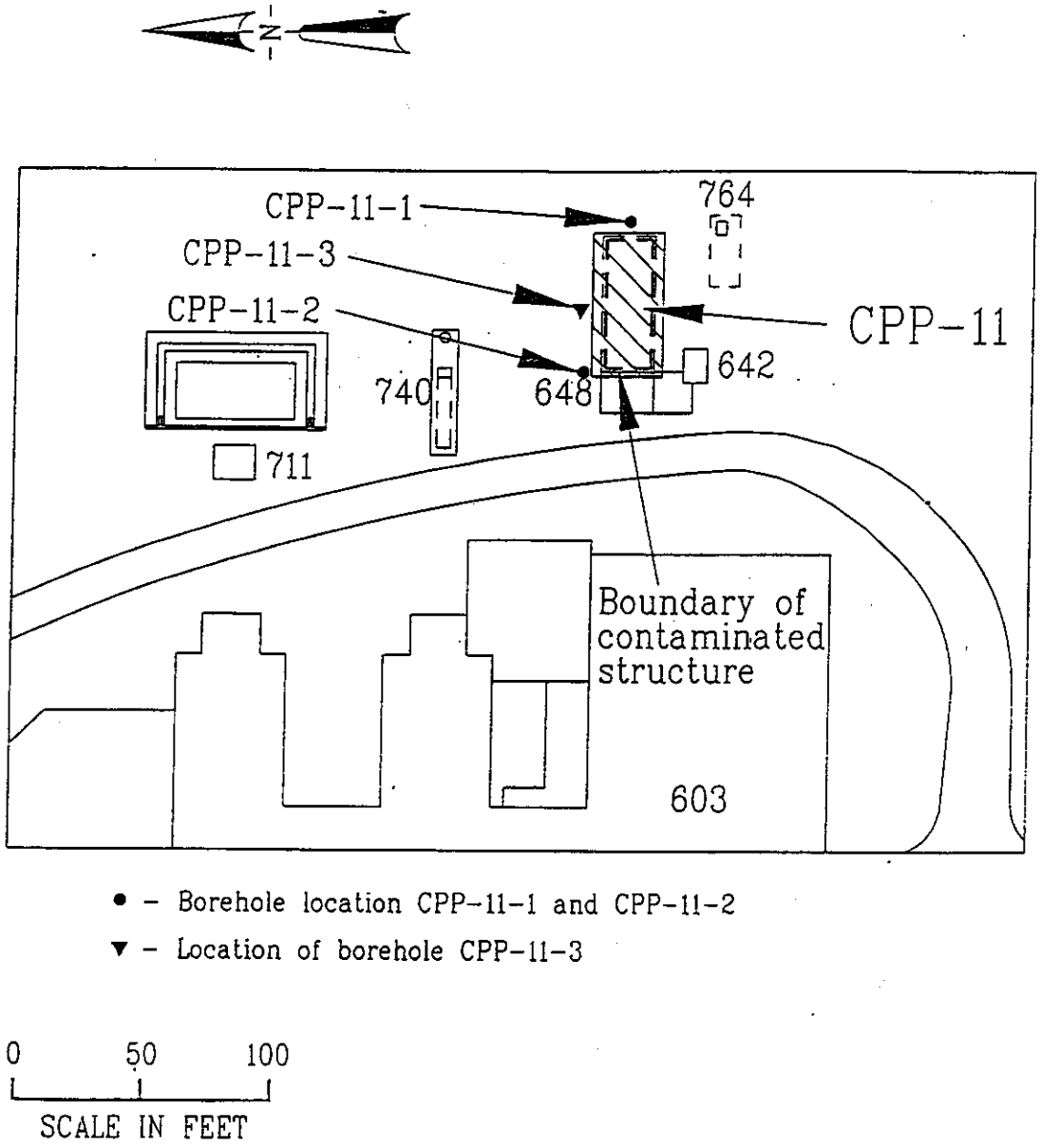


Figure 3-7. Plot plan and borehole locations for site CPP-15.

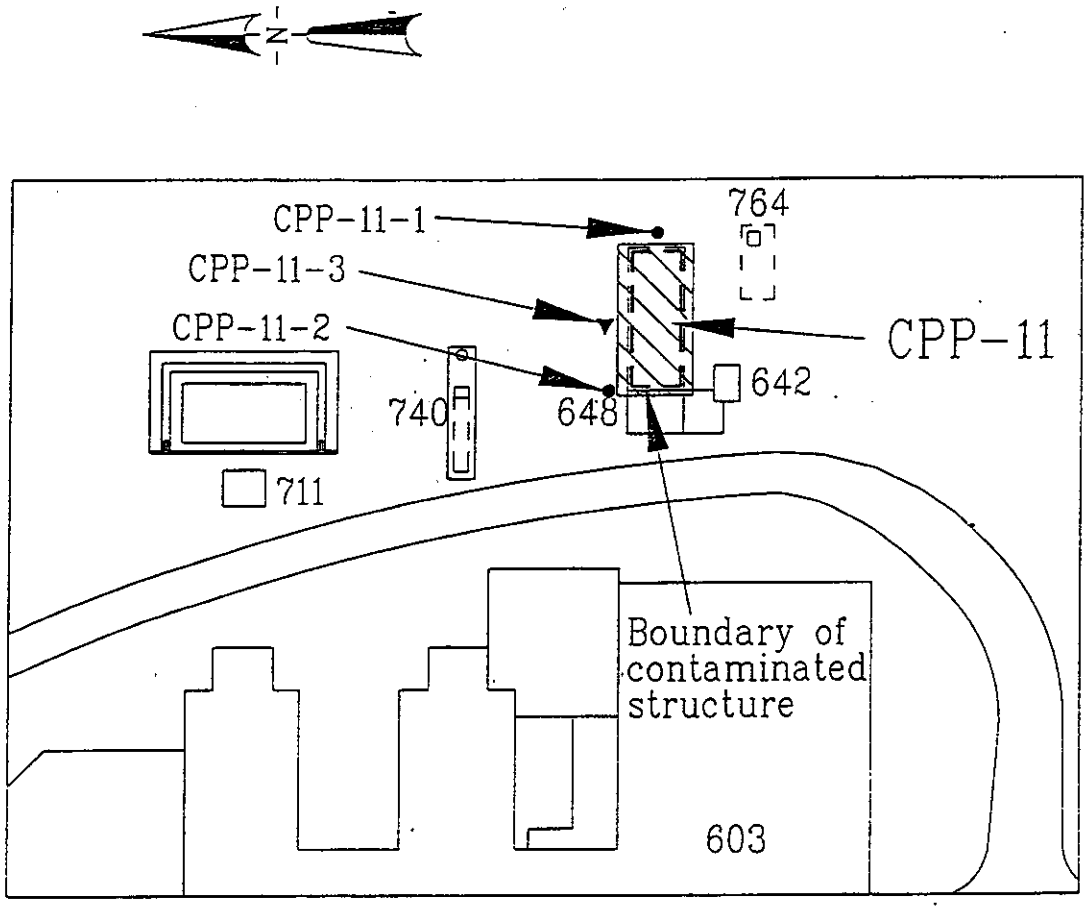


Figure 3-8. Plot plan for borehole locations for site CPP-11.

the sampling strategy described in Bin set 3.6.1, soil samples for laboratory analysis were collected from 0 to 0.2 m, 0.2 to 0.8 m, 2.3 to 3 m, and 3 to 3.8 m (0 to 0.5 ft, 0.5 to 2.5 ft, 7.5 to 10 ft, and 10 to 12.5 ft) bgs for CPP-11-1; and from 0 to 0.2 m, 0.2 to 0.8 m, and 2.3 to 3 m (0 to 0.5 ft, 0.5 to 2.5 ft, and 7.5 to 10 ft) bgs for CPP-11-2. The maximum radiation levels measured in boreholes CPP-11-1 and CPP-11-2 were 1,000 cpm [2.3 to 3 m (7.5 to 10 ft)] and 2,000 cpm [0 to 0.2 and 0.2 to 0.8 m (0 to 0.5 and 0.5 to 2.5 ft)], respectively.

Borehole (CPP-11-3) was drilled adjacent to the containment structure to investigate possible contamination beneath the tank. This borehole was located near the waste discharge line from the tank. This borehole was drilled to a depth of 25 ft bgs, which is approximately 9 ft below the bottom of the tank. Soil samples for laboratory analyses were collected from 0 to 0.2 m, 0.8 to 1.5 m, 1.5 to 2.3 m, and 7 to 7.6 m (0 to 0.5 ft, 2.5 to 5 ft, 5 to 7.5 ft, and 22.5 to 25 ft) bgs. The maximum radiation level measured in the borehole was 275 cpm [0.8 to 1.5 m (2.5 to 5 ft)].

3.3.1.6 Site CPP-19 (OU 3-09). Because of several obstructions in the area, borehole CPP-19-3 was located approximately 4.6-m (15-ft) north of CPP-19-1 along the waste transfer line. The second borehole (CPP-19-4), was drilled approximately 15 m (50 ft) south of CPP-19-2 (Figure 3-9). Soil samples for laboratory analyses from borehole CPP-19-3 were collected from 0 to 0.2 m, 0.8 to 1.5 m, 1.5 to 2.3 m, 8.4 to 9 m, and 9.6 m (0 to 0.5 ft, 2.5 to 5 ft, 5 to 7.5 ft, 27.5 to 30 ft, and 31.5 ft) bgs. The maximum radiation level measured in the borehole was 75 cpm (at all depths). Soil samples for laboratory analyses from borehole CPP-19-4 were collected from 0.2 to 0.8 m, 0.8 to 1.5 m, 2.3 to 3 m, 6.9 to 7.6 m, and 9.6 m (0.5 to 2.5 ft, 2.5 to 5 ft, 7.5 to 10 ft, 22.5 to 25 ft, and 31.4 ft) bgs. The maximum radiation level measured in the borehole was 175 cpm [6.9 to 7.6 m (22.5 to 25 ft)].

3.3.1.7 Site CPP-22 (OU 3-09). A surface radiation survey was performed on June 16, 1995 throughout site CPP-22 using a vehicle-mounted roadway monitor (VRM-1). The background radiation was 0.010 mR/hr at the northwest corner of the ICPP Percolation Pond. Readings were taken with the Bicron Micro R Meter during the survey. The results of this survey detected elevated radiation levels of 0.015, 0.013, and 0.025 mR/hr at the locations of the corresponding boreholes (Figure 3-10). Soil samples were then collected from the three locations and designated as boreholes CPP-22-1, -2, and -3, respectively. One borehole was augered at each location and three soil samples collected. Soil samples for laboratory analyses from CPP-22-1 were collected at depths of 0 to 0.2 m, 0.2 to 0.9 m, and 0.9 to 2.1 m (0 to 0.5 ft, 0.5 to 3 ft, and 3 to 7 ft) bgs. The maximum radiation level measured in the borehole was 180 cpm [0.9 to 2.1 m (3 to 7 ft)]. Soil samples from CPP-22-2 were collected at depths of 0 to 0.2 m, 0.2 to 0.8 m, and 2.1 to 3 m (0 to 0.5 ft, 0.5 to 2.5 ft, and 7 to 10 ft) bgs, with a maximum radiation level measured at 100 cpm (at all depths). Soil samples from CPP-22-3 were collected at depths of 0 to 0.2 m, 0.2 to 0.9 m, and 2.4 to 3 m (0 to 0.5 ft, 0.5 to 3 ft, and 8 to 10 ft) bgs. The maximum radiation level measured in the borehole was less than 100 cpm (at all depths).

3.3.1.8 Site CPP-78 (OU 3-09). Radiological contamination was reportedly detected while ICPP personnel were excavating a trench for the installation of an underground electrical conduit near building CPP-693. The exact location of the possible contamination was unknown since the original radiological survey only reported an approximate location. Since the location of the contamination is unknown, the first borehole (CPP-78-1) was located in the center of the Environmentally Controlled Area (ECA) boundary and

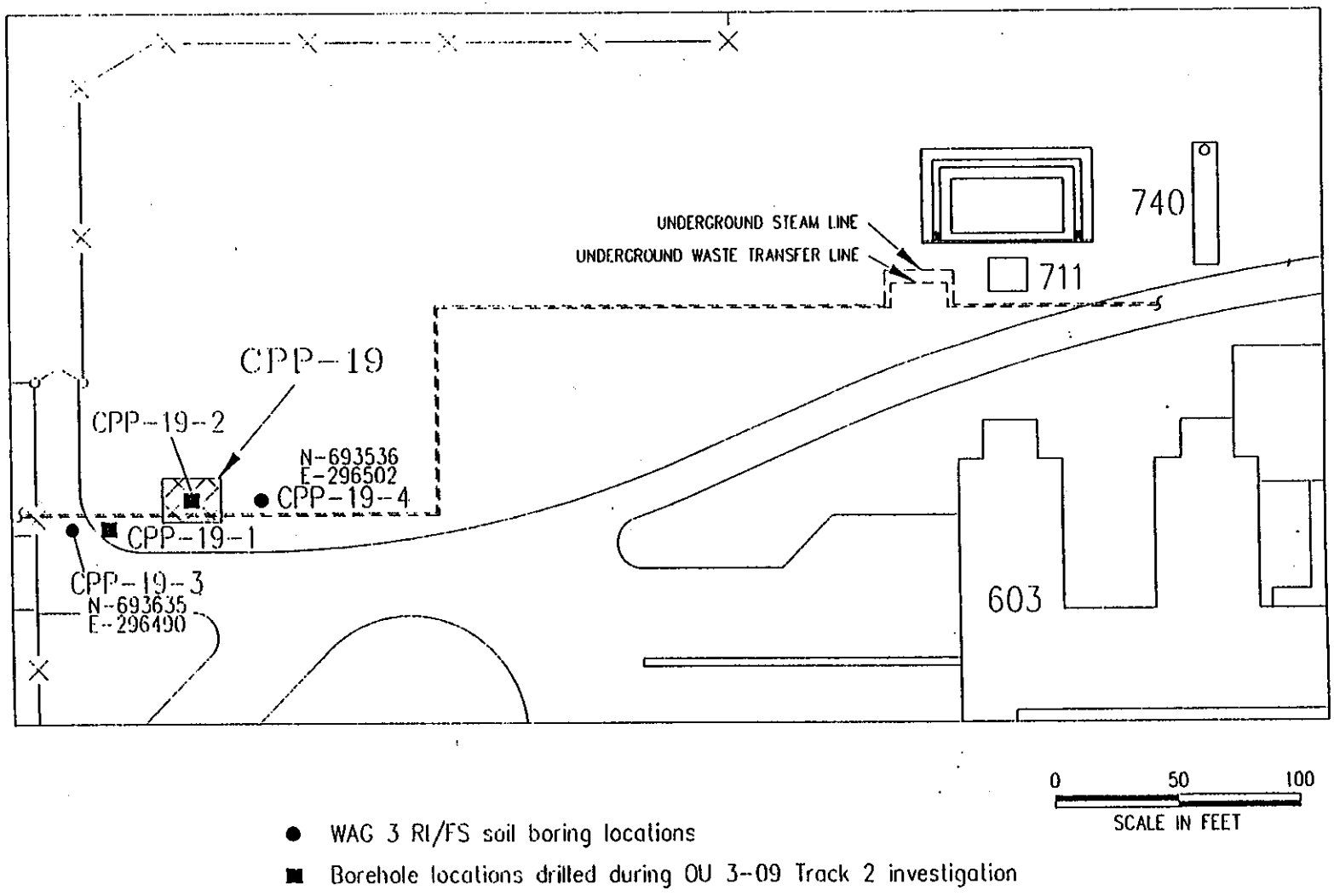


Figure 3-9. Plot plan and borehole locations for site CPP-19.

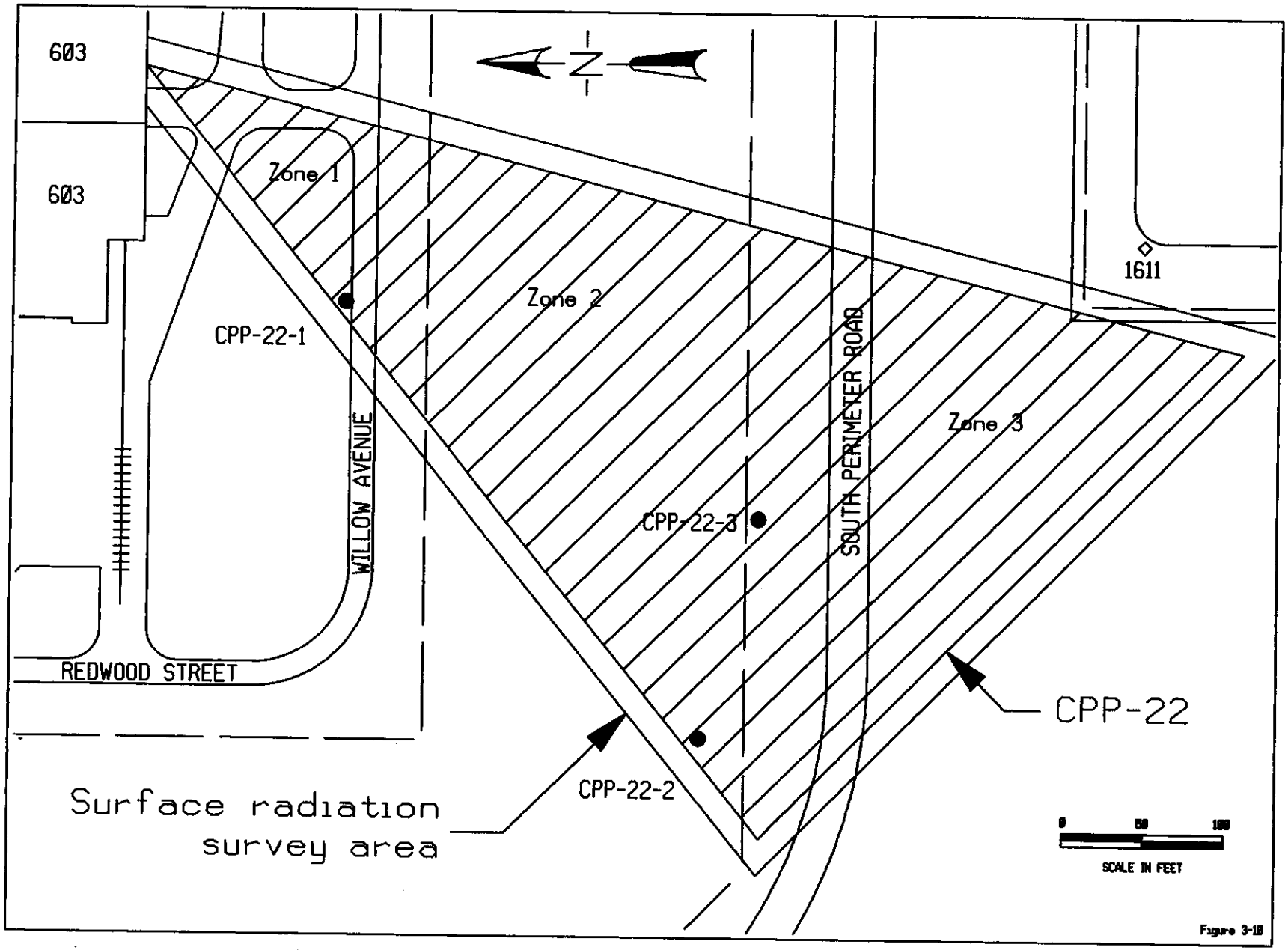


Figure 3-10. Plot plan and borehole locations for site CPP-22.

the second borehole (CPP-78-2) was located adjacent to the subsurface conduit near building CPP-693 (Figure 3-11).

A GPR survey was performed over the area before drilling so the location of the electrical conduit and other possible obstructions could be determined. The GPR survey also helped locate the subsurface utility that was being installed when the contamination was discovered, thereby increasing the probability of placing the borehole near the suspected contamination. Soil samples for laboratory analyses for the two boreholes were collected from 0 to 0.2 m, 0.8 to 1.5 m, and 2.3 to 3 m (0 to 0.5 ft, 2.5 to 5 ft, and 7.5 to 10 ft) bgs. The maximum radiation levels measured in the boreholes were less than 150 cpm (at all depths).

3.3.1.9 Area East of CPP-603 (OU 3-09). During the OU 3-09 Track 2 investigation, several boreholes were drilled east of CPP-603 to help identify contamination from numerous reported releases (Figure 3-12). Samples collected in boreholes CPP-01-1, -2, -3; CPP-08/09-1; and CPP-10-1 identified significant contamination between the surface and the soil/basalt interface. A 3-m (10-ft) deep excavation was also made along the southeast corner of CPP-603 during the OU 3-09 Track 2 investigation to locate an abandoned basin recirculation line. The eastern extent of the contamination detected in these boreholes is unknown.

Two additional boreholes (CPP-603-1 and -2) were drilled to a total depth of 9.8 m (32 ft) to help bound the eastern extent of contamination. Information obtained from the two additional boreholes will be used in conjunction with the existing information to estimate the risk from contamination and better define the eastern extent of contamination. The borehole locations for CPP-603-1 and CPP-603-2 are provided in Figure 3-12.

Soil samples for laboratory analyses for CPP-603-1 were collected from 0 to 0.2 m, 0.8 to 1.5 m, 1.5 to 2.3 m, 6.9 to 7.7 m, and 7.7 to 9.8 m (0 to 0.5 ft, 2.5 to 5 ft, 5 to 7.5 ft, 22.5 to 24.5 ft, and 31.5 to 32 ft) bgs. The maximum radiation level measured in the borehole was less than 200 cpm (at all depths). Soil samples for CPP-603-2 were collected from 0 to 0.2 m, 0.8 to 1.5 m, 2.3 to 3 m, 6.9 to 7.6 m, and 9.6 to 9.8 m (0 to 0.5 ft, 2.5 to 5 ft, 7.5 to 10 ft, 22.5 to 25 ft, and 31.5 to 32 ft) bgs. The maximum radiation level measured in the borehole was between 175 and 200 cpm (at all depths).

3.3.1.10 Site CPP-46 (OU 3-10). Results of a hand radiation survey measured background radiation levels less than 100 cpm. The highest radiation reading (80 cpm) was selected for the location of borehole CPP-46-1. The borehole was located immediately north of the concrete pad housing the tank (Figure 3-13). The entrance to the courtyard north of CPP-637 was too narrow to allow access by the drill rig, therefore, hand augering was used to collect samples at site CPP-46. Soil samples for laboratory analyses were collected from 0 to 0.2 m, 0.6 to 1.2 m, and 2.4 to 3 m (0 to 0.5 ft, 2 to 4 ft, and 8 to 10 ft) bgs. The maximum radiation level measured in the borehole was less than 100 cpm (at all depths).

3.3.1.11 Site CPP-88 (OU 3-13). To assess soil contamination associated with elevated field radiation measurements taken outside established ECAs and within the security perimeter fence at the ICPP, soil samples from the upper 3 m (10 ft) were collected from 15 soil borings. A systematic approach, described in the SAP, was used to help quantify the contamination associated with these elevated radiation measurements.

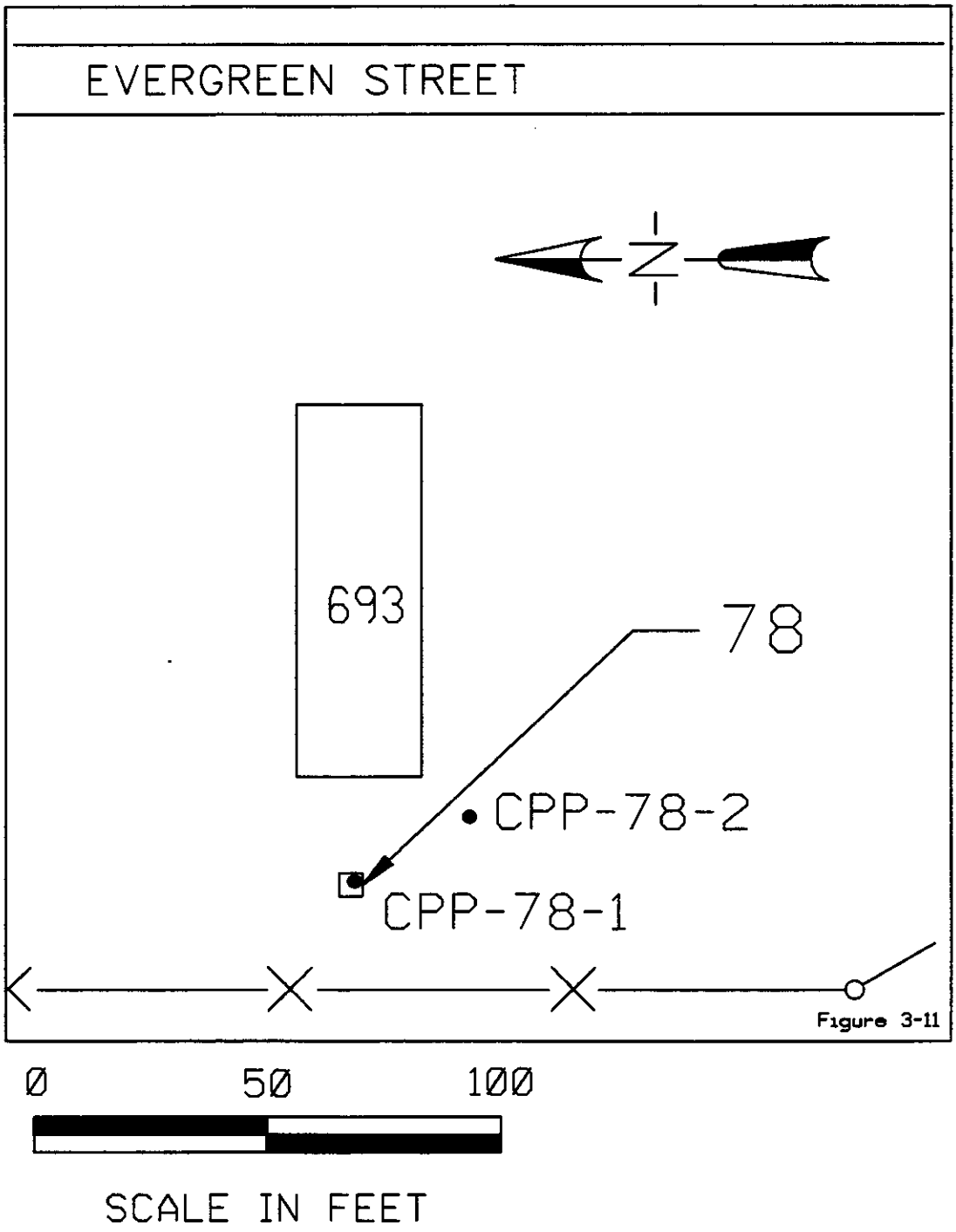
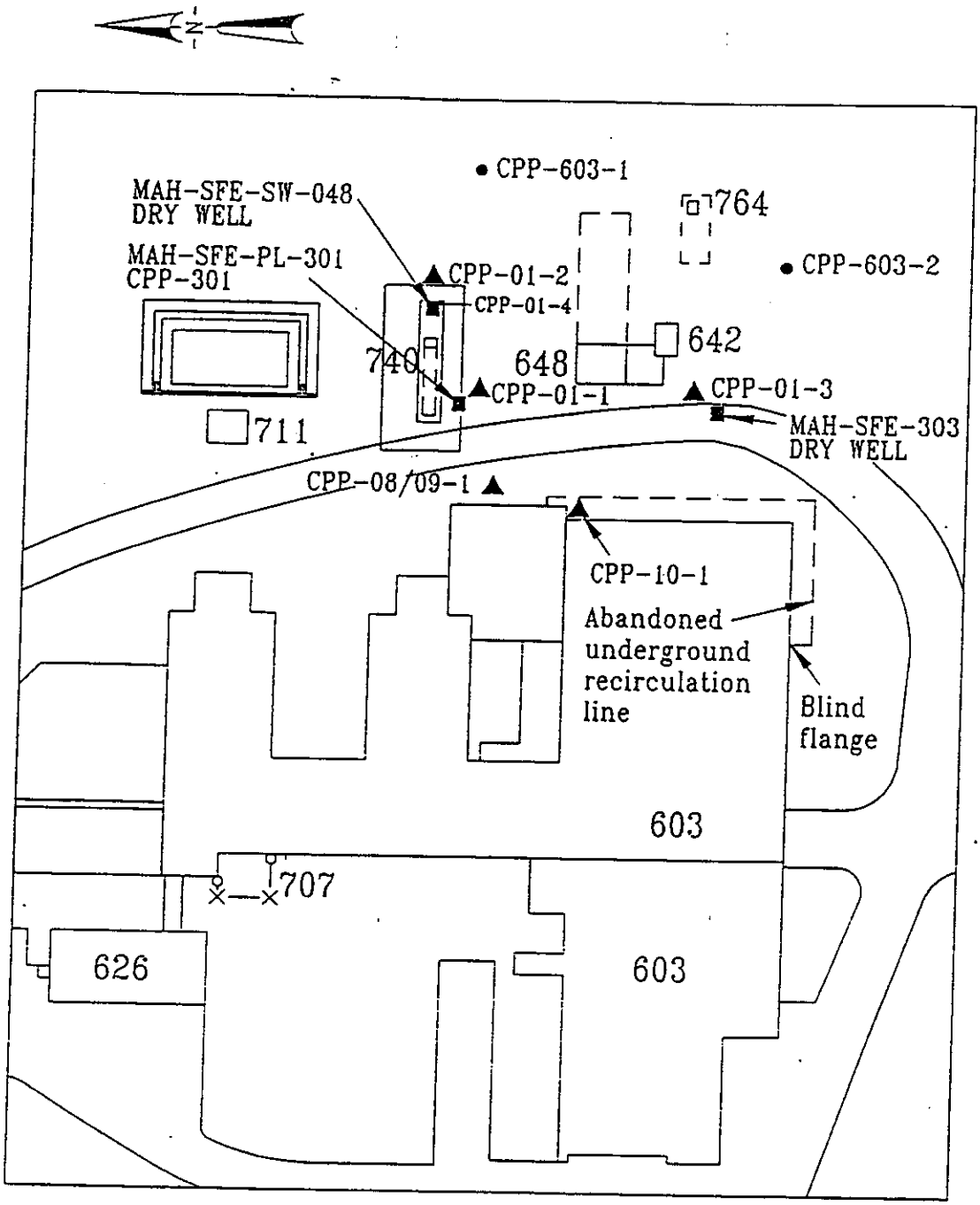


Figure 3-11. Plot plan and borehole locations for site CPP-78.



▲ - Locations of boreholes drilled during OU 3-09 Track 2 investigation

• - Borehole locations for RI/FS investigation

0 100 200

SCALE IN FEET

Figure 3-12. Plot plan and borehole locations for area east of CPP-603.

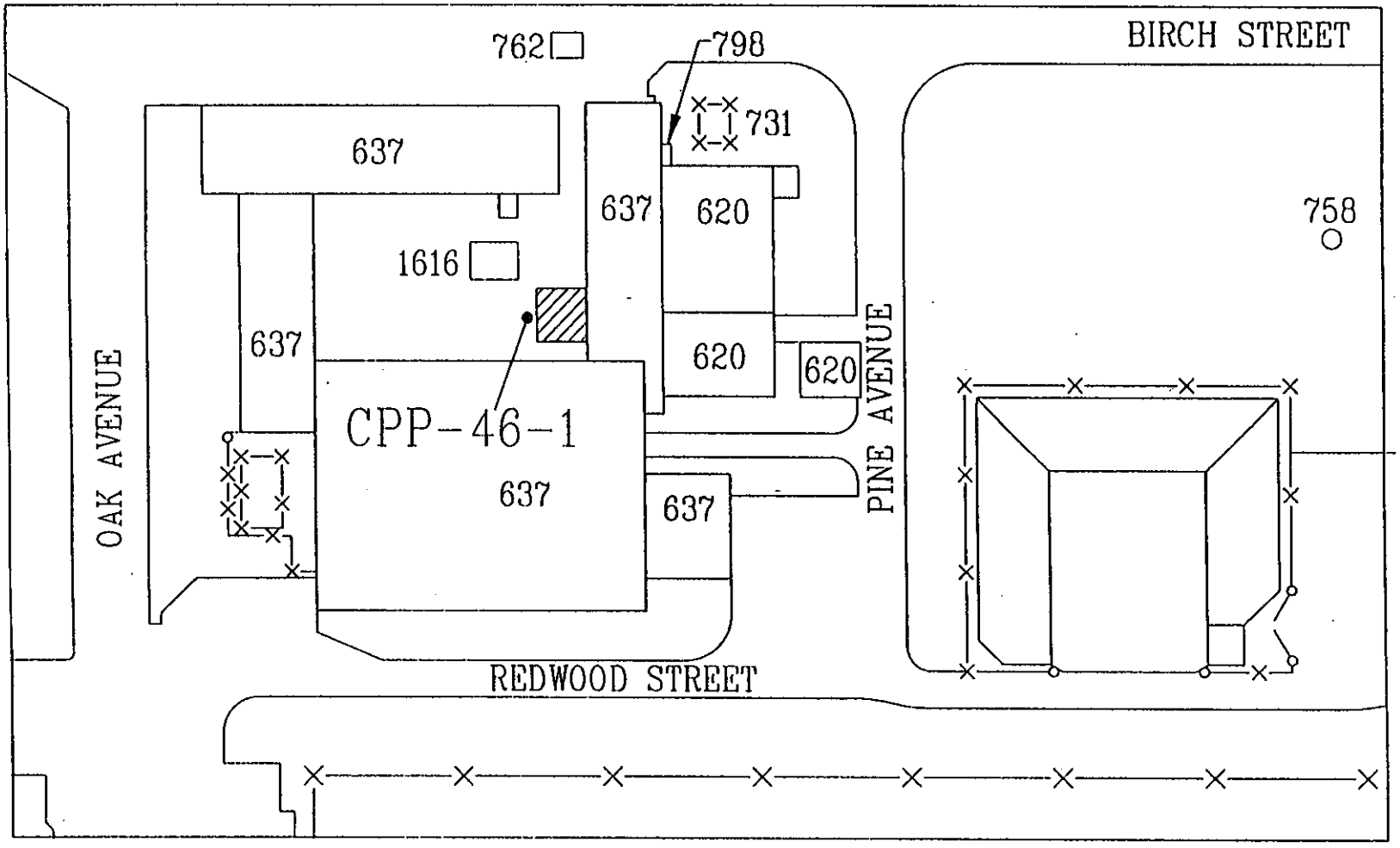


Figure 3-13. Plot plan and borehole locations for site CPP-46.

The occurrence of the elevated soil radiation measurements was evaluated and the majority of the measurements (≈90%) were incorporated into 15 independent areas (Figures 3-14 through 3-18).

The selected areas were approximately the same size (based on square footage), and were biased to include only areas outside established ECAs. After the area boundaries were identified, grids measuring 3 × 3 m (10 × 10 ft) were established. The grids were numbered in increasing order starting at the northeast corner of each area, and one grid was randomly selected using a random number generator. One borehole was then drilled in the center of the randomly selected grid. The boreholes, along with the depths and radiation levels are shown in Table 3-5.

In addition to the 15 boreholes, borehole 88-9-2 was also drilled in Area # 9 (Figure 3-17) at a location where surface radiation surveys have routinely detected radioactivity levels above 50,000 cpm. Three soil samples were then collected from each borehole (Table 3-3), with the sample having the highest radiation reading being sent to the laboratory for analysis.

3.3.1.12 Site CPP-90 (OU 3-13). Three boreholes (CPP-90-1, -2, and -3) were drilled to investigate possible contamination associated with a 61-cm (24-in.) clay tile waste disposal line between the CPP-709 pumphouse and the ICPP disposal well. The sample strategy for these three boreholes was to provide "hotspot" characterization for soils adjacent to the 61-cm (24-in.) clay tile line.

The first borehole (CPP-90-1) was located near the ICPP disposal well, the second borehole (CPP-90-2) was placed at a location along the 61-cm (24-in.) clay tile waste disposal line near building CPP-684 to identify possible contamination along the line, and the third borehole (CPP-90-3) was placed near the CPP-709 pumphouse (Figure 3-19). The three boreholes were drilled to the soil/basalt interface, having total depths of 12.8 m, 14.7 m, and 12.7 m (42 ft, 48.1 ft, and 41.8 ft) bgs, respectively.

Five soil samples for laboratory analyses were collected from each of the three boreholes. CPP-90-1 had soil samples collected from depths of 0 to 0.8 m, 0.8 to 1.5 m, 2.3 to 3 m, 8.4 to 9 m, and 12.2 to 12.8 m (0 to 2.5 ft, 2.5 to 5 ft, 7.5 to 10 ft, 27.5 to 30 ft, and 40 to 42 ft) bgs. The maximum radiation level measured in the borehole was 200 cpm (at all depths). CPP-90-2 had soil samples collected from depths of 0 to 0.2 m, 0.8 to 1.5 m, 2.3 to 3 m, 10 to 10.7 m, and 14.7 m (0 to 0.5 ft, 2.5 to 5 ft, 7.5 to 10 ft, 32.5 to 35 ft, and 48.1 ft) bgs, with a maximum radiation level measured at 150 cpm (at all depths). CPP-90-3 had soil samples collected from depths of 0 to 0.8 m, 0.8 to 1.5 m, 3 to 3.8 m, 6.9 to 7.6 m, and 12.2 to 12.7 m (0 to 2.5 ft, 2.5 to 5 ft, 10 to 12.5 ft, 22.5 to 25 ft, and 40 to 41.8 ft) bgs. The maximum radiation level measured in the borehole was less than 200 cpm (at all depths).

3.3.1.13 Site CPP-91 (OU 3-13). Two boreholes (CPP-91-1 and -2) were drilled to the alluvium/basalt interface to investigate possible contamination from the CPP-633 Blower Drain Pit (Figure 3-20). Before drilling, a GPR survey was performed adjacent to the location of the blower pit on the northwest corner of building CPP-633 to identify potential subsurface artifacts (e.g., underground lines). The first borehole (CPP-91-1) was located approximately 1.5 m (5 ft) from the building and used to detect possible hotspots. The second borehole (CPP-91-2) was drilled approximately 6 m (20 ft) to the northwest of the blower pit and the data collected were used to determine the possible extent of contamination.

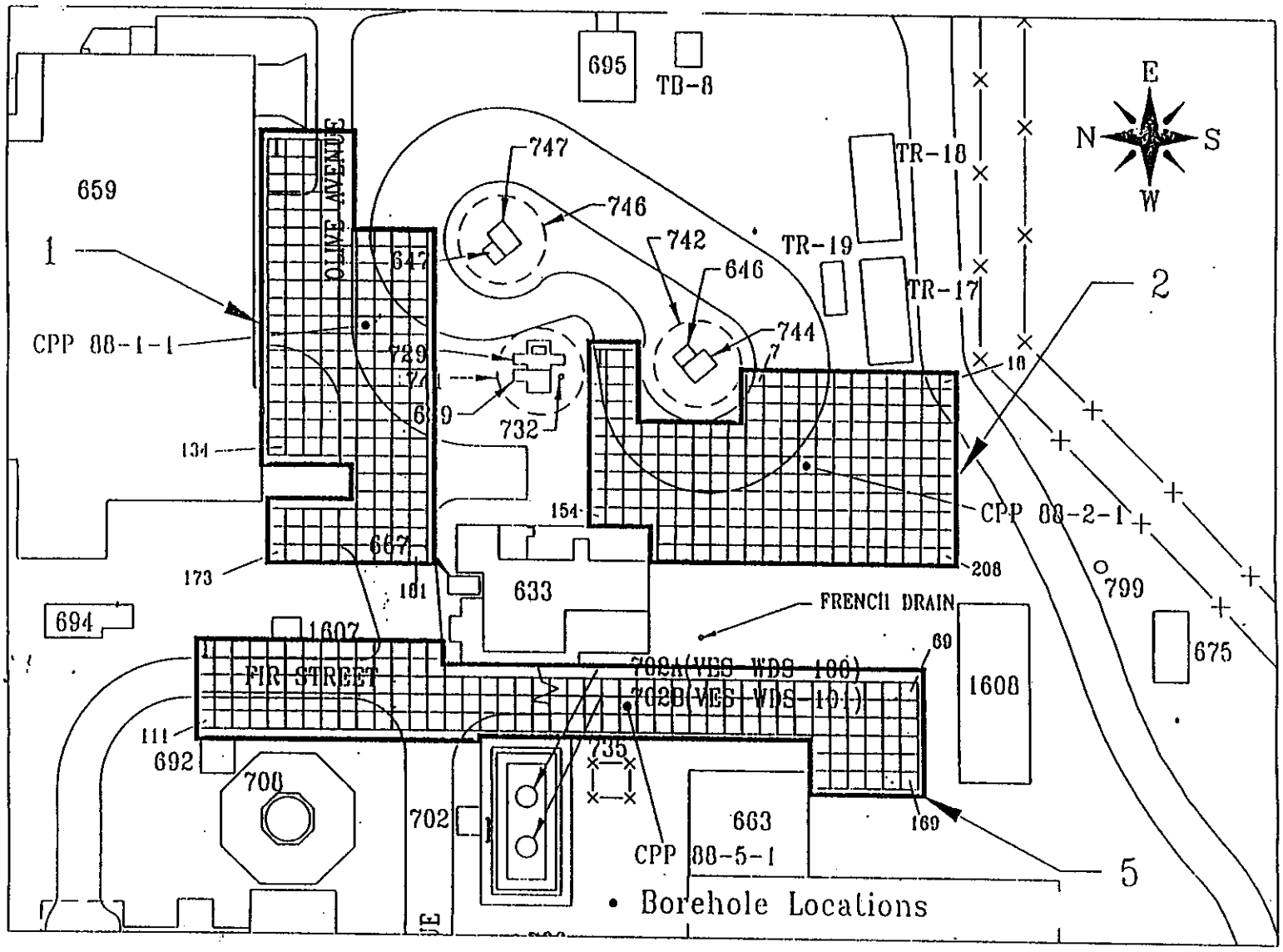


Figure 3-14. Borehole locations for site CPP-88 (areas 1, 2, and 5).

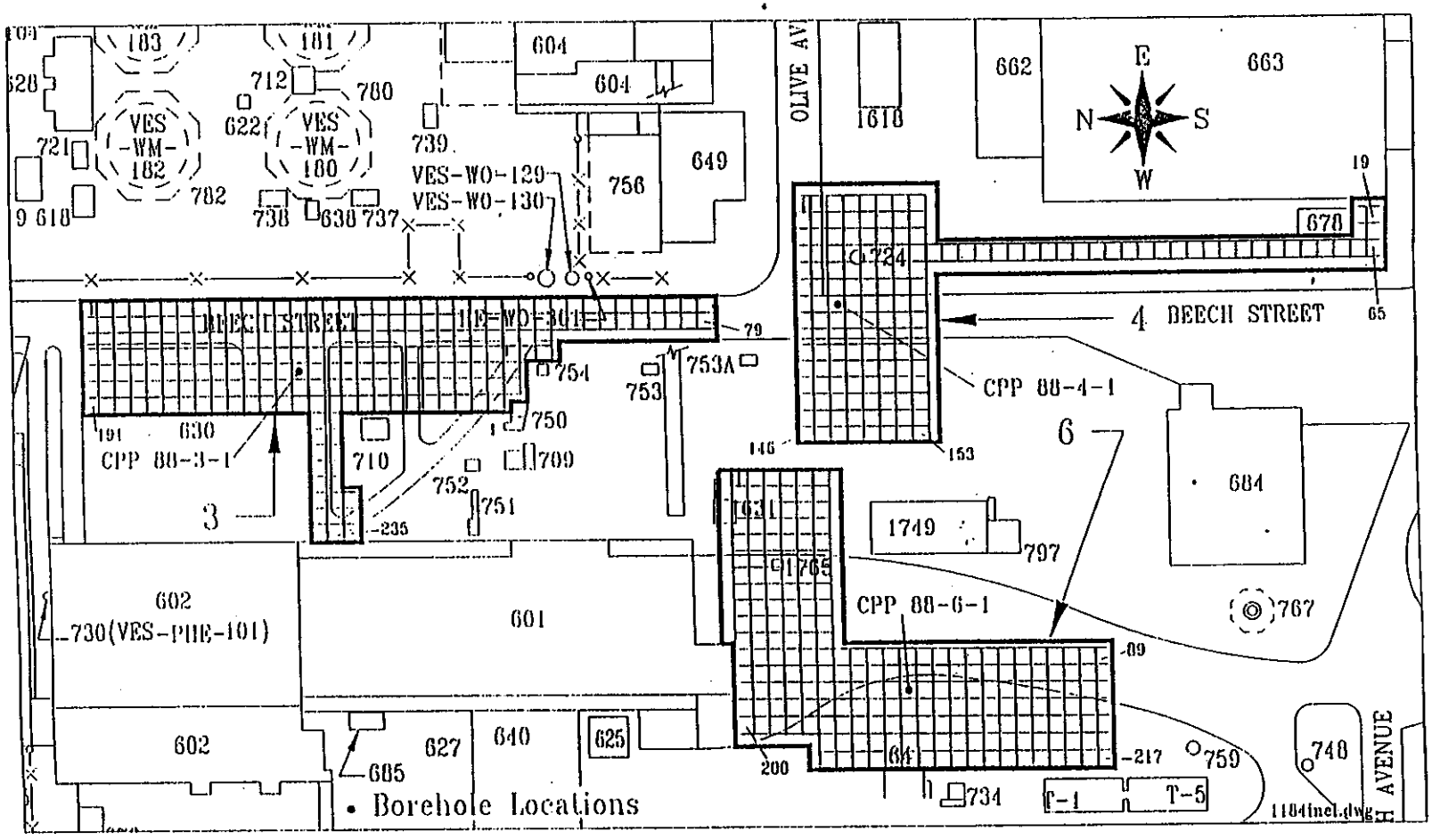


Figure 3-15. Borehole locations for site CPP-88 (areas 3, 4, and 6).

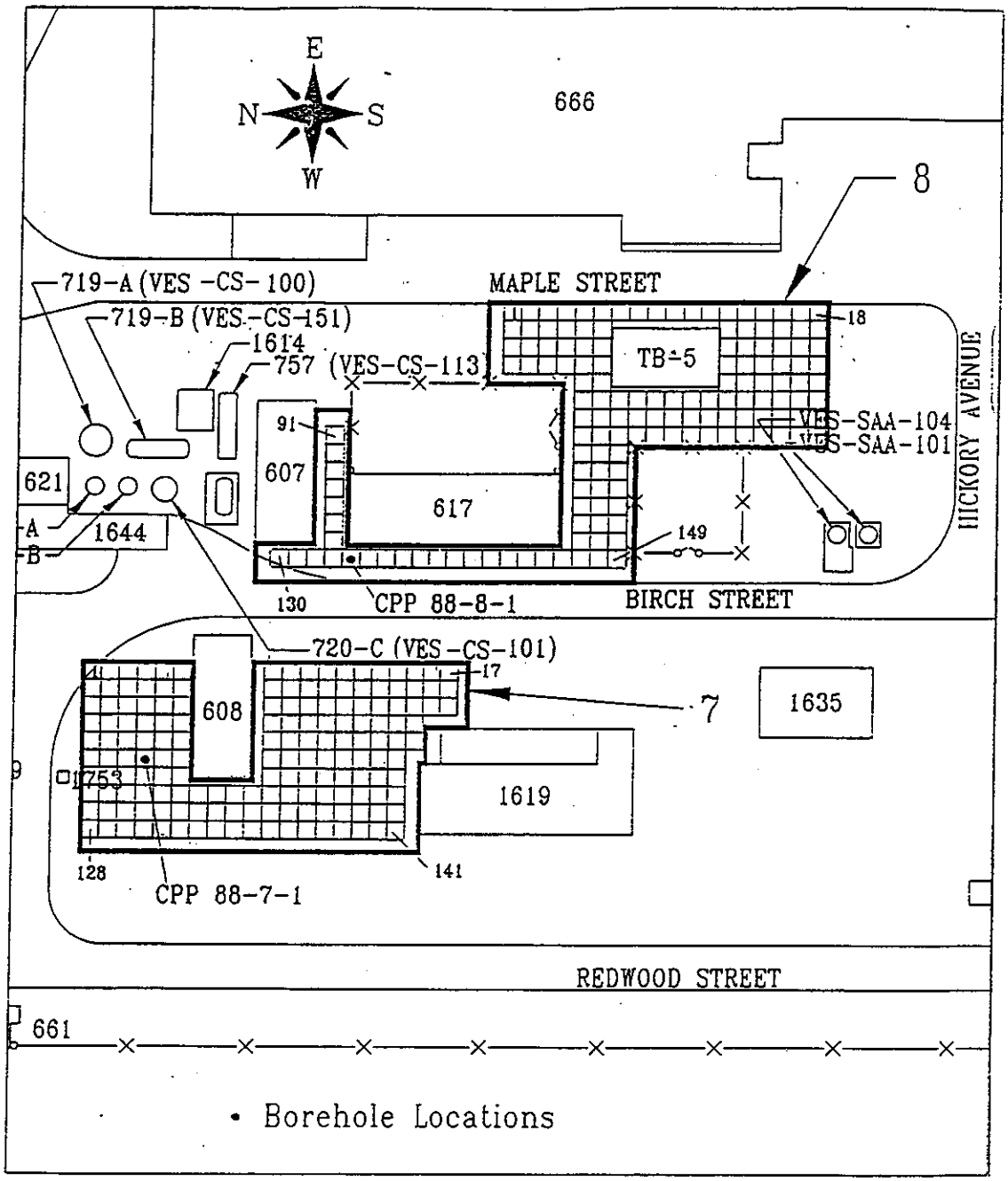


Figure 3-16. Borehole locations for site CPP-88 (areas 7 and 8).

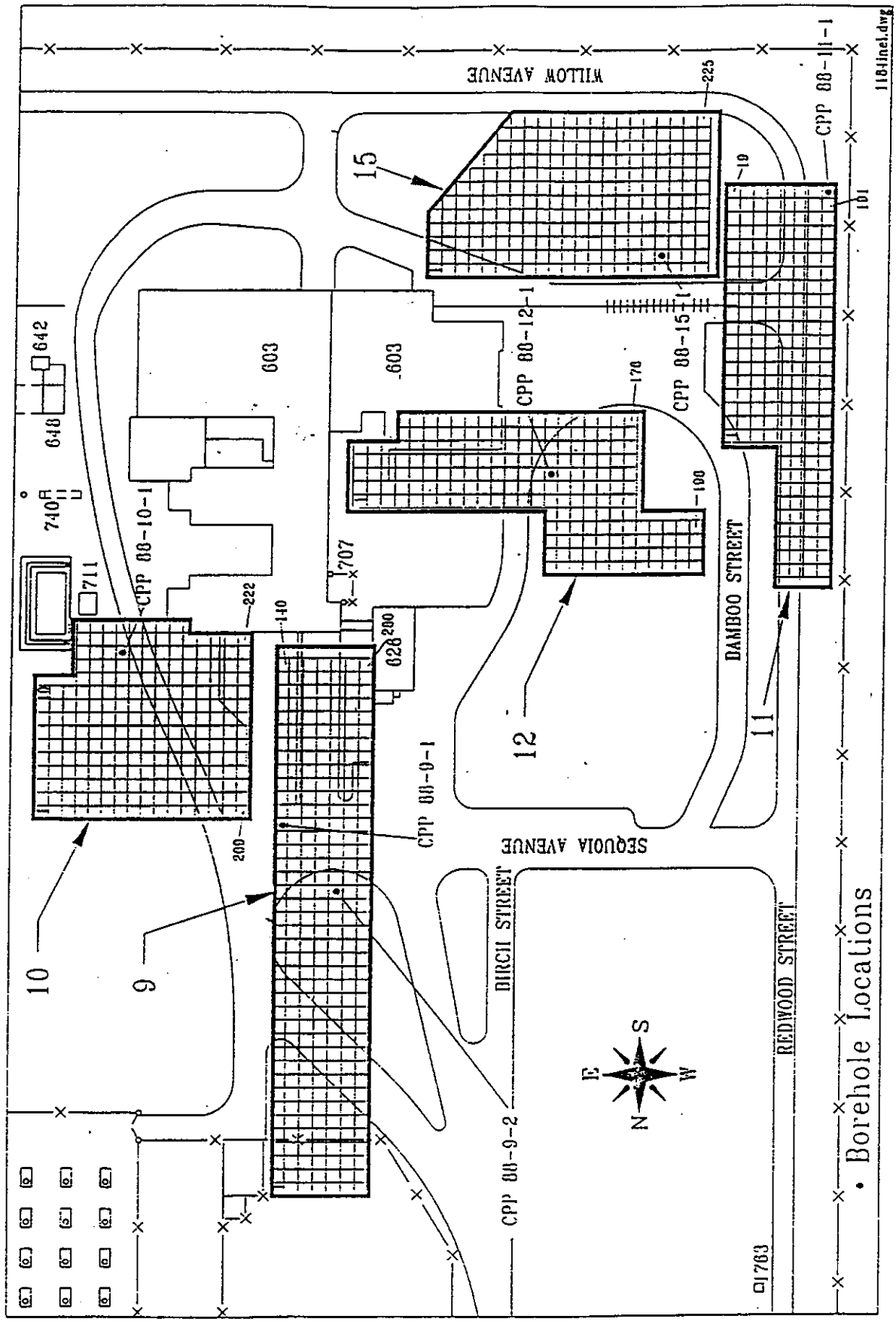


Figure 3-17. Borehole locations for site CPP 88 (areas 9, 10, 11, 12, and 15).

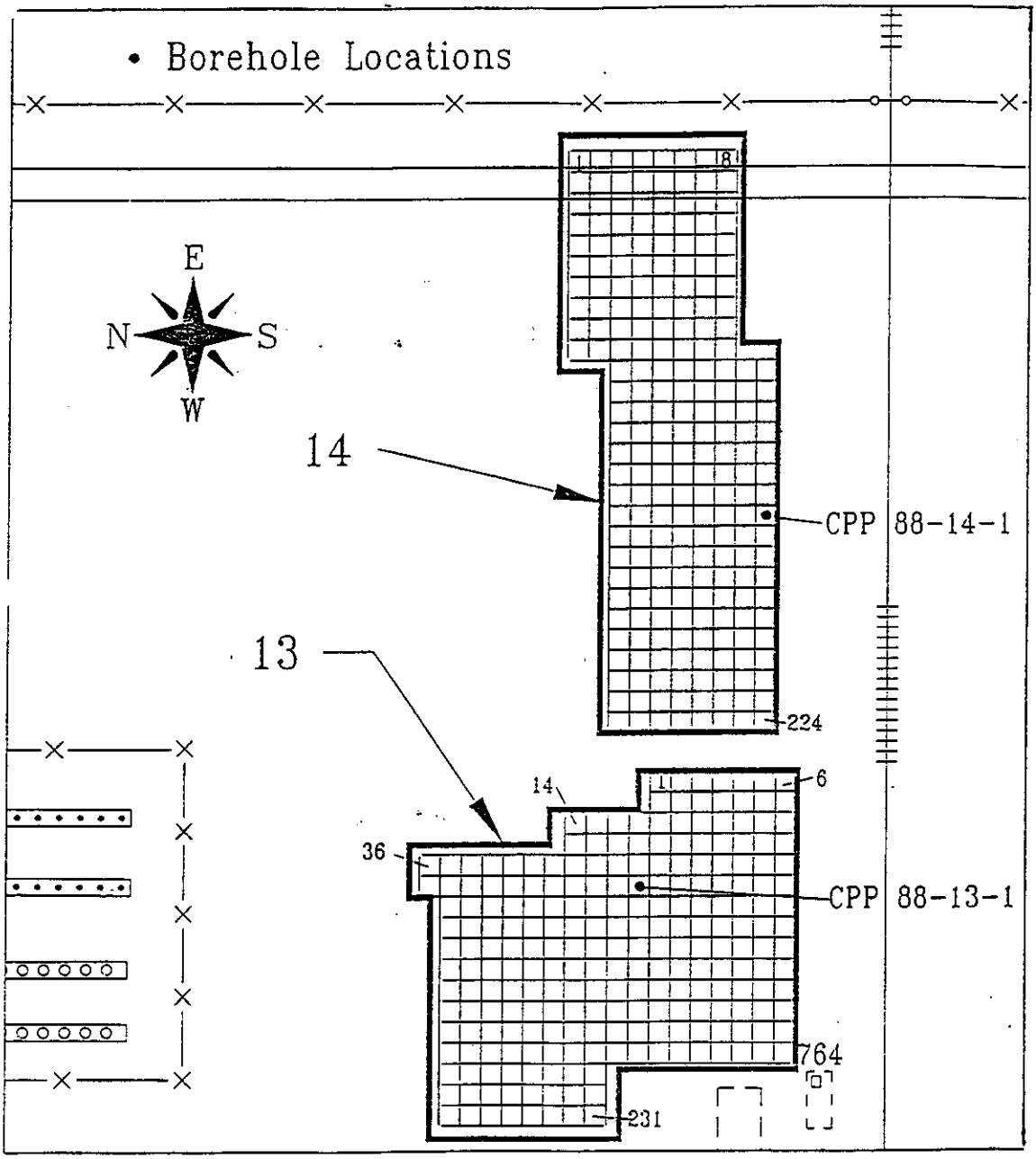


Figure 3-18. Borehole locations for site CPP-88 (areas 13 and 14).

Table 3-5. Site CPP-88 boreholes with depth and radiation levels.

Borehole	Maximum depth (ft bgs)	Maximum radiation (cpm)
88-1-1	10	120
88-2-1	7.5	125
88-3-1	10	125
88-4-1	10	200
88-5-1	10	100
88-6-1	6	100
88-7-1	10	100
88-8-1	10	100
88-9-1	10	150
88-9-2	10	150
88-10-1	10	150
88-11-1	10	125
88-12-1	10	150
88-13-1	10	125
88-14-1	10	100
88-15-1	11	180

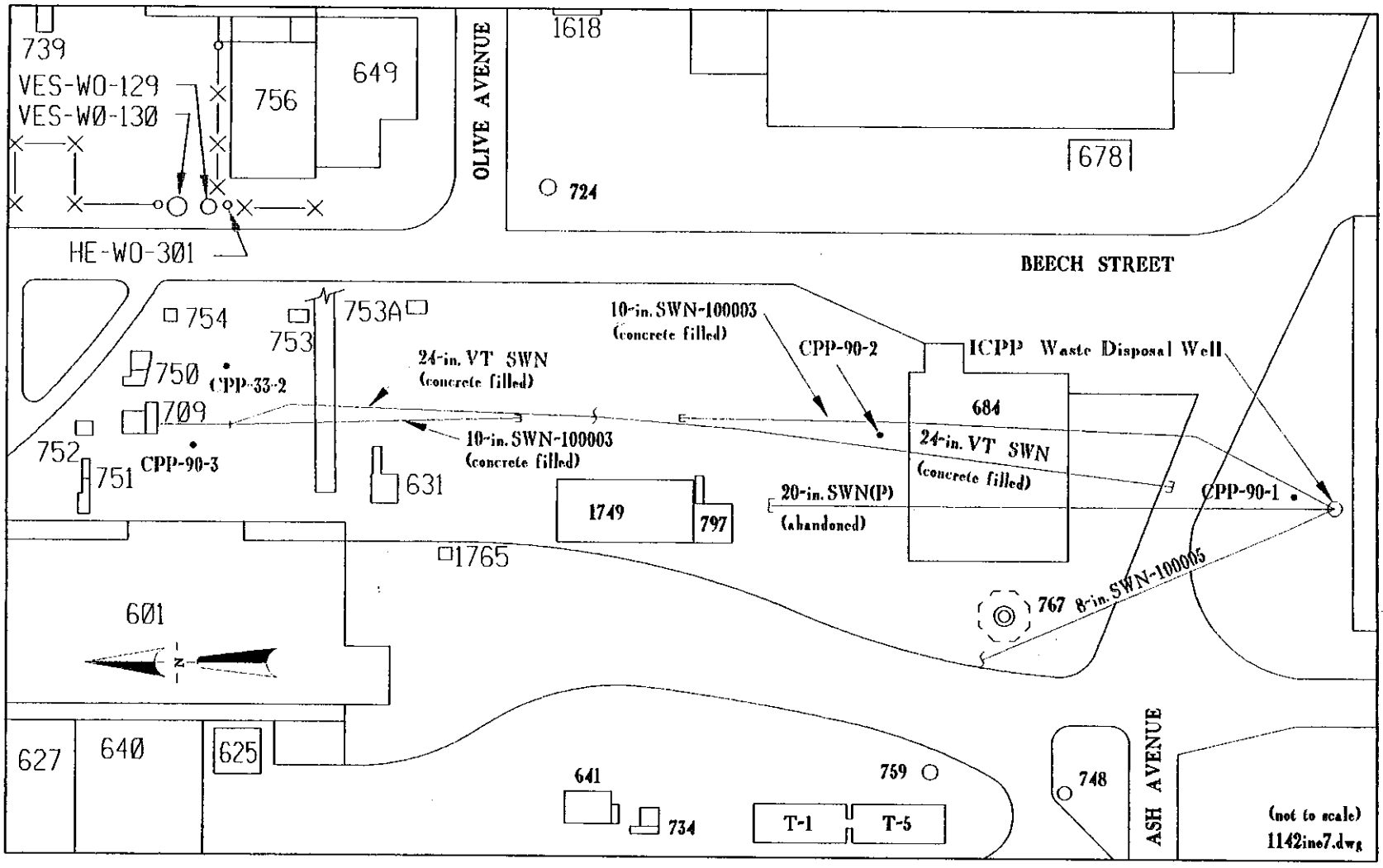


Figure 3-19. Plot plan and borehole locations for site CPP-90.

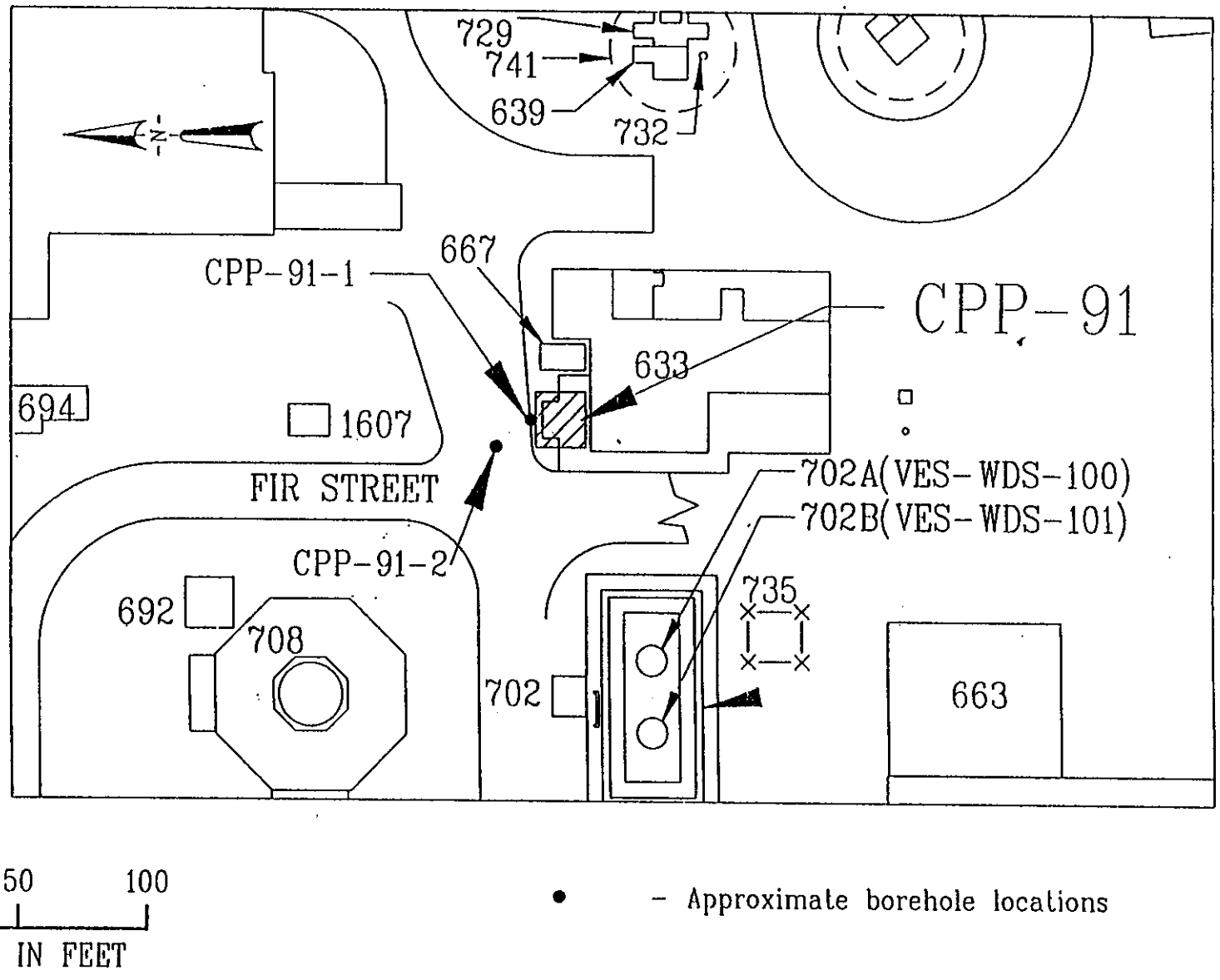


Figure 3-20. Plot plan and borehole locations for site CPP-91.

Soil samples for laboratory analyses for borehole CPP-91-1 were collected at depths of 0 to 0.2 m, 0.8 to 1.5 m, 2.3 to 3 m, 5.3 to 6 m, and 14 to 14.2 m (0 to 0.5 ft, 2.5 to 5 ft, 7.5 to 10 ft, 17.5 to 20 ft, and 46 to 46.5 ft) bgs. The maximum radiation level measured in the borehole was 8,000 cpm at 5.3 to 6 m (17.5 to 20 ft) bgs. Borehole CPP-91-2 had soil samples collected at depths of 0 to 0.2 m, 0.2 to 0.8 m, 1.5 to 2.3 m, 10 to 10.7 m, 11.4 to 12.2 m, and 12.8 to 13 m (0 to 0.5 ft, 0.5 to 2.5 ft, 5 to 7.5 ft, 32.5 to 35 ft, 37.5 to 40 ft, and 42 to 42.5 ft) bgs. The maximum radiation level measured in the borehole was 15 mR [12.8 to 13 m (42 to 42.5 ft) bgs].

3.3.1.14 Site CPP-93 (OU-3-13). A total of 65 boreholes were drilled between depths of 2.4 and 4.3 m (8 and 14 ft) bgs in the area southeast of the bin set area using the Geoprobe GH-40 (Figure 3-21). Simulated calcine was detected in four boreholes (CPP-93-1, -2, -3, and -4) in 3- to 5-cm (1- to 2-in.) thick layers at depths between 1 and 1.5 m (3.5 and 5 ft) bgs. Composite samples were collected from the thin layers of simulated calcine detected in each of the four boreholes and sent for laboratory analysis. As can be seen in Figure 3-22, boreholes CPP-93-1, -2, -3, and -4 were located in a line along a northwest to southeast direction in the immediate vicinity of the area where the trench was thought to be located. Grab samples were also collected in these four boreholes at least 1.5 m (5 ft) below where the thin layers of simulated calcine were encountered.

Very minute quantities of simulated calcine were detected in five additional boreholes, however, no samples were collected in these boreholes because they were located adjacent to boreholes CPP-93-1, -2, -3, and -4. A decision was made by the WAG 3 Project Manager to drill six additional boreholes in the area and collect soil samples between 2.1 and 2.4 m (7 and 8 ft) bgs. The six additional boreholes were designated in the field as CPP-93-7, -8, -9, -10, -11, and -12. The samples collected in these six boreholes were denoted in the sample logbook as 393013 through 393018 as identified in the sampling and analysis table for the soil investigation (Table 3-3). No simulated calcine was visible in the soil of any of the six additional samples collected. In addition to the radiological analyses, the samples were also analyzed for CLP metals (TAL) and nitrate/nitrite.

3.3.1.15 Critical Sample Collection. Critical samples are samples that must be collected to adequately characterize the nature of the contamination at each site and fulfill all the data gaps identified in the SAP. Completeness for critical samples must be 100%. Designated samples that are not collected, or for which valid data are not received, must be resampled and reanalyzed to obtain the required data. Critical samples collected during this field investigation are described in the SAP. Soil samples were not analyzed for Sr-90 and Tc-99 if gross beta was less than 30 pCi/g; and Am-241, neptunium-237 (Np-237), and U- and -Pu isotopes if gross alpha activity was less than 20 pCi/g. Analytical results for gross alpha/beta cannot be used to perform risk assessments, therefore, 10% of the samples with gross activity below the 20 pCi/g alpha and 30 pCi/g beta criteria were reanalyzed for the isotopes listed above. The samples to be reanalyzed were randomly chosen by the laboratory. This additional information will reduce the amount of uncertainty by providing further data to correlate results between the gross alpha and beta activity and isotopic breakdown.

3.4 Deviations from the Work Plan

There were several minor deviations from the Work Plan, none of which had a negative impact on data quality or performance of risk assessment and/or groundwater modeling tasks. For the SRPA sampling, an additional sample was collected for USGS-47. The planned sample for USGS-43 was not collected due to failure of dedicated pump. Also, for the vertical profile samples, gross beta analysis was also performed.

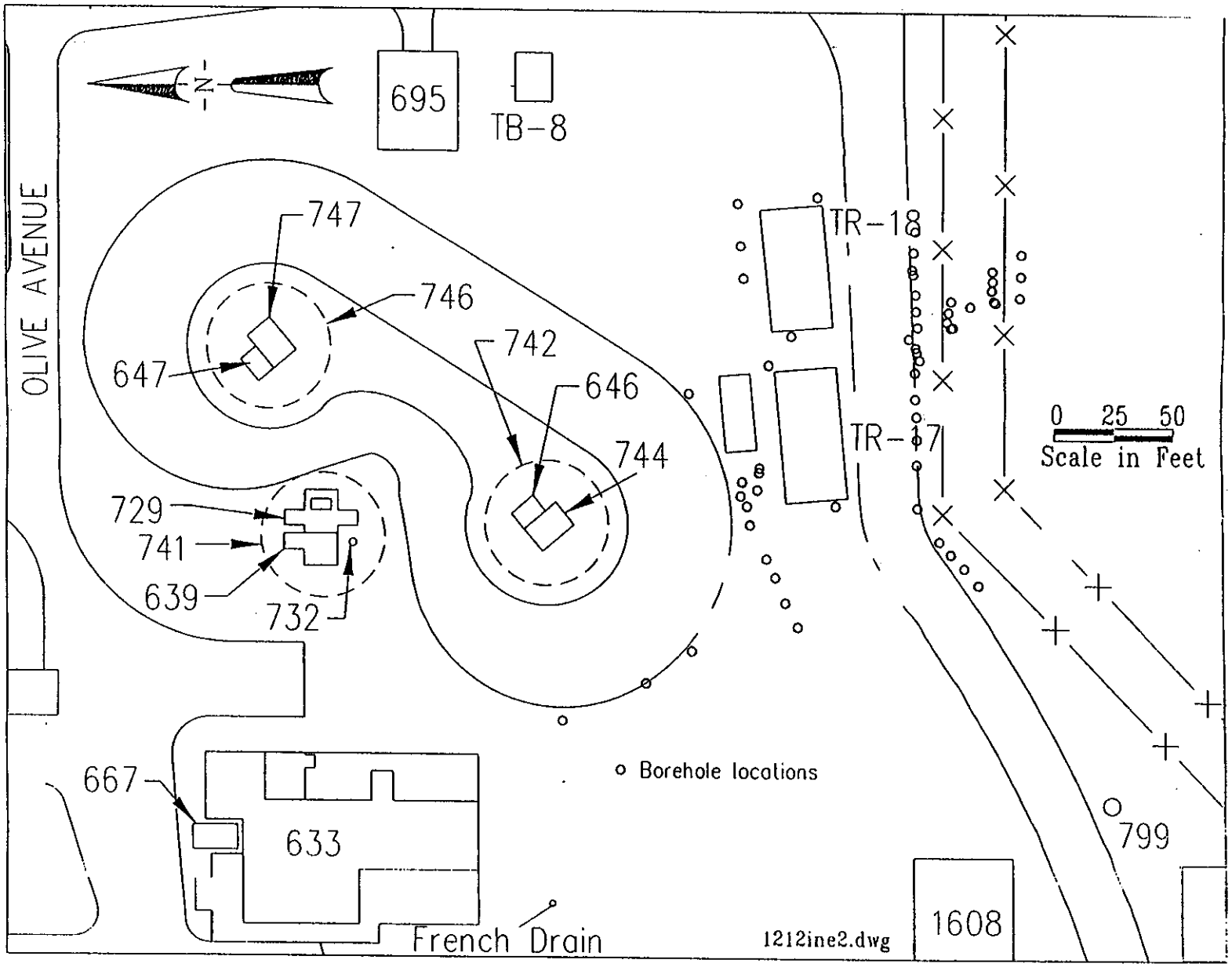


Figure 3-21. Borehole locations for site CPP-93.

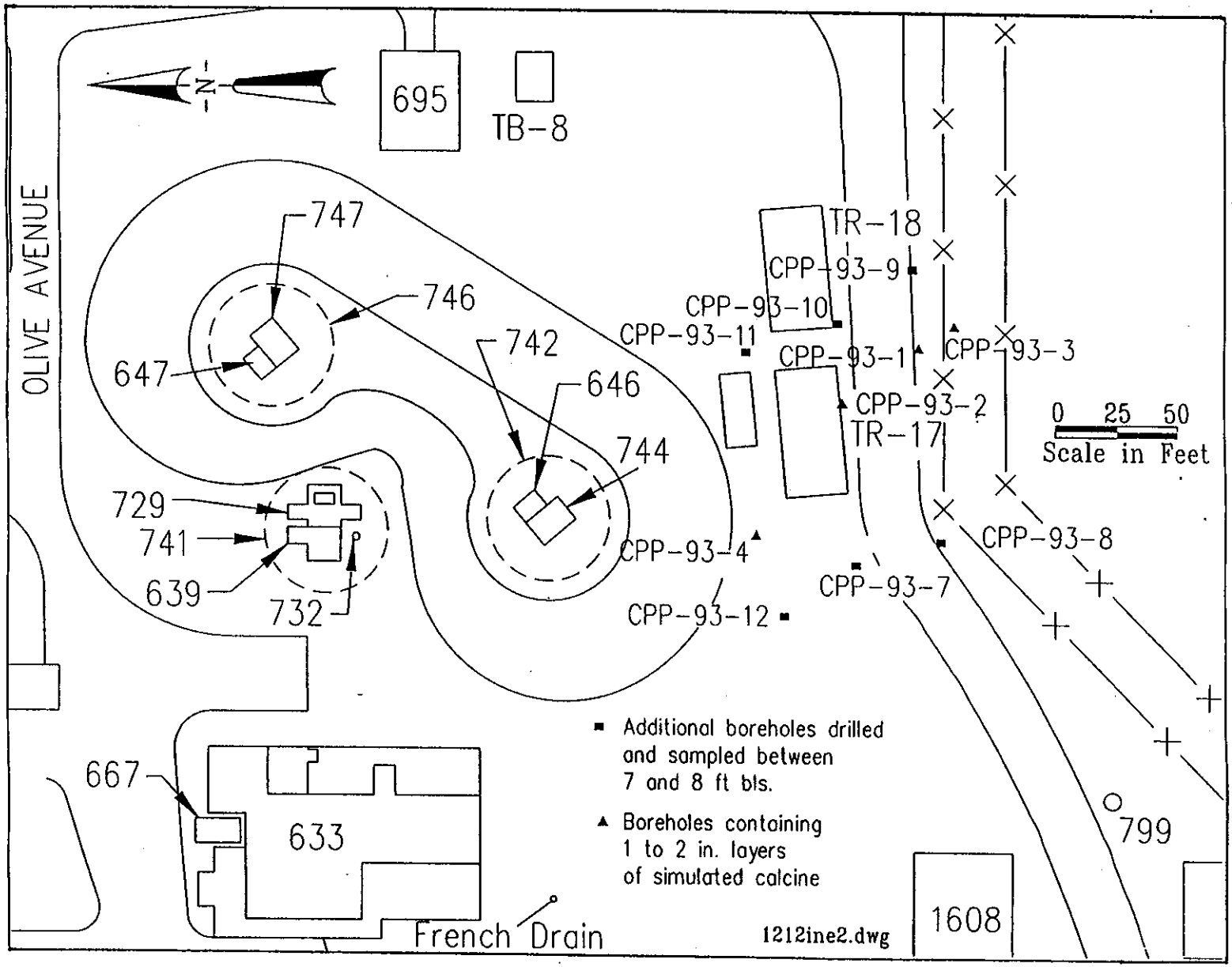


Figure 3-22. Location of soil samples collected at site CPP-93.

For soil samples, there were two minor deviations (1) Sample CPP-19-3 was collected to a depth of 7.5 ft instead of 10 feet and (2) CPP-93-1 was collected to a depth of 4 ft instead of 7.5 ft. In each case, sampling was done for a depth that corresponded to a radiation level of <100 cpm which indicated only minor levels of contamination existed. The unsuccessful tracer and pumping tests can be considered a minor deviation. These tests were conducted but did not provide useful results. As it turns out, the use of estimated values for hydraulic properties in the groundwater model showed good calibration of saturation and contaminant flow and thus, repeat of the tests was not necessary.

3.5 Data Quality Assessment

The purpose of data quality assessment is to determine whether the project data quality objectives (DQOs) and associated quality assurance (QA) objectives were achieved. The high level DQOs led to specific measurable QA objectives of precision, accuracy, representativeness, completeness, and comparability. The determination of whether objectives were met can be accomplished by comparing the sampling program DQOs and QA objectives with actual field performance. The DQOs and their status are summarized in Table 3-6 and the QA objectives are summarized in Table 3-7.

The QA objectives of precision, accuracy, and completeness are quantifiable for both field and laboratory analysis. The QA objectives of representativeness and comparability are qualitative and promoted through the design and implementation of the sampling and analysis program. Sections 3.5.1 and 3.5.2 describe the data quality assessment for the field and laboratory program, respectively.

3.5.1 Field Program

The QA objectives for the field program are summarized in Table 3-7. Quality control samples collected to support the evaluation of the quality of the field program in terms of the QA objectives for precision and accuracy were defined in the SAP and are summarized as follows:

- Field duplicates—defined as two independent samples collected in such a manner that they are equally representative of the variables of interest at a given point in space and time (collocated samples). Field duplicate samples provide an estimate of the field precision as indicated by the calculated relative percent difference (RPD) between duplicate results. The frequency of collection was 5% of the total number of samples collected.

- Rinsate samples (equipment blanks)—the final analyte-free water rinse collected from equipment decontaminated during a sampling event. Rinsates consisted of American Society for Testing and Materials (ASTM) Type II reagent water poured through the sampling equipment, transferred into the sample bottle, and transported to the laboratory for analysis. Results from the rinsate samples were used to evaluate the decontamination process, final rinse water, and sample containers for contamination. Results provide an indicator of the field accuracy. The frequency of collection was 5%.

- Field blanks (ambient condition blanks)—defined as samples collected in the field by pouring ASTM Type II reagent water into sample containers. Field blanks were used to determine the

Table 3-6. WAG 3 DQOS.

DQOS	Status
Soil DQOs	
Identify types of contamination present	Completed
Identify and confirm areas of soil contamination	Completed
Assess risk to workers and residents posed by inhalation of, external exposure to, and ingestion of soil or groundwater; where appropriate	Completed
Groundwater DQOS	
Determine possible source(s) for groundwater contamination	Completed
Determine extent of groundwater contamination	Completed
Assess potential risks from ingestion of water from the SRPA from migration of perched groundwater contaminants	Completed
Miscellaneous DQOs	
Determine vertical contaminant distribution in the SRPA in Well USGS-47	Completed
Determine hydraulic properties and interaction of upper perched water zone(s)	Completed[a]
Determine true water gradient of SRPA beneath the ICPP	Completed
Determine lateral extent and thickness of perched zones beneath ICPP	Completed
Determine hydraulic conductivity and transmissivity of aquifer in MW-18	Completed

Notes:
a. The tests to help define this objective were completed but the results were not useful. Estimated values of hydraulic properties of the aquifer were to the extent necessary, successfully used in the groundwater modeling task. Therefore, it was later determined that these results were not as critical as previously believed so the tests were not repeated.

presence of chemicals not attributable to the sample matrix or collection techniques used. Results provide an indicator of the field accuracy. The frequency of collection was 5%.

- Trip blanks—defined as samples originating from ASTM Type II reagent water from the laboratory, taken to the sample site (in a VOA vial), and returned to the laboratory with the samples to be analyzed for VOCs. The results of the trip blanks were used to help determine the level of chemicals, if any, introduced to the samples during shipping, handling, and storage. Results provide an indicator of the field accuracy. The frequency of occurrence was dependent upon the number of sample containers shipped that included VOC samples.

Table 3-7 summarizes the types of QC samples collected along with their sample identification numbers. Analytical results obtained are provided in Appendix D. Completeness is expressed in terms of critical and noncritical sample collection. Critical samples are samples that must be collected to adequately characterize the nature and extent of contamination at each site and fulfill the data gaps identified in Section 3.2. As indicated on Table 3-8, the target completeness for critical samples is 100%. Sections 3.5.1.1 and 3.5.1.2 describe the critical sample requirements for groundwater and soil, respectively.

Table 3-7. QA objectives s for the WAG 3 Comprehensive RI/BRA.

DQO element	Soil	Groundwater	Miscellaneous
Accuracy:			
Laboratory: measured using recovery of matrix spikes	Organics: Section 2 of the QAPjP Radionuclides: 75–125% Metals: 75–125% (if analytical results are greater than 10% of the detection limit)	Radionuclides: 75–125% Metals: 75–125% (if analytical results are greater than 10% of the detection limit)	Radionuclides: 75–125% (if analytical results are greater than 10% of the detection limit)
Field: measured using field blanks and rinsates	Sample accuracy will be assessed through an evaluation of field quality control	Sample accuracy will be assessed through an evaluation of field quality control	Sample accuracy will be assessed through an evaluation of field quality control
Precision:			
Laboratory: measured using laboratory duplicates and matrix spike duplicates	Organics: Section 2 of the QAPjP Radionuclides: ±35% Metals: ±20% (if analytical results are greater than 10% of the detection limit)	Radionuclides: ±35% Metals: ±20% (if analytical results are greater than 10% of the detection limit)	Radionuclides: ±35% (if analytical results are greater than 10% of the detection limit)
Field: measured using field duplicates	Heterogeneity assessed by evaluating field duplicate samples	Heterogeneity assessed by evaluating field duplicate samples	Heterogeneity assessed by evaluating field duplicate samples
Completeness:			
Measured as samples successfully collected and analyzed over number planned.	Critical: 100%	Critical: 100%	Critical: 100%
Representativeness:			
Qualitative Assessment	The boreholes are located as close to the release as possible to provide information on the maximum concentrations of contaminants to be encountered at the site	Will attempt to sample all groundwater wells listed in Tables 9 and 10. Well locations and distribution may be biased. Will evaluate the distribution of samples with respect to source(s) location.	Will attempt to sample all the identified flow zones throughout the saturated thickness of the well.
Comparability:			
Qualitative Assessment	Data will be collected and analyzed by comparable methods to those used in previous ICPP investigations	Data will be collected and analyzed by comparable methods to those used previously. In addition, the procedure used to collect the samples provide data comparable to MCL and 4% of the Derived Concentration Guide (DCG) standards.	Data will be collected and analyzed by comparable methods used for the groundwater sampling.

Table 3-8. QC samples collected for the WAG 3 Comprehensive RI.

Perched groundwater

Field duplicates:

Location	Samples numbers	
MW5	313242	313240
USGS50	303242	313238
CPP33-4	313244	313204

Rinsates: 313245

Field blank: 313246

SRPA groundwater

Field duplicates:

Location	Samples numbers	
USGS36	313348	313304
USGS121	313349	313330
USGS67	313350	313320

Rinsates: 313351
313412

Field blanks: 313352
313413

Soils

Field duplicates:

Location	Samples numbers
CPP-13-1	313503
CPP-19-4	319007
CPP-22-1	322001
CPP-40-1	340003
CPP-78-1	378001
CPP-88-2	388009
CPP-88-7-1	388037
CPP-88-9-2	388057 (6001)
CPP-88-13-1	388080
CPP-88-15-1	388096
CPP-90-2	390008
CPP-93-1	393002
CPP-13-1	313503

Field blanks: 3XF001 series

Rinsates: 3XR001 series

Trip blanks: 3XV001 series

3.5.1.1 Groundwater Samples. Before implementing the Work Plan water samples had been collected and analyzed for all contaminants of potential concern for all the perched water wells except USGS-50. Therefore, water samples collected from well USGS-50 were considered critical. For the SRPA, only the wells completed in the most direct flow path from the ICPP were considered critical. These wells included MW-18, USGS-47, USGS-48, USGS-57, USGS-112, USGS-121, and USGS-123.

3.5.1.2 Soil Samples. Critical samples for the boreholes drilled within sites CPP-61, CPP-40, CPP-46, CPP-22, CPP-78, and CPP-88 consisted of those collected between 0 and 0.15 m (0 and 0.5 ft) and the sample collected from the interval between 0.15 and 3.04 m (0.5 and 10 ft) bgs having the highest level of radioactivity. As described in the SAP, any borehole that had elevated levels of radioactivity at 3.04 m (10 ft) bgs, required advancement below 3.04 m (10 ft) bgs until radiation levels were at or near background.

If any interval below 3.04 m (10 ft) contained the highest radiation reading for that borehole, then the sample collected from that interval was also considered critical.

The critical samples for CPP-13 are those collected between 0.15 and 0.3 m (0.5 and 1 ft) bgs. Only one of the three sample locations was drilled to 3.04 m (10 ft); therefore, the sample collected in this borehole from the interval having the highest level of radioactivity between 0.3 and 3.04 m (1 and 10 ft) bgs was also considered critical. If elevated levels of radioactivity were screened in the soil at 3.04 m (10 ft), the borehole required advancement below 3.04 m (10 ft) bgs until radiation levels were at or near background. If any interval below 3.04 m (10 ft) contained the highest radiation reading for the borehole, then the sample collected from the interval was also considered critical.

Critical samples for each borehole at CPP-11 include the samples collected between 0 and 0.15 m (0 and 0.5 ft) and the sample collected between 0.15 and 3.04 m (0.5 and 10 ft) bgs from the interval surveyed as having the highest level of radioactivity. If an additional borehole was drilled adjacent to the SFE-106 tank, the 0 to 0.15 m (0 to 0.5 ft) sample and the sample collected between 0.15 and 3.04 m (0.5 and 10 ft) bgs was also considered critical. If drilled, this borehole required advancement to a minimum depth of 6.08 m (20 ft) bgs and was to be continued to the soil/basalt interface if elevated levels of radioactivity were encountered. If any interval below 3.04 m (10 ft) contained the highest radiation reading for that borehole, then the sample collected from that interval was also considered critical.

Critical samples for the boreholes drilled within sites CPP-19, CPP-90, CPP-91, and Area East of CPP-603 consisted of those between 0 and 0.15 m (0 and 0.5 ft) and the sample between 0.15 and 3.04 m (0.5 and 10 ft) from the interval having the highest radiation level. Also, one sample was planned collection between 3.04 m (10 ft) and the soil/basalt interface and one was a planned collection at the interface. If either of these two samples had the highest radiation reading for that borehole, then the sample collected from the highest radiation interval was also considered critical.

Critical samples in each of the seven boreholes drilled at CPP-93 consisted of the composite sample collected between 1.22 and 2.29 m (4 and 7.5 ft) bgs. In addition, the grab samples collected at 4.27 m (14 ft) bgs in each borehole were also considered critical.

3.5.1.3 Field Data Quality Assessment Results. The following sections summarize the field data quality assessment results with regard to precision, accuracy, and completeness.

3.5.1.3.1 Precision—Field precision is a measure of the variability not due to laboratory or analytical methods. Three sources of field variability or heterogeneity are: spatial, between-sample, and within sample heterogeneity. As indicated in Section 3.5.1, field duplicate results were used to calculate the RPD as an indicator of sampling precision. The RPD between results was calculated as specified in the QAPjP. Target acceptance levels for RPD were not defined in the SAP or QAPjP for field duplicates. For the purposes of this assessment, targets of ±35% for water and ±50% for soils were used. Additionally, if results were not in excess of five times the reporting limit, and the detected concentrations in the duplicate samples were within two times the reporting limit, precision was considered acceptable.

Groundwater. Exceedance of ±35% RPD target for groundwater samples was uncommon and generally limited to chemicals with concentrations at or near their respective detection limits. Gross alpha activity in the duplicate sample from USGS 121 had a calculated RPD of 57%; however, the results were near the reporting limit of 4 pCi/g (4.7 and 2.6 pCi/g). Similarly, vanadium concentrations for duplicate samples from USGS 50 resulted in a calculated RPD of greater than ± 35% (i.e., 80%, respectively). The concentrations, however, were within two times the reporting limit (3 μg/L). Copper concentrations for duplicate samples from USGS 50 had a calculated RPD of 96%. The results for the duplicates were 2.6 and 7.4 μg/L. Precision was acceptable for all other chemicals in all other duplicate samples. This indicates that, with only one exception (copper in USGS 50), precision of groundwater sampling in the field program was acceptable.

Soil. Exceedance of the 50% RPD target acceptance level for soil duplicates was generally limited to chemicals with concentrations at or near the detection limits. Chemicals in duplicate samples that exceeded either the ±50% target or were not within two times the reporting limit were cesium-137 and strontium-90 from CPP-88-7-1; mercury and nitrate/nitrite from CPP-93-1; nickel from CPP-88-15-1; and calcium from CPP-19-4. Precision was acceptable for all other chemicals in all other duplicate samples. Given the heterogeneous nature of soils and that no one set of duplicate samples exhibited gross precision problems, precision of soil sampling in the field program was acceptable.

3.5.1.3.2 Accuracy—The accuracy of the data obtained in an investigation is a function of the sampling and decontamination technique and potential for sample contamination in the field. As indicated in Section 3.5.1, field blanks, rinsates, and trip blanks were collected to aid in the evaluation of field accuracy. For the purpose of this assessment, any detected concentration in a blank indicates a potential positive bias in the field sample results for the associated chemical. If the chemical concentration in a sample does not exceed five times the chemical concentration observed in the investigative samples, the results for the investigative samples were considered to be suspect. An exception to this was common laboratory contaminants such as acetone and methylene chloride. The criterion for common laboratory contaminants was generally accepted as at 10 times. Results of these QC samples and impacts to the investigative samples associated with them are discussed below for the groundwater and soil field programs.

Groundwater. Groundwater chemicals detected in field blanks included barium, calcium, copper, cobalt, iron, lead, magnesium, manganese, nickel, potassium, silver, sodium, zinc, gross alpha, gross beta,

and strontium-90. Of these, copper, iron, manganese, zinc, cobalt, lead, silver, nickel, gross alpha, gross beta, and strontium-90 were at levels in field blanks similar to those of some investigative samples. Chemicals detected in rinsate samples included antimony, barium, beryllium, cadmium, copper, iron, lead, manganese, zinc, gross alpha, and gross beta. Review of the investigative results indicate that levels in the rinsates were similar to that of some of the investigative samples. As a result, a potential positive bias in the investigative samples is considered likely for these chemicals. Because VOCs in groundwater were not sampled, trip blanks were not included in the field QC program.

The gross beta result for aqueous sample number 31331301R8 was qualified as an estimate due to improper sample preservation. Aqueous samples for gross beta are required to be preserved with HNO_3 to a pH of <2. The pH was measured at 7 by the contract laboratory.

Soil. Potential cross-contamination of soil samples at distinguishable levels is rare because it would only result from gross negligence on the part of the field team. Because of the significant difference in reporting levels for water samples and soil samples (i.e., ppb range versus ppm range), chemicals detected in blanks are usually detected at levels that generally do not influence the investigative sample results. Chemicals detected in field blanks associated were barium, cobalt, copper, lead, manganese, nickel, potassium, silver, zinc, acetone, gross beta, and strontium-90. Chemicals detected in rinsate samples included aluminum, barium, calcium, cobalt, copper, iron, magnesium, manganese, nickel, potassium, thallium, zinc, acetone, 2-butanone, gross beta, and strontium-90. Chemicals detected in trip blanks were 2-butanone, 2-hexanone, and acetone. For the inorganics and radionuclide sample results, the levels observed in the blanks were in the low μg/l and pCi/L range while the soil sample results were reported at the milligram/kilogram (mg/kg) level. As a result, any bias is indistinguishable from the concentrations observed in the investigative samples. For the organic chemicals detected, the concentrations observed in the blanks were in excess of concentrations observed in the investigative samples. The maximum blank concentrations observed were acetone at 1.3 ppm, 2-butanone at 290 ppm, and 2-hexanone at 0.073 ppm. The maximum investigative sample concentrations were 0.21 ppm for acetone and 0.001 ppm for 2-butanone. 2-hexanone was not detected in any of the investigative samples. This indicates that the concentrations observed in the investigative samples were likely a result of either field or laboratory contamination and not attributable to contamination in the actual soil. Data for the investigative samples have been qualified accordingly.

3.5.1.3.3 Completeness—Completeness refers to the comparison of the number of samples collected to the number of samples planned. The planned samples and analyses are outlined in Tables 3 through 6 of the SAP. Field sampling completeness is most affected by insufficient sample recovery. As indicated on Table 3-8, the QA objectives completeness was 100% for critical samples and 90% for noncritical samples.

Groundwater. The QA objectives of 100% collection of critical groundwater samples was met. It is noted that several of the perched water wells that were specified for sampling in the SAP were dry. These samples were not included in the completeness estimate.

Soil. By and large, the QA objectives of 100% collection of critical soil samples was achieved although a small deviation was noted. Critical samples for the 93 series boreholes were specified in the 1.2- to 2.3-m (4- to 7.5-ft) interval. In boreholes 93-1, 93-2, and 93-3, these samples were not collected. However, samples from 2.0 to 2.1 m (6.5 to 7 ft) were collected in boreholes 93-4, 93-7, 93-8, 93-9, 93-10, and 93-11.

Results from these samples can be used to characterize the critical interval. Also, critical samples were to be collected at 4.3 m (14 ft) bgs. Samples were collected at 3.6 m (12 ft) bgs. However, it is noted that all radiation measurements were at background levels (i.e., contamination was not encountered).

3.5.1.3.4 Representativeness—Representativeness expresses the degree to which sample data accurately and precisely represents a characteristic(s) of an environmental site. Representativeness is a qualitative parameter that addresses the proper design of the sampling and analysis program. Table 3-7 describes the DQOs for representativeness. The data gaps identified in Section 3.4 were identified to provide representativeness. The sampling locations, frequencies, analytical methods, and procedures used were chosen based on filling previously existing data gaps. The QA objectives for representativeness was achieved.

3.5.1.3.5 Comparability—Comparability is the confidence with which one data set can be compared to another. This is a qualitative characteristic that must be ensured in all aspects of the work, from preparation for sampling through reporting. Table 3-7 describes the QA objectives for comparability. Comparability is promoted by using standardized sample collection techniques, analytical methods, data reporting procedures, and SOPs comparable to those used in other ICPP investigations. The QA objectives for comparability was achieved.

3.5.2 Laboratory Program

A phased approach was used to assess the quality and effects on the data usability for the laboratory program. The data quality assessment focused on determining whether the laboratory QA objectives were achieved for the data set. The first phase evaluated individual laboratory QC elements (i.e., calibration, spike recovery, and serial dilution) and the effects these may have on the sample results. This phase focused on a technical review of the findings documented in Limitations and Validation (L&V) Reports for the WAG 3 data. The second phase was dedicated to aggregating the evaluation results from the first phase into the broader categories of accuracy, precision, and completeness. The third phase compared the overall findings to the QA objectives. The results of this assessment are broad based and presented in terms of accuracy, precision, and completeness of the overall data set and the QA objectives for the laboratory program. Representativeness and compatibility are discussed qualitatively. Results for specific sample results are presented in the referenced L&V Reports.

Roy F. Weston, Inc. Laboratories performed the analyses for organic and inorganic compounds. Barringer Laboratories, Inc. performed the analyses for all radionuclides. Sample results and associated L&V Reports are organized by Sample Delivery Groups (SDGs). All analytical data were validated at method validation Level "A," as described in technical procedure, TPR-79, "Levels of Analytical Method Data Validation." The Level A validation included a check of completeness including chain-of-custody, requested versus reported analyses, analysis holding times, method blank analyses, MS/MSD analyses, duplicate analyses, internal standards areas, and review of the raw data for the sample analyses, including mass spectral confirmation and instrument calibration.

As part of Phase 1, the following SDGs were reviewed and summarized as part of this Data Quality Assessment:

SDGs for radionuclides.

RPW-234-95	RPW-257-95	RPW-258-95	RPW-271-95	RPW-191-95	RPW-196-95
RPW-198-95	RPW-199-95	RPW-201-95	RPW-206-95	RPW-208-95	RPW-226-95
RPW-227-95	RPW-175-95	RPW-176-95	RPW-177-95	RPW-178-95	RPW-179-95
RPW-180-95	RPW-181-95	RPW-182-95	RPW-183-95	RPW-184-95	RPW-185-95
RPW-186-95	RPW-187-95	RPW-188-95	RPW-189-95	RPW-190-95	RPW-192-95
RPW-193-95	RPW-194-95	RPW-195-95	RPW-200-95	RPW-202-95	RPW-203-95
RPW-205-95	RPW-207-95	RPW-209-95	RPW-211-95	RPW-212-95	RPW-213-95
RPW-215-95	RPW-216-95	RPW-217-95	RPW-218-95	RPW-219-95	RPW-225-95
RPW-229-95	RPW-230-95	RPW-235-95	RPW-236-95	RPW-238-95	RPW-239-95
RPW-240-95	RPW-241-95	RPW-244-95	RPW-246-95	RPW-268-95	RPW-270-95
RPW-269-95	DMF-14-95	DMF-13-95	DMF-12-95	DMF-11-95	DMF-10-95
DMF-09-95	DMF-08-95	DMF-07-95	DMF-06-95	DMF-05-95	DMF-04-95
DMF-03-95					

SDGs for organic and inorganic compounds.

JJE-123-95	JJE-133-95	JJE-142-95	JJE-144-95	JJE-161-95	JJE-162-95
JJE-164-95	JJE-169-95	JJE-170-95	JJE-175-95	JJE-184-95	JJE-185-95
JJE-207-95	JJE-208-95	JJE-173-95	JJE-163-95	JJE-183-95	JJE-172-95
JJE-171-95	JJE-121-95	JJE-120-95	JJE-143-95	JJE-159-95	JJE-176-95
JJE-178-95	JJE-122-95	JJE-134-95	JJE-165-95	JJE-166-95	JJE-167-95
JJE-168-95	JJE-174-95	JJE-177-95			

The qualified results from the L&V process are summarized in Appendix D. The summaries were designed to indicate the samples that were either qualified or rejected. The summaries also indicate and categorize the QC parameters (i.e., accuracy and precision) potentially affected for the SDG. SDG-specific L&V Reports provide detailed information for specific samples. The following qualifiers represent those assigned as a result of the Level A validation and represent those applied during the L&V process.

Nonradionuclides

J = The analyte was analyzed for and was positively identified, but the associated numerical value may not be consistent with the amount actually present in the environmental sample.

UJ = The material was analyzed for, but not detected. The associated value is an estimate and may not accurately reflect the instrument detection limit (IDL) in the sample matrix.

U = The material was analyzed for, but was not detected above the level of the associated value. The associated value is either the sample quantitation limit or the sample detection limit.

R = The data are unusable. These data are not included in the working data set for the RI/BRA.

Radionuclides

J = The result is a statistically positive value at the 95% confidence level and is considered to be an estimated quantity.

UJ = The result is a statistical nondetect at the 95% confidence level and is considered to be an estimated quantity because of an unacceptable quality control parameter.

R = The result is rejected because of an unacceptable quality control parameter. These data are not included in the working data set for the RI/BRA.

3.5.2.1 Laboratory Accuracy. Table 3-7 summarizes the laboratory QA objectives for accuracy. Accuracy measures the bias in a measurement system. Laboratory accuracy is primarily a function of the analytical methods used in the laboratory. Laboratory accuracy is affected by laboratory contaminants, sample handling, sample matrix, sample preparation, and analysis techniques. The QA objectives for accuracy in the laboratory were based on the QC limits specified in the analytical methods applied. The goal was to meet the objectives of the QC limits, thus indicating that accuracy in the analysis was achieved. If the limits were not met, the associated data were qualified. The following is an overview of the QC limits applied:

- Laboratory accuracy for inorganic analysis was assessed through the use of laboratory control samples and/or single blind control samples and matrix spikes. The established control limits were as follows: spike recovery within ±25% and laboratory control sample within ±20% of the known value. Initial and continuing calibration checks were also applied and the control limits per ±20% of unknown value. Additional inorganic and miscellaneous accuracy control limits are included in Tables 2-9 and 2-11 of the QAPjP and in Table 7 of the SAP. Matrix spikes are used for nonradioactive samples.

- Blank samples were also used in the laboratory as a means to verify accuracy. For radiological samples, results on blanks were in control if they were <½ contract detection limit (CDL); questionable if >½ CDL but <CDL; out of control if >CDL. For inorganic (e.g., metals) analytical results, blanks were compared to IDL for specific analytes. If a sample result is not >5 times the amount observed in any blank (i.e., method and continuing calibration), the concentration has likely been positively biased by blank contamination.

- Laboratory accuracy for organic analyses are specified in Tables 2-1 through 2-3 of the QAPjP, as defined by the analytical methods used.

- Laboratory accuracy for radionuclide analysis has been assessed through the use of percent recovery data from LCS as prescribed in SOP 12.1.2, "Radiological Data Validation" and on the uncertainty limits established on a per sample basis. The laboratory % recovery of ±15% was considered to be in control and ±20% is questionable. Any percent recovery >±20% was considered out of control. Radioactive samples were also compared to predetermined analytical yield values to verify accuracy. The control range was 40% to 105%. Results were considered questionable if they fall between 20% to 40% or 105% to 115%. Any results outside of these ranges were considered out of control.

Appendix E provides a summary, on a SDG-specific and sample-specific basis, of those chemicals for which accuracy was affected. For the 33 SDGs analyzed for nonradioactive parameters, 23 exhibited problems that affected the accuracy of the results; however, accuracy problems (i.e., out-of-tolerance results) resulted in the rejection of only 15 out of 4,092 individual sample results. For the 73 SDGs analyzed for radionuclides, 11 exhibited accuracy problems resulting in 44 out of 1,338 rejected results. As indicated in Appendix E , problems with strontium-90 and technetium-99 analyses resulted in several rejected data points.

3.5.2.2 Precision. Precision is a measurement of the reproducibility of a measurement under a given set of conditions. As for accuracy measurements, the QA objectives for laboratory precision are indicated on Table 3-7. The goal is to meet the objectives of the QC limits specified in the analytical method, thus indicating that precision in the analysis has been achieved. In most analytical methods, precision is stated in terms of the RPD. The following is an overview of the QC limits applied:

- Laboratory duplicates and MSD samples were predominantly used as the means to assess precision for the inorganic analyses. Inductively coupled plasma (ICP) serial dilution percent differences (%Ds) were also used to measure the precision of metals results. Results with %Ds >10% for results >50x the respective IDL are considered estimated quantities.

- The method of comparing radioactive duplicate samples involved the calculated mean difference (MD) between the sample and its duplicate. If the duplicate MD <1.5, the sample was considered in control; MD >1.5 but <2.0 the results are considered questionable; MD >2.0 the results were considered out of control.

- The QC limits for laboratory precision for organic analyses are specified in the analytical methods used and are listed in Tables 2-1 through 2-3 of the QAPjP.

Appendix E provides a summary, on a SDG-specific basis and sample-specific, of those chemicals for which precision was affected. For the 33 SDGs analyzed for nonradioactive parameters, 14 exhibited problems that affected the precision of the results; however, no data were rejected due to precision problems. For the 73 SDGs analyzed for radionuclides, nine exhibited precision problems. None of the analytical results were rejected because of precision problems. Additionally, it is noted that one of two required duplicate samples was collected but not analyzed by the laboratory for gross alpha and gross beta activity for sample 32200701EH-D. Comments regarding this duplicate sample can be found in L&V Report for SDG RPW-257-95. The impact of this omission is assumed minimal.

3.5.2.3 Completeness. Analytical completeness is measured by comparing the number of acceptable analytical results obtained against the number of analytical results that were deemed unusable based on the L&V process. Completeness is affected by holding time requirements, sample handling, shipping, packing, and storing as well as the analytical methods and techniques. However, completeness is primarily affected by the laboratories failure to meet the QC limits as specified in the analytical methods.

As summarized in Appendix E, the following SDGs contained sample results that were rejected during the data validation process. These rejected sample results have an impact on the total completeness.

Nonradionuclides

Antimony	SDG # JJE-144-95
Calcium	SDG # JJE-185-95
Iron	SDG # JJE-185-95
Magnesium	SDG # JJE-185-95
Sodium	SDG # JJE-185-95

Radionuclides

Sr-90	SDG # RPW-208-95
Sr-90	SDG # RPW-271-95
Tc-99	SDG # RPW-271-95

3.5.2.4 Representativeness. As discussed in Section 3.5.1.3.4, representativeness expresses the degree to which sample data accurately and precisely represents a characteristic(s) of an environmental site. Representativeness is a qualitative parameter that addresses the proper design of the sampling and analysis program. Representativeness has been achieved.

3.5.2.5 Comparability. As discussed in Section 3.5.1.3.5, comparability is the confidence with which one data set can be compared to another. Comparability has been promoted by using standard analytical methods and validation guidelines, therefore the QA objectives for comparability has been achieved.

3.5.2.6 Performance Evaluations. A review of the field logbook indicated that a field audit team was present at the site on May 5, 1995. Section 8.3 of the QAPjP describes the requirements for the performance and documentation of at least one system/performance evaluation (i.e., self-assessment, quality field surveillance, and independent assessment) to ensure that sample documentation, collection, preparation, storage, and transfer procedures are in place before or shortly after field activities start.

3.6 References

Department of Transportation Hazardous Materials Regulations, 49 CFR Parts 171–177.

EG&G Idaho, 1993a, EG&G Idaho *Company Procedures Manual.*

EG&G Idaho, 1993b, EG&G Idaho *Hazardous Materials Transportation Manual.*

EG&G Idaho, 1991, *Statement of Work of Radiological Analyses Performed for the Environmental Restoration Department at the INEL* (ER-SOW-33).

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EPA, 1993, *Statement of Work for Inorganic-Multi-Media, Multi-Concentration.*

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EPA, 1986, *Test Methods for Evaluating Solid Waste, Physical and Chemical Methods*, SW-846.

EPA, 1983, *Methods for the Chemical Analysis of Water and Wastes.*

QAPjP for Waste Area Groups 1, 2, 3, 4, 5, 6, 7,and 10, INEL-95/0086 (formerly EGG-WM-10076), Revision 4, March 1995. A. R. Baumer II, S. C. Flynn, C. S. Watkins.

Chapter 4

4. NATURE AND EXTENT OF CONTAMINATION

During more than 40 years of operations, radioactive and hazardous materials have been released to the environment at the ICPP. Releases, which are not unusual at industrial facilities, have occurred as the result of spills, leaks in waste transfer lines, and through previous waste management practices. To date, 94 potentially contaminated sites have been identified. Most of these sites were identified before finalization of the FFA/CO and are grouped in OUs based on similar waste streams or conditions. Some release sites were cleaned up at the time of the release and most have been sampled and characterized. The objective of this section is to describe the major sources of contamination that have led to adverse soil and groundwater impacts and subsequently describe the extent of contamination to groundwater. This section will also discuss efforts taken to verify the completeness of the data collected.

To this end, Section 4.1 will describe the nature of contamination in terms of the major sources and Sections 4.2 and 4.3 will describe the resulting extent of contamination in the perched water and aquifer. It should be noted that Section 4.1.3 briefly discusses soil contamination however, the nature and extent of soil contamination will be described in detail on a site basis in Sections 8 through 26. The completeness of the field investigations in terms of the inventory of radioactive contaminants expected given the spent nuclear fuel reprocessing mission of the ICPP is discussed in Section 4.4.

4.1 Sources and Source Inventory

Based on a review of the generation process and existing artifacts, the primary sources of contamination at the ICPP include (a) historical waste discharge to the ICPP disposal well (Section 4.1.1), (b) leakage from the concrete holding tanks in building CPP-603 (Section 4.1.2), and (c) accidental releases to the environment as identified in the FFA/CO. For all sources except the CPP-603 concrete holding tanks, the release of contamination to the environment is from historical events. Wastewater is currently being discharged to two active surface impoundments, the percolation ponds and sewage treatment ponds. According to existing characterization data on the ponds sediments and the quality of the waste stream, these two sources do not contribute significantly to the groundwater contamination. However, water movement from these ponds may affect the migration of contaminants in other areas of the ICPP such as the tank farm. Depending upon the location of the water source with respect to the contaminated areas, this discharge may contribute to contaminant migration in the subsurface.

4.1.1 ICPP Injection Well, CPP-23

Since 1952, ICPP processes have generated large volumes of plant cooling waters and condensates. These service waste waters contained small quantities of radioactive and inorganic contaminants. The ICPP injection well (MEH-FE-PL-304), located north of building CPP-666, was used to discharge these low-level radioactive and chemical wastes to the aquifer from 1952 to February 1984. The ICPP injection well was drilled in 1950 to a depth of 64.6 m (212 ft) and deepened in 1951 to 182 m (597 ft). A 61-cm (24-in.) diameter borehole was drilled and cased using 41-cm (16-in.) nominal diameter carbon steel casing. The annular space between the borehole and casing was filled with gravel. The well casing was perforated from 125.6 to 137.8 m (412- to 452-ft) and 149.4- to 180.7-m (490- to 593-ft) bls. The average discharge to the well during this period was about 1.4B L/yr (363M gal./yr) or about 3.8 ML/day (1M gal/day). Figure 4-1

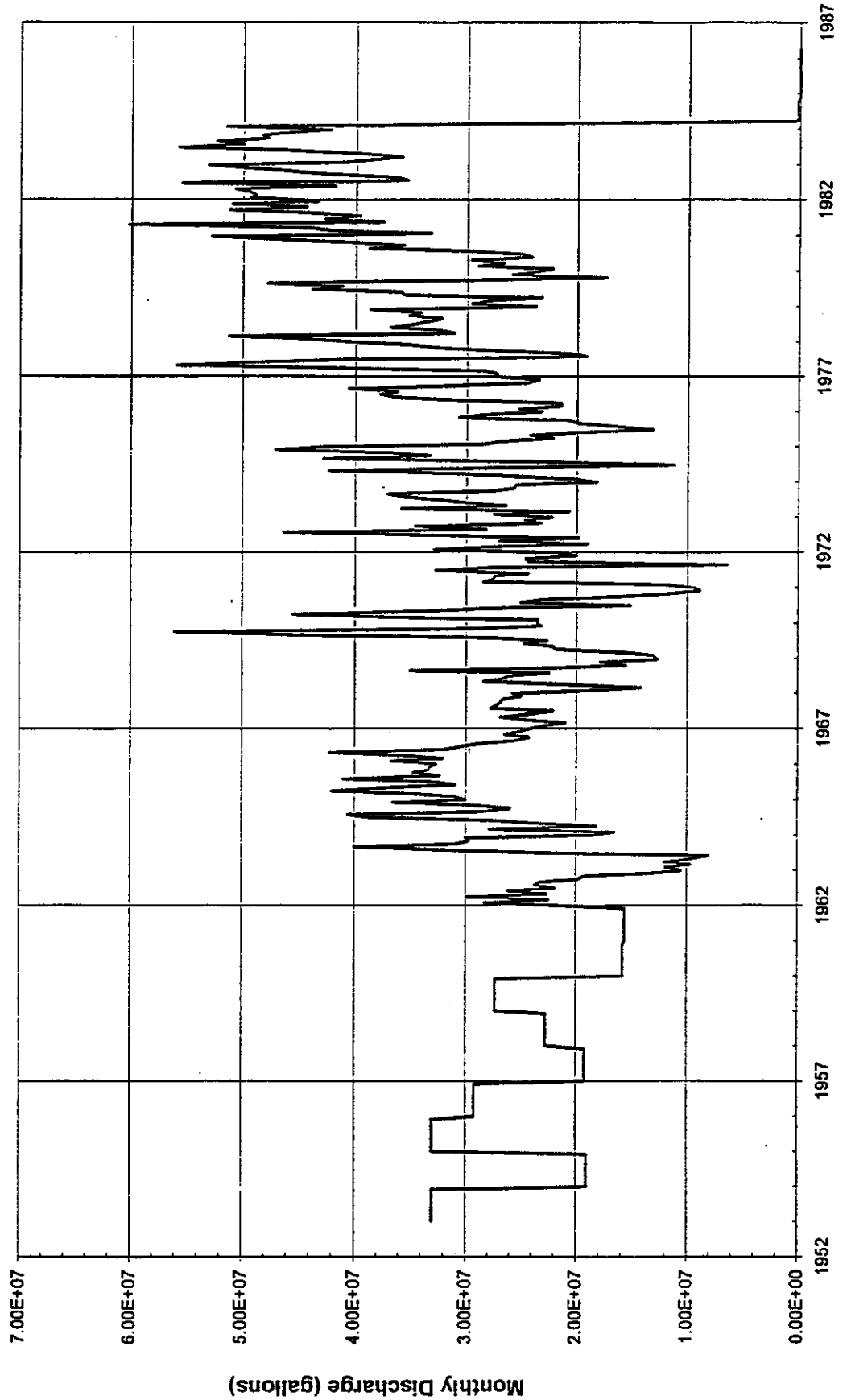


Figure 4-1. Monthly waste water discharge to the ICPP injection well (RWMIS records).

presents the monthly volume of wastewater discharged to the ICPP injection well. The available data for 1953 to 1961 are yearly totals and are plotted by assuming equal volumes discharged every month.

In June 1970, an attempt was made to replace a defective measuring line in the disposal well. It was discovered the well had collapsed and was plugged at a depth of 68.9 m (226 ft). Consequently, waste water was being injected into the unsaturated zone above 68.9 m (226 ft) (WINCO, 1990). The waste water discharged to the disposal well was warm (65° to 70°F) and salty (chloride content averaging approximately 200 to 250 mg/L). The salty, aerated waste water apparently corroded the casing until it collapsed, allowing the gravel pack and intruding sediment to fill the well up to the 68.9-m (226-ft) depth. Only fragmentary corroded pieces of the original 41-cm (16-in.) casing were left as indicated by caliper logs and first attempts at cleaning the well. Measurements made in 1966 showed the well was still intact. Therefore, most of the collapse took place in 1967 or early 1968. Additional evidence supporting this time frame are levels of H-3 and Sr-90 in USGS-50 which occurred in 1969 and 1990 (see Section 4.2.4).

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 this period of well rehabilitation, waste water was disposed to USGS-50. It is assumed during or after these well rehabilitation operations, the well collapsed again and was reopened to the water table in late 1982. At this time, a 2.5-cm (1-in.) thick high-density polyethylene line was placed in the well from ground level to the bottom of the well. The liner was perforated from 137 m (450 ft) bls [approximately 2.4 m (8 ft) above the water table] to the bottom of the well (WINCO Installation Assessment Report, 1986).

On February 7, 1984, the injection well was taken out of routine service and waste water has been pumped from two parallel collection vaults to Percolation Ponds 1 and 2. Disposal of waste water decreased in 1985 and 1986. The injection well also served as an emergency overflow protection for buildings CPP-709, -734, and -797, which contain the vaults from which the service waste water is monitored and pumped. The overflow protection was only required on a temporary basis if the operating and standby pumps from one of the parallel streams failed simultaneously. All the lines have been plugged and can no longer be used to route service waste water overflow from the vaults in the buildings.

In 1986, modifications were made to the injection well entry, which further decreased use of the well resulting in a decrease to approximately 12,200 L (3,220 gal.) to the injection well in 1986. No releases have occurred to the well since 1986.

In October and November 1989, the injection well was sealed by perforating the casing throughout and pumping in cement. The well was sealed from the basalt silt layer [145 m (475 ft) bls] to land surface to prevent hydraulic communication between the land surface, perched water, and SRPA.

4.1.1.1 Waste Disposal. From 1952 to 1984, the injection well was used for the disposal of waste water. According to the RWMIS database, it is estimated a total of 22,200 Ci (approximately 96% consisting of H-3) have been released in 4.2×10^{10} L (1.1×10^{10} gal.) of water. This database provides a qualitative estimate of the activity and volume of waste water discharged to the injection well. Table 4-1 presents a summary of the total curies discharged to the injection well for each radionuclide and includes the curies remaining after radioactive decay. Based on drinking water standards, the major radionuclides of concern

Table 4-1. Activity of radionuclides discharged to the ICPP injection well (RWMIS Database).

Radionuclide	Half Life (years)	Total Activity Injected (Ci)	Total Activity Remaining* (Ci)	Percent of the Injected Activity Remaining (after decay)	Percent of the Current Activity
Ag-110m	6.80E-01	8.36E-05	1.34E-12	0.0	0.00
Am-241	4.32E+02	3.17E-04	3.08E-04	97.2	0.00
Ba-140	3.49E-02	5.05E-04	8.86E-156	0.0	0.00
C-14	5.73E+03	1.27E-01	1.27E-01	99.8	0.00
Ce-141	8.90E-02	1.68E-04	3.19E-61	0.0	0.00
Ce-141/144	7.80E-01	1.16E-01	2.42E-14	0.0	0.00
Ce-144	7.80E-01	1.75E+01	2.07E-06	0.0	0.00
Co-57	7.40E-01	6.54E-03	8.91E-09	0.0	0.00
Co-60	5.27E+00	1.49E-01	8.77E-03	5.9	0.00
Cr-51	7.59E-02	5.37E-03	2.91E-67	0.0	0.00
Cs-134	2.06E+00	1.50E+00	2.03E-03	0.1	0.00
Cs-137	3.02E+01	2.05E+01	1.19E+01	57.8	0.30
Cs-138	6.10E-05	2.50E-01	0.00E+00	0.0	0.00
Eu-152	1.36E+01	8.12E-02	4.36E-02	53.7	0.00
Eu-154	8.80E+00	8.38E-02	2.95E-02	35.2	0.00
Eu-155	4.96E+00	2.22E-02	3.43E-03	15.5	0.00
H-3	1.23E+01	2.13E+04	3.89E+03	18.2	99.44
Hg-203	1.28E-01	7.33E-05	3.10E-42	0.0	0.00
I-129	1.57E+07	2.78E-01	2.78E-01	100.0	0.01
I-130	2.21E-02	2.98E+01	4.38E-152	0.0	0.00
K-40	1.28E+09	2.81E-12	2.81E-12	100.0	0.00
La-140	4.60E-03	6.22E-04	0.00E+00	0.0	0.00
Mn-54	8.80E-01	6.55E-03	7.02E-08	0.0	0.00
Nb-95	9.58E-02	4.63E-01	4.17E-35	0.0	0.00
Np-237	2.14E+06	5.48E-03	5.48E-03	100.0	0.00
Pr-144	3.29E-05	4.47E-01	0.00E+00	0.0	0.00
Pu-238	8.78E+01	1.32E-01	1.15E-01	87.1	0.00
Pu-239	2.44E+04	1.05E-02	1.04E-02	99.9	0.00
Pu-239/240	2.44E+04	3.74E-02	3.74E-02	99.9	0.00
Pu-240	6.57E+03	1.14E-03	1.14E-03	99.8	0.00
Rh-106	9.48E-07	4.81E+00	0.00E+00	0.0	0.00
Ru-103	1.10E-01	1.45E-01	4.59E-37	0.0	0.00
Ru-106	1.00E+00	1.70E+01	6.85E-04	0.0	0.00
Sb-124	1.65E-01	2.41E-04	5.02E-36	0.0	0.00
Sb-125	2.77E+00	1.86E+00	1.22E-02	0.7	0.00
Sr-85	1.78E-01	9.14E-05	1.78E-23	0.0	0.00
Sr-89	1.40E-01	5.59E+00	4.51E-27	0.0	0.00
Sr-89/90	2.86E+01	1.31E+00	6.40E-01	48.8	0.02
Sr-90	2.86E+01	1.60E+01	8.75E+00	54.8	0.22
U-234	2.45E+05	2.28E-02	2.28E-02	100.0	0.00
U-235	7.04E+08	1.94E-03	1.94E-03	100.0	0.00
U-236	2.34E+07	4.09E-04	4.09E-04	100.0	0.00
U-238	4.47E+09	6.81E-03	6.81E-03	100.0	0.00
Y-90	7.32E-03	1.32E+00	0.00E+00	0.0	0.00
Zn-65	6.68E-01	4.65E-04	1.39E-11	0.0	0.00
Zr-95	1.78E-01	2.34E-01	2.53E-23	0.0	0.00
Zr/Nb-95	1.78E-01	2.06E+01	1.38E-43	0.0	0.00
Unidentified Alpha	–	6.36E-01	–	–	–
Unidentified Beta-Gamma	–	5.82E+01	–	–	–
Others**		6.33E+02	–	–	–
	Total	2.22E+04	3.92E+03	–	100.0

* Decayed to January 1, 1995

** Estimate of radionuclides other than H-3 from 1957 to 1962 [assuming 95.5% of the total curies is H-3, Barraclough (1966)]

disposed to the injection well were H-3 and Sr-90 with Cs-137 exhibiting the second highest remaining activity. Figures 4-2 and 4-3 provides plots of the disposal history of H-3 and Sr-90 to the ICPP injection well, respectively. The waste water also contained low concentrations of various chemicals. Since well closure in February 7, 1984, the well was used only for emergencies such as loss of pump power and overflow protection for buildings CPP-709, -734, and -797, which contain vaults from which service waste water was monitored and pumped.

Since the percolation ponds were placed in service, the volumes of service waste effluents transferred to the injection well during emergencies decreased to about 2.96×10^8 L (7.8×10^7 gal.) in 1984, 185,490 L (49,000 gal.) in 1985, and 12,190 L (3,220 gal.) in 1986. Emergency releases to the injection well decreased from 1984 to 1986 because the percolation ponds were placed in service and volumes of service waste effluents transferred to the injection well decreased. No discharges to the injection well occurred after 1986.

During the ICPP operational life, known accidental discharges to the injection well occurred and are described below (WINCO, 1992).

1. July 1953: The contents of a tank discharged to the waste water flowing to the well. A post discharge analysis showed that 51 mCi of radioactive contaminants were released in 923,640 L (244,000 gal.) of water.

2. December 1958: About 29 Ci of radioactive contaminants, including 7 Ci of Sr-90 were released to the well.

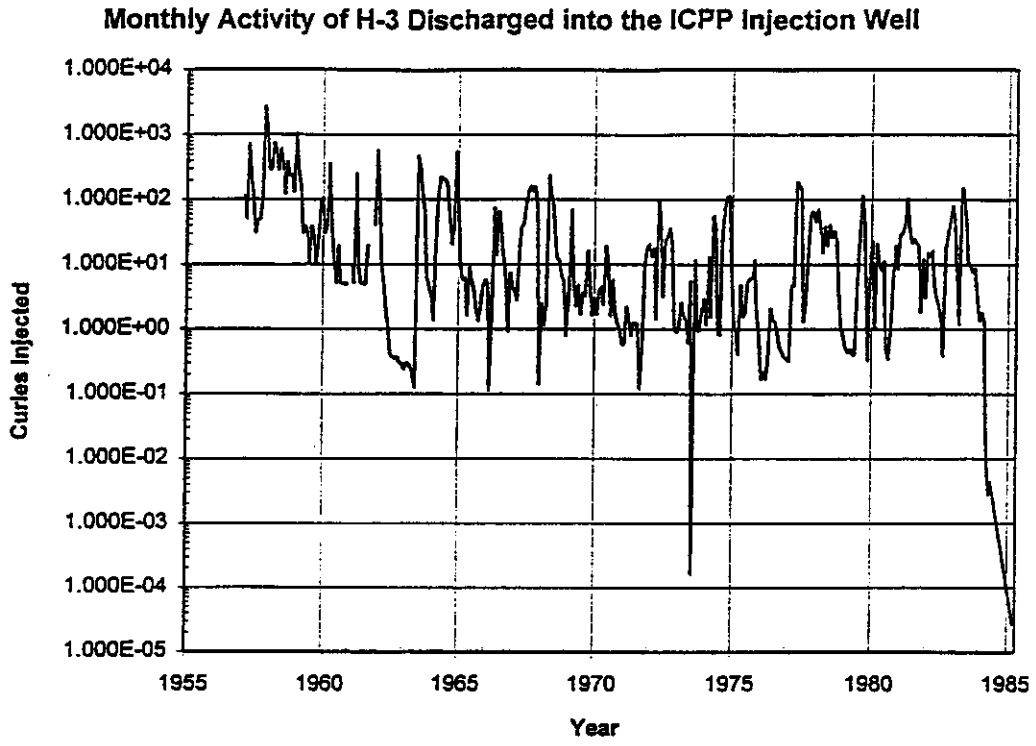
3. September 1969: Two separate releases resulted in 19 Ci of fission products released to the well. Releases included Cs-137, Cs-134, cerium (Ce)-144, and antimony (Sb)-125 in 12.4×10^6 L (3.28×10^6) of waste water.

4. December 1969: Two releases occurred in which the quantity of Sr-90 released was higher than expected. About 1 Ci, including 30% Sr-90 was released.

5. March 1981: mercury was detected during routine monitoring of the ICPP Service Waste System. Mercury in the form of mercuric nitrate was released from CPP-601, through the ICPP Service Waste System to the ICPP injection well. An estimated 0.207 mg/L of mercury was detected in service waste (RCRA EP Toxicity limit for mercury is 0.2 mg/L).

   Soluble mercury, as mercuric nitrate, is used as a catalyst in certain ICPP fuel dissolution processes. These operations are the only ones in which significant quantities of soluble mercury have been used at the ICPP. In March 1981, a batch of catalyst was mixed, then found to contain solids. The solution was discarded and it is assumed it was drained to the waste system. Assuming the worst case scenario of draining one batch of catalyst, the maximum catalyst lost would be 250 L (66.0 gal) of solution containing 15 kg of mercury. This is the only contaminant release to the well identified as a RCRA concern.

4.1.1.2 Monitoring. Eight monitoring wells within 0.40 km (0.25 mi) and downgradient of the injection well have been established by the USGS. Although there is typical dispersion of waste plumes laterally and



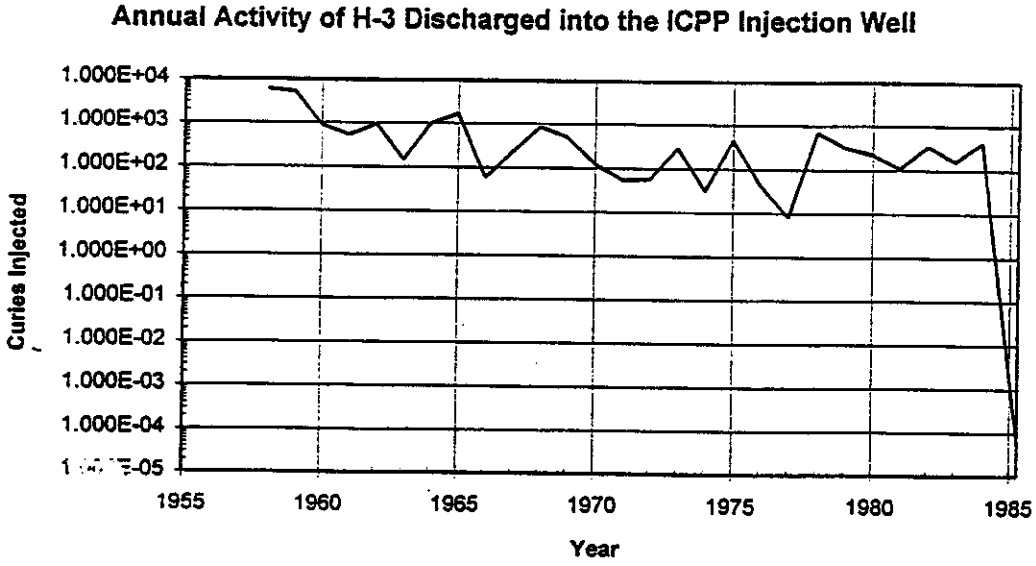
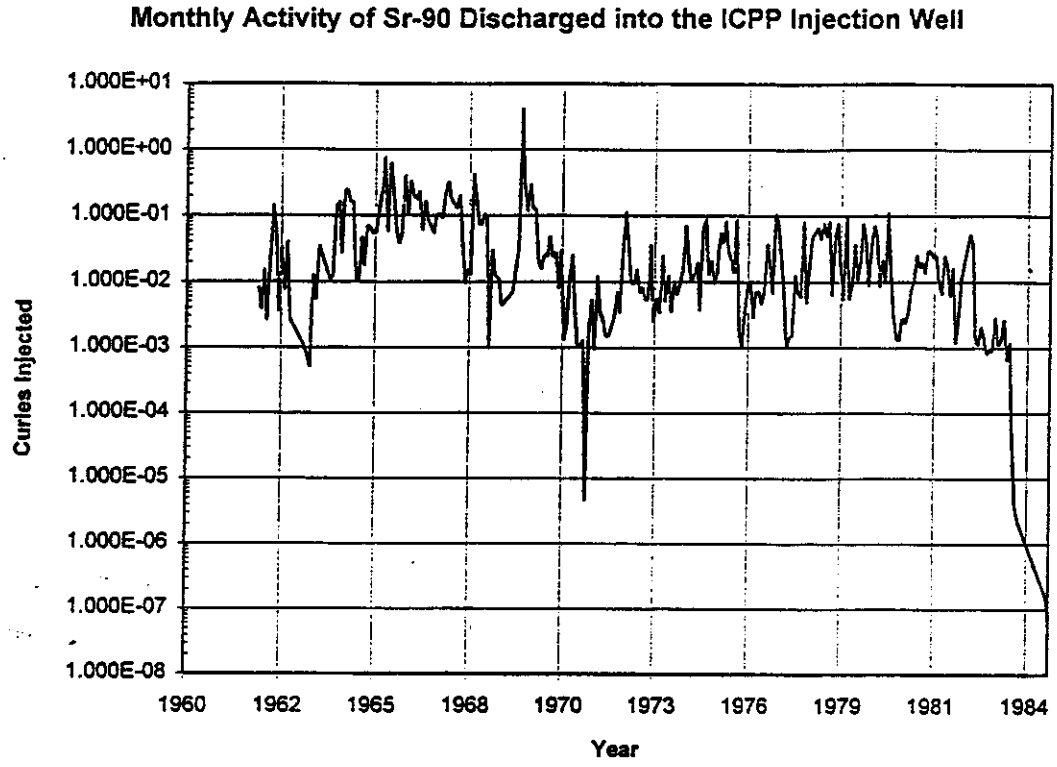


Figure 4-2. Monthly and annual activity of H-3 discharged to the ICPP injection well (RWMIS Records).



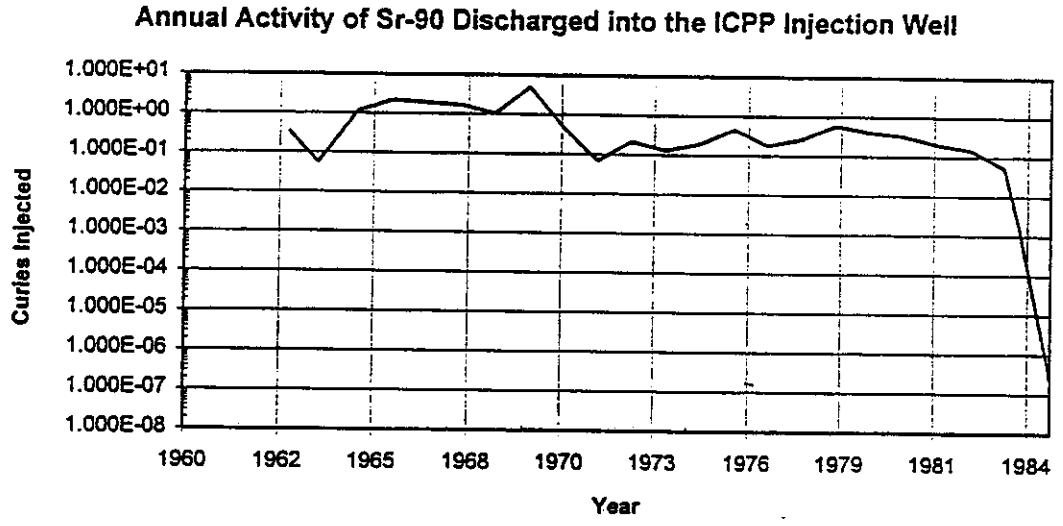


Figure 4-3. Monthly and annual activity of Sr-90 discharged to the ICPP injection well (RWMIS Records).

longitudinally, there appears to be little vertically because of relatively low vertical permeability and apparent lower permeability at depths greater than about 76.2 m (250 ft) below the water table. Analyses of water samples collected from the USGS wells downgradient of the ICPP indicated detectable mercury concentrations (0.2 µg/L) in three USGS wells (36, 37, and 41). Because heavy metal analysis is not conducted by the USGS on a regular frequency, it is not certain if these analyses indicate detectable mercury because of the March 1981 injection well release.

A sample of the sediment within the injection well was collected on August 31, 1989. PCB 1260 (Arochlor) was the only organic compound detected above method detection limit (MDL) in this sediment sample; however, the sample was collected from the top of the sediment column in the injection well and may not be representative of contaminants and concentrations at deeper intervals of the column. Arochlor was detected at a concentration of 10 µg/kg; the minimum detectable limit is 8.3 µg/kg. Downgradient monitoring wells were sampled and PCB was not indicated. Radionuclide analyses of sediments taken from the injection well measured indicate beta activity at 150 pCi/g and three radionuclides: Cs-137 at 100 pCi/g; Eu-152 at 3.8 pCi/g; and Eu-154 at 2.5 pCi/g.

4.1.2 CPP-603 Basins

CPP-603 fuel storage basin has been operational since 1952 and is utilized to store spent fuel assemblies until such time a sufficient amount of fuel was accumulated for a processing run. CPP-603 consists of three reinforced concrete fuel storage basins connected by a transfer channel. The basins are 6.1 m (20 ft) thick and the water inventory is maintained at approximately 5.7M L (1.5M/gal). Based on two studies performed in 1986/87 and 1993 the estimated loss rates from the basins are between 500–700 L/day.

Limited basin water quality data collected by plant operations is available over the period from 1976 to 1996. Water quality parameters analyzed for during this period included pH, chlorides, conductivity, nitrate, and total activity. During this period pH has ranged from 7.2 and 8.3 (1977–1996 data), chlorides 382 mg/L (1977 data) to 35 mg/L (1995 data), conductivity 592.5 to 511 uS/cm (1995–1996 data), and nitrate 682 mg/L (1981 data) to 149 mg/L (1995 data). The total activity for the period 1976 to 1996 has ranged from 0.12 uCi/mL (1976 data) to 3.3 E-05 uCi/mL (1987 data). The major contributor to total activity over this period was Cs-137.

4.1.3 Soil Contamination

Based on the WAG 3 RI/FS Work Plan (INEL-95/0056, Rev. 2), 73 different contaminants have been identified at the ICPP including 13 metals, 25 organic compounds, 32 radionuclides, and 3 other (fluoride, nitrate, and oil and grease) contaminants. Results from the Track 1 and Track 2 investigations indicate that radionuclides are the most significant contaminants at the ICPP. Most if not all field investigations to define the nature of contamination within the soil release areas and groundwater were scoped during the Track 1 and 2 process. Of course, the more recent investigations in 1995 were scoped during the RI Report work plan phase. The sampling programs were designed with the use of process history to the extent that it was available and therefore, the analysis suite was in large part defined by what was known to have been released at a particular site. For example, the soil samples taken within the releases associated with the operation of the HLW tank farm were analyzed for contaminants known to be present in the HLW inside the 11 tanks.

The soil sample results are located in Appendix G and are summarized on a site by site basis in Sections 8 through 26 of this document.

4.2 Perched Groundwater

Perched groundwater zones have been identified to occur in the basalts beneath the ICPP at depths ranging from 30.5 to 42.7 m (100 to 140 ft) bls and 110 to 128 m (360 to 420 ft) bls. Within the upper perched water zone, one perched water body is being monitored beneath the sewage treatment pond, two perched water bodies are being monitored beneath the Tank Farm, one perched water body is being monitored in the vicinity of building CPP-603, and one perched water body is being monitored beneath the percolation ponds. The extent of the lower perched water body(s) is less well defined, being monitored by only three wells in the northern portion of the plant and only one well in the southern portion.

As part of the WAG 3 RI, a complete round of groundwater samples were collected during May and June 1995 from all perched water wells having sufficient water for sample collection. The results from this sampling effort are provided in Table 4-2 and described in the following subsections. The results from previous groundwater sampling efforts have been described in the WAG 3 RI/FS Work Plan (INEL-95/0056, Rev. 2).

4.2.1 Northern Perched Groundwater

Wells that monitor the groundwater quality in the upper perched water zone in the northern ICPP include CPP 33-2, CPP 33-3, CPP 33-4, CPP 37-4, CPP 55-06, MW-2, MW-3, MW-4, MW-5, MW-6, MW-8, MW-10, MW-11, MW-12, MW-18, and MW-20. In addition, well ICPP-Mon-A-024 was installed to monitor the perched water beneath the sewage treatment plan. In addition, well ICPP-Mon-A-024 was installed to monitor the perched water beneath the sewage treatment plant. During the WAG 3 RI, sufficient water was available for the collection of groundwater samples for analysis in all wells except MW-3, MW-8, MW-11, MW-12, and in the 113.5 to 123.5-ft completion zone of MW-18.

4.2.1.1 Chemical Contaminants. The only chemical constituent in the upper perched groundwater zone that was detected above either a Federal primary or secondary maximum contaminant level (MCL) was nitrate. Nitrate/nitrite was detected above the Federal primary MCL of 10 mg/L in wells CPP 33-4, CPP 37-4, CPP 55-06, MW-2, MW-4, MW-5, MW-10, and MW-20 (Figure 4-4). The highest nitrate/nitrite concentrations (35.4 mg/L in well CPP 55-06 and 26.8 mg/L in well MW-10) were measured in the southeastern portion of the perched groundwater body. As shown in Figure 4-4, Nitrate/nitrite concentrations decrease toward the northeastern portion of the perched water body.

4.2.1.2 Radionuclides. The distribution of radionuclide contamination in the upper perched water zones is illustrated by plots of gross alpha and gross beta concentrations (Figures 4-5 and 4-6, respectively). These plots indicate the highest radioactive contamination occurs within the southeastern portion of the perched water body, particularly associated with wells MW-2, MW-5, and CPP 55-06. The maximum gross alpha and gross beta activity 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 groundwater were 137±9 pCi/L and 65,300±600 pCi/L in wells MW-10 and MW-20.

Table 4-2. Water quality results from the perched water wells (May–June 1995).

Well		MW-17	MW-17	MW-18	MW-20	USGS-50	MW-5	MW-5	MW-5	MW-5	USGS-50	CPP 33-4
Date		May-95	May-95	Jun-95	Jun-95	May-95	Oct-95	Oct-95	Oct-95	Oct-95	Duplicate	Duplicate
Sample Depth		190.18 to 195.2	364.8 to 381	407.63 to 414	137.33 to 148.4	384-405	START	MIDDLE	END	MIDDLE	384-405	102.85 to 118.2
Sample ID	Units	31323101	31323301	31323501	31323601	31323801	31323901	31324001	31324101	31324201	31324301	31324401
Field Parameters												
Temperature	(celsius)	17.85	19.96	18.4	15.68	N/A	N/A	N/A	N/A	N/A	N/A	N/A
pH		7.77	9.05	8.81	7.72	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Conductivity	(mmhos)	0.434	0.615	0.53	0.747	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Misc. Inorganics												
Alkalinity	(mg/L)	152	61.2	143	284	129	ND	ND	ND	ND	130	216
Bic Alkaline	(mg/L)	152	55.9	143	284	129	ND	ND	ND	ND	130	216
Carbonate	(mg/L)	2 U	5.4	2 U	2 U	2 U	ND	ND	ND	ND	2 U	2 U
Chloride	(mg/L)	21.5	125	78.6	28.3	66	ND	ND	ND	ND	69.6	81.3
Fluoride	(mg/L)	0.3	0.28	0.21	0.23	0.36	ND	ND	ND	ND	0.35	0.15
Sulfate	(mg/L)	28.1	33.5	58.6	49.3	44.8	ND	ND	ND	ND	44.5	60.1
TKN	(mg/L)	0.1	0.22	1.5 J	0.1 UJ	0.11	ND	ND	ND	ND	0.1 U	0.1 U
Ammonia-N	(mg/L)	0.1	0.1 U	0.1 U	0.1 U	0.1	ND	ND	ND	ND	0.1 U	0.1 U
NO3/NO2-N	(mg-N/L)	4.9	4.6	34.4	12.1	31.3	ND	ND	ND	ND	33.2	12.7
TAL Inorganics												
Aluminum	(ug/L)	68.9 BU	26.8 U	69.7 BU	26.8 U	26.8 U	ND	ND	ND	ND	33.1 BU	26.8 U
Antimony	(ug/L)	1.9 U	6.4 B	2.7 U	1.9 U	1.9 U	ND	ND	ND	ND	1.9 U	1.9 U
Arsenic	(ug/L)	4 U	4 U	3.4 B	4 U	4 U	ND	ND	ND	ND	4 U	4 U
Barium	(ug/L)	72.1 B	136 B	86.8 B	194 B	183 B	ND	ND	ND	ND	165 BU	284
Beryllium	(ug/L)	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	ND	ND	ND	ND	0.1 U	0.1 U
Cadmium	(ug/L)	0.4 U	0.4 U	0.3 U	0.4 U	0.4 U	ND	ND	ND	ND	0.4 U	0.4 U
Calcium	(ug/L)	40600	22100	49100	87700	73300	ND	ND	ND	ND	67100	103000
Chromium	(ug/L)	4.1 U	4.1 U	11.1	4.1 U	4.3 B	ND	ND	ND	ND	3.2 B	4.1 U
Cobalt	(ug/L)	0.5 U	0.5 U	0.94 B	0.5 U	0.5 U	ND	ND	ND	ND	1.2 B	0.52 B
Copper	(ug/L)	2.7 BJ	14.9 B	2.2 U	2.1 B	2.6 B	ND	ND	ND	ND	7.4 B	1.3 UJ
Iron	(ug/L)	173	21.5 U	30 B	21.5 U	21.5 U	ND	ND	ND	ND	21.5 U	21.5 U
Lead	(ug/L)	2 U	2 U	2 U	2 U	2 U	ND	ND	ND	ND	2 U	2 U
Magnesium	(ug/L)	10400	9250	18900	23400	20000	ND	ND	ND	ND	18400	27000
Manganese	(ug/L)	51.7	3.7 B	1.3 BU	0.8 U	1.8 B	ND	ND	ND	ND	2.2 B	0.8 U
Mercury	(ug/L)	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	ND	ND	ND	ND	0.28	0.1 U
Nickel	(ug/L)	3.4 U	3.4 U	2.5 B	3.4 U	3.4 U	ND	ND	ND	ND	3.8 B	3.4 U
Potassium	(ug/L)	5160 EJ	24500	8060 EJ	5310	6350	ND	ND	ND	ND	5750	3930 BEJ
Selenium	(ug/L)	3.2 BU	2.7 U	2.8 U	2.7 U	2.7 U	ND	ND	ND	ND	3.4 B	5.4 BU
Silver	(ug/L)	0.6 NUJ	0.6 U	1.4 B	0.6 U	0.6 U	ND	ND	ND	ND	0.6 U	0.6 NUJ
Sodium	(ug/L)	33300	75600	75200 EJ	47200	66200	ND	ND	ND	ND	59400	30300
Thallium	(ug/L)	4.6 U	4.6 U	3.2 U	4.6 U	4.6 U	ND	ND	ND	ND	4.6 U	4.6 U
Vanadium	(ug/L)	1.5 BJ	6.7 B	3.4 BU	3.3 BU	6.5 B	ND	ND	ND	ND	6 B	1.1 BJ
Zinc	(ug/L)	3.4 BU	4.2 BU	27.1 EJ	12.6 BU	10.8 BU	ND	ND	ND	ND	10.8 BU	13.7 B
Zirconium	(ug/L)	ND	31.2 U	ND	31.2 U	31.2 U	ND	ND	ND	ND	31.2 U	ND
Radionuclides												
Gross Alpha	(pCi/L)	2.3±1	0±1.1 U	3.2±1.7 U	16±19 U	0.3±1.7 U	ND	ND	ND	ND	2.6±1.8 U	8.4±2.6
Gross Beta	(pCi/L)	11±1	45±2	756±7	65300±600	456±6	ND	ND	ND	ND	479±6	491±7
Tritium	(pCi/L)	25700±400	25100±400	73000±700	1150±180	61900±700	ND	ND	ND	ND	62800±700	971±143
Sr-90	(pCi/L)	1.6±1.4 U	0.7±0.4 U	207±2	25800±30	151±2	76700±400	98400±500	104000±500	101000±500	159±2	173±1
Pu-238	(pCi/L)	ND	ND	ND	0±0.12 U	ND	ND	ND	ND	ND	ND	0.06±0.07 U
Pu-239/240	(pCi/L)	ND	ND	ND	0.07±0.08 U	ND	ND	ND	ND	ND	ND	0±0.07 U
Am-241	(pCi/L)	ND	ND	ND	0±0.06 U	ND	ND	ND	ND	ND	ND	0±0.04 U
Np-237	(pCi/L)	ND	ND	ND	0.02±0.14 U	ND	ND	ND	ND	ND	ND	0±0.11 U
I-129	(pCi/L)	0±0.4 U	0±0.3 U	0±0.3 U	0±0.3 U	0±0.3 U	ND	ND	ND	ND	0±0.2 U	0±0.3 U
Tc-99	(pCi/L)	6.4±0.6	5.9±0.6	736±6 J	18.3±0.5	63±1 J	ND	ND	ND	ND	75±1	0.5±0.5 U
U-234	(pCi/L)	ND	ND	ND	3.3±0.5 J	ND	ND	ND	ND	ND	ND	3.2±0.6
U-235	(pCi/L)	ND	ND	ND	0±0.2 U	ND	ND	ND	ND	ND	ND	0±0.2 U
U-238	(pCi/L)	ND	ND	ND	2.7±0.5 J	ND	ND	ND	ND	ND	ND	2.8±0.5

NA - not analyzed.
ND - not detected.
NS - not sampled.
U - analyzed, not detected.
B - contaminant in associated blank.
R - concentration reported is unusable.
J - estimated concentration.

Table 4-2. (Continued).

Well		CPP 33-2	CPP 33-4	CPP 37-4	CPP 55-06	MW-1	MW-2	MW-4	MW-5	MW-6	MW-10	MW-15
Date		May-95	May-95	May-95	Jun-95	May-95	Jun-95	Jun-95	Jun-95	May-95	Jun-95	Jun-95
Sample Depth		97.5 to 105.8	102.85 to 118.2	103.8 to 109.9	106.25 to 113.1	322.28 to 336	107.49 to 112	105.85 to 110.6	112.5 to 126.5	122.7 to 137	148.12 to 151	122.85 to 131.3
Sample ID	Units	31320201	31320401	31320501	31320601	31320701	31320901	31321201	31321401	31321501	31322101	31322901
Field Parameters												
Temperature	(celsius)	19.07	14.11	16.02	16.4	15.24	19.9	10.9	24.8	18.69	18.4	21.3
pH		7.15	7.19	7.72	7.85	7.59	7.5	7.92	7.57	7.19	7.95	7.84
Conductivity	(mciemens)	0.44	0.766	0.692	1.28	0.993	1.11	0.91	1	0.572	0.9	0.83
Misc. Inorganics												
Alkalinity	(mg/L)	168	217	214	229	165	223	246	293	180	217	178
Bic Alkaline	(mg/L)	168	217	214	229	165	223	246	293	180	217	178
Carbonate	(mg/L)	2 U	2	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U
Chloride	(mg/L)	27.4	81.2	32.6	52.5	63.4	83.7	45.8	37.6	55.7	54.4	24.1
Fluoride	(mg/L)	0.29	0.16	0.27	0.21	0.22	0.24	0.25	0.28	0.21	0.24	0.26
Sulfate	(mg/L)	27.7	61.8	48.9	39.8	26.4	35.5	42.6	27.9	26.2	61.4	31.9
TKN	(mg/L)	0.1	0.1 U	0.1 U	0.1 U	0.1 UJ	0.1 U	0.1 U	0.1 U	0.1 U	0.1 UJ	0.1 U
Ammonia-N	(mg/L)	0.1 U	0.1 U	0.1 U	0.1 U	0.1 UJ	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
NO3/NO2-N	(mg-N/L)	3.3	13	17.7	35.4	69.6	15.7	10.9	19	4.6	26.8	14.7
TAL Inorganics												
Aluminum	(ug/L)	26.8 U	26.8 U	45.7 BU	50.5 BU	26.8 U	47 BU	58.2 BU	65.9 BU	79.6 BU	44.8 BU	45.8 BU
Antimony	(ug/L)	1.9 U	1.9 U	2.8 B	2 B	3.4 B	1.9 U	1.9 U	3.4 B	1.9 U	2.7 U	1.9 U
Arsenic	(ug/L)	4 U	4 U	4 U	4.9 B	4 U	4 U	4.2 B	4 U	4 U	2.4 U	5.1 BU
Barium	(ug/L)	139 B	138 B	220	289	253	328	227	394	230	165 B	71.4 B
Beryllium	(ug/L)	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.12	0.1 U
Cadmium	(ug/L)	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.3 U	0.4 U
Calcium	(ug/L)	56200	51000	72200	94100	114000	84400	85700	94900	75800	97100	62700
Chromium	(ug/L)	5.7 B	4.1 U	4.1 U	5 B	4.1 U	4.8 B	5.4 B	4.1 U	4.1 U	1.6 U	4.1 U
Cobalt	(ug/L)	0.5 U	0.5 U	1.3 B	0.9 B	0.6 B	0.63 B	0.66 B	0.64 B	0.57 B	0.6 U	0.5 U
Copper	(ug/L)	1.3 U	1.3 U	1.3 B	1.3 U	2 B	1.3 U	2.7 B	1.7 B	1.3 UJ	2.2 U	1.3 U
Iron	(ug/L)	21.5 U	21.5 U	21.5 U	21.5 U	21.5 U	21.5 U	33.8 B	62.7 B	21.5 U	5.3 BU	21.5 U
Lead	(ug/L)	2 U	2 U	2 U	2 UJ	2 U	2 UJ	2 UJ	2 UJ	2 U	2 U	2 BJ
Magnesium	(ug/L)	14500	13700	23800	27700	34000	22900	24300	29200	17900	27900	15200
Manganese	(ug/L)	1.5 B	0.85 B	2.2 B	2.2 B	18.9	0.8 U	1.4	186	1.2 B	1.1 B	1.7 B
Mercury	(ug/L)	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Nickel	(ug/L)	3.4 U	3.4 U	3.9 B	7.5 B	3.4 U	3.4 U	3.4 U	3.4 U	3.4 U	3 BU	3.4 U
Potassium	(ug/L)	2910 BEJ	1910 BEJ	3960 B	5240	6220 B	5340	4490 B	5300	3380 BEJ	6510 EJ	3980 B
Selenium	(ug/L)	2.7 U	2.7 U	4 B	2.7 U	2.7 U	2.7 U	2.7 U	2.7 U	2.7 U	3 B	3 B
Silver	(ug/L)	0.6 UN	0.77 BNJ	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 NUJ	0.8 UN	0.6 U
Sodium	(ug/L)	21900	14300	40200	48000	35400	59000	38500	41700	19600	44400 EJ	37900
Thallium	(ug/L)	5 B	4.6 U	4.6 U	4.6 U	4.6 U	4.6 U	4.6 U	4.6 U	4.6 U	3.3 B	4.6 U
Vanadium	(ug/L)	3 BU	1.4 BU	4.1 B	2.6 B	2.2 BU	2.8 B	2.7 B	2.8 B	2.4 BJ	1.9 B	5.2 B
Zinc	(ug/L)	69.3 EJ	7.6 BEUJ	7.9 BU	2.6 B	29.5	3 B	30.2	4.1 B	16.7 B	28.1 EJ	4.3 B
Zirconium	(ug/L)	31.3 U	31.3 U	31.2 U	31.2 U	31.2 U	31.2 U	31.2 U	31.2 U	ND	11.6 U	31.2 U
Radionuclides												
Gross Alpha	(pCi/L)	3±1.4	2.1±1.8 U	3.8±1.6	92±9	3±2.1 U	1140±220	23±4	265±108	0.3±1.4 U	137±9 J	25±4
Gross Beta	(pCi/L)	317±4	505±6	57±2	139000±200	26±3	589000±2600	23400±40	207000±1600	5.2±1.7	48800±100	44700±100
Tritium	(pCi/L)	2540±170	839±134	1680±190	621±113	24780±400	6380±260	382±106 U	15300±400	197±123 U	38000±500	3630±176
Sr-90	(pCi/L)	102±1	191±2	5±0.5	66300±600	4.5±0.4	320000±3000	11900±200	104000±1000	0.7±0.3	17200±200	22100±200
Pu-238	(pCi/L)	ND	ND	ND	0.17±0.11 U	ND	0±0.4	0.07±0.08 U	0±0.01	ND	0.05±0.06 U	0.03±0.07 U
Pu-239/240	(pCi/L)	ND	ND	ND	0.02±0.06 U	ND	0±0.5	0±0.04 U	0±0.5	ND	0±0.04 U	0.01±0.08 U
Am-241	(pCi/L)	ND	ND	ND	0±0.06 U	ND	0.16±0.1	0±0.06 U	0.03±0.08	ND	ND	0.11±0.1 U
Np-237	(pCi/L)	ND	ND	ND	0±0.14 U	ND	0±0.9 U	0±0.09 U	0±0.14 U	ND	0±0.14 U	0±0.13 U
I-129	(pCi/L)	0±0.5 U	0±0.3	0±0.2 U	0±1.2 U	0±0.3 U	0.5±0.3 U	0±1.3 U	0.5±0.3 U	0±0.3 U	0±0.6 U	0±1.4 U
Tc-99	(pCi/L)	3.1±0.7	0.4±0.6	3.3±0.6	73±1 J	0.3±0.3 UJ	77±2 J	12.9±0.7	105±2 J	0±0.5 U	127±2	23.7±0.6 J
U-234	(pCi/L)	ND	ND	ND	3.5±0.6 J	ND	3.7±0.6 J	4.1±0.6 J	1.9±0.4 J	ND	4.6±0.7	11.8±1
U-235	(pCi/L)	ND	ND	ND	0±0.2 U	ND	0±0.2 U	0.1±0.2 U	0±0.2 U	ND	0±0.2 U	0.2±0.3 U
U-238	(pCi/L)	ND	ND	ND	2.1±0.5 J	ND	1.6±0.4 J	1.9±0.4 J	0.8±0.3 J	ND	2.2±0.5	2.3±0.5 J

NA - not analyzed.
ND - not detected.
NS - not sampled.
U - analyzed, not detected.
B - contaminant in associated blank.
R - concentration reported is unusable.
J - estimated concentration.

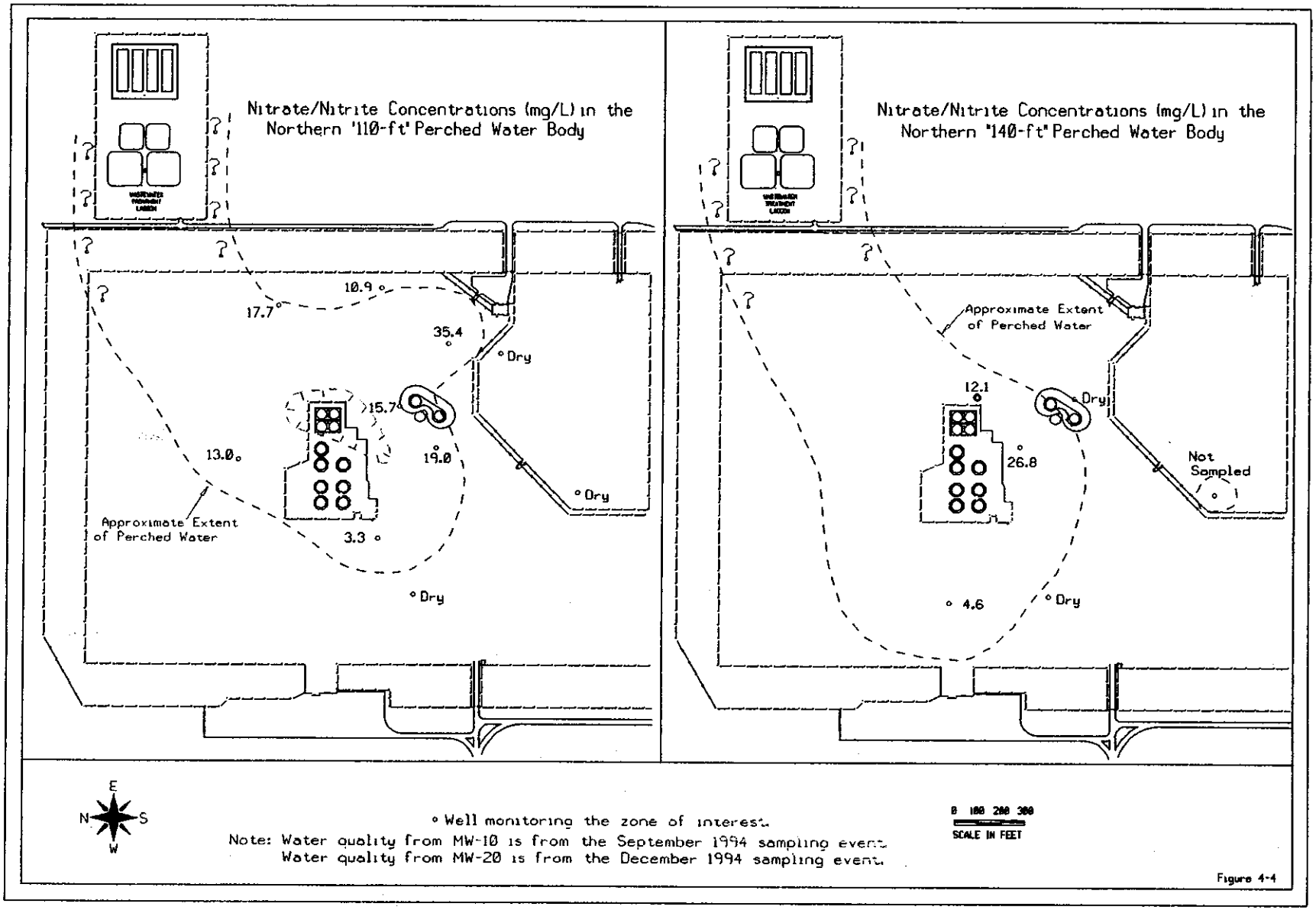


Figure 4-4. Nitrate/Nitrite concentrations in the upper perched water body (May–June 1995).

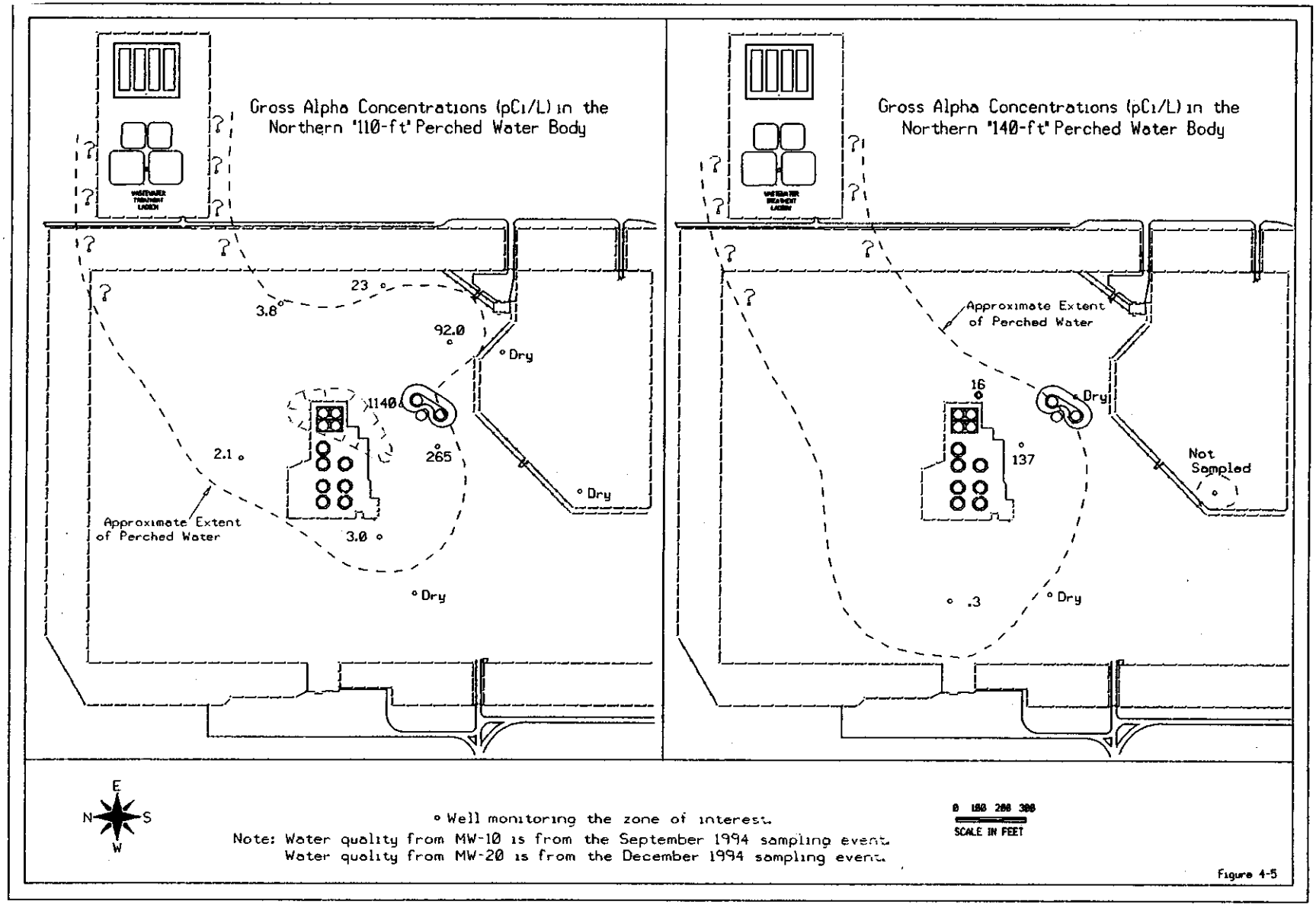


Figure 4-5. Gross alpha activities in the upper perched groundwater (May–June 1995).

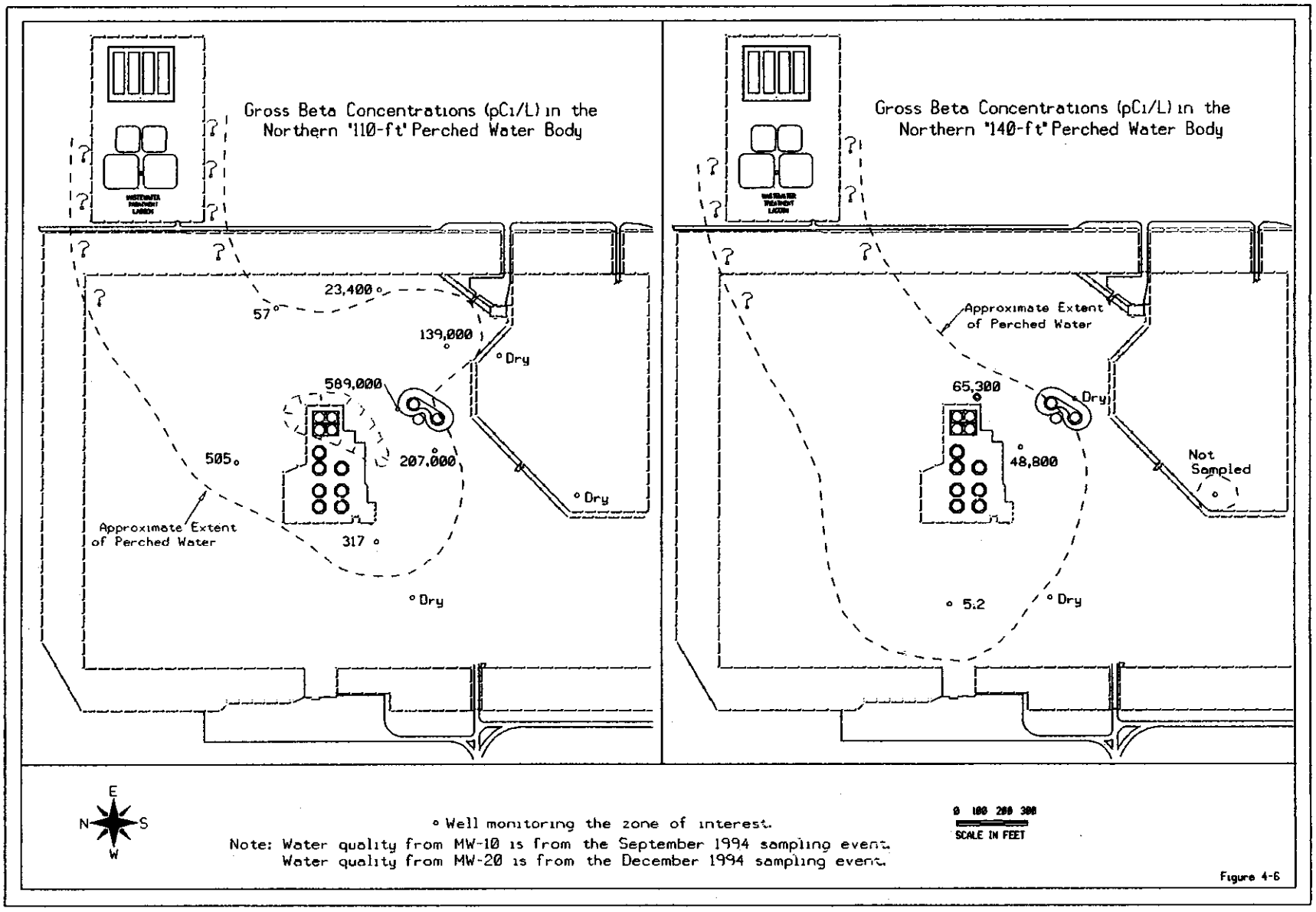


Figure 4-6. Gross beta activities in the upper perched groundwater (May–June 1995).

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, however, none of the water samples exceeded the Federal primary MCL of 20,000 pCi/L. The low H-3 concentrations in the upper perched water zone significantly contrast the waste stream that was directed to the ICPP disposal well where the vast majority of the associated radioactivity consisted of H-3.

Radioactivity from fission products is due almost equally from Sr-90 and two Cs isotopes (Cs-134 and Cs-137) with minor contributions from several other intermediate term radionuclides. Cesium isotopes have not been detected in the groundwater, probably as a result of the high sorption capacity of Cs, which makes it relatively immobile in the environment. Strontium-90 was detected in all wells completed in the upper perched water zone with the distribution shown in Figure 4-7. The maximum Sr-90 concentration detected in the upper perched water zone 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. This radionuclide has been detected in all wells except CPP 33-4 and MW-6 with the distribution provided in Figure 4-8. The maximum Tc-99 concentration detected in the upper perched groundwater zone was 105±2 pCi/L in well MW-5.

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 [i.e., 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.

4.2.2 Southern Perched Groundwater

Two perched water bodies have been identified in the southern ICPP. 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 waste water to the percolation ponds.

Wells that monitor the groundwater quality in the upper perched groundwater zone around CPP-603 include MW-7, MW-9, MW-13, MW-14, MW-15, MW-16, and MW-17. Of these seven wells, wells MW-7, MW-9, MW-15, and MW-17 have historically had sufficient water for sample collection. During the WAG 3 RI, sufficient water was only available in wells MW-15 and MW-17.

Water samples were collected from wells MW-15 and MW-17 and analyzed for miscellaneous inorganics, target analyte list (TAL) inorganics, and radionuclides. From the inorganic analysis, only nitrate/nitrite was detected at a concentration exceeding either a Federal primary or secondary MCL. The nitrate/nitrite concentration in well MW-15 was 14.7 mg/L, compared to the Federal primary MCL of 10 mg/L. The nitrate/nitrite concentration in well MW-17 was 4.9 mg/L.

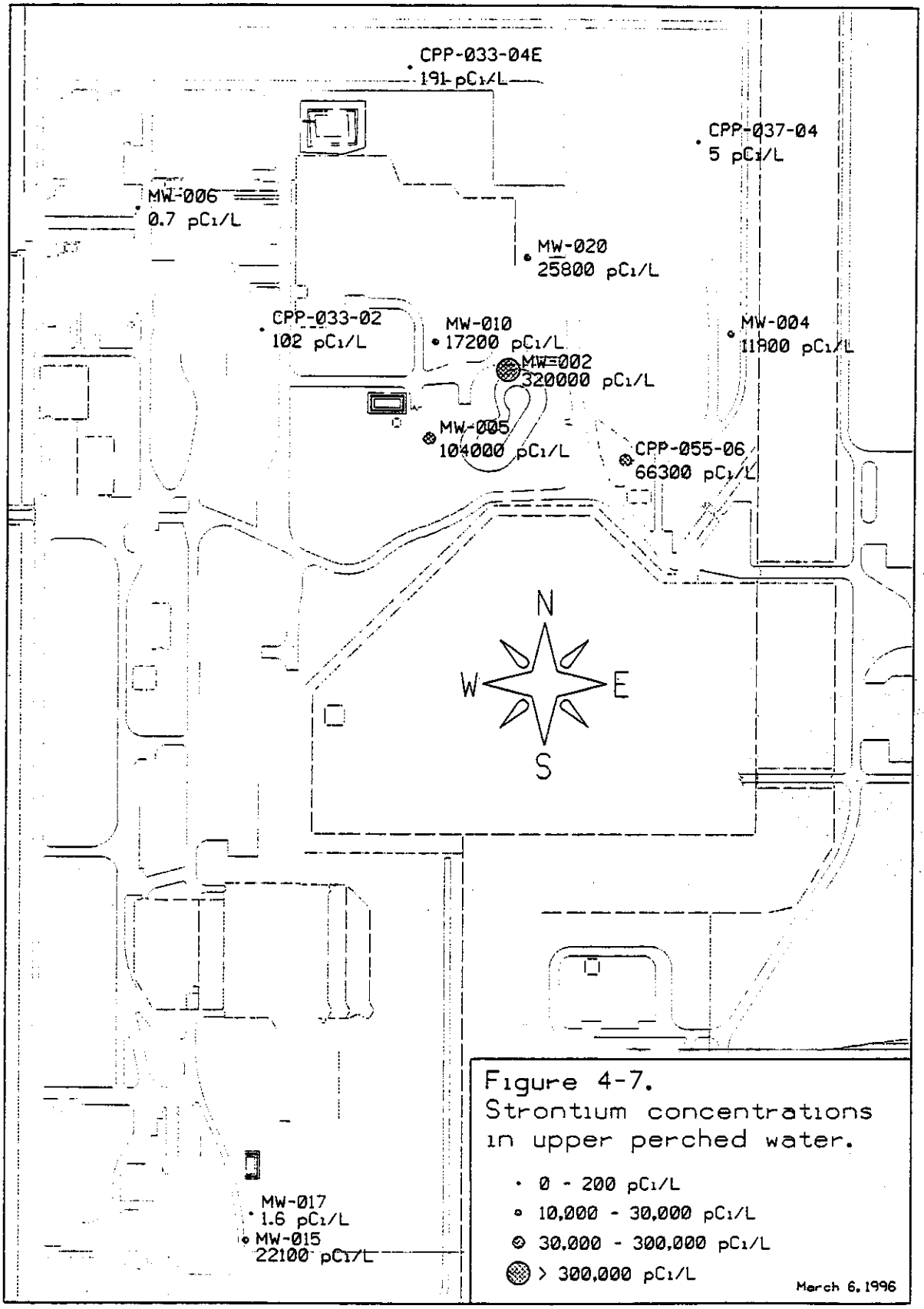


Figure 4-7. Sr-90 concentrations in the upper perched groundwater (May–June 1995).

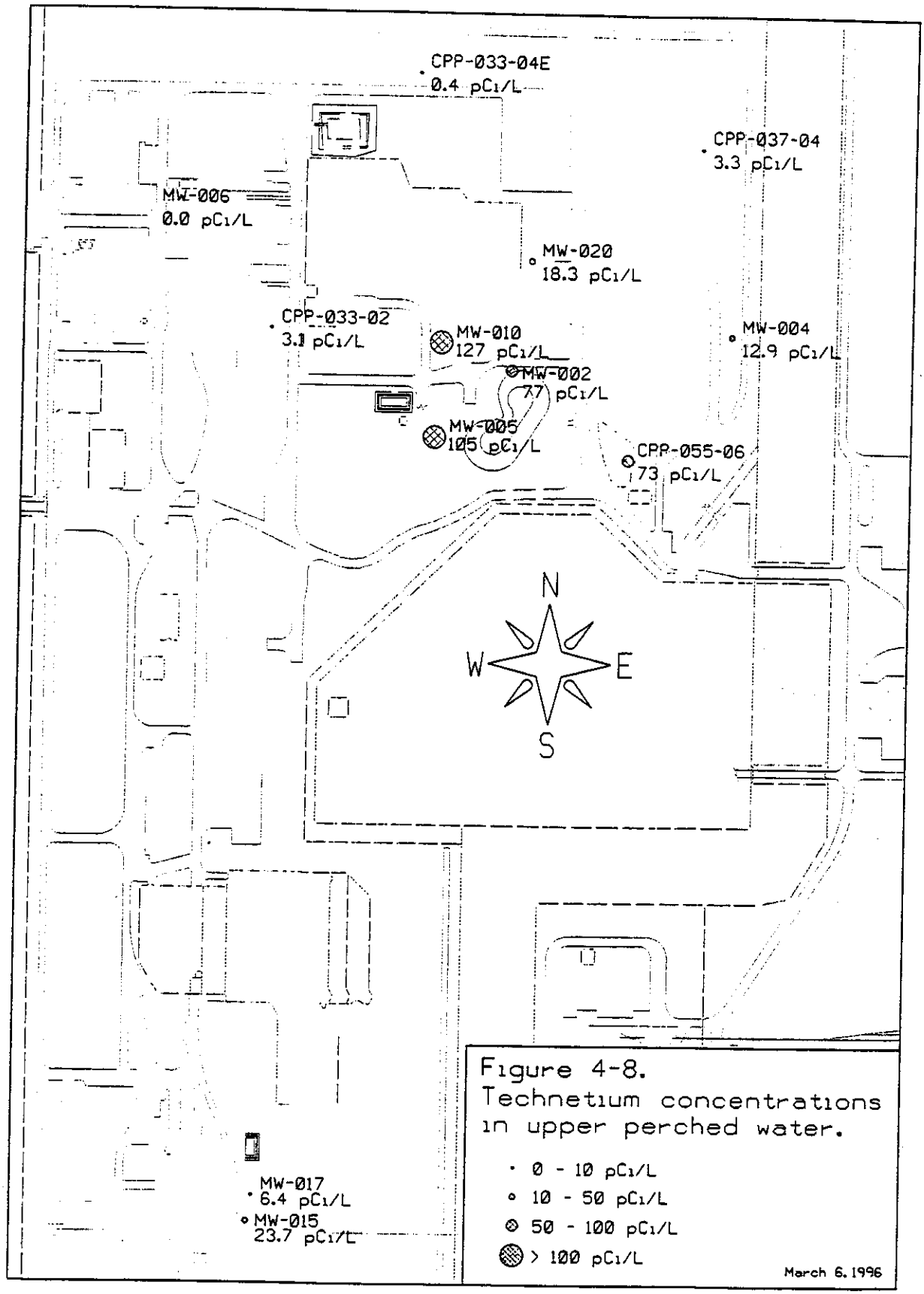


Figure 4-8. Tc-99 concentrations in the upper perched groundwater (May–June 1995).

The radionuclides detected in the groundwater from both wells 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.

4.2.3 Percolation Pond Perched Groundwater

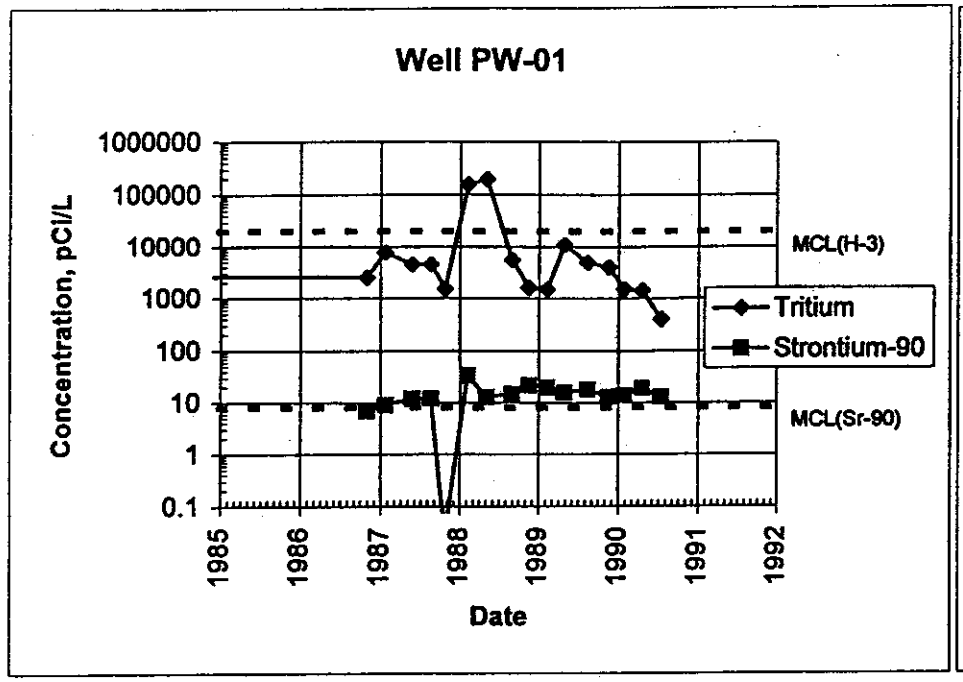
Six wells, designated as PW-1 through PW-6, were installed in 1986 to monitor the upper-most perched groundwater body associated with waste water discharge to the percolation ponds. These wells have been monitored by the USGS since 1987. Wells PW-1, PW-2, PW-4, and PW-5 have been sampled on a quarterly basis as part of the ICPP groundwater monitoring program since 1991 (INEL-95/0056, Rev. 2). They were not sampled however, as part of the OU 3-13 RI.

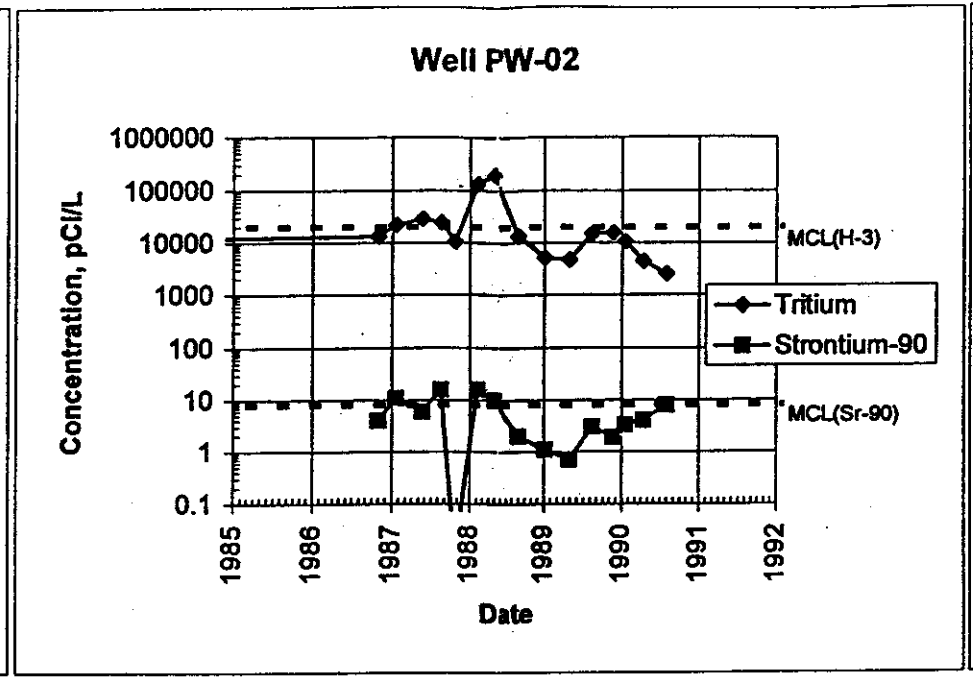
Since the waste stream to the percolation ponds is virtually the same as the waste stream formerly sent to the disposal well (with somewhat better contaminant removal than in the past), the contamination in these wells should not differ significantly from that observed downgradient from the disposal well. As would be expected, 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 (Figure 4-9).

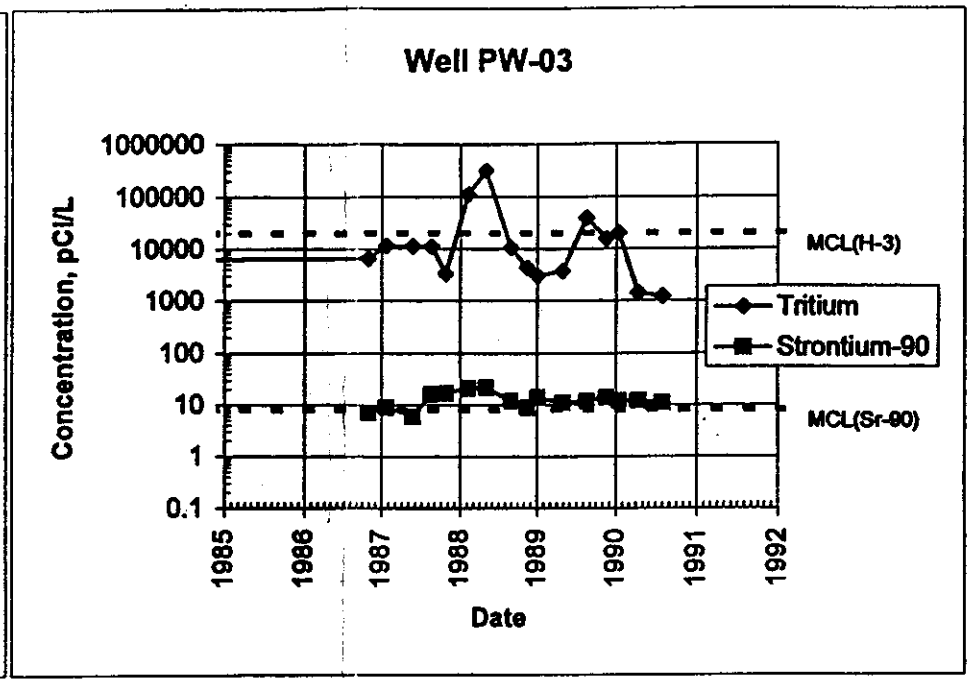
According to the results from the ICPP groundwater monitoring program, the constituents detected in the upper perched water zone that exceeded either a Federal primary or secondary MCL include chloride, nitrate, manganese, iron, and Sr-90. Chloride concentrations generally exceeded the Federal secondary MCL of 250 mg/L in all wells. Nitrate concentrations exceeded the Federal primary MCL of 10 mg/L in a single sample collected from well PW-4 (14.1J mg/L from the October 1993 sample). Manganese concentrations exceeded the Federal secondary MCL of 50 μg/L in two samples collected from well PW-2 (165 μg/L from the October 1991 sample and 60.2 μg/L from the August 1993 sample). Iron concentrations exceeded the Federal secondary MCL of 300 μg/L in one sample collected from PW-1 (324J μg/L from the April 1993 sample) and the first three samples collected from PW-2 (i.e., prior to September 1992). Strontium-90 concentrations exceeded the Federal primary MCL of 8 pCi/L in samples collected from PW-1, PW-4, and PW-5 with the maximum concentration measured during October 1991 sampling event at PW-1 (15.7 pCi/L).

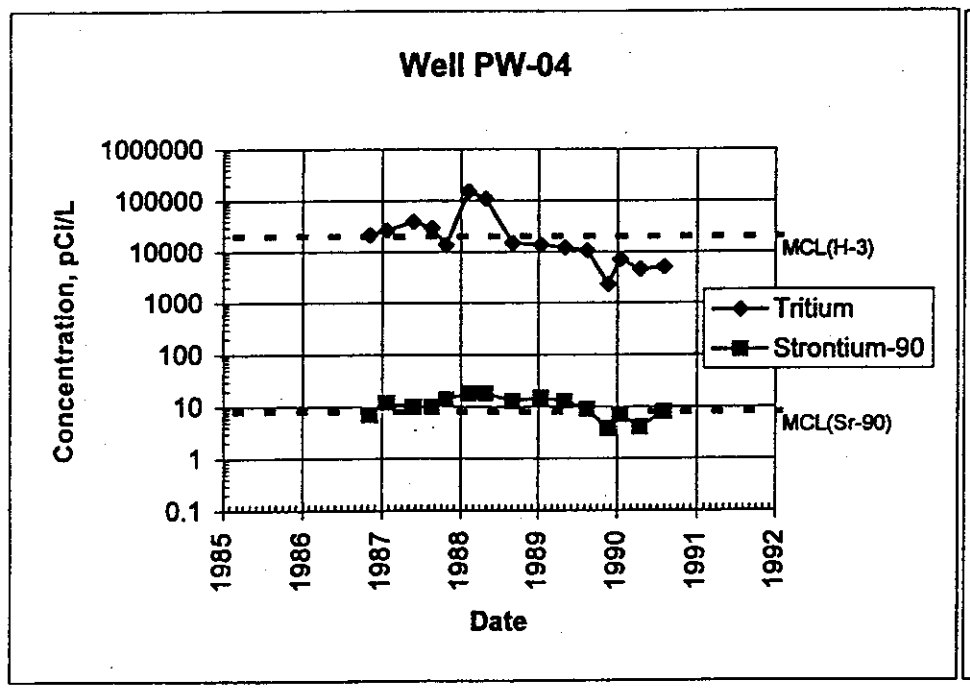
4.2.4 Deep Perched Groundwater

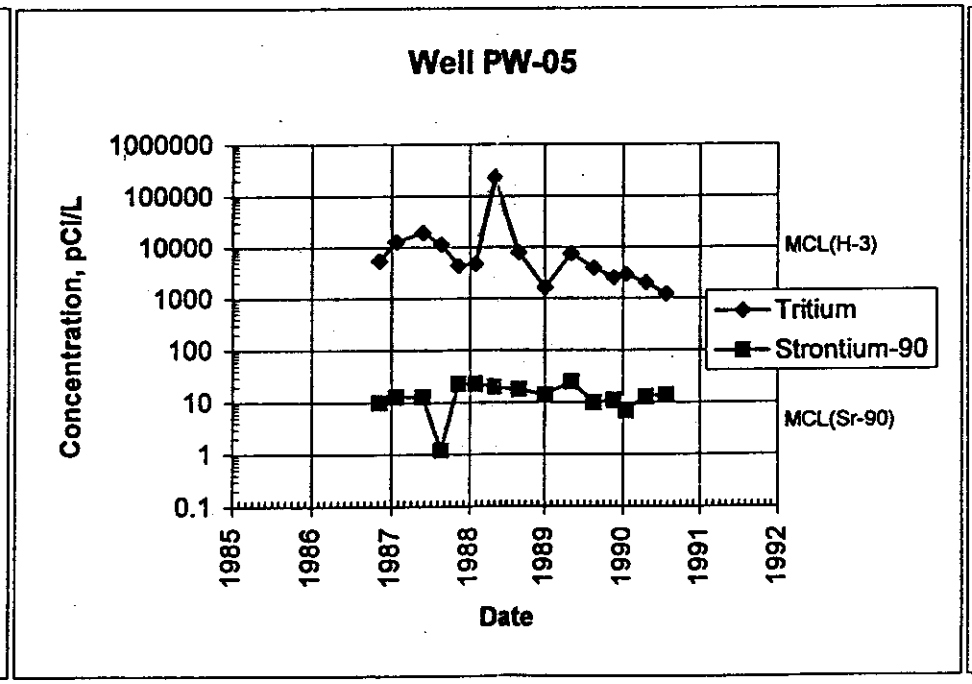
Four wells at the ICPP monitor deeper perched groundwater zones. These wells include MW-1, MW-17, MW-18, and USGS-50 that are completed in water-bearing zones occurring at depths between 99.4 to 102.4 m (326 to 336 ft), 109.7 to 116.1 m (360 to 381 ft), 120.1 to 126.2 m (394 to 414 ft), and 109.7 to 123.4 m (360 to 405 ft), respectively. Historically, two rounds of groundwater samples have been collected from MW-1, one round of groundwater samples have 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 (INEL-95/0056, Rev. 2).











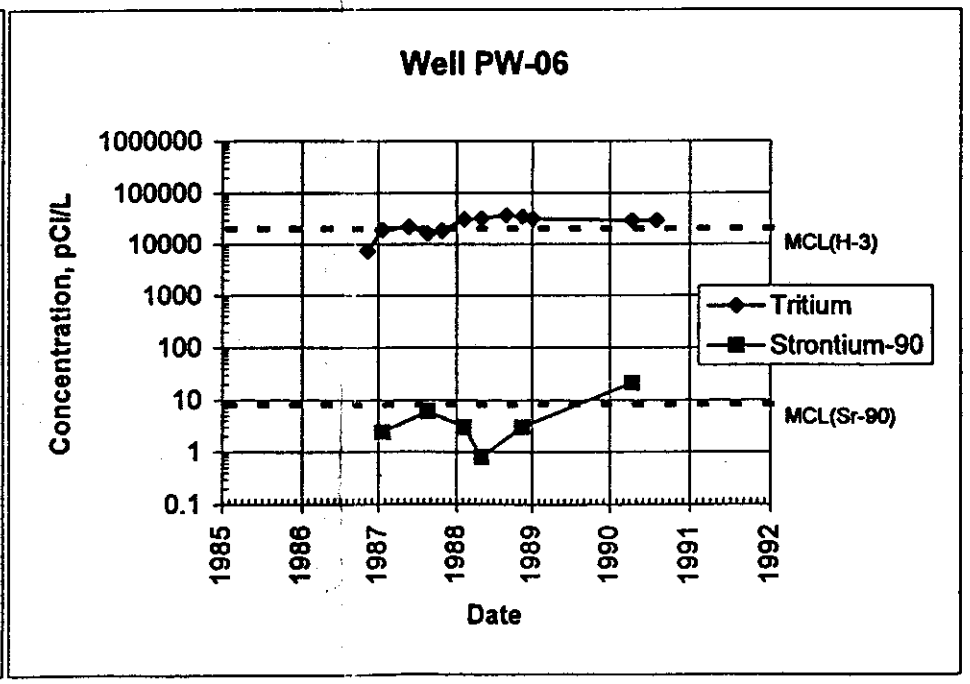


Figure 4-9. Historical H-3 and Sr-90 concentrations in the PW-series wells (USGS records).

Well MW-1 is located in the northern ICPP along the southwestern edge of the deeper perched water body. The only chemical contaminant to exceed either a Federal primary or secondary MCL was nitrate/nitrite. Nitrate/nitrite was detected above the Federal primary MCL of 10 mg/L 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 from a historical release where the contaminants have moved through the system or waste water disposal to the ICPP injection well.

Well MW-18 is completed in the deeper perched water zone near the eastern boundary of the ICPP. 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 groundwater beneath the ICPP.

USGS-50 was originally intended to be completed in the aquifer, but was ultimately drilled to a total depth of 123 m (405 ft) to monitor a deep perched water zone. This well is located in the north central portion of the facility, to the south of the northern perched water zone and upgradient from the former ICPP disposal well. According to the historical water quality, the highest concentrations of H-3 and Sr-90 occurred in 1969 and 1970 (Figure 4-10). These elevated concentrations were attributed to the failure of the ICPP disposal well where the waste water was injected into the vadose zone rather than directly to the aquifer. The relationship between the ICPP disposal well discharge and the water level and H-3 concentrations in well USGS-50 is shown in Figure 4-11. Based on the response observed in well USGS-50 and the ICPP disposal well records, it appears the well failed in mid-1967 and allowed approximately 3.41×10^9 L (9.0×10^8 gal.) of waste water to be injected into the basalt above the 69-m (226-ft) plug (Robertson et al., 1974). The ICPP disposal well was repaired by early 1971. It again failed in the 1970s and was repaired in 1982.

Since 1970, H-3 and Sr-90 concentrations have varied little between sampling events, indicating an overall slight decrease with time. Two periods of slight increase are noted with the first period occurring from the late 1970s until 1982 and the second period from late 1986 to early 1988. The first period of increase (from approximately 1978 to 1982) was probably the result of the ICPP disposal well failing and injecting waste water directly into the vadose zone. It is uncertain exactly when the ICPP disposal well failed the second time, however, it was reportedly repaired by 1982. The second period of increase, from late 1986 to early 1988, is after the ICPP disposal well was taken out of service. The increase in Sr-90 concentrations during this period suggests either (1) a local, post-disposal well source or (2) a delay in the migration of contamination from a near surface source. It should also be noted water from overlying perched water has been observed leaking into the wellbore though the annular space. This mixing of water from two perched water zones places additional uncertainty on the representativeness of the water quality from USGS-50. The leaky borehole annulus was repaired during the FY-94 field season.

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

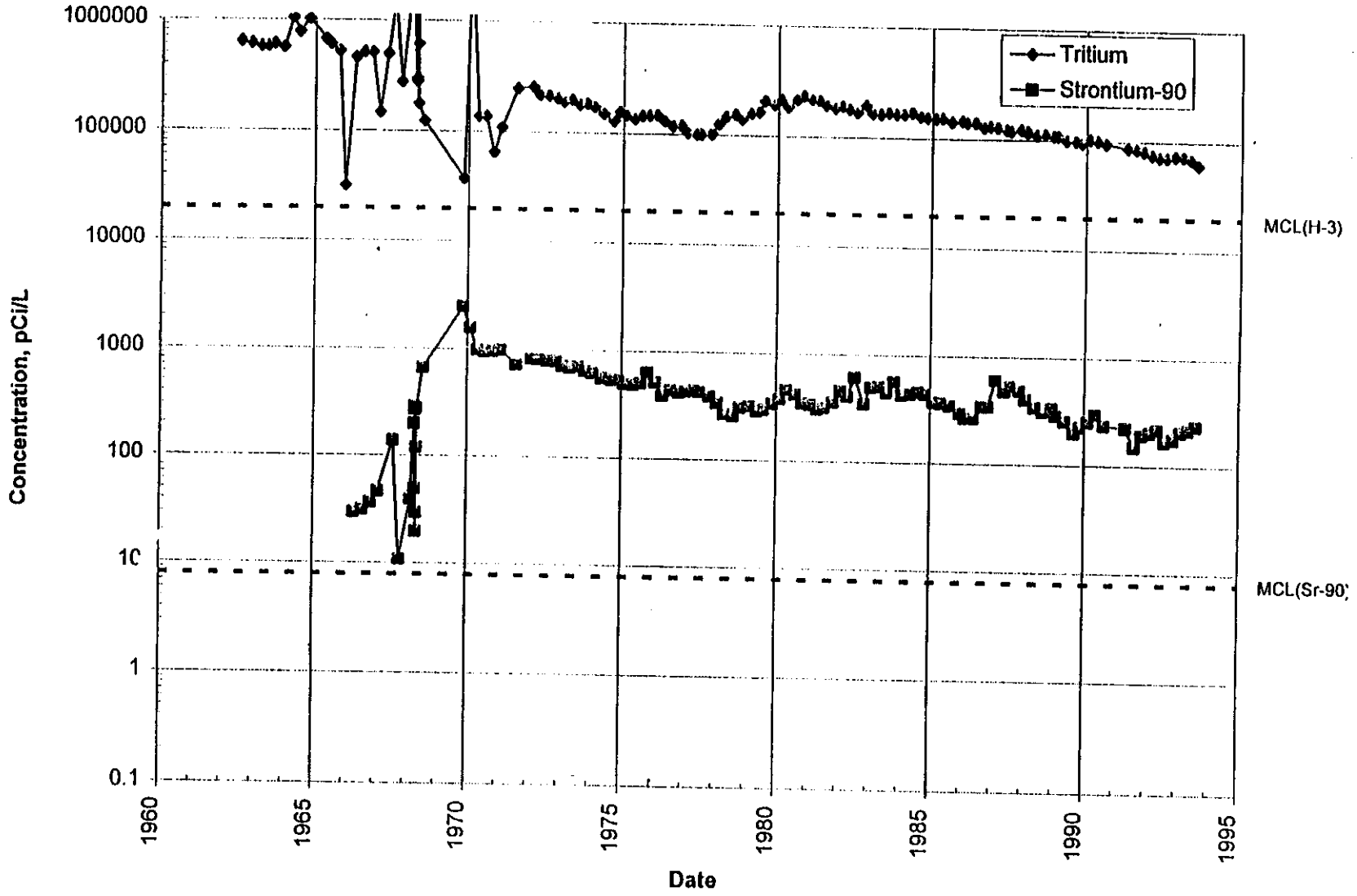


Figure 4-10. Historical H-3 and Sr-90 concentrations in well USGS-50 (USGS records).

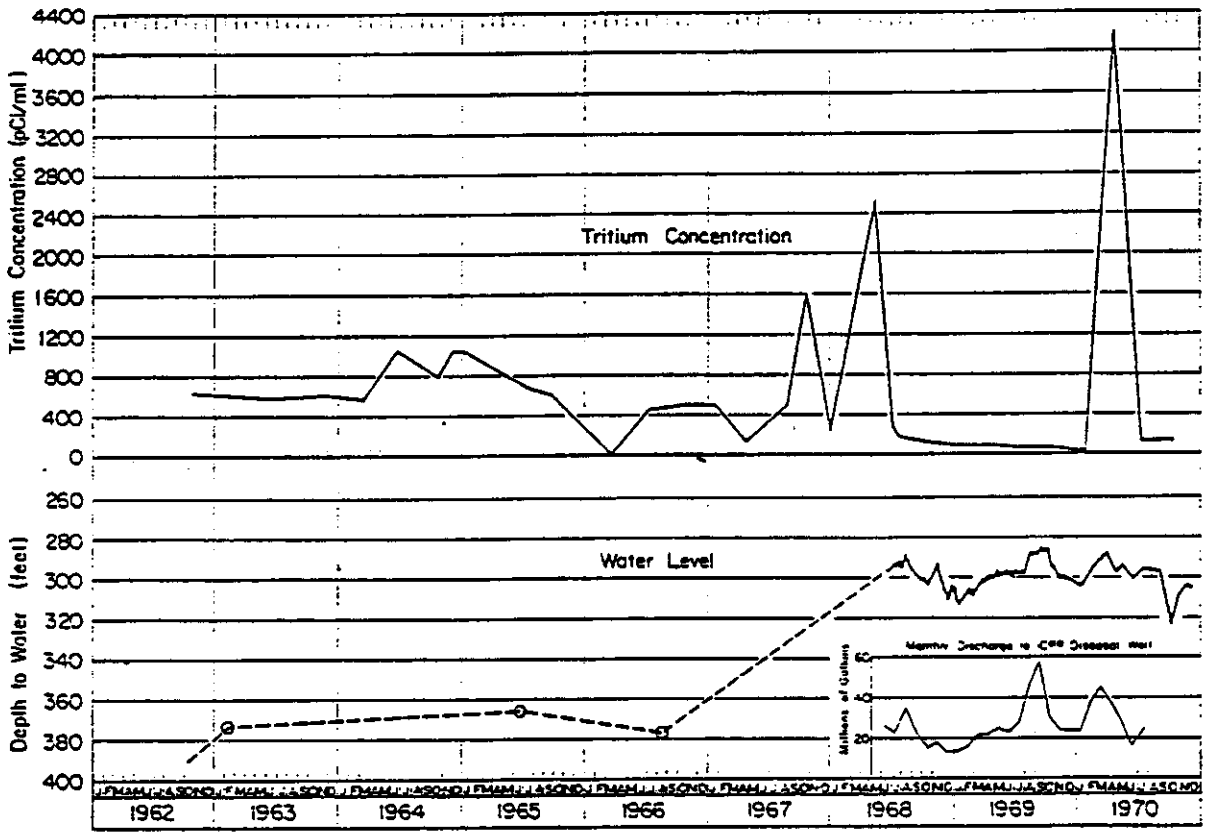


Figure 4-11. Relationship between discharge to the ICPP injection well and water level and H-3 concentrations in USGS-50 (Robertson et al., 1974).

groundwater 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 ICPP. 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) bls, a middle zone from 80.4 to 83.5 m (263.8 to 273.8 ft) bls, and a lower zone from 110 to 116 m (360 to 381 ft) bls. During the May 1995 sampling event, water was only present in the upper and lower zones. None of the chemical constituents detected in the groundwater exceeded either a Federal primary or secondary MCL. Only two radionuclides (H-3 and Tc-99) were detected in groundwater 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.

4.2.5 Sedimentary Interbed Results

Twelve perched water wells were drilled and installed in 1993 and 1994 during the perched water investigation at the ICPP. Sedimentary interbed samples were collected and analyzed. The results of this analysis are summarized in Table 4-3. A review of the data indicates a large presence of gross beta activity at the MW-2 location, most of which is due to Sr-90. This confirms that Sr-90 has migrated to the 110 ft interbed from a number of possible sources that include the release areas within the tank farm or possibly from the old calcine bin storage located next to MW-2.

4.3 Snake River Plain Aquifer

The water quality in the SRPA at and downgradient from the ICPP has been adversely impacted due to past facility operations, primarily related to the disposal of wastes through the ICPP injection well. This well was the primary source for waste disposal from 1952 through February 1984 and used intermittently for emergency situations until 1986. It has been estimated a total of 22,000 Ci of radioactive contaminants have been released in 4.2×10^{10} L (1.1×10^{10} gal.) of water (WINCO, 1994). The vast majority of radioactivity is being attributed to H-3 (approximately 96%) with minor components of Am-241, Tc-99, Sr-90, Cs-137, Co-60, iodine (I)-129, and Pu. During the last 2 yrs of operation (1984 to 1986) when it was only used for emergency situations, the injection well discharged 0.002 Ci in 15.2×10^6 L (4×10^6 gal.) of water. A discussion of the waste discharge to the ICPP injection well is provided in Section 4.1.1.

Since the 1950's, the USGS has installed 33 monitoring wells around the ICPP to characterize the occurrence, movement, and quality of the water in the SRPA. The radioactive and chemical character of the water in the SRPA is determined from analyses of water samples collected as part of a comprehensive sampling program to identify contaminant concentrations and define the pattern of waste migration in the aquifer (Orr and Cecil, 1991). This sampling program has been in place since the early 1960s and provides an excellent database to evaluate the impact of facility operations on the SRPA. The location of the wells completed in the SRPA and the frequency of groundwater sample collection by the USGS are provided in Figure 4-12.

Table 4-3. Summary of radiological results from sedimentary interbed samples at the ICPP (pCi/g).

Sample Number	Well	Depth(ft)	Gross Alpha	Gross Beta	Am-241	Ce-144	Co-60	Cs-134	Cs-137	Eu-154	EU-155
3PG10101BG	MW-1	231-232.5	13 ± 3	23 ± 2	ND	ND	ND	ND	ND	ND	ND
3PG10201BG	MW-1	375-378.1	13 ± 3	26 ± 3	ND	ND	ND	ND	ND	ND	ND
3PG10501BG	MW-2	111.6-112	140 ± 10	76000 ± 100	.09 ± .07	ND	ND	ND	ND	ND	ND
3PG10301BG	MW-2	94.2-94.5	26 ± 4	4300 ± 20	.06 ± .06	ND	ND	ND	ND	ND	ND
3PG10401BG	MW-2	109-110.5	520 ± 15	74000 ± 100	.06 ± .06	ND	ND	ND	ND	ND	ND
3PG10701BG	MW-3	118-118.3	15 ± 3	27 ± 3	ND	ND	ND	ND	ND	ND	ND
3PG10801BG	MW-3	138-139	16 ± 3	28 ± 3	ND	ND	ND	ND	ND	ND	ND
3PG11001BG	MW-4	106.8-108	16 ± 3	75 ± 3	ND	ND	ND	ND	ND	ND	ND
3PG11301BG	MW-5	119.5-120	8.1 ± 2.4	520 ± 5	ND	ND	ND	ND	ND	ND	ND
3PG11601BG	MW-6	106.2-106.8	8 ± 2.4	15 ± 2	ND	ND	ND	ND	ND	ND	ND
3PG11701BG	MW-6	141-141.5	19 ± 3	30 ± 3	0 ± .02	ND	ND	ND	ND	ND	ND
3PG11901BG	MW-7	103.6-104	9.5 ± 2.4	25 ± 2	ND	ND	ND	ND	ND	ND	ND
3PG12201BG	MW-8	123.7-124	17 ± 3	36 ± 3	0 ± .02	ND	ND	ND	ND	ND	ND
3PG12601BG	MW-9	145.6-148.4	11 ± 3	23 ± 3	0 ± .02	ND	ND	ND	ND	ND	ND
3PG12501BG	MW-9	105.8-106.1	24 ± 4	1390 ± 10	ND	ND	ND	ND	ND	ND	ND
3PG12801BG	MW-10	109-109.5	18 ± 3	87 ± 3	ND	ND	ND	ND	ND	ND	ND
3PG12901BG	MW-10	154.0-154.3	12 ± 3	75 ± 3	ND	ND	ND	ND	ND	ND	.2 ± .05
3PG13101BG	MW-11	113.7-115.3	18 ± 3	25 ± 3	.11 ± .05	ND	ND	ND	ND	ND	ND
3PG13201BG	MW-11	134.135.4	13 ± 3	22 ± 2	ND	ND	ND	ND	ND	ND	ND
3PG13301BG	MW-12	117.8-118.1	9.5 ± 2.4	61 ± 3	ND	ND	ND	ND	ND	ND	ND
3PG13401BG	MW-12	152.0-152.5	20 ± 3	28 ± 3	.08 ± .03	ND	ND	ND	ND	ND	.21 ± .05
31311101E9	MW-17	208-210.5	14 ± 4	14 ± 2	.03 ± .03	ND	ND	ND	ND	ND	ND
31310101E9	MW-18	196-196.5	9.4 ± 1.7	544 ± 6	ND	ND	ND	ND	ND	ND	ND
31310201E9	MW-18	397.6-398	12 ± 2	23 ± 2	ND	ND	ND	ND	ND	ND	ND
31311601E9	MW-18	397.6-398	11 ± 2	27 ± 2	ND	ND	ND	ND	ND	ND	ND
31310301E9	MW-18	420.75-421	17 ± 2	33 ± 2	ND	ND	ND	ND	ND	ND	ND
31311501E9	MW-20	108	29 ± 5	30 ± 3	.03 ± .03	ND	ND	ND	ND	ND	ND

ND = Not Detected.

Table 4-3. (continued).

Sample Number	Well	Depth(ft)	Nb-95	Pu-238	Pu-239/240	Ru-103	Ru-106	Sb-125	Sr-90	U-234	U-235	U-238
3PG10101BG	MW-1	231-232.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3PG10201BG	MW-1	375-378.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3PG10501BG	MW-2	111.6-112	ND	0 ±.03	0 ± .04	ND	ND	ND	40400 ± 10	1 ± .10	0 ± .10	.9 ± .10
3PG10301BG	MW-2	94.2-94.5	ND	0 ±.03	0 ± .05	ND	ND	ND	38900 ± 10	.9 ± .10	0 ± .10	.9 ± .10
3PG10401BG	MW-2	109-110.5	ND	0 ±.03	.04 ± .06	ND	ND	ND	2390 ± 3	.8 ± .10	0 ± .10	.8 ± .10
3PG10701BG	MW-3	118-118.3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3PG10801BG	MW-3	138-139	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3PG11001BG	MW-4	106.8-108	ND	ND	ND	ND	ND	ND	32.8 ± .50	ND	ND	ND
3PG11301BG	MW-5	119.5-120	ND	ND	ND	ND	ND	ND	321 ± 2	ND	ND	ND
3PG11601BG	MW-6	106.2-106.8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3PG11701BG	MW-6	141-141.5	ND	0 ±.02	0 ±.03	ND	ND	ND	3.7 ± .5	.9 ± .10	0 ± .10	.9 ± .10
3PG11901BG	MW-7	103.6-104	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3PG12201BG	MW-8	123.7-124	ND	0 ±.02	0 ±.03	ND	ND	ND	4 ± .20	1.1 ± .10	0 ± .10	1.1 ± .10
3PG12601BG	MW-9	145.6-148.4	ND	0 ±.02	0 ±.02	ND	ND	ND	819 ± 2	1.3 ± .10	0 ± .10	1.4 ± .10
3PG12501BG	MW-9	105.8-106.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3PG12801BG	MW-10	109-109.5	ND	ND	ND	ND	ND	ND	32.2 ± .50	ND	ND	ND
3PG12901BG	MW-10	154.0-154.3	ND	ND	ND	ND	ND	ND	24.5 ± .70	ND	ND	ND
3PG13101BG	MW-11	113.7-115.3	ND	0 ±.02	.03 ±.04	ND	ND	ND	ND	1 ± .10	0 ± .10	1.1 ± .10
3PG13201BG	MW-11	134.135.4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3PG13301BG	MW-12	117.8-118.1	ND	ND	ND	ND	ND	ND	29 ± 1.00	ND	ND	ND
3PG13401BG	MW-12	152.0-152.5	ND	0 ±.01	0 ±.02	ND	ND	ND	ND	1.6 ± .10	.06 ± .05	1.4 ± .10
31311101E9	MW-17	208-210.5	ND	.01 ±.02	0 ±.02	ND	ND	ND	0 ± .20	.67 ± .06	.01 ± .05	.68 ± .06
31310101E9	MW-18	196-196.5	ND	ND	ND	ND	ND	ND	321 ± 200	ND	ND	ND
31310201E9	MW-18	397.6-398	ND	ND	ND	ND	ND	ND	.6 ± .20	ND	ND	ND
31311601E9	MW-18	397.6-398	ND	ND	ND	ND	ND	ND	.3 ± .10	ND	ND	ND
31310301E9	MW-18	420.75-421	ND	ND	ND	ND	ND	ND	.3 ± .20	ND	ND	ND
31311501E9	MW-20	108	ND	0 ±.01	0 ±.02	ND	ND	ND	0 ± .40	.74 ± .07	.02 ± .05	.74 ± .07

ND = Not Detected.

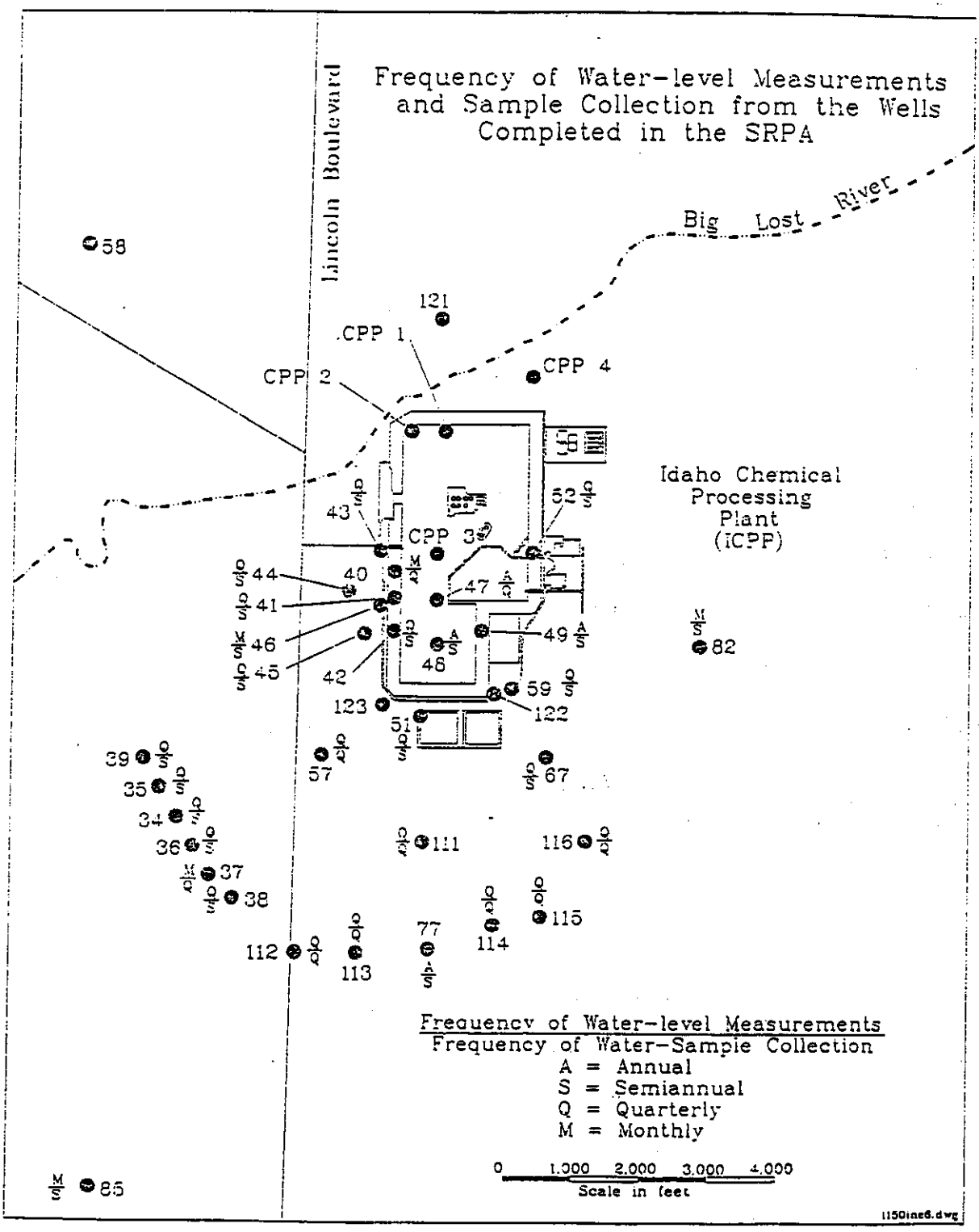


Figure 4-12. Locations of wells completed in the SRPA.

According to the latest USGS report describing SRPA water quality (Bartholomay, 1997), detectable concentrations of H-3, Sr-90, Co-60, Cs-137, Pu-238, Pu-239/-240 (undivided), and americium (Am)-241 from samples taken from wells in the SRPA at INEEL decreased or remained constant during 1992–1995. Decreased concentrations are attributed to reduced rates of radioactive-waste disposal, sorption processes, radioactive decay, and changes in waste disposal practices. Chemical constituents detected in SRPA at the INEEL include total chromium, sodium, chloride, and nitrate. Purgeable organic compounds were detected in samples from wells at the INEEL. This report provides information concerning the distribution of chemical and radionuclide constituents in the SRPA and covers the period from 1992 to 1995. Of the 14 purgeable organic compounds detected at the INEEL, only 1,1,1-trichloroethane was detected in the vicinity of the ICPP at concentrations well below the federal drinking water standard (MCL) of 200 μg/L.

The ICPP has a groundwater sampling program of selected SRPA wells to satisfy the groundwater monitoring requirements for the RCRA and DOE Order 5400.1. This sampling program, implemented in October 1991, uses selected USGS wells and collects samples on a quarterly basis to be analyzed for the RCRA groundwater contamination parameters, RCRA drinking water parameters, RCRA groundwater quality parameters, and selected radionuclides. The results from this sampling program are provided in the WAG 3 RI/FS Work Plan (INEL-95/0056, Rev. 2). Also, wells ICPP-Mon-A-021 and -022 were installed to monitor the SRPA water quality beneath the sewage treatment plant.

In May and June 1995, a complete round of groundwater samples were collected from the aquifer wells located near and downgradient from the ICPP (see Figure 4-12). The results from this sampling effort are provided in Table 4-4, and described in the following subsections.

4.3.1 Contaminant Distribution

4.3.1.1 Cesium-137. According to Bartholomay (1997), Cs-137 has been detected above reporting levels through 1985 in wells USGS-40 and USGS-47 at the ICPP due to liquid-waste discharge to the ICPP injection well. During 1982 to 1985, maximum concentrations in wells USGS-40 and USGS-47 were 237±45 and 200±50 pCi/L, respectively. During 1986 to 1988, Cs-137 was not detected in these wells (Orr and Cecil, 1991). Since 1988, cesium-137 was detected in one sample from well USGS-40 (70±30 pCi/L on January 15, 1990) and one sample from well USGS-47 (70±30 pCi/L on April 29, 1992). Cs-137 was not detected in any of the aquifer wells sampled during the WAG 3 RI. The half-life for Cs-137 is 30.17 yrs.

4.3.1.2 Plutonium. Monitoring the quantities of Pu-238 and Pu-239/-240 (undivided) discharged to the ICPP disposal well began in 1974. Prior to that time, alpha activity from plutonium disintegration was not separable from the monitored, undifferentiated alpha activity. During 1974 through 1985, about 0.15 Ci of Pu-238 and 0.05 Ci of Pu-239/-240 (undivided) were discharged to the ICPP injection well. During the period from 1986 to 1988, approximately 0.06 Ci of plutonium isotopes were discharged to the infiltration ponds at the ICPP. The half-lives of Pu-238, -239, and -240 are 87.7, 24 100, and 6,560 years, respectively.

According to Orr and Cecil (1991), plutonium has been detected in the SRPA near the ICPP in wells USGS-40 and USGS-47. Both of these wells are located near the ICPP injection well. In well USGS-40, Pu-238 and Pu-239/-240 (undivided) were last detected in January 1987 at concentrations of 0.47±0.16 pCi/L and 5.5±0.4 pCi/L, respectively. In well USGS-47, Pu-238 was last detected in October 1983 at a concentration of 0.5±0.06 pCi/L. Since the 1986 to 1988 period reported by Orr and Cecil (1991),

Table 4-4. Water quality from the wells completed in the SRPA (May–June 1995).

Well		MW-18	USGS 34	USGS 35	USGS 36
Date		Jun-95	May-95	May-95	May-95
Sample Depth		464.19 to 479	477.33 to 700	477.76 to 580.5	477.48 to 567.1
Sample ID	Units	31330101	31330201	31330301	31330401
Field Parameters					
Temperature	(celsius)	18.2	12.31	12.08	12.75
pH		7.88	7.67	7.73	7.81
Conductivity	(msiemen)	0.73	0.468	0.454	0.486
TAL Inorganics					
Aluminum	(ug/L)	26.8 U	49.9 BU	53.4 BU	26.8 U
Antimony	(ug/L)	1.9 U	42.2 U	42.2 U	1.9 U
Arsenic	(ug/L)	4 U	1.8 U	1.8 U	4 U
Barium	(ug/L)	122 B	95.1 B	98.1 B	109 B
Beryllium	(ug/L)	0.1 U	0.1 U	0.1 U	0.1 U
Cadmium	(ug/L)	0.4 U	2.9 U	2.9 U	0.4 U
Calcium	(ug/L)	62300	57000	57400	57200
Chromium	(ug/L)	4.1 U	21.6	29.2	13.5
Cobalt	(ug/L)	0.5 U	4.9 U	4.9 U	0.5 U
Copper	(ug/L)	2.8 B	7.1 U	7.1 U	2 BU
Iron	(ug/L)	21.5 U	7.1 U	20.3 B	21.5 U
Lead	(ug/L)	2 U	2.3 BWJ	1.5 UW	2 U
Magnesium	(ug/L)	18700	14300	14900	14700
Manganese	(ug/L)	2 B	1.2 U	1.2 U	0.8 U
Mercury	(ug/L)	0.1 U	0.1 U	0.1 U	0.1 U
Nickel	(ug/L)	3.4 U	12.4 U	12.4 U	3.4 U
Potassium	(ug/L)	4650 B	2640 B	3110 B	2770 BEJ
Selenium	(ug/L)	2.7 U	1.2 U	1.2 U	2.7 U
Silver	(ug/L)	0.6 U	5.2 BNR	6.5 BNR	0.6 UN
Sodium	(ug/L)	30800	10100	9950	16600
Thallium	(ug/L)	4.6 U	2.3 UW	2.3 UW	4.6 U
Vanadium	(ug/L)	3.2 B	6.9 B	4 U	3.7 BU
Zinc	(ug/L)	14.2 BU	2.6 B	3.5 B	2 BEUJ
Zirconium	(ug/L)	31.2 U	31.3 U	31.3 U	31.3 U
Radionuclides					
Gross Alpha	(pCi/L)	10±2	2±1.2 U	2.4±1.2	4.4±1.4
Gross Beta	(pCi/L)	469±6	13±1	14±1	32±2
Tritium	(pCi/L)	26400±400	4530±217	6680±250	6560±240
Sr-90	(pCi/L)	84±1	2.4±0.3	2.6±0.3	9±0.5
Pu-238	(pCi/L)	0±0.07 U	ND	ND	ND
Pu-239/240	(pCi/L)	0.03±0.05 U	ND	ND	ND
Am-241	(pCi/L)	0.05±0.07 U	ND	ND	ND
Np-237	(pCi/L)	3.1±0.3 U	ND	ND	ND
I-129	(pCi/L)	0±0.3 U	0±0.3 U	0±0.3 U	0±0.3 U
Tc-99	(pCi/L)	448±4 J	0.9±0.6 U	0.9±0.8 U	4.1±0.5
U-234	(pCi/L)	0.7±0.3	ND	ND	ND
U-235	(pCi/L)	0±0.2 U	ND	ND	ND
U-238	(pCi/L)	0.9±0.3	ND	ND	ND

NA - not analyzed.
ND - not detected.
NS - not sampled.
U - analyzed, not detected.
B - contaminant in blank.
R - concentration is unusable.
J - estimated concentration.

Table 4-4. (continued).

Well		USGS 37	USGS 38	USGS 39	USGS 40
Date		May-95	May-95	May-95	May-95
Sample Depth		477.61 to 573	478.03 to 729	479.16 to 573.9	463.58 to 679
Sample ID	Units	31330501	31330601	31330701	31330801
Field Parameters					
Temperature	(celsius)	13.46	14.41	12.1	14.31
pH		7.76	7.69	7.73	7.46
Conductivity	(msiemen)	0.751	0.737	0.436	0.524
TAL Inorganics					
Aluminum	(ug/L)	26.8 U	26.8 U	42.9 U	26.8 U
Antimony	(ug/L)	1.9 U	1.9 U	42.2 U	1.9 U
Arsenic	(ug/L)	4 U	4 U	1.8 U	4 U
Barium	(ug/L)	170 B	197 B	104 B	98.3 B
Beryllium	(ug/L)	0.1 U	0.1 U	0.1 U	0.1 U
Cadmium	(ug/L)	0.4 U	0.4 U	3 B	0.4 U
Calcium	(ug/L)	71200	66900	58000	62100
Chromium	(ug/L)	7.1 B	5.6 B	38.8	5.3 B
Cobalt	(ug/L)	0.5 U	0.5 U	4.9 U	0.5 U
Copper	(ug/L)	1.3 U	1.3 U	7.1 U	1.3 U
Iron	(ug/L)	21.5 U	21.5 U	9.4 B	21.5 U
Lead	(ug/L)	3.9 B	2 U	1.5 UW	2 U
Magnesium	(ug/L)	18900	18300	15700	17000
Manganese	(ug/L)	0.8 U	0.84 B	1.4 BU	0.8 U
Mercury	(ug/L)	0.1 U	0.1 U	0.1 U	0.1 U
Nickel	(ug/L)	3.4 U	3.4 U	12.4 U	3.4 U
Potassium	(ug/L)	4220 BEJ	4500 BEJ	2250 B	2510 BEJ
Selenium	(ug/L)	2.7 U	2.7 U	1.2 U	2.7 U
Silver	(ug/L)	0.6 UN	0.6 UN	5.1 UN	0.6 UN
Sodium	(ug/L)	41900	52000	8460	16100
Thallium	(ug/L)	4.6 U	4.6 U	2.3 UW	4.6 U
Vanadium	(ug/L)	3.8 BU	3.8 BU	6.3 B	3.5 BU
Zinc	(ug/L)	179 EJ	18.6 BEJ	3.9 B	216 EJ
Zirconium	(ug/L)	31.3 U	31.3 U	31.3 U	31.3 U
Radionuclides					
Gross Alpha	(pCi/L)	1.7±1.6 U	4.9±2	1.6±1 U	3±1.3
Gross Beta	(pCi/L)	38±2	63±3	3.2±1.2	81±2
Tritium	(pCi/L)	17700±400	17300±400	7620±260	9850±280
Sr-90	(pCi/L)	7.6±0.5	19±0.7	0±0.3	17.4±0.6 J
Pu-238	(pCi/L)	ND	ND	ND	ND
Pu-239/240	(pCi/L)	ND	ND	ND	ND
Am-241	(pCi/L)	ND	ND	ND	ND
Np-237	(pCi/L)	ND	ND	ND	ND
I-129	(pCi/L)	0±0.3 U	0±0.3 U	0±0.4	0±0.4 U
Tc-99	(pCi/L)	7.3±0.5	14±1	39±1	3.9±0.5
U-234	(pCi/L)	ND	ND	ND	ND
U-235	(pCi/L)	ND	ND	ND	ND
U-238	(pCi/L)	ND	ND	ND	ND

NA - not analyzed.
ND - not detected.
NS - not sampled.
U - analyzed, not detected.
B - contaminant in blank.
R - concentration is unusable.
J - estimated concentration.

Table 4-4. (continued).

Well		USGS 41	USGS 42	USGS 44	USGS 45
Date		May-95	May-95	May-95	May-95
Sample Depth		646.53 to 674.4	464.83 to 678.5	465.58 to 650	467.41 to 651.2
Sample ID	Units	31330901	31334301	31331101	31331201
Field Parameters					
Temperature	(celsius)	13.05	13.29	12.18	12.55
pH		7.41	7.37	7.69	7.56
Conductivity	(msiemen)	0.484	0.468	0.397	0.441
TAL Inorganics					
Aluminum	(ug/L)	26.8 U	26.8 U	42.9 U	27.2 BU
Antimony	(ug/L)	1.9 U	1.9 U	42.2 U	1.9 U
Arsenic	(ug/L)	4 U	4 U	1.8 U	4 U
Barium	(ug/L)	94.2 B	91.8 B	89.9 B	82 B
Beryllium	(ug/L)	0.1 U	0.1 U	0.1 U	0.1 U
Cadmium	(ug/L)	0.4 U	0.4 U	2.9 U	0.4 U
Calcium	(ug/L)	60800	58800	56300	54400
Chromium	(ug/L)	5.3 B	5.4 B	5.5 U	5.1 B
Cobalt	(ug/L)	0.5 U	0.5 U	4.9 U	0.5 U
Copper	(ug/L)	1.3 U	1.8 BU	7.1 U	1.3 UJ
Iron	(ug/L)	21.5 U	21.5 U	7.1 U	21.5 U
Lead	(ug/L)	2 U	2 U	1.5 UW	2 U
Magnesium	(ug/L)	16700	16200	14600	14700
Manganese	(ug/L)	0.8 U	0.8 U	1.2 BU	0.8 U
Mercury	(ug/L)	0.1 B	0.1 U	0.1 U	0.1 U
Nickel	(ug/L)	3.4 U	3.4 U	12.4 U	3.4 U
Potassium	(ug/L)	2410 BEJ	2350 BEJ	2550 B	2510 BEJ
Selenium	(ug/L)	2.7 U	2.7 U	1.2 U	2.7 U
Silver	(ug/L)	0.6 UN	0.6 UN	5.1 UN	0.6 NUJ
Sodium	(ug/L)	13200	10500	8360	10300
Thallium	(ug/L)	4.6 U	4.6 U	2.3 U	4.6 U
Vanadium	(ug/L)	4.1 BU	4.1 BU	4.2 B	3.5 BJ
Zinc	(ug/L)	10.8 BEUJ	11.1 BEUJ	3.2 B	4.5 BU
Zirconium	(ug/L)	31.3 U	31.3 U	31.3 U	ND
Radionuclides					
Gross Alpha	(pCi/L)	4.1±1.4	2.6±1.2	3.6±1.3	2.3±1.2 U
Gross Beta	(pCi/L)	52.4±2.2	33±2	14±1	14±1
Tritium	(pCi/L)	7770±250	3880±200	581±138	2540±180
Sr-90	(pCi/L)	15.8±0.6	9.7±0.6	3.6±0.3	3.8±0.4
Pu-238	(pCi/L)	ND	0.03±0.04 U	ND	ND
Pu-239/240	(pCi/L)	ND	0±0.03 U	ND	ND
Am-241	(pCi/L)	ND	0.54±0.14	ND	ND
Np-237	(pCi/L)	ND	0±0.11 U	ND	ND
I-129	(pCi/L)	0±0.3 U	0±0.3 U	0±0.3 U	0±0.3 U
Tc-99	(pCi/L)	8.2±0.6	8±0.8	0.4±0.6 U	0.4±0.5 U
U-234	(pCi/L)	ND	1.8±0.4	ND	ND
U-235	(pCi/L)	ND	0±0.2 U	ND	ND
U-238	(pCi/L)	ND	0.9±0.3	ND	ND

NA - not analyzed.
ND - not detected.
NS - not sampled.
U - analyzed, not detected.
B - contaminant in blank.
R - concentration is unusable.
J - estimated concentration.

Table 4-4. (continued).

Well		USGS 46	USGS 47	USGS 48	USGS 51
Date		May-95	Jun-95	May-95	May-95
Sample Depth		468.1 to 654.9	460.35 to 652	464.16 to 752	466.77 to 659
Sample ID	Units	31331301	31334401	31331401	31331601
Field Parameters					
Temperature	(celsius)	13.52	16.2	14.77	13.73
pH		7.55	7.75	7.42	7.69
Conductivity	(msiemen)	0.61	0.54	0.59	0.623
TAL Inorganics					
Aluminum	(ug/L)	120 BU	25.2 BU	47.5 BU	26.8 U
Antimony	(ug/L)	1.9 U	2.7 U	42.2 U	1.9 U
Arsenic	(ug/L)	4 U	2.4 U	1.8 U	4 U
Barium	(ug/L)	107 B	98.3 B	85 B	101 B
Beryllium	(ug/L)	0.1 U	0.1 U	0.1 U	0.1 U
Cadmium	(ug/L)	0.4 U	0.3 U	2.9 U	0.4 U
Calcium	(ug/L)	64500	64800	57400	59400
Chromium	(ug/L)	4.7 B	6.7 B	5.5 U	8.9 B
Cobalt	(ug/L)	0.93 B	0.6 U	4.9 U	0.5 U
Copper	(ug/L)	1.3 U	2.2 U	7.1 U	1.6 BU
Iron	(ug/L)	119	3 B	7.1 U	21.5 U
Lead	(ug/L)	2 U	2 U	1.5 UW	2.9 B
Magnesium	(ug/L)	17100	17200	15700	20000
Manganese	(ug/L)	1.3 B	0.8 U	1.7 BU	0.8 U
Mercury	(ug/L)	0.1 U	0.32	0.11 B	0.1 U
Nickel	(ug/L)	3.4 U	1.8 U	12.4 U	3.4 U
Potassium	(ug/L)	2740 B	2290 B	2550 B	5000 EJ
Selenium	(ug/L)	2.7 U	2.8 B	1.5 B	2.7 U
Silver	(ug/L)	0.6 U	0.8 UN	5.5 BNR	0.6 UN
Sodium	(ug/L)	16000	20000	14500	23700
Thallium	(ug/L)	4.6 U	3.2 U	2.3 U	4.6 U
Vanadium	(ug/L)	4 B	3.8 B	4.1 B	5.7 BU
Zinc	(ug/L)	7.6 BU	380	5.5 B	166 EJ
Zirconium	(ug/L)	31.2 U	11.6 U	31.3 U	31.3 U
Radionuclides					
Gross Alpha	(pCi/L)	2.8±1.3 J	3.8±1.5 U	2.3±1.2 U	0.2±1.2 U
Gross Beta	(pCi/L)	140±3 J	233±3	81±2	5.7±1.4
Tritium	(pCi/L)	10200±300	15800±400 U	6820±252	23900±400
Sr-90	(pCi/L)	23.4±0.8	67±1 J	18.4±0.5	0.4±0.3 U
Pu-238	(pCi/L)	ND	ND	0±0.03 U	ND
Pu-239/240	(pCi/L)	ND	ND	0±0.04 U	ND
Am-241	(pCi/L)	ND	ND	0±0.05 U	ND
Np-237	(pCi/L)	ND	ND	0±0.11 U	ND
I-129	(pCi/L)	0±0.4 U	0.1±0.3 U	0±0.3 U	0±0.4 U
Tc-99	(pCi/L)	9.7±0.7	174±2	2±0.7	0.8±0.5 U
U-234	(pCi/L)	ND	2.6±0.8	1.9±0.4	ND
U-235	(pCi/L)	ND	0±0.3 U	0±0.2 U	ND
U-238	(pCi/L)	ND	0.4±0.5 U	0.8±0.3	ND

NA - not analyzed.
ND - not detected.
NS - not sampled.
U - analyzed, not detected.
B - contaminant in blank.
R - concentration is unusable.
J - estimated concentration.

Table 4-4. (continued).

Well		USGS 52	USGS 57	USGS 59	USGS 67
Date		May-95	May-95	May-95	May-95
Sample Depth		457.75 to 650	471.8 to 732	470 to 657	462 to 699
Sample ID	Units	31331701	31331801	31331901	31332001
Field Parameters					
Temperature	(celsius)	13.69	13.77	14.89	14.03
pH		7.48	7.7	7.51	7.48
Conductivity	(msiemen)	0.475	0.811	0.897	0.875
TAL Inorganics					
Aluminum	(ug/L)	26.8 U	26.8 U	36.4 BU	56.7 BU
Antimony	(ug/L)	1.9 U	1.9 U	3.1 B	1.9 U
Arsenic	(ug/L)	4 U	4 U	10.8 B	4 U
Barium	(ug/L)	99.5 B	90.9 B	188 B	185 B
Beryllium	(ug/L)	0.1 U	0.1 U	0.1 U	0.1 U
Cadmium	(ug/L)	0.4 U	0.4 U	0.4 U	0.4 U
Calcium	(ug/L)	48700	30000	62500	77200
Chromium	(ug/L)	6.2 B	4.1 U	5.8 B	5.6 B
Cobalt	(ug/L)	0.5 U	0.5 U	0.5 U	0.5 U
Copper	(ug/L)	1.7 BU	1.3 U	1.6 BJ	1.3 UJ
Iron	(ug/L)	21.5 U	21.5 U	21.5 U	21.5 U
Lead	(ug/L)	2 U	2 U	2 U	5 BU
Magnesium	(ug/L)	14100	8250	16800	21700
Manganese	(ug/L)	0.8 U	0.8 U	0.8 U	0.8 U
Mercury	(ug/L)	0.1 U	0.18 B	0.1 U	0.1 U
Nickel	(ug/L)	3.4 U	3.4 U	3.4 U	3.4 U
Potassium	(ug/L)	3280 BEJ	1960 BEJ	5140 EJ	5340 EJ
Selenium	(ug/L)	2.7 U	2.7 U	4.5 BU	5 BU
Silver	(ug/L)	0.6 UN	0.6 UN	0.6 NUJ	0.6 NUJ
Sodium	(ug/L)	22400	24400	76700	44700
Thallium	(ug/L)	4.6 U	4.6 U	4.6 U	4.6 U
Vanadium	(ug/L)	4.9 BU	1.8 BU	3.1 BJ	3.1 BJ
Zinc	(ug/L)	5.9 BEUJ	4.4 BEUJ	296	329
Zirconium	(ug/L)	31.3 U	31.3 U	ND	ND
Radionuclides					
Gross Alpha	(pCi/L)	2.8±1.3 U	2±1.8 U	1±1.7 U	1.6±1.6 U
Gross Beta	(pCi/L)	183±3	83±3	43±3	45±3
Tritium	(pCi/L)	10700±300	18400±400	17900±400	21200±400
Sr-90	(pCi/L)	12.1±0.6	22.7±0.7	12±0.5	10.3±0.5
Pu-238	(pCi/L)	ND	0±0.07 U	ND	ND
Pu-239/240	(pCi/L)	ND	0±0.02 U	ND	ND
Am-241	(pCi/L)	ND	0.09±0.07 U	ND	ND
Np-237	(pCi/L)	ND	0±0.14 U	ND	ND
I-129	(pCi/L)	0±0.3 U	0.1±0.3 U	0±0.3 U	1±0.3
Tc-99	(pCi/L)	235±3	28±1	20±1	13±1
U-234	(pCi/L)	ND	2±0.4	ND	ND
U-235	(pCi/L)	ND	0±0.2 U	ND	ND
U-238	(pCi/L)	ND	0.9±0.3 U	ND	ND

NA - not analyzed.
ND - not detected.
NS - not sampled.
U - analyzed, not detected.
B - contaminant in blank.
R - concentration is unusable.
J - estimated concentration.

Table 4-4. (continued).

Well		USGS 77	USGS 82	USGS 84	USGS 85
Date		May-95	May-95	May-95	May-95
Sample Depth		471.26 to 610	454.94 to 700	486.56 to 505	489.07 to 637
Sample ID	Units	31332101	31332201	31334201	31332301
Field Parameters					
Temperature	(celsius)	13.05	12.48	12.28	12.7
pH		7.7	7.78	7.91	7.54
Conductivity	(msiemen)	0.704	0.31	0.454	0.508
TAL Inorganics					
Aluminum	(ug/L)	26.8 U	43.4 BU	26.8 U	38.4 BU
Antimony	(ug/L)	1.9 U	42.2 U	1.9 U	1.9 U
Arsenic	(ug/L)	4 U	3.1 B	4 U	4 U
Barium	(ug/L)	147 B	50 B	92.6 B	127 B
Beryllium	(ug/L)	0.1 U	0.1 U	0.1 U	0.1 U
Cadmium	(ug/L)	0.4 U	2.9 U	0.4 U	0.4 U
Calcium	(ug/L)	68000	35300	55500	63400
Chromium	(ug/L)	11.4	5.5 U	19.9	16.2
Cobalt	(ug/L)	0.5 U	4.9 U	0.5 U	0.55 B
Copper	(ug/L)	2.3 BU	7.1 U	5.7 BU	1.3 UJ
Iron	(ug/L)	21.5 U	8.8 B	29.1 B	21.5 U
Lead	(ug/L)	2 U	1.5 UW	17.5 B	2 U
Magnesium	(ug/L)	20000	13000	17700	16200
Manganese	(ug/L)	0.8 U	1.4 BU	0.8 U	1.9 B
Mercury	(ug/L)	0.1 U	0.1 U	0.1 U	0.1 U
Nickel	(ug/L)	3.4 U	12.4 U	3.4 U	3.4 U
Potassium	(ug/L)	4430 BEJ	3460 B	2030 BEJ	3530 BEJ
Selenium	(ug/L)	2.7 U	1.2 U	2.7 U	2.7 U
Silver	(ug/L)	0.73 BNJ	5.8 BNR	0.6 UN	0.63 BNJ
Sodium	(ug/L)	30800	10400	8980	25600
Thallium	(ug/L)	4.6 U	2.3 U	4.6 U	4.6 U
Vanadium	(ug/L)	3.7 BU	9.9 B	3.2 BU	3.2 BJ
Zinc	(ug/L)	5.3 BEUJ	106	428 EJ	8.6 B
Zirconium	(ug/L)	31.3 U	31.3 U	31.3 U	ND
Radionuclides					
Gross Alpha	(pCi/L)	4.6±1.7	2.9±1.1	1±1.2 U	3±1.4
Gross Beta	(pCi/L)	13±2	4.1±1.3	2.4±1.2	16±2
Tritium	(pCi/L)	30700±500	67±122 U	4790±210	11800±300
Sr-90	(pCi/L)	1.3±0.3	0.1±0.3 U	0±0.3 U	4±0.4
Pu-238	(pCi/L)	ND	ND	ND	ND
Pu-239/240	(pCi/L)	ND	ND	ND	ND
Am-241	(pCi/L)	ND	ND	ND	ND
Np-237	(pCi/L)	ND	ND	ND	ND
I-129	(pCi/L)	0±0.3 U	0±0.3 U	0±0.3 U	0±0.3 U
Tc-99	(pCi/L)	7.5±0.7	0.1±0.6 U	0.8±0.6 U	6.4±0.6
U-234	(pCi/L)	ND	ND	ND	ND
U-235	(pCi/L)	ND	ND	ND	ND
U-238	(pCi/L)	ND	ND	ND	ND

NA - not analyzed.
ND - not detected.
NS - not sampled.
U - analyzed, not detected.
B - contaminant in blank.
R - concentration is unusable.
J - estimated concentration.

Table 4-4. (continued).

Well		USGS 111	USGS 112	USGS 113	USGS 114
Date		May-95	May-95	May-95	May-95
Sample Depth		475.98 to 597	479.67 to 563	480.31 to 564	474.02 to 564
Sample ID	Units	31332401	31332501	31332601	31332701
Field Parameters					
Temperature	(celsius)	13.46	13.94	13.37	13.55
pH		9.02	7.6	7.71	7.72
Conductivity	(msiemen)	0.608	0.18	0.945	0.531
TAL Inorganics					
Aluminum	(ug/L)	57.6 BU	44.1 BU	26.8 U	26.8 U
Antimony	(ug/L)	42.2 U	1.9 U	1.9 U	1.9 U
Arsenic	(ug/L)	1.8 U	4 U	4 U	4 U
Barium	(ug/L)	105 B	205	107 B	102 B
Beryllium	(ug/L)	0.1 U	0.1 U	0.1 U	0.1 U
Cadmium	(ug/L)	2.9 U	0.4 U	0.4 U	0.4 U
Calcium	(ug/L)	58100	71500	32000	55600
Chromium	(ug/L)	29.6	6 B	4.1 U	9.3 B
Cobalt	(ug/L)	4.9 U	0.5 U	0.5 U	0.5 U
Copper	(ug/L)	7.1 U	1.3 UJ	1.7 BU	3.9 BU
Iron	(ug/L)	86.8 B	21.5 U	21.5 U	21.5 U
Lead	(ug/L)	1.5 UW	2 U	2 U	2 U
Magnesium	(ug/L)	16900	19000	9060	17700
Manganese	(ug/L)	1.2 U	0.8 U	0.8 U	0.8 U
Mercury	(ug/L)	0.1 U	0.1 B	0.1 U	0.1 U
Nickel	(ug/L)	12.4 U	3.4 U	3.4 U	3.4 U
Potassium	(ug/L)	3600 B	4920 BEJ	2520 BEJ	3850 BEJ
Selenium	(ug/L)	1.4 B	2.7 U	2.7 U	2.7 U
Silver	(ug/L)	5.1 UN	0.6 NUJ	0.88 BNJ	0.6 UN
Sodium	(ug/L)	23700	57000	33500	19800
Thallium	(ug/L)	2.3 WUJ	4.6 U	4.6 U	4.6 U
Vanadium	(ug/L)	6.1 B	3.6 BJ	1.9 BU	3.6 BU
Zinc	(ug/L)	200	169	90.7 EJ	261 EJ
Zirconium	(ug/L)	31.3 U	ND	31.3 U	31.3 U
Radionuclides					
Gross Alpha	(pCi/L)	0.2±1.2 U	2.3±1.7 U	0±1.8 U	0.4±1.1 U
Gross Beta	(pCi/L)	3.5±1.3	78±3	38±3	11±1
Tritium	(pCi/L)	10900±300	17900±400	15500±300	27000±400
Sr-90	(pCi/L)	0.2±0.3 U	21.5±0.7	12±0.5	0.1±0.4 U
Pu-238	(pCi/L)	ND	0±0.02 U	ND	ND
Pu-239/240	(pCi/L)	ND	0±0.04 U	ND	ND
Am-241	(pCi/L)	ND	0.09±0.07 U	ND	ND
Np-237	(pCi/L)	ND	0.02±0.14 U	ND	ND
I-129	(pCi/L)	0±0.3 U	0.1±0.4 U	0.1±0.3 U	0±0.3 U
Tc-99	(pCi/L)	1.5±0.8 U	18±1	9.6±0.7	12.6±0.9
U-234	(pCi/L)	ND	1.3±0.4	ND	ND
U-235	(pCi/L)	ND	0±0.2 U	ND	ND
U-238	(pCi/L)	ND	0.6±0.3 U	ND	ND

NA - not analyzed.
ND - not detected.
NS - not sampled.
U - analyzed, not detected.
B - contaminant in blank.
R - concentration is unusable.
J - estimated concentration.

Table 4-4. (continued).

Well		USGS 115	USGS 116	USGS 121	USGS 122
Date		May-95	May-95	May-95	May-95
Sample Depth		470.27 to 581	464.71 to 580	459.12 to 475	465 to 476
Sample ID	Units	31332801	31332901	31333001	31333101
Field Parameters					
Temperature	(celsius)	13.31	12.99	12.6	15.39
pH		7.85	7.71	7.58	7.65
Conductivity	(msiemen)	0.385	0.69	0.424	0.59
TAL Inorganics					
Aluminum	(ug/L)	26.8 U	26.8 U	36.6 BU	26.8 U
Antimony	(ug/L)	1.9 U	1.9 U	1.9 B	1.9 U
Arsenic	(ug/L)	4 U	4 U	7.5 B	4 U
Barium	(ug/L)	57.6 B	137 B	88.6 B	114 B
Beryllium	(ug/L)	0.1 U	0.1 U	0.1 U	0.1 U
Cadmium	(ug/L)	0.4 U	0.4 U	0.4 U	0.4 U
Calcium	(ug/L)	40100	59000	52800	46000
Chromium	(ug/L)	7.7 B	7.8 B	4.2 B	4.1 U
Cobalt	(ug/L)	0.5 U	0.5 U	0.5 U	0.5 U
Copper	(ug/L)	1.7 BU	2 BU	1.3 UJ	1.3 U
Iron	(ug/L)	21.5 U	21.5 U	21.5 U	21.5 U
Lead	(ug/L)	3 B	2.9 B	2 U	2 U
Magnesium	(ug/L)	12600	17000	14100	11900
Manganese	(ug/L)	0.8 U	0.8 U	0.8 U	44
Mercury	(ug/L)	0.1 U	0.1 U	0.1 U	0.1 U
Nickel	(ug/L)	3.4 U	3.4 U	3.4 U	4.3 B
Potassium	(ug/L)	3300 BEJ	4950 BEJ	2350 BEJ	6800
Selenium	(ug/L)	2.7 U	2.7 U	3 BU	2.7 U
Silver	(ug/L)	0.6 UN	0.6 UN	0.6 NUJ	0.6 U
Sodium	(ug/L)	13100	32200	7340	30600
Thallium	(ug/L)	4.6 U	4.6 U	4.6 U	4.6 U
Vanadium	(ug/L)	4.1 BU	4.4 BU	3.4 BJ	3.2 B
Zinc	(ug/L)	454 EJ	197 EJ	6.8 BU	46.8
Zirconium	(ug/L)	31.3 U	31.3 U	ND	31.2 U
Radionuclides					
Gross Alpha	(pCi/L)	2.3±1	3.5±1.6	2.6±1.1	1.6±1.1 U
Gross Beta	(pCi/L)	8.4±1.3	5.8±1.6	2.7±1.1	13±1
Tritium	(pCi/L)	5340±220	8020±260	168±123 U	19300±300
Sr-90	(pCi/L)	0.6±0.3 U	0.8±0.3	0.3±0.3 U	2.2±0.3
Pu-238	(pCi/L)	ND	ND	ND	ND
Pu-239/240	(pCi/L)	ND	ND	ND	ND
Am-241	(pCi/L)	ND	ND	ND	ND
Np-237	(pCi/L)	ND	ND	ND	ND
I-129	(pCi/L)	0±0.4 U	0±0.3 U	0±0.4 U	0±0.2 U
Tc-99	(pCi/L)	4±0.7	3.4±0.6	0.1±0.5 U	2±0.5 J
U-234	(pCi/L)	ND	ND	ND	ND
U-235	(pCi/L)	ND	ND	ND	ND
U-238	(pCi/L)	ND	ND	ND	ND

NA - not analyzed.
ND - not detected.
NS - not sampled.
U - analyzed, not detected.
B - contaminant in blank.
R - concentration is unusable.
J - estimated concentration.

Table 4-4. (continued).

Well		USGS 123	CPP-1	CPP-2	LF2-08
Date		May-95	Jun-95	May-95	May-95
Sample Depth		468.39 to 475	595	595	495
Sample ID	Units	31333201	31334501	31334601	31333301
Field Parameters					
Temperature	(celsius)	14.61	16.6	15.2	12.84
pH		8.26	7	7.7	7.87
Conductivity	(msiemen)	0.662	0.547	0.534	0.748
TAL Inorganics					
Aluminum	(ug/L)	69.1 BU	26.8 U	43.9 BU	26.8 U
Antimony	(ug/L)	1.9 U	1.9 U	1.9 U	1.9 U
Arsenic	(ug/L)	4 U	4 U	4 U	4 U
Barium	(ug/L)	173 B	96.2 B	186 B	159 B
Beryllium	(ug/L)	0.1 U	0.1 U	0.1 U	0.1 U
Cadmium	(ug/L)	0.4 U	0.4 U	0.4 U	2.1 B
Calcium	(ug/L)	70400	58100	77500	74900
Chromium	(ug/L)	8.6 B	4.1 U	5.9 B	9.1 B
Cobalt	(ug/L)	0.79 B	0.5 U	0.5 U	0.5 U
Copper	(ug/L)	1.8 B	1.3 U	1.3 UJ	2.1 B
Iron	(ug/L)	129	21.5 U	21.5 U	21.5 U
Lead	(ug/L)	2 U	2 U	2.1 BU	37.7
Magnesium	(ug/L)	18900	17000	21600	20400
Manganese	(ug/L)	3 B	0.8 U	0.8 U	0.8 U
Mercury	(ug/L)	0.14 B	0.1 U	0.1 U	0.1 U
Nickel	(ug/L)	4.7 B	3.4 U	3.4 U	3.4 U
Potassium	(ug/L)	4570 B	2980 B	5330 EJ	6100
Selenium	(ug/L)	2.7 U	2.7 U	2.7 U	2.7 U
Silver	(ug/L)	0.6 U	0.6 U	0.6 NUJ	0.6 U
Sodium	(ug/L)	46100	9110	44500	40600
Thallium	(ug/L)	4.6 U	4.6 U	4.6 U	4.6 U
Vanadium	(ug/L)	3.9 B	4.9 B	3.4 BJ	3.1 B
Zinc	(ug/L)	7.3 BU	1.3 BU	339	5.7 BU
Zirconium	(ug/L)	31.2 U	31.2 U	ND	31.2 U
Radionuclides					
Gross Alpha	(pCi/L)	1.7±1.5 U	1.9±1.1 U	ND	2±1.6 U
Gross Beta	(pCi/L)	123±3	25±2	ND	38±2
Tritium	(pCi/L)	25900±400	754±173	ND	21000±400
Sr-90	(pCi/L)	30±1	0.9±0.3 U	ND	0.6±0.3 U
Pu-238	(pCi/L)	0.08±0.06 U	ND	ND	ND
Pu-239/240	(pCi/L)	0±0.03 U	ND	ND	ND
Am-241	(pCi/L)	0.03±0.06 U	ND	ND	ND
Np-237	(pCi/L)	0±0.12 U	ND	ND	ND
I-129	(pCi/L)	0±0.2 U	0±0.3 U	ND	0.4±0.4 U
Tc-99	(pCi/L)	48±1	31±1 J	ND	4.7±0.4
U-234	(pCi/L)	1.3±0.4	ND	ND	ND
U-235	(pCi/L)	0±0.2 U	ND	ND	ND
U-238	(pCi/L)	1.1±0.4	ND	ND	ND

NA - not analyzed.
ND - not detected.
NS - not sampled.
U - analyzed, not detected.
B - contaminant in blank.
R - concentration is unusable.
J - estimated concentration.

Table 4-4. (continued).

Well		LF2-10	LF2-11	LF2-12	LF3-08
Date		May-95	Aug-95	Jun-95	May-95
Sample Depth		765	499	489	510
Sample ID	Units	31333501	31333601	31333701	31333801
Field Parameters					
Temperature	(celsius)	12.79	12.77	13.73	12.85
pH		8.58	8.11	7.59	7.79
Conductivity	(msiemen)	0.515	1.035	0.724	0.705
TAL Inorganics					
Aluminum	(ug/L)	26.8 U	76.3 BU	26.8 U	26.8 U
Antimony	(ug/L)	1.9 U	4.6 B	1.9 U	1.9 U
Arsenic	(ug/L)	4 U	2.4 U	4 U	4 U
Barium	(ug/L)	92.1 B	127 B	177 B	139 B
Beryllium	(ug/L)	0.1 U	0.1 U	0.1 U	0.1 U
Cadmium	(ug/L)	0.4 U	1 BU	2.7 B	0.4 U
Calcium	(ug/L)	64800	66200	77000	69900
Chromium	(ug/L)	8.9 B	1.8 B	4.1 U	4.1 U
Cobalt	(ug/L)	0.5 U	1.4 B	0.74 B	1 B
Copper	(ug/L)	1.8 B	18.5 BU	1.3 U	3.2 B
Iron	(ug/L)	21.5 U	6.3 BU	21.5 U	21.5 U
Lead	(ug/L)	2 U	2 U	12.2	2 U
Magnesium	(ug/L)	18100	19600	20300	20100
Manganese	(ug/L)	0.8 U	62.8	6.7 B	0.8 U
Mercury	(ug/L)	0.1 UJ	0.1 U	0.44	0.1 U
Nickel	(ug/L)	3.4 U	206	23.3 B	3.4 U
Potassium	(ug/L)	2840 B	1490 EJ	5340	5950
Selenium	(ug/L)	2.7 U	3.7 B	2.7 B	2.8 B
Silver	(ug/L)	0.6 U	0.8 U	0.6 U	0.6 U
Sodium	(ug/L)	11700	54500	46700	42700
Thallium	(ug/L)	4.6 U	3.4 BU	4.6 U	4.6 U
Vanadium	(ug/L)	4 B	0.7 U	2.3 B	3.7 B
Zinc	(ug/L)	18.3 BU	11.2 BEUJ	30.8	46
Zirconium	(ug/L)	31.2 U	11.6 U	31.2 U	31.2 U
Radionuclides					
Gross Alpha	(pCi/L)	2.5±1.3 U	0±1.7 U	2.6±1.6 U	4±1.8
Gross Beta	(pCi/L)	3.4±1.3	18±2	12±2	17±2
Tritium	(pCi/L)	7700±300	24000±400	25200±400	25200±400
Sr-90	(pCi/L)	0.7±0.3	0.4±0.3 U	0.3±0.3 U	0.2±0.3 U
Pu-238	(pCi/L)	ND	ND	ND	ND
Pu-239/240	(pCi/L)	ND	ND	ND	ND
Am-241	(pCi/L)	ND	ND	ND	ND
Np-237	(pCi/L)	ND	ND	ND	ND
I-129	(pCi/L)	0±0.3 U	0.3±0.3 U	1.2±0.3	0.3±0.3 U
Tc-99	(pCi/L)	0.6±0.5 U	3.1±0.5	8.5±0.6	9.4±0.6
U-234	(pCi/L)	ND	ND	ND	ND
U-235	(pCi/L)	ND	ND	ND	ND
U-238	(pCi/L)	ND	ND	ND	ND

NA - not analyzed.
ND - not detected.
NS - not sampled.
U - analyzed, not detected.
B - contaminant in blank.
R - concentration is unusable.
J - estimated concentration.

Table 4-4. (continued).

Well		LF3-09	LF3-10	USGS 36	USGS 67
Date		May-95	Aug-95	Duplicate	Duplicate
Sample Depth		500	501	477.48 to 567.1	462.34 to 698
Sample ID	Units	31333901	31334001	31334801	31335001
Field Parameters					
Temperature	(celsius)	12.83	12.96	12.75	14.03
pH		7.6	8.33	7.81	7.48
Conductivity	(msiemen)	0.681	0.771	0.486	0.875
TAL Inorganics					
Aluminum	(ug/L)	26.8 U	96.4 BU	26.8 U	NA
Antimony	(ug/L)	1.9 U	2.7 U	1.9 U	NA
Arsenic	(ug/L)	4 U	2.4 U	4 U	NA
Barium	(ug/L)	132 B	152 B	108 B	NA
Beryllium	(ug/L)	0.1 U	0.1 U	0.1 U	NA
Cadmium	(ug/L)	0.48 B	0.94 BU	0.4 U	NA
Calcium	(ug/L)	68500	65700	56000	NA
Chromium	(ug/L)	4.1 U	5.1 B	12.9	NA
Cobalt	(ug/L)	0.52 B	0.69 B	0.5 U	NA
Copper	(ug/L)	1.8 B	16.2 BU	1.8 BU	NA
Iron	(ug/L)	36.6 B	6.3 BU	21.5 U	NA
Lead	(ug/L)	13.9	2.6 B	2 U	NA
Magnesium	(ug/L)	20300	18700	14500	NA
Manganese	(ug/L)	1.8 B	10.4 B	0.8 U	NA
Mercury	(ug/L)	0.1 U	0.1 U	0.1 U	NA
Nickel	(ug/L)	24.7 B	7 B	3.4 U	NA
Potassium	(ug/L)	5030	4810 BEJ	2810 BEJ	NA
Selenium	(ug/L)	2.7 U	3.2 B	2.7 U	NA
Silver	(ug/L)	0.6 U	0.8 U	0.6 UN	NA
Sodium	(ug/L)	36500	40800	16200	NA
Thallium	(ug/L)	4.6 U	7.6 BU	4.6 U	NA
Vanadium	(ug/L)	3 B	2.5 BU	3.3 BU	NA
Zinc	(ug/L)	168	109 EJ	6.2 BEUJ	NA
Zirconium	(ug/L)	31.2 U	11.6 U	31.3 U	NA
Radionuclides					
Gross Alpha	(pCi/L)	1.8±1.4 U	2.3±1.6 U	2.9±1.3	0±1.5 U
Gross Beta	(pCi/L)	31±2	13±2	31±2	47±3
Tritium	(pCi/L)	26900±400	17600±400	6110±230	21000±400
Sr-90	(pCi/L)	0.2±0.3 U	0.7±0.3	8.6±0.5	12.8±0.5
Pu-238	(pCi/L)	ND	ND	ND	ND
Pu-239/240	(pCi/L)	ND	ND	ND	ND
Am-241	(pCi/L)	ND	ND	ND	ND
Np-237	(pCi/L)	ND	ND	ND	ND
I-129	(pCi/L)	0.9±0.3	0.2±0.3 U	0±0.3 U	0±0.3 U
Tc-99	(pCi/L)	9.4±0.6	1.8±0.5	4.8±0.8	12±1
U-234	(pCi/L)	ND	ND	ND	ND
U-235	(pCi/L)	ND	ND	ND	ND
U-238	(pCi/L)	ND	ND	ND	ND

NA - not analyzed.
ND - not detected.
NS - not sampled.
U - analyzed, not detected.
B - contaminant in blank.
R - concentration is unusable.
J - estimated concentration.

Table 4-4. (continued).

Well		USGS 121	CPP-2	USGS 47	USGS 47
Date		Duplicate	Duplicate	Jun-95	Jun-95
Sample Depth		459.12 to 475	595	462 to 470.8	483 to 491.8
Sample ID	Units	31334901	31334601	31340601	31340701
Field Parameters					
Temperature	(celsius)	12.6	15.2	16.2	16.2
pH		7.58	7.7	7.75	7.75
Conductivity	(msiemen)	0.424	0.534	0.54	0.54
TAL Inorganics					
Aluminum	(ug/L)	38.7 BU	26.8 U	NA	NA
Antimony	(ug/L)	1.9 U	1.9 U	NA	NA
Arsenic	(ug/L)	4 U	4 U	NA	NA
Barium	(ug/L)	90.7 B	96.6 B	NA	NA
Beryllium	(ug/L)	0.1 U	0.1 U	NA	NA
Cadmium	(ug/L)	0.4 U	0.4 U	NA	NA
Calcium	(ug/L)	53900	55100	NA	NA
Chromium	(ug/L)	5.1 B	4.1 U	NA	NA
Cobalt	(ug/L)	0.5 U	0.5 U	NA	NA
Copper	(ug/L)	1.3 UJ	13.5 B	NA	NA
Iron	(ug/L)	21.5 U	21.5 U	NA	NA
Lead	(ug/L)	2 U	2 U	NA	NA
Magnesium	(ug/L)	14300	16300	NA	NA
Manganese	(ug/L)	0.8 U	0.8 U	NA	NA
Mercury	(ug/L)	0.1 U	0.1 U	NA	NA
Nickel	(ug/L)	3.4 U	3.4 U	NA	NA
Potassium	(ug/L)	2380 BEJ	2890 B	NA	NA
Selenium	(ug/L)	5.5 BU	2.7 U	NA	NA
Silver	(ug/L)	0.6 NUJ	0.6 U	NA	NA
Sodium	(ug/L)	7480	8180	NA	NA
Thallium	(ug/L)	4.6 U	4.6 U	NA	NA
Vanadium	(ug/L)	3.8 BJ	4.9 B	NA	NA
Zinc	(ug/L)	9.5 B	3.6 BU	NA	NA
Zirconium	(ug/L)	ND	31.2 U	NA	NA
Radionuclides					
Gross Alpha	(pCi/L)	4.7±1.2	1.6±1 U	1.4±0.8 U	4.3±1.6
Gross Beta	(pCi/L)	3.8±1.2	3.8±1.2	105±2	267±4
Tritium	(pCi/L)	240±123 U	136±156 U	10300±300	15600±400
Sr-90	(pCi/L)	0±0.4 U	0.7±0.3 U	31±1	44±1 U
Pu-238	(pCi/L)	ND	ND	ND	ND
Pu-239/240	(pCi/L)	ND	ND	ND	ND
Am-241	(pCi/L)	ND	ND	ND	ND
Np-237	(pCi/L)	ND	ND	ND	ND
I-129	(pCi/L)	0±0.3 U	0±0.3 U	0±0.3 U	0.2±0.3 U
Tc-99	(pCi/L)	0.1±0.5 U	1.1±0.5	119±2	17±1
U-234	(pCi/L)	ND	ND	ND	ND
U-235	(pCi/L)	ND	ND	ND	ND
U-238	(pCi/L)	ND	ND	ND	ND

NA - not analyzed.
ND - not detected.
NS - not sampled.
U - analyzed, not detected.
B - contaminant in blank.
R - concentration is unusable.
J - estimated concentration.

Table 4-4. (continued).

Well		USGS 47	USGS 47	USGS 47	USGS 47
Date		Jun-95	Jun-95	Jun-95	Jun-95
Sample Depth		511.5 to 520.8	558 to 566.8	576 to 584.8	483 to 491.8
Sample ID	Units	31340801	31340901	31341001	31341101
Field Parameters					
Temperature	(celsius)	16.2	16.2	16.2	16.2
pH		7.75	7.75	7.75	7.75
Conductivity	(msiemen)	0.54	0.54	0.54	0.54
TAL Inorganics					
Aluminum	(ug/L)	NA	NA	NA	NA
Antimony	(ug/L)	NA	NA	NA	NA
Arsenic	(ug/L)	NA	NA	NA	NA
Barium	(ug/L)	NA	NA	NA	NA
Beryllium	(ug/L)	NA	NA	NA	NA
Cadmium	(ug/L)	NA	NA	NA	NA
Calcium	(ug/L)	NA	NA	NA	NA
Chromium	(ug/L)	NA	NA	NA	NA
Cobalt	(ug/L)	NA	NA	NA	NA
Copper	(ug/L)	NA	NA	NA	NA
Iron	(ug/L)	NA	NA	NA	NA
Lead	(ug/L)	NA	NA	NA	NA
Magnesium	(ug/L)	NA	NA	NA	NA
Manganese	(ug/L)	NA	NA	NA	NA
Mercury	(ug/L)	NA	NA	NA	NA
Nickel	(ug/L)	NA	NA	NA	NA
Potassium	(ug/L)	NA	NA	NA	NA
Selenium	(ug/L)	NA	NA	NA	NA
Silver	(ug/L)	NA	NA	NA	NA
Sodium	(ug/L)	NA	NA	NA	NA
Thallium	(ug/L)	NA	NA	NA	NA
Vanadium	(ug/L)	NA	NA	NA	NA
Zinc	(ug/L)	NA	NA	NA	NA
Zirconium	(ug/L)	NA	NA	NA	NA
Radionuclides					
Gross Alpha	(pCi/L)	2.3±1.2 J	2.5±1.2	4.6±1.4	1.4±1.3 U
Gross Beta	(pCi/L)	148±3	158±3	151±3	268±4
Tritium	(pCi/L)	5310±260	6130±270	7570±280	15800±400
Sr-90	(pCi/L)	40±1	41±1	42±1	44±1 U
Pu-238	(pCi/L)	ND	ND	ND	ND
Pu-239/240	(pCi/L)	ND	ND	ND	ND
Am-241	(pCi/L)	ND	ND	ND	ND
Np-237	(pCi/L)	ND	ND	ND	ND
I-129	(pCi/L)	0±0.3 U	0±0.3 U	0±0.3 U	0.8±0.3
Tc-99	(pCi/L)	62±1	23±1	63±1	18±1
U-234	(pCi/L)	ND	ND	ND	ND
U-235	(pCi/L)	ND	ND	ND	ND
U-238	(pCi/L)	ND	ND	ND	ND

NA - not analyzed.
ND - not detected.
NS - not sampled.
U - analyzed, not detected.
B - contaminant in blank.
R - concentration is unusable.
J - estimated concentration.

Table 4-4. (continued).

Well		USGS 47
Date		Jun-95
Sample Depth		596 to 604.8
Sample ID	Units	31341401
Field Parameters		
Temperature	(celsius)	N/A
pH		N/A
Conductivity	(msiemen)	N/A
TAL Inorganics		
Aluminum	(ug/L)	NA
Antimony	(ug/L)	NA
Arsenic	(ug/L)	NA
Barium	(ug/L)	NA
Beryllium	(ug/L)	NA
Cadmium	(ug/L)	NA
Calcium	(ug/L)	NA
Chromium	(ug/L)	NA
Cobalt	(ug/L)	NA
Copper	(ug/L)	NA
Iron	(ug/L)	NA
Lead	(ug/L)	NA
Magnesium	(ug/L)	NA
Manganese	(ug/L)	NA
Mercury	(ug/L)	NA
Nickel	(ug/L)	NA
Potassium	(ug/L)	NA
Selenium	(ug/L)	NA
Silver	(ug/L)	NA
Sodium	(ug/L)	NA
Thallium	(ug/L)	NA
Vanadium	(ug/L)	NA
Zinc	(ug/L)	NA
Zirconium	(ug/L)	NA
Radionuclides		
Gross Alpha	(pCi/L)	4±1.3 U
Gross Beta	(pCi/L)	80±2
Tritium	(pCi/L)	3280±220
Sr-90	(pCi/L)	29±1
Pu-238	(pCi/L)	ND
Pu-239/240	(pCi/L)	ND
Am-241	(pCi/L)	ND
Np-237	(pCi/L)	ND
I-129	(pCi/L)	0±0.3 U
Tc-99	(pCi/L)	34±1
U-234	(pCi/L)	ND
U-235	(pCi/L)	ND
U-238	(pCi/L)	ND

NA - not analyzed.
ND - not detected.
NS - not sampled.
U - analyzed, not detected.
B - contaminant in blank.
R - concentration is unusable.
J - estimated concentration.

Pu-238 was only detected in a single water sample collected from well USGS-48. The sample was collected in October 1990 and had a concentration near the MDL at 0.05±0.02 pCi/L. During 1992–1995, all plutonium measurements at the INEEL were below the reporting level (Bartholomay, 1997). Plutonium was not detected in any of the aquifer wells sampled during the WAG 3 RI field investigation of 1995.

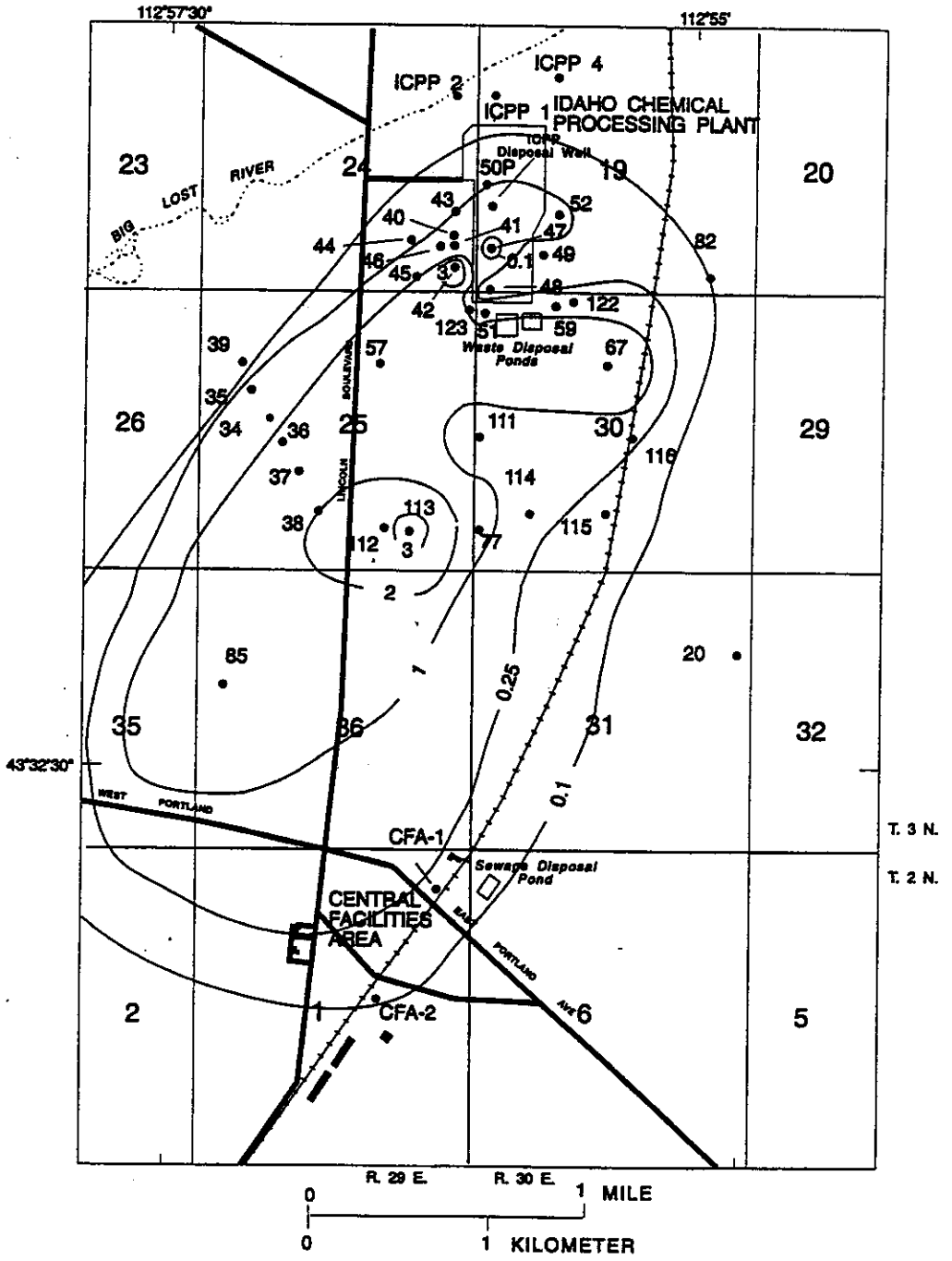
4.3.1.3 Americium-241. Americium-241 is a decay product of Pu-241 and has a half-life of 432.7 years. According to Orr and Cecil (1991), Am-241 has only been detected in the SRPA near the RWMC and TAN. Since 1988, however, Am-241 was detected in well USGS-44 during July 1992 at concentrations of 0.07±0.03 and 0.08±0.03 pCi/L, in well USGS-37 during October 1992 at a concentration of 0.09±0.03 pCi/L, and in well USGS-85 during June 1991 at concentrations of 0.08±0.03 pCi/L. During 1992–1995, all other plutonium measurements were below the reporting level (Bartholomay, 1997). During the WAG 3 RI field investigation in 1995, Am-241 was detected in well USGS-42 at a concentration of 0.54±0.14 pCi/L.

4.3.1.4 Iodine-129. From 1953 to 1983, an estimated 0.01 to 0.136 Ci/yr (0.56 to 1.18 Ci) of I-129 were contained in the waste water discharged to the disposal well (Mann et al., 1988). For 1984 to 1986, the annual amount of I-129 in the waste water discharged to the ICPP percolation ponds ranged from 0.0064 to 0.039 Ci.

Four rounds of groundwater samples (1977, 1981, 1986, and 1990–1991) have been collected by the USGS from the SRPA at the ICPP (Mann and Beasley, 1994). During 1990 through 1991, samples were collected from 50 aquifer wells. Figure 4-13 displays approximate areal extent of groundwater containing greater than 0.1 pCi/L I-129 based on the 1990–1991 sampling results. According to Mann and Beasley (1994), "In 1990–1991 concentrations of I-129 in water samples from wells that obtain water from the Snake River Plain aquifer ranged from 0.0000006±0.0000002 to 3.82±0.19 picocuries per liter (pCi/L). The mean concentration in water from 18 wells was 0.81±0.19 as compared to 1.3±0.26 in 1986." Mann et al. (1988) reported a similar decrease in I-129 groundwater concentrations between the 1981 and 1986 sampling events. Decreases in the I-129 concentration in groundwater at the ICPP are attributed to (1) the decrease in the amount of I-129 disposed annually, (2) a change in the disposal techniques from the disposal well to the percolation ponds, and (3) dilution by infiltration of stream flow from the Big Lost River.

During the WAG 3 RI, I-129 was detected in wells USGS-67, LF2-12, and LF3-08 at concentrations of 1±0.3 pCi/L, 1.2±0.3 pCi/L, and 0.9±0.3 pCi/L, respectively. Two of these wells are located several miles downgradient from the ICPP indicating the contamination is from a historical release rather than an on-going source. The limited amount of I-129 contamination in the aquifer is consistent with the observations made by Mann et al. (1988) where decreasing I-129 concentrations were attributed to decreasing I-129 disposal and the change in disposal techniques. The half-life of I-129 is 1.57E+07 years.

4.3.1.5 Tritium. A H-3 plume has developed in the SRPA since the 1950s from disposal of liquid wastes at the INEL. The principle sources of H-3 in the aquifer have been through injection of liquid wastes through the disposal well at the ICPP and discharge of waste water to the infiltration ponds at the ICPP and the TRA. It is estimated approximately 30,900 Ci of H-3 have been discharged to the SRPA at the ICPP since 1952 (Orr and Cecil, 1991). Of this amount, approximately 22,200 Ci were discharged via the disposal well at the ICPP. The remainder of the H-3 was discharged to the aquifer via the ICPP percolation ponds.



EXPLANATION

—1— LINE OF EQUAL IODINE-129 CONCENTRATION--Interval, in picocuries per liter, is variable

57 • WELL FROM WHICH WATER SAMPLE FOR IODINE-129 WAS COLLECTED IN 1990-91--Number, 57, is local well identifier; P indicates well obtains water from a perched ground-water zone. See table 2 for iodine-129 concentrations in specific wells

Figure 4-13. I-129 distribution in the SRPA during 1990–1991 (taken from Mann and Beasely, 1994).

According to Orr and Cecil (page 30, 1991), "Tritium concentrations in water from the Snake River Plain aquifer decreased by as much as 39,000 pCi/L during 1986–88. By October 1988, tritium concentrations ranged from 700±200 pCi/L to 61,600±1,100 pCi/L and the tritium plume extended southwestward in the general direction of ground-water flow. The size of the plume in which tritium concentrations exceeded 0.5 pCi/mL decreased from about 51 mi^2 in October 1985 to about 45 mi^2 in October 1988. The area of the plume containing tritium concentrations in excess of the maximum contaminant level (MCL) of 20,000 pCi/L (EPA 1989, p. 551) decreased from 4.4 to 2.8 mi^2." They attributed the reduced concentrations of H-3 and decreased size of the plume to radioactive decay processes, overall reduction in H-3 disposal rates, dilution from recharge, and changes in the disposal methods. Long term radioactive decay processes and an overall decrease in tritium disposal rates have contributed to decreased concentrations and a decrease in the area of the tritium plume at the INEEL during 1992–1995 (Figure 4-14).

The distribution of H-3 in the SRPA for May 1995 is shown in Figure 4-15. The size of the plume that exceeds the federal drinking water standard of 20,000 pCi/L is approximately 3.3 km^2 (1.3 mi^2), significantly smaller than the 7.3 km^2 (2.8 mi^2) reported in October 1988. Using these areas, the distribution of H-3 in May 1995, an aquifer thickness of 76.2 m (250 ft), and an effective porosity of 10% yields approximately 706 Ci of H-3 currently present in the SRPA. This is a rough approximation of high uncertainty due to the assumptions that were necessary for this estimate. Of the 44 aquifer monitoring wells sampled during the WAG 3 RI, water samples from 11 wells exceeded the federal MCL for H-3 of 20,000 pCi/L. H-3 concentrations from these 11 wells was a maximum of 30,700 pCi/L in well USGS-77. Historical H-3 concentrations for the USGS and CPP aquifer wells were provided in the WAG 3 RI/FS Work Plan (INEL-95/0056, Rev. 2).

4.3.1.6 Strontium-90. A plume of Sr-90 has formed downgradient from the ICPP primarily in response to the ICPP disposal well. According to Orr and Cecil (page 32, 1991), "in October 1985, the size of the strontium-90 plume where concentration exceeded 6 pCi/L was about 2 mi^2 (Pittman et al., 1988, p. 53); the concentrations of strontium-90 in wells 57 and 47 were 74±5 and 63±5 pCi/L, respectively. Strontium concentrations decreased as much as 33 pCi/L during 1986-88. By October 1988, strontium-90 concentrations ranged from 8±2 to 48±3 pCi/L, and the area of the strontium-90 plume had decreased to approximately 0.8 mi^2. The strontium-90 concentrations in wells 57 and 47, both within the plume, decreased to 41±3 and 48±3 pCi/L, respectively." They attributed the reduced areal extent and concentration of Sr-90 to the diversion of liquid radioactive wastes from the disposal well to the infiltration ponds in addition to radioactive decay, diffusion, dispersion, and dilution from natural recharge. Since 1989, concentrations of Sr-90 in water samples from most wells have remained relatively constant. Figure 4-17 depicts the plume extent for 2, 8, 40 ad 70 pCi/L based on the most recent data.

The distribution of Sr-90 in the SRPA for May 1995 is provided in Figure 4-17. The areal extent of the Sr-90 plume has decreased between October 1988 and May 1995, consistent with the previous years' trend. The size of the plume exceeding the federal drinking water standard is approximately 1.6 km^2 (0.6 mi^2). Using the distribution of Sr-90 in May 1995, an aquifer thickness of 76.2 m (250 ft), and an effective porosity of 10% yields approximately 0.27 Ci of Sr-90 currently present in the SRPA. This is a rough approximately of high uncertainty due to the assumptions that were necessary for this estimate. Of the 44 aquifer monitoring wells, water samples from 16 wells exceeded the federal drinking water standard during May 1995 of 8 pCi/L. The maximum Sr-90 concentration detected in the aquifer was 84 pCi/L in well

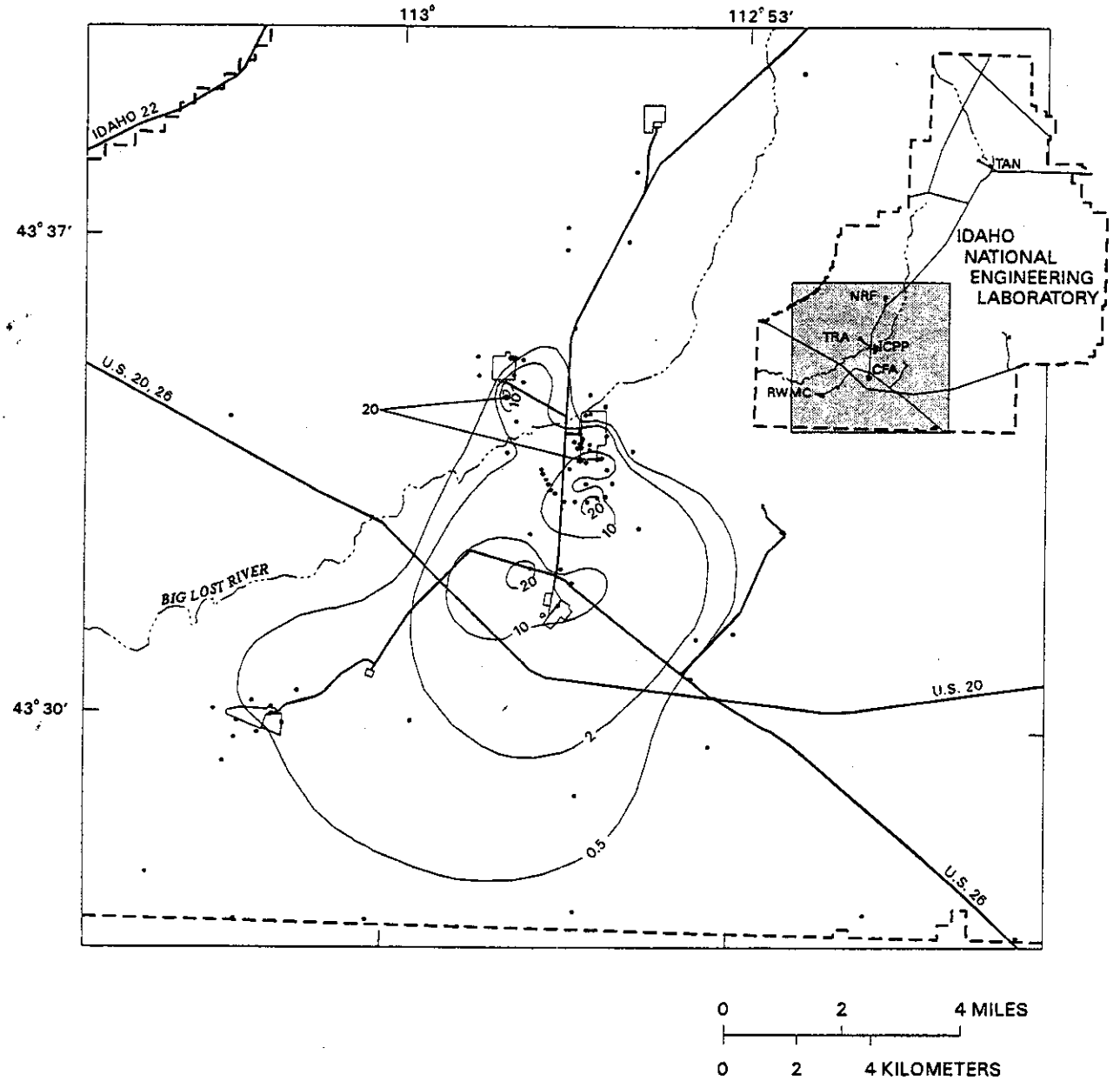


Figure 4-14. H-3 distribution in the SRPA during October 1995 (Bartholomay, 1997).

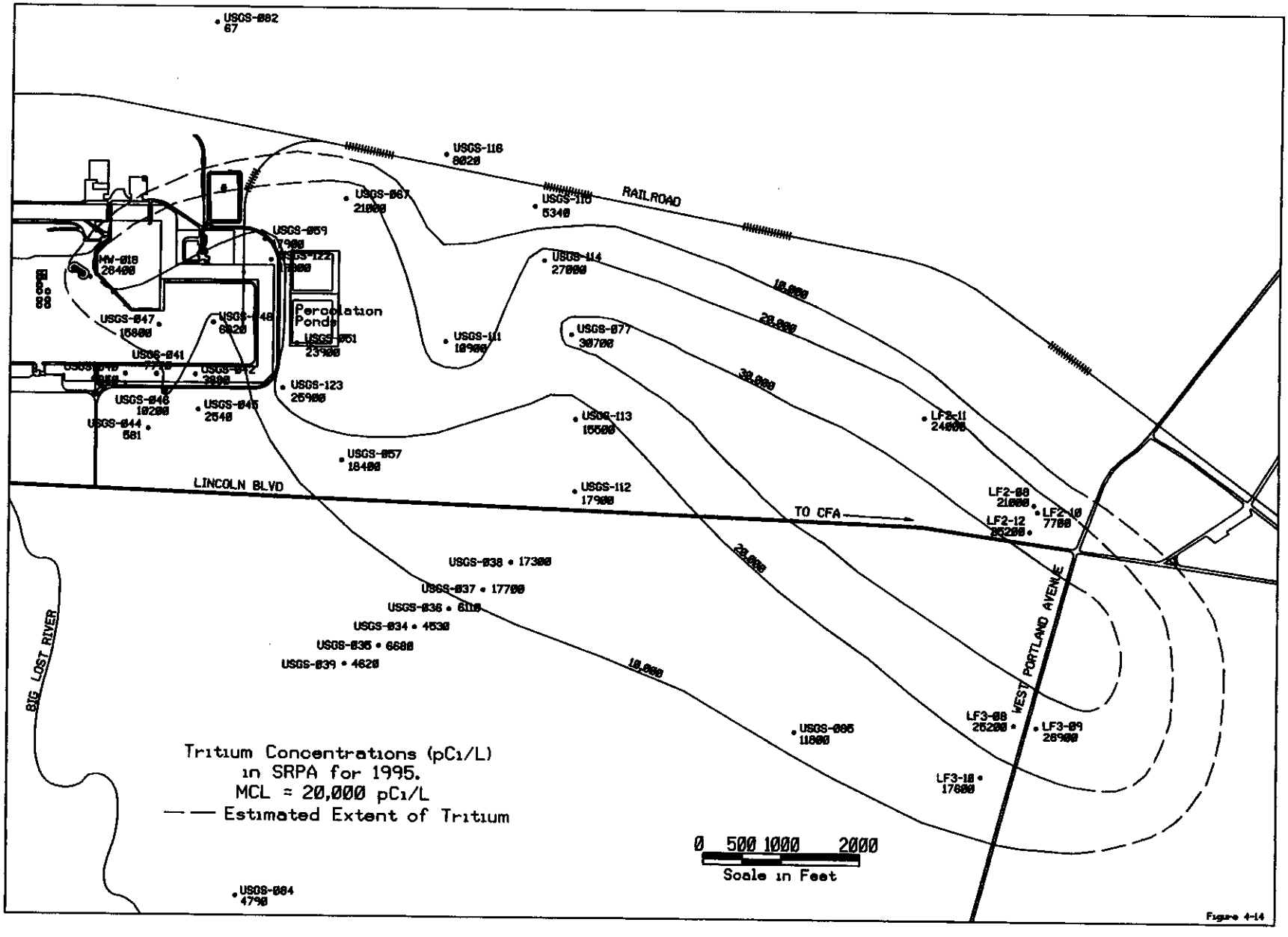


Figure 4-15. H-3 distribution in the SRPA (May 1995).

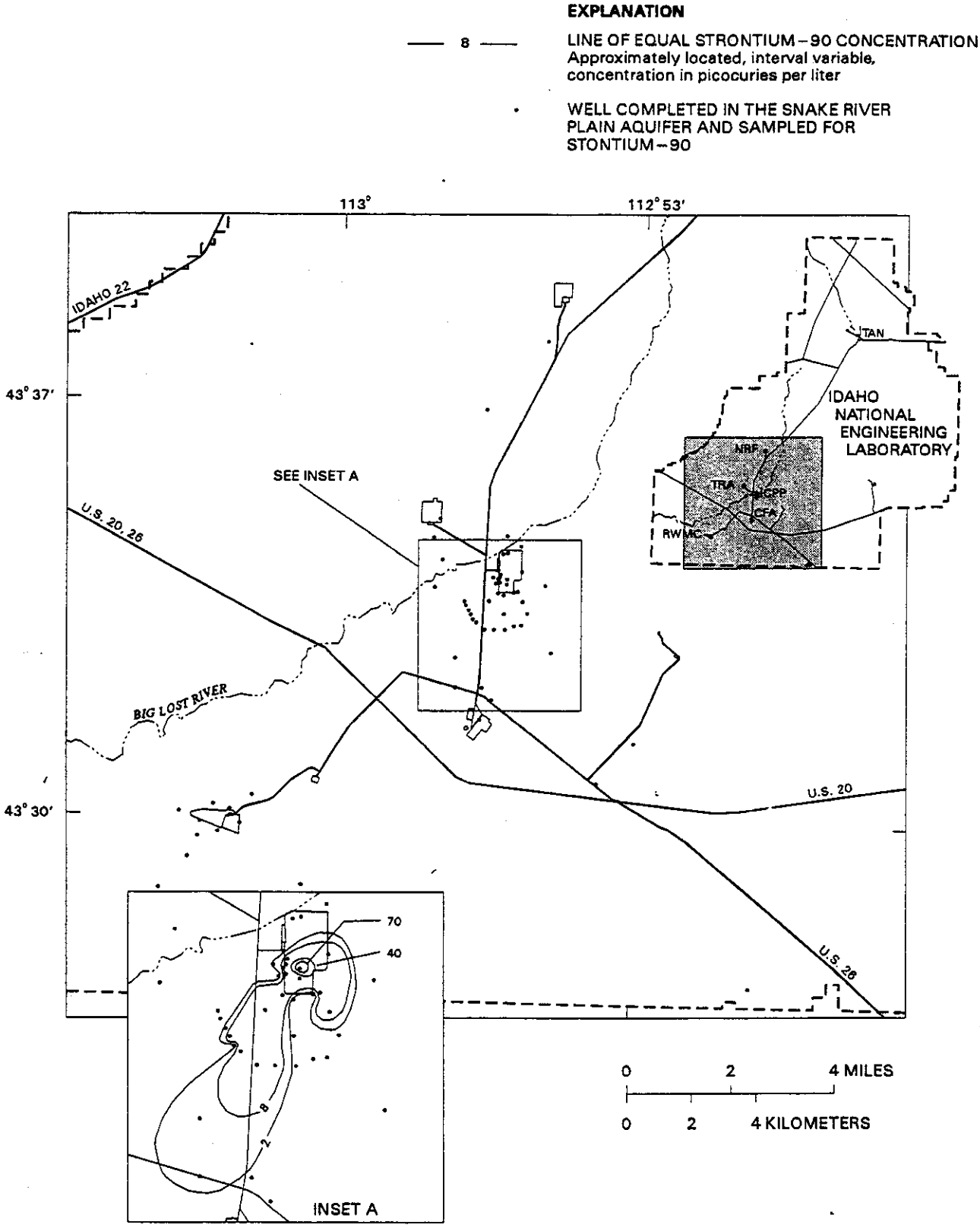


Figure 4-16. Sr-90 distribution in the SRPA during October 1995 (Bartholomay, 1997).

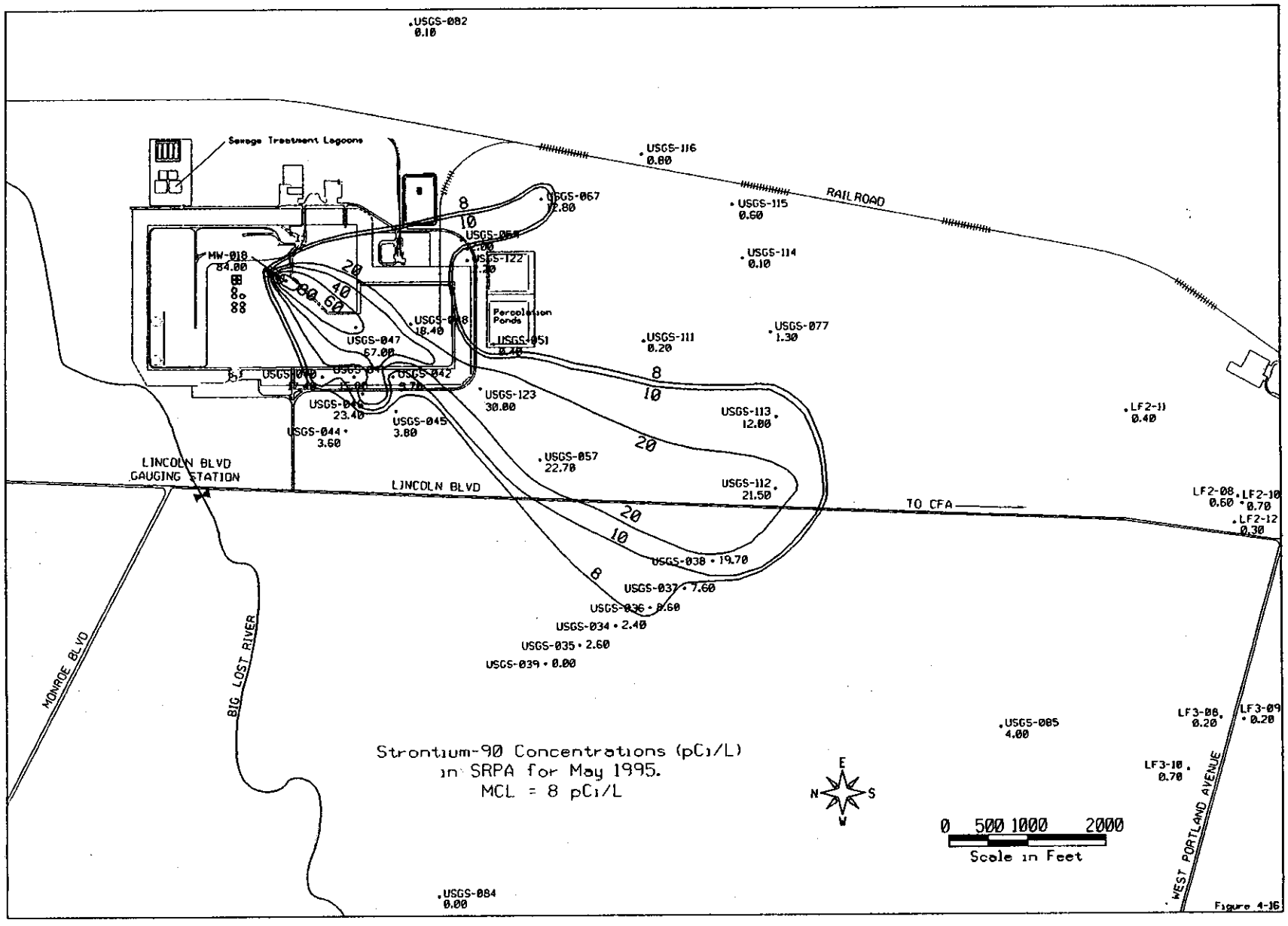


Figure 4-17. Sr-90 distribution in the SRPA (May 1995).

MW-18. Historical Sr-90 concentrations for the USGS and CPP aquifer wells were provided in the WAG 3 RI/FS Work Plan (INEL-95/0056, Rev. 2).

4.3.1.7 Technetium-99. Tc-99 was identified in 32 of the 44 wells sampled during the WAG 3 RI (Figure 4-18). The highest concentration of Tc-99 were identified in the north central portion of the ICPP in wells MW-18, USGS-47, and USGS-52 having concentrations of 448±4 pCi/L, 235±3 pCi/L, and 174±2 pCi/L, respectively. The Tc-99 plume extends to the southwest of the ICPP and includes wells USGS-123, USGS-57, and USGS-39. The maximum Tc-99 concentration outside the ICPP security perimeter fence is 49 pCi/L in well USGS-123.

4.3.1.8 Inorganics. During the WAG 3 RI, water samples were collected from all aquifer wells and analyzed for CLP metals plus zirconium. From the 44 wells tested, only the water sample from well LF2-11 exceeded a federal primary or secondary MCL. The magnesium concentration in LF2-11 was measured at 62.8 μg/L, compared to a federal secondary MCL of 50 μg/L. This well is located approximately three miles downgradient from ICPP and since magnesium was not measured in other wells above the federal secondary MCL, this contamination is not likely associated with the ICPP.

4.3.2 Background Concentrations and Regulatory Limits

The established Federal Primary and Secondary Maximum contaminant Levels (MCLs) and back ground water quality for the SRPA are included in Table 4-5 for inorganic, organic and radionuclides. The background inorganic concentration reported by the USGS in Orr et al. (1991) are for filtered groundwater samples. The Primary MCLs are the maximum permissible levels of contaminants in water delivered from a public water system. The EPA uses MCLs under the Safe Drinking Water Act as reference points for water resource protection efforts when groundwater in question is a potential source of drinking water. The Secondary MCLs control contaminants in drinking water that primarily affect the aesthetic qualities. The Secondary regulations are not Federally enforceable, but are intended as guidelines for the States.

A report by Orr et al. (1991) describes the background concentrations of selected radionuclides, organic compounds, and inorganic chemical constituents in the groundwater from the SRPA in the vicinity of INEL. This report statistically presents the median and mean concentrations for various constituents in the groundwater. This statistical interpretation is based only on sample analyses having reportable concentrations based on the instrument/method detection level. Any analyses that resulted in non-detects for a given constituent were not used for the determination of background concentrations.

4.4 Verification of Source Inventory

At the time of this writing, a number of issues were raised regarding the inventory of contaminants considered in this RI/BRA Report. Specifically, the concern focused on radioactive contaminants that, given the nature of the former reprocessing mission at the ICPP, should be present in areas where HLW solutions have been released to the soil. The presumption is that raffinates produced by the reprocessing of spent U.S. Navy nuclear fuel contains more actinides and activation and fission products than have actually been measured during recent and past field investigations. To help address this concern, the computer code

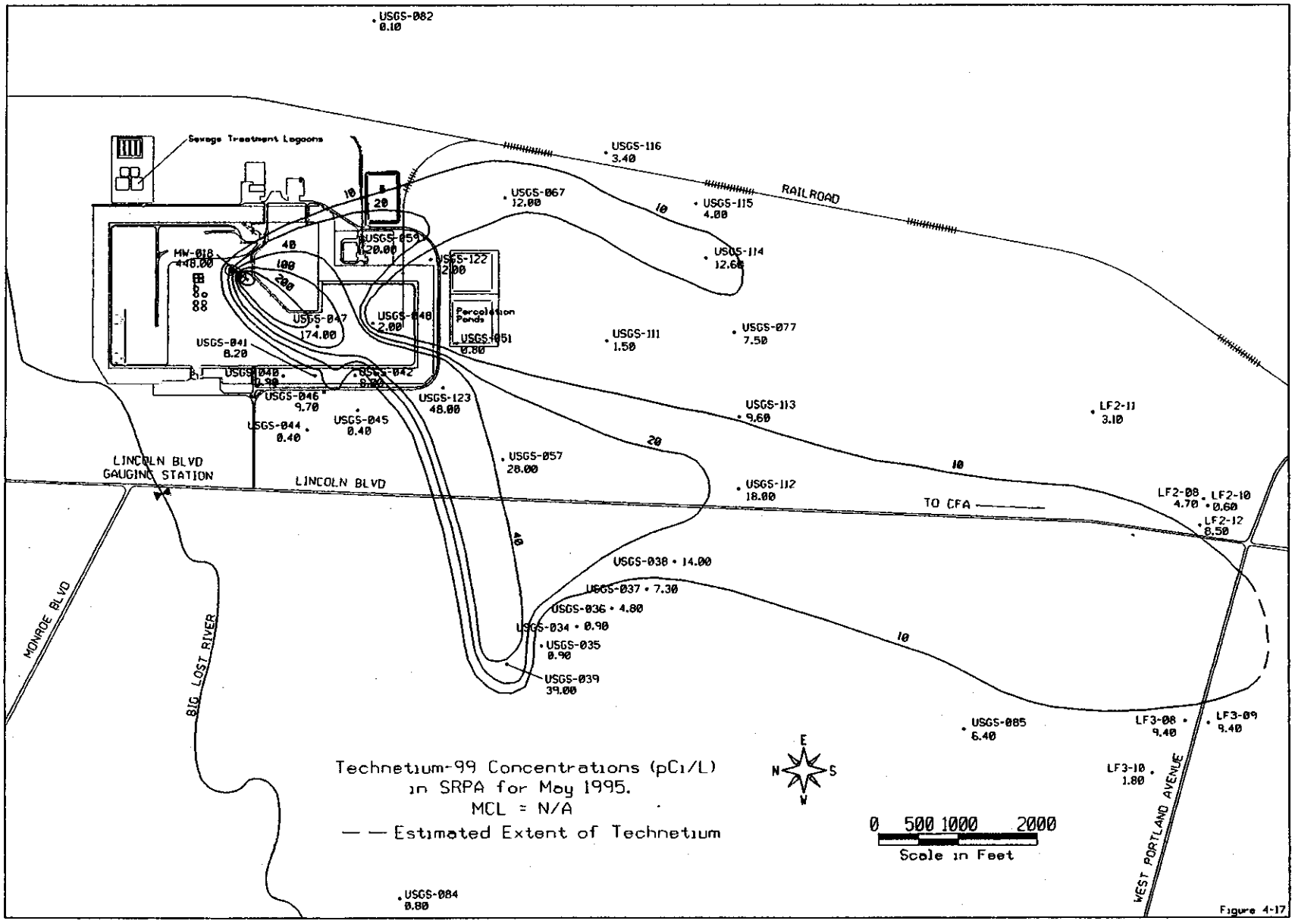


Figure 4-18. Tc-99 distribution in the SRPA (May 1995).

Table 4-5. Federal drinking water standards and background concentrations for inorganic constituents, organic constituents, and radionuclides.

Inorganic	Federal Primary Drinking Water Standard 40 CFR 141.11 (μg\L)	Federal Secondary Drinking Water Standard 40 CFR 143.3 (μg\L)	Background[a] (μg\L)
Arsenic	50	—	2–3
Barium	1,000	—	50–70
Beryllium	2,000	—	—
Cadmium	10	—	<1
Chromium	50	—	2–3
Chloride	—	250,000	—
Copper	—	1,000	—
Fluoride	4,000	2,000	400–500
Iron	—	300	—
Lead	50	—	<5
Manganese	—	50	—
Mercury	2	—	<0.1
Nitrate	10,000	—	<1,400
pH	—	6.5–8.5	—
Selenium	5	—	<1
Silver	—	—	<1
Sulfate	—	250,000	—
TDS	—	500,000	—
Thallium	200	—	—
Zinc	—	5,000	—

a. Background for Snake River Plain Aquifer in the vicinity of INEL. (From Orr et al., 1991)

Table 4-5. (continued).

Organic	Federal Primary Drinking Water Standard 40 CFR 141.12 40 CFR 141.61 (μg\L)	Background[a] (μg\L)
Volatile Organic		
Benzene	5	<0.2
Carbon Tetrachloride	5	<0.2
1,1-Dichloroethylene	7	<0.2
1,2-Dichloroethylene	5	<0.2
para-Dichlorobenzene	75	<0.2
Total trihalomethanes	100[b]	<0.2
1,1,1-Trichloroethane	200	<0.2
Trichloroethylene	5	<0.2
Vinyl chloride	2	<0.2
Pesticides/Herbicides		
Endrin	0.2	<0.01
Lindane	4	<0.01
Methoxychlor	100	<0.01
Toxaphene	5	<1
2,4-D	100	<0.01
2,4,5-TP Silvex	10	<0.01

a. Background for Snake River Plain Aquifer in the vicinity of INEL (Orr et al., 1991).

b. Sum of the concentrations of bromodichloromethane, Dibromochloromethane, bromoform, and chloroform.

Table 4-5. (continued).

Radionuclide	Federal Primary Drinking Water Standard 40 CFR 141.15 40 CFR 141.16 (pCi/mL)	Background[a] (pCi/mL)
Total Uranium[b]	—	0–0.009
Radium 226 & 228	0.005	<0.005
Radon 222	—	0–0.25
Plutonium 238	—	0
Plutonium 239,240	—	0
Americium 241	—	0
Tritium	20	0.75–0.15
Strontium 90	0.008	0
Iodine 129	—	0–0.00005
Gross alpha[c]	0.015	0–0.005
Man-made beta	Concentration causing 4 mrem/yr total body or organ dose	0–0.008
Cesium 137	—	0
Cobalt 60	—	0

a. Background for Snake River Plain Aquifer in the vicinity of INEL (Orr et al., 1991).

b. Total uranium is the sum of U-234, U-235, and U-238.

c. Gross alpha particle activity excluding radon and uranium.

ORIGEN was used to evaluate the inventory of radioactive contaminants that could be expected in the waste solutions released within several areas at the ICPP. The computer code simulates the activation, actinide, and fission product yields for the fissioning of U-235. Ideally, the composition of the nuclear fuel, cladding material, reactor time, and other information about the Navy spent fuel would need to be known to estimate the inventory and quantities of radionuclides present in the spent fuel. However, this information is sensitive and could not be obtained. The approach used to help address the issue of missing contaminants was to compare the screened results of the ORIGEN code against soil contaminant field measurements and/or assumptions used to estimate sources for use in the groundwater model. As a result, any contaminants identified as potentially missing from source estimates can be explained as uncertainty and the impact it could have on the results of the RI/BRA.

Results from two ORIGEN runs were used to provide a benchmark of the radionuclides that could be present in areas where these waste solutions were released. One of the ORIGEN runs was based on a high enrichment fuel configuration used by Oak Ridge National Laboratory (ORNL) to conduct irradiation and material studies. This ORIGEN run was already available and was developed with assumptions of 93% U-235 fuel enrichment (i.e., 285 grams of U-235 per element), aluminum cladding, 49% fissional yield (or U-235 "burn-up"), a fissionable period of 234 days, followed by a decay period of 10.8 years. The other ORIGEN run was prepared by personnel familiar with the reprocessing history at the ICPP, especially during the November 1972 release of HLW during a transfer between tanks WM-181 and WM-180, now known as site CPP-31. The assumptions for this run are described in Appendix N of the RI/BRA but include the type of fuel and extraction chemistry being used at that time.

The raw results from both ORIGEN runs each included over 150 different radionuclides. These were reduced to a more manageable number by separately placing the results of each ORIGEN run through a screening step. The technique used is that recommended by EPA in the Risk Assessment Guidance that consists of a toxicity-concentration screen whereby risk factors are calculated for each contaminant, and those having a factor of less than 0.01 can be screened out from further consideration. Since site risks are expected to be high, the factor used in this screen was lowered to 0.0001 or 0.01%. Approximately 25 radionuclides did not have health criteria and could not be evaluated. Normally, these would not screen out; however, their activity relative abundance were very small, ranging between 0.001 to 1E-10% and are not expected to contribute significantly. The contaminants contributing to a relative risk of 99.99% for both ORIGEN runs are shown on Table 4-6. Many of these radioactive contaminants have a half-life of 5 years or less and will decay by a factor of about 1E+06 or more by the year 2095. These are flagged in Table 4-6. Based on the screened results of both ORIGEN runs, the most significant radionuclides at the ICPP would be Sr-90, Cs-137, Eu-154, Am-241, Pu-238, Pu-239, Pu-240, and Pu-241.

The next step in the use of these results was to compare this inventory against what has been measured in the soil, perched water, aquifer, and the source estimates used for the tank farm releases. The purpose of this comparison is to help identify potential data gaps. The results are shown in Table 4-7. For the perched water and SRPA, they indicate that the sampling programs have included those contaminants shown by the screened ORIGEN runs to be of concern. The results of the comparisons with regard to the soil measurements at each site are further discussed in each site-specific section of this document.

Table 4-6. Summary of the results for both ORIGEN simulations.

Simulated Radionuclide Having Risk Factor > 0.01%	Half-Life (years)	Potential Problem	Reason
		ORNL Fuel	
Sr-90+D	29.1	Y	
Cs-137+D	30.0	Y	
Cs-134	2.06	N	Half-Life < 5 years
Eu-154	8.6	Y	
Eu-155	4.96	N	Half-Life < 5 years
Ce-144+D	0.8	N	Half-Life < 5 years
Ru-106+D	1.01	N	Half-Life < 5 years
Sb-125+D	2.77	N	Half-Life < 5 years
Pm-147	2.62	N	Half-Life < 5 years
Am-241	432	Y	
Pu-238	87.8	Y	
Pu-239	24,100	Y	
Pu-240	6,570	Y	
Pu-241	14.4	Y	
		CPP-31 Release	
Co-60	5.27	N	Half life is within 5% of the screening criteria.
Cs-134	2.06	N	Half-Life < 5 years
Cs-137	30.0	Y	
Eu-154	8.6	Y	
Sb-125+D	2.77	N	Half-Life < 5 years
Sr-90+D	29.1	Y	
Pm-147	2.62	N	Half-Life < 5 years
Am-241	432	Y	
Pu-238	87.8	Y	
Pu-239	24,100	Y	
Pu-240	6,570	Y	
Pu-241	14.4	Y	

Table 4-7. Summary of which nuclides were sampled for in the aquifer, perched water, and contaminated soil sites.

Site	Am-241	Cs-137	Eu-154	Pu-238	Pu-239	Pu-240	Pu-241	Sr-90
Aquifer	X	X	X	X	X	X	X	X
Perched Water	X	X	X	X	X	X	X	X
Soil Sites								
Tank Farm								
CPP-20/-25	X	X	X	X	X	X		X
CPP-26	X	X	X	X	X			X
CPP-28[a]		X	X		X	X	X	X
CPP-31[a]	X	X	X		X	X	X	X
CPP-32E/W		X	X					X
CPP-79		X	X		X	X	X	X
Tank Farm South								
CPP-15 - zone 1W CPP-15 - zone 1E CPP-15 - zone 2	X	X	X	X	X	X		
CPP-27/-33	X	X	X	X	X	X		X
CPP-58E/W	X	X	X	X	X	X		X
WCF								
CPP-35	X	X	X	X	X	X		X
CPP-36/-91 - zone 1 CPP-36/-91 - zone 2	X	X	X	X	X	X		X
CPP-85		X	X					X
Old Storage Pool								
CPP-01/-04/-05	X	X	X		X	X		X
CPP-08/09		X	X					X
CPP-10		X	X					X
CPP-11	X	X	X	X	X	X		X
Storage Yard East								
CPP-03		X						X
CPP-17A		X	X					X
CPP-17B		X						

Table 4-7. (continued).

Site	Am-241	Cs-137	Eu-154	Pu-238	Pu-239	Pu-240	Pu-241	Sr-90
WAG 3 individual sites								
CPP-06		X						X
CPP-13		X	X					X
CPP-14 Imhoff	X	X		X	X	X		X
CPP-14 Plant	X	X		X	X	X		X
CPP-14 Drain	X	X		X	X	X		X
CPP-19	X	X	X		X	X		X
CPP-22		X	X					X
CPP-34		X		X				X
CPP-37A	X	X		X				X
CPP-37B	X	X		X				X
CPP-67	X	X		X	X	X		X
CPP-89	X	X		X	X	X		X
CPP-90		X	X					X

Notes: "X's" indicate radioactive contaminants that were analyzed for in the various environmental medium. Spaces are blank in this table to indicate radioactive contaminants that have not been part of the sampling program.

a. The CPP-28 (and CPP-79) release estimate for groundwater modeling use was based on release history and not soil data therefore the "X" denotes contaminants included in the gw release. This estimate did not include Am-241 or Pu-238. See Section 9 of Appendix F for a discussion of uncertainty and/or impacts to the simulations from not including these COCs. The same comment applies to only Pu-238 at CPP-31.

4.5 References

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Chapter 5

5. SITE AND CHEMICAL SCREENING AND GROUPING OF SITES

The intent of the Remedial Investigation/Baseline Risk Assessment (RI/BRA) is to evaluate the nature and extent of contamination, fate and transport, and risks associated with site-related contamination contained within the waste area group (WAG) 3 release sites. The goal of the site and chemical screening process is to focus the RI/BRA evaluation on those sites and chemicals that will contribute significantly to the estimated cancer risk and noncarcinogenic hazard at WAG 3 and likely drive the alternatives considered in the feasibility study (FS), the decisionmaking process, and any subsequent remediation. In addition to the chemicals of potential concern (COPCs) retained from the chemical screening, within a site or group of sites, all chemicals detected should be considered in the FS to the extent they may affect the effectiveness of potential process options. Figure 5-1 illustrates the site and chemical screening processes. Sections 5.1 and 5.2 describe each screening step as depicted on Figure 5-1 and present the results of each screen. The main sources of information used in this screening process consisted of sampling results contained in the Environmental Restoration Information System (ERIS) database and/or site-specific Track 1 or Track 2 reports. In a few cases it was necessary to use other sources such as various types of investigation reports or communications with Department of Energy Idaho Operations Office (DOE-ID) personnel. Data sources are listed in the site-specific contaminant screening tables (Tables 5-2 through 5-50). Environmental Restoration projects at the INEL use the ERIS database to store data gathered as a result of field investigations. The data in ERIS have been validated and include all qualifiers indicating the quality and usability of the results. Section 5.3 provides a summary and discussion of the site and chemical screening. As proposed in the Work Plan, grouping of sites to address cumulative risk between Environmentally Controlled Areas (ECAs) was performed after completing the site and chemical screening. Grouping of the retained sites is introduced in Section 5.4.

5.1 Site Screening

Screening sites that have been determined to contain either no contamination or acceptable levels of residual contamination will allow the WAG 3 RI/BRA to focus on those sites most likely to adversely affect human health and the environment. As illustrated on Figure 5-1, the first phase of the screening process is to compile information on all release sites within WAG 3 followed by implementing two screening steps. The WAG 3 release sites, associated site descriptions, and chemicals detected are listed by OU on Table 5-1. Also included on the Table 5-1 listing is the Windblown Area.

The Windblown Area has been characterized as part of OU 10-06. Site screening Steps 1 and 2 are described below in Sections 5.1.1 and 5.1.2. The results of the site screening (retain or eliminate) are summarized in the last column on Table 5-1.

5.1.1 Step 1—Eliminate No Action/No Further Action Sites

Step 1 of the site screening identifies sites that were eliminated per the Federal Facility Agreement and Consent Order (FFA/CO) or via Track 1 or Track 2 decision statements approved by the DOE, Environmental Protection Agency (EPA), and the Idaho Department of Health and Welfare (IDHW). Sites eliminated per Step 1 either: (a) contain no source of contamination, either through process knowledge or as a result of sampling activity; or, (b) contain no source of contamination because the contaminant source has been removed. All signed (i.e., approved) decision statements were reviewed to ensure that the assumptions on which these recommendations were based remain valid. Pending decisions (i.e., 3-13) recommending no further action were assumed valid for the purposes of the RI/BRA.

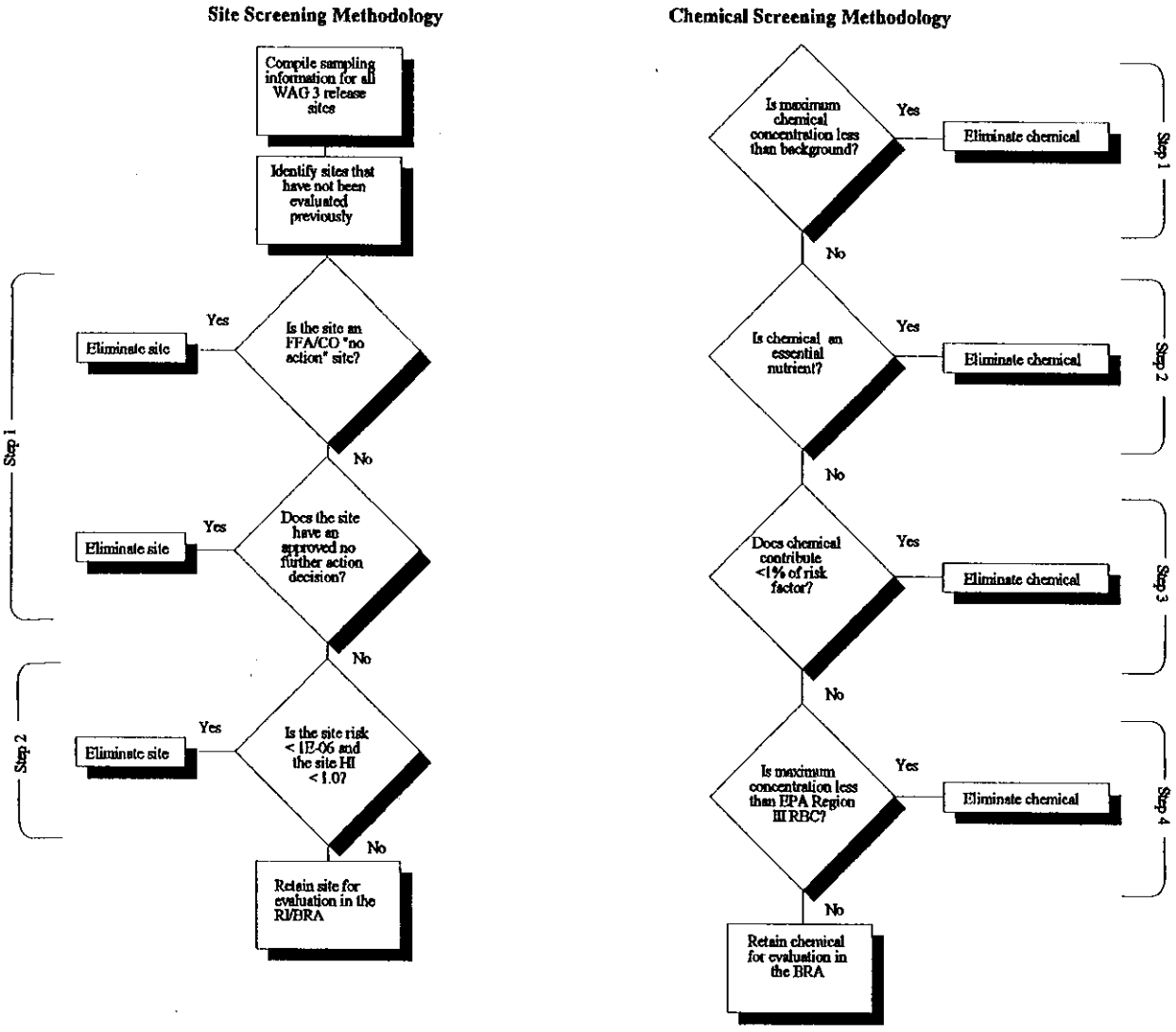

Figure 5-1. OU 3-13 site and chemical screening methodology.

5.1.2 Step 2—Eliminate Sites Below Acceptable Risk Levels

Step 2 of the site screening process is based on the results of previous risk evaluations performed under a Track 1 or Track 2 framework. All sites for which preliminary risk evaluations using Track 1 or Track 2 methods (30-year residential intrusion scenario) have shown cancer risk or hazard levels to be less than 1E-06 and 1.0, respectively, will be eliminated from further evaluation in the WAG 3 RI/BRA. It should be noted that these preliminary screening level risk evaluations are not cumulative nor comprehensive in nature, and for screening purposes assume human receptors to be the most sensitive species. For this reason, the site screening process described herein will be conducted for the human health risk assessment but sites screened here will be reevaluated for ecological concerns in Section 28.

5.2 Chemical Screening

This section describes the methodology used to screen the list of chemicals detected at those sites retained for further evaluation. The implementation of the second screening phase will result in a list of COPCs for each of the retained WAG 3 release sites. As discussed in Section 5.0, the goal of selecting COPCs in this phase of the RI/BRA is to identify those site-related chemicals that will most significantly impact the estimated cancer risks and hazard for each site at WAG 3. Once identified, COPCs will be advanced through the nature and extent evaluation, considered in the assessment of fate and transport, and included in the quantitative risk assessment for WAG 3. As illustrated on Figure 5-1, the screening of site-related chemicals is comprised of four steps: (1) background comparison, (2) essential nutrient identification, (3) concentration-toxicity evaluation, and (4) comparison against risk-based concentrations. The maximum concentration for each chemical detected at each retained site is used for screening purposes. This screening process is summarized in a series of tables (Tables 5-2 through 5-50) at the end of the section. In the series, soil source sites are presented first followed by the perched water sites identified on Table 5-1. The four screening steps are described in Sections 5.2.1 through 5.2.4.

5.2.1 Step 1—Background Comparison

The first step in the chemical screening process is to distinguish potential contamination associated with the WAG 3 release sites from nonanthropogenic (naturally occurring) background conditions. This comparison is conducted for each chemical measured at a site and is limited to metals and radionuclides. Organic contamination present at the WAG 3 release sites is assumed to be anthropogenic. The background comparison is straightforward: if the maximum concentration for a given chemical is less than or equal to background concentrations [i.e., the 95/95 upper tolerance limit (UTL) of composite background samples] as presented in *Background Dose Equivalent Rates and Surficial Soil Metal and Radionuclide Concentrations for the Idaho National Engineering Laboratory* (Rood et al., 1995), the chemical will be eliminated from quantitative evaluation in the RI/BRA. Composite background values from Rood (1995) are used for comparison because they are more conservative than the group sample background values reported in the document. The background values used in this screening step are included on the screening tables. There are a few sites where arsenic was measured approximately 2% above background levels. There are no known processes at the ICPP that include arsenic and therefore, in these cases arsenic was not evaluated quantitatively.

5.2.2 Step 2—Essential Nutrient Identification

Step 2 of the chemical screening process is an essential nutrient analysis. Site chemicals that are routinely considered to be essential nutrients will not be evaluated further in the RI/BRA unless the concentration is greatly in excess of the value. There are five metals that are affected by this screening step: calcium, iron, magnesium, potassium, and sodium (EPA, 1991).

5.2.3 Step 3—Concentration-Toxicity Screen

The objective of a concentration-toxicity screen is to identify the chemicals that based on concentration and toxicity, are most likely to contribute significantly to risks. The inputs used in this screening step include the inherent toxicity of individual chemicals and the maximum detected concentrations at specific release sites (EPA, 1989). Toxicity values used to calculate individual risk factors are slope factors (SFs) for carcinogens, or the reciprocal of the reference dose (1/RfD) for noncarcinogens as shown in Equation (5-1). Thus, the risk factor for carcinogenic effects is the maximum detected concentration (or activity) multiplied by the SF for that chemical. The risk factor for noncarcinogenic effects is the maximum detected concentration divided by the RfD for that chemical.

$$R_i = C_i \times T_i \qquad (5\text{-}1)$$

where

R_i = chemical-specific risk factor for chemical $_i$

C_i = maximum detected concentration of chemical $_i$

T_i = toxicity value (either the SF or 1/RfD) for chemical $_i$

For chemicals with separate oral and inhalation toxicity values, the most conservative value is used in the concentration-toxicity screen step. Chemicals without EPA-derived toxicity values cannot be screened out by this procedure, nor can specific health risks be estimated quantitatively. As a result, such chemicals will remain COPCs and will be discussed qualitatively in the uncertainty analysis. Radionuclides were not subject to the concentration-toxicity screen step.

To avoid eliminating chemicals prematurely, the concentration-toxicity evaluation for WAG 3 will be implemented on a contaminant-group specific basis (i.e., inorganics and organics). Chemicals having carcinogenic and noncarcinogenic effects within the inorganic and organic groups are evaluated separately. Some analytes, such as arsenic, have both noncarcinogenic and carcinogenic effects and, as a result, are included in both the carcinogenic and noncarcinogenic screens.

After calculating individual chemical risk factors, they are summed to obtain the total risk factor (Rj) for all chemicals in a medium. Individual chemical risk factors will then be divided by the total risk factor to derive a chemical-specific ratio (Ri/Rj), which provides an index of the relative risk contributed by each chemical. All chemicals that contribute less than 1% (ratio of 0.01) of the overall risk factor will be eliminated from quantitative consideration in the RI/BRA. Consequently, chemicals advanced into the quantitative risk assessment will represent the COPCs expected to provide the most significant contribution to the risk at a particular site.

5.2.4 Step 4—Risk-Based Concentration Screen

The last step in the chemical screening process is to compare potential contaminants associated with the WAG 3 release sites with risk-based concentrations (RBCs). This comparison is conducted for each chemical measured at a site that had survived chemical screening Steps 1 through 3. The comparison is limited to metals, inorganics, and organics. The RBC comparison is straightforward: if the maximum concentration for a given chemical is less than or equal to the most conservative RBC as presented in EPA Region III Risk-based Concentration Table (October 1995), the chemical will be eliminated from quantitative

evaluation in the RI/BRA. One exception is lead. Because lead does not have an EPA Region III RBC, lead concentrations were compared to the residential soil screening level of 400 mg/kg as presented in EPA (1994).

5.3 Discussion

The results of the site and chemical screening processes aid in focusing the RI/BRA and ultimately, the FS for WAG 3. In addition to the COPCs retained from the chemical screening, all chemicals detected within a site or group of sites should be considered in the FS to the extent they affect the effectiveness of potential process options. As summarized in Table 5-51, all sites and COPCs retained from these screening processes will be considered for the RI/BRA. In some cases professional judgment can be used to determine if a site should be retained for further quantitative evaluation beyond the screening stage. This judgment was based on the evaluation of the extent and magnitude of a chemical's occurrence above background values. The assessment of nature and extent of contamination in the site-specific sections of this report describes the conditions observed at each release site and where professional judgment was conservatively employed to focus the BRA for WAG 3. For example, Section 8 discusses several sites that have been tentatively identified as sites containing negligible contamination. Based on a review of the maximum concentrations for CPP-46, CPP-61, CPP-78, and the Windblown Area, it was concluded that these sites likely do not have contamination significantly above background and/or are present at levels less than a cleanup level and, based on professional judgment, should be evaluated qualitatively rather than quantitatively.

5.4 Grouping of Sites

The retained sites have been grouped based on magnitude of contamination above background, or depth of contamination, and based on the areas impacted by remediation. Generally these groups consist of sites with similar contaminant sources and, as a result, will likely be remediated together; however, there is a possibility that different groupings will be identified in the WAG 3-13 FS. The groupings and individual sites to be further evaluated in the RI/BRA are illustrated on Figure 5-2. A group is comprised of the sites listed by the group name. As shown on Figure 5-2, the first group is Sites with Negligible Soil Contamination. These sites have been tentatively identified for further qualitative rather than quantitative evaluation in the WAG 3 RI/BRA because the contaminant levels are only slightly above background. It should be noted that CPP-40 is included in this group and the explanation leading to this decision is discussed in Section 8. The second group listed on Figure 5-2 is Sites of Exclusive Ground Water Concern. As indicated on Figure 5-2, the contamination present at the sites included in this group is present at depths greater than 3.05 m (10 ft) below ground surface (bgs). Given this, these sites may influence groundwater; however, the surface pathways are incomplete. The next five groups: Tank Farm, Tank Farm South, Waste Calcining Facility (WCF), Old Storage Pool, and Storage Yard East of CPP-603 have been grouped based on the areas impacted by remediation. Generally, these groups consist of sites with similar contaminant sources and, as a result, will likely be remediated together, however there is a possibility that different groupings will be identified during the OU 3-13 feasibility study. The groups were defined jointly with personnel from the project team, EPA, and IDHW. Sites that are evaluated individually are physically separate and require individual evaluation. These sites are identified on Figure 5-2 as the WAG 3 Individual Sites.

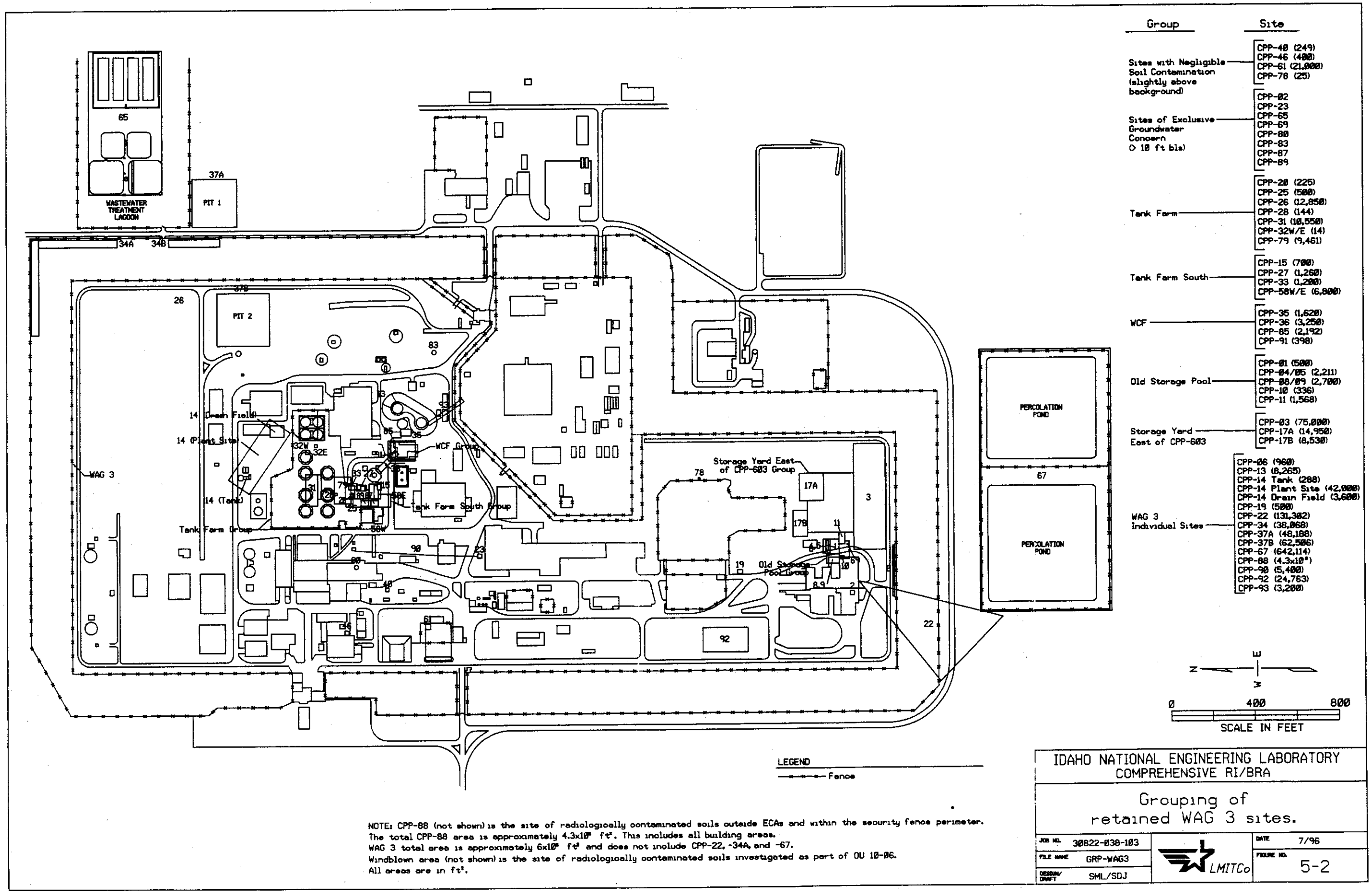

Figure 5-2. Grouping of retained WAG 3 sites.

Table 5-1. Summary of the site screening for WAG 3 release sites.

OU/Site	Description	Chemical(s) detected and/or removal actions	Step 1: Site has a signed No Action or No Further Action decision	Step 2: Risk estimates for the site indicate risk <1E-06 and HQ <1.0	Eliminate/retain site for the OU 3-13 RI/BRA
00/CPP-43 Grease Pit South of CPP-637	Disposal of an unknown quantity of oil and grease.	No source	Yes—FFA/CO	—	Eliminate
00/CPP-52 Pickling Shed East of CPP-631	Used to treat piping with mineral acids. No record of spillage or leakage.	No source	Yes—FFA/CO	—	Eliminate
00/CPP-70 Septic Tank East of CPP-655	Septic tank only; no record of hazardous waste entering the system.	No source	Yes—FFA/CO	—	Eliminate
00/CPP-71 Seepage Pits West of CPP-655	Seepage pits were used in conjunction with septic tank CPP-70.	No source	Yes—FFA/CO	—	Eliminate
00/CPP-72 CPP-758 Cesspool East of CPP-651	Cesspool connected to bathrooms from temporary office trailers.	No source	Yes—FFA/CO	—	Eliminate
00/CPP-73 Leaching Cesspool East of CPP-T-5	Cesspools connected to a temporary building.	No source	Yes—FFA/CO	—	Eliminate
00/CPP-74 Seepage Pit West of CPP-626	Seepage pit and septic tank were connected to a building that contained no hazardous material.	No source	Yes—FFA/CO	—	Eliminate
00/CPP-75 Septic Tank West of CPP-603	The septic tank was connected to the bathroom and was physically separated from hazardous substances.	No source	Yes—FFA/CO	—	Eliminate
00/CPP-76 Septic Tank West of CPP-659	The septic system was removed and there is no known record of hazardous wastes entering the unit.	No source	Yes—FFA/CO	—	Eliminate
00/CPP-77 Seepage Pit and Cesspool North of CPP-662	The seepage pit and cesspool have no known records of hazardous wastes entering the units.	No source	Yes—FFA/CO	—	Eliminate

Table 5-1. (continued).

OU/Site	Description	Chemical(s) detected and/or removal actions	Step 1: Site has a signed No Action or No Further Action decision	Step 2: Risk estimates for the site indicate risk <1E-06 and HQ <1.0	Eliminate/retain site for the OU 3-13 RI/BRA
3-01/CPP-49 PCB Transformer Yard (CPP-705)	A transformer oil spill with polychlorinated biphenyl (PCB) contamination occurred on the cement pad. The pad has been encapsulated.	Residual PCB remains in concrete (21.9 parts per million [ppm]) and soil (≤1 ppm)	Yes—T1 was approved 4/92	—	Eliminate
3-01/CPP-50 PCB Transformer Yard (CPP-731)	A PCB spill occurred on the concrete pad. The spill was restricted to the concrete pad.	PCB source was removed	Yes—T1 was approved 4/92	—	Eliminate
3-01/CPP-51 PCB Staging Area West of CPP-660	Transformer leak of PCBs. The plastic sheeting on which the transformer oil leaked has been removed.	PCB source was removed but residual remains in soil (<0.12 ppm)	Yes—T1 was approved 1/93	—	Eliminate
3-01/CPP-61 PCB Spill in CPP-718 Transformer Yard	This site is the result of an oil spill containing PCBs. Because of radioactively-contaminated soil, the site was deferred to the WAG 3 Comprehensive RI/FS for further evaluation. (See entry below.)	PCB source was removed but residual remains in soil (<10 ppm)	Yes—T1 was approved 1/93	—	Eliminate
3-01/CPP-61 PCB Spill in CPP-718 Transformer Yard-Radiological contamination	This site is the result of an oil spill containing PCBs; however, potential radiological contamination was identified during removal activities	Radionuclides	No—T1 was approved 1/93 recommending further evaluation in RI/FS	Not determined	Retain
3-02/CPP-07 Contaminated Soil NW of CPP-642	Radioactively-contaminated condensate from the basin waste collection tank.	Source and contamination was removed	Yes—T1 was approved 1/93	—	Eliminate
3-02/CPP-12 Contaminated Paint Chips and Pad South of CPP-603	Radioactively-contaminated paint chips from the cement pad.	Source and contamination was removed	Yes—T1 was approved 1/93	—	Eliminate
3-02/CPP-18 Gas Storage Building CPP-668	Open-sided building used to store radioactively-contaminated gas cylinders.	Source and contamination was removed	Yes—T1 was approved 9/92	—	Eliminate
3-02/CPP-21 Solid Waste Storage Bin South of CPP-668	Solid waste including paper rags and contaminated metal was collected in bins before being sent to the RWMC.	Source and contamination was removed	Yes—T1 was approved 4/93	—	Eliminate

Table 5-1. (continued).

OU/Site	Description	Chemical(s) detected and/or removal actions	Step 1: Site has a signed No Action or No Further Action decision	Step 2: Risk estimates for the site indicate risk <1E-06 and HQ <1.0	Eliminate/retain site for the OU 3-13 RI/BRA
3-02/CPP-23 CPP Injection Well	Injection well used for disposal of cooling water and condensate containing low levels of radioactivity. Sediments contained in the well were contaminated by the materials injected and act as a residual source.	Radionuclides, metals, and PCBs	No—T2 recommended further evaluation in RI/FS	Yes	Retain[a]
3-02/CPP-37A CPP Gravel Pits #1 and #2	Pit #1 was used for the decontamination of radioactively-contaminated equipment and as a temporary percolation pond for ICPP service waste water.	Radionuclides, metals, and organics	No—T2 recommended further evaluation in RI/FS	No	Retain
	Pit #2 was used for disposal of water from the sludge dewatering pit of the old sewage treatment plant. Also used to dispose of construction debris.	Radionuclides, metals, and organics	No—T2 recommended further evaluation in RI/FS	No	Retain
3-02/CPP-41 Fire Training Pits (41A and 41B) between CPP-602 and CPP-603	Consisted of two pits where oils and organic materials were placed in metal drip pans and ignited for fire extinguishing practice.	Source was removed when building CPP-666 and CPP-663	Yes—T1 was approved 1/93	—	Eliminate
3-02/CPP-53 Paint and Paint Solvent Area South of CPP-697	The area was used for storage of 30 to 40 drums of paint and paint solvents.	Source was removed. Characterization results indicate organic contaminants were below detection and metals are below background values.	Yes—T1 was approved 1/93	—	Eliminate
3-02/CPP-54 Drum Storage Area West of CPP-606	The area was used to store 30 to 40 drums of organic solvents and used oil on pallets.	Source was removed. Characterization results indicate organic and metals concentrations were either below risk-based concentrations or below background values.	Yes—T1 was approved 1/93	—	Eliminate
3-02/CPP-55 Mercury Contaminated Area South of CPP-T-15	Paint solvents were discarded to the soil adjacent to building CPP-T-15.	Characterization results indicate that organic contaminants, chromium, lead, and mercury were measured either below risk-based concentrations or below background.	Yes—T1 was approved 4/93	—	Eliminate

Table 5-1. (continued).

OU/Site	Description	Chemical(s) detected and/or removal actions	Step 1: Site has a signed No Action or No Further Action decision	Step 2: Risk estimates for the site indicate risk <1E-06 and HQ <1.0	Eliminate/retain site for the OU 3-13 RI/BRA
3-02/CPP-57 Sulfuric acid Spills East of CPP-606	Sulfuric acid spilled and leaked from a tank near CPP-606.	Contaminated soil resulting from spill was removed.	Yes—T1 was approved 1/93	—	Eliminate
3-02/CPP-59 Kerosene Tank Overflow West of CPP-633 Zone 1	CPP-59 Zone 1 is the site of kerosene spills of 53 L 200 gal because of tank overflow.	Kerosene	Yes—T2 recommendation for No Further Action was approved	—	Eliminate
3-02/CPP-59 Kerosene Tank Overflow West of CPP-633 Zone 2	CPP-59 is the site of kerosene spills of an estimated 16 L (60 gal) because of tank overflow.	Kerosene, xylene	Yes—T2 recommendation for No Further Action was approved	—	Eliminate
3-02/CPP-60 Paint Shop at Present Location of CPP-645	CPP-60 is the site of the old paint shop, which was removed and CPP-645 was built.	Source and contamination (if any) were removed when CPP-645 was built.	Yes—T1 was approved 1/93	—	Eliminate
3-02/CPP-62 Mercury Contaminated Area Near CPP-TB-4	CPP-62 is the site where spent paint solvents were discarded into the soil.	Source and contaminated soil was removed.	Yes—T1 was approved 9/92	—	Eliminate
3-02/CPP-63 Hexone Spill by CPP-710	A 13 L (50 gal) hexone spill caused by damage to a line.	Source was removed. Characterization results indicate hexone was below the detection level.	Yes—T1 was approved 4/93	—	Eliminate
3-02/CPP-64 Hexone Spill West of CPP-660	Hexone was spilled on a concrete pad due to a pierced barrel in Zone 1 and vermiculite was used to absorb the hexone. This vermiculite and contaminated snow were moved across the road to Zone 2.	Contamination resulting from spill was removed.	Yes -T1 was approved 9/92	—	Eliminate
3-02/CPP-65 CPP Sewage Treatment Plant Lagoons—Sediments	CPP-65 consists of two aerated lagoons, two stabilization lagoons, four infiltration trenches, and six weir boxes. These facilities receive wastewater from the sewage treatment plant, which receives sanitary waste from 31 buildings at the ICPP. The lagoons are still in use. The site will be evaluated as a perched water source only. The Track 1 indicated the sediments were nonhazardous and not radioactively contaminated.	Radionuclides, metals, inorganics, and organics	No—T1 was approved 6/94 and recommended further evaluation in RI/FS	Not determined	Retain[a]

Table 5-1. (continued).

OU/Site	Description	Chemical(s) detected and/or removal actions	Step 1: Site has a signed No Action or No Further Action decision	Step 2: Risk estimates for the site indicate risk <1E-06 and HQ <1.0	Eliminate/retain site for the OU 3-13 RI/BRA
3-02/CPP-66 CPP CFSGP Fly Ash Pit	CPP-66 is the site of an ash pit currently used for disposal of ash generated by the Coal-Fired Steam Generation Facility.	Radionuclides and metals	Yes—T1 was approved 4/94 and recommended No Further Action. However, this decision is to be revisited in the Record of Decision (ROD) with regard to solid waste regulations	Not determined	Eliminate
3-02/CPP-68 Abandoned Gasoline Tank CPP VES-UTI-652	CPP-68 is the site where a 132 L (500 gal) underground gasoline storage tank was removed.	Source was removed.	Yes—T1 was approved 4/93	—	Eliminate
3-03/CPP-67 CPP Percolation Ponds #1 and #2 - Sediments	CPP-67 consists of two unlined percolation ponds. The ponds received service wastewater consisting primarily of cooling water and condensed steam generated by various ICPP operations. Resource Conservation and Recovery Act (RCRA) clean-closure equivalency was achieved for the nonradioactive contamination in Pond #1 and Pond #2 in 4/94 and 5/95, respectively. Radiological contamination will be assessed.	Radionuclides, metals, inorganics, and organics	No—T1 was approved 6/94 recommending further evaluation in RI/FS	Not determined	Retain
3-04/CPP-38 Friable Transite	CPP-38 is the site of nine CPP buildings with outside walls containing transite, which is 40% asbestos. Asbestos abatement work outside the FFA/CO is proposed for this site.	Asbestos	Yes—T1 was approved 6/93; however the decision with regard to the asbestos abatement program will be updated in the ROD	—	Eliminate
3-05/CPP-14 Imhoff Tanks	The unit was divided into three sites for risk analysis. CPP-14 is the site of a decommissioned sewage treatment plant. The plant processed sanitary waste from nine facilities at the ICPP. The facility was decommissioned and demolished in 1983 except for underground structures. The Imhoff tank area is limited to the sludge that remains in the two tanks. The tanks are not intact.	Radionuclides, metals, PCBs, and organics	No—T2 recommended further evaluation in RI/FS	No	Retain

Table 5-1. (continued).

OU/Site	Description	Chemical(s) detected and/or removal actions	Step 1: Site has a signed No Action or No Further Action decision	Step 2: Risk estimates for the site indicate risk <1E-06 and HQ <1.0	Eliminate/retain site for the OU 3-13 RI/BRA
3-05/CPP-14 Plant Site	CPP-14 is the site of a decommissioned sewage treatment plant. The plant processed sanitary waste from nine facilities at the ICPP. The facility was decommissioned and demolished in 1983 except for underground structures. The plant site consists of the soil where the remaining facilities were demolished.	Radionuclides, metals, PCBs, and organics	No—T2 recommended further evaluation in RI/FS	No	Retain
3-05/CPP-14 Drain Field	CPP-14 is the site of a decommissioned sewage treatment plant. The drain field consists of the soil that received treated water from the sewage treatment plant and the soil where the piping associated with the drain field was removed.	Radionuclides, metals, and organics	No—T2 recommended further evaluation in RI/FS	No	Retain
3-06/CPP-33 Contaminated Soil in the Tank Farm Area NE of CPP-604	CPP-33 is the site of a high-level liquid waste (HLLW) subsurface release from a leak of the Tank Farm transfer system. In 1974, the leak was discovered and 229 m^3 (300 yd^3) of soil were removed. Additional soil contamination was encountered in 1983, which was attributed to the same leak and 10,704 m^3 (14,000 yd^3) of soil were removed. Since the contamination is from the same transfer line (different release), this site was recommended for inclusion in the CPP-27 Track 2 investigation (see CPP-27 and discussion below).	Radionuclides, metals, and trichloroethylene	No—T1 approved 6/93 recommending further evaluation with CPP-27	No	Retain and address with CPP-27
3-06/CPP-34 Soil Storage Area in the NE Corner of the ICPP	CPP-34 is the site of three trenches that were used to store radioactively-contaminated (<30 mR/h) soil from the "hot dirt" pile located east of CPP-603. The trenches are located in the northeast corner of the ICPP.	Radionuclides, metals, and bis (2-ethylhexyl)phthalate, and fluoride	No—T1 approved 3/94 recommended further evaluation in RI/FS	No	Retain
3-06/CPP-40 Lime Pit at the Base of the CPP-601 Berm and French Drain	CPP-40 is the site of a lime pit and associated piping that were used to neutralize leaks and spills of hydrofluoric acid from the product makeup area of CPP-601. The pit was filled with powdered lime to neutralize the hydrofluoric acid. Radiological contamination was encountered during decontamination. (See entry below.)	Chromium Lead Fluoride	Yes—T1 was approved 6/94	—	Eliminate

Table 5-1. (continued).

OU/Site	Description	Chemical(s) detected and/or removal actions	Step 1: Site has a signed No Action or No Further Action decision	Step 2: Risk estimates for the site indicate risk <1E-06 and HQ <1.0	Eliminate/retain site for the OU 3-13 RI/BRA
3-06/CPP-40 Lime Pit at the Base of the CPP-601 Berm and French Drain—Radiological Contamination	CPP-40 is the site of a lime pit and associated piping that were used to neutralize leaks and spills of hydrofluoric acid from the product makeup area of CPP-601. Radiological contamination was encountered during decontamination.	Radionuclides	No—T1 approved 6/94 recommended further evaluation in RI/FS	Not determined	Retain
3-06/CPP-47 Pilot Plant Storage Area West of CPP-620	CPP-47 is located west of the southwest corner of CPP-620 and was the location where 44 Molar hydrofluoric acid was stored for use in the ICPP Pilot Plant Operation. Sometime in 1984, approximately 0.5 L (2 gal) of hydrofluoric acid were spilled at this site.	Fluoride	Yes—T1 was approved 9/92	—	Eliminate
3-07/CPP-16 Contaminated Soil from Leak in Line from CPP WM-181 to PEW	CPP-16 is the site of approximately 793 L (3,000 gal) of low-level contaminated wastewater released during routine transfer of solution from WM-181 to the PEW feed tank WL-102. The release was caused by a failure of the diversion valve flange gasket.	Contaminated soil was removed during construction of a new valve box.	Yes—T2 recommendation was approved	—	Eliminate
3-07/CPP-20 CPP-604 Radioactive Waste Unloading Area	CPP-20 is the location of the Radioactive Waste Unloading Area north of CPP-604. Wastes from other INEL facilities were transported to the ICPP where they were unloaded via transfer hoses to an underground storage tank before concentration in the PEW Evaporator. The entire area was excavated and replaced with low-level radioactively-contaminated backfill during upgrades in the Tank Farm.	Radionuclides, and metals	T2 recommendation was approved with the exception of the backfill material to be evaluated in RI/FS	Not determined	Retain[b] and evaluate with Tank Farm Group (CPP-20, 25, 26, 28, 31, 32, 79, and soil stockpile)
3-07/CPP-24 CPP Tank Farm Area Bucket Spill	CPP-24 was the site of a small bucket spill [0.26 L (1 gal)] of radioactively-contaminated solution. The site was in the vicinity of one of the HLLW tank WM-180 risers.	Contaminated soil was removed.	Yes—T2 recommendation was approved	—	Eliminate

Table 5-1. (continued).

OU/Site	Description	Chemical(s) detected and/or removal actions	Step 1: Site has a signed No Action or No Further Action decision	Step 2: Risk estimates for the site indicate risk <1E-06 and HQ <1.0	Eliminate/retain site for the OU 3-13 RI/BRA
3-07/CPP-25 Contaminated Soil in Tank Farm Area North of CPP-604	CPP-25 is the site of a line rupture near CPP-604, which contaminated the building and adjacent soil. The area was excavated due to upgrades in the Tank Farm and low-level radioactively-contaminated soil was used as backfill.	Radionuclides, and metals	T2 recommendation was approved with the exception of the backfill material to be evaluated in RI/FS	Not determined	Retain[b] and address with Tank Farm Group (CPP-20, 25, 26, 28, 31, 32, 79, and soil stockpile)
3-07/CPP-26 Contaminated Soil in Tank Farm Area Steam Flushing— Operation outside the Tank Farm perimeter	CPP-26 is the site of a radioactive steam release through a faulty hose coupling during flushing of the decontamination header. This release is assumed to have contaminated 13 acres to the northeast of CPP-635. The contaminated area has been designated as "inside" and "outside" the Tank Farm perimeter.	Radionuclides, metals, inorganics, and toluene	Yes—T2 recommendation was approved for outside area	—	Eliminate
3-07/CPP-26 Contaminated Soil in Tank Farm Area Steam Flushing—Operation inside the Tank Farm perimeter	CPP-26 is the site of a radioactive steam release through a faulty hose coupling during flushing of the decontamination header. This release is assumed to have contaminated 13 acres to the northeast of CPP-635. The contaminated area has been designated "inside" and "outside" the Tank Farm perimeter.	Radionuclides, metals, inorganics, and toluene	No—T2 recommended further evaluation in RI/FS	No	Retain and address with Tank Farm Group (CPP-20, 25, 26, 28, 31, 32, 79, and soil stockpile)
3-07/CPP-28 Contaminated Soil in the Tank Farm Area South of WM-181 by Valve Box A-6	CPP-28 is the site where approximately 32 L (120 gal) of high-level radioactive liquid waste was leaked to the soil from a 7.6 cm (3 in.) diameter stainless steel transfer line. This line was used to transfer radioactive first-cycle-extraction waste solution from the uranium recovery process to the underground storage tanks in the Tank Farm.	Radionuclides, metals, and inorganics	No—T2 recommended further evaluation in RI/FS	No	Retain and address with the Tank Farm Group (CPP-20, 25, 26, 28, 31, 32, 79, and soil stockpile)

Table 5-1. (continued).

OU/Site	Description	Chemical(s) detected and/or removal actions	Step 1: Site has a signed No Action or No Further Action decision	Step 2: Risk estimates for the site indicate risk <1E-06 and HQ <1.0	Eliminate/retain site for the OU 3-13 RI/BRA
3-07/CPP-30 Contaminated Soil in Tank Farm Area Near Valve Box B-9	CPP-30 is an area of radioactively-contaminated soil near the Tank Farm Valve Box B-9. The contamination covered an area of approximately 37 m^2 (400 ft^2). The contamination was from a one time preventative maintenance activity in which residual decontamination solution from the valve box floor contaminated personnel clothing and equipment that was placed on blotter paper at this site. The paper leaked and contaminated the soil.	Contaminated soil was removed.	Yes—T2 recommendation was approved	—	Eliminate
3-07/CPP-31 Contaminated Soil in Tank Farm Area South of Tank WM-183	CPP-31 is the site of a release of approximately 3,703 L (14,000 gal) of HLLW to surrounding soils during a transfer between tank WM-181 and WM-180. The release was caused by the failure of a 7.6 cm (3 in.) diameter WRN-1037 carbon steel waste transfer line.	Radionuclides, metals, and inorganics	No—T2 recommended further evaluation in RI/FS	No	Retain and address with the Tank Farm Group (CPP-20, 25, 26, 28, 31, 32, 79, and soil stockpile)
3-07/CPP-32W/E Contaminated Soil in the Tank Farm area of Valve Box B-4	CPP-32W is the site of a release of radioactive liquid from a 5.1-cm (2-in.) aboveground transfer line. The site was located approximately 15.2 m (50 ft) northwest of Valve Box B-4. This release covered an area approximately 0.9 × 0.6 m (3 × 2 ft) having a radiation level as high as 2 R/hr. CPP-32E is a contaminated site that is suspected to have originated from a surface release of condensate originating from a vent tube in Valve Box B-4. The area of contamination was originally identified as 0.74 m^2 (8 ft^2) and extended to a depth of 0.3 m (1 ft) bgs. Since the discovery of the contamination, the area has been covered with approximately 0.61 m (2 ft) of soil, the Tank Farm membrane, and an additional 15 cm (6 in.) of soil.	Radionuclides, mercury, and toluene	No—T2 recommended further evaluation in RI/FS	No	Retain and address with the Tank Farm Group (CPP-20, 25, 26, 28, 31, 32, 79, and soil stockpile)

Table 5-1. (continued).

OU/Site	Description	Chemical(s) detected and/or removal actions	Step 1: Site has a signed No Action or No Further Action decision	Step 2: Risk estimates for the site indicate risk <1E-06 and HQ <1.0	Eliminate/retain site for the OU 3-13 RI/BRA
3-07/CPP-79 Tank Farm Release Near Valve Box A-2	CPP-79 is the site of a release of low-level radioactivity, heavy metals, and trace organic compounds from a transfer line between WCF and tank WL-102. The release occurred in July or August 1976. The transfer line and valve box were at a depth of 3 m (10 ft) bgs.	Radionuclides and nitrate	No—T2 recommended further evaluation in RI/FS	Not determined	Retain and address with the Tank Farm Group (CPP-20, 25, 26, 28, 31, 32, 79, and soil stockpile)
3-07/CPP-83 Perched Water	This site consists of the contaminated perched groundwater in the northern portion of the facility. The perched water is associated with leaks from the Tank Farm.	Radionuclides, metals, and inorganics	No—T2 recommended further evaluation in RI/FS	Not determined	Retain[a]
3-08/CPP-13 Pressurization of the Solid Storage Cyclone NE of CPP-13	In 1976, calcined high-level waste was released and covered a 27.9 m^2 (300 ft^2) area on the berm covering the bin sets. The bin sets contain high-level waste and as a result, high levels of radiation are present at this site that mask contamination.	Radionuclides and metals	No—T2 recommended further evaluation in RI/FS	Not determined	Retain
3-08/CPP-15 Solvent Burner East of CPP-605	CPP-15 was the site of a waste solvent spill in the facility that was used to burn the waste solvents. The solvents contained primarily kerosene and tributyl phosphate degradation products, with small quantities of radionuclides. The facility consisted of a fire-brick lined enclosure that used a standard furnace burner. Radiological contamination was discovered at this site in 1995 (See entry below).	Solvent-contaminated soil was removed during dismantling of the furnace and removal of the feed tank.	Yes—T2 recommendation for solvent contamination was approved.	—	Eliminate
3-08/CPP-15 Solvent Burner East of CPP-605—Radiological Contamination	CPP-15 was the site of a waste solvent spill in the facility that was used to burn the waste solvents. Radionuclides are suspected contaminants at this site.	Radionuclides	No	Not determined	Retain and evaluate with Tank Farm South Group (CPP-15, 27, 33, and 58)

Table 5-1. (continued).

OU/Site	Description	Chemical(s) detected and/or removal actions	Step 1: Site has a signed No Action or No Further Action decision	Step 2: Risk estimates for the site indicate risk <1E-06 and HQ <1.0	Eliminate/retain site for the OU 3-13 RI/BRA
3-08/CPP-27 Contaminated Soil in Tank Farm Area East of CPP-604 and CPP-33	CPP-33 and CPP-27 are located near the northeast corner of building CPP-604 and are the sites of a subsurface release of HLLW from the Tank Farm transfer system. The leak was discovered in 1974 and was attributed to a 0.3-m (1-ft) transfer line buried 3.6 m (12 ft) bgs, which may have leaked since early 1960s. It was estimated that 79 L (300 gal) of radioactive waste containing 1,000 Ci of activity was released into the soil; this site was initially designated CPP-27. Cleanup efforts in 1974 removed approximately 22.9 m^3 (300 yd^3) of contaminated soil. In 1983, additional contaminated soil was discovered while excavating WL-102, which was located near the northeast building CPP-604. Cleanup efforts in 1983 removed approximately 10,704 m^3 (14,000 yd^3) of contaminated soil. This release was designated CPP-33. It was determined the contamination from the release sites CPP-27 and CPP-33 appear to be from the same source and, therefore, should be addressed as a single release site.	Radionuclides, and metals	No—T2 recommended further evaluation in RI/FS	No	Retain and evaluate with Tank Farm South Group (CPP-15, 27, 33, and 58)
3-08/CPP-29 Contaminated Soil North and West of the Main Stack (CPP-708)	CPP-29 is the site of a release of small quantities of radioactive liquid from the base of the main ICPP stack. During the main stack refurbishment project, the soil in the area of the release was excavated, and the area was covered with a concrete pad.	Contaminated soil was removed.	Yes—T2 recommendation was approved.	—	Eliminate
3-08/CPP-35 CPP-633 Decontamination Spill	CPP-35 is the site of an inadvertent release of decontamination solution through the air transport system during decontamination operation of the calcine vessel WC-102. An estimated 2.6 L (10 gal) of solution containing 10 Ci of beta activity was released. The ensuing cleanup involved the removal of 7.5 Ci of activity.	Radionuclides, metals, and inorganics	No—T2 recommended further evaluation in RI/FS	No	Retain and evaluate with WCF Group (CPP-35, 36, 85, and 91)

Table 5-1. (continued).

OU/Site	Description	Chemical(s) detected and/or removal actions	Step 1: Site has a signed No Action or No Further Action decision	Step 2: Risk estimates for the site indicate risk <1E-06 and HQ <1.0	Eliminate/retain site for the OU 3-13 RI/BRA
3-08/CPP-36 Transfer Line Leak from CPP-633 to WI-102	CPP-36 is the result of several releases that have been discovered at different times. In June 1970, an excavation to repair calcine vessel off-gas lines found contaminated soil (20 R/hr). The suspected cause of this release was a faulty flowmeter in the PSA-3001 transfer line. In 1974, contamination was again discovered during replacement of transfer lines (PSA-3001 and PWA-3002) between the WCF and the ICPP main stack. In addition, a release from a flange in valve pit MAH-OGF-P-04 occurred in 1974 during transfer of dilute decontamination solution from WC-119 to WL-02. An estimated 198 L (750 gal) containing 4 Ci of activity was released during this event.	Radionuclides, mercury, fluoride, nitrate, and nitrite	No—T2 recommended further evaluation in RI/FS	No	Retain and evaluate with WCF Group (CPP-35, 36, 85, and 91)
3-09/CPP-01 Horizontal Settling Basin, and Vertical Settling Pit and Soil Adjacent to SW-048 Dry Well and CPP-303 Dry Well—Environmental Release	CPP-01 consists of a concrete horizontal settling basin, concrete vertical settling pit, and two dry wells east of building CPP-603. Releases from this system have occurred and contamination in the alluvium is suspected.	Radionuclides	No—T2 recommended further evaluation in RI/FS	No	Retain and address with the Old Storage Pool Group (CPP-01, 04, 05, 08, 09, 10, and 11)
3-09/CPP-02 French Drain West of CPP-603	CPP-02 is the site of a former French drain located west of building CPP-603 [now located underneath the Graphite Storage Facility (GSF)], which was used to dispose of CPP-603 fuel storage basin "bleed-off" water.	Suspected: cesium-137, strontium-90, and tritium	No—T2 recommended further evaluation in RI/FS	Not determined	Retain[a]
3-09/CPP-03 Temporary Storage Area SE of CPP-603 Stockpiled Soil	CPP-03 is the site of a former temporary storage area southeast of building CPP-603. The area was used to store old abandoned radioactively-contaminated equipment such as tanks, valves, and fuel casks. The top several inches of soil were contaminated and removed to the RWMC.	Source and contaminated soil were removed. Residual radionuclides in soil remain.	No—T2 recommended further evaluation in RI/FS	No	Retain and evaluate in Storage Yard Group (CPP-03 and 17)

Table 5-1. (continued).

OU/Site	Description	Chemical(s) detected and/or removal actions	Step 1: Site has a signed No Action or No Further Action decision	Step 2: Risk estimates for the site indicate risk <1E-06 and HQ <1.0	Eliminate/retain site for the OU 3-13 RI/BRA
3-09/CPP-04 and CPP-05 Contaminated Soil Around CPP-603 Settling Tank	Sites CPP-04 and -05 are the surface contaminated soils surrounding the concrete settling basin and pit. The sites were combined because contamination was determined to be from the same source.	Radionuclides	No—T2 recommended further evaluation in RI/FS	No	Retain and address with the Old Storage Pool Group (CPP-01, 04, 05, 08, 09, 10, and 11)
3-09/CPP-06 Trench East of CPP-603 Fuel Storage Basin	CPP-06 is the site of a trench south of CPP-603 that received 132,275 L (500,000 gal) of radioactively-contaminated basin water.	Radionuclides	No—T2 recommended further evaluation in RI/FS	No	Retain
3-09/CPP-08 and CPP-09 CPP-603 Basin Filter System Line Failure and Soil Contamination Near NE Corner of CPP-603 South Basin	CPP-08 and -09 are the sites of a release of radioactively-contaminated liquid from the CPP-603 basin due to a leak in a recirculation line. CPP-08 and -09 were combined because contamination was determined to be from the same source.	Radionuclides	No—T2 recommended further evaluation in RI/FS	No	Retain and address with the Old Storage Pool Group (CPP-01, 04, 05, 08, 09, 10, and 11)
3-09/CPP-10 CPP-603 Plastic Pipeline Break	Site CPP-10, east of CPP-603, is the location of a release of radioactively-contaminated fluid. It was estimated 211 L (800 gal) of basin water drained onto the shield area floor and contaminated a small area of asphalt and dirt next to building CPP-603.	Radionuclides	No—T2 recommended further evaluation in RI/FS	No	Retain and address with the Old Storage Pool Group (CPP-01, 04, 05, 08, 09, 10, and 11)
3-09/CPP-11 CPP-603 Sludge and Water Release	Site CPP-11 is a surface spill of CPP-603 fuel storage basin sludge and liquids. The spill was directly above the basin liquid waste tank, SFE-106, which is east of CPP-603. The spill was reported as between 79 to 132 L (300 to 500 gal) of waste containing sludge and basin water, which was reportedly cleaned up. The present day contamination is thought to be from small spills associated with sludge removal.	Radionuclides and metals	No—T2 recommended further evaluation in RI/FS	Not determined	Retain and address with the Old Storage Pool Group (CPP-01, 04, 05, 08, 09, 10, and 11)

Table 5-1. (continued).

OU/Site	Description	Chemical(s) detected and/or removal actions	Step 1: Site has a signed No Action or No Further Action decision	Step 2: Risk estimates for the site indicate risk <1E-06 and HQ <1.0	Eliminate/retain site for the OU 3-13 RI/BRA
3-09/CPP-17 Soil Storage Area South of CPP Peach Bottom Fuel Storage Area	CPP-17 consists of two areas that were used for storing piles of soil, asphalt, concrete, metal debris, and other items. CPP-17a measures approximately 35 × 40 m (114 × 130 ft). The stored material reportedly came from various construction and maintenance activities at the ICPP. In 1992, the soil mounds and debris were removed.	Radionuclides	No—T2 recommended further evaluation in RI/FS	No	Retain and evaluate in Storage Yard Group (CPP-03 and 17)
	CPP-17 consists of two areas that were used for storing piles of soil, asphalt, concrete, metal debris, and other items. CPP-17b measures approximately 38 × 21 m (125 × 70 ft). The stored material reportedly came from various construction and maintenance activities at ICPP. In 1992, the soil mounds and debris were removed.	Residual cesium-137, and Cobalt-57	No—T2 recommended further evaluation in RI/FS	No	Retain and evaluate in Storage Yard Group (CPP-03 and 17)
3-09/CPP-19 CPP-603 to CPP-604 Line Leak	Site CPP-19 is an area of a radioactively-contaminated liquid release from a transfer line between the basin tank (SFE-106) and feed tank (Wl-102). Approximately 2,000 gal of waste fluid was released. An unknown volume of contaminated soil was removed following the release. The top 15 cm (6 in.) is fill material.	Radionuclides and metals	No—T2 recommended further evaluation in RI/FS	No	Retain
3-09/CPP-22 Particulate Air Release South of CPP-603	Site CPP-22 is the location of potential surface contamination associated with an air release. The release occurred during a failure of a high-efficiency particulate air (HEPA) filter associated with the Fuel Element Cutting Facility (FECF). Airborne radioactive contamination spread over an estimated 12,214 m^2 (131,302 ft^2) area. Most of this contamination was believed to have been removed during construction activities around this area.	No source; contaminated soil reportedly was removed. Residual radioactivity was left behind.	No—T2 recommended further evaluation in RI/FS	Not determined	Retain

Table 5-1. (continued).

OU/Site	Description	Chemical(s) detected and/or removal actions	Step 1: Site has a signed No Action or No Further Action decision	Step 2: Risk estimates for the site indicate risk <1E-06 and HQ <1.0	Eliminate/retain site for the OU 3-13 RI/BRA
3-09/CPP-69 Abandoned Liquid Radioactive Waste Storage Tank CPP VES-SFE-20	Site CPP-69 consists of the SFE-20 Hot Waste Tank (and contents) and surrounding tank vault, access tunnel, and pump pit. The system was constructed in 1957 to collect low-level radioactive liquid wastes from the newly constructed FECF addition of CPP-603 FRSF. The entire SFE-20 waste holding and transfer system was disconnected and shutdown in 1976. Because this site is a potential release site, it was deferred to the WAG 3 Comprehensive RI/FS.	Radionuclides	No—T2 recommended further evaluation in RI/FS	Not determined	Retain[a,c]
3-09/CPP-78 Contaminated Soil West of CPP-693, East of Dry Fuel Storage Area	Site CPP-78 consists of a 2.3 m^2 (25 ft^2) area of radioactively-contaminated soil located west of building CPP-693 and east of the Dry Fuel Storage Area. The radioactively-contaminated soil was discovered during excavation activities. The origin of the contamination is not known, but it is assumed to have resulted from an unintentional spill.	Radionuclides	No—T2 recommended further evaluation in RI/FS	Not determined	Retain
3-10/CPP-42 Drainage Ditch West of CPP-637	CPP-42 is a drainage ditch that is west of building CPP-637 and was originally designed to handle precipitation runoff. It is suspected laboratory wastes may have been transported by hand from CPP-637 and released into the soil at CPP-42.	Metals, fluoride, and nitrate	Yes—T2 recommendation was approved.	—	Eliminate
3-10/CPP-44 Grease Pit South of CPP-608	CPP-44 is the site of a grease pit and concrete pad used for servicing vehicles and equipment during the construction of the ICPP. The pit consists of a 12.5 × 5.2-m (41 × 17-ft) concrete pad with a 7.6 × 0.9 × 1.7 m (25 × 3 × 5.5-ft) trench in the middle, which contained a sump. The trench may have been used for disposal of petroleum products. The area has been taken out of service and covered with gravel.	Metals and organics	Yes—T2 recommendation was approved.	—	Eliminate

Table 5-1. (continued).

OU/Site	Description	Chemical(s) detected and/or removal actions	Step 1: Site has a signed No Action or No Further Action decision	Step 2: Risk estimates for the site indicate risk <1E-06 and HQ <1.0	Eliminate/retain site for the OU 3-13 RI/BRA
3-10/CPP-46 CPP-637 Courtyard Pilot Plant Release—Inorganic Contamination	CPP-46 is the site of a 119 L (450 gal) simulated zirconium waste release located in the courtyard north of the Low Bay Laboratory CPP-637. The simulated waste was used as nonradioactive feed stock for testing processes related to process and handling of zirconium-clad fuel rods. The waste was acidic and contained zirconium, aluminum cations, and fluoride and nitrate anions. However, potential radiological contamination at this site will be evaluated. (See entry below.)	Contaminated soil resulting from release was removed.	Yes—T2 recommendation was approved for inorganic contamination.	—	Eliminate
3-10/CPP-46 CPP-637 Courtyard Pilot Plant Release—Radiological Contamination	CPP-46 is the site of a 119 L (450 gal) simulated zirconium waste release located in the courtyard north of the Low Bay Laboratory CPP-637. The simulated waste was used as nonradioactive feed stock for testing processes related to process and handling of zirconium-clad fuel rods. The waste was acidic and contained zirconium, aluminum cations, and fluoride and nitrate anions. However, radiological contamination at this site is suspected.	Radionuclides	No—T2 recommended further evaluation in RI/FS	Not determined	Retain
3-10/CPP-56 Nitric acid Contamination South of CPP-734	CPP-56 is the site of a nonradioactive liquid waste release caused by a leaking transfer line between holdup tank WL-103 and the west side monitoring station (CPP-734). Approximately 1,322 L (5,000 gal) of dilute nitric acid was released to the surrounding soil. Records indicate the acid had been neutralized by sodium hydroxide before transfer. The site was partially excavated during the construction of building CPP-796.	Nitrate	Yes—T2 recommendation was approved.	—	Eliminate

Table 5-1. (continued).

OU/Site	Description	Chemical(s) detected and/or removal actions	Step 1: Site has a signed No Action or No Further Action decision	Step 2: Risk estimates for the site indicate risk <1E-06 and HQ <1.0	Eliminate/retain site for the OU 3-13 RI/BRA
3-11/CPP-45 CPP-621 Chemical Storage Area Spills	CPP-45 is the site of various acid and aluminum nitrate spills beneath and around the storage area located east of CPP-621 (Chemical Storage Pumphouse). The storage area contained eight chemical storage tanks, transfer lines, valves, six French drains, and a sludge pit. The area has been broken into four subunits. Subunit 1 contains acid storage tanks containing hydrofluoric acid, sulfuric acid, and hydrochloric acid. Subunit 2 contains three aluminum nitrate tanks. Subunit 3 contains two nitric acid tanks, and Subunit 4 contains the sludge pit. Five releases have been documented and other spills or releases are suspected. There were no radioactive materials stored at this site.	Contaminated area was remediated.	Yes—T2 recommendation was approved.	—	Eliminate
3-11/CPP-58W/E Subsurface release of contaminants associated with PEW spills and Evaporator Overhead Pipeline Spills	CPP-58W is the site of a subsurface release 1.8 to 2.4 m (6 to 8 ft) bgs of low-level radioactively-contaminated liquid from the underground transfer line from the PEW Evaporator to the monitoring station in CPP-709. This release occurred in 1954. Since the time of the release, building CPP-649 was constructed on top of the area containing the spill. Minimum excavation for footing was 3.6 m (12 ft) bgs. The size and amount of the spills are unknown but are believed to be contained under the building. CPP-58E is the site of a subsurface release of approximately 5,291 L (20,000 gal) of radioactively-contaminated PEW condensate. The release was caused by a failure of the condensate transfer line between the PEW Evaporator and Service Waste Diversion System. The line was excavated and fixed but contaminated soil was left in place and covered with several feet of clean soil.	Radionuclides, metals, nitrate, nitrite, and fluoride	No—T2 recommended further evaluation in RI/FS	Not determined	Retain[a] and evaluate in Tank Farm South Group (CPP-15, 27, 33, and 58)
3-12/CPP-80 CPP-601 Vent Tunnel Drain Leak (VT-300)	CPP-80 is the site of a release of radioactive and hazardous contaminants due to a failed floor drain in CPP-601. The leak was discovered in 1989 and is believed to have started in 1982. It is estimated the release contained approximately 550 Ci of radioactivity as well as unknown quantities of metal contaminants.	Radionuclides, metals, and inorganics	No—T1 recommended further evaluation in RI/FS	No	Retain[a]

Table 5-1. (continued).

OU/Site	Description	Chemical(s) detected and/or removal actions	Step 1: Site has a signed No Action or No Further Action decision	Step 2: Risk estimates for the site indicate risk <1E-06 and HQ <1.0	Eliminate/retain site for the OU 3-13 RI/BRA
3-12/CPP-81 Abandoned CPP-637/CPP-601 VOG Line	CPP-81 is the site of a plugged vessel off-gas 7.6 cm (3 in.) VGA-100 line during Run No. 15 of the 30 cm (12 in.) Diameter Calciner Pilot Plant. A 20.7 m (68 ft) section of the line was abandoned, with most of the line being under a concrete floor at the south end of CPP-620. In 1993, the line was removed and there was no indication of a release to the environment.	Source was removed as part of a removal action in 1995	Yes—T1 was approved 6/94	—	Eliminate
3-12/CPP-82 Abandoned Line 1.5 in. - PLA- 776 West of Beech Street	CPP-82 is divided into three locations associated with the removal of an underground pipe (PLA-76). Site A, located east of CPP-797, is the site where the abandoned line PLA-776 was damaged and released 0.66 L (2.5 gal) of low-level radioactive waste into the soil. During repairs, the discarded pipe and contaminated soil were removed from the site. Site B is located south of CPP-797 and is an area where underground piping was damaged during excavation of PLA-776. It was determined the damaged line did not carry any hazardous materials. Site C is located west of CPP-T1 and is the site of two ruptured plastic lines. It was determined the lines did not carry any hazardous material.	Contaminated soil was removed.	Yes—T1 was approved 5/93	—	Eliminate
3-13/CPP-39 CPP HF Storage Tank (YDB-105) and Dry Well	CPP-39 consists of a hydrofluoric acid (HF) storage tank containment vault and a 38-m (125-ft) tile line connected to a dry well. CPP-39 is located in the northwest portion of the ICPP at the intersection of Birch and Pine Avenues. Hydrofluoric acid (HF) was transferred from the tank to CPP-601 before the dissolution process. Only off-specification solution was returned to the containment vault for neutralization. The tile line was removed in 1993. No radioactive constituents were associated with this process.	Metals, fluoride, and semivolatile organic compounds (SVOCs)	A T2 Preliminary Scoping Package (PSP) has been submitted recommending this site for No Further Action	Yes	Eliminate

Table 5-1. (continued).

OU/Site	Description	Chemical(s) detected and/or removal actions	Step 1: Site has a signed No Action or No Further Action decision	Step 2: Risk estimates for the site indicate risk <1E-06 and HQ <1.0	Eliminate/retain site for the OU 3-13 RI/BRA
3-13/CPP-48 French Drain South of CPP-633	CPP-48 is an excess chemical dump tank that was used as a French drain for excess nitric acid, aluminum nitrate, calcium nitrate, and other chemicals used in the calcining process from the old Waste Calcining Facility. The chemicals deposited in the dump tank were not treated or neutralized before being released. The dump tank was removed in 1993.	Source was removed. Residual cesium-137, antimony-125, europium-155, strontium-90, mercury, and nitrate	A T2 PSP has been submitted recommending this site for No Further Action	Yes	Eliminate
3-13/CPP-84 Buried Gas Cylinder Site	CPP-84 is the site of 40 to 100 construction gas cylinders buried in a trench northwest of the ICPP near the Big Lost River. The number and contents of the cylinders are not known but are expected to be construction gases such as acetylene, nitrogen, oxygen, helium, argon, carbon dioxide, and compressed air. The only contaminants of concern were determined to be acetone and asbestos (fillers in acetylene cylinders).	Acetone and asbestos	A T1 document has been submitted recommending this site for No Further Action	Yes	Eliminated[f]
3-13/CPP-85 WCF Blower Corridor	CPP-85 is the site of the WCF Blower Corridor that is made of 0.46 to 0.6 m (1.5 to 2 ft) vitrified clay and is surrounded by a 0.9 m (3 ft) poured concrete envelope. The blower corridor is roughly 2.7 m (9 ft) bgs and was used for keeping a negative pressure in the WCF hot cells. Vent gases from the hot cells were blown through the blower corridor to building CPP-649 for HEPA filtering before discharge.	Radionuclides, and metals	A T1 document has been submitted recommending this site for further evaluation in RI/FS	—	Retain
3-13/CPP-86 CPP-602 Waste Trench Sump	Process waste generated in CPP-602 is collected using a waste trench that underlies the basement level of CPP-602. Site CPP-86 is a sump associated with this trench and is part of the PEW system. CPP-602 houses laboratories and offices that provide plant analytical support (radiochemistry development and research).	Metals	A T1 document has been submitted recommending this site for No Further Action	Yes	Eliminate[g]
3-13/CPP-94 Buried Cylinders East	Three or perhaps four cylinders that may contain hydrofluoric acid were discovered about 1/2 mile NE of ICPP on December 1966.	Hydrofluoric acid	No	No	Eliminate[j]

Table 5-1. (continued).

OU/Site	Description	Chemical(s) detected and/or removal actions	Step 1: Site has a signed No Action or No Further Action decision	Step 2: Risk estimates for the site indicate risk <1E-06 and HQ <1.0	Eliminate/retain site for the OU 3-13 RI/BRA
3-13/CPP-87 VOG Blower Cell Floor Drain/Sump and PEW Evaporator Feed Pump Cell—Metals Contamination	The PEW Evaporator System vents to the ICPP vessel off-gas (VOG) system. A new piping system, the process waste liquid (PWL) collection system, was installed in 1990. At that time, soil samples were collected under the Blower Cell. Metals concentrations in the soil were used to estimate risk for this site. The system is operational and collects hazardous wastes from several buildings, including CPP-604. In CPP-604, wastes are collected from various floor drains including the floor drain in the VOG blower cell. Based on the Track 1, contamination, if any, is not present above risk-based levels. Potential radiological contamination for the PEW Evaporator Feed Pump Cell will be evaluated (See entry below).	Characterization results indicate metals, nitrate, and fluoride were either below risk-based concentrations for the groundwater pathway or below background values	A T1 document has been submitted recommending this site for No Further Action	Yes	Eliminate[b]
3-13/CPP-87 VOG Blower Cell Floor Drain/Sump and PEW Evaporator Feed Pump Cell—Radiological Contamination	The PEW Evaporator System vents to the ICPP VOG system. A new piping system, the PWL collection system, was installed in 1990. The system is operational and collects hazardous wastes from several buildings, including CPP-604. A potential release from a leak in the stainless steel liner in the PEW Evaporator Feed Pump Cell was discovered in 1/94 and has since been repaired. Samples of the waste that was released were collected and cobalt-60, cesium-134, and cesium-137 were detected. The T1 concluded metals present in the waste were below risk-based concentrations. Potential radiological contamination for the PEW Evaporator Feed Pump Cell will be evaluated.	Radionuclides	A T1 document has been submitted recommending further evaluation in RI/FS for this site	Not determined	Retain[a]
3-13/CPP-88 Radiologically Contaminated Soils Map	Site CPP-88 consists of mapped areas with radioactive soil contamination concentrations above background.	Radionuclides and metals	A T1 document has been submitted recommending further evaluation in RI/FS for this site	No	Retain
3-13/CPP-89 CPP-604/605 Tunnel Excavation	Contaminated soil was encountered during excavation activities for a fire protection egress tunnel. The contamination was determined to be the result of leaks from deteriorated and abandoned drain lines running to the PEW system.	Radionuclides and metals	A T1 document has been submitted recommending further evaluation in RI/FS for this site	Not determined	Retain[a]

Table 5-1. (continued).

OU/Site	Description	Chemical(s) detected and/or removal actions	Step 1: Site has a signed No Action or No Further Action decision	Step 2: Risk estimates for the site indicate risk <1E-06 and HQ <1.0	Eliminate/retain site for the OU 3-13 RI/BRA
3-13/CPP-90 CPP-709 Ruthenium Detection	In 1959, trace amounts of Ru-106 were detected in the CPP Production Wells. The contamination occurred as a result of a deteriorated service waste line washing contaminated soil into the CPP-Injection Well.	Radionuclides, metals, and organics	A T1 document has been submitted recommending further evaluation in RI/FS for this site	Not determined	Retain
3-13/CPP-91 CPP-633 Blower Pit Drain	A blower pit is located on the NW corner of building CPP-633, which is the WCF. A floor drain in the blower pit is used to remove water that has accumulated in the pit. Original blueprints for CPP-633 indicate that the drain was not piped into a plant service line and discharges directly into the soil. Rainfall and snowmelt have historically been able to enter the pit through the hatch on the surface. The drain has been sealed with an expandable plug and the hatch has been made watertight.	Radionuclides and metals	A T1 document has been submitted recommending further evaluation in RI/FS for this site	Not determined	Retain and evaluate as part of WCF Group (CPP-35, 36, 85, and 91)
3-13/CPP-92 Soil Boxes West of CPP-1617	CPP-92 consists of approximately 1,500 1.2 × 1.2 × 2.4-m (4 × 4 × 8-ft) plywood boxes lined with a polyethylene membrane liner and containing radioactively-contaminated soil from the Tank Farm upgrade, Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) remediation projects, the CPP-603 cleanup, and miscellaneous excavations throughout the ICPP. Most of the boxes contain radionuclides at levels that are too low for acceptance at the RWMC and disposal of all the boxes at the RWMC would severely diminish the remaining capacity of the facility.	Radionuclides, metals, and organics	A T1 document has been submitted recommending further evaluation in RI/FS for this site	No	Retain[i]
3-13/CPP-93 Simulated Calcine Trench	In the early to mid-1960s, a 9 × 106-m (30 × 350-ft) trench was excavated for the disposal of simulated calcine before the hot start of CPP-633 WCF. Ten test batches of calcine were disposed to the trench. Nine batches used solutions containing aluminum nitrate, nitric acid, sodium nitrate, and boric acid. The tenth batch included these solutions plus mercuric nitrate. No radioactive material was disposed.	Metals and nitrate	A T1 document has been submitted recommending further evaluation in RI/FS for this site	No	Retain

Table 5-1. (continued).

OU/Site	Description	Chemical(s) detected and/or removal actions	Step 1: Site has a signed No Action or No Further Action decision	Step 2: Risk estimates for the site indicate risk <1E-06 and HQ <1.0	Eliminate/retain site for the OU 3-13 RI/BRA
3-13/Windblown Area (OU 10-06)	Sites outside the ICPP perimeter fence are considered potentially contaminated as a result of airborne dispersion of radionuclides from ICPP operations predominantly southwest and northwest from ICPP.	Radionuclides	The 10-06 RI Report presents results for this area. DOE-ID recommended inclusion in the WAG 3 RI/FS	No	Retain

a. There are no surface pathways associated with the site; however, impact to groundwater will be considered.

b. Contaminants in the backfill are slightly elevated with respect to background (3–5 mR). Their concentrations will be assumed to be similar to that of the stockpiled soil. The stockpiled soil sample results will be used to estimate the source term for this site.

c. CPP-69 is a 169-L (640-gal) waste tank located inside a concrete vault approximately 15 ft bgs. Surface pathways will be assumed incomplete. The contents of this tank [approximately 1,700 L (450 gal)] will be evaluated during the groundwater modeling effort, if appropriate.

d. The basis for the CPP-39 T2 PSP recommendation was that the risk estimates and HQs for the site were below 1E-06 and 1.0, respectively. Specifically, the T2 PSP risk assessment evaluated mercury and fluoride for the surface soil pathway because they were the only contaminants detected above background in soil <10 ft. In addition to these two contaminants, contaminant evaluated for the groundwater pathway included silver, barium, and several semivolatiles (PAHs). The additional contaminants were only detected in soils >10 bls. Risk estimates for all exposure routes were below 1E-06 (highest being 3.3E-09) and HQs were less than 1 (highest being 5.7E-2). Given the results of the T2 PSP risk assessment, the site should be eliminated form the OU 3-13 RI/BRA.

e. The basis for he CPP-48 T2 PSP recommendation was that contamination was limited to depths >10 ft bls and the resulting risk estimates were acceptable. Because of the depth of contamination, contaminants at the site were only evaluated for the groundwater pathway. The risk estimate for groundwater ingestion was less than 1E-06 (highest being 1.8E-74) and the HQ was less than 1 (3.4E-5). Given the results of the T2 PSP risk assessment, the site should be eliminated from the OU 3-13 RI/BRA.

f. The basis for the CPP-84 T1 recommendation was a conservative risk estimate of 1E-07 and HQ of 0.37 given a hypothetical release of acetone and transport to the aquifer. The assumptions for the hypothetical release in the T1 were worst case: acetone was assumed to be present in all cylinders, 100% of the acetone leaked from the cylinders, none of the acetone volatilized, and, as a result, was available for transport to a receptor. Given the conservatism of the risk estimate leading to the no action recommendation and a resulting acceptable risk estimate, the site should be eliminated from the OU 3-13 RI/BRA. However, alternatives to mitigate a potential explosion hazard will be provided in Appendix F of the FS Report.

g. The basis for the CPP-86 T1 recommendation was that risk estimates for the potential metals contaminants were at or below 1E-08 for the groundwater pathway. The site is located under building CPP-602, thus transport to groundwater is the only viable pathway. Additionally, the depth of contamination is at least 14.5 ft bls. This limits the potential for exposure to the groundwater pathway even if building CPP-602 were removed. It should also be noted that the estimated [i.e., back-calculated from toxicity characterization leaching procedure (TCLP) results] concentrations for two of the contaminants (barium and chromium) were below background values. Given these circumstances, the site should be eliminated from consideration in the OU 3-13 RI/BRA.

h. The basis for the CPP-87 T1 recommendation for potential metals contamination in soil below the VOG blower cell was the risk estimates for the potential metals contaminants were at or below 1E-06 for the groundwater pathway. This site is located under building CPP-604, thus transport to groundwater is the only viable pathway. It should also be noted that the estimated (i.e., back-calculated from TCLP results) concentrations were below background values. Given these circumstances, the site should be eliminated from consideration in the OU 3-13 RI/BRA. Potential radiological contamination for the PEW Feed Pump Cell, however, will be assessed.

i. Moderate radiation fields and direct exposure the gamma-radiation have been measured outside some of the boxes within CPP-92. This site will be evaluated as part of the WAG 3 FS.

j. CPP-94 is a newly discovered site (12/96) and characterization data is not available to quantitatively evaluate this site in the BRA. However, there is a potential threat to human health and the environment and alternatives to mitigate the potential hazard will be presented in Appendix F of the FS Report.

Table 5-2. Contaminant screening process for OU 3-01, CPP-61, PCB spill in CPP-718 transformer yard.

		Step 1		Step 2	Step 3					Step 4		
Chemicals	Source concentration (mg/kg or pCi/g)	Background concentration (mg/kg or pCi/g)	Is the maximum concentration greater than background value?	Is the chemical an essential nutrient?	Organic risk factor (%)	Inorganic risk factor (%)	Organic hazard factor (%)	Inorganic hazard factor (%)	Chemical comprises > 1% of the risk/hazard factor?	Region III soil residential RBC (mg/kg)	Is maximum concentration greater than RBC?	Site COPC?
Cs-137	2.51	0.82	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Sr-90	3	0.49	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Tc-99	1.9	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes

Source: ERIS.
"NA" in Step 1 indicates that a background value is not available.
"----" in Step 3 indicates that the chemical evaluated does not correspond with the analyses (organic, inorganic) as stated in the column heading.
"N/A" in Step 3 indicates that the chemical is not evaluated since it has already been screened out in Step 1 and/or Step 2 or because it is a radionuclide.
"No Tox" indicates that a toxicity value (slope factor or reference dose) is not available.
"No RBC" indicates that an EPA Region III risk-based concentration based on residential soil ingestion is not available
"Yes (NT)" indicates that this chemical does not have toxicity data and will be further evaluated.
Note: The following contaminants were analyzed for but not detected at this site: Ce-144, Co-58, Co-60, Cs-134, Eu-154, Eu-155, Nb-95, Ru-103, Ru-106, Sb-125.

Table 5-3. Contaminant screening process for OU 3-02, CPP-23, CPP injection well.

		Step 1		Step 2	Step 3					Step 4		
Chemicals	Source concentration (mg/kg or pCi/g)	Background concentration (mg/kg or pCi/g)	Is the maximum concentration greater than background value?	Is the chemical an essential nutrient?	Organic risk factor (%)	Inorganic risk factor (%)	Organic hazard factor (%)	Inorganic hazard factor (%)	Chemical comprises > 1% of the risk/hazard factor?	Region III soil residential RBC (mg/kg)	Is maximum concentration greater than RBC?	Site COPC?
Aroclor-1260	0.01	NA	NA	No	100.00%	—	No Tox	—	Yes	0.08	No	No
Arsenic	0.0039	5.8	No	No	—	N/A	—	N/A	No	0.43	No	No
Barium	0.16	300	No	No	—	N/A	—	N/A	No	5500	No	No
Calcium	3.6	24000	No	Yes	—	N/A	—	N/A	No	No RBC	No RBC	No
Chromium	0.13	33	No	No	—	N/A	—	N/A	No	390	No	No
Copper	0.017	22	No	No	—	N/A	—	N/A	No	3100	No	No
Manganese	0.19	490	No	No	—	N/A	—	N/A	No	390	No	No
Mercury	0.00056	0.05	No	No	—	N/A	—	N/A	No	23	No	No
Nickel	0.092	35	No	No	—	N/A	—	N/A	No	1600	No	No
Osmium	0.0056	NA	NA	No	—	No Tox	—	No Tox	No	No RBC	No RBC	Yes (NT)
Potassium	2.3	4300	No	Yes	—	N/A	—	N/A	No	No RBC	No RBC	No
Sodium	0.33	320	No	Yes	—	N/A	—	N/A	No	No RBC	No RBC	No
Strontium	0.0067	NA	NA	No	—	No Tox	—	100.00%	Yes	47000	No	No
Thallium	0.017	0.43	No	No	—	N/A	—	N/A	No	No RBC	No RBC	No
Zinc	0.1	150	No	No	—	N/A	—	N/A	No	23000	No	No
Cs-137	100	0.82	Yes	No	—	—	—	—	N/A	No RBC	No RBC	Yes
Eu-152	3.8	NA	NA	No	—	—	—	—	N/A	No RBC	No RBC	Yes
Eu-154	2.5	NA	NA	No	—	—	—	—	N/A	No RBC	No RBC	Yes
Sr-90	75	0.49	Yes	No	—	—	—	—	N/A	No RBC	No RBC	Yes

Source: Track 1 Decision Documentation Package for CPP-23.
"NA" in Step 1 indicates that a background value is not available.
"—" in Step 3 indicates that the chemical evaluated does not correspond with the analyses (organic, inorganic) as stated in the column heading.
"N/A" in Step 3 indicates that the chemical is not evaluated since it has already been screened out in Step 1 and/or Step 2 or because it is a radionuclide.
"No Tox" indicates that a toxicity value (slope factor or reference dose) is not available.
"No RBC" indicates that an EPA Region III risk-based concentration based on residential soil ingestion is not available
"Yes (NT)" indicates that this chemical does not have toxicity data and will be further evaluated.

Table 5-4. Contaminant screening process for OU 3-02, CPP-37A, CPP gravel pit #1.

		Step 1		Step 2	Step 3					Step 4		
Chemicals	Source concentration (mg/kg or pCi/g)	Background concentration (mg/kg or pCi/g)	Is the maximum concentration greater than background value?	Is the chemical an essential nutrient?	Organic risk factor (%)	Inorganic risk factor (%)	Organic hazard factor (%)	Inorganic hazard factor (%)	Chemical comprises > 1% of the risk/hazard factor?	Region III soil residential RBC (mg/kg)	Is maximum concentration greater than RBC?	Site COPC?
Methylene chloride	0.14	NA	NA	No	100.00%	----	97.47%	----	Yes	85	No	No
Toluene	0.001	NA	NA	No	No Tox	----	0.21%	----	No	16000	No	No
1,1,1-Trichloroethane	0.005	NA	NA	No	No Tox	----	2.32%	----	Yes	7000	No	No
Arsenic	8.7	5.8	Yes	No	----	100.00%	----	71.99%	Yes	0.43	Yes	Yes
Barium	229	300	No	No	----	N/A	----	N/A	No	5500	No	No
Cadmium	1.5	2.2	No	No	----	N/A	----	N/A	No	39	No	No
Chromium	30.1	33	No	No	----	N/A	----	N/A	No	390	No	No
Lead	17.7	17	Yes	No	----	No Tox	----	No Tox	No	400	No	No
Mercury	0.96	0.05	Yes	No	----	No Tox	----	27.81%	Yes	23	No	No
Selenium	0.41	0.22	Yes	No	----	No Tox	----	0.20%	No	390	No	No
Am-241	0.99	0.011	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Co-60	0.55	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Cs-137	3.82	0.82	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Np-237	1.07	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Pu-238	0.12	0.0049	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Sr-90	0.69	0.49	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
U-234	0.71	1.44	No	No	----	----	----	----	N/A	No RBC	No RBC	No
U-235	0.05	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
U-238	3.99	1.4	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes

Sources: Metal data from Table 4-2 of GAI 1992 (Report for the ICPP Drilling and Sampling Program at LDU CPP-37)
Organic data from Table 4-3 of GAI 1992 (Report for the ICPP Drilling and Sampling Program at LDU CPP-37)
Radionuclide data from Table 4-4 of GAI 1992 (Report for the ICPP Drilling and Sampling Program at LDU CPP-37)
Table 3a Contaminant Worksheet, 5/5/94, Track 2 Preliminary Scoping Package for CPP-37.

"NA" in Step 1 indicates that a background value is not available.

"----" in Step 3 indicates that the chemical evaluated does not correspond with the analyses (organic, inorganic) as stated in the column heading.

"N/A" in Step 3 indicates that the chemical is not evaluated since it has already been screened out in Step 1 and/or Step 2 or because it is a radionuclide.

"No Tox" indicates that a toxicity value (slope factor or reference dose) is not available.

"No RBC" indicates that an EPA Region III risk-based concentration based on residential soil ingestion is not available

"Yes (NT)" indicates that this chemical does not have toxicity data and will be further evaluated.

Note: The following contaminants were analyzed for but not detected at this site: I-129, silver.

Table 5-5. Contaminant screening process for OU 3-02, CPP-37B, CPP gravel pit #2.

		Step 1		Step 2	Step 3					Step 4		
Chemicals	Source concentration (mg/kg or pCi/g)	Background concentration (mg/kg or pCi/g)	Is the maximum concentration greater than background value?	Is the chemical an essential nutrient?	Organic risk factor (%)	Inorganic risk factor (%)	Organic hazard factor (%)	Inorganic hazard factor (%)	Chemical comprises > 1% of the risk/hazard factor?	Region III soil residential RBC (mg/kg)	Is maximum concentration greater than RBC?	Site COPC?
Acenaphthene	0.037	NA	NA	No	No Tox	—	0.01%	—	No	4700	No	No
Anthracene	0.35	NA	NA	No	No Tox	—	0.01%	—	No	23000	No	No
Aroclor-1254	0.23	NA	NA	No	34.97%	—	99.72%	—	Yes	1.6	No	No
Aroclor-1260	0.42	NA	NA	No	63.86%	—	No Tox	—	Yes	0.08	Yes	Yes
Benzo(a)anthracene	0.072	NA	NA	No	1.04%	—	No Tox	—	Yes	0.88	No	No
bis(2-Ethylhexyl)phthala	0.24	NA	NA	No	0.07%	—	0.10%	—	No	46	No	No
Chrysene	0.11	NA	NA	No	0.02%	—	No Tox	—	No	88	No	No
Fluoranthene	0.22	NA	NA	No	No Tox	—	0.05%	—	No	3100	No	No
Fluorene	0.061	NA	NA	No	No Tox	—	0.01%	—	No	3100	No	No
Kepone	0.07	NA	NA	No	No Tox	—	No Tox	—	No	0.035	Yes	Yes (NT)
Methylene chloride	0.29	NA	NA	No	0.04%	—	0.04%	—	No	85	No	No
Pyrene	0.21	NA	NA	No	No Tox	—	0.06%	—	No	2300	No	No
Arsenic	11.4	5.8	Yes	No	—	8.63%	—	1.14%	Yes	0.43	Yes	Yes
Barium	468	300	Yes	No	—	No Tox	—	98.41%	Yes	5500	No	No
Cadmium	3.2	2.2	Yes	No	—	1.02%	—	0.10%	Yes	39	No	No
Chromium	42.6	33	Yes	No	—	90.35%	—	0.26%	Yes	390	No	No
Lead	22.6	17	Yes	No	—	No Tox	—	No Tox	No	400	No	No
Mercury	0.12	0.05	Yes	No	—	No Tox	—	0.04%	No	23	No	No
Selenium	0.65	0.22	Yes	No	—	No Tox	—	0.00%	No	390	No	No
Silver	8.5	3.7	Yes	No	—	No Tox	—	0.05%	No	390	No	No
Am-241	1.09	0.011	Yes	No	—	—	—	—	N/A	No RBC	No RBC	Yes
Cs-137	6.31	0.82	Yes	No	—	—	—	—	N/A	No RBC	No RBC	Yes
I-129	1.57	NA	NA	No	—	—	—	—	N/A	No RBC	No RBC	Yes
Np-237	0.86	NA	NA	No	—	—	—	—	N/A	No RBC	No RBC	Yes
Pu-238	0.5	0.0049	Yes	No	—	—	—	—	N/A	No RBC	No RBC	Yes
Sr-90	4.31	0.49	Yes	No	—	—	—	—	N/A	No RBC	No RBC	Yes
U-234	1.21	1.44	No	No	—	—	—	—	N/A	No RBC	No RBC	No
U-235	0.07	NA	NA	No	—	—	—	—	N/A	No RBC	No RBC	Yes
U-238	7.44	1.4	Yes	No	—	—	—	—	N/A	No RBC	No RBC	Yes

Sources: Metal data from Table 4-2 of GAI 1992 (Report for the ICPP Drilling and Sampling Program at LDU CPP-37)
Organic data from Table 4-3 of GAI 1992 (Report for the ICPP Drilling and Sampling Program at LDU CPP-37)
Radionuclide data from Table 4-4 of GAI 1992 (Report for the ICPP Drilling and Sampling Program at LDU CPP-37)
Table 3a Contaminant Worksheet, 5/5/94, Track 2 Preliminary Scoping Package for CPP-37.

"NA" in Step 1 indicates that a background value is not available.
"—" in Step 3 indicates that the chemical evaluated does not correspond with the analyses (organic, inorganic) as stated in the column heading.
"N/A" in Step 3 indicates that the chemical is not evaluated since it has already been screened out in Step 1 and/or Step 2 or because it is a radionuclide.
"No Tox" indicates that a toxicity value (slope factor or reference dose) is not available.
"No RBC" indicates that an EPA Region III risk-based concentration based on residential soil ingestion is not available
"Yes (NT)" indicates that this chemical does not have toxicity data and will be further evaluated.

Table 5-6. Contaminant screening process for OU 3-03, CPP-67, CPP percolation ponds #1 and #2 (sediments).

		Step 1		Step 2	Step 3					Step 4		
Chemicals	Source concentration (mg/kg or pCi/g)	Background concentration (mg/kg or pCi/g)	Is the maximum concentration greater than background value?	Is the chemical an essential nutrient?	Organic risk factor (%)	Inorganic risk factor (%)	Organic hazard factor (%)	Inorganic hazard factor (%)	Chemical comprises > 1% of the risk/hazard factor?	Region III soil residential RBC (mg/kg)	Is maximum concentration greater than RBC?	Site COPC?
Am-241	7.8	0.011	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Ce-144	1.5	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Co-60	2.35	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Cs-134	3.5	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Cs-137	93.6	0.82	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
H-3	0.61	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
I-129	3.7	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Np-237	1.63	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Pu-238	13	0.0049	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Pu-239/240	2.07	0.1	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Ru/Rh-106	5.97	NA	NA	No	----	----	----	----	N/A	#N/A	#N/A	#N/A
Sb-125	1.89	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Sr-90	16.3	0.49	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
U-234	2.75	1.44	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
U-235	0.07	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
U-235/236	0.1	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
U-238	2.6	1.4	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes

Source: Table 5-4, Radiochemistry Results Service Waste Percolation Pond No. 1, Report for the ICPP Sampling and Analysis Program at Service Waste Percolation Pond No. 1 (11/25/92).
Table 5-2c, Detected Radionuclides Service Waste Percolation Pond No. 2 Report for the ICPP Sampling and Analysis Program at Service Waste Percolation Pond No. 2 (4/15/92).

"NA" in Step 1 indicates that a background value is not available.

"----" in Step 3 indicates that the chemical evaluated does not correspond with the analyses (organic, inorganic) as stated in the column heading.

"N/A" in Step 3 indicates that the chemical is not evaluated since it has already been screened out in Step 1 and/or Step 2 or because it is a radionuclide.

"No Tox" indicates that a toxicity value (slope factor or reference dose) is not available.

"No RBC" indicates that an EPA Region III risk-based concentration based on residential soil ingestion is not available

"Yes (NT)" indicates that this chemical does not have toxicity data and will be further evaluated.

Metals and other inorganics measured in the pond sediments are absent from this table because they are being evaluated under a separate RCRA closure activity.

Note: The following contaminants were analyzed for but not detected at this site: cadmium, chromium, mercury, selenium, silver, Co-58, Y-90.

Table 5-7. Contaminant screening process for OU 3-05, CPP-14, Imhoff tanks.

		Step 1		Step 2	Step 3					Step 4		
Chemicals	Source concentration (mg/kg or pCi/g)	Background concentration (mg/kg or pCi/g)	Is the maximum concentration greater than background value?	Is the chemical an essential nutrient?	Organic risk factor (%)	Inorganic risk factor (%)	Organic hazard factor (%)	Inorganic hazard factor (%)	Chemical comprises > 1% of the risk/hazard factor?	Region III soil residential RBC (mg/kg)	Is maximum concentration greater than RBC?	Site COPC?
Acetone	0.021	NA	NA	No	No Tox	—	0.03%	----	No	7800	No	No
Aroclor-1260	23	NA	NA	No	98.31%	—	No Tox	—	Yes	0.08	Yes	Yes
Benzo(a)anthracene	0.38	NA	NA	No	0.15%	—	No Tox	----	No	0.88	No	No
Benzo(a)pyrene	0.34	NA	NA	No	1.38%	----	No Tox	—	Yes	0.088	Yes	Yes
Benzo(b)fluoranthene	0.32	NA	NA	No	0.13%	----	No Tox	----	No	0.88	No	No
Benzo(k)fluoranthene	0.27	NA	NA	No	0.01%	----	No Tox	----	No	8.8	No	No
Benzoic acid	0.32	NA	NA	No	No Tox	—	0.01%	----	No	310000	No	No
bis(2-Ethylhexyl)phthal	1.7	NA	NA	No	0.01%	----	14.00%	—	Yes	46	No	No
4-Chloroaniline	1.1	NA	NA	No	No Tox	----	45.31%	----	Yes	310	No	No
Chrysene	0.38	NA	NA	No	0.00%	----	No Tox	----	No	88	No	No
1,2-Dichloroethene	0.003	NA	NA	No	No Tox	—	0.05%	----	No	700	No	No
1,4-Dichlorobenzene	0.31	NA	NA	No	0.00%	----	0.22%	—	No	27	No	No
Di-n-octylphthalate	0.29	NA	NA	No	No Tox	—	2.39%	----	Yes	1600	No	No
Fluoranthene	0.72	NA	NA	No	No Tox	----	2.97%	—	Yes	3100	No	No
Methylene chloride	0.12	NA	NA	No	0.00%	----	0.33%	—	No	85	No	No
4-Methylphenol	0.76	NA	NA	No	No Tox	—	25.04%	----	Yes	390	No	No
Naphthalene	1.3	NA	NA	No	No Tox	—	5.35%	----	Yes	3100	No	No
Phenanthrene	0.37	NA	NA	No	No Tox	—	No Tox	----	No	No RBC	No RBC	Yes (NT)
Phenol	2.3	NA	NA	No	No Tox	—	0.63%	----	No	47000	No	No
Pyrene	0.66	NA	NA	No	No Tox	—	3.62%	----	Yes	2300	No	No
Toluene	0.029	NA	NA	No	No Tox	—	0.02%	----	No	16000	No	No
Xylene	0.027	NA	NA	No	No Tox	—	0.00%	----	No	160000	No	No
Aluminum	8990	16000	No	No	—	N/A	----	N/A	No	78000	No	No
Arsenic	4.9	5.8	No	No	—	N/A	----	N/A	No	0.43	Yes	No
Barium	207	300	No	No	----	N/A	—	N/A	No	5500	No	No
Beryllium	0.56	1.8	No	No	—	N/A	—	N/A	No	0.15	Yes	No
Calcium	69300	24000	Yes	Yes	—	N/A	----	N/A	No	No RBC	No RBC	No
Chromium	60.7	33	Yes	No	—	100.00%	----	16.73%	Yes	390	No	No
Copper	96.3	22	Yes	No	—	No Tox	----	3.32%	Yes	3100	No	No
Iron	21900	24000	No	Yes	—	N/A	----	N/A	No	23000	No	No
Lead	211	17	Yes	No	—	No Tox	----	No Tox	No	400	No	No
Magnesium	5790	12000	No	Yes	—	N/A	----	N/A	No	No RBC	No RBC	No
Manganese	248	490	No	No	—	N/A	—	N/A	No	390	No	No
Mercury	4	0.05	Yes	No	—	No Tox	----	64.30%	Yes	23	No	No
Nickel	26.2	35	No	No	—	N/A	----	N/A	No	1600	No	No
Potassium	1910	4300	No	Yes	—	N/A	—	N/A	No	No RBC	No RBC	No
Silver	48.9	3.7	Yes	No	—	No Tox	----	13.47%	Yes	390	No	No
Sodium	549	320	Yes	Yes	—	N/A	—	N/A	No	No RBC	No RBC	No
Thallium	0.24	0.43	No	No	----	N/A	—	N/A	No	No RBC	No RBC	No
Vanadium	34.9	45	No	No	----	N/A	—	N/A	No	550	No	No
Zinc	475	150	Yes	No	—	No Tox	----	2.18%	Yes	23000	No	No
Cs-137	6.21	0.82	Yes	No	—	----	----	—	N/A	No RBC	No RBC	Yes
Np-237	1.98	NA	NA	No	—	----	----	—	N/A	No RBC	No RBC	Yes
Sr-90	1.07	0.49	Yes	No	—	----	----	—	N/A	No RBC	No RBC	Yes
U-234	1.15	1.44	No	No	—	----	----	----	N/A	No RBC	No RBC	No
U-235	0.05	NA	NA	No	—	----	----	----	N/A	No RBC	No RBC	Yes
U-238	0.53	1.4	No	No	—	----	----	----	N/A	No RBC	No RBC	No

Source: Track 2 Summary Report for CPP-14.
"NA" in Step 1 indicates that a background value is not available.
"—" in Step 3 indicates that the chemical evaluated does not correspond with the analyses (organic, inorganic) as stated in the column heading.
"N/A" in Step 3 indicates that the chemical is not evaluated since it has already been screened out in Step 1 and/or Step 2 or because it is a radionuclide.
"No Tox" indicates that a toxicity value (slope factor or reference dose) is not available.
"No RBC" indicates that an EPA Region III risk-based concentration based on residential soil ingestion is not available
"Yes (NT)" indicates that this chemical does not have toxicity data and will be further evaluated.
Note: The following contaminants were analyzed for but not detected at this site: antimony, cadmium, cobalt, cyanide, selenium, Am-241, Ce-144, Co-58, Co-60, Cs-134, I-129, Pu-238, Pu-239/240, Ru-103, Ru-106, Sb-12

Table 5-8. Contaminant screening process for OU 3-05, CPP-14, plant site.

		Step 1		Step 2	Step 3					Step 4		
Chemicals	Source concentration (mg/kg or pCi/g)	Background concentration (mg/kg or pCi/g)	Is the maximum concentration greater than background value?	Is the chemical an essential nutrient?	Organic risk factor (%)	Inorganic risk factor (%)	Organic hazard factor (%)	Inorganic hazard factor (%)	Chemical comprises > 1% of the risk/hazard factor?	Region III soil residential RBC (mg/kg)	Is maximum concentration greater than RBC?	Site COPC?
Aroclor-1254	0.12	NA	NA	No	14.18%	----	99.45%	----	Yes	1.6	No	No
Aroclor-1260	0.72	NA	NA	No	85.09%	----	No Tox	----	Yes	0.08	Yes	Yes
Benzoic acid	0.2	NA	NA	No	No Tox	----	0.00%	----	No	310000	No	No
bis(2-Ethylhexyl)phthala	0.043	NA	NA	No	0.01%	----	0.04%	----	No	46	No	No
2-Butanone	0.001	NA	NA	No	No Tox	----	0.00%	----	No	47000	No	No
Di-n-octylphthalate	0.24	NA	NA	No	No Tox	----	0.20%	----	No	1600	No	No
Methylene chloride	0.12	NA	NA	No	0.01%	----	0.03%	----	No	85	No	No
4-Nitrophenol	0.26	NA	NA	No	No Tox	----	0.07%	----	No	4800	No	No
Pentachlorophenol	0.38	NA	NA	No	0.70%	----	0.21%	----	No	5.3	No	No
Tetrachloroethylene	0.001	NA	NA	No	0.00%	----	0.00%	----	No	12	No	No
Toluene	0.004	NA	NA	No	No Tox	----	0.00%	----	No	16000	No	No
Xylene	0.044	NA	NA	No	No Tox	----	0.00%	----	No	160000	No	No
Aluminum	7770	16000	No	No	----	N/A	----	N/A	No	78000	No	No
Antimony	12.3	4.8	Yes	No	----	No Tox	----	81.44%	Yes	31	No	No
Arsenic	5.3	5.8	No	No	----	N/A	----	N/A	No	0.43	Yes	No
Barium	149	300	No	No	----	N/A	----	N/A	No	5500	No	No
Beryllium	0.63	1.8	No	No	----	N/A	----	N/A	No	0.15	Yes	No
Cadmium	0.83	2.2	No	No	----	N/A	----	N/A	No	39	No	No
Calcium	26900	24000	Yes	Yes	----	N/A	----	N/A	No	No RBC	No RBC	No
Chromium	30.4	33	No	No	----	N/A	----	N/A	No	390	No	No
Cobalt	6.6	11	No	No	----	N/A	----	N/A	No	4700	No	No
Copper	31.1	22	Yes	No	----	No Tox	----	2.06%	Yes	3100	No	No
Iron	23700	24000	No	Yes	----	N/A	----	N/A	No	23000	Yes	No
Lead	62.2	17	Yes	No	----	No Tox	----	No Tox	No	400	No	No
Magnesium	5270	12000	No	Yes	----	N/A	----	N/A	No	No RBC	No RBC	No
Manganese	292	490	No	No	----	N/A	----	N/A	No	390	No	No
Mercury	0.38	0.05	Yes	No	----	No Tox	----	11.74%	Yes	23	No	No
Nickel	26.5	35	No	No	----	N/A	----	N/A	No	1600	No	No
Potassium	1680	4300	No	Yes	----	N/A	----	N/A	No	No RBC	No RBC	No
Selenium	0.69	0.22	Yes	No	----	No Tox	----	0.37%	No	390	No	No
Silver	8.3	3.7	Yes	No	----	No Tox	----	4.40%	Yes	390	No	No
Sodium	272	320	No	Yes	----	N/A	----	N/A	No	No RBC	No RBC	No
Vanadium	30.4	45	No	No	----	N/A	----	N/A	No	550	No	No
Zinc	88.6	150	No	No	----	N/A	----	N/A	No	23000	No	No
Am-241	1.15	0.011	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Cs-137	3.89	0.82	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Np-237	5.5	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Sb-125	0.1	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Sr-90	0.57	0.49	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
U-234	6.89	1.44	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
U-235	0.68	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
U-238	52.1	1.4	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes

Source: Track 2 Summary Report for CPP-14.
"NA" in Step 1 indicates that a background value is not available.
"----" in Step 3 indicates that the chemical evaluated does not correspond with the analyses (organic, inorganic) as stated in the column heading.
"N/A" in Step 3 indicates that the chemical is not evaluated since it has already been screened out in Step 1 and/or Step 2 or because it is a radionuclide.
"No Tox" indicates that a toxicity value (slope factor or reference dose) is not available.
"No RBC" indicates that an EPA Region III risk-based concentration based on residential soil ingestion is not available
"Yes (NT)" indicates that this chemical does not have toxicity data and will be further evaluated.
Note: The following contaminants were analyzed for but not detected at this site: cyanide, thallium, Ce-144, Co-58, Co-60, Cs-134, I-129, Eu-154, Eu-155, Pu-238, Pu-239/240, Ru-103, Ru-106, Sb-125, Y-90.

Table 5-9. Contaminant screening process for OU 3-05, CPP-14, drain field.

		Step 1		Step 2	Step 3					Step 4		
Chemicals	Source concentration (mg/kg or pCi/g)	Background concentration (mg/kg or pCi/g)	Is the maximum concentration greater than background value?	Is the chemical an essential nutrient?	Organic risk factor (%)	Inorganic risk factor (%)	Organic hazard factor (%)	Inorganic hazard factor (%)	Chemical comprises > 1% of the risk/hazard factor?	Region III soil residential RBC (mg/kg)	Is maximum concentration greater than RBC?	Site COPC?
Di-n-butylphthalate	0.09	NA	NA	No	No Tox	----	16.67%	----	Yes	7800	No	No
Naphthalene	0.18	NA	NA	No	No Tox	----	83.33%	----	Yes	3100	No	No
Phenanthrene	0.087	NA	NA	No	No Tox	----	No Tox	----	No	No RBC	No RBC	Yes (NT)
Aluminum	5340	16000	No	No	----	N/A	----	N/A	No	78000	No	No
Arsenic	8.6	5.8	Yes	No	----	100.00%	----	99.70%	Yes	0.43	Yes	Yes
Barium	199	300	No	No	----	N/A	----	N/A	No	5500	No	No
Calcium	10100	24000	No	Yes	----	N/A	----	N/A	No	No RBC	No RBC	No
Chromium	25.2	33	No	No	----	N/A	----	N/A	No	390	No	No
Cobalt	9	11	No	No	----	N/A	----	N/A	No	4700	No	No
Copper	19.4	22	No	No	----	N/A	----	N/A	No	3100	No	No
Iron	17600	24000	No	Yes	----	N/A	----	N/A	No	23000	No	No
Lead	15.5	17	No	No	----	N/A	----	N/A	No	400	No	No
Magnesium	5250	12000	No	Yes	----	N/A	----	N/A	No	No RBC	No RBC	No
Manganese	413	490	No	No	----	N/A	----	N/A	No	390	Yes	No
Nickel	22.6	35	No	No	----	N/A	----	N/A	No	1600	No	No
Potassium	2090	4300	No	Yes	----	N/A	----	N/A	No	No RBC	No RBC	No
Selenium	0.43	0.22	Yes	No	----	No Tox	----	0.30%	No	390	No	No
Sodium	149	320	No	Yes	----	N/A	----	N/A	No	No RBC	No RBC	No
Thallium	0.24	0.43	No	No	----	N/A	----	N/A	No	No RBC	No RBC	No
Vanadium	29.7	45	No	No	----	N/A	----	N/A	No	550	No	No
Zinc	69.8	150	No	No	----	N/A	----	N/A	No	23000	No	No
Np-237	1.4	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Sr-90	0.88	0.49	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
U-234	0.39	1.44	No	No	----	----	----	----	N/A	No RBC	No RBC	No
U-238	0.39	1.4	No	No	----	----	----	----	N/A	No RBC	No RBC	No

Source: Track 2 Summary Report for CPP-14.

"NA" in Step 1 indicates that a background value is not available.

"----" in Step 3 indicates that the chemical evaluated does not correspond with the analyses (organic, inorganic) as stated in the column heading.

"N/A" in Step 3 indicates that the chemical is not evaluated since it has already been screened out in Step 1 and/or Step 2 or because it is a radionuclide.

"No Tox" indicates that a toxicity value (slope factor or reference dose) is not available.

"No RBC" indicates that an EPA Region III risk-based concentration based on residential soil ingestion is not available

"Yes (NT)" indicates that this chemical does not have toxicity data and will be further evaluated.

Note: The following contaminants were analyzed for but not detected at this site: antimony, beryllium, cadmium, cyanide, mercury, silver, Am-241, Ce-144, Co-58, Co-60, Cs-134, Cs-137, I-129, Pu-238, Pu-239/240, Ru-103, Ru-106, Sb-125, U-235.

Table 5-10. Contaminant screening process for OU 3-06, CPP-33, contaminated soil in the Tank Farm area NE of CPP-604.

		Step 1		Step 2	Step 3					Step 4		
Chemicals	Source concentration (mg/kg or pCi/g)	Background concentration (mg/kg or pCi/g)	Is the maximum concentration greater than background value?	Is the chemical an essential nutrient?	Organic risk factor (%)	Inorganic risk factor (%)	Organic hazard factor (%)	Inorganic hazard factor (%)	Chemical comprises > 1% of the risk/hazard factor?	Region III soil residential RBC (mg/kg)	Is maximum concentration greater than RBC?	Site COPC?
Trichloroethene	0.001	NA	NA	No	100.00%	----	100.00%	----	Yes	58	No	No
Arsenic	6.8	5.8	Yes	No	----	5.51%	----	38.00%	Yes	0.43	Yes	Yes
Barium	193	300	No	No	----	N/A	----	N/A	No	5500	No	No
Cadmium	11.2	2.2	Yes	No	----	3.81%	----	18.78%	Yes	39	No	No
Chromium	40	33	Yes	No	----	90.69%	----	13.41%	Yes	390	No	No
Lead	31.7	17	Yes	No	----	No Tox	----	No Tox	No	400	No	No
Mercury	1.51	0.05	Yes	No	----	No Tox	----	29.54%	Yes	23	No	No
Selenium	0.78	0.22	Yes	No	----	No Tox	----	0.26%	No	390	No	No
Silver	1.15	3.7	No	No	----	N/A	----	N/A	No	390	No	No
Am-241	9.59	0.011	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Cs-137	606	0.82	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Np-237	1.14	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Pu-238	0.46	0.0049	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Pu-239/240	0.34	0.1	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Sr-90	328.8	0.49	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
U-234	0.51	1.44	No	No	----	----	----	----	N/A	No RBC	No RBC	No
U-238	0.54	1.4	No	No	----	----	----	----	N/A	No RBC	No RBC	No

Source: Track 1 Decision Documentation Package for CPP-33.
"NA" in Step 1 indicates that a background value is not available.
"----" in Step 3 indicates that the chemical evaluated does not correspond with the analyses (organic, inorganic) as stated in the column heading.
"N/A" in Step 3 indicates that the chemical is not evaluated since it has already been screened out in Step 1 and/or Step 2 or because it is a radionuclide.
"No Tox" indicates that a toxicity value (slope factor or reference dose) is not available.
"No RBC" indicates that an EPA Region III risk-based concentration based on residential soil ingestion is not available
"Yes (NT)" indicates that this chemical does not have toxicity data and will be further evaluated.

Table 5-11. Contaminant screening process for OU 3-06, CPP-34, soil storage area in the NE corner of the ICPP.

		Step 1		Step 2	Step 3					Step 4		
Chemicals	Source concentration (mg/kg or pCi/g)	Background concentration (mg/kg or pCi/g)	Is the maximum concentration greater than background value?	Is the chemical an essential nutrient?	Organic risk factor (%)	Inorganic risk factor (%)	Organic hazard factor (%)	Inorganic hazard factor (%)	Chemical comprises > 1% of the risk/hazard factor?	Region III soil residential RBC (mg/kg)	Is maximum concentration greater than RBC?	Site COPC?
bis(2-Ethylhexyl)phthalate	0.62	NA	NA	No	100.00%	----	100.00%	----	Yes	46	No	No
Aluminum	8608	16000	No	No	----	N/A	----	N/A	No	78000	No	No
Arsenic	7.1	5.8	Yes	No	----	100.00%	----	76.71%	Yes	0.43	Yes	Yes
Barium	239	300	No	No	----	N/A	----	N/A	No	5500	No	No
Beryllium	0.5	1.8	No	No	----	N/A	----	N/A	No	0.15	Yes	No
Cadmium	1	2.2	No	No	----	N/A	----	N/A	No	39	No	No
Calcium	21972	24000	No	Yes	----	N/A	----	N/A	No	No RBC	No RBC	No
Chromium	28	33	No	No	----	N/A	----	N/A	No	390	No	No
Cobalt	7.6	11	No	No	----	N/A	----	N/A	No	4700	No	No
Copper	17.1	22	No	No	----	N/A	----	N/A	No	3100	No	No
Fluoride	2.6	NA	NA	No	----	No Tox	----	0.14%	No	4700	No	No
Lead	132	17	Yes	No	----	No Tox	----	No Tox	No	400	No	No
Magnesium	6923	12000	No	Yes	----	N/A	----	N/A	No	No RBC	No RBC	No
Manganese	269	490	No	No	----	N/A	----	N/A	No	390	No	No
Mercury	0.6	0.05	Yes	No	----	No Tox	----	22.69%	Yes	23	No	No
Nickel	26	35	No	No	----	N/A	----	N/A	No	1600	No	No
Potassium	1512	4300	No	Yes	----	N/A	----	N/A	No	No RBC	No RBC	No
Selenium	0.7	0.22	Yes	No	----	No Tox	----	0.45%	No	390	No	No
Silver	2.5	3.7	No	No	----	N/A	----	N/A	No	390	No	No
Sodium	177	320	No	Yes	----	N/A	----	N/A	No	No RBC	No RBC	No
Sulfide	81.4	NA	NA	No	----	No Tox	----	No Tox	No	230	No	No
Vanadium	22.1	45	No	No	----	N/A	----	N/A	No	550	No	No
Zinc	89.5	150	No	No	----	N/A	----	N/A	No	23000	No	No
Cs-137	2000	0.82	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Np-237	0.7	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Pu-238	5.1	0.0049	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Sr-90	6000	0.49	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
U-234	2.5	1.44	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
U-238	2.8	1.4	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes

Source: Tables 4.2 and 4.4, Report for ICPP Drilling & Sampling Program.

"NA" in Step 1 indicates that a background value is not available.

"----" in Step 3 indicates that the chemical evaluated does not correspond with the analyses (organic, inorganic) as stated in the column heading.

"N/A" in Step 3 indicates that the chemical is not evaluated since it has already been screened out in Step 1 and/or Step 2 or because it is a radionuclide.

"No Tox" indicates that a toxicity value (slope factor or reference dose) is not available.

"No RBC" indicates that an EPA Region III risk-based concentration based on residential soil ingestion is not available

"Yes (NT)" indicates that this chemical does not have toxicity data and will be further evaluated.

Table 5-12. Contaminant screening process for OU 3-06, CPP-40, lime pit at the base of the CPP-601 berm and french drain.

		Step 1		Step 2	Step 3					Step 4		
Chemicals	Source concentration (mg/kg or pCi/g)	Background concentration (mg/kg or pCi/g)	Is the maximum concentration greater than background value?	Is the chemical an essential nutrient?	Organic risk factor (%)	Inorganic risk factor (%)	Organic hazard factor (%)	Inorganic hazard factor (%)	Chemical comprises > 1% of the risk/hazard factor?	Region III soil residential RBC (mg/kg)	Is maximum concentration greater than RBC?	Site COPC?
Cs-137	1.34	0.82	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes

Source: ERIS.

"NA" in Step 1 indicates that a background value is not available.

"----" in Step 3 indicates that the chemical evaluated does not correspond with the analyses (organic, inorganic) as stated in the column heading.

"N/A" in Step 3 indicates that the chemical is not evaluated since it has already been screened out in Step 1 and/or Step 2 or because it is a radionuclide.

"No Tox" indicates that a toxicity value (slope factor or reference dose) is not available.

"No RBC" indicates that an EPA Region III risk-based concentration based on residential soil ingestion is not available

"Yes (NT)" indicates that this chemical does not have toxicity data and will be further evaluated.

Note: The following contaminants were analyzed for but not detected at this site: Am-241, Ce-144, Co-58, Co-60, Cs-134, Eu-154, Eu-155, Nb-95, Ru-103, Ru-106, Sb-125, Sr-90, Tc-99.

Table 5-13. Contaminant screening process for OU 3-07, CPP-20, CPP-604 radioactive waste unloading area.

		Step 1		Step 2	Step 3					Step 4		
Chemicals	Source concentration (mg/kg or pCi/g)	Background concentration (mg/kg or pCi/g)	Is the maximum concentration greater than background value?	Is the chemical an essential nutrient?	Organic risk factor (%)	Inorganic risk factor (%)	Organic hazard factor (%)	Inorganic hazard factor (%)	Chemical comprises > 1% of the risk/hazard factor?	Region III soil residential RBC (mg/kg)	Is maximum concentration greater than RBC?	Site COPC?
Aluminum	4600	16000	No	No	----	N/A	----	N/A	No	78000	No	No
Arsenic	5.9	5.8	Yes	No	----	100.00%	----	93.68%	Yes	0.43	Yes	No[a]
Barium	83.3	300	No	No	----	N/A	----	N/A	No	5500	No	No
Beryllium	0.45	1.8	No	No	----	N/A	----	N/A	No	0.15	Yes	No
Cadmium	0.38	2.2	No	No	----	N/A	----	N/A	No	39	No	No
Calcium	31500	24000	Yes	Yes	----	N/A	----	N/A	No	No RBC	No RBC	No
Chromium	14	33	No	No	----	N/A	----	N/A	No	390	No	No
Cobalt	4.4	11	No	No	----	N/A	----	N/A	No	4700	No	No
Copper	12.8	22	No	No	----	N/A	----	N/A	No	3100	No	No
Iron	9230	24000	No	Yes	----	N/A	----	N/A	No	23000	No	No
Lead	8.4	17	No	No	----	N/A	----	N/A	No	400	No	No
Magnesium	3630	12000	No	Yes	----	N/A	----	N/A	No	No RBC	No RBC	No
Manganese	175	490	No	No	----	N/A	----	N/A	No	390	No	No
Mercury	0.1	0.05	Yes	No	----	No Tox	----	5.56%	Yes	23	No	No
Nickel	17.1	35	No	No	----	N/A	----	N/A	No	1600	No	No
Potassium	788	4300	No	Yes	----	N/A	----	N/A	No	No RBC	No RBC	No
Selenium	0.8	0.22	Yes	No	----	No Tox	----	0.76%	No	390	No	No
Silver	0.28	3.7	No	No	----	N/A	----	N/A	No	390	No	No
Sodium	211	320	No	Yes	----	N/A	----	N/A	No	No RBC	No RBC	No
Vanadium	18.5	45	No	No	----	N/A	----	N/A	No	550	No	No
Zinc	55.5	150	No	No	----	N/A	----	N/A	No	23000	No	No
Am-241	0.17	0.011	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Co-60	0.09	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Cs-134	0.19	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Cs-137	114	0.82	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Eu-154	0.48	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Np-237	0.17	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Pu-238	0.43	0.0049	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Pu-239/240	0.09	0.1	No	No	----	----	----	----	N/A	No RBC	No RBC	No
Sr-90	330	0.49	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Tc-99	2.2	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
U-234	1	1.44	No	No	----	----	----	----	N/A	No RBC	No RBC	No
U-238	1	1.4	No	No	----	----	----	----	N/A	No RBC	No RBC	No

Source: ERIS.

"NA" in Step 1 indicates that a background value is not available.

"----" in Step 3 indicates that the chemical evaluated does not correspond with the analyses (organic, inorganic) as stated in the column heading.

"N/A" in Step 3 indicates that the chemical is not evaluated since it has already been screened out in Step 1 and/or Step 2 or because it is a radionuclide.

"No Tox" indicates that a toxicity value (slope factor or reference dose) is not available.

"No RBC" indicates that an EPA Region III risk-based concentration based on residential soil ingestion is not available

"Yes (NT)" indicates that this chemical does not have toxicity data and will be further evaluated.

Note: The following contaminants were analyzed for but not detected at this site: antimony, thallium, nitrate, toluene, Ce-144, Co-58, Eu-155, Nb-95, Ru-103, Ru-106, Sb-125, U-235.

a. Arsenic was eliminated as a COPC because its maximum detected concentration is less than 2% above background.

Table 5-14. Contaminant screening process for OU 3-07, CPP-25, contaminated soil in Tank Farm area north of CPP-604.

		Step 1		Step 2	Step 3					Step 4		
Chemicals	Source concentration (mg/kg or pCi/g)	Background concentration (mg/kg or pCi/g)	Is the maximum concentration greater than background value?	Is the chemical an essential nutrient?	Organic risk factor (%)	Inorganic risk factor (%)	Organic hazard factor (%)	Inorganic hazard factor (%)	Chemical comprises > 1% of the risk/hazard factor?	Region III soil residential RBC (mg/kg)	Is maximum concentration greater than RBC?	Site COPC?
Aluminum	4600	16000	No	No	----	N/A	----	N/A	No	78000	No	No
Arsenic	5.9	5.8	Yes	No	----	100.00%	----	93.68%	Yes	0.43	Yes	No[a]
Barium	83.3	300	No	No	----	N/A	----	N/A	No	5500	No	No
Beryllium	0.45	1.8	No	No	----	N/A	----	N/A	No	0.15	Yes	No
Cadmium	0.38	2.2	No	No	----	N/A	----	N/A	No	39	No	No
Calcium	31500	24000	Yes	Yes	----	N/A	----	N/A	No	No RBC	No RBC	No
Chromium	14	33	No	No	----	N/A	----	N/A	No	390	No	No
Cobalt	4.4	11	No	No	----	N/A	----	N/A	No	4700	No	No
Copper	12.8	22	No	No	----	N/A	----	N/A	No	3100	No	No
Iron	9230	24000	No	Yes	----	N/A	----	N/A	No	23000	No	No
Lead	8.4	17	No	No	----	N/A	----	N/A	No	400	No	No
Magnesium	3630	12000	No	Yes	----	N/A	----	N/A	No	No RBC	No RBC	No
Manganese	175	490	No	No	----	N/A	----	N/A	No	390	No	No
Mercury	0.1	0.05	Yes	No	----	No Tox	----	5.56%	Yes	23	No	No
Nickel	17.1	35	No	No	----	N/A	----	N/A	No	1600	No	No
Potassium	788	4300	No	Yes	----	N/A	----	N/A	No	No RBC	No RBC	No
Selenium	0.8	0.22	Yes	No	----	No Tox	----	0.76%	No	390	No	No
Silver	0.28	3.7	No	No	----	N/A	----	N/A	No	390	No	No
Sodium	211	320	No	Yes	----	N/A	----	N/A	No	No RBC	No RBC	No
Vanadium	18.5	45	No	No	----	N/A	----	N/A	No	550	No	No
Zinc	55.5	150	No	No	----	N/A	----	N/A	No	23000	No	No
Am-241	0.17	0.011	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Co-60	0.09	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Cs-134	0.19	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Cs-137	114	0.82	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Eu-154	0.48	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Np-237	0.17	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Pu-238	0.43	0.0049	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Pu-239/240	0.09	0.1	No	No	----	----	----	----	N/A	No RBC	No RBC	No
Sr-90	330	0.49	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Tc-99	2.2	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
U-234	1	1.44	No	No	----	----	----	----	N/A	No RBC	No RBC	No
U-238	1	1.4	No	No	----	----	----	----	N/A	No RBC	No RBC	No

Source: ERIS.

"NA" in Step 1 indicates that a background value is not available.

"----" in Step 3 indicates that the chemical evaluated does not correspond with the analyses (organic, inorganic) as stated in the column heading.

"N/A" in Step 3 indicates that the chemical is not evaluated since it has already been screened out in Step 1 and/or Step 2 or because it is a radionuclide.

"No Tox" indicates that a toxicity value (slope factor or reference dose) is not available.

"No RBC" indicates that an EPA Region III risk-based concentration based on residential soil ingestion is not available

"Yes (NT)" indicates that this chemical does not have toxicity data and will be further evaluated.

Note: The following contaminants were analyzed for but not detected at this site: antimony, thallium, nitrate, toluene, Ce-144, Co-58, Eu-155, Nb-95, Ru-103, Ru-106, Sb-125, U-235.

a. Arsenic was eliminated as a COPC because its maximum detected concentration is less than 2% above background.

Table 5-15. Contaminant screening process for OU 3-07, CPP-26, contaminated soil in the Tank Farm Area steam flushing-operation inside the Tank Farm perimeter.

		Step 1		Step 2	Step 3					Step 4		
Chemicals	Source concentration (mg/kg or pCi/g)	Background concentration (mg/kg or pCi/g)	Is the maximum concentration greater than background value?	Is the chemical an essential nutrient?	Organic risk factor (%)	Inorganic risk factor (%)	Organic hazard factor (%)	Inorganic hazard factor (%)	Chemical comprises > 1% of the risk/hazard factor?	Region III soil residential RBC (mg/kg)	Is maximum concentration greater than RBC?	Site COPC?
Toluene	0.002	NA	NA	No	No Tox	----	100.00%	----	Yes	16000	No	No
Chromium	15.5	33	No	No	----	N/A	----	N/A	No	390	No	No
Fluoride	2.09	NA	NA	No	----	No Tox	----	95.05%	Yes	4700	No	No
Manganese	238	490	No	No	----	N/A	----	N/A	No	390	No	No
Nickel	19.4	35	No	No	----	N/A	----	N/A	No	1600	No	No
Nitrate	2.9	NA	NA	No	----	No Tox	----	4.95%	Yes	130000	No	No
Am-241	1.34	0.011	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Cs-137	6730	0.82	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Eu-154	10.7	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
K-40	21.7	24	No	No	----	----	----	----	N/A	No RBC	No RBC	No
Pu-238	3.58	0.0049	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Pu-239	0.841	0.1	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Sr-90	15800	0.49	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
U-234	2.21	1.44	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
U-235	0.104	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
U-238	1.25	1.4	No	No	----	----	----	----	N/A	No RBC	No RBC	No

Source: Table 4.1, Results of the soil analysis at CPP-26, Track 2 Summary Report for Operable Unit 3-07.
"NA" in Step 1 indicates that a background value is not available.
"----" in Step 3 indicates that the chemical evaluated does not correspond with the analyses (organic, inorganic) as stated in the column heading.
"N/A" in Step 3 indicates that the chemical is not evaluated since it has already been screened out in Step 1 and/or Step 2 or because it is a radionuclide.
"No Tox" indicates that a toxicity value (slope factor or reference dose) is not available.
"No RBC" indicates that an EPA Region III risk-based concentration based on residential soil ingestion is not available
"Yes (NT)" indicates that this chemical does not have toxicity data and will be further evaluated.

Table 5-16. Contaminant screening process for OU 3-07, CPP-28, contaminated soil in the Tank Farm Area south of WM-181 by valve box A-6.

		Step 1		Step 2	Step 3					Step 4		
Chemicals	Source concentration (mg/kg or pCi/g)	Background concentration (mg/kg or pCi/g)	Is the maximum concentration greater than background value?	Is the chemical an essential nutrient?	Organic risk factor (%)	Inorganic risk factor (%)	Organic hazard factor (%)	Inorganic hazard factor (%)	Chemical comprises > 1% of the risk/hazard factor?	Region III soil residential RBC (mg/kg)	Is maximum concentration greater than RBC?	Site COPC?
Ce-144	14.4	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Co-60	22700	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Cs-134	75500	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Cs-137	102000000	0.82	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Eu-154	565000	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
H-3	24900	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Np-237	1.63	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Pu-239	12600	0.1	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Pu-240	12200	0.1	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Pu-241	1050000	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Pu-242	32	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Ru-106	54.1	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Sr-90	56800000	0.49	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
U-234	21.2	1.44	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
U-235	0.241	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
U-236	0.755	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
U-238	0.0451	1.4	No	No	----	----	----	----	N/A	No RBC	No RBC	No

Source: Table 4.7, Estimated Soil Contamination at CPP-28, Track 2 Summary Report for Operable Unit 3-07. Values are calculated 1992 soil concentrations.

"NA" in Step 1 indicates that a background value is not available.

"----" in Step 3 indicates that the chemical evaluated does not correspond with the analyses (organic, inorganic) as stated in the column heading.

"N/A" in Step 3 indicates that the chemical is not evaluated since it has already been screened out in Step 1 and/or Step 2 or because it is a radionuclide.

"No Tox" indicates that a toxicity value (slope factor or reference dose) is not available.

"No RBC" indicates that an EPA Region III risk-based concentration based on residential soil ingestion is not available

"Yes (NT)" indicates that this chemical does not have toxicity data and will be further evaluated.

Table 5-17. Contaminant screening process for OU 3-07, CPP-31, contaminated soil in the Tank Farm Area south of WM-183.

		Step 1		Step 2	Step 3					Step 4		
Chemicals	Source concentration (mg/kg or pCi/g)	Background concentration (mg/kg or pCi/g)	Is the maximum concentration greater than background value?	Is the chemical an essential nutrient?	Organic risk factor (%)	Inorganic risk factor (%)	Organic hazard factor (%)	Inorganic hazard factor (%)	Chemical comprises > 1% of the risk/hazard factor?	Region III soil residential RBC (mg/kg)	Is maximum concentration greater than RBC?	Site COPC?
Co-60	336	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Cs-134	24	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Cs-137	2190000	0.82	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Eu-154	2750	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Pu-239/240	1500	0.1	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Ru-106	0.0666	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Sr-90	710000	0.49	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
U-235	9000	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes

Source: Table 4.12, Results of the 1975 Radiological Analyses of the Soil and the Calculated 1992 Concentrations Based on Radioactive Decay, Track 2 Summary Report for Operable Unit 3-07.
Values are calculated 1992 soil concentrations.

"NA" in Step 1 indicates that a background value is not available.

"----" in Step 3 indicates that the chemical evaluated does not correspond with the analyses (organic, inorganic) as stated in the column heading.

"N/A" in Step 3 indicates that the chemical is not evaluated since it has already been screened out in Step 1 and/or Step 2 or because it is a radionuclide.

"No Tox" indicates that a toxicity value (slope factor or reference dose) is not available.

"No RBC" indicates that an EPA Region III risk-based concentration based on residential soil ingestion is not available

"Yes (NT)" indicates that this chemical does not have toxicity data and will be further evaluated.

Table 5-18. Contaminant screening process for OU 3-07, CPP-32E/W, contaminated soil in the Tank Farm Area of valve box B-4.

		Step 1		Step 2	Step 3					Step 4		
Chemicals	Source concentration (mg/kg or pCi/g)	Background concentration (mg/kg or pCi/g)	Is the maximum concentration greater than background value?	Is the chemical an essential nutrient?	Organic risk factor (%)	Inorganic risk factor (%)	Organic hazard factor (%)	Inorganic hazard factor (%)	Chemical comprises > 1% of the risk/hazard factor?	Region III soil residential RBC (mg/kg)	Is maximum concentration greater than RBC?	Site COPC?
Toluene	0.001	NA	NA	No	No Tox	---	100.00%	---	Yes	16000	No	No
Mercury	0.3	0.05	Yes	No	---	No Tox	---	100.00%	Yes	23	No	No
Cs-137	277	0.82	Yes	No	---	---	---	---	N/A	No RBC	No RBC	Yes
Eu-154	0.811	NA	NA	No	---	---	---	---	N/A	No RBC	No RBC	Yes
K-40	21	24	No	No	---	---	---	---	N/A	No RBC	No RBC	No
Sr-90	278	0.49	Yes	No	---	---	---	---	N/A	No RBC	No RBC	Yes

Source: Table 4-17, Results from the Soil Samples Analyzed at Site CPP-32E, Track 2 Summary Report for Operable Unit 3-07.

"NA" in Step 1 indicates that a background value is not available.

"---" in Step 3 indicates that the chemical evaluated does not correspond with the analyses (organic, inorganic) as stated in the column heading.

"N/A" in Step 3 indicates that the chemical is not evaluated since it has already been screened out in Step 1 and/or Step 2 or because it is a radionuclide.

"No Tox" indicates that a toxicity value (slope factor or reference dose) is not available.

"No RBC" indicates that an EPA Region III risk-based concentration based on residential soil ingestion is not available

"Yes (NT)" indicates that this chemical does not have toxicity data and will be further evaluated.

Table 5-19. Contaminant screening process for OU 3-07, CPP-79, tank farm release near valve box A-2.

		Step 1		Step 2	Step 3					Step 4		
Chemicals	Source concentration (mg/kg or pCi/g)	Background concentration (mg/kg or pCi/g)	Is the maximum concentration greater than background value?	Is the chemical an essential nutrient?	Organic risk factor (%)	Inorganic risk factor (%)	Organic hazard factor (%)	Inorganic hazard factor (%)	Chemical comprises > 1% of the risk/hazard factor?	Region III soil residential RBC (mg/kg)	Is maximum concentration greater than RBC?	Site COPC?
Nitrate	2.3	NA	NA	No	----	No Tox	----	100.00%	Yes	130000	No	No
Am-241	16600	0.011	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Cs-137	33700000	0.82	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
K-40	22.9	24	No	No	----	----	----	----	N/A	No RBC	No RBC	No
Pu-238	0.13	0.0049	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Pu-239	0.0978	0.1	No	No	----	----	----	----	N/A	No RBC	No RBC	No
Sr-90	5410000	0.49	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
U-234	5.55	1.44	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
U-235	0.16	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
U-238	1.39	1.4	No	No	----	----	----	----	N/A	No RBC	No RBC	No

Source: Table 4-21, Results from the Soil Analyses from Site CPP-79, Track 2 Summary Report for Operable Unit 3-07.

"NA" in Step 1 indicates that a background value is not available.

"----" in Step 3 indicates that the chemical evaluated does not correspond with the analyses (organic, inorganic) as stated in the column heading.

"N/A" in Step 3 indicates that the chemical is not evaluated since it has already been screened out in Step 1 and/or Step 2 or because it is a radionuclide.

"No Tox" indicates that a toxicity value (slope factor or reference dose) is not available.

"No RBC" indicates that an EPA Region III risk-based concentration based on residential soil ingestion is not available

"Yes (NT)" indicates that this chemical does not have toxicity data and will be further evaluated.

Table 5-20. Contaminant screening process for OU 3-08, CPP-13, pressurization of the solid storage cyclone NE of CPP-13.

		Step 1		Step 2	Step 3					Step 4		
Chemicals	Source concentration (mg/kg or pCi/g)	Background concentration (mg/kg or pCi/g)	Is the maximum concentration greater than background value?	Is the chemical an essential nutrient?	Organic risk factor (%)	Inorganic risk factor (%)	Organic hazard factor (%)	Inorganic hazard factor (%)	Chemical comprises > 1% of the risk/hazard factor?	Region III soil residential RBC (mg/kg)	Is maximum concentration greater than RBC?	Site COPC?
Aluminum	6440	16000	No	No	----	N/A	----	N/A	No	78000	No	No
Arsenic	8.3	5.8	Yes	No	----	100.00%	----	71.90%	Yes	0.43	Yes	Yes
Barium	113	300	No	No	----	N/A	----	N/A	No	5500	No	No
Beryllium	0.53	1.8	No	No	----	N/A	----	N/A	No	0.15	Yes	No
Calcium	16400	24000	No	Yes	----	N/A	----	N/A	No	No RBC	No RBC	No
Chromium	17.1	33	No	No	----	N/A	----	N/A	No	390	No	No
Cobalt	5.6	11	No	No	----	N/A	----	N/A	No	4700	No	No
Copper	17.4	22	No	No	----	N/A	----	N/A	No	3100	No	No
Iron	11900	24000	No	Yes	----	N/A	----	N/A	No	23000	No	No
Lead	13.9	17	No	No	----	N/A	----	N/A	No	400	No	No
Magnesium	3930	12000	No	Yes	----	N/A	----	N/A	No	No RBC	No RBC	No
Manganese	257	490	No	No	----	N/A	----	N/A	No	390	No	No
Mercury	0.91	0.05	Yes	No	----	No Tox	----	27.60%	Yes	23	No	No
Nickel	19.7	35	No	No	----	N/A	----	N/A	No	1600	No	No
Potassium	1190	4300	No	Yes	----	N/A	----	N/A	No	No RBC	No RBC	No
Selenium	0.96	0.22	Yes	No	----	No Tox	----	0.50%	No	390	No	No
Sodium	139	320	No	Yes	----	N/A	----	N/A	No	No RBC	No RBC	No
Vanadium	26.5	45	No	No	----	N/A	----	N/A	No	550	No	No
Zinc	85.9	150	No	No	----	N/A	----	N/A	No	23000	No	No
Zirconium	14.3	NA	NA	No	----	No Tox	----	No Tox	No	No RBC	No RBC	Yes (NT)
Co-60	0.9	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Cs-134	0.6	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Cs-137	4630	0.82	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Eu-154	31	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Sr-90	4180	0.49	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Tc-99	2.7	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes

Source: ERIS.

"NA" in Step 1 indicates that a background value is not available.

"----" in Step 3 indicates that the chemical evaluated does not correspond with the analyses (organic, inorganic) as stated in the column heading.

"N/A" in Step 3 indicates that the chemical is not evaluated since it has already been screened out in Step 1 and/or Step 2 or because it is a radionuclide.

"No Tox" indicates that a toxicity value (slope factor or reference dose) is not available.

"No RBC" indicates that an EPA Region III risk-based concentration based on residential soil ingestion is not available

"Yes (NT)" indicates that this chemical does not have toxicity data and will be further evaluated.

Note: The following contaminants were analyzed for but not detected at the site: antimony, cadmium, silver, thallium, Ce-144, Co-58, Eu-155, Nb-95, Ru-103, Ru-106, Sb-125.

Table 5-21. Contaminant screening process for OU 3-08, CPP-15, solvent burner east of CPP-605.

		Step 1		Step 2	Step 3					Step 4		
Chemicals	Source concentration (mg/kg or pCi/g)	Background concentration (mg/kg or pCi/g)	Is the maximum concentration greater than background value?	Is the chemical an essential nutrient?	Organic risk factor (%)	Inorganic risk factor (%)	Organic hazard factor (%)	Inorganic hazard factor (%)	Chemical comprises > 1% of the risk/hazard factor?	Region III soil residential RBC (mg/kg)	Is maximum concentration greater than RBC?	Site COPC?
Methylene chloride	0.0091	NA	NA	No	57.43%	----	16.52%	----	Yes	85	No	No
Trichloroethene	0.0046	NA	NA	No	42.57%	----	83.48%	----	Yes	58	No	No
Aluminum	4405	16000	No	No	----	N/A	----	N/A	No	78000	No	No
Arsenic	3.46	5.8	No	No	----	N/A	----	N/A	No	0.43	Yes	No
Barium	81.51	300	No	No	----	N/A	----	N/A	No	5500	No	No
Beryllium	0.0976	1.8	No	No	----	N/A	----	N/A	No	0.15	No	No
Cadmium	0.578	2.2	No	No	----	N/A	----	N/A	No	39	No	No
Calcium	129550	24000	Yes	Yes	----	N/A	----	N/A	No	No RBC	No RBC	No
Chromium	19.04	33	No	No	----	N/A	----	N/A	No	390	No	No
Cobalt	3.885	11	No	No	----	N/A	----	N/A	No	4700	No	No
Copper	12.58	22	No	No	----	N/A	----	N/A	No	3100	No	No
Iron	9740	24000	No	Yes	----	N/A	----	N/A	No	23000	No	No
Lead	9.17	17	No	No	----	N/A	----	N/A	No	400	No	No
Magnesium	4395	12000	No	Yes	----	N/A	----	N/A	No	No RBC	No RBC	No
Manganese	161.7	490	No	No	----	N/A	----	N/A	No	390	No	No
Mercury	4.44	0.05	Yes	No	----	No Tox	----	89.61%	Yes	23	No	No
Nickel	18	35	No	No	----	N/A	----	N/A	No	1600	No	No
Potassium	745	4300	No	Yes	----	N/A	----	N/A	No	No RBC	No RBC	No
Sodium	134	320	No	Yes	----	N/A	----	N/A	No	No RBC	No RBC	No
Strontium	3605	NA	NA	No	----	No Tox	----	10.39%	Yes	47000	No	No
Thallium	4.85	0.43	Yes	No	----	No Tox	----	No Tox	No	No RBC	No RBC	Yes (NT)
Vanadium	17.44	45	No	No	----	N/A	----	N/A	No	550	No	No
Zinc	51.06	150	No	No	----	N/A	----	N/A	No	23000	No	No
Zirconium	13.98	NA	NA	No	----	No Tox	----	No Tox	No	No RBC	No RBC	Yes (NT)
Am-241	538	0.011	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Cs-137	586000	0.82	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Eu-154	243	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Np-237	0.63	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Pu-238	4570	0.0049	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Pu-239/240	825	0.1	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Tc-99	36.7	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
U-235	0.0203	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes

Source: Log data as run by L. Zacca.

"NA" in Step 1 indicates that a background value is not available.

"----" in Step 3 indicates that the chemical evaluated does not correspond with the analyses (organic, inorganic) as stated in the column heading.

"N/A" in Step 3 indicates that the chemical is not evaluated since it has already been screened out in Step 1 and/or Step 2 or because it is a radionuclide.

"No Tox" indicates that a toxicity value (slope factor or reference dose) is not available.

"No RBC" indicates that an EPA Region III risk-based concentration based on residential soil ingestion is not available

"Yes (NT)" indicates that this chemical does not have toxicity data and will be further evaluated.

Note: The following contaminants were analyzed for but not detected at the site: VOCs (except for methylene chloride and trichloroethene), antimony, selenium, silver, mercury, nitrate, nitrite, Co-60, Cs-134, I-129, Ru-103, Ru-106, Sr-90, U-234, U-238.

Table 5-22. Contaminant screening process for OU 3-08, CPP-27, contamined soil in Tank Farm area east of CPP-604 and CPP-33.

		Step 1		Step 2	Step 3					Step 4		
Chemicals	Source concentration (mg/kg or pCi/g)	Background concentration (mg/kg or pCi/g)	Is the maximum concentration greater than background value?	Is the chemical an essential nutrient?	Organic risk factor (%)	Inorganic risk factor (%)	Organic hazard factor (%)	Inorganic hazard factor (%)	Chemical comprises > 1% of the risk/hazard factor?	Region III soil residential RBC (mg/kg)	Is maximum concentration greater than RBC?	Site COPC?
Arsenic	6.8	5.8	Yes	No	----	5.51%	----	38.01%	Yes	0.43	Yes	Yes
Barium	193	300	No	No	----	N/A	----	N/A	No	5500	No	No
Cadmium	11.1	2.2	Yes	No	----	3.78%	----	18.61%	Yes	39	No	No
Chromium	40	33	Yes	No	----	90.72%	----	13.41%	Yes	390	No	No
Fluoride	5.48	NA	NA	No	----	No Tox	----	0.15%	No	4700	No	No
Lead	25.5	17	Yes	No	----	No Tox	----	No Tox	No	400	No	No
Mercury	1.51	0.05	Yes	No	----	No Tox	----	29.55%	Yes	23	No	No
Nitrate	3.7	NA	NA	No	----	No Tox	----	0.00%	No	130000	No	No
Selenium	0.78	0.22	Yes	No	----	No Tox	----	0.26%	No	390	No	No
Silver	1.15	3.7	No	No	----	N/A	----	N/A	No	390	No	No
Am-241	9.59	0.011	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Cs-137	1370	0.82	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Eu-154	4.23	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
K-40	23.4	24	No	No	----	----	----	----	N/A	No RBC	No RBC	No
Np-237	1.14	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Pu-238	1.41	0.0049	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Pu-239/240	0.349	0.1	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Sr-90	506	0.49	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
U-234	1.22	1.44	No	No	----	----	----	----	N/A	No RBC	No RBC	No
U-235	0.069	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
U-238	1.17	1.4	No	No	----	----	----	----	N/A	No RBC	No RBC	No

Source: Table 4-3, Analytical Results from the Soil Samples Collected at CPP-27 (7/14/93) and Table 4-2, Soil Sample Results from Borehole 33-1 (Golder, 1991), Track 2 Summary Report for Operable Unit 3-08.

"NA" in Step 1 indicates that a background value is not available.

"----" in Step 3 indicates that the chemical evaluated does not correspond with the analyses (organic, inorganic) as stated in the column heading.

"N/A" in Step 3 indicates that the chemical is not evaluated since it has already been screened out in Step 1 and/or Step 2 or because it is a radionuclide.

"No Tox" indicates that a toxicity value (slope factor or reference dose) is not available.

"No RBC" indicates that an EPA Region III risk-based concentration based on residential soil ingestion is not available

"Yes (NT)" indicates that this chemical does not have toxicity data and will be further evaluated.

Table 5-23. Contaminant screening process for OU 3-08, CPP-35, CPP-633 decontamination spill.

		Step 1		Step 2	Step 3					Step 4		
Chemicals	Source concentration (mg/kg or pCi/g)	Background concentration (mg/kg or pCi/g)	Is the maximum concentration greater than background value?	Is the chemical an essential nutrient?	Organic risk factor (%)	Inorganic risk factor (%)	Organic hazard factor (%)	Inorganic hazard factor (%)	Chemical comprises > 1% of the risk/hazard factor?	Region III soil residential RBC (mg/kg)	Is maximum concentration greater than RBC?	Site COPC?
Cadmium	1.4	2.2	No	No	----	N/A	----	N/A	No	39	No	No
Fluoride	2.67	NA	NA	No	----	No Tox	----	0.05%	No	4700	No	No
Mercury	7.2	0.05	Yes	No	----	No Tox	----	99.94%	Yes	23	No	No
Nitrate	5.5	NA	NA	No	----	No Tox	----	0.00%	No	130000	No	No
Am-241	1.21	0.011	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Cs-137	8640	0.82	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Eu-154	11.8	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
K-40	23.6	24	No	No	----	----	----	----	N/A	No RBC	No RBC	No
Pu-238	13.2	0.0049	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Pu-239	0.725	0.1	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Sr-90	3240	0.49	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
U-234	1.02	1.44	No	No	----	----	----	----	N/A	No RBC	No RBC	No
U-235	0.0716	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
U-238	1.14	1.4	No	No	----	----	----	----	N/A	No RBC	No RBC	No

Source: Table 4-7, Analytical Results from the Soil Samples Collected at CPP-35, Track 2 Summary Report for Operable Unit 3-08.

"NA" in Step 1 indicates that a background value is not available.

"----" in Step 3 indicates that the chemical evaluated does not correspond with the analyses (organic, inorganic) as stated in the column heading.

"N/A" in Step 3 indicates that the chemical is not evaluated since it has already been screened out in Step 1 and/or Step 2 or because it is a radionuclide.

"No Tox" indicates that a toxicity value (slope factor or reference dose) is not available.

"No RBC" indicates that an EPA Region III risk-based concentration based on residential soil ingestion is not available

"Yes (NT)" indicates that this chemical does not have toxicity data and will be further evaluated.

Note: The following contaminant was analyzed for but not detected at the site: nitrite.

Table 5-24. Contaminant screening process for OU 3-08, CPP-36, transfer line leak from CPP-633 to W1-102.

		Step 1		Step 2	Step 3					Step 4		
Chemicals	Source concentration (mg/kg or pCi/g)	Background concentration (mg/kg or pCi/g)	Is the maximum concentration greater than background value?	Is the chemical an essential nutrient?	Organic risk factor (%)	Inorganic risk factor (%)	Organic hazard factor (%)	Inorganic hazard factor (%)	Chemical comprises > 1% of the risk/hazard factor?	Region III soil residential RBC (mg/kg)	Is maximum concentration greater than RBC?	Site COPC?
Fluoride	17.1	NA	NA	No	----	No Tox	----	0.15%	No	4700	No	No
Mercury	16.6	0.05	Yes	No	----	No Tox	----	99.85%	Yes	23	No	No
Nitrate	8.2	NA	NA	No	----	No Tox	----	0.00%	No	130000	No	No
Nitrite	0.28	NA	NA	No	----	No Tox	----	0.00%	No	7800	No	No
Am-241	763	0.011	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Cs-134	868.8	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Cs-137	5174400	0.82	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Eu-154	5037	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
K-40	33.7	24	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Pu-238	8180	0.0049	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Pu-239	324	0.1	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Sr-90	139750	0.49	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
U-234	2.81	1.44	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
U-235	0.0995	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
U-238	1.84	1.4	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes

Source: Tables 4-11 and 4-12, Track 2 Summary Report for Operable Unit 3-08.

"NA" in Step 1 indicates that a background value is not available.

"----" in Step 3 indicates that the chemical evaluated does not correspond with the analyses (organic, inorganic) as stated in the column heading.

"N/A" in Step 3 indicates that the chemical is not evaluated since it has already been screened out in Step 1 and/or Step 2 or because it is a radionuclide.

"No Tox" indicates that a toxicity value (slope factor or reference dose) is not available.

"No RBC" indicates that an EPA Region III risk-based concentration based on residential soil ingestion is not available

"Yes (NT)" indicates that this chemical does not have toxicity data and will be further evaluated.

Note: The following contaminant was analyzed for but not detected at the site: cadmium.

Table 5-25. Contaminant screening process for OU 3-09, CPP-01, horizontal settling basin, and vertical settling pit and soil adjacent to SW-048 dry well and CPP-303 dry well.

		Step 1		Step 2	Step 3					Step 4		
Chemicals	Source concentration (mg/kg or pCi/g)	Background concentration (mg/kg or pCi/g)	Is the maximum concentration greater than background value?	Is the chemical an essential nutrient?	Organic risk factor (%)	Inorganic risk factor (%)	Organic hazard factor (%)	Inorganic hazard factor (%)	Chemical comprises > 1% of the risk/hazard factor?	Region III soil residential RBC (mg/kg)	Is maximum concentration greater than RBC?	Site COPC?
Am-241	1.78	0.011	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Co-57	1.02	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Co-60	332	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Cs-137	46000	0.82	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Eu-152	104	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Eu-154	79.7	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Eu-155	8.81	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Pu-239	12	0.1	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Sr-90	4850	0.49	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
U-235	0.0394	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
U-238	0.25	1.4	No	No	----	----	----	----	N/A	No RBC	No RBC	No

Source: Table 3-4, OU 3-09 Track 2 investigation sample results for gamma analysis and cadmium, and Table 3-5, OU 3-09 Track 2 investigation sample results for alpha and beta analyses. Track 2 Preliminary Scoping Summary Report for Operable Unit 3-09.
"NA" in Step 1 indicates that a background value is not available.
"----" in Step 3 indicates that the chemical evaluated does not correspond with the analyses (organic, inorganic) as stated in the column heading.
"N/A" in Step 3 indicates that the chemical is not evaluated since it has already been screened out in Step 1 and/or Step 2 or because it is a radionuclide.
"No Tox" indicates that a toxicity value (slope factor or reference dose) is not available.
"No RBC" indicates that an EPA Region III risk-based concentration based on residential soil ingestion is not available
"Yes (NT)" indicates that this chemical does not have toxicity data and will be further evaluated.

Table 5-26. Contaminant screening process for OU 3-09, CPP-02, french drain west of CPP-603.

		Step 1		Step 2	Step 3					Step 4		
Chemicals	Source concentration (mg/kg or pCi/g)	Background concentration (mg/kg or pCi/g)	Is the maximum concentration greater than background value?	Is the chemical an essential nutrient?	Organic risk factor (%)	Inorganic risk factor (%)	Organic hazard factor (%)	Inorganic hazard factor (%)	Chemical comprises > 1% of the risk/hazard factor?	Region III soil residential RBC (mg/kg)	Is maximum concentration greater than RBC?	Site COPC?

Contamination associated with CPP-02 is under a building.
Contaminant data from the release is not available.
Contaminant screening is not appropriate.

Table 5-27. Contaminant screening process for OU 3-09, CPP-03, temporary storage area SE of CPP-603 stockpiled soil.

		Step 1		Step 2	Step 3					Step 4		
Chemicals	Source concentration (mg/kg or pCi/g)	Background concentration (mg/kg or pCi/g)	Is the maximum concentration greater than background value?	Is the chemical an essential nutrient?	Organic risk factor (%)	Inorganic risk factor (%)	Organic hazard factor (%)	Inorganic hazard factor (%)	Chemical comprises > 1% of the risk/hazard factor?	Region III soil residential RBC (mg/kg)	Is maximum concentration greater than RBC?	Site COPC?
Cs-137	65.1	0.82	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Eu-152	2.13	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Sr-90	43.9	0.49	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes

Source: Table 3-4, OU 3-09 Track 2 investigation sample results for gamma analysis and cadmium, and Table 3-5, OU 3-09 Track 2 investigation sample results for alpha and beta analyses. Track 2 Preliminary Scoping Summary Report for Operable Unit 3-09.
"NA" in Step 1 indicates that a background value is not available.
"----" in Step 3 indicates that the chemical evaluated does not correspond with the analyses (organic, inorganic) as stated in the column heading.
"N/A" in Step 3 indicates that the chemical is not evaluated since it has already been screened out in Step 1 and/or Step 2 or because it is a radionuclide.
"No Tox" indicates that a toxicity value (slope factor or reference dose) is not available.
"No RBC" indicates that an EPA Region III risk-based concentration based on residential soil ingestion is not available
"Yes (NT)" indicates that this chemical does not have toxicity data and will be further evaluated.

Table 5-28. Contaminant screening process for OU 3-09, CPP-04/-05, contaminated soil around CPP-603 settling tank.

		Step 1		Step 2	Step 3					Step 4		
Chemicals	Source concentration (mg/kg or pCi/g)	Background concentration (mg/kg or pCi/g)	Is the maximum concentration greater than background value?	Is the chemical an essential nutrient?	Organic risk factor (%)	Inorganic risk factor (%)	Organic hazard factor (%)	Inorganic hazard factor (%)	Chemical comprises > 1% of the risk/hazard factor?	Region III soil residential RBC (mg/kg)	Is maximum concentration greater than RBC?	Site COPC?
Ce-144	2390	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Co-60	2390	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Cs-134	1450	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Cs-137	26500	0.82	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Eu-152	35000	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Eu-154	35000	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Eu-155	7600	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
U-235	0.302	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes

Source: Table 4-10, Summary of CPP-04/-05 forward risk calculations, Track 2 Preliminary Scoping Summary Report for Operable Unit 3-09.
"NA" in Step 1 indicates that a background value is not available.
"----" in Step 3 indicates that the chemical evaluated does not correspond with the analyses (organic, inorganic) as stated in the column heading.
"N/A" in Step 3 indicates that the chemical is not evaluated since it has already been screened out in Step 1 and/or Step 2 or because it is a radionuclide.
"No Tox" indicates that a toxicity value (slope factor or reference dose) is not available.
"No RBC" indicates that an EPA Region III risk-based concentration based on residential soil ingestion is not available
"Yes (NT)" indicates that this chemical does not have toxicity data and will be further evaluated.

Table 5-29. Contaminant screening process for OU 3-09, CPP-06, trench east of CPP-603 fuel storage basin.

		Step 1		Step 2	Step 3					Step 4		
Chemicals	Source concentration (mg/kg or pCi/g)	Background concentration (mg/kg or pCi/g)	Is the maximum concentration greater than background value?	Is the chemical an essential nutrient?	Organic risk factor (%)	Inorganic risk factor (%)	Organic hazard factor (%)	Inorganic hazard factor (%)	Chemical comprises > 1% of the risk/hazard factor?	Region III soil residential RBC (mg/kg)	Is maximum concentration greater than RBC?	Site COPC?
Cs-137	14.4	0.82	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Sr-90	6.98	0.49	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes

Source: Table 3-4, OU 3-09 Track 2 investigation sample results for gamma analysis and cadmium, and Table 3-5, OU 3-09 Track 2 investigation sample results for alpha and beta analyses. Track 2 Preliminary Scoping Summary Report for Operable Unit 3-09.
"NA" in Step 1 indicates that a background value is not available.
"----" in Step 3 indicates that the chemical evaluated does not correspond with the analyses (organic, inorganic) as stated in the column heading.
"N/A" in Step 3 indicates that the chemical is not evaluated since it has already been screened out in Step 1 and/or Step 2 or because it is a radionuclide.
"No Tox" indicates that a toxicity value (slope factor or reference dose) is not available.
"No RBC" indicates that an EPA Region III risk-based concentration based on residential soil ingestion is not available
"Yes (NT)" indicates that this chemical does not have toxicity data and will be further evaluated.

Table 5-30. Contaminant screening process for OU 3-09, CPP-08/-09, CPP-603 basin filter system line failure and soil contamination NE corner of CPP-603 south basin.

		Step 1		Step 2	Step 3					Step 4		
Chemicals	Source concentration (mg/kg or pCi/g)	Background concentration (mg/kg or pCi/g)	Is the maximum concentration greater than background value?	Is the chemical an essential nutrient?	Organic risk factor (%)	Inorganic risk factor (%)	Organic hazard factor (%)	Inorganic hazard factor (%)	Chemical comprises > 1% of the risk/hazard factor?	Region III soil residential RBC (mg/kg)	Is maximum concentration greater than RBC?	Site COPC?
Cs-137	1080	0.82	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Eu-152	4.38	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Eu-154	2.95	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Sr-90	140	0.49	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
U-235	0.0261	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
U-238	0.161	1.4	No	No	----	----	----	----	N/A	No RBC	No RBC	No

Source: Table 3-4, OU 3-09 Track 2 investigation sample results for gamma analysis and cadmium, and Table 3-5, OU 3-09 Track 2 investigation sample results for alpha and beta analyses. Track 2 Preliminary Scoping Summary Report for Operable Unit 3-09.

"NA" in Step 1 indicates that a background value is not available.

"----" in Step 3 indicates that the chemical evaluated does not correspond with the analyses (organic, inorganic) as stated in the column heading.

"N/A" in Step 3 indicates that the chemical is not evaluated since it has already been screened out in Step 1 and/or Step 2 or because it is a radionuclide.

"No Tox" indicates that a toxicity value (slope factor or reference dose) is not available.

"No RBC" indicates that an EPA Region III risk-based concentration based on residential soil ingestion is not available

"Yes (NT)" indicates that this chemical does not have toxicity data and will be further evaluated.

Table 5-31. Contaminant screening process for OU 3-09, CPP-10, CPP-603 plastic pipeline break.

		Step 1		Step 2	Step 3					Step 4		
Chemicals	Source concentration (mg/kg or pCi/g)	Background concentration (mg/kg or pCi/g)	Is the maximum concentration greater than background value?	Is the chemical an essential nutrient?	Organic risk factor (%)	Inorganic risk factor (%)	Organic hazard factor (%)	Inorganic hazard factor (%)	Chemical comprises > 1% of the risk/hazard factor?	Region III soil residential RBC (mg/kg)	Is maximum concentration greater than RBC?	Site COPC?
Co-60	3.18	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Cs-137	1190	0.82	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Eu-152	9.16	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Eu-154	5.7	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Eu-155	1.48	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Sr-90	58.3	0.49	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
U-235	0.0142	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
U-238	0.21	1.4	No	No	----	----	----	----	N/A	No RBC	No RBC	No

Source: Table 3-4, OU 3-09 Track 2 investigation sample results for gamma analysis and cadmium, and Table 3-5, OU 3-09 Track 2 investigation sample results for alpha and beta analyses. Track 2 Preliminary Scoping Summary Report for Operable Unit 3-09.

"NA" in Step 1 indicates that a background value is not available.

"----" in Step 3 indicates that the chemical evaluated does not correspond with the analyses (organic, inorganic) as stated in the column heading.

"N/A" in Step 3 indicates that the chemical is not evaluated since it has already been screened out in Step 1 and/or Step 2 or because it is a radionuclide.

"No Tox" indicates that a toxicity value (slope factor or reference dose) is not available.

"No RBC" indicates that an EPA Region III risk-based concentration based on residential soil ingestion is not available

"Yes (NT)" indicates that this chemical does not have toxicity data and will be further evaluated.

Table 5-32. Contaminant screening process for OU 3-09, CPP-11, CPP-603 sludge and water release.

		Step 1		Step 2	Step 3					Step 4		
Chemicals	Source concentration (mg/kg or pCi/g)	Background concentration (mg/kg or pCi/g)	Is the maximum concentration greater than background value?	Is the chemical an essential nutrient?	Organic risk factor (%)	Inorganic risk factor (%)	Organic hazard factor (%)	Inorganic hazard factor (%)	Chemical comprises > 1% of the risk/hazard factor?	Region III soil residential RBC (mg/kg)	Is maximum concentration greater than RBC?	Site COPC?
Aluminum	7420	16000	No	No	----	N/A	----	N/A	No	78000	No	No
Antimony	0.83	4.8	No	No	----	N/A	----	N/A	No	31	No	No
Arsenic	6.4	5.8	Yes	No	----	100.00%	----	96.59%	Yes	0.43	Yes	Yes
Barium	122	300	No	No	----	N/A	----	N/A	No	5500	No	No
Beryllium	0.5	1.8	No	No	----	N/A	----	N/A	No	0.15	Yes	No
Cadmium	1.7	2.2	No	No	----	N/A	----	N/A	No	39	No	No
Calcium	30700	24000	Yes	Yes	----	N/A	----	N/A	No	NA	Yes	No
Chromium	23.7	33	No	No	----	N/A	----	N/A	No	390	No	No
Cobalt	6.3	11	No	No	----	N/A	----	N/A	No	4700	No	No
Copper	15.4	22	No	No	----	N/A	----	N/A	No	3100	No	No
Iron	14300	24000	No	Yes	----	N/A	----	N/A	No	23000	No	No
Lead	8.8	17	No	No	----	N/A	----	N/A	No	400	No	No
Magnesium	4720	12000	No	Yes	----	N/A	----	N/A	No	NA	Yes	No
Manganese	258	490	No	No	----	N/A	----	N/A	No	390	No	No
Mercury	0.05	0.05	Yes	No	----	No Tox	----	2.64%	Yes	23	No	No
Nickel	20.6	35	No	No	----	N/A	----	N/A	No	1600	No	No
Potassium	1410	4300	No	Yes	----	N/A	----	N/A	No	NA	Yes	No
Selenium	0.85	0.22	Yes	No	----	No Tox	----	0.77%	No	390	No	No
Sodium	168	320	No	Yes	----	N/A	----	N/A	No	NA	Yes	No
Thallium	1.3	0.43	Yes	No	----	No Tox	----	No Tox	No	NA	Yes	Yes (NT)
Vanadium	28.1	45	No	No	----	N/A	----	N/A	No	550	No	No
Zinc	64.2	150	No	No	----	N/A	----	N/A	No	23000	No	No
Co-60	0.61	NA	NA	No	----	----	----	----	N/A	NA	Yes	Yes
Cs-137	72.7	0.82	Yes	No	----	----	----	----	N/A	NA	Yes	Yes
Eu-154	1.8	NA	NA	No	----	----	----	----	N/A	NA	Yes	Yes
Np-237	0.15	NA	NA	No	----	----	----	----	N/A	NA	Yes	Yes
Sr-90	13.1	0.49	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
U-234	1.2	1.44	No	No	----	----	----	----	N/A	No RBC	No RBC	No
U-238	1	1.4	No	No	----	----	----	----	N/A	No RBC	No RBC	No

Source: ERIS.

"NA" in Step 1 indicates that a background value is not available.

"----" in Step 3 indicates that the chemical evaluated does not correspond with the analyses (organic, inorganic) as stated in the column heading.

"N/A" in Step 3 indicates that the chemical is not evaluated since it has already been screened out in Step 1 and/or Step 2 or because it is a radionuclide.

"No Tox" indicates that a toxicity value (slope factor or reference dose) is not available.

"No RBC" indicates that an EPA Region III risk-based concentration based on residential soil ingestion is not available

"Yes (NT)" indicates that this chemical does not have toxicity data and will be further evaluated.

Table 5-33. Contaminant screening process for OU 3-09, CPP-17a, soil storage area south of CPP Peach Bottom fuel storage area.

		Step 1		Step 2	Step 3					Step 4		
Chemicals	Source concentration (mg/kg or pCi/g)	Background concentration (mg/kg or pCi/g)	Is the maximum concentration greater than background value?	Is the chemical an essential nutrient?	Organic risk factor (%)	Inorganic risk factor (%)	Organic hazard factor (%)	Inorganic hazard factor (%)	Chemical comprises > 1% of the risk/hazard factor?	Region III soil residential RBC (mg/kg)	Is maximum concentration greater than RBC?	Site COPC?
Cs-137	19.4	0.82	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Eu-152	2.07	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Eu-154	1.88	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Sr-90	2.72	0.49	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes

Source: Table 3-4, OU 3-09 Track 2 investigation sample results for gamma analysis and cadmium, and Table 3-5, OU 3-09 Track 2 investigation sample results for alpha and beta analyses. Track 2 Preliminary Scoping Summary Report for Operable Unit 3-09.

"NA" in Step 1 indicates that a background value is not available.

"----" in Step 3 indicates that the chemical evaluated does not correspond with the analyses (organic, inorganic) as stated in the column heading.

"N/A" in Step 3 indicates that the chemical is not evaluated since it has already been screened out in Step 1 and/or Step 2 or because it is a radionuclide.

"No Tox" indicates that a toxicity value (slope factor or reference dose) is not available.

"No RBC" indicates that an EPA Region III risk-based concentration based on residential soil ingestion is not available

"Yes (NT)" indicates that this chemical does not have toxicity data and will be further evaluated.

Table 5-34. Contaminant screening process for OU 3-09, CPP-17b, soil storage area south of CPP Peach Bottom fuel storage area.

		Step 1		Step 2	Step 3					Step 4		
Chemicals	Source concentration (mg/kg or pCi/g)	Background concentration (mg/kg or pCi/g)	Is the maximum concentration greater than background value?	Is the chemical an essential nutrient?	Organic risk factor (%)	Inorganic risk factor (%)	Organic hazard factor (%)	Inorganic hazard factor (%)	Chemical comprises > 1% of the risk/hazard factor?	Region III soil residential RBC (mg/kg)	Is maximum concentration greater than RBC?	Site COPC?
Co-57	0.543	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Cs-137	10.5	0.82	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes

Source: Table 3-4, OU 3-09 Track 2 investigation sample results for gamma analysis and cadmium, and Table 3-5, OU 3-09 Track 2 investigation sample results for alpha and beta analyses. Track 2 Preliminary Scoping Summary Report for Operable Unit 3-09.
"NA" in Step 1 indicates that a background value is not available.
"----" in Step 3 indicates that the chemical evaluated does not correspond with the analyses (organic, inorganic) as stated in the column heading.
"N/A" in Step 3 indicates that the chemical is not evaluated since it has already been screened out in Step 1 and/or Step 2 or because it is a radionuclide.
"No Tox" indicates that a toxicity value (slope factor or reference dose) is not available.
"No RBC" indicates that an EPA Region III risk-based concentration based on residential soil ingestion is not available
"Yes (NT)" indicates that this chemical does not have toxicity data and will be further evaluated.

Table 5-35. Contaminant screening process for OU 3-09, CPP-19, CPP-603 to CPP-604 line leak.

		Step 1		Step 2	Step 3					Step 4		
Chemicals	Source concentration (mg/kg or pCi/g)	Background concentration (mg/kg or pCi/g)	Is the maximum concentration greater than background value?	Is the chemical an essential nutrient?	Organic risk factor (%)	Inorganic risk factor (%)	Organic hazard factor (%)	Inorganic hazard factor (%)	Chemical comprises > 1% of the risk/hazard factor?	Region III soil residential RBC (mg/kg)	Is maximum concentration greater than RBC?	Site COPC?
Aluminum	9390	16000	No	No	----	N/A	----	N/A	No	78000	No	No
Antimony	0.83	4.8	No	No	----	N/A	----	N/A	No	31	No	No
Arsenic	8.3	5.8	Yes	No	----	100.00%	----	94.05%	Yes	0.43	Yes	Yes
Barium	184	300	No	No	----	N/A	----	N/A	No	5500	No	No
Beryllium	0.66	1.8	No	No	----	N/A	----	N/A	No	0.15	Yes	No
Cadmium	0.96	2.2	No	No	----	N/A	----	N/A	No	39	No	No
Calcium	232000	24000	Yes	Yes	----	N/A	----	N/A	No	No RBC	No RBC	Yes**
Chromium	26.3	33	No	No	----	N/A	----	N/A	No	390	No	No
Cobalt	8.2	11	No	No	----	N/A	----	N/A	No	4700	No	No
Copper	16.7	22	No	No	----	N/A	----	N/A	No	3100	No	No
Iron	18200	24000	No	Yes	----	N/A	----	N/A	No	23000	No	No
Lead	10.1	17	No	No	----	N/A	----	N/A	No	400	No	No
Magnesium	9700	12000	No	Yes	----	N/A	----	N/A	No	No RBC	No RBC	No
Manganese	294	490	No	No	----	N/A	----	N/A	No	390	No	No
Mercury	0.15	0.05	Yes	No	----	No Tox	----	5.95%	Yes	23	No	No
Nickel	26.4	35	No	No	----	N/A	----	N/A	No	1600	No	No
Potassium	1690	4300	No	Yes	----	N/A	----	N/A	No	No RBC	No RBC	No
Sodium	507	320	Yes	Yes	----	N/A	----	N/A	No	No RBC	No RBC	No
Vanadium	36.4	45	No	No	----	N/A	----	N/A	No	550	No	No
Zinc	86	150	No	No	----	N/A	----	N/A	No	23000	No	No
Am-241	1.97	0.011	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Co-60	21600	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Cs-134	0.06	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Cs-137	408000	0.82	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Eu-152	87600	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Eu-154	53500	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Eu-155	9620	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
K-40	20.1	24	No	No	----	----	----	----	N/A	No RBC	No RBC	No
Nb-95	0.09	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Pu-239	141	0.1	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Sr-90	125000	0.49	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
U-235	2.36	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
U-238	0.453	1.4	No	No	----	----	----	----	N/A	No RBC	No RBC	No

** Calcium will be further evaluated since it is about 9.67 times greater than the background concentration.

Source: ERIS.

"NA" in Step 1 indicates that a background value is not available.

"----" in Step 3 indicates that the chemical evaluated does not correspond with the analyses (organic, inorganic) as stated in the column heading.

"N/A" in Step 3 indicates that the chemical is not evaluated since it has already been screened out in Step 1 and/or Step 2 or because it is a radionuclide.

"No Tox" indicates that a toxicity value (slope factor or reference dose) is not available.

"No RBC" indicates that an EPA Region III risk-based concentration based on residential soil ingestion is not available

"Yes (NT)" indicates that this chemical does not have toxicity data and will be further evaluated.

Table 5-36. Contaminant screening process for OU 3-09, CPP-22, particulate air release south of CPP-603.

		Step 1		Step 2	Step 3					Step 4		
Chemicals	Source concentration (mg/kg or pCi/g)	Background concentration (mg/kg or pCi/g)	Is the maximum concentration greater than background value?	Is the chemical an essential nutrient?	Organic risk factor (%)	Inorganic risk factor (%)	Organic hazard factor (%)	Inorganic hazard factor (%)	Chemical comprises > 1% of the risk/hazard factor?	Region III soil residential RBC (mg/kg)	Is maximum concentration greater than RBC?	Site COPC?
Cs-137	14.3	0.82	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Sr-90	5.4	0.49	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Tc-99	3.5	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes

Source: ERIS.
"NA" in Step 1 indicates that a background value is not available.
"----" in Step 3 indicates that the chemical evaluated does not correspond with the analyses (organic, inorganic) as stated in the column heading.
"N/A" in Step 3 indicates that the chemical is not evaluated since it has already been screened out in Step 1 and/or Step 2 or because it is a radionuclide.
"No Tox" indicates that a toxicity value (slope factor or reference dose) is not available.
"No RBC" indicates that an EPA Region III risk-based concentration based on residential soil ingestion is not available
"Yes (NT)" indicates that this chemical does not have toxicity data and will be further evaluated.

Table 5-37. Contaminant screening process for OU 3-09, CPP-69, abandoned liquid radioactive waste storage tank CPP VES-SFE-20.

		Step 1		Step 2	Step 3					Step 4		
Chemicals	Source concentration (mg/kg or pCi/g)	Background concentration (mg/kg or pCi/g)	Is the maximum concentration greater than background value?	Is the chemical an essential nutrient?	Organic risk factor (%)	Inorganic risk factor (%)	Organic hazard factor (%)	Inorganic hazard factor (%)	Chemical comprises > 1% of the risk/hazard factor?	Region III soil residential RBC (mg/kg)	Is maximum concentration greater than RBC?	Site COPC?
Co-60	23800	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Cs-134	13300	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Cs-137	2290000	0.82	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Eu-152	56500	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Eu-154	46200	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Eu-155	20500	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Pu-239/240	3010	0.1	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Sb-125	47300	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Sr-90	5890000	0.49	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes

Source: Based on D&D characterization report dated 1984. Data for "wet solids"..

"NA" in Step 1 indicates that a background value is not available.

"----" in Step 3 indicates that the chemical evaluated does not correspond with the analyses (organic, inorganic) as stated in the column heading.

"N/A" in Step 3 indicates that the chemical is not evaluated since it has already been screened out in Step 1 and/or Step 2 or because it is a radionuclide.

"No Tox" indicates that a toxicity value (slope factor or reference dose) is not available.

"No RBC" indicates that an EPA Region III risk-based concentration based on residential soil ingestion is not available

"Yes (NT)" indicates that this chemical does not have toxicity data and will be further evaluated.

Table 5-38. Contaminant screening process for OU 3-09, CPP-78, contaminated soil west of CPP-693, east of dry fuel storage area.

		Step 1		Step 2	Step 3					Step 4		
Chemicals	Source concentration (mg/kg or pCi/g)	Background concentration (mg/kg or pCi/g)	Is the maximum concentration greater than background value?	Is the chemical an essential nutrient?	Organic risk factor (%)	Inorganic risk factor (%)	Organic hazard factor (%)	Inorganic hazard factor (%)	Chemical comprises > 1% of the risk/hazard factor?	Region III soil residential RBC (mg/kg)	Is maximum concentration greater than RBC?	Site COPC?
Cs-137	0.38	0.82	No	No	----	----	----	----	N/A	No RBC	No RBC	No
Sr-90	0.7	0.49	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes

Source: ERIS

"NA" in Step 1 indicates that a background value is not available.

"----" in Step 3 indicates that the chemical evaluated does not correspond with the analyses (organic, inorganic) as stated in the column heading.

"N/A" in Step 3 indicates that the chemical is not evaluated since it has already been screened out in Step 1 and/or Step 2 or because it is a radionuclide.

"No Tox" indicates that a toxicity value (slope factor or reference dose) is not available.

"No RBC" indicates that an EPA Region III risk-based concentration based on residential soil ingestion is not available

"Yes (NT)" indicates that this chemical does not have toxicity data and will be further evaluated.

Table 5-39. Contaminant screening process for OU 3-10, CPP-46, CPP-637 courtyard pilot plant release.

		Step 1		Step 2	Step 3					Step 4		
Chemicals	Source concentration (mg/kg or pCi/g)	Background concentration (mg/kg or pCi/g)	Is the maximum concentration greater than background value?	Is the chemical an essential nutrient?	Organic risk factor (%)	Inorganic risk factor (%)	Organic hazard factor (%)	Inorganic hazard factor (%)	Chemical comprises > 1% of the risk/hazard factor?	Region III soil residential RBC (mg/kg)	Is maximum concentration greater than RBC?	Site COPC?
Cs-134	0.07	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Cs-137	1.76	0.82	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Sr-90	0.9	0.49	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Tc-99	1.5	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes

Source: ERIS

"NA" in Step 1 indicates that a background value is not available.

"----" in Step 3 indicates that the chemical evaluated does not correspond with the analyses (organic, inorganic) as stated in the column heading.

"N/A" in Step 3 indicates that the chemical is not evaluated since it has already been screened out in Step 1 and/or Step 2 or because it is a radionuclide.

"No Tox" indicates that a toxicity value (slope factor or reference dose) is not available.

"No RBC" indicates that an EPA Region III risk-based concentration based on residential soil ingestion is not available

"Yes (NT)" indicates that this chemical does not have toxicity data and will be further evaluated.

Table 5-40. Contaminant screening process for OU 3-11, CPP-58W, subsurface release associated with PEW spills.

		Step 1		Step 2	Step 3					Step 4		
Chemicals	Source concentration (mg/kg or pCi/g)	Background concentration (mg/kg or pCi/g)	Is the maximum concentration greater than background value?	Is the chemical an essential nutrient?	Organic risk factor (%)	Inorganic risk factor (%)	Organic hazard factor (%)	Inorganic hazard factor (%)	Chemical comprises > 1% of the risk/hazard factor?	Region III soil residential RBC (mg/kg)	Is maximum concentration greater than RBC?	Site COPC?
Cadmium	1.2	2.2	No	No	----	N/A	----	N/A	No	39	No	No
Fluoride	2.78	NA	NA	No	----	No Tox	----	0.26%	No	4700	No	No
Mercury	1.5	0.05	Yes	No	----	No Tox	----	99.71%	Yes	23	No	No
Nitrate	8.1	NA	NA	No	----	No Tox	----	0.03%	No	130000	No	No
Am-241	0.101	0.011	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Cs-137	63.6	0.82	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Eu-154	0.248	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
K-40	22.8	24	No	No	----	----	----	----	N/A	No RBC	No RBC	No
Pu-238	0.295	0.0049	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Pu-239	0.0403	0.1	No	No	----	----	----	----	N/A	No RBC	No RBC	No
Sr-90	95.6	0.49	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
U-234	1.13	1.44	No	No	----	----	----	----	N/A	No RBC	No RBC	No
U-235	0.0679	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
U-238	1.11	1.4	No	No	----	----	----	----	N/A	No RBC	No RBC	No

Source: Table 4-1, Analytical results for soil samples collected at CPP-58E, Track 2 Summary Report. Data from CPP-58E was extrapolated to CPP-58W.
"NA" in Step 1 indicates that a background value is not available.
"----" in Step 3 indicates that the chemical evaluated does not correspond with the analyses (organic, inorganic) as stated in the column heading.
"N/A" in Step 3 indicates that the chemical is not evaluated since it has already been screened out in Step 1 and/or Step 2 or because it is a radionuclide.
"No Tox" indicates that a toxicity value (slope factor or reference dose) is not available.
"No RBC" indicates that an EPA Region III risk-based concentration based on residential soil ingestion is not available
"Yes (NT)" indicates that this chemical does not have toxicity data and will be further evaluated.

Table 5-41. Contaminant screening process for OU 3-12, CPP-80, CPP-601 vent tunnel drain leak (VT-300).

		Step 1		Step 2	Step 3					Step 4		
Chemicals	Estimated concentration (mg/kg or pCi/g)	Background concentration (mg/kg or pCi/g)	Is the maximum concentration greater than background value?	Is the chemical an essential nutrient?	Organic risk factor (%)	Inorganic risk factor (%)	Organic hazard factor (%)	Inorganic hazard factor (%)	Chemical comprises > 1% of the risk/hazard factor?	Region III soil residential RBC (mg/kg)	Is maximum concentration greater than RBC?	Site COPC?
Aluminum	5.35	16000	No	No	----	N/A	----	N/A	No	78000	No	No
Boron	0.0217	NA	NA	No	----	No Tox	----	11.15%	Yes	7000	No	No
Cadmium	0.0333	2.2	No	No	----	N/A	----	N/A	No	39	No	No
Chloride	0.00833	NA	NA	No	----	No Tox	----	No Tox	No	No RBC	No RBC	Yes (NT)
Fluoride	0.222	NA	NA	No	----	No Tox	----	10.86%	Yes	4700	No	No
Iron	0.19	24000	No	Yes	----	N/A	----	N/A	No	23000	No	No
Nitrate	42.5	NA	NA	No	----	No Tox	----	77.99%	Yes	130000	No	No
Sodium	0.0766	320	No	Yes	----	N/A	----	N/A	No	No RBC	No RBC	No
Sulfate	0.697	NA	NA	No	----	No Tox	----	No Tox	No	No RBC	No RBC	Yes (NT)
Zirconium	0.152	NA	NA	No	----	No Tox	----	No Tox	No	No RBC	No RBC	Yes (NT)
Ce-144	0.969	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Cs-134	235	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Cs-137	86300	0.82	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Eu-154	959	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Eu-155	13.8	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Pu-238	22.1	0.0049	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Pu-239/240	454	0.1	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Ru-106	1.84	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Sb-125	9.98	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Sr-90	85600	0.49	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes

Source: Personal communication with DOE Idaho (fax sent 1/25/96).

"NA" in Step 1 indicates that a background value is not available.

"----" in Step 3 indicates that the chemical evaluated does not correspond with the analyses (organic, inorganic) as stated in the column heading.

"N/A" in Step 3 indicates that the chemical is not evaluated since it has already been screened out in Step 1 and/or Step 2 or because it is a radionuclide.

"No Tox" indicates that a toxicity value (slope factor or reference dose) is not available.

"No RBC" indicates that an EPA Region III risk-based concentration based on residential soil ingestion is not available

"Yes (NT)" indicates that this chemical does not have toxicity data and will be further evaluated.

Note: Contaminant source concentrations evaluated for this site are estimated values.

Table 5-42. Contaminant screening process for OU 3-13, CPP-85, WCF blower corridor.

		Step 1		Step 2	Step 3					Step 4		
Chemicals	Source concentration (mg/kg or pCi/g)	Background concentration (mg/kg or pCi/g)	Is the maximum concentration greater than background value?	Is the chemical an essential nutrient?	Organic risk factor (%)	Inorganic risk factor (%)	Organic hazard factor (%)	Inorganic hazard factor (%)	Chemical comprises > 1% of the risk/hazard factor?	Region III soil residential RBC (mg/kg)	Is maximum concentration greater than RBC?	Site COPC?
Arsenic	2.24	5.8	No	No	----	N/A	----	N/A	No	0.43	Yes	No
Barium	3.64	300	No	No	----	N/A	----	N/A	No	5500	No	No
Cadmium	1.93	2.2	No	No	----	N/A	----	N/A	No	39	No	No
Chromium	1.17	33	No	No	----	N/A	----	N/A	No	390	No	No
Lead	8.7	17	No	No	----	N/A	----	N/A	No	400	No	No
Mercury	0.0953	0.05	Yes	No	----	No Tox	----	50.32%	Yes	23	No	No
Nickel	1.86	35	No	No	----	N/A	----	N/A	No	1600	No	No
Selenium	1.57	0.22	Yes	No	----	No Tox	----	14.21%	Yes	390	No	No
Silver	3.92	3.7	Yes	No	----	No Tox	----	35.47%	Yes	390	No	No
Co-60	57.8	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Cs-134	50.1	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Cs-137	49600	0.82	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Eu-154	218	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Sr-90	49600	0.49	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes

Source: Track 1 Decision Document.

"NA" in Step 1 indicates that a background value is not available.

"----" in Step 3 indicates that the chemical evaluated does not correspond with the analyses (organic, inorganic) as stated in the column heading.

"N/A" in Step 3 indicates that the chemical is not evaluated since it has already been screened out in Step 1 and/or Step 2 or because it is a radionuclide.

"No Tox" indicates that a toxicity value (slope factor or reference dose) is not available.

"No RBC" indicates that an EPA Region III risk-based concentration based on residential soil ingestion is not available

"Yes (NT)" indicates that this chemical does not have toxicity data and will be further evaluated.

Table 5-43. Contaminant screening process for OU 3-13, CPP-88, radiologically contaminated soils map.

		Step 1		Step 2	Step 3					Step 4		
Chemicals	Source concentration (mg/kg or pCi/g)	Background concentration (mg/kg or pCi/g)	Is the maximum concentration greater than background value?	Is the chemical an essential nutrient?	Organic risk factor (%)	Inorganic risk factor (%)	Organic hazard factor (%)	Inorganic hazard factor (%)	Chemical comprises > 1% of the risk/hazard factor?	Region III soil residential RBC (mg/kg)	Is maximum concentration greater than RBC?	Site COPC?
Aluminum	12400	16000	No	No	----	N/A	----	N/A	No	78000	No	No
Antimony	0.46	4.8	No	No	----	N/A	----	N/A	No	31	No	No
Arsenic	7.3	5.8	Yes	No	----	100.00%	----	48.48%	Yes	0.43	Yes	Yes
Barium	197	300	No	No	----	N/A	----	N/A	No	5500	No	No
Beryllium	0.82	1.8	No	No	----	N/A	----	N/A	No	0.15	Yes	No
Cadmium	1.1	2.2	No	No	----	N/A	----	N/A	No	39	No	No
Calcium	26600	24000	Yes	Yes	----	N/A	----	N/A	No	No RBC	No RBC	No
Chromium	21.7	33	No	No	----	N/A	----	N/A	No	390	No	No
Cobalt	8.4	11	No	No	----	N/A	----	N/A	No	4700	No	No
Copper	17.1	22	No	No	----	N/A	----	N/A	No	3100	No	No
Iron	17600	24000	No	Yes	----	N/A	----	N/A	No	23000	No	No
Lead	24.8	17	Yes	No	----	No Tox	----	No Tox	No	400	No	No
Magnesium	7180	12000	No	Yes	----	N/A	----	N/A	No	No RBC	No RBC	No
Manganese	285	490	No	No	----	N/A	----	N/A	No	390	No	No
Mercury	1	0.05	Yes	No	----	No Tox	----	23.25%	Yes	23	No	No
Nickel	280	35	Yes	No	----	No Tox	----	27.89%	Yes	1600	No	No
Potassium	2070	4300	No	Yes	----	N/A	----	N/A	No	No RBC	No RBC	No
Selenium	0.95	0.22	Yes	No	----	No Tox	----	0.38%	No	390	No	No
Silver	0.21	3.7	No	No	----	N/A	----	N/A	No	390	No	No
Sodium	277	320	No	Yes	----	N/A	----	N/A	No	No RBC	No RBC	No
Thallium	1.5	0.43	Yes	No	----	No Tox	----	No Tox	No	No RBC	No RBC	Yes (NT)
Vanadium	27.7	45	No	No	----	N/A	----	N/A	No	550	No	No
Zinc	105	150	No	No	----	N/A	----	N/A	No	23000	No	No
Cs-137	36.6	0.82	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Sr-90	9.2	0.49	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes

Source: ERIS.

"NA" in Step 1 indicates that a background value is not available.

"----" in Step 3 indicates that the chemical evaluated does not correspond with the analyses (organic, inorganic) as stated in the column heading.

"N/A" in Step 3 indicates that the chemical is not evaluated since it has already been screened out in Step 1 and/or Step 2 or because it is a radionuclide.

"No Tox" indicates that a toxicity value (slope factor or reference dose) is not available.

"No RBC" indicates that an EPA Region III risk-based concentration based on residential soil ingestion is not available

"Yes (NT)" indicates that this chemical does not have toxicity data and will be further evaluated.

Note: The following contaminants were analyzed for but not detected at this site: Ce-144, Co-58, Co-60, Cs-134, Eu-154, Eu-155, Nb-95, Ru-103, Ru-106, Sb-125.

Table 5-44. Contaminant screening process for OU 3-13, CPP-89, CPP-604/605 tunnel excavation.

		Step 1		Step 2	Step 3					Step 4		
Chemicals	Source concentration (mg/kg or pCi/g)	Background concentration (mg/kg or pCi/g)	Is the maximum concentration greater than background value?	Is the chemical an essential nutrient?	Organic risk factor (%)	Inorganic risk factor (%)	Organic hazard factor (%)	Inorganic hazard factor (%)	Chemical comprises > 1% of the risk/hazard factor?	Region III soil residential RBC (mg/kg)	Is maximum concentration greater than RBC?	Site COPC?
Arsenic	5.9	5.8	Yes	No	----	100.00%	----	13.94%	Yes	0.43	Yes	No[a]
Barium	126	300	No	No	----	N/A	----	N/A	No	5500	No	No
Cadmium	1	2.2	No	No	----	N/A	----	N/A	No	39	No	No
Chromium	21.3	33	No	No	----	N/A	----	N/A	No	390	No	No
Lead	12	17	No	No	----	N/A	----	N/A	No	400	No	No
Mercury	10.4	0.05	Yes	No	----	No Tox	----	86.01%	Yes	23	No	No
Selenium	0.4	0.22	Yes	No	----	No Tox	----	0.06%	No	390	No	No
Silver	0.2	3.7	No	No	----	N/A	----	N/A	No	390	No	No
Am-241	23.6	0.011	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Co-60	3.9	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Cs-134	2.3	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Cs-137	7730	0.82	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
I-129	3.1	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Np-237	0.15	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Pu-238	259	0.0049	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Pu-239/240	24.7	0.1	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Sb-125	13	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Sr-90	10800	0.49	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
U-234	5.1	1.44	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
U-235	0.23	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
U-238	1.2	1.4	No	No	----	----	----	----	N/A	No RBC	No RBC	No

Source: Contaminant Worksheet for CPP-89, Track 2 Preliminary Scoping Package.
"NA" in Step 1 indicates that a background value is not available.
"----" in Step 3 indicates that the chemical evaluated does not correspond with the analyses (organic, inorganic) as stated in the column heading.
"N/A" in Step 3 indicates that the chemical is not evaluated since it has already been screened out in Step 1 and/or Step 2 or because it is a radionuclide.
"No Tox" indicates that a toxicity value (slope factor or reference dose) is not available.
"No RBC" indicates that an EPA Region III risk-based concentration based on residential soil ingestion is not available
"Yes (NT)" indicates that this chemical does not have toxicity data and will be further evaluated.
Note: The following contaminants were analyzed for but not detected at this site: beryllium, cyanide, bis(2-ethylhexyl)phthalate.
a. Arsenic was eliminated as a COPC because its maximum detected concentration is less than 2% above background.

Table 5-45. Contaminant screening process for OU 3-13, CPP-90, CPP-709 ruthenium detection.

		Step 1		Step 2	Step 3					Step 4		
Chemicals	Source concentration (mg/kg or pCi/g)	Background concentration (mg/kg or pCi/g)	Is the maximum concentration greater than background value?	Is the chemical an essential nutrient?	Organic risk factor (%)	Inorganic risk factor (%)	Organic hazard factor (%)	Inorganic hazard factor (%)	Chemical comprises > 1% of the risk/hazard factor?	Region III soil residential RBC (mg/kg)	Is maximum concentration greater than RBC?	Site COPC?
Acenaphthene	0.055	NA	NA	No	No Tox	----	3.33%	----	Yes	4700	No	No
Acetone	0.014	NA	NA	No	No Tox	----	0.51%	----	No	7800	No	No
Anthracene	0.049	NA	NA	No	No Tox	----	0.59%	----	No	23000	No	No
Benzo(a)anthracene	0.16	NA	NA	No	8.51%	----	No Tox	----	Yes	0.88	No	No
Benzo(a)pyrene	0.15	NA	NA	No	79.77%	----	No Tox	----	Yes	0.088	Yes	Yes
Benzo(b)fluoranthene	0.12	NA	NA	No	6.38%	----	No Tox	----	Yes	0.88	No	No
Benzo(g,h,i)perylene	0.089	NA	NA	No	0.05%	----	No Tox	----	No	No RBC	No RBC	No
Benzo(k)fluoranthene	0.15	NA	NA	No	0.80%	----	No Tox	----	No	8.8	No	No
bis(2-Ethylhexyl)phthalate	0.057	NA	NA	No	0.06%	----	10.37%	----	Yes	46	No	No
Chrysene	0.22	NA	NA	No	0.12%	----	No Tox	----	No	88	No	No
Fluoranthene	0.39	NA	NA	No	No Tox	----	35.47%	----	Yes	3100	No	No
Indeno(1,2,3-cd)pyrene	0.081	NA	NA	No	4.31%	----	No Tox	----	Yes	0.88	No	No
Methylene Chloride	0.02	NA	NA	No	0.01%	----	1.21%	----	Yes	85	No	No
Phenanthrene	0.29	NA	NA	No	No Tox	----	No Tox	----	No	No RBC	No RBC	Yes (NT)
Pyrene	0.4	NA	NA	No	No Tox	----	48.51%	----	Yes	2300	No	No
Aluminum	6860	16000	No	No	----	N/A	----	N/A	No	78000	No	No
Antimony	9.5	4.8	Yes	No	----	No Tox	----	17.58%	Yes	31	No	No
Arsenic	29.5	5.8	Yes	No	----	100.00%	----	72.80%	Yes	0.43	Yes	Yes
Barium	140	300	No	No	----	N/A	----	N/A	No	5500	No	No
Beryllium	0.69	1.8	No	No	----	N/A	----	N/A	No	0.15	Yes	No
Cadmium	0.3	2.2	No	No	----	N/A	----	N/A	No	39	No	No
Calcium	43100	24000	Yes	Yes	----	N/A	----	N/A	No	No RBC	No RBC	No
Chromium	17	33	No	No	----	N/A	----	N/A	No	390	No	No
Cobalt	7.8	11	No	No	----	N/A	----	N/A	No	4700	No	No
Copper	21	22	No	No	----	N/A	----	N/A	No	3100	No	No
Iron	12900	24000	No	Yes	----	N/A	----	N/A	No	23000	No	No
Lead	17.3	17	Yes	No	----	No Tox	----	No Tox	No	400	No	No
Magnesium	4590	12000	No	Yes	----	N/A	----	N/A	No	No RBC	No RBC	No
Manganese	313	490	No	No	----	N/A	----	N/A	No	390	No	No
Mercury	1.1	0.05	Yes	No	----	No Tox	----	9.50%	Yes	23	No	No
Nickel	24.1	35	No	No	----	N/A	----	N/A	No	1600	No	No
Potassium	1080	4300	No	Yes	----	N/A	----	N/A	No	No RBC	No RBC	No
Selenium	0.74	0.22	Yes	No	----	No Tox	----	0.11%	No	390	No	No
Silver	0.18	3.7	No	No	----	N/A	----	N/A	No	390	No	No
Sodium	219	320	No	Yes	----	N/A	----	N/A	No	No RBC	No RBC	No
Thallium	1.4	0.43	Yes	No	----	No Tox	----	No Tox	No	No RBC	No RBC	Yes (NT)
Vanadium	23.7	45	No	No	----	N/A	----	N/A	No	550	No	No
Zinc	113	150	No	No	----	N/A	----	N/A	No	23000	No	No
Co-58	0.07	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Cs-134	0.09	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Cs-137	7.5	0.82	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Eu-155	0.26	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Nb-95	0.13	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Sr-90	6.3	0.49	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes

Source: ERIS.

"NA" in Step 1 indicates that a background value is not available.

"----" in Step 3 indicates that the chemical evaluated does not correspond with the analyses (organic, inorganic) as stated in the column heading.

"N/A" in Step 3 indicates that the chemical is not evaluated since it has already been screened out in Step 1 and/or Step 2 or because it is a radionuclide.

"No Tox" indicates that a toxicity value (slope factor or reference dose) is not available.

"No RBC" indicates that an EPA Region III risk-based concentration based on residential soil ingestion is not available

"Yes (NT)" indicates that this chemical does not have toxicity data and will be further evaluated.

Note: The following contaminants were analyzed for but not detected at this site: VOCs (except those listed above), Ce-144, Co-60, Eu-154, Ru-103, Ru-106, Sb-125, thallium.

Table 5-46. Contaminant screening process for OU 3-13, CPP-91, CPP-633 blower pit drain.

		Step 1		Step 2	Step 3					Step 4		
Chemicals	Source concentration (mg/kg or pCi/g)	Background concentration (mg/kg or pCi/g)	Is the maximum concentration greater than background value?	Is the chemical an essential nutrient?	Organic risk factor (%)	Inorganic risk factor (%)	Organic hazard factor (%)	Inorganic hazard factor (%)	Chemical comprises > 1% of the risk/hazard factor?	Region III soil residential RBC (mg/kg)	Is maximum concentration greater than RBC?	Site COPC?
Di-n-butylphthalate	0.061	NA	NA	No	No Tox	----	100.00%	----	Yes	7800	No	No
Aluminum	23500	16000	Yes	No	----	No Tox	----	0.06%	No	78000	No	No
Antimony	1.2	4.8	No	No	----	N/A	----	N/A	No	31	No	No
Arsenic	10.3	5.8	Yes	No	----	8.87%	----	0.09%	Yes	0.43	Yes	Yes
Barium	186	300	No	No	----	N/A	----	N/A	No	5500	No	No
Beryllium	1.2	1.8	No	No	----	N/A	----	N/A	No	0.15	Yes	No
Cadmium	3.3	2.2	Yes	No	----	1.19%	----	0.01%	Yes	39	No	No
Calcium	26300	24000	Yes	Yes	----	N/A	----	N/A	No	No RBC	No RBC	No
Chromium	37.3	33	Yes	No	----	89.94%	----	0.02%	Yes	390	No	No
Cobalt	12.2	11	Yes	No	----	No Tox	----	0.11%	No	4700	No	No
Copper	32.8	22	Yes	No	----	No Tox	----	0.00%	No	3100	No	No
Iron	26500	24000	Yes	Yes	----	N/A	----	N/A	No	23000	Yes	No
Lead	17.2	17	Yes	No	----	No Tox	----	No Tox	No	400	No	No
Magnesium	8810	12000	No	Yes	----	N/A	----	N/A	No	No RBC	No RBC	No
Manganese	534	490	Yes	No	----	No Tox	----	99.69%	Yes	390	Yes	Yes
Mercury	0.54	0.05	Yes	No	----	No Tox	----	0.02%	No	23	No	No
Nickel	38	35	Yes	No	----	No Tox	----	0.00%	No	1600	No	No
Potassium	3770	4300	No	Yes	----	N/A	----	N/A	No	No RBC	No RBC	No
Selenium	2	0.22	Yes	No	----	No Tox	----	0.00%	No	390	No	No
Sodium	231	320	No	Yes	----	N/A	----	N/A	No	No RBC	No RBC	No
Thallium	1.8	0.43	Yes	No	----	No Tox	----	No Tox	No	No RBC	No RBC	Yes (NT)
Vanadium	43.4	45	No	No	----	N/A	----	N/A	No	550	No	No
Zinc	107	150	No	No	----	N/A	----	N/A	No	23000	No	No
Cs-137	140	0.82	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Sr-90	7580	0.49	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes

Source: ERIS.

"NA" in Step 1 indicates that a background value is not available.

"----" in Step 3 indicates that the chemical evaluated does not correspond with the analyses (organic, inorganic) as stated in the column heading.

"N/A" in Step 3 indicates that the chemical is not evaluated since it has already been screened out in Step 1 and/or Step 2 or because it is a radionuclide.

"No Tox" indicates that a toxicity value (slope factor or reference dose) is not available.

"No RBC" indicates that an EPA Region III risk-based concentration based on residential soil ingestion is not available

"Yes (NT)" indicates that this chemical does not have toxicity data and will be further evaluated.

Note: The following contaminants were analyzed for but not detected at this site: VOCs (except di-n-butylphthalate), antimony, cadmium, silver, Ce-144, Co-58, Co-60, Cs-134, Eu-154, Eu-155, Nb-95, Ru-103, Ru-106, Sb-125.

Table 5-47. Contaminant screening process for OU 3-13, CPP-92, soil boxes west of CPP-1617.

		Step 1		Step 2	Step 3					Step 4		
Chemicals	Source concentration (mg/kg or pCi/g)	Background concentration (mg/kg or pCi/g)	Is the maximum concentration greater than background value?	Is the chemical an essential nutrient?	Organic risk factor (%)	Inorganic risk factor (%)	Organic hazard factor (%)	Inorganic hazard factor (%)	Chemical comprises > 1% of the risk/hazard factor?	Region III soil residential RBC (mg/kg)	Is maximum concentration greater than RBC?	Site COPC?
Acetone	0.012	NA	NA	No	No Tox	----	0.13%	----	No	7800	No	No
bis(2-Ethylhexyl)phthalate	0.097	NA	NA	No	96.11%	----	5.20%	----	Yes	46	No	No
Di-n-butylphthalate	0.074	NA	NA	No	No Tox	----	0.79%	----	No	7800	No	No
Di-n-octylphthalate	1.7	NA	NA	No	No Tox	----	91.17%	----	Yes	1600	No	No
Fluoranthene	0.037	NA	NA	No	No Tox	----	0.99%	----	No	3100	No	No
Isophorone	0.05	NA	NA	No	3.36%	----	0.27%	----	Yes	670	No	No
Methylene chloride	0.001	NA	NA	No	0.53%	----	0.02%	----	No	85	No	No
Pyrene	0.04	NA	NA	No	No Tox	----	1.43%	----	Yes	2300	No	No
Arsenic	5.9	5.8	Yes	No	----	100.00%	----	13.94%	Yes	0.43	Yes	No[a]
Barium	126	300	No	No	----	N/A	----	N/A	No	5500	No	No
Cadmium	1	2.2	No	No	----	N/A	----	N/A	No	39	No	No
Chromium	21.3	33	No	No	----	N/A	----	N/A	No	390	No	No
Lead	12	17	No	No	----	N/A	----	N/A	No	400	No	No
Mercury	10.4	0.05	Yes	No	----	No Tox	----	86.01%	Yes	23	No	No
Selenium	0.4	0.22	Yes	No	----	No Tox	----	0.06%	No	390	No	No
Silver	0.2	3.7	No	No	----	N/A	----	N/A	No	390	No	No
Am-241	23.6	0.011	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Co-60	3.9	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Cs-134	2.3	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Cs-137	7730	0.82	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Eu-152	2	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Eu-154	1.9	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
I-129	3.1	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Np-237	0.15	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Pu-238	259	0.0049	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Pu-239/240	24.7	0.1	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Sb-125	13	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Sr-90	10800	0.49	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
U-234	5.1	1.44	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
U-235	0.23	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
U-238	1.2	1.4	No	No	----	----	----	----	N/A	No RBC	No RBC	No

Source: Contaminant Worksheet for CPP-89, Track 2 Preliminary Scoping Package.

"NA" in Step 1 indicates that a background value is not available.

"----" in Step 3 indicates that the chemical evaluated does not correspond with the analyses (organic, inorganic) as stated in the column heading.

"N/A" in Step 3 indicates that the chemical is not evaluated since it has already been screened out in Step 1 and/or Step 2 or because it is a radionuclide.

"No Tox" indicates that a toxicity value (slope factor or reference dose) is not available.

"No RBC" indicates that an EPA Region III risk-based concentration based on residential soil ingestion is not available

"Yes (NT)" indicates that this chemical does not have toxicity data and will be further evaluated.

a. Arsenic was eliminated as a COPC because its maximum concentration is less than 2% above background.

Table 5-48. Contaminant screening process for OU 3-13, CPP-93, simulated calcine trench.

		Step 1		Step 2	Step 3					Step 4		
Chemicals	Source concentration (mg/kg or pCi/g)	Background concentration (mg/kg or pCi/g)	Is the maximum concentration greater than background value?	Is the chemical an essential nutrient?	Organic risk factor (%)	Inorganic risk factor (%)	Organic hazard factor (%)	Inorganic hazard factor (%)	Chemical comprises > 1% of the risk/hazard factor?	Region III soil residential RBC (mg/kg)	Is maximum concentration greater than RBC?	Site COPC?
Aluminum	120000	16000	Yes	No	----	No Tox	----	6.84%	Yes	78000	Yes	Yes
Mercury	140	0.05	Yes	No	----	No Tox	----	93.12%	Yes	23	Yes	Yes
Nitrate/Nitrite	74.9	NA	NA	No	----	No Tox	----	0.04%	No	7800	No	No
Sodium	429	320	Yes	Yes	----	N/A	----	N/A	No	No RBC	No RBC	No

Source: WAG 3 RI/FS Soil Data (FAX) received from LITCO (1/4/96).

"NA" in Step 1 indicates that a background value is not available.

"----" in Step 3 indicates that the chemical evaluated does not correspond with the analyses (organic, inorganic) as stated in the column heading.

"N/A" in Step 3 indicates that the chemical is not evaluated since it has already been screened out in Step 1 and/or Step 2 or because it is a radionuclide.

"No Tox" indicates that a toxicity value (slope factor or reference dose) is not available.

"No RBC" indicates that an EPA Region III risk-based concentration based on residential soil ingestion is not available

"Yes (NT)" indicates that this chemical does not have toxicity data and will be further evaluated.

Table 5-49. Contaminant screening process for OU 3-13, CPP windblown area.

Chemicals	Source concentration (mg/kg or pCi/g)	Step 1: Background concentration (mg/kg or pCi/g)	Step 1: Is the maximum concentration greater than background value?	Step 2: Is the chemical an essential nutrient?	Step 3: Organic risk factor (%)	Step 3: Inorganic risk factor (%)	Step 3: Organic hazard factor (%)	Step 3: Inorganic hazard factor (%)	Step 3: Chemical comprises > 1% of the risk/hazard factor?	Step 4: Region III soil residential RBC (mg/kg)	Step 4: Is maximum concentration greater than RBC?	Site COPC?
Am-241	0.0347	0.011	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Cs-134	0.0024	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Cs-137	18.4	0.82	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
K-40	27.8	24	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Pu-238	0.373	0.0049	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
Pu-239	0.073	0.1	No	No	----	----	----	----	N/A	No RBC	No RBC	No
Pu-240	0.073	0.1	No	No	----	----	----	----	N/A	No RBC	No RBC	No
Sr-90	5.72	0.49	Yes	No	----	----	----	----	N/A	No RBC	No RBC	Yes
U-233	1.09	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
U-234	1.18	1.44	No	No	----	----	----	----	N/A	No RBC	No RBC	No
U-235	0.052	NA	NA	No	----	----	----	----	N/A	No RBC	No RBC	Yes
U-238	1.17	1.4	No	No	----	----	----	----	N/A	No RBC	No RBC	No

Source: Remedial Investigation/Feasibility Study Report for Operable Unit 10-06: Radionuclide-Contaminated Soils at the Idaho National Engineering Laboratory, 1995.
"NA" in Step 1 indicates that a background value is not available.
"----" in Step 3 indicates that the chemical evaluated does not correspond with the analyses (organic, inorganic) as stated in the column heading.
"N/A" in Step 3 indicates that the chemical is not evaluated since it has already been screened out in Step 1 and/or Step 2 or because it is a radionuclide.
"No Tox" indicates that a toxicity value (slope factor or reference dose) is not available.
"No RBC" indicates that an EPA Region III risk-based concentration based on residential soil ingestion is not available
"Yes (NT)" indicates that this chemical does not have toxicity data and will be further evaluated.

Table 5-50. Contaminant screening process for OU 3-13, CPP-87, VOG blower cell floor drain/sump and PEW evaporator feed pump cell.

		Step 1		Step 2	Step 3					
Chemicals	Maximum concentration (mg/L or pCi/L)	Background concentration (mg/L or pCi/L)	Is the maximum concentration greater than background value?	Is the chemical an essential nutrient?	Organic risk factor (%)	Inorganic risk factor (%)	Organic hazard factor (%)	Inorganic hazard factor (%)	Chemical comprises > 1% of the risk/hazard factor?	Site COPC?
Arsenic	1.7	0.002	Yes	No	----	11.83%	----	5.49%	Yes	Yes
Barium	6.8	0.05	Yes	No	----	No Tox	----	46.08%	Yes	Yes
Cadmium	17.5	0.001	Yes	No	----	51.15%	----	33.91%	Yes	Yes
Chromium	1.9	0.002	Yes	No	----	37.02%	----	0.37%	Yes	Yes
Fluoride	2.5	0.4	Yes	No	----	No Tox	----	0.04%	No	No
Lead	184	0.005	Yes	No	----	No Tox	----	No Tox	No	Yes (NT)
Mercury	1.1	0.0001	Yes	No	----	No Tox	----	12.44%	Yes	Yes
Nickel	13.4	NA	NA	No	----	No Tox	----	0.65%	No	No
Nitrate	0.4	1.4	No	No	----	N/A	----	N/A	No	No
Selenium	1.4	0.001	Yes	No	----	No Tox	----	0.27%	No	No
Silver	3.9	0.001	Yes	No	----	No Tox	----	0.76%	No	No
Co-60	70740	NA	NA	No	----	----	----	----	N/A	Yes
Cs-134	4018	NA	NA	No	----	----	----	----	N/A	Yes
Cs-137	330480	NA	NA	No	----	----	----	----	N/A	Yes

Source: Track 2 Preliminary Scoping Package and Track 1 for site CPP-87.
"NA" in Step 1 indicates that a background value is not available.
"----" in Step 3 indicates that the chemical evaluated does not correspond with the analyses (organic, inorganic, radionuclide) as stated in the column heading.
"N/A" in Step 3 indicates that the chemical is not evaluated since it has already been screened out in Step 1 and/or Step 2.
"No Tox" indicates that a toxicity value (slope factor or reference dose) is not available.
"Yes (NT)" indicates that this chemical does not have toxicity data and will be further evaluated.

Table 5-51. Results of the site and chemical screening processes.

OU/Site	Chemicals of potential concern
3-01/CPP-61 PCB Spill in CPP-718 Transformer Yard-Radiological contamination	Cesium-137 Strontium-90 Technicium-99
3-02/CPP-23 CPP Injection Well	Osmium[a] Cesium-137 Europium-152 Europium-154 Strontium-90
3-02/CPP-37A CPP Gravel Pit #1	Arsenic Americium-241 Cesium-137 Cobalt-60 Neptunium-237 Plutonium-238 Strontium-90 Uranium-235 Uranium-238
3-02/CPP-37B CPP Gravel Pit #2	Aroclor-1260 Kepone[a] Arsenic Americium-241 Cesium-137 Iodine-129 Neptunium-237 Plutonium-238 Strontium-90 Uranium-235 Uranium-238
3-02/CPP-65 Sewage Treatment Plant	Will be evaluated only as a source of recharge to perched zones and SRPA.

Table 5-51. (continued).

OU/Site	Chemicals of potential concern
3-03/CPP-67 CPP Percolation Ponds #1 and #2—Sediments	Americium-241 Cerium-144 Cobalt-60 Cesium-134 Cesium-137 Iodine-129 Neptunium-237 Plutonium-238 Plutonium-239/-240 Ruthenium-106 Antimony-125 Strontium-90 Tritium Uranium-234 Uranium-235 Uranium-238
3-05/CPP-14 Imhoff Tanks	Aroclor-1260 Benzo(a)pyrene Phenanthrene[a] Cadmium Cesium-137 Neptunium-237 Strontium-90 Uranium-235
3-05/CPP-14 Plant Site	Aroclor-1260 Americium-241 Cesium-137 Neptunium-237 Antimony-125 Strontium-90 Uranium-234 Uranium-235 Uranium-238
3-05/CPP-14 Drain Field	Phenanthrene[a] Arsenic Neptunium-237 Strontium-90

Table 5-51. (continued).

OU/Site	Chemicals of potential concern
3-06/CPP-33 Contaminated Soil in the Tank Farm Area NE of CPP-604	Arsenic Americium-241 Cesium-137 Neptunium-237 Plutonium-238 Plutonium-239/240 Strontium-90
3-06/CPP-34 Soil Storage Area in the NE Corner of the ICPP	Arsenic Cesium-137 Neptunium-237 Plutonium-238 Strontium-90 Uranium-234 Uranium-238
3-06/CPP-40 Lime Pit at the Base of the CPP-601 Berm and French Drain—Radiological Contamination	Cesium-137
3-07/CPP-20 CPP-604 Radioactive Waste Unloading Area	Americium-241 Cesium-134 Cesium-137 Cobalt-60 Europium-154 Neptunium-237 Plutonium-238 Strontium-90 Technicium-99
3-07/CPP-25 Contaminated Soil in Tank Farm Area North of CPP-604	Americium-241 Cesium-134 Cesium-137 Cobalt-60 Europium-154 Neptunium-237 Plutonium-238 Strontium-90 Technicium-99

Table 5-51. (continued).

OU/Site	Chemicals of potential concern
3-07/CPP-26 Contaminated Soil in Tank Farm Area Steam Flushing—Operation inside the Tank Farm perimeter	Americium-241 Cesium-137 Europium-154 Plutonium-238 Plutonium-239 Strontium-90 Uranium-234 Uranium-235
3-07/CPP-28 Contaminated Soil in the Tank Farm Area South of WM-181 by Valve Box A-6	Cerium-144 Cesium-134 Cesium-137 Cobalt-60 Europium-154 Neptunium-237 Plutonium-239 Plutonium-240 Plutonium-241 Plutonium-242 Ruthenium-106 Strontium-90 Tritium Uranium-234 Uranium-235 Uranium-236
3-07/CPP-31 Contaminated Soil in Tank Farm Area South of Tank WM-183	Cesium-134 Cesium-137 Cobalt-60 Europium-154 Plutonium-239/-240 Ruthenium-106 Strontium-90 Uranium-235
3-07/CPP-32W/E Contaminated soil in the Tank Farm area of Valve Box B-4	Cesium-137 Europium-154 Strontium-90

Table 5-51. (continued).

OU/Site	Chemicals of potential concern
3-07/CPP-79 Tank Farm Release Near Valve Box A-2	Americium-241 Cesium-137 Plutonium-238 Strontium-90 Uranium-234 Uranium-235
3-07/CPP-83 Perched Water	Arsenic Chromium Americium-241 Strontium-90 Technicium-99 Tritium Uranium-234 Uranium-238
3-08/CPP-13 Pressurization of the Solid Storage Cyclone NE of CPP-13	Arsenic Zirconium[a] Cobalt-60 Cesium-134 Cesium-137 Europium-154 Strontium-90 Technicium-99
3-08/CPP-15 Solvent Burner East of CPP-605—Radiological Contamination	Thallium[a] Zirconium[a] Americium-241 Cesium-137 Europium-154 Neptunium-237 Plutonium-238 Plutonium-239/-240 Tecnicium-99 Uranium-235
3-08/CPP-27 Contaminated Soil in Tank Farm Area East of CPP-604 and CPP-33	Americium-241 Cesium-137 Europium-154 Neptunium-237 Plutonium-238 Plutonium-239/-240 Strontium-90 Uranium-235

Table 5-51. (continued).

OU/Site	Chemicals of potential concern
3-08/CPP-35 CPP-633 Decontamination Spill	Americium-241 Cesium-137 Europium-154 Plutonium-238 Plutonium-239 Strontium-90 Uranium-235
3-08/CPP-36 Transfer Line Leak from CPP-633 to Wl-102	Americium-241 Cesium-134 Cesium-137 Europium-154 Plutonium-238 Plutonium-239 Potassium-40 Strontium-90 Uranium-234 Uranium-235 Uranium-238
3-09/CPP-01 Horizontal Settling Basin, and Vertical Settling Pit and Soil Adjacent to SW-048 Dry Well and CPP-303 Dry Well—Environmental Release.	Americium-241 Cobalt-57 Cobalt-60 Cesium-137 Europium-152 Europium-154 Europium-155 Plutonium-239 Strontium-90 Uranium-235
3-09/CPP-02 French Drain West of CPP-603	Suspected Cesium-137 Suspected Strontium-90 Suspected Tritium
3-09/CPP-03 Temporary Storage Area SE of CPP-603 Stockpiled Soil	Cesium-137 Europium-152 Strontium-90

Table 5-51. (continued).

OU/Site	Chemicals of potential concern
3-09/CPP-04 and CPP-05 Contaminated Soil Around CPP-603 Settling Tank	Cerium-144 Cobalt-60 Cesium-134 Cesium-137 Europium-152 Europium-154 Europium-155 Uranium-235
3-09/CPP-06 Trench East of CPP-603 Fuel Storage Basin	Cesium-137 Strontium-90
3-09/CPP-08 and CPP-09 CPP-603 Basin Filter System Line Failure and Soil Contamination Near NE Corner of CPP-603 South Basin	Cesium-137 Europium-152 Europium-154 Strontium-90 Uranium-235
3-09/CPP-10 CPP-603 Plastic Pipeline Break	Cobalt-60 Cesium-137 Europium-152 Europium-154 Europium-155 Strontium-90 Uranium-235
3-09/CPP-11 CPP-603 Sludge and Water Release	Arsenic Thallium[a] Cesium-137 Cobalt-60 Europium-154 Neptunium-237 Strontium-90
3-09/CPP-17a Soil Storage Area South of CPP Peach Bottom Fuel Storage Area	Cesium-137 Europium-152 Europium-154 Strontium-90
3-09/CPP-17b Soil Storage Area South of CPP Peach Bottom Fuel Storage Area	Cobalt-57 Cesium-137

Table 5-51. (continued).

OU/Site	Chemicals of potential concern
3-09/CPP-19 CPP-603 to CPP-604 Line Leak	Arsenic Calcium[a,b] Americium-241 Cobalt-60 Cesium-134 Cesium-137 Europium-152 Europium-154 Europium-155 Niobium-95 Plutonium-239 Strontium-90 Uranium-235
3-09/CPP-22 Particulate Air Release South of CPP-603	Cesium-137 Strontium-90 Technicium-99
3-09/CPP-69 Abandoned Liquid Radioactive Waste Storage Tank CPP VES-SFE-20	Cobalt-60 Cesium-134 Cesium-137 Europium-152 Europium-154 Europium-155 Plutonium-239/-240 Antimony-125 Strontium-90
3-09/CPP-78 Contaminated Soil West of CPP-693, East of Dry Fuel Storage Area	Strontium-90
3-10/CPP-46 CPP-637 Courtyard Pilot Plant Release—Radiological Contamination	Cesium-134 Cesium-137 Strontium-90 Technicium-99

Table 5-51. (continued).

OU/Site	Chemicals of potential concern
3-11/CPP-58W/E Subsurface release of contaminants associated with PEW spills and CPP PEW Evaporator Overhead Pipeline Spills	Americium-241 Cesium-137 Europium-154 Plutonium-238 Plutonium-239 Strontium-90 Uranium-235
3-12/CPP-80 CPP-601 Vent Tunnel Drain Leak (VT-300)	Chloride[a] Sulfate[a] Zirconium[a] Cerium-144 Cesium-134 Cesium-137 Europium-154 Europium-155 Plutonium-238 Plutonium-239/-240 Ruthenium-106 Antimony-125 Strontium-90
3-13/CPP-85 WCF Blower Corridor	Cobalt-60 Cesium-134 Cesium-137 Europium-154 Strontium-90
3-13/CPP-87 VOG Blower Cell Floor Drain/Sump and PEW Evaporator Feed Pump Cell	Arsenic Barium Cadmium Chromium Lead[a] Mercury Cobalt-60 Cesium-134 Cesium-137
3-13/CPP-88 Radiologically Contaminated Soils Map	Arsenic Thallium[a] Cesium-137 Strontium-90

Table 5-51. (continued).

OU/Site	Chemicals of potential concern
3-13/CPP-89 CPP-604/605 Tunnel Excavation	Americium-241 Cesium-134 Cesium-137 Cobalt-60 Iodine-129 Neptunium-237 Plutonium-238 Plutonium-239/240 Strontium-90 Antimony-125 Uranium-234 Uranium-235
3-13/CPP-90 CPP-709 Ruthenium Detection	Benzo(a)pyrene Phenanthrene[a] Arsenic Thallium[a] Cobalt-58 Cesium-134 Cesium-137 Europium-155 Niobium-95 Strontium-90
3-13/CPP-91 CPP-633 Blower Pit Drain	Arsenic Manganese Thallium[a] Cesium-137 Strontium-90
3-13/CPP-92 Soil Boxes West of CPP-1617	Americium-241 Cesium-134 Cesium-137 Cobalt-60 Europium-152 Europium-154 Iodine-129 Neptunium-237 Plutonium-238 Plutonium-239/240 Strontium-90 Antimony-125 Uranium-234 Uranium-235

Table 5-51. (continued).

OU/Site	Chemicals of potential concern
3-13/CPP-93 Simulated Calcine Trench	Aluminum Mercury
3-13/Windblown Area (OU 10-06)	Americium-241 Cesium-134 Cesium-137 Potassium-40 Plutonium-238 Plutonium-239 Plutonium-240 Strontium-90 Uranium-233 Uranium-235

a. No toxicity value is available. This will be further discussed in the uncertainty section.

b. Calcium is further evaluated since its concentration is about 9.67 times greater than background concentrations.

5.5 References

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Chapter 6

6 CONTAMINANT IDENTIFICATION, FATE, AND TRANSPORT

Numerical predictions of contaminant transport from the land surface at the ICPP and TRA areas to the aquifer and extending south to the INEEL boundary were made and are presented in Appendix F. Simulations were performed to predict water infiltration and transport through the vadose zone separate from the flow and transport occurring in the aquifer. The predicted water and contaminant mass fluxes from the vadose zone model are used as input to the aquifer model. Detailed information for the simulations presented in that appendix by section number includes: (1) pertinent data and interpretation of hydrogeologic conditions, (2) parameterization of the vadose zone model extending from the ICPP land surface to the SRPA (Snake River Plain Aquifer) defined by the ICPP footprint and the parameterization of the aquifer model extending from north of the TRA to the south INEEL boundary, (3) calibration results for the vadose zone model to the perched water beneath the ICPP and aquifer heads, (4) calibration results for the vadose zone model using the chloride percolation pond disposal history and calibration results for the aquifer model using TRA and ICPP injection well tritium disposal history, (5) volumetric and mass delineation for surface contaminant discharges with a final determination of contaminants of potential groundwater concern, (6) conversion of the contaminant source terms for use in the numerical model, (7) base case simulation results for each of the contaminants of potential concern, (8) sensitivity study results for those parameters of primary importance or highest uncertainty, (9) discussion of physical and parameter uncertainty, (10) discussion of the uncertainty in the identification of the contaminants of potential concern (COPCs) and source inventory, and (11) summary of the uncertainty, by specific COPC. Summary conclusions and observations are given at the end of the base case simulations and sensitivity study results sections. Because the interpretation of hydrogeologic conditions, contaminant source delineation, and final simulation results require extensive documentation and graphics (presented in Appendix F), only a brief summary of each is presented here, following the purpose and scope.

The simulated vadose zone and aquifer model domains are shown in Figures 6-1 and 6-2. Because the remediation alternatives could vary depending on the location of aquifer contamination, peak aquifer concentrations are presented in the results sections (Sections 6.6 and 6.7) for the entire aquifer domain, as well as in the vicinity of the ICPP (defined as the ICPP footprint) and the vicinity of the TRA (defined as the TRA footprint). The location of the ICPP and TRA footprints are shown in Figure 6-1. The horizontal extent of the vadose zone model defined by the ICPP footprint. Contaminant transport is first simulated through the vadose zone model and the mass flux out the bottom of the vadose model is used as an input to the aquifer model. The aquifer simulations were first performed using the small aquifer simulation domain (inset in Figure 6-2). For contaminants for which the plumes are predicted to extend beyond the small aquifer domain boundary, simulations were repeated using the large aquifer domain.

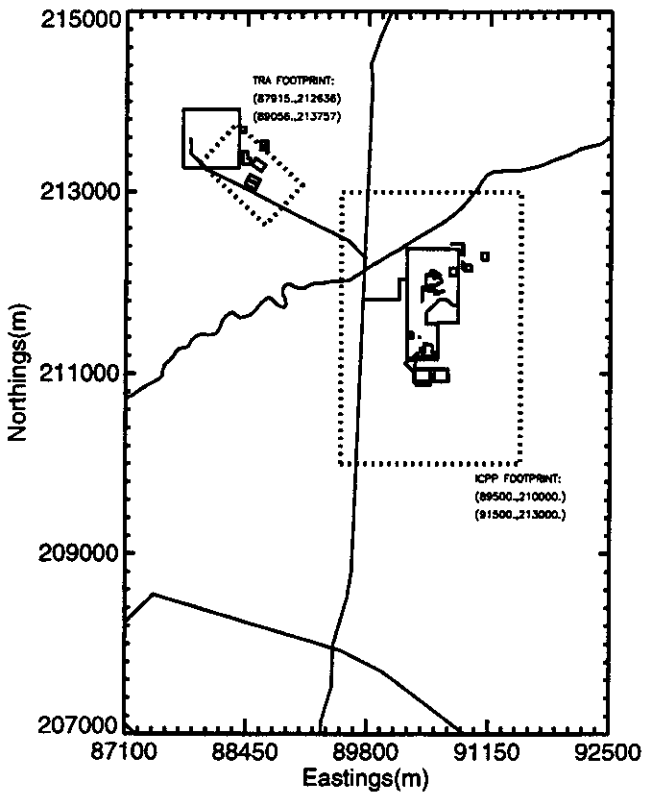

Figure 6-1 TRA and ICPP footprints bounded by the dotted lines in this small aquifer model domain. The vadose zone model is over the area of the ICPP footprint.

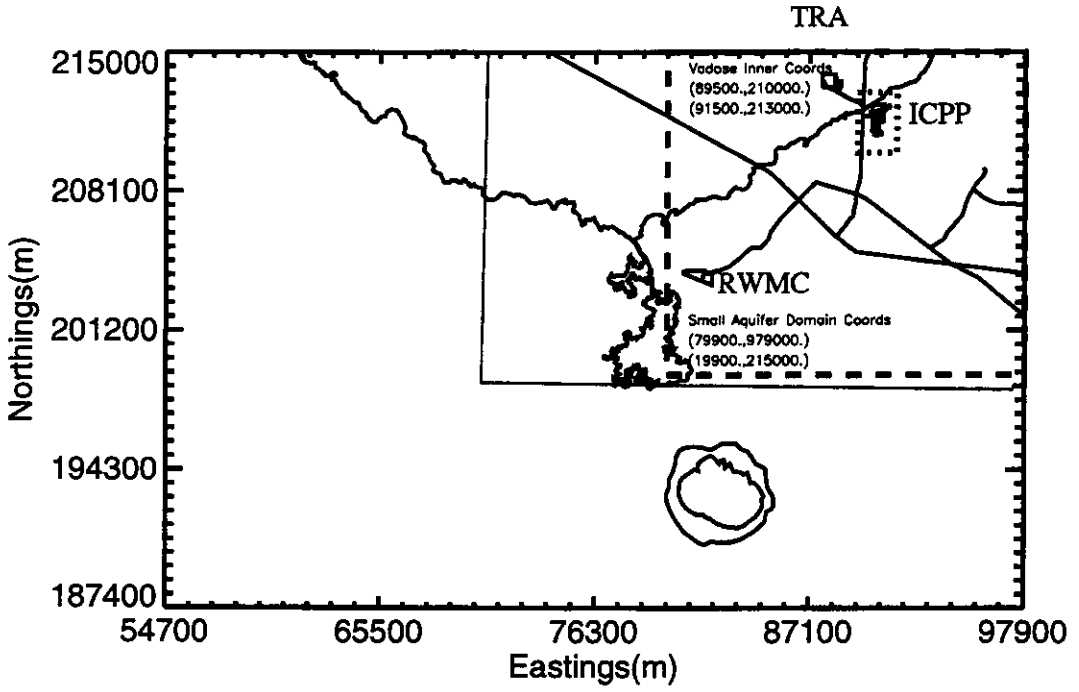

Figure 6-2 Large and aquifer and vadose model domains. Primary TRA facilities are shown North-West of the ICPP facilities, the RWMC is in the southwest of the model domain.

6.1 Modeling Purpose and Scope

Modeling scope included base-case predictions of flow and contaminant movement. In addition, the sensitivity of predicted contaminant migration to the parameters used to implement the conceptual model was obtained. The base-case conceptualization of the flow and hydraulic transport domain is representative, rather than overly conservative, in that the model has been calibrated to the arrival and concentration distributions of known contaminants from known releases. As a result, predicted concentrations are, based on the best information available, within acceptable accuracy. The sensitivity analysis is provided to illustrate the possible range of various predicted measures of contaminant transport given the (1) uncertainty in the input estimates of physical properties having a primary influence on the flow and transport domain (parametric study), (2) uncertainty in the input estimates of available process water, (3) uncertainty in contaminant mass estimations, and (4) possibility of additional subsurface flow routes associated with inadequate well completions.

Focus in the base-case simulations was on obtaining future groundwater concentrations in the year 2095 to support the 100-year risk scenario for the WAG 3 comprehensive BRA. Simulations were performed for arsenic, chromium, mercury, Am-241, Co-60, Cs-137, H-3, I-129, Np-237, Sr-90, Tc-99, total Pu, and total U originating either at the land surface (current soil inventory), historical waste process water discharge streams, accidental releases, and/or past use of the injection well. In addition, because the TRA facility is close to the ICPP there is the potential that plumes from the two facilities will merge at some point down gradient. To account for the possibility, the two primary contaminants identified in the TRA RI (Cr and H-3) were included as aquifer source terms in the ICPP aquifer model. Concentrations were presented as a function of time for the period minimally spanning the years 1953-2095, and as discussed below spanning much longer time periods for the adsorbing contaminants.

In order to simulate contaminant transport from surface sources through the vadose zone, and eventually through the aquifer, two conceptual models were developed. The first of these two models was parameterized to simulate the infiltration of water, and the subsequent transport of contaminants through the vadose zone. The vadose zone was conceptualized as being fully three-dimensional, with contaminants originating primarily at ground surface and allowed to infiltrate vertically as well as to spread laterally. Water and contaminant mass fluxes through the bottom layer of the vadose zone model were used as the upper boundary condition for the aquifer simulation domain. This second model (aquifer model) was also three-dimensional to account for contaminants being injected at depth from the injection well and for the mass fluxes originating at land surface. There were other hydrologic considerations that resulted in the decision to treat the subsurface of the ICPP as two three-dimensional domains, as summarized in terms of the conceptual model for both flow domains below.

6.2 Hydrologic Description

The subsurface of the ICPP has been extensively drilled and sampled, primarily by the USGS, in an effort to understand and monitor the movement of groundwater and contaminants beneath the ICPP. Basically, the subsurface at the ICPP is typical of the INEEL as a whole and is part of a large volcanic plain of layered late Cenozoic basalt flows overlying a Rhyolitic basement. Section 2.4.1.3 states:

> "A lava flow is generally defined as a solidified body of rock that has been extruded out horizontally across the earth's surface from a fissure or vent. A lava flow may be described as a flow, which refers to the overall body of rock, a lava flow may also be described as a separate distinct flow unit that is defined as a separate distinct lobe that issues out from a flow, or a lava flow may be described as a flow group, which is a sequence of petrographically similar flows that erupted from the same magma chamber (Anderson and Lewis 1989). Between the lava flows, there is a contact that represents a cooling surface between flows. The cooling surface is typically marked by an increase in the number of vesicles and fractures in the rock as well as a significant amount of oxidation. There may also be a layer of sediments between flows. Commonly, these sediments are referred to as interbeds."

The geologic interpretation of the ICPP indicates that the lithology (i.e., fracturing, vesicles, weathering surfaces, etc.) is not continuous between the 40 wells that have been drilled at the ICPP. On the other hand, the larger-scale stratigraphic relationships between the basalt flows can be correlated horizontally between the wells. Typically, the correlation indicates that the sediment units are of variable thickness and differ in strike and dip angles. Permeability and porosity for the basalt, basalt fractures, and sedimentary interbeds differ by orders of magnitude as determined from the field data, as discussed in Sections 1.4.1 and 1.4.2 of Appendix F.

From a hydrologic perspective, it is the change in vertical stratigraphy (and corresponding change in permeability and porosity) that controls the downward migration of water and contaminants into the vadose zone; the strike and dip of the sedimentary interbeds that allows subsurface lateral mixing of water sources to occur in the vadose zone; and the larger scale sub-horizontal stratigraphic changes (and corresponding permeability and porosity) that have a primary influence on the direction of flow and depth of mixing of contaminants in the aquifer. As a result, the stratigraphy plays a primary role in the hydrologic description of the ICPP. A detailed presentation of stratigraphically related field data is given in Section 1.3 of Appendix F, and for the hydrologic field data in Section 1.4 of Appendix F. Interpretation of stratigraphic and hydrologic data for the purposes of model parameterization is given in Sections 2.2 and 2.3 of Appendix F, for the vadose and aquifer computational domains, respectively.

The other primary hydrologic control at the ICPP is presented by the numerous high-volume surface water recharge sources. There are eight broad categories of water sources distributed throughout the surface and shallow subsurface of the ICPP. These are discussed extensively in Section 1.5.2 of Appendix F, and include natural infiltration (558,960 kg/day), water system leaks (41,277 kg/day), landscape irrigation (13,500 kg/day), steam condensate (17,332 kg/day), the CPP-603 infiltration basins (511 kg/day), sewage treatment ponds (155,565 kg/day), service waste water (5,838,868 kg/day), and the Big Lost River (2,696,458 kg/day). Of these surface water sources, the service waste water discharges and Big Lost River are

the primary contributors to infiltration and are located to the south and northwest of the ICPP facility, respectively. The complex stratigraphy in combination with the high-volume water sources results in variably saturated flow in the vadose zone where regions of very low water saturation (approaching zero) are found in the basalt and where water saturations approach unity throughout many of the sedimentary interbeds. Within these sedimentary interbeds and interlayered basalts, water originating in the north mixes with water originating in the south. As a result of the complex stratigraphy and surface water sources, flow in the subsurface of the ICPP occurs in a subhorizontal direction as well as infiltrating vertically. This phenomenon explains why the vadose zone conceptual model was, of necessity, three-dimensional. Justification for the three-dimensional aquifer model is similar, and is based on both stratigraphic variability and vertical variability of the sources of contaminants entering the aquifer.

6.3 Contaminant Sources

The contaminants discharged to the surface and subsurface at the ICPP are numerous in chemical composition and have been discharged at many locations. For the purposes of modeling the potential risk via the groundwater pathway, the entire inventory of contaminants was reduced to those posing a potential risk. These contaminants are referred to as groundwater contaminants of potential concern (COPCs). Following the identification of the COPCs, their mass or activity, locations, and time of disposal were put into a modeling framework. Appendix F, Section 5.1 describes how the groundwater pathway COPCs were identified, and Section 5.2 of Appendix F presents the procedure used to calculate the mass or activity for each of the contaminant sources.

Contaminants of potential concern (COPCs) were identified using three steps. First, an initial set of contaminants was identified by comparing the maximum concentrations measured in the aquifer and perched water to the limiting concentration defined by either the water concentration based on a 10^{-6} risk level, a Hazard Quotient of 1 (HQ=1), or the EPA Maximum Contaminant Level (MCL). This step identified those contaminants that currently pose a risk to the perched water or aquifer regions. The first identification step is presented in Appendix F, Section 5.1.1. The second identification step designed and applied a screening process to evaluate the potential for groundwater contamination from contaminated soils. Contaminants in the soils were evaluated for their maximum risk in the alluvium pore-water, their propensity to infiltrate through the alluvium, and the expected reduction in concentration resulting from radioactive decay. This second identification step is presented in Appendix F, Section 5.1.2. Contaminants of concern based on other factors are identified in the third identification step and presented in Appendix F, Section 5.1.3. In each identification step, possible COPCs are identified with these relatively conservative screens. Then all the historical data is evaluated in order to determine whether or not the possible COPC should be added to the list of COPCs for quantitative evaluation. In Appendix F, Section 10.3.2, COPCs are identified based on the known processes that produced the CPP-31 radionuclide contamination. The analysis was part of a contaminant source uncertainty analysis designed to verify that the COPCs identified in Section 5.1 did not miss any radionuclide COPCs.

In Section 5.1 of Appendix F, field data were presented in terms of the maximum observed concentration of a given chemical species and the associated risk. That data originated from (1) aquifer and perched water sample information, (2) service wastewater source logs, and (3) measurements of soil contamination. Mass or activity for all COPCs are presented based on these three source type categories. In Section 5.2 of Appendix F, the COPCs were presented and analyzed by source location, a necessary step prior to integrating the data into model predictions. The actual source terms used in the model were presented in Appendix F, Section 6. Because the steps in determining the COPCs were fairly long and involved, only the

final results are presented in Tables 6-1 and 6-2. For those interested in the model source terms, the information is presented in Appendix F, Section 6.

Table 6-1 Summary of the total mass or activity for each of the COPCs, from each of groundwater contamination sources.

COPCs	Units	Known Release		Service Waste		Soil Contamination	TRA	Total
		Tank Farm	Other	Injection Well	SWPs			
Arsenic	kg	0	0	0	0	4.57E+02	0	4.57E+02
Chromium	kg	1.60E+01	0	0	0	1.20E+02	2.15E+04	2.17E+04
Mercury	kg	2.81E+01	0	4.00E+02	0	5.96E+02	0	1.02E+03
Am-241	Ci	1.10E+02	0	1.23E-01	0	9.05E-01	0	1.11E+02
Co-60	Ci	6.84E+01	0	1.24E+00	1.12E-02	1.06E+02	0	1.76E+02
Cs-137	Ci	2.68E+04	3.09E+02	2.58E+01	5.34E-01	2.68E+03	0	2.98E+04
H-3	Ci	1.85E+01	3.78E+02	2.01E+04	9.99E+02	0	8.92E+03	3.04E+04
I-129	Ci	7.05E-03	0	1.39E+00	8.20E-02	3.89E-02	0	1.52E+00
Np-237	Ci	2.16E-01	0	1.07E+00	0	1.33E-01	0	1.42E+00
Total Pu	Ci	1.18E+03	0	8.22E-01	6.92E-02	1.02E+01	0	1.19E+03
Sr-90	Ci	1.80E+04	3.09E+02	2.43E+01	2.95E-01	1.11E+03	0	1.94E+04
Tc-99	Ci	2.58E+00	0	0	0	1.06E-01	0	2.69E+00
Total U	Ci	7.47E-01	0	2.69E-01	7.01E-02	9.40E-01	0	2.03E+00

a. Time period over which the estimates are available (from RWMIS) varies by contaminant.

Table 6-2 Summary of the percent (%*) mass or activity for each of the COPCs, from each of groundwater contamination sources.

	Source						
	Known Release		Service Waste		Soil Contamination	TRA	Total**
COPCs	Tank Farm	Other	Injection Well	SWPs			
Arsenic	0	0	0	0	100.00	0	100
Chromium	0.07	0	0	0	0.55	99.37	100
Mercury	2.74	0	39.06	0	58.2	0	100
Am-241	99.07	0	0.11	0.00	0.82	0	100
Co-60	38.94	0	0.71	0.01	60.35	0	100
Cs-137	89.89	1.04	0.09	0.00	8.99	0	100
H-3	0.06	1.24	66.08	3.28	0	29.33	100
I-129	0.46	0	91.57	5.40	2.56	0	100
Np-237	15.22	0	75.41	0	9.37	0	100
Total Pu	99.07	0	0.07	0.01	0.86	0	100
Sr-90	92.58	1.59	0.12	0.00	5.71	0	100
Tc-99	96.05	0	0	0	3.95	0	100
Total U	36.87	0	13.28	3.46	46.39	0	100

* % mass =% activity for a given COPC with the exception of Total Pu and Total U which are given just in % activity.
** for a given COPC, accumulating the percentage across the various sources results in 100% of the mass or activity.

For purposes of this study, the contaminant sources were discretized into known releases, service waste, contaminated soils, and releases to the aquifer from the TRA. Table 6-1 summarizes the list of COPCs

and the total amount of mass or activity of each, by source type. Three non-radionuclides and 10 radionuclides were identified as COPCs. Physical and chemical properties for the COPCs are given in Tables 5-1 and 5-2 of Appendix F.

Table 6-2 presents a summary by general source of the mass or activity percentage for each groundwater pathway COPC. The tank farm known releases provide the vast majority of the Am-241, Cs-137, Total Pu, Sr-90, and Tc-99. The injection well provides most of the Np-237, I-129 and H-3. The soil contamination provides all of the arsenic and most of the mercury and Co-60. The TRA provides almost all of the chromium and much of the H-3. Overall, the tank farm known releases accounts for the majority of the contamination to the environment.

Predictive simulations were performed for each of these COPCs using the information given in the tables in Appendix F, Section 6. These tables break the total mass or activity of the contaminants at general source locations into more specific locations and gives the best estimate of time during which the releases occurred. For each of the contaminant sources, a summary of the source locations and simulation time frames is given in Table 6-1 and Figure 6-1 of Appendix F.

6.4 Numerical Model Description and Parameterization

The vadose zone-aquifer-contaminant system at the ICPP was simulated using the three-dimensional multiphase transient code TETRAD. This code allowed incorporation of the heterogeneous physical properties necessary to solve the vadose zone infiltration problem with the large areal and point source influxes of water and contaminants. The numerical problem was broken into a vadose zone conceptual domain and an aquifer conceptual domain because of computational hardware limitations, although in theory, the two conceptual domains could have been included in a single numerical simulation. The contaminant mass flux through the bottom plane of the vadose zone model was output throughout the vadose zone modeling time frame. These mass fluxes were then input as source terms for the top plane of the aquifer model. Inherent in the approach is the assumption that the mass flux was constant over the period between output times. These times were kept relatively small and are indicated as the asterisks on the plots labeled "mass flux of the COPC into the aquifer" for each contaminant. Because there are several documents describing the use and utility of TETRAD, its specific attributes will not be discussed here, but the reviewers are referred to the following references: Shook (1995), Shook and Faulder (1991), Magnuson (1995), and Vinsom and Shook (1993).

Fundamental parameters necessary to solve the vadose zone and aquifer water and contaminant transport problems include permeability relationships (saturated permeability for air and water, permeability-saturation curves, capillary pressure-saturation curves), porosity, dispersivity, and soil-contaminant partitioning relationships. These parameters need to be assigned for each different stratigraphic or lithologic unit incorporated by the conceptual model. In addition, the model requires boundary conditions in the form of either prescribed pressure or prescribed flux. In Appendix F Section 2, the field data presented in Section 1 (Appendix F) are reviewed and cast into a model parameterization framework. Because Section 2 of Appendix F presents simplifying assumptions and the details associated with numerical implementation, only a brief summary is included below.

6.4.1 Hydraulic Parameters

6.4.1.1 Vadose Zone Model.

Hydraulic parameters for the transient vadose zone infiltration and transport model include saturated permeability for air and water, moisture characteristic relationships describing the constitutive relationships between capillary pressure-saturation and relative permeability-saturation, porosity, dispersivity, and parameters describing (in this specific case) matrix-contaminant adsorption. These parameters were assigned for the sedimentary units (alluvium and effective interbeds), and for the basalt fractures. Values for the basalt matrix were not assigned based on results of a previous modeling study conducted for the Large Scale Infiltration Test (LSIT) by Magnuson (1995). Reasons for neglecting the matrix contribution are given by

Magnuson (1995) and are discussed in Section 2.2.5 of Appendix F. Neglecting the contribution of the basalt matrix is based on simulations examining the relative contribution of basalt matrix (high porosity, low permeability) and basalt fractures (low porosity, high permeability) for a large field-scale infiltration test conducted at the INEEL. The simulation results indicated that the contribution of basalt matrix in the dual porosity formulation was negligible and that adequate matches to field data could be obtained considering only the basalt fractures and sediments in a single porosity formulation.

For this modeling, it was assumed that the basalt characteristics determined from the LSIT modeling (Magnuson, 1995) were essentially appropriate for the ICPP basalts. Based on Magnuson's results, it was assumed that the basalts could be treated as an anisotropic "single porosity" media (i.e., neglect the matrix and only simulate the fracture network), with a horizontal and vertical fracture permeability of 90,000 mD and 300 mD, respectively, and a basalt fracture effective porosity of 5%. Unsaturated moisture characteristic curves for the fractured material were discussed in Section 2.2.5 of Appendix F. The sediment characteristics at the ICPP were slightly different than those observed during the LSIT test primarily because of the distribution by thickness and in clay content. Thus, the sediment permeability was used as a calibration parameter, and results based in values ranging from 78 mD to 4 mD were obtained. Porosity for the sediments was also a calibration parameter.

The final parameter set corresponds to the simulation shown in Appendix F Section 3.2.15 and is based on the tabulated constitutive parameters presented in Appendix F Section 2.2.5.1. Additional parameters used were: (a) saturated water permeability of 4 mD (isotropic) in the sedimentary interbeds, (b) an isotropic alluvium permeability of 78 mD, (c) basalt fracture permeability of 90,000 mD horizontally and 300 mD vertically, and (d) sediment porosity of 48.7% and basalt fracture porosity of 5%. An extensive sensitivity analysis to these parameters is given in Appendix F Section 3.2, as part of the perched water calibration process documentation.

6.4.1.2 Aquifer Model.

Hydraulic parameters for the transient aquifer transport model include saturated permeability for water, porosity, dispersivity, and parameters describing (in this specific case) matrix-contaminant adsorption. There were four distinct stratigraphic types identified as playing a primary role in the transport of contaminants through the aquifer. These included an upper I basalt unit, a lower I basalt unit, the HI interbed, and the H basalt. Estimates of permeability for the I basalt region, wells local to the ICPP facility, and regional estimates of hydraulic conductivity formed the data base for aquifer hydraulic values. The I basalt unit was assigned permeabilities representative of those obtained in the ICPP pumping and injection wells. Larger-scale regional permeabilities were taken from the WAG 10 modeling effort (McCarthy et al., 1995). Local scale ICPP permeabilities are consistent with the ICPP well test results. Hydraulic parameters were assigned to the model grid based on the area in which the stratigraphic units appeared as discussed below.

The hydraulic conductivities used in the aquifer model were first interpolated onto the WAG 3 model grid from the final values determined from WAG 10 regional groundwater flow model. The WAG 10 model used an Eastern Snake River Plain regional water balance to define the boundaries in order to ensure a water mass balance through the Eastern Snake River Plain Aquifer. WAG 10 hydraulic conductivities ranged from 85,000 to 1,530,000 mD and were comparable in magnitude to the local ICPP values given in Appendix F Table 1-5. Because of this similarity, the WAG 10 conductivities were felt to provide reasonable larger-scale values for long-term transport predictions for this ICPP model.

The upper I basalt unit, lower I basalt unit, and HI interbed are the dominant stratigraphic features in the saturated zone (Appendix F Section 1.3.3). The upper I basalt flow and lower I basalt flow differ hydraulically because the I basalt flow dips steeply near the north to northwest boundary of the ICPP model domain. This dip means that the top of that basalt flow is probably more highly fractured and thus exhibits higher permeability, with the permeability decreasing in the flatter regions to the south. Distinguishing an upper and lower I basalt region was done by assigning a value representative of the CPP-01, CPP-02, and CPP-3 wells (1.3E6 mD from Appendix F Table 1-5) to the upper I basalt region, and assigning one-half of the

lowest WAG 10 ICPP permeability (8.5E4 mD) to the lower I basalt region. These values replaced the WAG 10 permeabilities in grid blocks containing the I basalt flow. To be consistent with the sediment properties used in the vadose zone, permeability of 4 mD was assigned to the first layer of grid blocks overlying the I basalt flow. Assigning sediment properties uniformly over the I flow assumes that the HI interbed was 7.6 m thick and existed everywhere the I basalt flow exists. The final level of refinement for hydraulic conductivities in the ICPP aquifer model incorporated ICPP local scale field data. These local scale hydraulic conductivities above 90,000 mD (Appendix F Figure 1-15) were applied throughout the vertical profile defined by the footprint of the vadose zone model. The 90,000 mD cutoff limit was used based on observations made during the transport calibration phase (see Appendix F Section 4.2).

6.4.2 Boundary Conditions

Exterior boundary conditions for the vadose zone model (edge of domain conditions) were no-flow laterally, unit gradient across the bottom (allowing water and contaminants to pass into the aquifer model), and variable recharge across the upper boundary. The upper recharge condition was highly variable to account for: (a) areal infiltration outside the ICPP facility boundaries, (b) areal infiltration inside the ICPP facility boundaries, (c) the influence of the Big Lost River, and (d) all of the ICPP process water. Data describing the process water, infiltration rates, and the influence of the Big Lost River were presented in Appendix F Section 1.5. Conversion of the field data to the context of model implementation was discussed in Appendix F Sections 2.2.6 and 2.2.7.

Boundary conditions for the aquifer model allowed lateral influx on all four sides, influx from the vadose zone model of water and contaminant, influx of contaminants from the TRA area, and influx from the Big Lost River. No flow was allowed to occur across the bottom of the domain. Sources of information pertaining to the aquifer boundary influxes were presented in the context of modeling in Appendix F Sections 2.2.5 through 2.2.7.

6.5 Calibration

The calibration process for the vadose zone model involved performing an extensive sensitivity study to match observed perched water elevations. In contrast, the bulk of the aquifer sensitivity study was done as a part of transport calibration. As a result, there are many perched water maps given in Appendix F Section 3, but that section contains only the heads resulting from the final transport calibration run. The primary reason for this is that transport is governed by the in situ velocity and not just the head distribution. Thus, matching the heads does not imply that transport velocity is appropriate. For the purposes of aquifer flow and transport calibration, it was decided to concentrate on matching the breakthrough curves of tritium to field data rather than matching heads at wells. This was done in part because a steady state head model was used to try to capture long-term effects of the transient head on transport. This is different than the calibration of the vadose zone model because there was sufficient field data to calibrate the transient infiltration (pressure and saturation), but not enough to extensively calibrate to chemical transport.

The vadose zone simulation parameters given in Appendix F Table 3-1 represent a parametric study with respect to key features controlling the formation of perched water in the vadose zone as well as including a sensitivity to most of the primary water source volumetric rates applied at the ICPP. Specifically, that table illustrates the sensitivity to sediment permeability, basalt characteristics, the application of fire line leaks, the influence of the Big Lost River, and local grid refinement. Results of those simulations are presented in the form of saturation contour plots for various time periods as well as a 40-year saturation condition in each of the wells compared to measured field data. The 40-year saturation plots were given for wells in which perched water is known to exist as well as for wells in which perched water is not typically found. Simulations presented in Appendix F by section are:

- 3.2.1 Base Case Simulation Without the Big Lost River
- 3.2.2 Big Lost River Added to the Base Case Simulation
- 3.2.3 Reducing Sediment Saturated Permeability to 10 mD From the Base Case

3.2.4 Additional Refinement in the ICPP Footprint Area for ksat=10 mD, With Big Lost River
3.2.5 Non Linear Basalt Characteristic Curves (Sediment ksat=9 mD, Alluvium ksat=10 mD)
3.2.6 Reduced Basalt Permeability (Basalt ksat=9000 mD, Sediment=78 mD,&Alluvium=78 mD)
3.2.7 Increased Fluxes From Fire Water in the North (ksat=10 mD)
3.2.8 Increased Big Lost River Fluxes (ksat = 10 mD)
3.2.9 Decreased Sediment Permeability (ksat=5 mD) With 10 mD Alluvium Permeability
3.2.10 Decreased Sediment Porosity (Sediment ksat=5 mD, Alluvium ksat=10 mD)
3.2.11 Anisotropic Sediment Permeability (khsat=8 mD, kvsat=5 mD) and Alluvium ksat=10 mD
3.2.12 Increased Background Infiltration (sediment ksat=5 mD, Alluvium ksat=10 mD)
3.2.13 Increased Facility Infiltration (Sediment ksat=5 mD, Alluvium ksat=10 mD)
3.2.14 Transient Big Lost River Fluxes (Sediment ksat = 10 mD)
3.2.15 Reduced Sediment Permeability (ksat=4 mD) With 78 mD Alluvium Permeability

The final set of calibrated parameters for the vadose zone perched water are given in Appendix F Section 3.2.15.

Heads resulting from the final transport calibration run appear in Appendix F Section 3.3. These heads are essentially steady state as shown by the time progression of head contours. This was done in part because steady state head boundary conditions were used to try to capture long-term effects of the SRPA transient head on transport.

Section 4 of Appendix F presents the results of transport calibration. Vadose zone transport used the percolation pond chloride disposal history for calibration, and transport in the aquifer was calibrated against observed tritium. These contaminants were selected because both chloride and tritium are considered to be conservative tracers in the SRPA sediments and basalts and because source and monitoring data were available. Section 4.1 of Appendix F presented field data for transport calibration with a comparison to model predictions of transport. Because an extensive calibration effort was undertaken to match the perched water distribution in the vadose zone, the chloride simulations for transport matched the field observed breakthrough extremely well as shown in Figures 4-2 through 4-4 of Appendix F. Calibration of the aquifer transport required a parametric study as presented in Section 4.2. The aquifer results presented in Appendix F Section 4.2 by section include:

4.2.1 Base case simulation with WAG 10 permeability
4.2.2 Adding a single layer I basalt flow
4.2.3 Adding the HI interbed above the I basalt flow
4.2.4 Adding the higher-permeability upper I basalt flow
4.2.5 Adding the local ICPP permeabilities
4.2.6 Reducing the upper I basalt flow permeability by a factor of 10
4.2.7 Increasing the lower permeability cutoff in the local ICPP area
4.2.8 Decreasing the porosity by a factor of two

Aquifer transport calibration results shown in Appendix F Section 4.2.8 indicate an excellent match to observed tritium arrival at wells near to the CPP-03 injection well, mid-distance wells, and wells much farther downgradient.

6.6 Predictive Simulations

Simulation results for the transport of the thirteen COPCs through the vadose zone and aquifer are presented by section in Appendix F as given in Table 6-3 below with summary observations given in Tables 6-4 through 6-9. In all cases, each contaminant was simulated using all of the available contaminant and water sources. Information about these source terms was presented in Appendix F, Sections 5 and 6. Specific

tables, figures, or sections containing contaminant source term information used for each contaminant are listed in Table 6-3 below.

Table 6-3 Vadose Zone and Aquifer Simulations

COPCs	Sections, Tables, or Figures for Source Term Information in Appendix F							
	Simulation Results by Section in Appendix F	Isotope to Total COPCs	Uniform Releases	Non-Uniform Releases	Injection Well	Percolation Pond	Soil Contamination	TRA Sources
Arsenic	7.1		Table 6-11				Table 6-15	
Chromium	7.2		Table 6-11				Table 6-15	
Mercury	7.3		Table 6-11		Figures 6-2 through 6-20		Table 6-15	
Co-60	7.4		Table 6-11		Table 6-13, and Figures 6-2 through 6-20	Table 6-14	Table 6-16	
Cs-137	7.5		Table 6-11	Table 6-12	Figures 6-2 through 6-20	Table 6-14	Table 6-16	Table 5-41
H-3	7.6		Table 6-11	Table 6-12	Figures 6-2 through 6-20	Table 6-14	Table 6-16	Table 5-41
I-129	7.7		Table 6-11		Table 6-13, and Figures 6-2 through 6-20	Table 6-14	Table 6-16	
Np-237	7.8		Table 6-11		Table 6-13, and Figures 6-2 through 6-20		Table 6-16	
Total Pu	7.9	Section 6.2.1	Table 6-11		Table 6-13, and Figures 6-2 through 6-20	Table 6-14	Table 6-16	
Sr-90	7.10		Table 6-11	Table 6-12	Figures 6-2 through 6-20	Table 6-14	Table 6-16	
Tc-99	7.11		Table 6-11		Table 6-13		Table 6-16	
Total Uranium	7.12	Section 6.2.2	Table 6-11		Table 6-13, and Figures 6-2 through 6-20	Table 6-14	Table 6-16	
Am-241	7.13		Table 6-11		Table 6-13, and Figures 6-2 through 6-20		Table 6-16	

Using the surface source term information, the transport of each contaminant was first simulated through the vadose zone to determine the mass flux entering the aquifer. That mass flux rate was then used in addition to injection well mass fluxes to simulate the transport of each contaminant in the aquifer. Therefore, each contaminant has two sets of simulation results representing 1) vadose zone transport and 2) aquifer transport. The mass flux output from the vadose zone model is part of the mass flux input to the aquifer model. For consistency, each of the simulation results sections followed the same format beginning with the vadose zone results consisting of:

- contour plots of the peak concentration compressed horizontally at eight different time frames with the concentrations indicative of the MCL and orders of magnitude above and below,
- contour plots of the peak concentration compressed vertically at eight different time frames with the concentrations indicative of the MCL and orders of magnitude above and below,
- the time history of the peak concentration and the corresponding risk,
- the time history of the areal mass flux of the contaminant to the aquifer.

Risk in the vadose zone pore water was given in the peak concentration plots because it was used in most cases to determine when to stop the vadose zone simulations. The risk numbers are based on the predicted concentrations, and the exposure assessment, toxicity assessment, and risk characterization assumptions described in Sections 7.1, 7.2, and 7.3. Risk numbers in the vadose zone are generally not useful unless the

perched water bodies are to be used as domestic water supplies. This use is unlikely given the relatively small volume of water available for that purpose.

The aquifer transport simulation results are similar in presentation format with the exception that the peak concentration has been distinguished between the entire aquifer, the TRA, and the ICPP footprints (shown in Figure 6-1). These results consist of:

- contour plots of the peak concentration at eight different time frames centered about the MCL
- contours of either the hazard quotient (or HQ) or risk number depending on applicability for eight time frames centered on the 10^{-6} risk (or HQ=1)
- the time history of the peak concentration and corresponding risk (or HQ) for the entire aquifer, for the TRA footprint, and for the ICPP footprint.

In the presentation of transport simulation results, the total simulation time for each contaminant was different. The total simulation time varied between contaminants because:

- the relative travel time necessary to reach the aquifer from the surface is a function of Kd and is contaminant specific. The simulation time was in part based on observing the bulk of the mass to pass through the vadose zone and into the aquifer. In addition, transport for all contaminants was simulated for the period of time necessary for the peak mass flux from the vadose zone to reach the aquifer.
- as radioactive contaminants traverse the vadose zone, the decay rate is (in some cases) fast enough to allow the contaminant to reach concentrations below both risk based and MCL levels prior to 2095 (the 100 year risk time period). It was felt unnecessary to continue simulations beyond that point.
- the predicted peak mass flux from the vadose zone had occurred and it was apparent that concentrations would not fall below the 10^{-6} risk (or HQ=1) levels within a (subjective) 1000 year time frame. Continuing simulations beyond 1000 years was felt to be unnecessary.

The year at the end of the simulation time for each contaminant is given in the descriptive text of Appendix F, and in Tables 6-4 and 6-5 below.

In Appendix F, Section 7 are presented comparisons between the model predicted concentrations and field data for Am-241, Chromium, Co-60, Cs-137, H-3, I-129, Mercury, Np-237, Sr-90, and Tc-99. Comparisons are not presented for arsenic because measured concentrations are only slightly above background levels and there are no known anthropogenic sources of arsenic at the ICPP, however, there was one source term identified for arsenic from soil samples. The maximum measured soils concentration was 10.3 mg/kg which is only twice as large as the reported background soils concentration of 5 mg/kg (Knobel et al, 1992), and given the pore water variability noted in that source could very well be within the range of background concentrations. Comparisons are not presented for total Pu because there are no field samples with concentrations greater than the measurement error. Comparisons are not presented for total U because it was simulated as total U but field data exists for a) random numbers of the various isotopes at given sample times; b) single isotopes at a given time; or c) total U at a given time. As a result of offset sampling intervals and the combination of isotopic and total data, direct comparison of the model predicted concentration to the field data would be at best subjective, and at the minimum very difficult to interpret. Therefore, these comparisons are not presented. For the cases in which the comparisons are presented, they are not meant to imply that this model has been calibrated to the field data for those contaminants. In contrast, the only transport calibration that was done was presented in Section 4 of Appendix F for aquifer tritium and vadose zone chloride. Information that can be gathered from the comparison curves includes an assessment of the model assumed Kd, the model assumed source concentration, and the impact of sampling field data at irregular intervals. For most of the vadose zone and aquifer comparison curves presented, there is relatively little field data available,

and the model predictions span a much larger period in time. As a result, the field data was often a single (or closely spaced pair) of data points plotted on curves spanning a much larger time period.

Presentation format for the vadose zone comparison curves consisted of the field data and three curves showing a) the center of the screened interval, b) the average of nine grid blocks centered vertically on the middle of the screened interval, and c) the grid block (of the seven) that most closely matched the peak concentration for the screened interval. Presentation of the model block representing the center of the screened interval is consistent with the presentation of the chloride calibration data. As opposed to the aquifer region, there are very sharp contrasts in concentration that exist across material (basalt to sediment) interfaces. This occurs because of adsorption that effectively lowers the pore water concentration because the mass is adsorbed to sediment units. Note that in the chloride calibration that was presented in Section 4.1 of Appendix F, this wasn't an issue because the chloride was assumed to be non-reactive (non-sorbing). Presenting an average concentration over several grid blocks centered on the screened interval allowed assessment of the relative difference in the magnitude of the concentration when the actual screened interval occurs in (or adjacent to) material property contrasts. The third curve represented the best fit match of the nine grid blocks to the field data simply based on the peak concentration during the time period during which the field data were collected. In cases where the screened interval fell near the center of a column of sediment grid blocks, the three curves were very similar. On the other hand, where the model screened interval was clearly in a basalt block, the average and screened interval curves typically overestimated the field data.

Presentation of the aquifer calibration curves is exactly like the presentation of the H-3 calibration curves shown in Section 4.2 of Appendix F. As with the vadose zone comparison curves, the aquifer comparison is difficult because of the three-dimensionality of the model. As a result of the third dimension, the concentration over time at various depths is not uniform. To illustrate the relative impact of the dimensionality, the concentration curves at well locations given by the field data, a depth averaged concentration (not flux averaged), and for every model depth was given. The depth averaged value was used as the basis of comparison to the field data rather than using the center of the screened interval because, in many cases, the depth of influence sampled during data collection was either unknown, or not perfectly aligned with sediment/basalt material types in the aquifer model.

The mass flux to the aquifer and peak concentrations in the vadose zone for each COPC for the entire aquifer region are given in Figures 6-3 through 6-42 below. It is important to note that the mass flux to the aquifer curves do not include the injection well flux to the aquifer. The curves are actually the mass flux out of the vadose zone model that is input to the aquifer model. This includes the injection well discharge only at times when the injection well failed and the service wastewater was disposed of directly to the deep vadose zone. The injection well discharges directly to the aquifer were incorporated separately in the aquifer model.

Figures 6-3 through 6-42 are included to illustrate when the bulk of the mass passes through to the aquifer from the vadose zone and to show when the aquifer concentrations peak and when they drop below MCLs or the 10^{-6} (HQ=1) risk based limits. In the peak concentration plots, the solid line represents predicted concentrations corresponding to the 10^{-6} or HQ=1 levels and should be compared to the left axis and the solid horizontal line representing the risk based level. The dotted lines in the peak concentration plots represent the predicted concentration corresponding to the MCL for each COPC and the horizontal dotted line represents that MCL.

The mass flux to the aquifer curves are primarily functions of the contaminant inventory, contaminant discharge location and time, water flux rate through the vadose zone, Kd, and radioactive decay rate. For example, in the Sr-90 mass flux to the aquifer curve (Figure 6-31), a very large activity inventory is assumed to be discharged at the surface (primarily the tank farm), but the early rise through the first local maximum (approximately year 2025) is due to the Sr-90 discharged to the deep vadose zone during time the injection well failed. The second rise is the arrival of the Sr-90 from the surface sources (from the tank farm). The drop in the year 2095 is because the percolation pond water is assumed to be turned off and the water velocities in the vadose zone decrease significantly. The last local maximum is the peak mass flux from the surface sources. There is an extremely large surface source activity of Sr-90 simulated, however, because Sr-90 has a relatively

large Kd (so it moves slowly through the vadose zone) and relatively short decay half-life, very little of the activity released at the surface is predicted to reach the aquifer.

Tables 6-1 and 6-2 present summaries of the initial COPCs inventories assumed to be discharged at each contaminant source. These tables are useful, but can be misleading (primarily because of radioactive decay in the vadose zone) for interpreting which sources contribute significantly to the peak concentrations in the aquifer. By analyzing the information in Tables 6-1 and 6-2, the mass flux to the aquifer plots, and the peak aquifer concentration plots (shown in Figures 6-4 through 6-42), the primary sources of the aquifer contamination at various time frames can be identified. Of the COPCs;

- contaminant discharges to the surface are the primary contributors to the aquifer peak concentrations and the discharges to the ICPP injection well are insignificant for arsenic, chromium (in the ICPP footprint), total Pu, and Tc-99. For these COPCs, the peak aquifer concentration curves are strongly correlated to the mass flux to the aquifer curves.
- contaminant discharges to the ICPP injection well are the primary contributors to the aquifer peak concentrations and surface discharges are insignificant for mercury, Co-60, Cs-137, H-3, I-129, Np-237, and Am-241. For these COPCs, there are is no correlation between the peak aquifer concentration curves and the mass flux to the aquifer curves, because the discharges to the ICPP injection well are not included in the mass flux to the aquifer curves.
- contaminant discharges to both the injection well and surface are significant contributors to the aquifer peak concentrations for Sr-90 and Total U. Therefore, the peak concentration curve is a composite of the aquifer response to the injection well discharges in early time and the mass flux to the aquifer curve (from the time of the failed injection well and surface sources) in later time.

Summaries of the results shown in the peak aquifer concentration plots are presented in Tables 6-4 through 6-9 below.

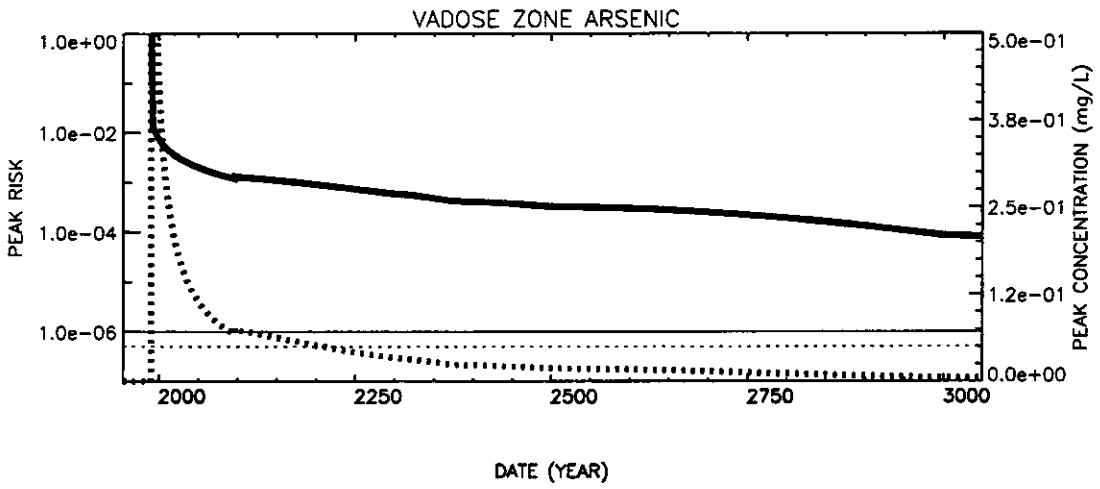

Figure 6-3 Peak vadose zone risk and concentration for arsenic. Risk indicated by the thick line on the log scale with the 10^{-6} value shown as the solid line. The dotted line represents concentration given by the linear scale on the right axis with the MCL shown as the straight horizontal line.

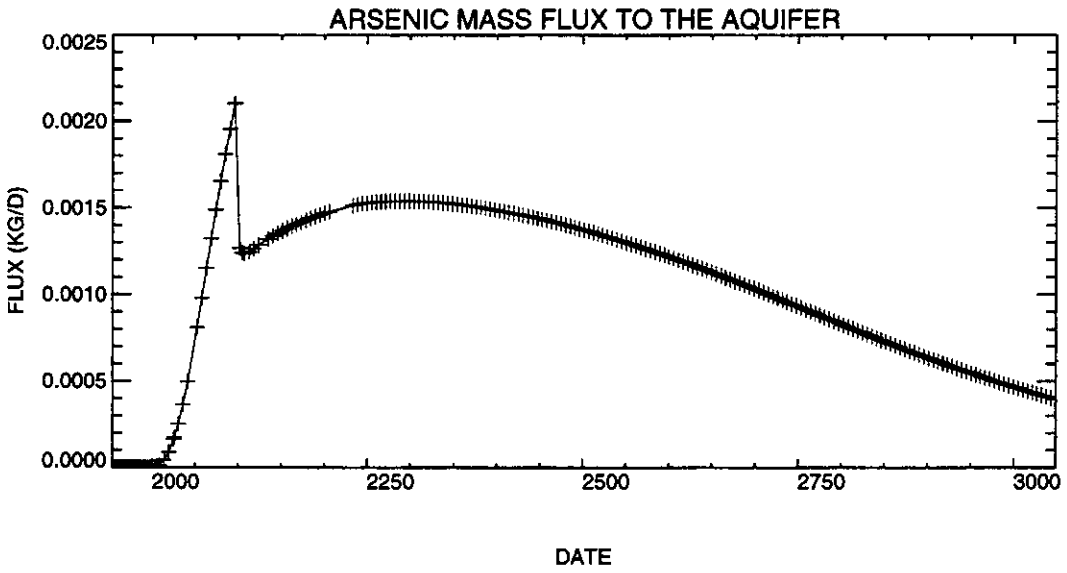

Figure 6-4 Mass flux of arsenic into the aquifer from the vadose zone.

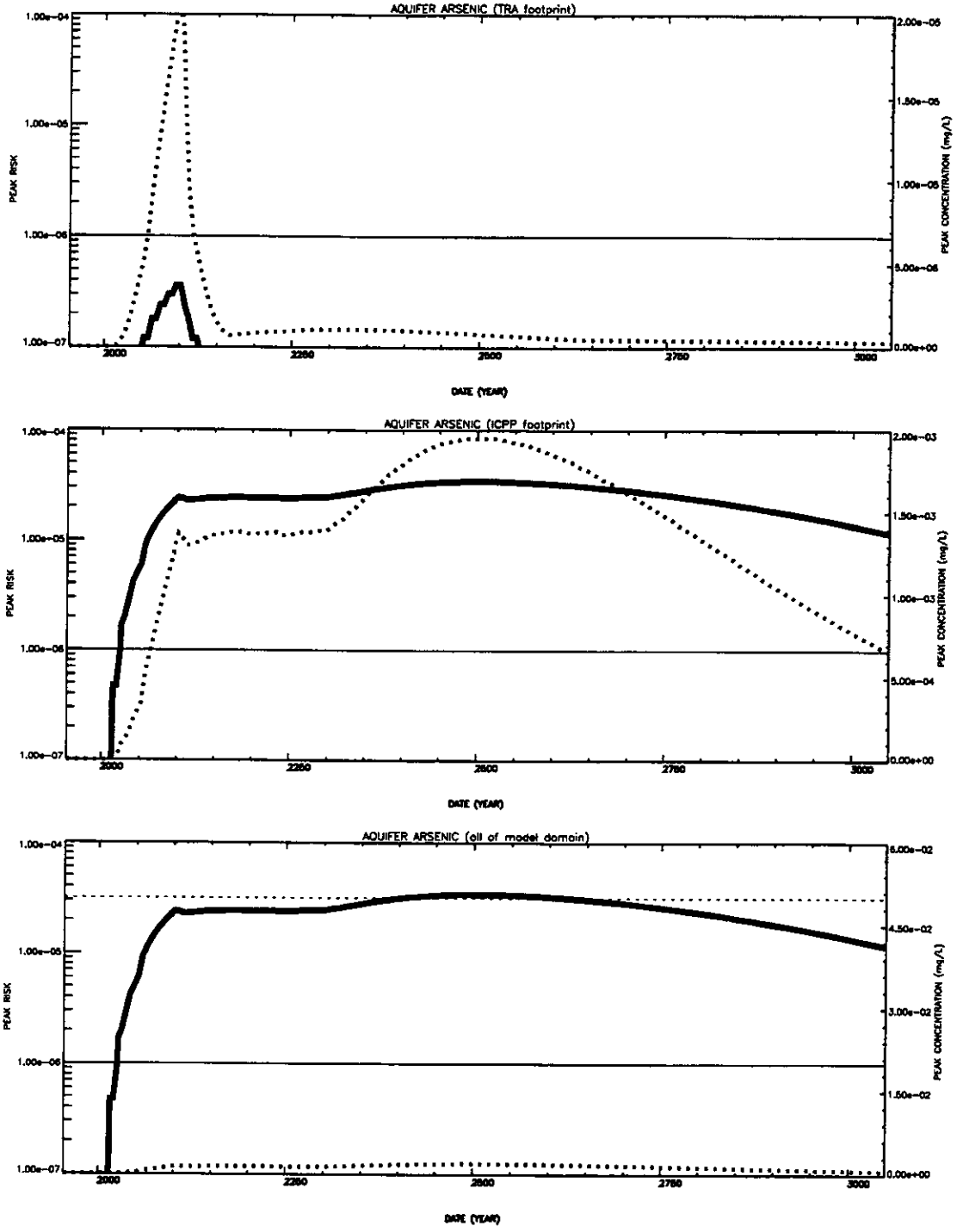

Figure 6-5 Peak aquifer concentration for arsenic. Top figure: TRA foot print, Middle figure: ICPP footprint, Bottom Figure: entire aquifer domain. Thick line risk (left scale), dotted line concentration (right scale) solid line 10^{-6} risk (left scale).

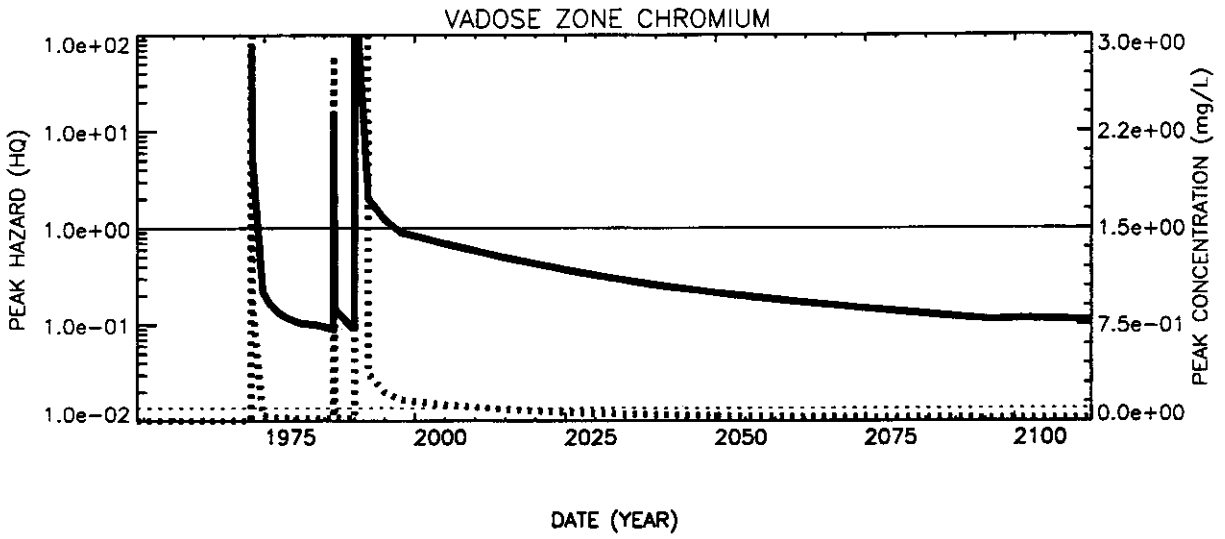

Figure 6-6 Peak vadose zone hazard quotient and concentration for chromium. HQ indicated by the thick line on the log scale with the HQ=1 value shown as the solid line. The dotted line represents concentration given by the linear scale on the right axis with the MCL shown as the straight horizontal line.

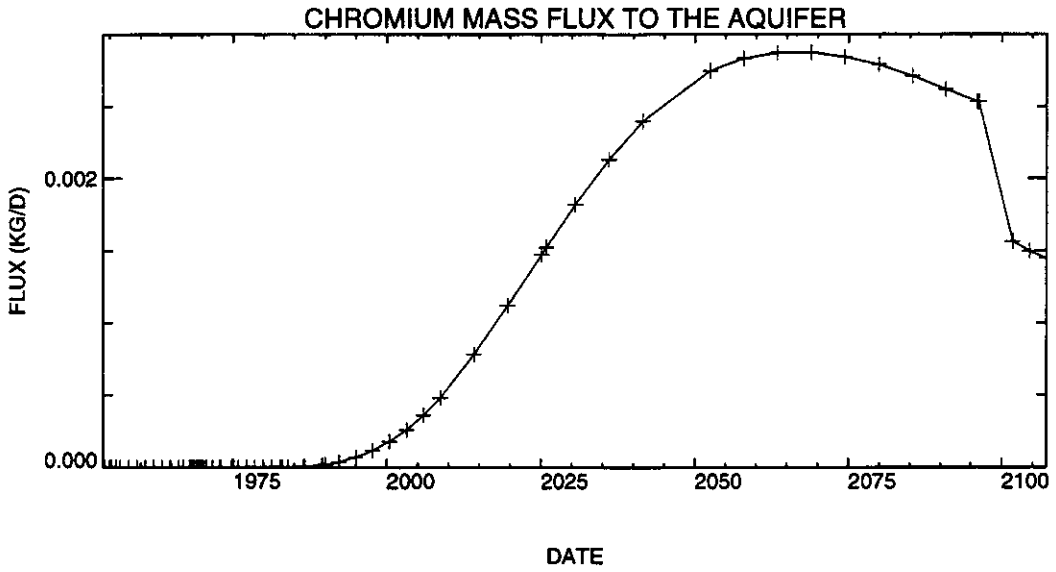

Figure 6-7 Mass flux of chromium into the aquifer from the vadose zone.

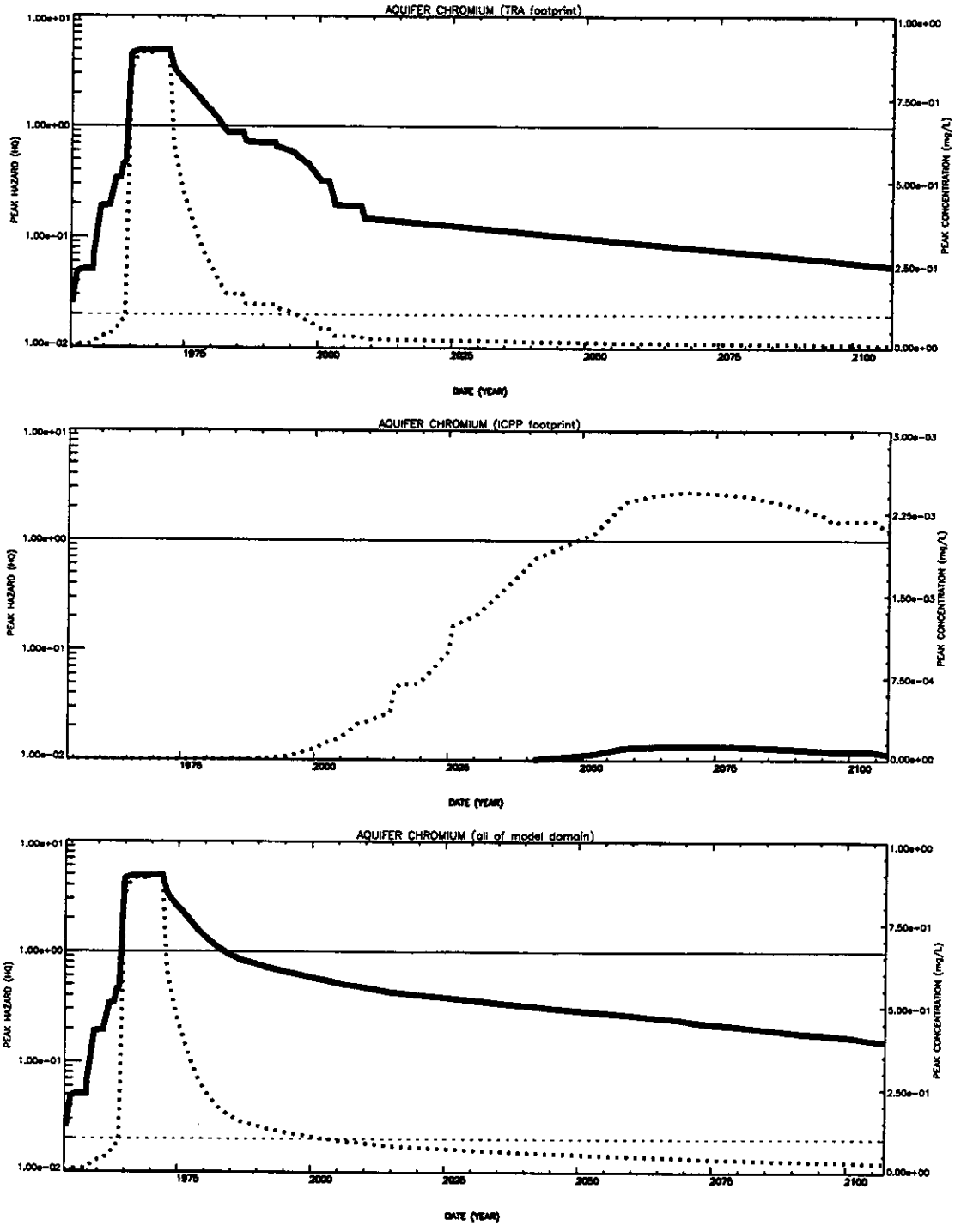

Figure 6-8 Peak aquifer concentration for chromium. Top figure: TRA foot print, Middle figure: ICPP footprint, Bottom Figure: entire aquifer domain. Thick line risk (left scale), dotted line concentration (right scale) solid line 10^{-6} risk (left scale).

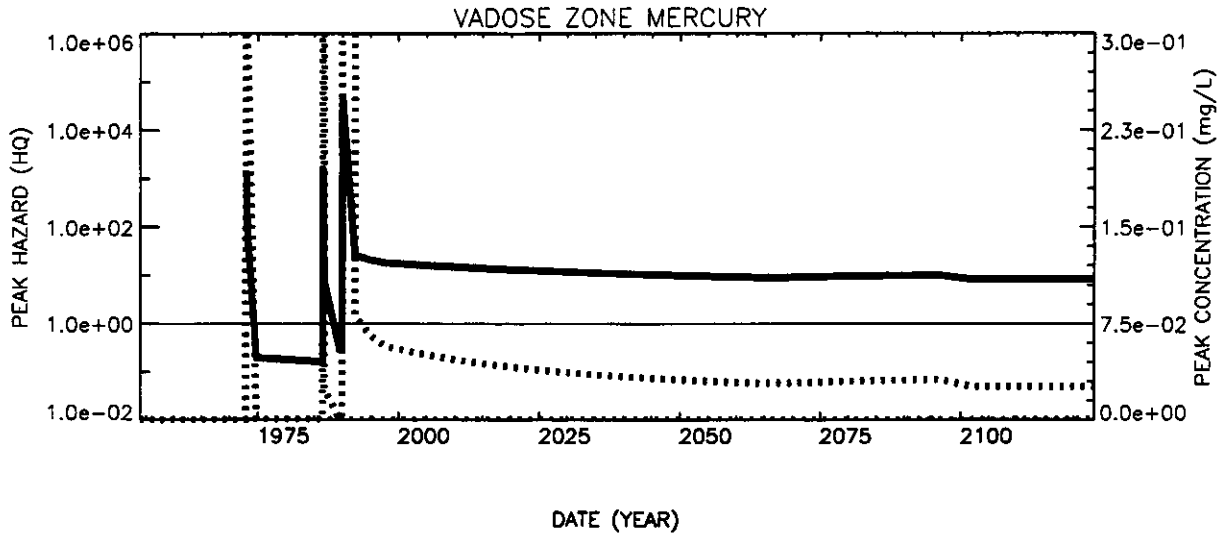

Figure 6-9 Peak vadose zone risk and concentration for mercury. Risk indicated by the thick line on the log scale with the 10^{-6} value shown as the solid line. The dotted line represents concentration given by the linear scale on the right axis with the MCL shown as the straight horizontal line.

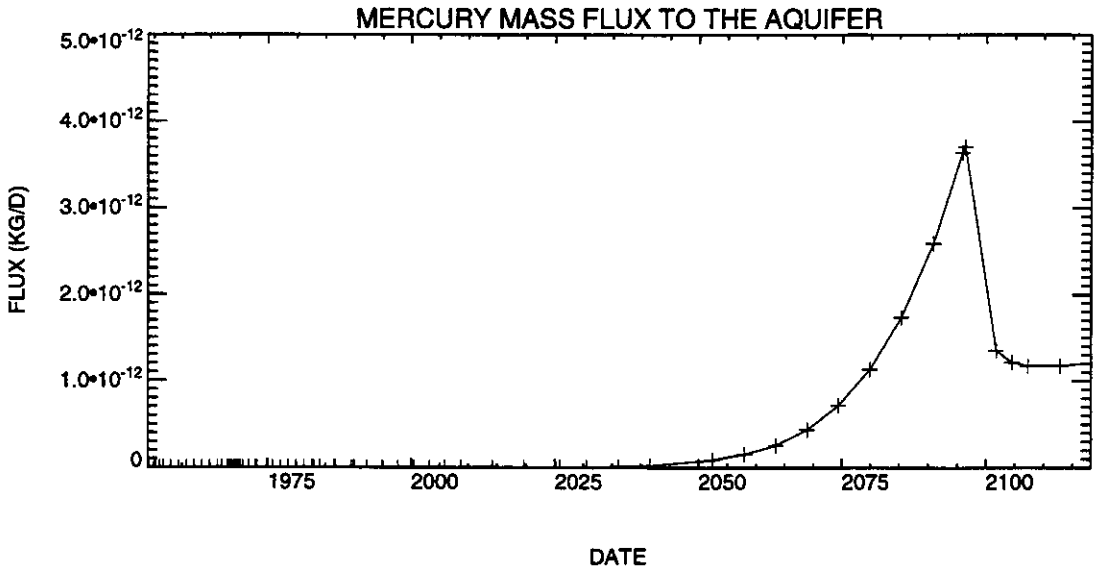

Figure 6-10 Mass flux of mercury into the aquifer from the vadose zone.

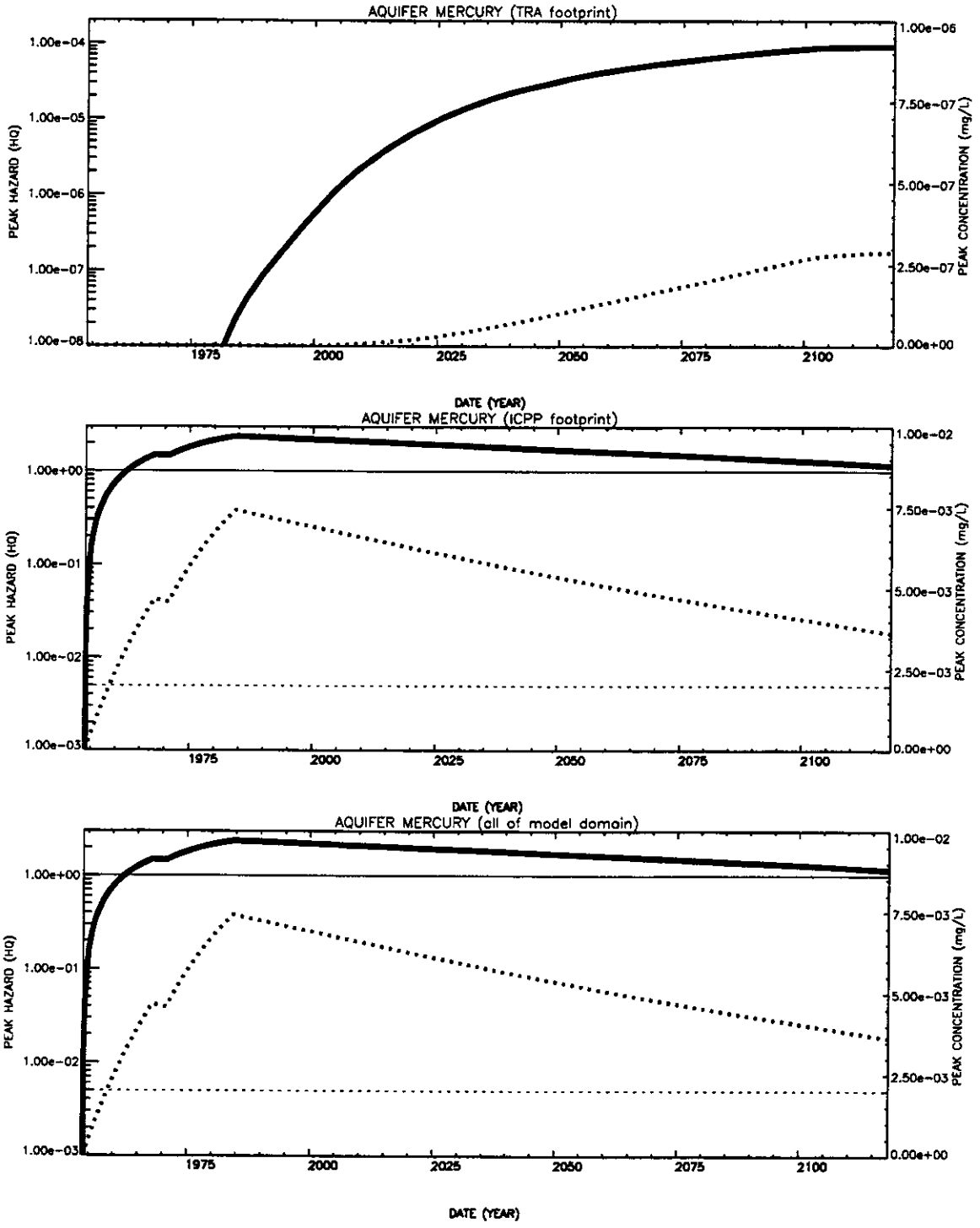

Figure 6-11 Peak aquifer concentration for mercury. Top figure: TRA foot print, Middle figure: ICPP footprint, Bottom Figure: entire aquifer domain. Thick line risk (left scale), dotted line concentration (right scale) solid line 10^{-6} risk (left scale).

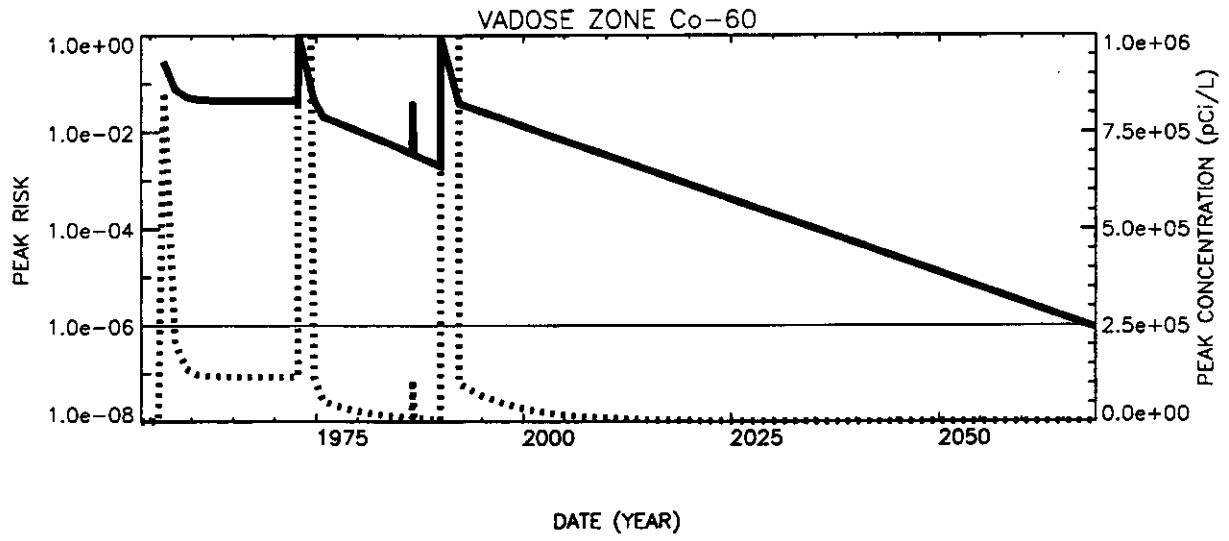

Figure 6-12 Peak vadose zone risk and concentration for Co-60. Risk indicated by the thick line on the log scale with the 10^{-6} value shown as the solid line. The dotted line represents concentration given by the linear scale on the right axis with the MCL (100 pCi/L) shown as the straight horizontal line.

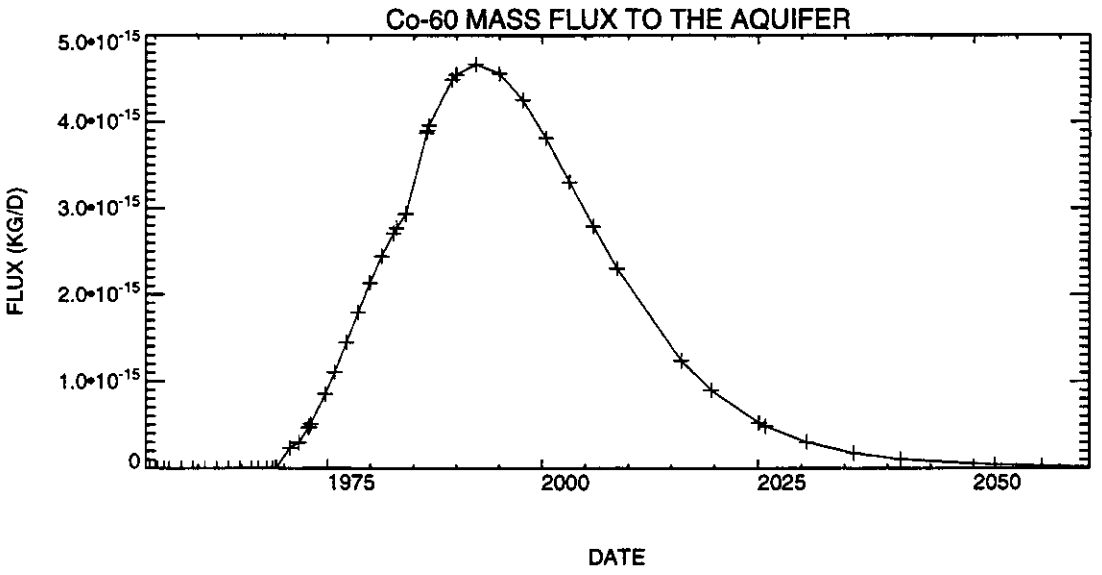

Figure 6-13 Mass flux of Co-60 into the aquifer from the vadose zone.

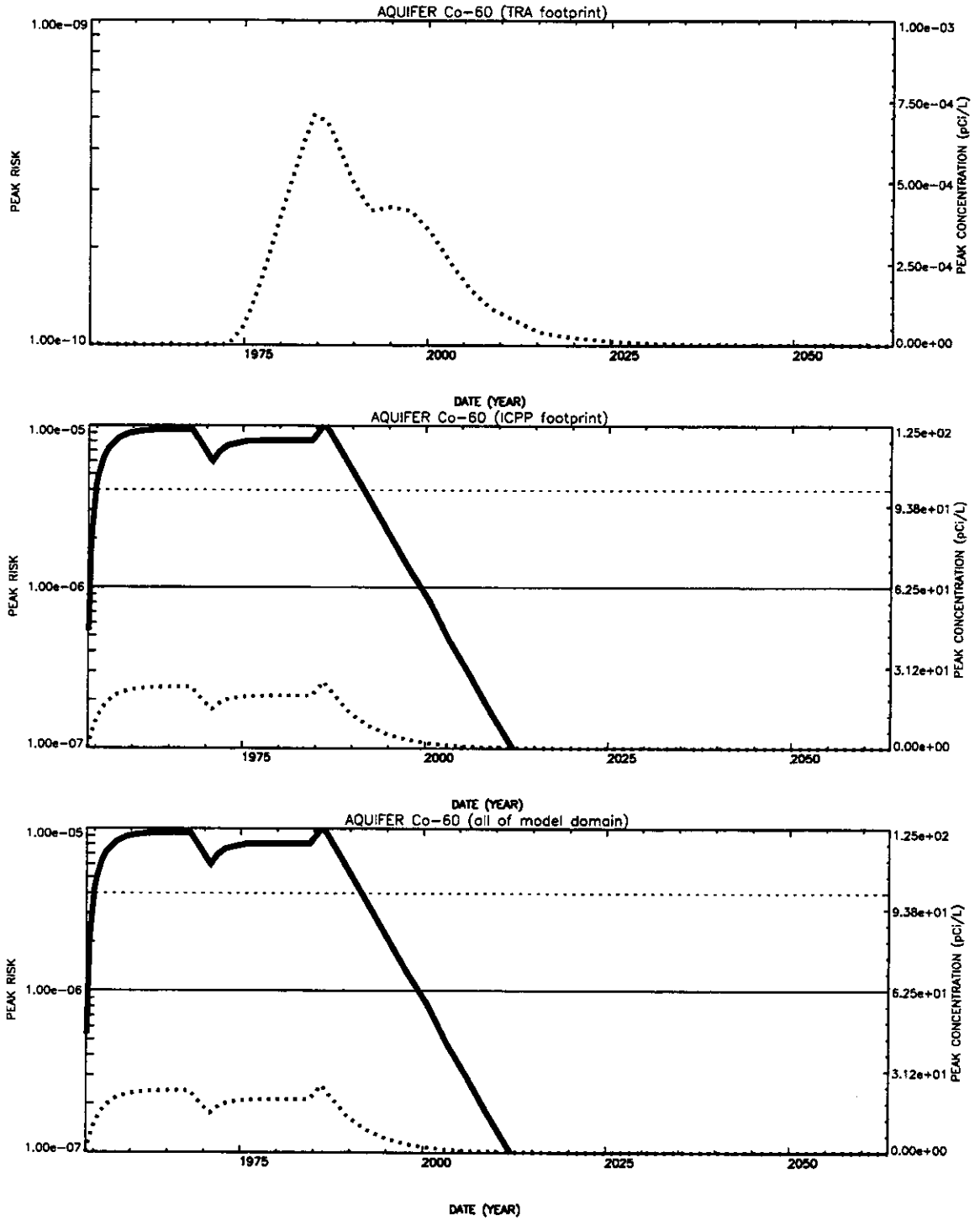

Figure 6-14 Peak aquifer concentration for Co-60. Top figure: TRA foot print, Middle figure: ICPP footprint, Bottom Figure: entire aquifer domain. Thick line risk (left scale), dotted line concentration (right scale) solid line 10^{-6} risk (left scale).

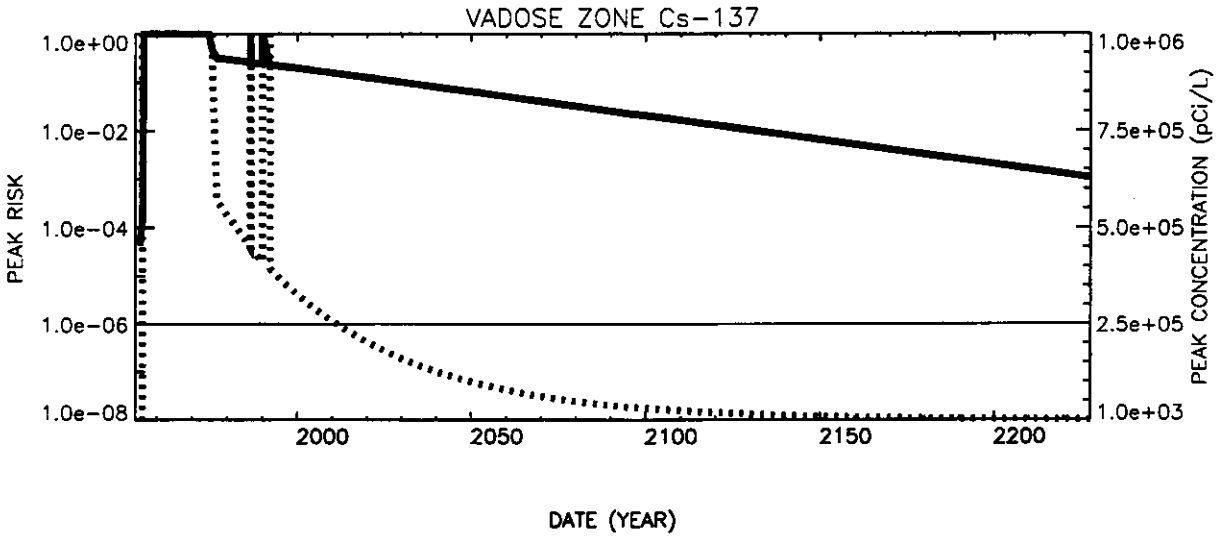

Figure 6-15 Peak vadose zone risk and concentration for Cs-137. Risk indicated by the thick line on the log scale with the 10^{-6} value shown as the solid line. The dotted line represents concentration given by the linear scale on the right axis with the MCL shown as the straight horizontal line.

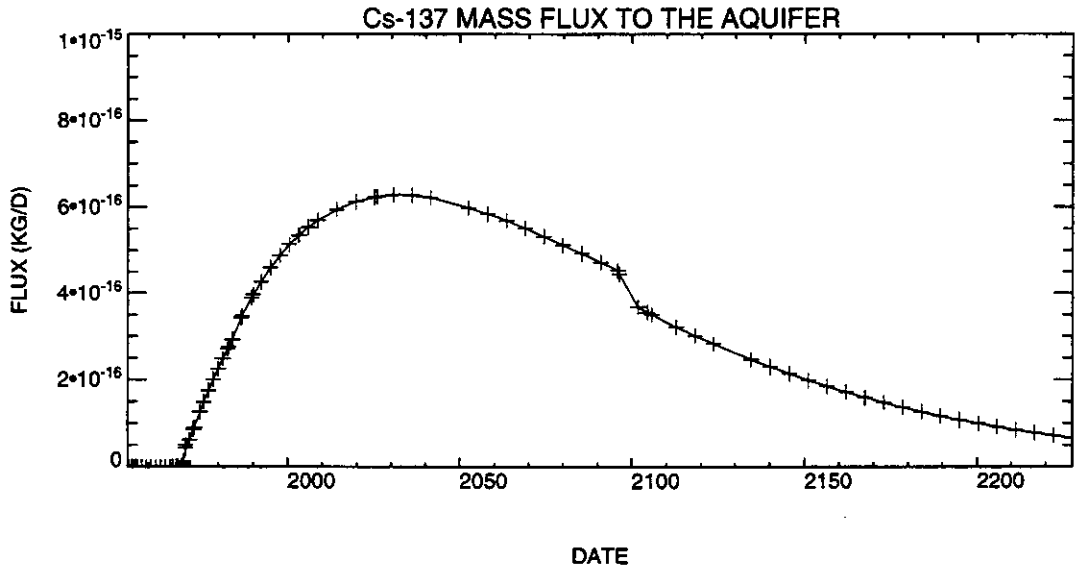

Figure 6-16 Mass flux of Cs-137 into the aquifer from the vadose zone.

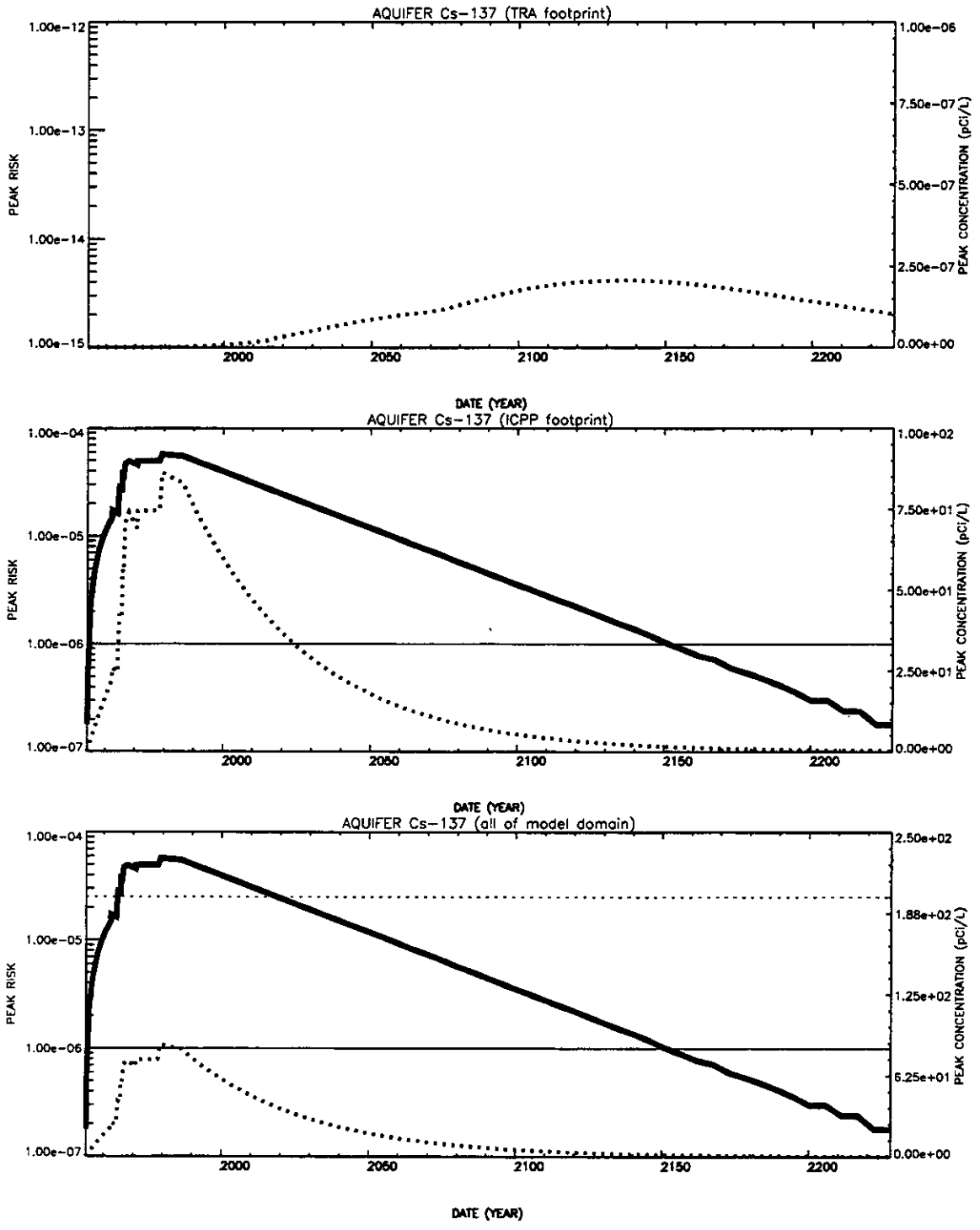

Figure 6-17 Peak aquifer concentration for Cs-137. Top figure: TRA foot print, Middle figure: ICPP footprint, Bottom Figure: entire aquifer domain. Thick line risk (left scale), dotted line concentration (right scale) solid line 10^{-6} risk (left scale).

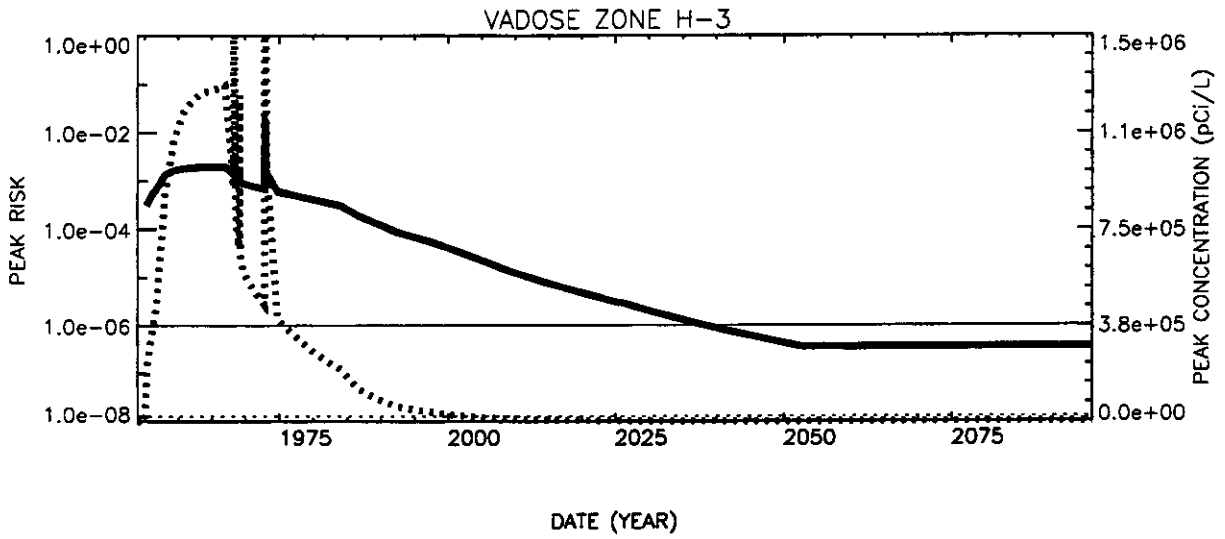

Figure 6-18 Peak vadose zone risk and concentration for H-3. Risk indicated by the thick line on the log scale with the 10^{-6} value shown as the solid line. The dotted line represents concentration given by the linear scale on the right axis with the MCL shown as the straight horizontal line.

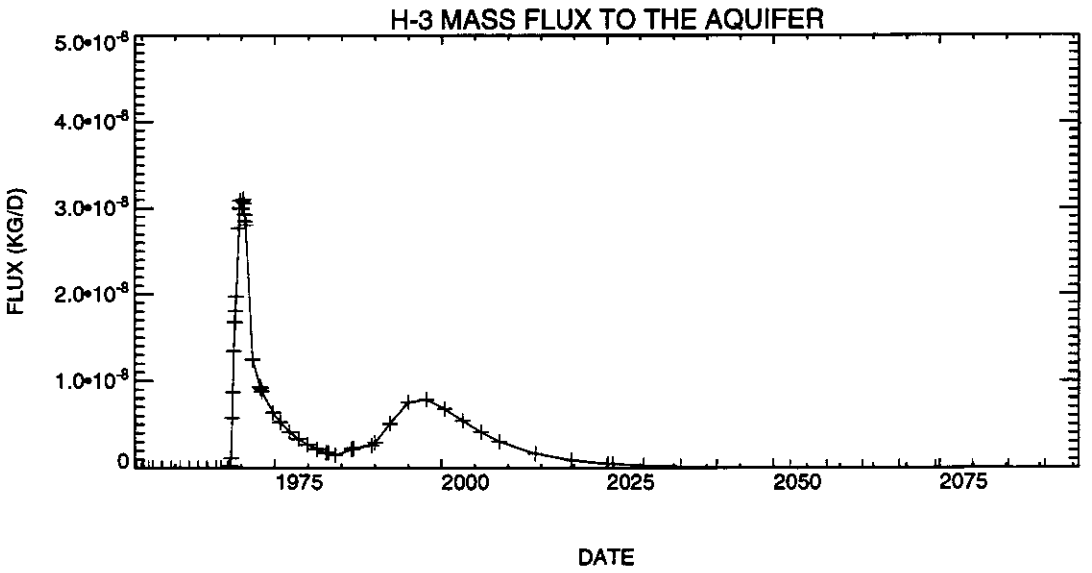

Figure 6-19 Mass flux of H-3 into the aquifer from the vadose zone.

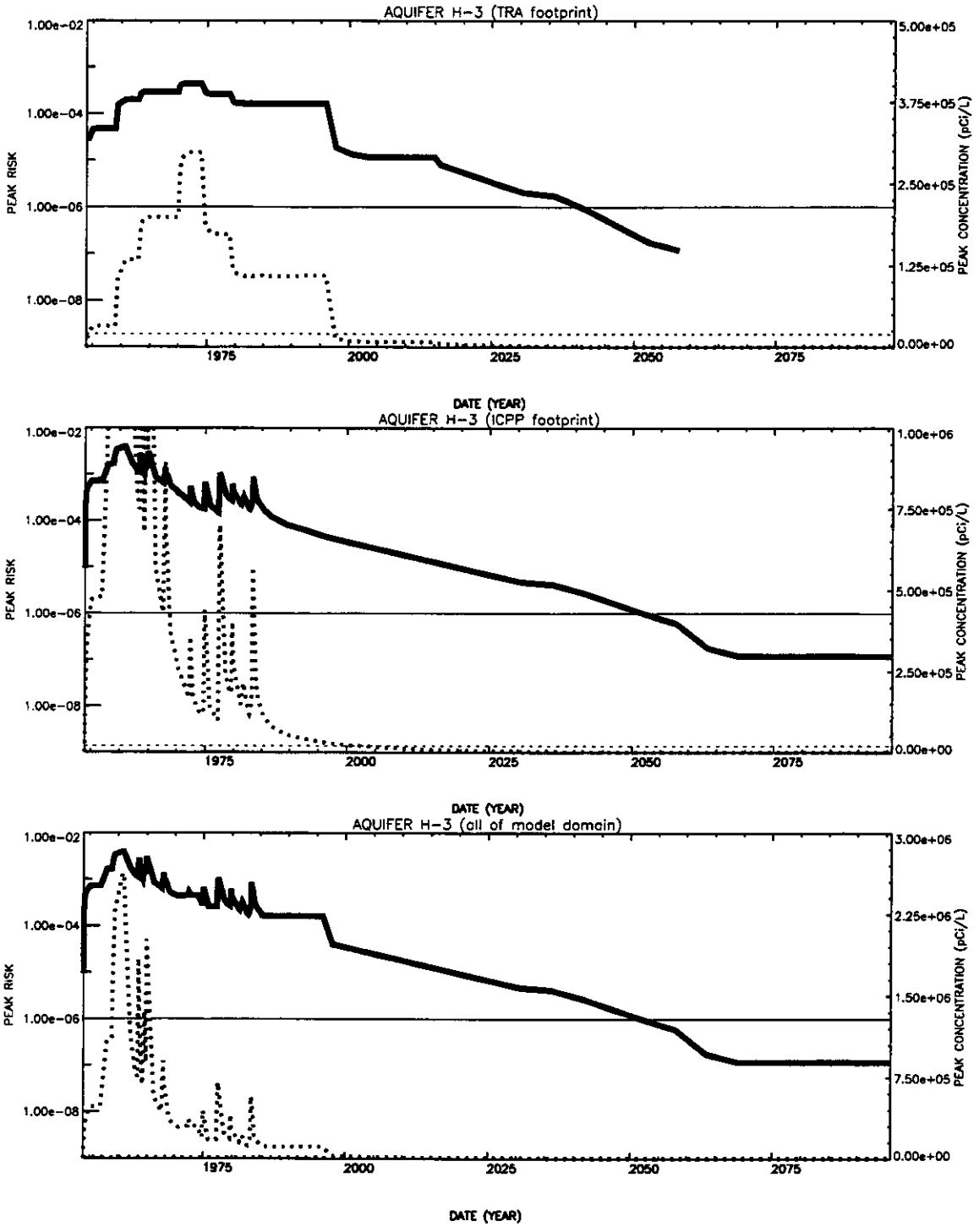

Figure 6-20 Peak aquifer concentration for H-3. Top figure: TRA foot print, Middle figure: ICPP footprint, Bottom Figure: entire aquifer domain. Thick line risk (left scale), dotted line concentration (right scale) solid line 10^{-6} risk (left scale).

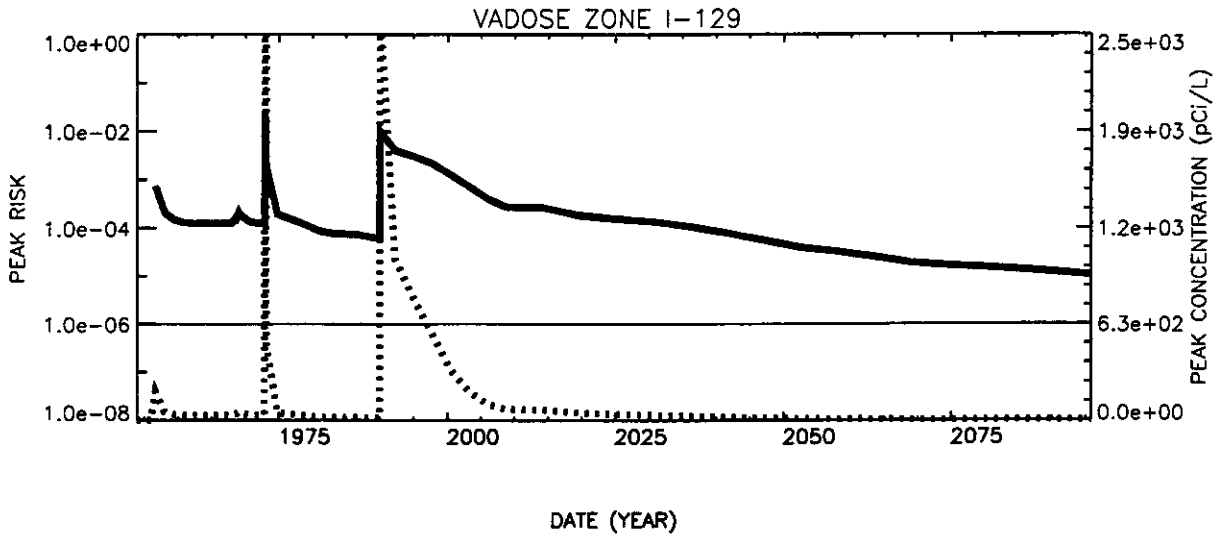

Figure 6-21 Peak vadose zone risk and concentration for I-129. Risk indicated by the thick line on the log scale with the 10^{-6} value shown as the solid line. The dotted line represents concentration given by the linear scale on the right axis with the MCL (1 pCi/L) shown as the straight horizontal line.

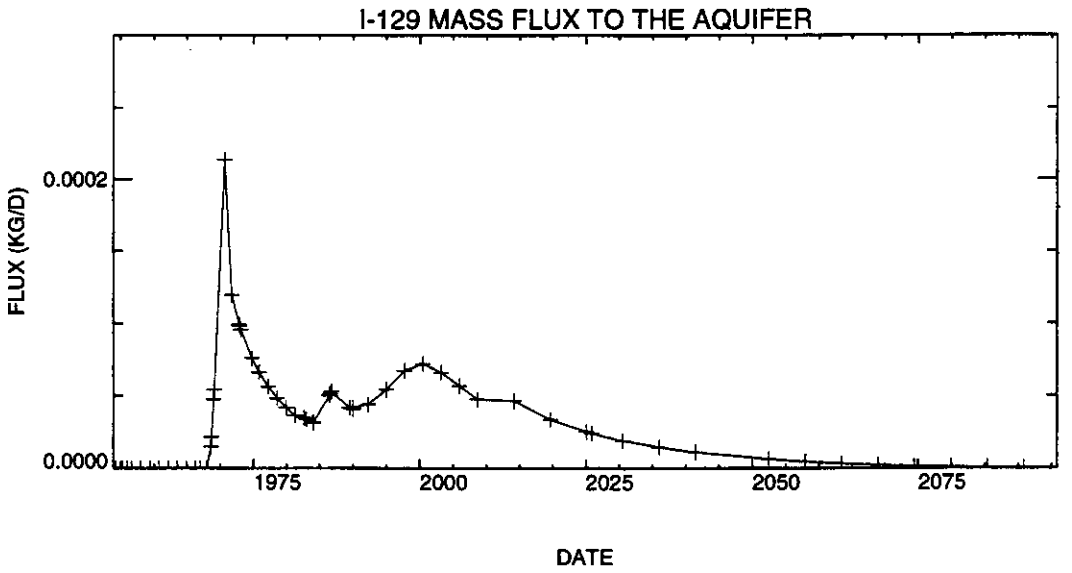

Figure 6-22 Mass flux of I-129 into the aquifer from the vadose zone.

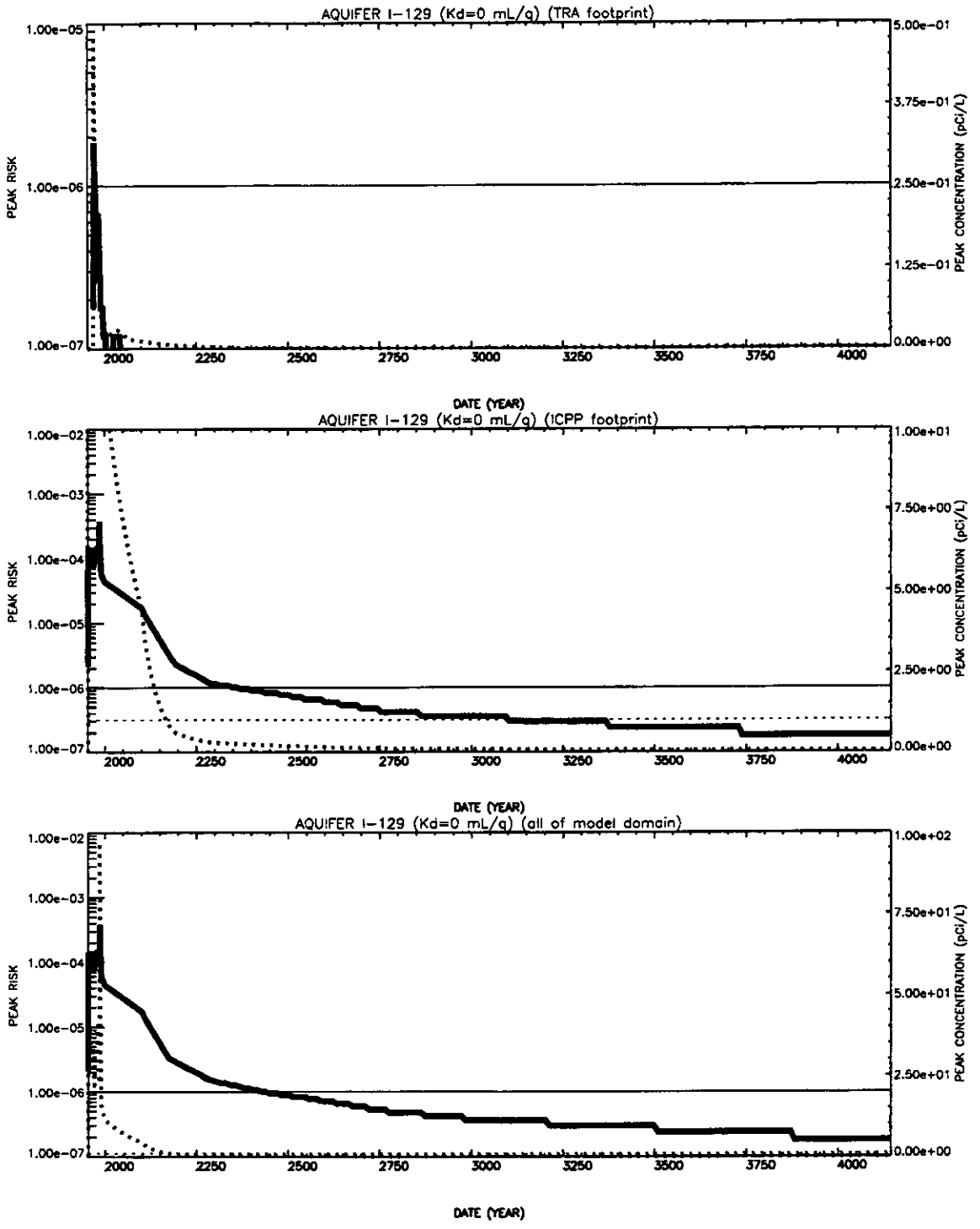

Figure 6-23 Peak aquifer concentration for I-129. Top figure: TRA foot print, Middle figure: ICPP footprint, Bottom Figure: entire aquifer domain. Thick line risk (left scale), dotted line concentration (right scale) solid line 10^{-6} risk (left scale).

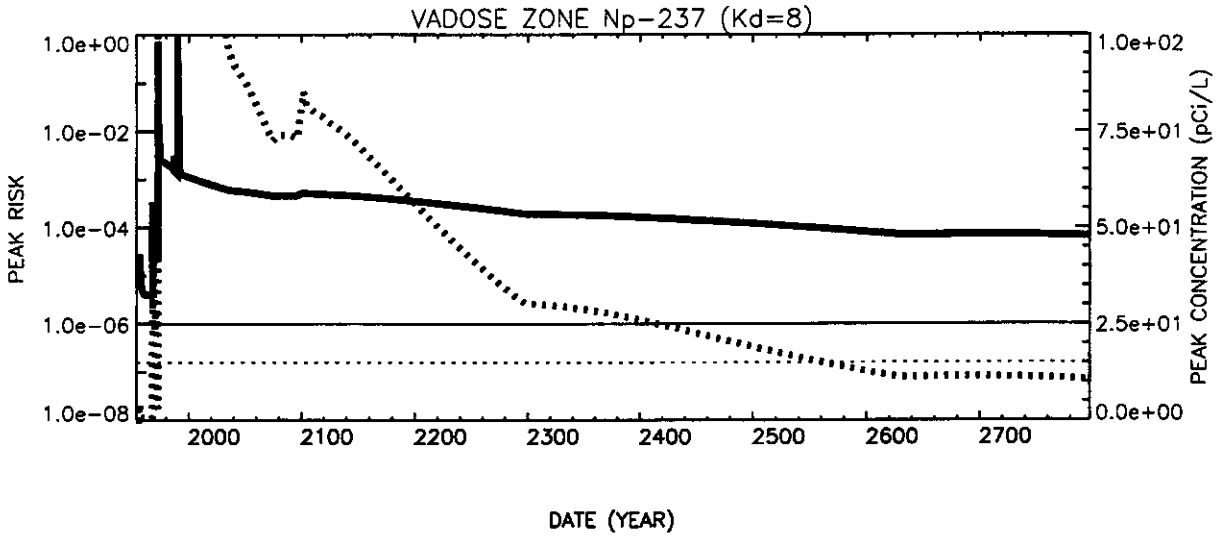

Figure 6-24 Peak vadose zone risk and concentration for Np-237. Risk indicated by the thick line on the log scale with the 10^{-6} value shown as the solid line. The dotted line represents concentration given by the linear scale on the right axis with the MCL shown as the straight horizontal line.

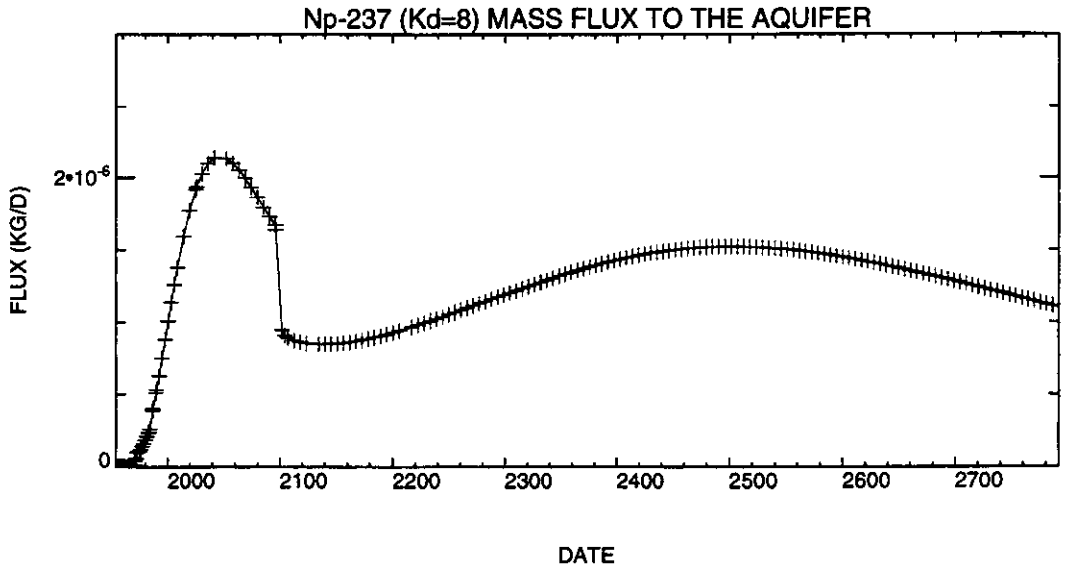

Figure 6-25 Mass flux of Np-237 into the aquifer from the vadose zone.

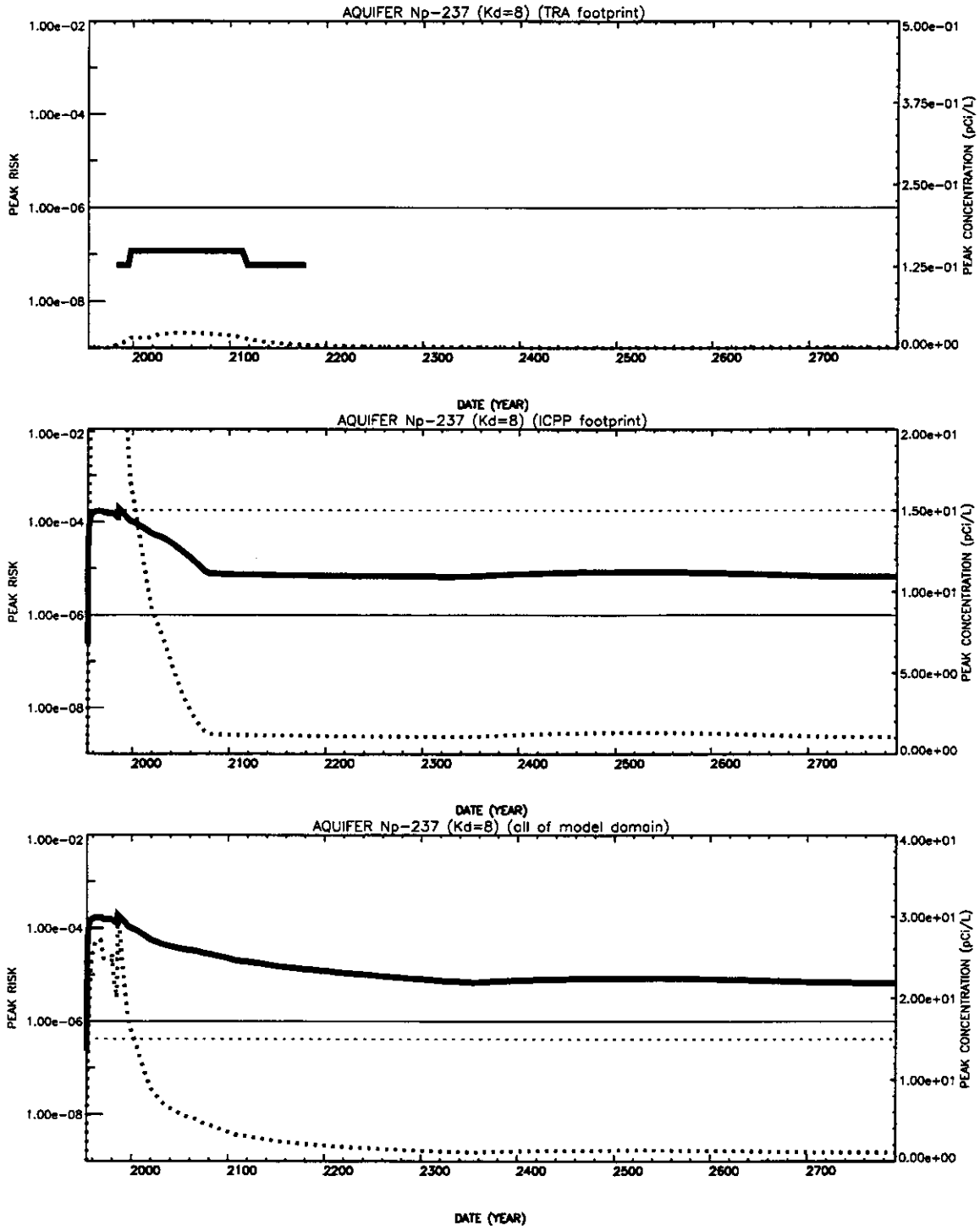

Figure 6-26 Peak aquifer concentration for Np-237. Top figure: TRA foot print, Middle figure: ICPP footprint, Bottom Figure: entire aquifer domain. Thick line risk (left scale), dotted line concentration (right scale) solid line 10^{-6} risk (left scale).

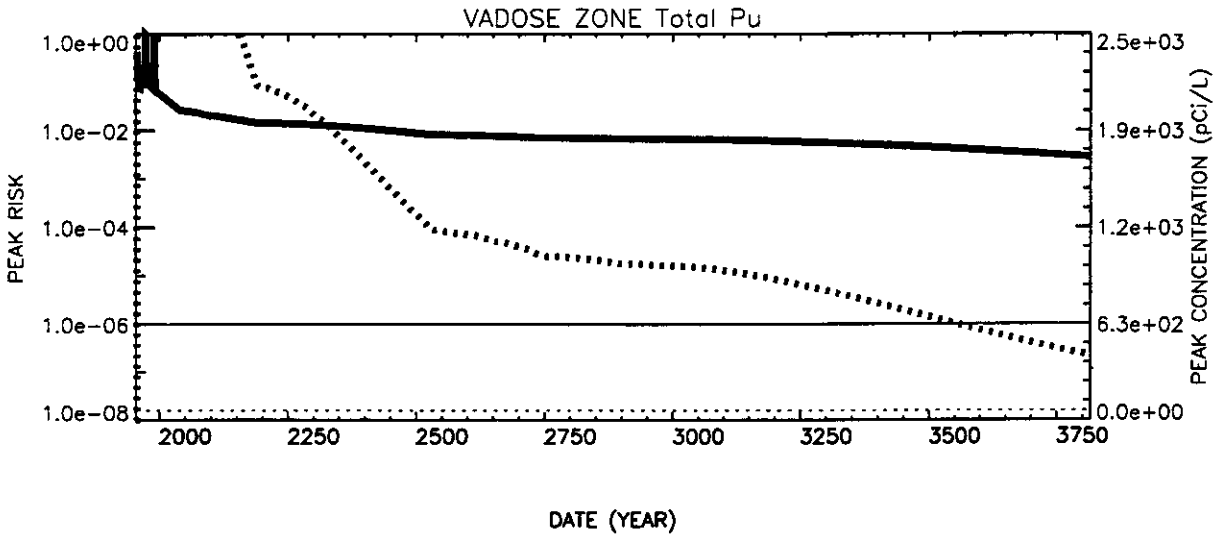

Figure 6-27 Peak vadose zone risk and concentration for Pu. Risk indicated by the thick line on the log scale with the 10^{-6} value shown as the solid line. The dotted line represents concentration given by the linear scale on the right axis with the MCL shown as the straight horizontal line.

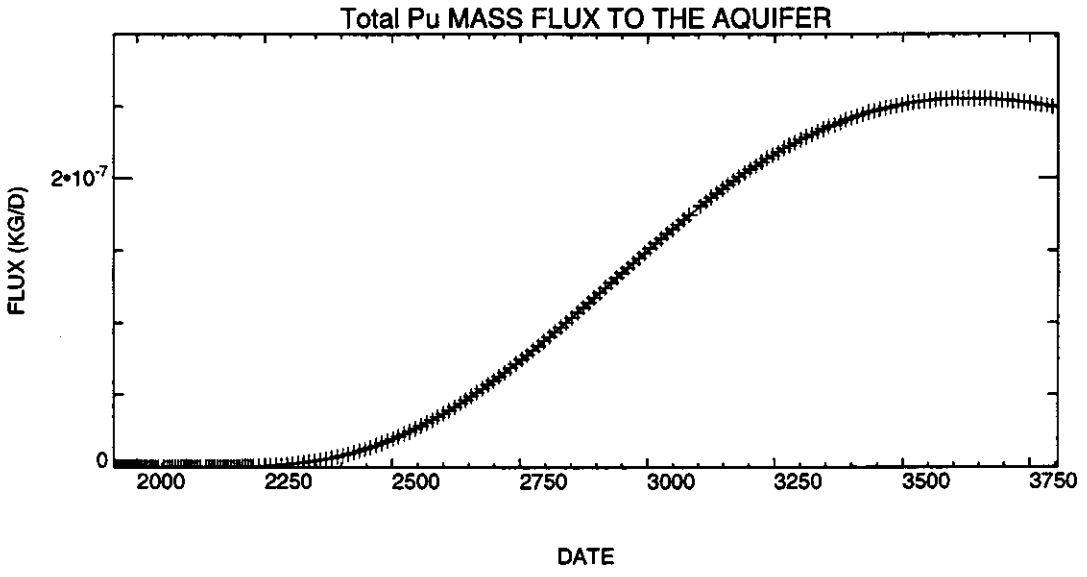

Figure 6-28 Mass flux of Pu into the aquifer from the vadose zone.

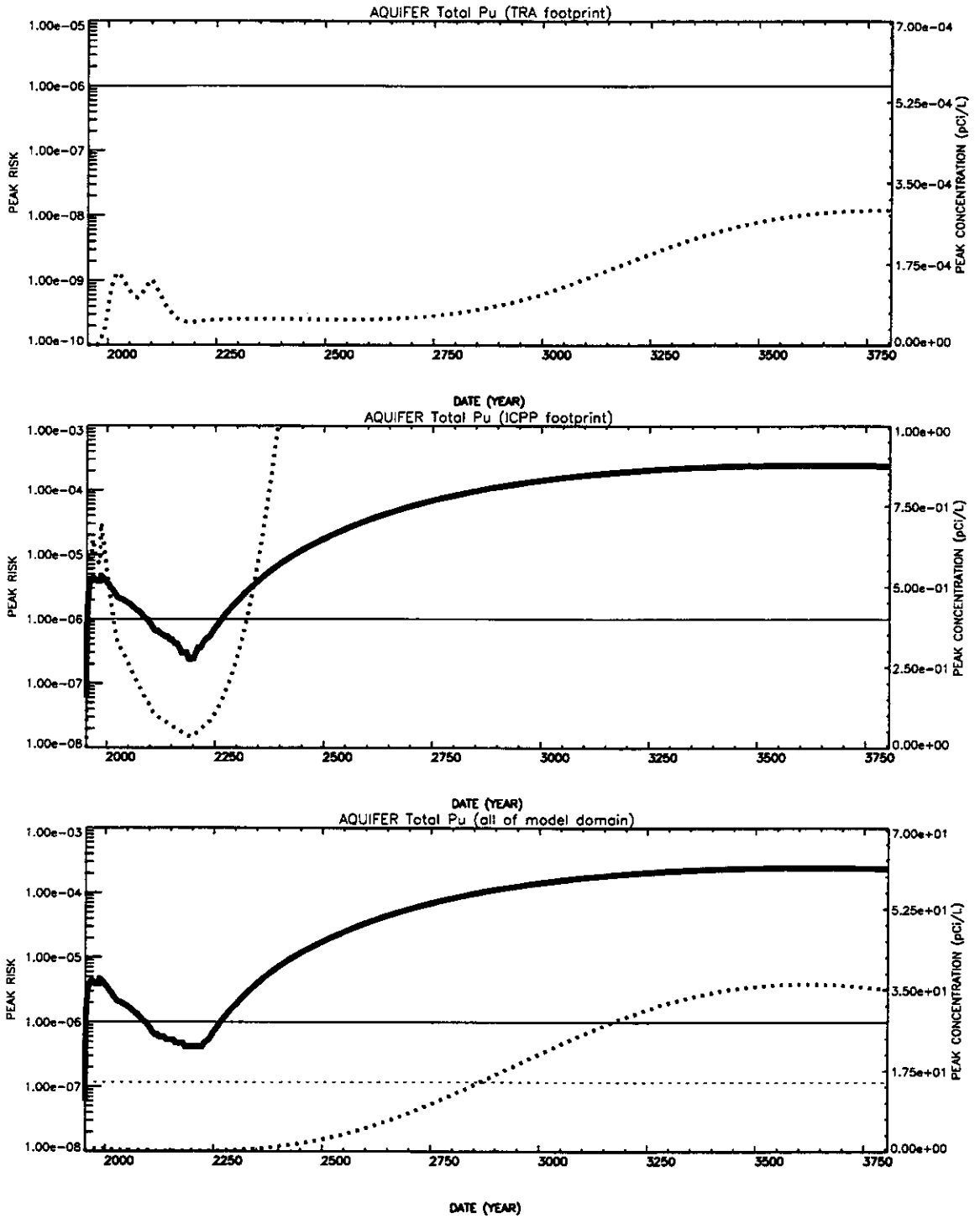

Figure 6-29 Peak aquifer concentration for Pu. Top figure: TRA foot print, Middle figure: ICPP footprint, Bottom Figure: entire aquifer domain. Thick line risk (left scale), dotted line concentration (right scale) solid line 10^{-6} risk (left scale).

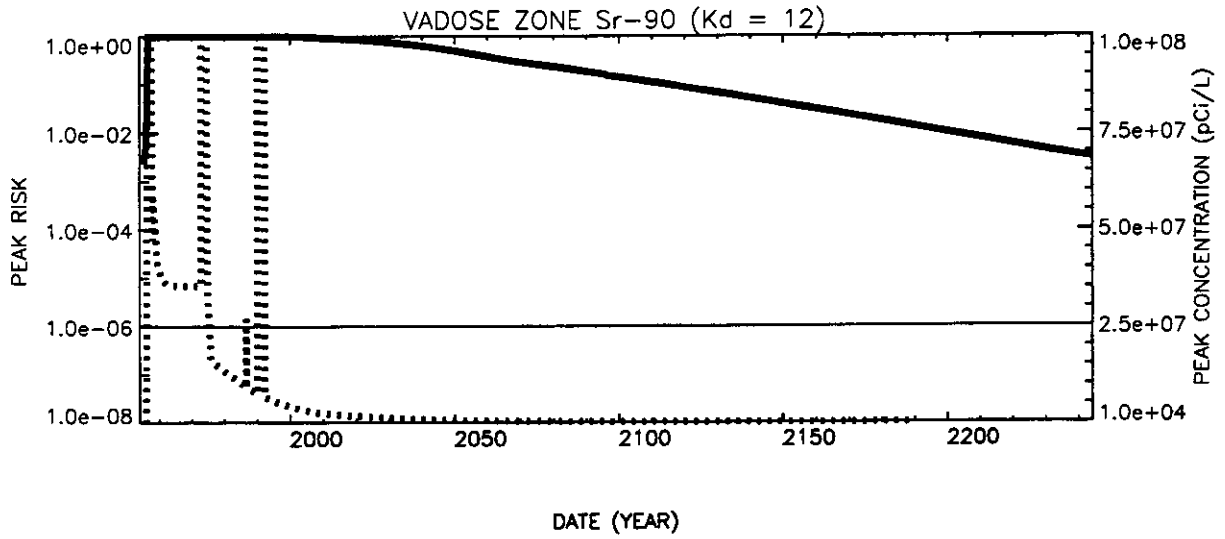

Figure 6-30 Peak vadose zone risk and concentration for Sr-90. Risk indicated by the thick line on the log scale with the 10^{-6} value shown as the solid line. The dotted line represents concentration given by the linear scale on the right axis. The MCL = 8 pCi/L.

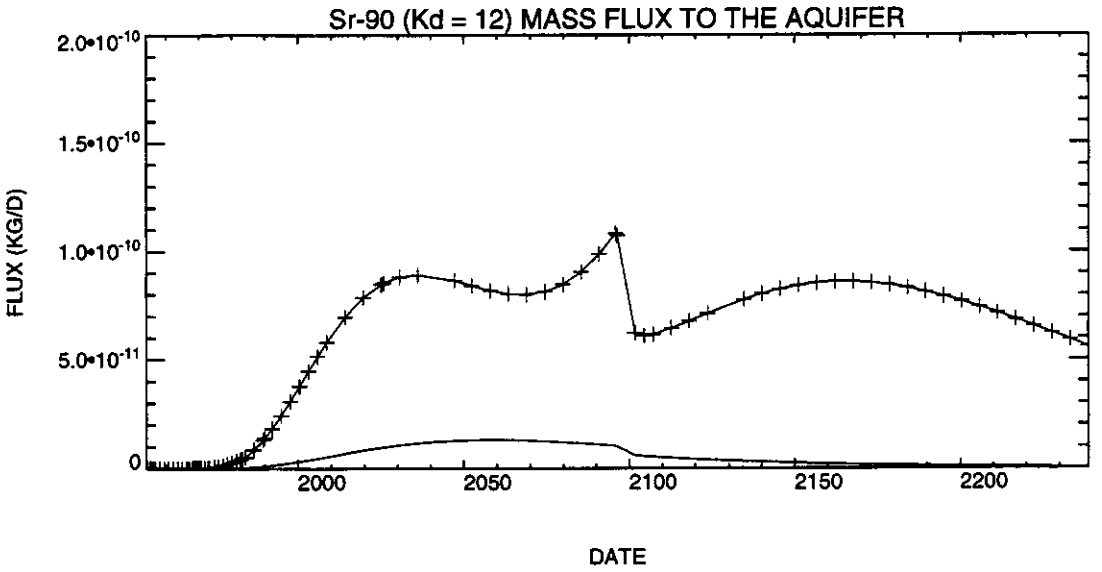

Figure 6-31 Mass flux of Sr-90 into the aquifer from the vadose zone. The solid line is the mass flux for the Sr-90 sensitivity simulation with a Kd=24 cm^3/g.

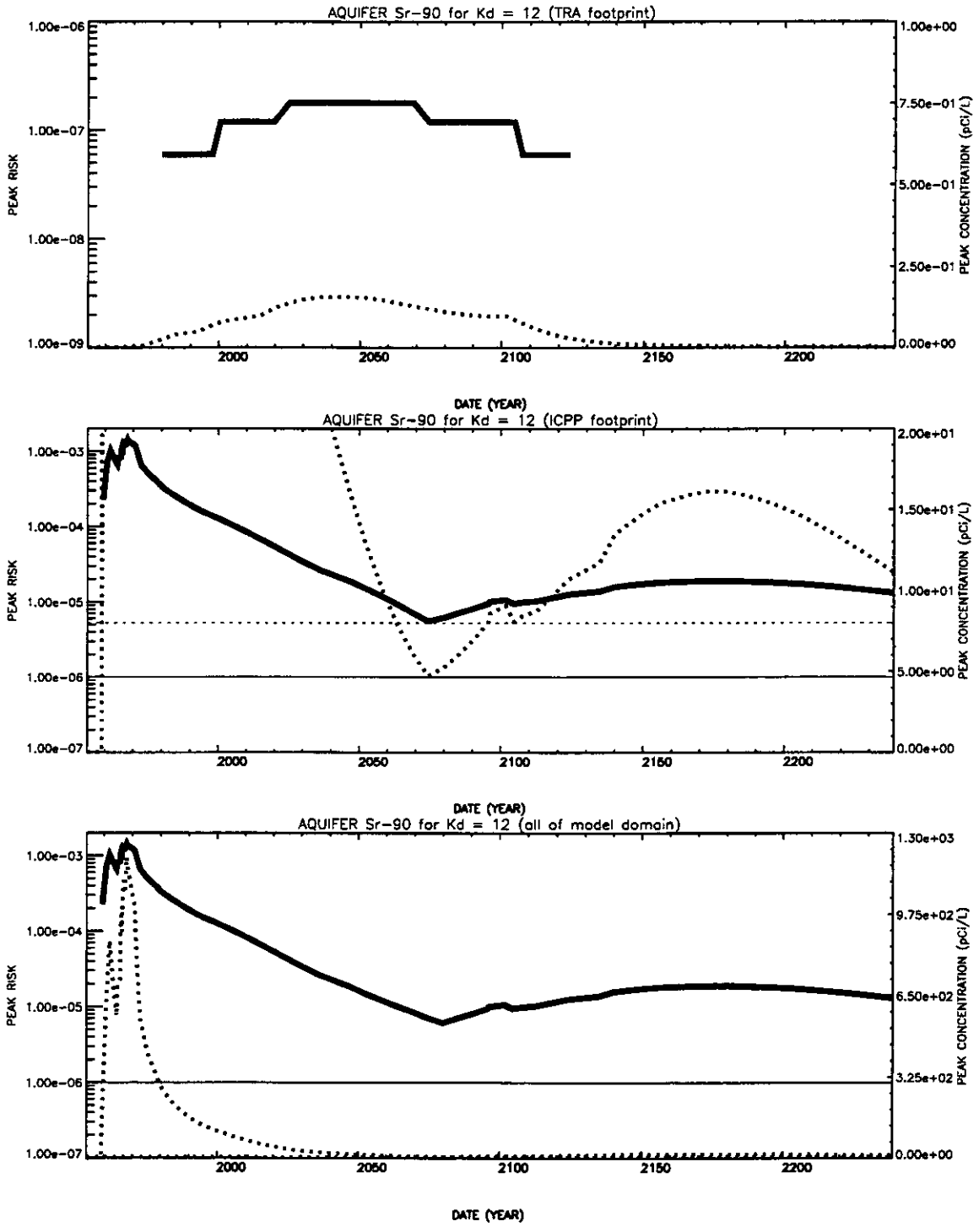

Figure 6-32 Peak aquifer concentration for Sr-90. Top figure: TRA foot print, Middle figure: ICPP footprint, Bottom Figure: entire aquifer domain. Thick line risk (left scale), dotted line concentration (right scale) solid line 10^{-6} risk (left scale).

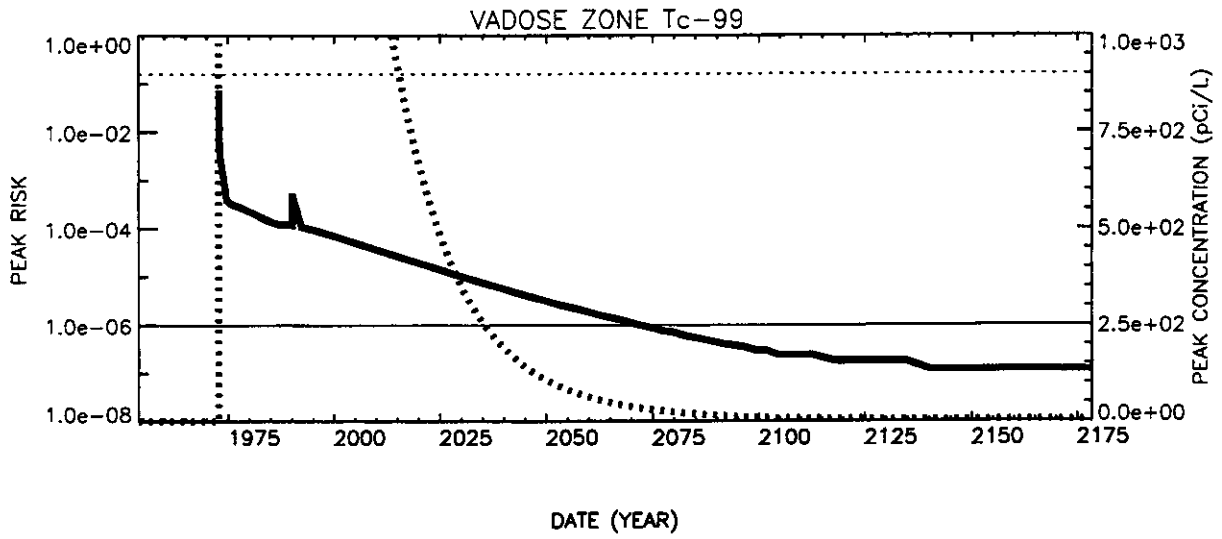

Figure 6-33 Peak vadose zone risk and concentration for Tc-99. Risk indicated by the thick line on the log scale with the 10^{-6} value shown as the solid line. The dotted line represents concentration given by the linear scale on the right axis with the MCL shown as the straight horizontal line.

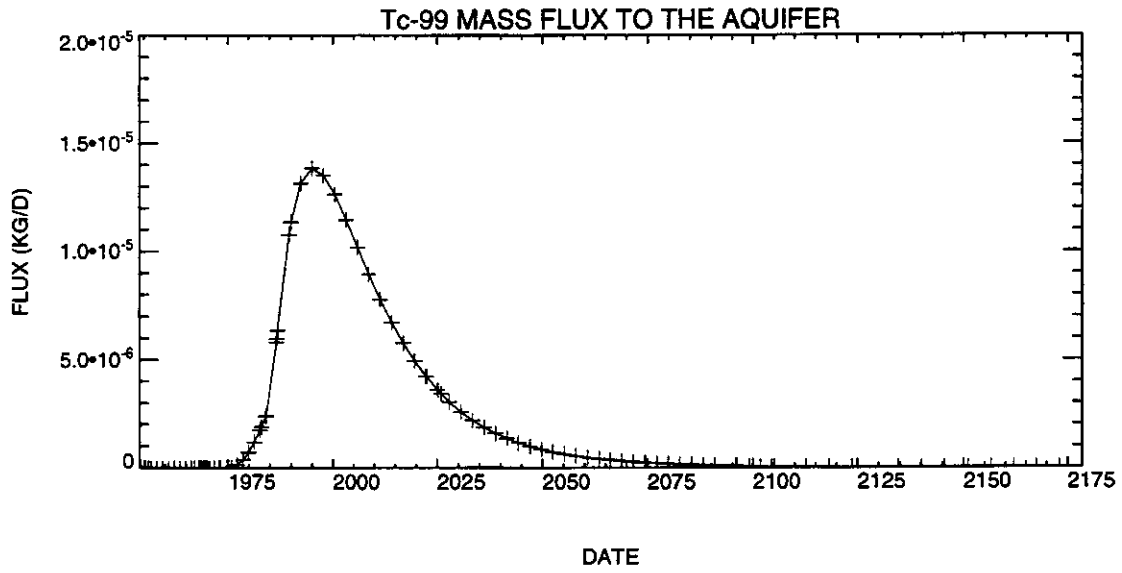

Figure 6-34 Mass flux of Tc-99 into the aquifer from the vadose zone.

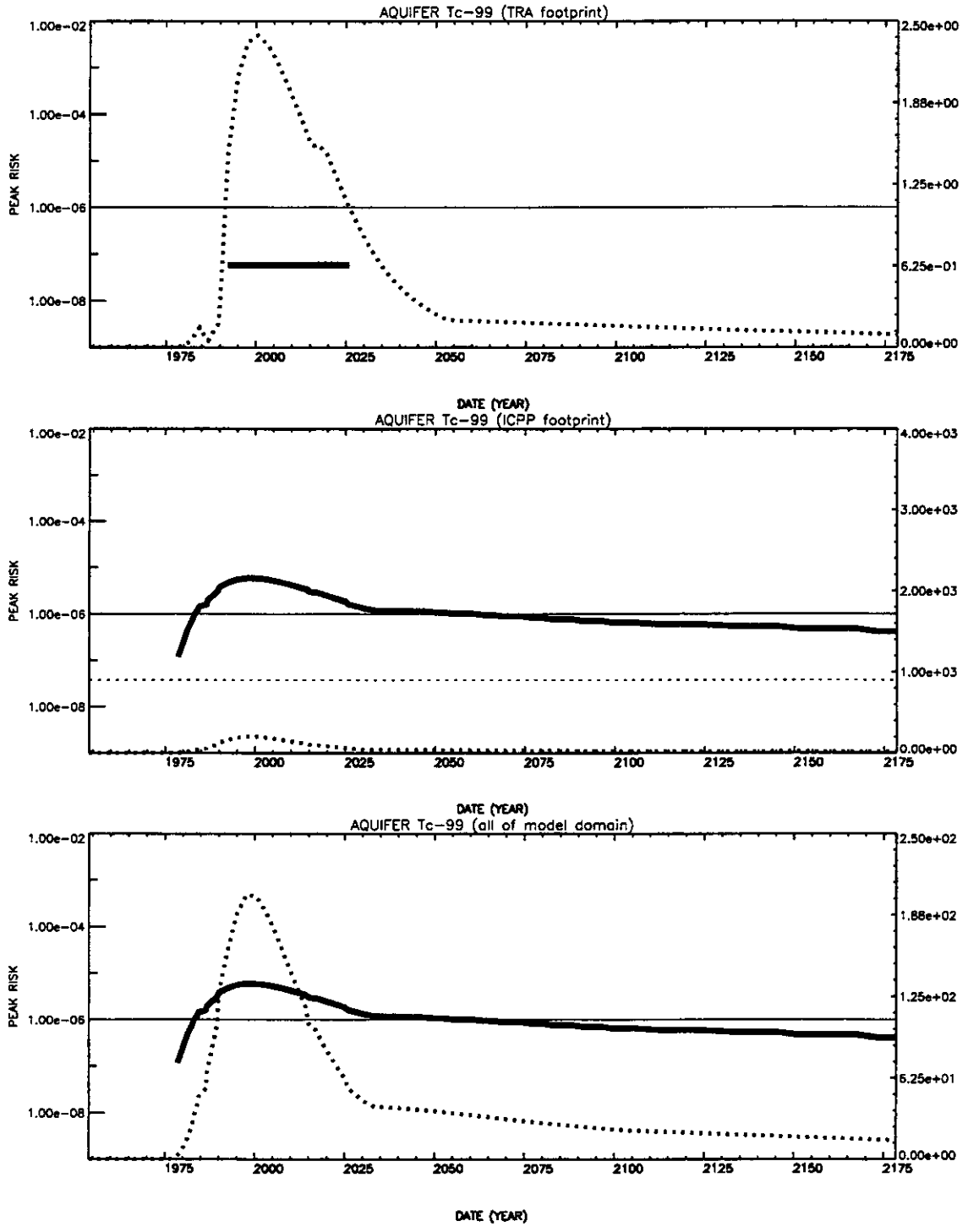

Figure 6-35 Peak aquifer concentration for Tc-99. Top figure: TRA foot print, Middle figure: ICPP footprint, Bottom Figure: entire aquifer domain. Thick line risk (left scale), dotted line concentration (right scale) solid line 10^{-6} risk (left scale).

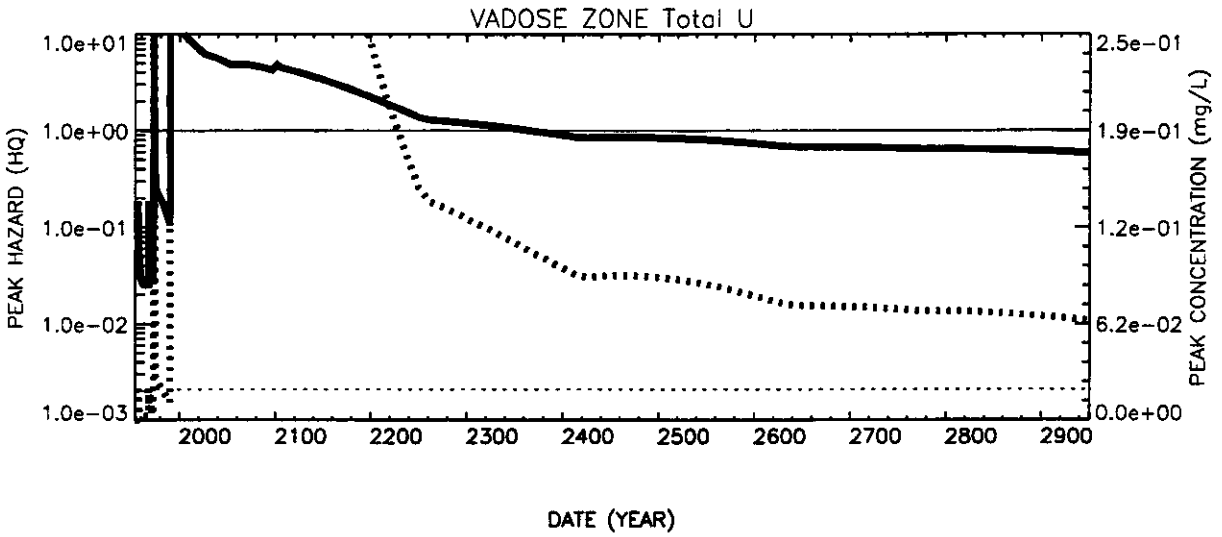

Figure 6-36 Peak vadose zone HQ and concentration for Uranium. HQ indicated by the thick line on the log scale with the HQ=1 value shown as the solid line. The dotted line represents concentration given by the linear scale on the right axis with the MCL shown as the straight horizontal line.

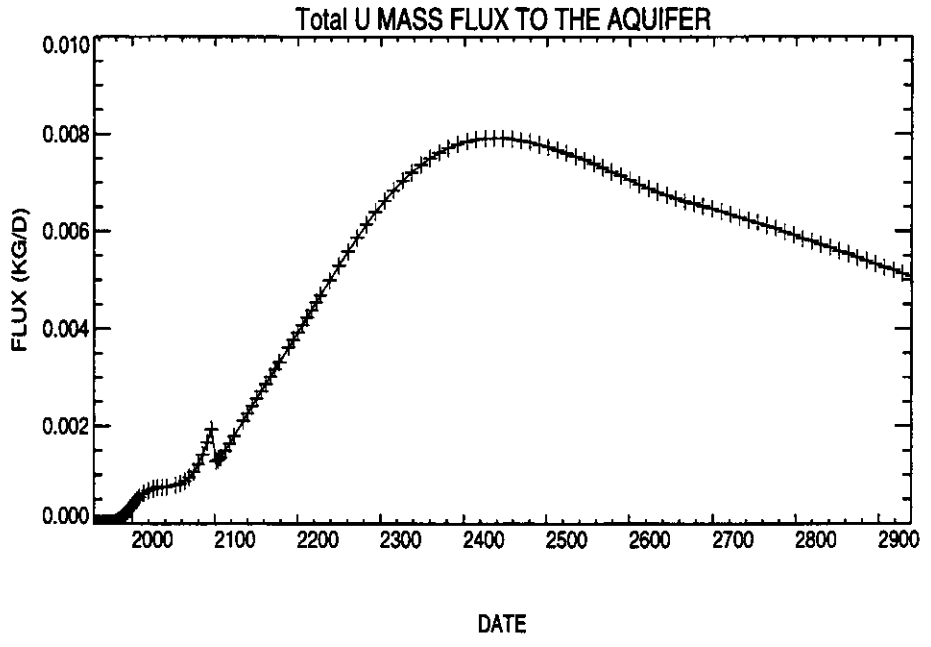

Figure 6-37 Mass flux of Uranium into the aquifer from the vadose zone.

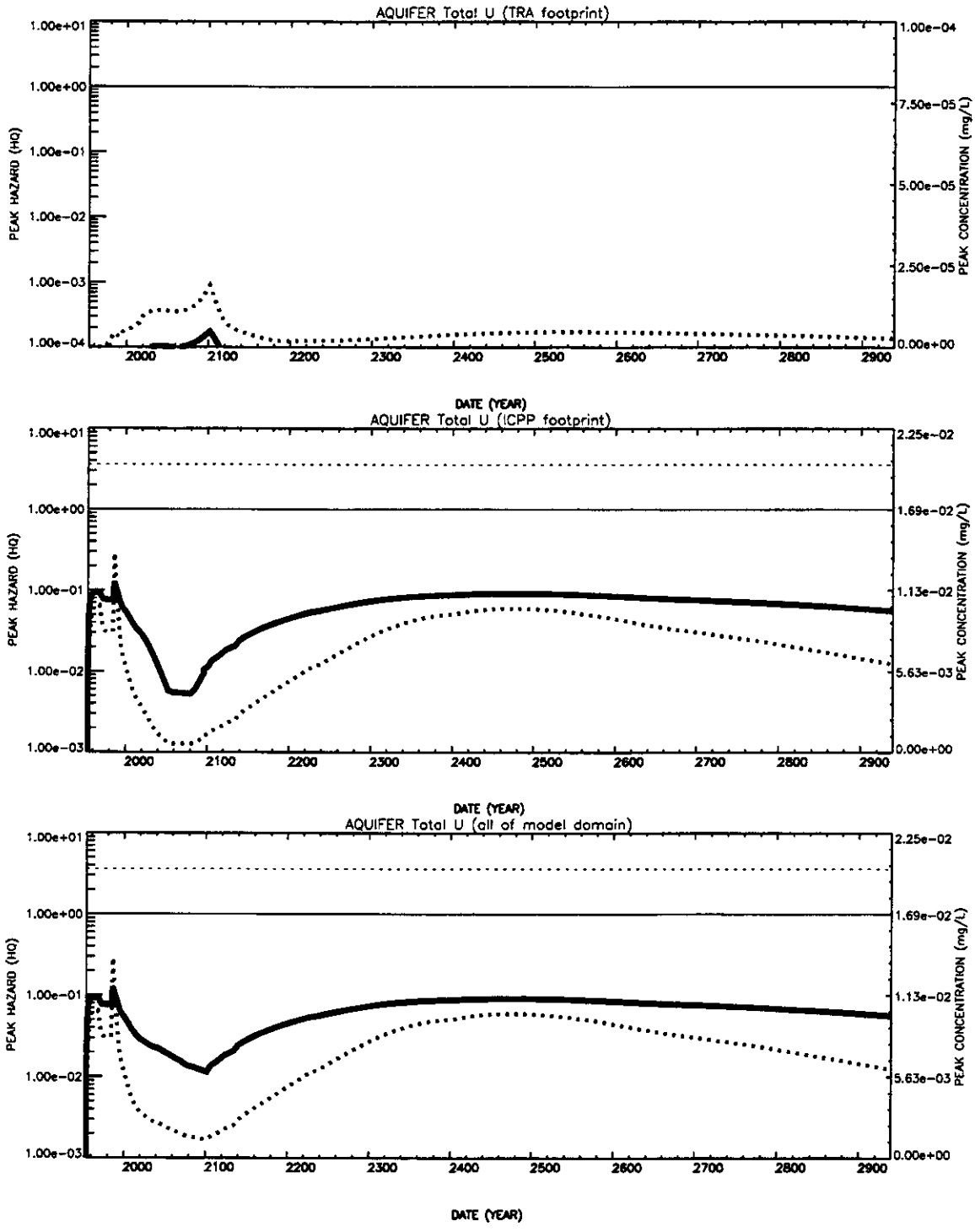

Figure 6-38 Peak aquifer concentration for Uranium. Top figure: TRA foot print, Middle figure: ICPP footprint, Bottom Figure: entire aquifer domain. Thick line risk (left scale), dotted line concentration (right scale) solid line 1--6 risk (left scale).

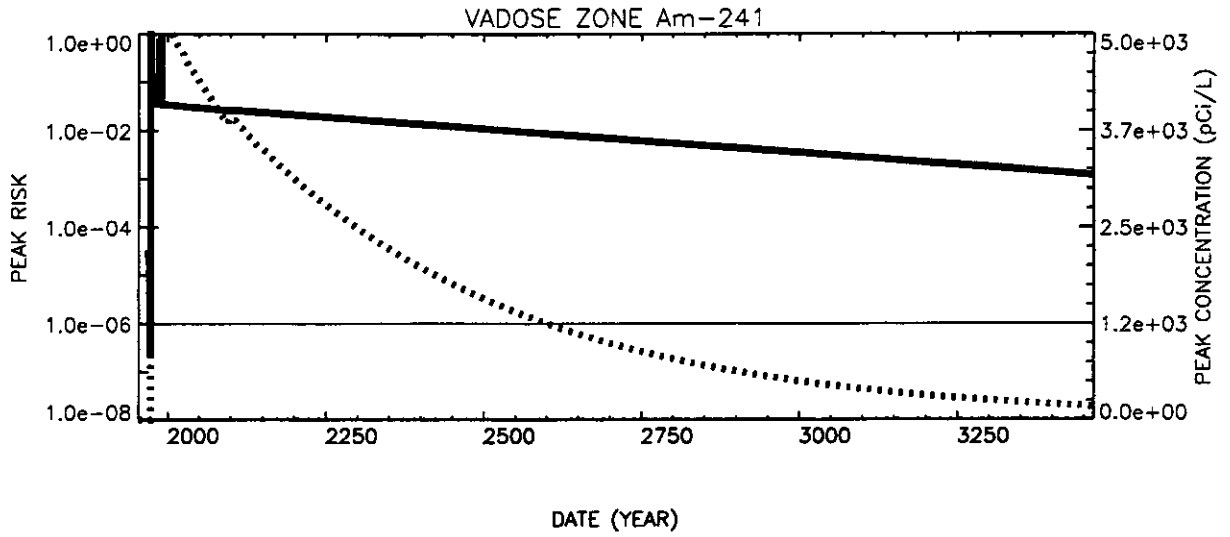

Figure 6-39 Peak vadose zone risk and concentration for Am-241. Risk indicated by the thick line on the log scale with the 10^{-6} value shown as the solid line. The dotted line represents concentration given by the linear scale on the right axis with the MCL shown as the straight horizontal line.

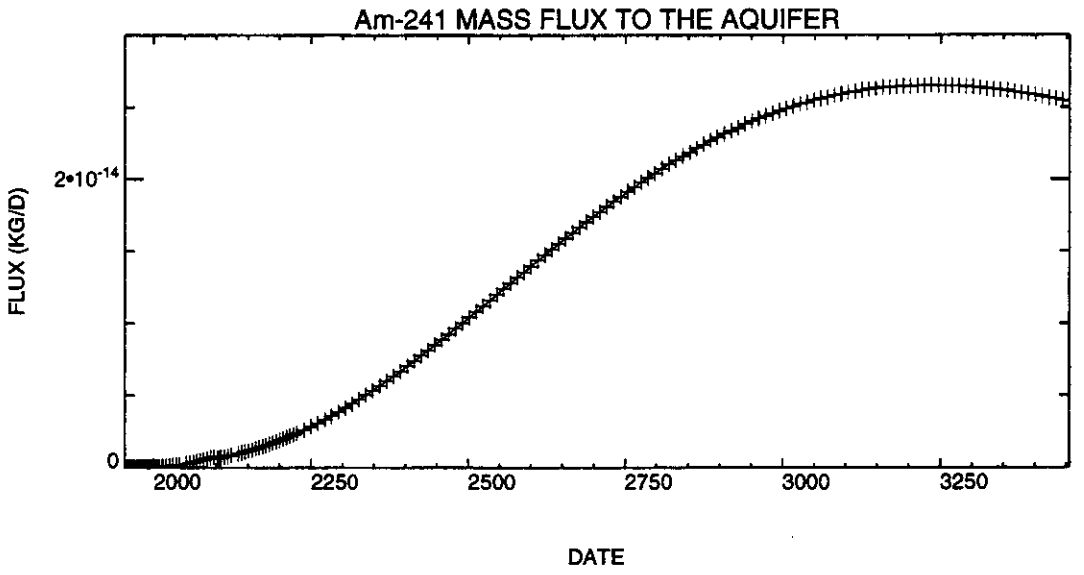

Figure 6-40 Mass flux of Am-241 into the aquifer from the vadose zone.

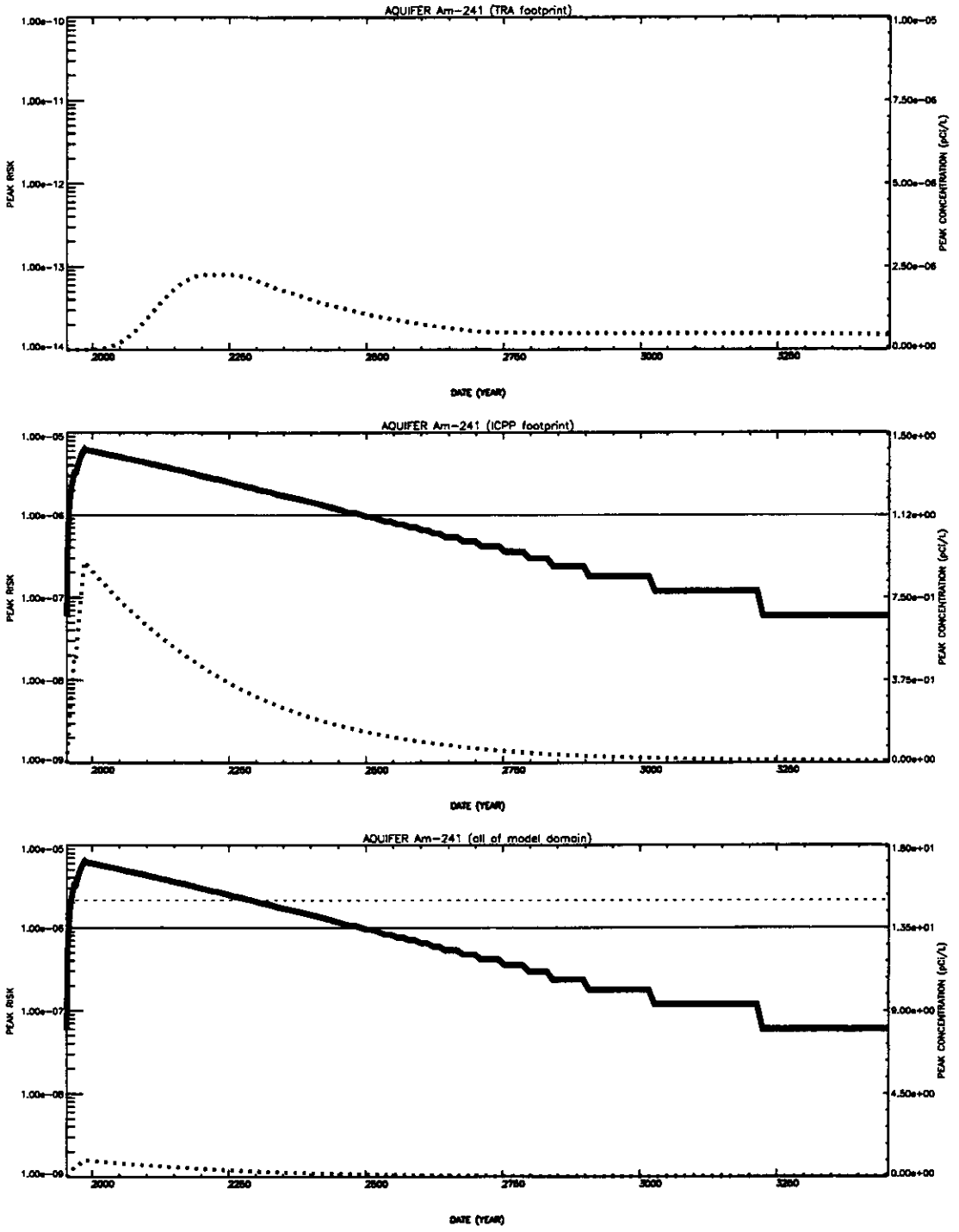

Figure 6-41 Peak aquifer concentration for Am-241. Top figure: TRA foot print, Middle figure: ICPP footprint, Bottom Figure: entire aquifer domain. Thick line risk (left scale), dotted line concentration (right scale) solid line 10^{-6} risk (left scale).

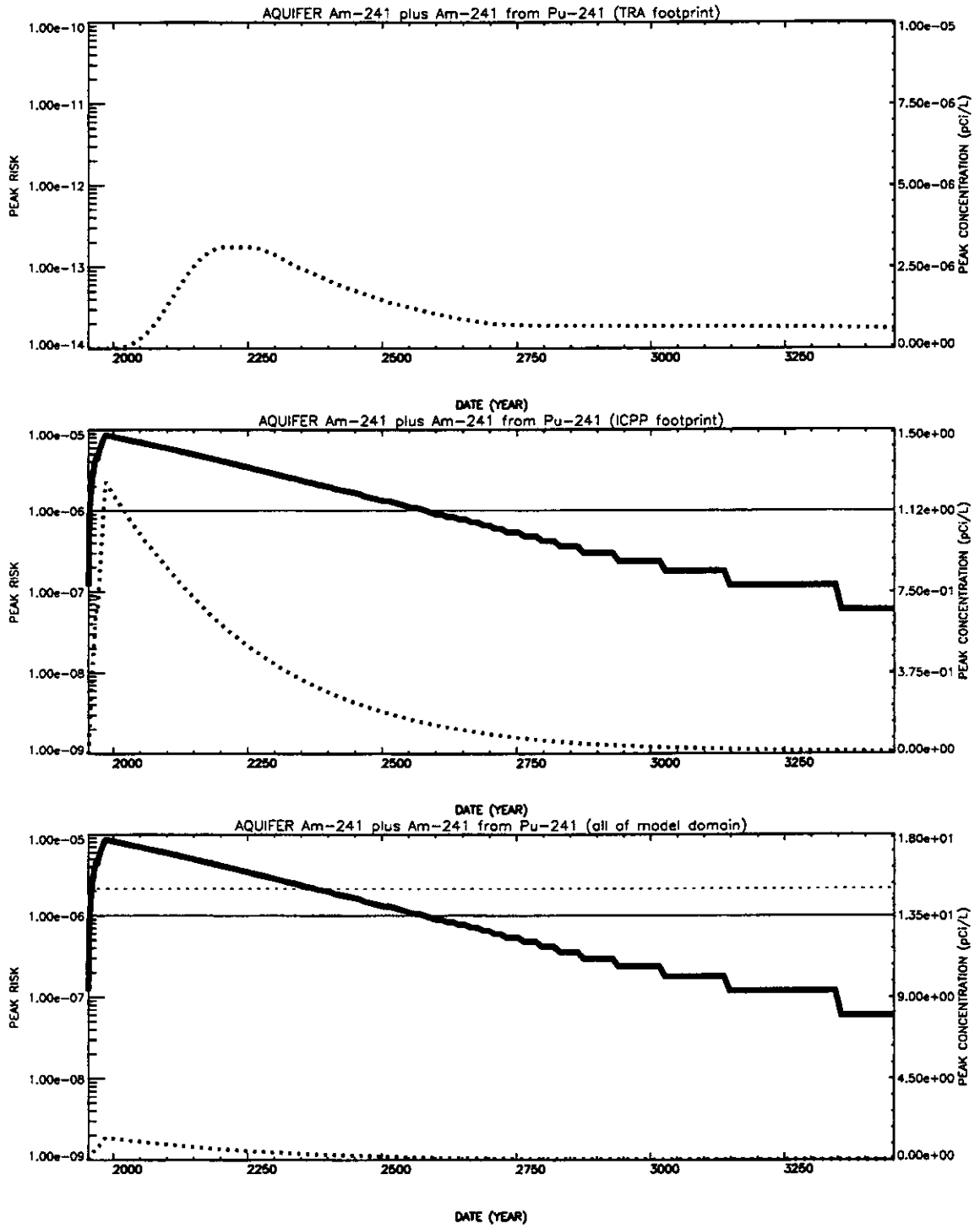

Figure 6-42 Peak aquifer concentration for Am-241. This includes the Am-241 and the Am-241 ingrowth from Pu-241. Top figure: TRA foot print, Middle figure: ICPP footprint, Bottom Figure: entire aquifer domain. Thick line risk (left scale), dotted line concentration (right scale) solid line 10^{-6} risk (left scale).

VADOSE ZONE RESULTS: Table 6-4 contains the predicted peak concentration in the vadose zone for a) the entire simulation time (Column 4), b) the simulated time corresponding to 30 years from 1995 (Column 9), and c) the simulated time corresponding to 100 years from 1995 (Column 10). Tables 6-5 through 6-8 summarize the peak concentration information for the aquifer transport results. The first column of these tables gives the COPC for which transport was simulated. The second column of Table 6-4 lists the concentration corresponding to the MCL for each COPC given in Column 1. Columns 3 through 8 summarize the simulation results for transport in the vadose zone for the entire simulation period. Column 3 lists the year at the end of the simulation time for each COPC. Column 4 gives the peak concentration predicted in the vadose zone throughout the entire simulation time for each COPC. Column 5 lists the time corresponding to the peak value, with Columns 6 through 8 indicating where the peak concentration was predicted to occur. The peak concentration 30 years from now is given in Column 9 and the predicted peak concentration 100 years in the future is given in Column 10. The values given in these last two columns can be compared against the MCL given in Column 2. This table indicates that with the exception of H-3, Tc-99, and Chromium, all of the COPCs exceed MCLs in the year 2025. The Co-60 peak concentrations also fall below the MCL by the year 2095.

Table 6-4 Vadose zone peak concentrations.

		Simulation Results For The Period Spanning 1953 Through The Total Simulation Time						Simulation Results For The Year 2025	Simulation Results For The Year 2095
COPCs	MCL (mg/L or pCi/L)	Year at the End of Simulation Time	Peak Concentration (mg/L or pCi/L)	Year of Peak	Easting (m)	Northing (m)	Depth From Surface (m)	Maximum Concentration in 2025 (mg/L or pCi/L)	Maximum Concentration in 2095 (mg/L or pCi/L)
Arsenic[a]	5.00E-02	3049	2.20E+03	1990	90800.	212300.	20.	1.77E-01	6.85E-02
Chromium[a]	1.00E-01	2112	8.23E+01	1990	90400.	211900.	20.	6.59E-02	2.06E-02
Co-60	1.00E+02	2068	1.97E+09	1990	90400.	211500.	18.	9.18E+02	0.00E+00
Cs-137	2.00E+02	2227	2.97E+10	1990	90400.	211500.	18.	1.77E+05	3.35E+04
H-3	2.00E+04	2095	1.38E+07	1973	90400.	212100.	26.	1.99E+03	2.31E+02
I-129	1.00E+00	2095	6.95E+03	1973	90400.	212100.	26.	3.94E+01	2.74E+00
Mercury[a]	2.00E-03	2123	1.72E+02	1990	90400.	211900.	20.	3.86E-02	3.15E-02
Np-237[b]	<1.50E+01	2797	2.15E+06	1990	90600.	212100.	20.	1.13E+02	7.33E+01
Total Pu[b]	<1.50E+01	3815	2.66E+07	1990	90400.	211500.	18.	5.32E+03	3.08E+03
Sr-90	8.00E+00	2244	1.36E+10	1973	90400.	212100.	26.	1.38E+06	1.46E+05
Tc-99	9.00E+02	2178	2.59E+06	1973	90400.	212100.	26.	4.58E+02	1.16E+01
Total U	1.40E+01	2950	7.30E+04	1990	90600.	212100.	21.	4.97E+02	3.39E+02
Total U[a]	2.00e-02	2950	9.99E+01	1990	90600.	212100.	21.	6.81E-01	4.64E-01
Am-241[b]	<1.50E+01	3465	1.34E+08	1973	90400.	212100.	26.	4.70E+03	3.84E+03
Total Am-241[b]	<1.50E+01	---	---	---	---	---	---	---	---

[a] mg/L
[b] total alpha MCL is 15 pCi/L

AQUIFER RESULTS: Table 6-5 contains the predicted peak concentration in the entire aquifer simulation domain. Results are presented for a) the entire simulation time, b) 30 years from 1995, and c) 100 years from 1995. Column 3 gives the year at the end of the simulation time for each COPC. Columns 4 through 10 summarize the simulation results for transport in the aquifer for the entire simulation period. Columns 4, 5 and 6 give the peak concentration and corresponding risk (or HQ) predicted in the aquifer throughout the entire simulation time for each COPC. Column 7 lists the year corresponding to that value, with Columns 8 through 10 indicating where the peak concentration was predicted to occur. The maximum concentration and corresponding risk 30 years from now is given in Columns 11, 12 and 13, while the

predicted maximum concentration and corresponding risk 100 years in the future is given in Columns 14, 15 and 16. With the exception of chromium, there is little variation in the horizontal location of the peak concentration in the aquifer. The vertical peaks are 19 m below the water table for the COPCs for which the peak concentration is the result of disposal to the injection well and 4 m below the water table for COPCs for which the peak concentration is the result of disposal at the surface (primarily the tank farm).

Table 6-5 indicates that by the year 2025, the chemical concentrations of chromium and Total U will be below their HQ=1 based concentration and the Co-60 concentration will be below its 10^{-6} risk based concentration. By the year 2095, the concentrations of H-3, Total Pu, and Tc-99 will be below their 10^{-6} risk based concentrations. Chromium, Co-60, H-3, and Tc-99 concentrations will all continue to decrease in the future. Total U, and Total Pu concentrations will increase in the future. Of the remaining COPCs, the aquifer concentrations of Cs-137, I-129, mercury, Np-237, and Am-241 will all decrease after 2095 and the concentrations of arsenic and Sr-90 will increase. After the year 2095, the arsenic increase is predicted to be minor but the Total Pu (factor of 250), Sr-90 (factor of 2), and Total U (factor of 10) increases are predicted to be significant.

Table 6-5 Aquifer peak concentrations and risk for the entire aquifer domain.

COPCs	MCL (mg/L or pCi/L)	Simulation Results For The Period Spanning 1953 Through The Total Simulation Time								Simulation Results For The Year 2025			Simulation Results For The Year 2095		
		Year at the End of Simulation Time	Peak Concentration (mg/L or pCi/L)	Peak HQ	Peak Risk	Year of Peak	Easting (m)	Northing (m)	Depth Below Water Table (m)	Maximum Concentration (mg/L or pCi/L)	Maximum HQ	Maximum Risk	Maximum Concentration (mg/L or pCi/L)	Maximum HQ	Maximum Risk
Arsenic[a]	5.00E-02	3049	1.95E-03	---	3.42E-05	2479	90900.	212000.	4.	9.42E-05	---	1.67E-06	1.25E-03	---	2.19E-05
Chromium[a,b]	1.00E-01	2107	9.01E-01	4.94E+00	--	1971	88500.	213200.	19.	6.95E-02	3.81E-01	---	3.23E-02	1.77E-01	---
Co-60	1.00E+02	2063	2.59E+01	---	1.03E-05	1986	90500.	211600.	19.	3.36E-02	---	1.33E-08	0.00E+00	---	0.00E+00
Cs-137	2.00E+02	2227	8.62E+01	---	5.72E-05	1979	90500.	211600.	19.	3.20E+01	---	2.12E-05	5.91E+00	---	3.93E-06
H-3	2.00E+04	2095	2.62E+06	---	3.93E-03	1960	90500.	211600.	19.	4.24E+03	---	6.38E-06	8.92E+01	---	1.19E-07
I-129	1.00E+00	4144	9.71E+01	---	3.75E-04	1986	90500.	211600.	19.	8.97E+00	---	3.46E-05	4.68E+00	---	1.81E-05
Mercury[a,b]	2.00E-03	2118	7.42E-03	2.36E+00	---	1984	90500.	211600.	19.	6.09E-03	1.94E+00	---	4.17E-03	1.33E+00	---
Np-237	<1.50E+01	2791	3.05E+01	---	1.92E-04	1986	90500.	211600.	19.	8.03E+00	---	5.06E-05	3.76E+00	---	2.37E-05
Total Pu	<1.50E+01	3804	3.62E+01	---	2.43E-04	3585	90500.	211600.	4.	3.22E-01	---	2.15E-06	1.39E-01	---	9.54E-07
Sr-90	8.00E+00	2238	1.20E+03	---	1.41E-03	1967	90500.	211600.	19.	3.54E+01	---	4.15E-05	8.08E+00	---	9.48E-06
Tc-99	9.00E+02	2178	2.03E+02	---	5.96E-06	1997	90500.	212000.	4.	5.51E+01	---	1.61E-06	2.39E+01	---	7.15E-07
Total U	1.40E+01	2939	1.01E+01	---	1.31E-05	1986	90500.	211600.	19.	2.13E+00	---	2.74E-06	9.57E-01	---	1.25E-06
Total U[a,b]	2.00E-02	2939	1.38E-02	1.26E-01	---	1986	90500.	211600.	19.	2.91E-03	2.66E-02	---	1.31E-03	1.20E-02	---
Am-241	<1.50E+01	3454	9.13E-01	---	6.32E-06	1986	90500.	211600.	19.	8.00E-01	---	5.48E-06	6.32E-01	---	4.35E-06
Total Am-241	<1.50E+01	---	---	---	---	---	---	---	---	---	---	---	8.72E-01	---	6.02E-06

[a] mg/L
[b] Hazard Quotient

As indicated in Appendix F, Section 5.2, the primary source of chromium and one of the primary sources of H-3 were the disposal practices at TRA. As a result, the peak concentrations noted in Table 6-5 reflect the contribution to the aquifer at TRA. To distinguish the aquifer contamination between the ICPP and TRA areas, Tables 6-6 and 6-7 below present the peak concentrations underlying those local facility areas. By comparing the peak concentrations for the entire aquifer area, the ICPP area and the TRA area, it is clear that the source of primary aquifer concern resulting from chromium occurs as a result of TRA disposal practices. TRA is a primary contributor of H-3 to the aquifer, but by the year 2095, the short half-life and lack of adsorption allows H-3 concentrations to fall below risk based levels. For contaminants not disposed of at TRA, the concentrations shown in Table 6-7 reflect the mass transported into that area from dispersion and lateral migration from the ICPP area.

Table 6-6 Aquifer peak concentrations and risk for the ICPP footprint area.

COPCs	MCL (mg/L or pCi/L)	Simulation Results For The Period Spanning 1953 Through The Total Simulation Time				Simulation Results For The Year 2025			Simulation Results For The Year 2095		
		Peak Concentration (mg/L or pCi/L)	Peak HQ	Peak Risk	Year of Peak	Maximum Concentration (mg/L or pCi/L)	Maximum HQ*	Maximum Risk	Maximum Concentration (mg/L or pCi/L)	Maximum HQ*	Maximum Risk
Arsenic[a]	5.00E-02	1.95E-03	---	3.42E-05	2479	9.42E-05	---	1.67E-06	1.25E-03	---	2.19E-05
Chromium[a,b]	1.00E-01	2.44E-03	1.34E-02	---	2068	1.22E-03	6.69E-03	---	2.21E-03	1.21E-02	---
Co-60	1.00E+02	2.59E+01	---	1.03E-05	1986	3.36E-02	---	1.33E-08	0.00E+00	---	0.00E+00
Cs-137	2.00E+02	8.62E+01	---	5.72E-05	1979	3.20E+01	---	2.12E-05	5.91E+00	---	3.93E-06
H-3	2.00E+04	2.62E+06	---	3.93E-03	1960	4.24E+03	---	6.38E-06	8.92E+01	---	1.19E-07
I-129	1.00E+00	9.71E+01	---	3.75E-04	1986	8.97E+00	---	3.46E-05	4.68E+00	---	1.81E-05
Mercury[a,b]	2.00E-03	7.42E-03	2.36E+00	---	1984	6.09E-03	1.94E+00	---	4.17E-03	1.33E+00	---
Np-237	<1.50E+01	3.05E+01	---	1.92E-04	1986	8.03E+00	---	5.06E-05	1.20E+00	---	7.57E-06
Total Pu	<1.50E+01	3.62E+01	---	2.43E-04	3585	3.22E-01	---	2.15E-06	1.39E-01	---	9.54E-07
Sr-90	8.00E+00	1.20E+03	---	1.41E-03	1967	3.54E+01	---	4.15E-05	8.08E+00	---	9.48E-06
Tc-99	9.00E+02	2.03E+02	---	5.96E-06	1997	5.51E+01	---	1.61E-06	2.39E+01	---	7.15E-07
Total U	1.40E+01	1.01E+01	---	1.31E-05	1986	1.86E+00	---	2.44E-06	7.38E-01	---	9.54E-07
Total U[a,b]	2.00E-02	1.38E-02	1.26E-01	---	1986	2.55E-03	2.33E-02	---	1.01E-03	9.22E-03	---
Am-241	<1.50E+01	9.13E-01	---	6.32E-06	1986	8.00E-01	---	5.48E-06	6.32E-01	---	4.35E-06
Total Am-241	<1.50E+01	---	---	---	---	---	---	---	8.72E-01	---	6.02E-06

[a] mg/L
[b] Hazard Quotient

Table 6-7 Aquifer peak concentrations and risk for the TRA footprint area.

COPCs	MCL (mg/L or pCi/L)	Simulation Results For The Period Spanning 1953 Through The Total Simulation Time				Simulation Results For The Year 2025			Simulation Results For The Year 2095		
		Peak Concentration (mg/L or pCi/L)	Peak HQ	Peak Risk	Year of Peak	Maximum Concentration (mg/L or pCi/L)	Maximum HQ*	Maximum Risk	Maximum Concentration (mg/L or pCi/L)	Maximum HQ*	Maximum Risk
Arsenic[a]	5.00E-02	2.13E-05	---	3.58E-07	2101	6.98E-07	---	1.17E-08	2.00E-05	---	3.58E-07
Chromium[a,b]	1.00E-01	9.01E-01	4.94E+00	---	1971	2.29E-02	1.25E-01	---	1.14E-02	6.25E-02	---
Co-60	1.00E+02	7.07E-04	----	2.81E-10	1984	1.16E-05	----	4.62E-12	0.00E+00	----	0.00E+00
Cs-137	2.00E+02	2.07E-07	----	1.37E-13	2134	4.42E-08	----	2.93E-14	1.68E-07	----	1.11E-13
H-3	2.00E+04	2.97E+05	----	4.46E-04	1972	2.08E+03	----	3.10E-06	2.28E-01	----	3.42E-10
I-129	1.00E+00	4.82E-01	----	1.85E-06	1971	2.56E-02	----	1.19E-07	1.21E-02	----	5.96E-08
Mercury[a,b]	2.00E-03	2.89E-07	9.21E-05	---	2118	3.21E-08	1.02E-05	---	2.54E-07	8.09E-05	---
Np-237	<1.50E+01	2.33E-02	----	1.19E-07	2052	2.00E-02	----	1.19E-07	1.96E-02	----	1.19E-07
Total Pu	<1.50E+01	2.91E-04	----	1.94E-09	3782	1.54E-04	----	1.03E-09	1.37E-04	----	9.13E-10
Sr-90	8.00E+00	1.56E-01	----	1.79E-07	2047	1.39E-01	----	1.79E-07	9.65E-02	----	1.19E-07
Tc-99	9.00E+02	2.39E+00	----	5.96E-08	2000	1.07E+00	----	5.96E-08	1.71E-01	----	9.52E-09
Total U	1.40E+01	1.39E-02	----	0.00E+00	2101	7.74E-03	----	0.00E+00	1.21E-02	----	0.00E+00
Total U[a,b]	2.00E-02	1.90E-05	1.73E-04	----	2101	1.06E-05	9.68E-05	----	1.65E-05	1.51E-04	----
Am-241	<1.50E+01	2.26E-06	----	1.56E-11	2211	5.94E-08	----	4.09E-13	8.69E-07	----	5.98E-12
Total Am-241	<1.50E+01	---	---	---	---	---	---	---	1.20E-06	----	8.25E-12

[a] mg/L
[b] Hazard Quotient

Institutional controls have been assumed to be in place until the year 2095. Of particular interest are the peak groundwater concentrations after the institutional control period. These peak concentrations and the time of peak are shown in Table 6-8. In the year 2095, peak concentrations in the aquifer are predicted to be decreasing for chromium, Co-60, Cs-137, H-3, I-129, mercury, Np-237, Tc-99, and Am-241. However, aquifer peak concentrations are predicted to rise after the year 2095 for Sr-90 (until year 2172), U (until year 2468), arsenic (until year 2479), and Pu (until year 3585).

Table 6-8 Aquifer peak concentrations and risk in the year 2095 or beyond.

COPCs	MCL (mg/L or pCi/L)	Peak Concentration For The Year 2095 And Beyond (mg/L or pCi/L)	Peak Risk (or HQ) For The Year 2095 And Beyond	Time of Peak Concentration
Arsenic[a]	5.00E-02	1.95E-03 (mg/L)	3.42E-05	2479
Chromium[a,b]	1.00E-01	3.23E-02 (mg/L)	1.77E-01 (HQ)	2095
Co-60	1.00E+02	0 (pCi/L)	0	2095
Cs-137	2.00E+02	5.91 (pCi/L)	3.92E-06	2095
H-3	2.00E+04	89.2 (pCi/L)	1.34E-07	2095
I-129	1.00E+00	4.68 (pCi/L)	1.81E-05	2095
Mercury[a,b]	2.00E-03	4.17E-03 (mg/L)	1.33 (HQ)	2095
Np-237	<1.50E+01	3.76 (pCi/L)	2.37E-05	2095
Total Pu	<1.50E+01	36.2 (pCi/L)	2.43E-04	3585
Sr-90	8.00E+00	16.1 (pCi/L)	1.87E-05	2172
Tc-99	9.0E+02	23.9 (pCi/L)	7.03E-07	2095
Total U	1.40E+01	7.3 (pCi/L)	7.30E-06	2468
Total U[a,b]	2.00E-02	0.01 (mg/L)	0.50 (HQ)	2468
Am-241	<1.50E+01	0.63 (pCi/L)	4.35E-06	2095
Total Am-241	<1.50E+01	0.87 (pCi/L)	6.00E-06	2095

[a] mg/L
[b] Hazard Quotient

As explained earlier in text, Tables 6-1 and 6-2 present summaries of the initial COPCs inventories assumed to be discharged at each contaminant source. These tables are useful, but can be misleading (primarily as a result of radioactive decay in the vadose zone) for interpreting which sources contribute significantly to the peak concentrations in the aquifer. Table 6-9 summarizes the primary contributing sources to the predicted peak aquifer concentrations, for the time periods pre- and post- the year 2095.

Table 6-9 Summarize the primary contributing sources to the predicted peak aquifer concentrations, for the time periods pre- and post- the year 2095.

COPC	Pre-2095	Post-2095
Arsenic	Soil Contamination	Soil Contamination
Chromium	Total aquifer domain - TRA ICPP footprint - Soil Contamination	Total aquifer domain - TRA ICPP footprint - Soil Contamination
Co-60	Injection Well	Injection well
Cs-137	Injection Well	Injection well
H-3	Injection Well	Injection well
I-129	Injection Well	Injection well
Mercury	Injection Well	Injection well[1]
Np-237	Injection Well	Injection well, Tank Farm, and Soil Contamination
Total Pu	Injection Well	Initially the Injection well. Tank Farm after the year 2200
Sr-90	Injection Well	Tank Farm
Tc-99	Tank Farm	Tank Farm
Total U	Injection Well	Tank Farm and Soil Contamination
Am-241	Injection Well	Injection Well

[1] the mercury from soil contamination is expected to reach the aquifer in approximately 10,00 years but the mercury flow and transport was only simulated for approximately 150 years because it was determined that the vadose zone concentrations could not pose a risk to the aquifer. Eventually, the soil contamination mercury source will be a larger contributor to the aquifer concentrations than the injection well.

The sensitivity analysis results are discussed in Appendix F, Section 8. Uncertainty in the results and means of estimating the relative impact of some of the modeling assumptions is addressed as part of the model calibration activities presented in Appendix F, Sections 3 and 4, and as sensitivity studies in Appendix F, Sections 8 through 11. The sensitivity analysis results are summarized below.

6.7 Sensitivity Analysis

Eleven sensitivity simulation runs were evaluated in order to identify the sensitivity of the model results to 1) the Sr-90 assumed Kd, 2) increases in the Sr-90 source from the Tank Farm area, 3) increase in the assumed water leakage from the water supply and fire system lines, 4) possibly leaky well that allows water in the upper interbed to move directly to the aquifer, 5) the assumed Kd for I-129 and to assess the relative influence of Kd in the vadose zone vs. that in the sediments, 6) the Np-237 assumed Kd value, and 7) the aquifer Kd for Total Pu. Table 6-10 lists the sensitivity runs and the sections where the discussion is presented in Appendix F. These results are summarized in this section.

Table 6-10 Sensitivity Analyses.

Purpose of Simulation Run	Section of Appendix F	Parameter Varied
Sr-90 Sensitivity to Kd	8.1.1	Sr-90 With A Kd=24 cm^3/g
	8.1.2	Sr-90 With A Kd=0 cm^3/g
Sr-90 With Increased Tank Farm Source Mass	8.2	Sr-90 With Increased Tank Farm Source Mass
Sr-90 With Increased Fire Water Leakage	8.3	Sr-90 With Increased Fire Water Leakage

Table 6-10 Sensitivity Analyses.

Purpose of Simulation Run	Section of Appendix F	Parameter Varied
Sr-90 Leakage From The Upper Interbed	8.4.1	Sr-90 With 1-GPM Leakage From The Upper Interbed
	8.4.2	Sr-90 With 5-GPM Leakage From The Upper Interbed
	8.4.3	Sr-90 With 10-GPM Leakage From The Upper Interbed
I-129 Sensitivity to Kd	8.5.1	I-129 With A Sediment Kd=0.4 cm^3/g, and Aquifer Basalt Kd=0.016 cm^3/g
	8.5.2	I-129 With A Sediment Kd=0.4 cm^3/g, and Aquifer Basalt Kd=0.4 cm^3/g
Np-237 Sensitivity to Kd	8.6.1	Np-237 With A Kd=0 cm^3/g
Total Pu Sensitivity to Kd	8.7.1	Total Pu With the Sediment Kd=220 cm^3/g and Aquifer Basalt Kd=8.8 cm^3/g

Table 6-11 contains the predicted peak concentration in the vadose zone for a) the entire simulation time, b) the simulated time corresponding to 30 years from 1995, and c) the simulated time corresponding to 100 years from 1995. Tables 6-12 through 6-14 summarize the peak concentration information for the aquifer transport results. Columns 3 through 8 in Table 6-11 summarize the simulation results for transport in the vadose zone for the entire simulation period. Column 3 lists the year at the end of the simulation time, for each COPC. Column 4 gives the peak concentration predicted in the vadose zone throughout the entire simulation time for each COPC. Column 5 lists the time corresponding to the peak value, with Columns 6 through 8 indicating where the peak concentration was predicted to occur. The peak concentration 30 years from now is given in Column 9 and the predicted peak concentration 100 years in the future is given in Column 10.

Table 6-11 Vadose zone peak concentrations for the sensitivity analyses runs.

Section of Appendix F	Simulation	Simulation Results For The Period Spanning 1953 Through The Total Simulation Time						Simulation Results For The Year 2025	Simulation Results For The Year 2095
		Year at the End of Simulation Time	Peak Concentration pCi/L	Year of Peak	Easting (m)	Northing (m)	Depth From Surface (m)	Maximum Concentration in 2025 pCi/L	Maximum Concentration in 2095 pCi/L
Sr-90 Sensitivity to Kd									
7.10	Sr-90 Base Case With A Kd=12 cm^3/g	2244	1.36E+10	1973	90400.	212100.	26.	1.38E+06	1.46E+05
8.1.1	Sr-90 With A Kd=24 cm^3/g	2227	1.36E+10	1973	90400.	212100.	26.	1.13E+06	1.22E+05
8.1.2	Sr-90 With A Kd=0 cm^3/g	2095	1.11E+10	1973	90400.	212100.	26.	1.62E+06	8.30E+04
Sr-90 With Increased Tank Farm Source Mass									
8.2	Sr-90 With Increased Tank Farm Source Mass[a]	2194	1.94E+10	1973	90400.	212100.	26.	1.62E+06	1.79E+05
Sr-90 With Increased Fire Water Leakage									
8.3	Sr-90 With Increased Fire Water Leakage[a]	2227	1.25E+10	1990	90400.	211500.	18.	4.30E+05	5.69E+04
Sr-90 Leakage From The Upper Interbed									
8.4.1	Sr-90 With 1-GPM Leakage From The Upper Interbed[a]	----	---	----	---	----	---	----	---
8.4.2	Sr-90 With 5-GPM Leakage From The Upper Interbed[a]	----	---	----	---	----	---	----	---
8.4.3	Sr-90 With 10-GPM Leakage From The Upper Interbed[a]	----	---	----	---	----	---	----	---
I-129 Sensitivity to Kd									
7.7	I-129 Base case with Kd=0 cm^3/g	2095	6.95E+03	1973	90400.	212100.	26.	3.94E+01	2.74E+00
8.5.1	I-129 With A Sediment Kd=0.4 cm^3/g, and Aquifer Basalt Kd=0.016 cm^3/g	2095	6.94E+03	1973	90400.	212100.	26.	3.51E+01	4.41E+00
8.5.2	I-129 With A Sediment Kd=0.4 cm^3/g, and Aquifer Basalt Kd=0.4 cm^3/g	2095	6.94E+03	1973	90400.	212100.	26.	3.51E+01	4.41E+00
Np-237 Sensitivity to Kd									
7.8	Np-237 Base case with Kd=8 cm^3/g	2797	2.15E+06	1990	90600.	212100.	20.	1.13E+02	7.33E+01
8.6.1	Np-237 With A Kd=0 cm^3/g	2123	7.61E+05	1990	90600.	212100.	20.	9.37E+01	6.81E+00
Total Pu Sensitivity to Kd									

Table 6-11 Vadose zone peak concentrations for the sensitivity analyses runs.

Section of Appendix F	Simulation	Simulation Results For The Period Spanning 1953 Through The Total Simulation Time						Simulation Results For The Year 2025	Simulation Results For The Year 2095
		Year at the End of Simulation Time	Peak Concentration pCi/L	Year of Peak	Easting (m)	Northing (m)	Depth From Surface (m)	Maximum Concentration in 2025 pCi/L	Maximum Concentration in 2095 pCi/L
7.9	Total Pu Base Case With the Sediment Kd=22 cm^3/g and the Aquifer Basalt Kd=1 cm^3/g	3815	2.66E+07	1990	90400.	211500.	18.	5.32E+03	3.08E+03
8.7.1	Total Pu With the Sediment Kd=220 cm^3/g and Aquifer Basalt Kd=8.8 cm^3/g	NA	NA	NA	NA	NA	NA	9.97E+02	8.91E+02

Table 6-12 contains the predicted peak concentration in the entire aquifer simulation domain. Results are presented for a) the entire simulation time, b) 30 years from 1995, and c) 100 years from 1995. The third column of Table 6-12 lists the concentration corresponding to the MCL for each COPC given in Column 2. Column 4 gives the year at the end of the simulation time for transport through the aquifer for each COPC. Columns 5 through 10 summarize the simulation results for transport in the aquifer for the entire simulation period. Columns 5 and 6 give the peak concentration and corresponding risk predicted in the aquifer throughout the entire simulation time for each COPC. Column 7 lists the time corresponding to that value, with Columns 8 through 10 indicating where the peak concentration was predicted to occur. The maximum concentration and corresponding risk 30 years from now is given in Columns 11 and 12, while the predicted maximum concentration and corresponding risk 100 years in the future is given in Columns 13 and 14. The values given in the concentration columns can be compared against the MCL given in Column 3.

Table 6-12 Aquifer peak concentrations and risk for the entire aquifer domain for the sensitivity analyses runs.

Section of Appendix F	Simulation	MCL (pCi/L)	Simulation Results For The Period Spanning 1953 Through The Total Simulation Time							Simulation Results For The Year 2025		Simulation Results For The Year 2095	
			Year at the End of Simulation Time	Peak Concen. pCi/L	Peak Risk	Year of Peak	Easting (m)	Northing (m)	Depth Below Water Table (m)	Maximum Concen. pCi/L	Maximum Risk	Maximum Concen. pCi/L	Maximum Risk
Sr-90 Sensitivity to Kd													
7.10	Sr-90 Base case with A Kd=12 cm^3/g	8	2238	1.20E+03	1.41E-03	1967	90500.	211600.	19.	3.54E+01	4.15E-05	8.08E+00	9.48E-06
8.1.1	Sr-90 With A Kd=24 cm^3/g	8	2227	9.20E+02	1.08E-03	1967	90500.	211600.	19.	4.56E+01	5.35E-05	4.12E+00	4.83E-06
8.1.2	Sr-90 With A Kd=0 cm^3/g	8	2095	1.67E+06	8.58E-01	1994	90500.	212000.	4.	2.18E+05	2.26E-01	2.24E+04	2.59E-02

Table 6-12 Aquifer peak concentrations and risk for the entire aquifer domain for the sensitivity analyses runs.

Section of Appendix F	Simulation	MCL (pCi/L)	Simulation Results For The Period Spanning 1953 Through The Total Simulation Time							Simulation Results For The Year 2025		Simulation Results For The Year 2095	
			Year at the End of Simulation Time	Peak Concen. pCi/L	Peak Risk	Year of Peak	Easting (m)	Northing (m)	Depth Below Water Table (m)	Maximum Concen. pCi/L	Maximum Risk	Maximum Concen. pCi/L	Maximum Risk
Sr-90 With Increased Tank Farm Source Mass													
8.2	Sr-90 With Increased Tank Farm Source Mass[a]	8	2189	9.17E+02	1.08E-03	1967	90500.	211600.	19.	4.55E+01	5.33E-05	4.16E+00	4.89E-06
Sr-90 With Increased Fire Water Leakage													
8.3	Sr-90 With Increased Fire Water Leakage[a]	8	2227	9.17E+02	1.08E-03	1967	90500.	211600.	19.	4.70E+01	5.51E-05	4.20E+00	4.95E-06
Sr-90 Leakage From The Upper Interbed													
8.4.1	Sr-90 With 1-GPM Leakage From The Upper Interbed[a]	8	2227	2.27E+05	2.34E-01	1977	90500.	212000.	4.	2.22E+04	2.58E-02	1.35E+03	1.58E-03
8.4.2	Sr-90 With 5-GPM Leakage From The Upper Interbed[a]	8	2227	8.26E+05	6.21E-01	1975	90500.	212000.	4.	1.07E+05	1.18E-01	6.42E+03	7.50E-03
8.4.3	Sr-90 With 10-GPM Leakage From The Upper Interbed[a]	8	2227	1.24E+06	7.67E-01	1975	90500.	212000.	4.	2.05E+05	2.14E-01	1.23E+04	1.43E-02
I-129 Sensitivity to Kd													
7.7	I-129 Base case with Kd=0.	1	4144	9.71E+01	3.75E-04	1986	90500.	211600.	19.	8.97E+00	3.46E-05	4.68E+00	1.81E-05
8.5.1	I-129 With A Sediment Kd=0.4 cm^3/g, and Aquifer Basalt Kd=0.016 cm^3/g	1	4144	8.65E+01	3.34E-04	1986	90500.	211600.	19.	7.13E+00	2.75E-05	4.98E+00	1.93E-05
8.5.2	I-129 With A Sediment Kd=0.4 cm^3/g, and Aquifer Basalt Kd=0.4 cm^3/g	1	2095	3.78E+01	1.46E-04	1986	90500.	211600.	19.	1.27E+01	4.92E-05	6.53E+00	2.52E-05
Np-237 Sensitivity to Kd													
7.8	Np-237 Base case with Kd=8 cm^3/g	<1.5E+01	2791	3.05E+01	1.92E-04	1986	90500.	211600.	19.	8.03E+00	5.06E-05	3.76E+00	2.37E-05
8.6.1	Np-237 With A Kd=0 cm^3/g	<1.5E+01	2928	9.02E+01	5.68E-04	1986	90500.	211600.	19.	9.02E+00	5.68E-05	4.82E+00	3.03E-05
Total Pu Sensitivity to Kd													

Table 6-12 Aquifer peak concentrations and risk for the entire aquifer domain for the sensitivity analyses runs.

Section of Appendix F	Simulation	MCL (pCi/L)	Simulation Results For The Period Spanning 1953 Through The Total Simulation Time							Simulation Results For The Year 2025		Simulation Results For The Year 2095	
			Year at the End of Simulation Time	Peak Concen. pCi/L	Peak Risk	Year of Peak	Easting (m)	Northing (m)	Depth Below Water Table (m)	Maximum Concen. pCi/L	Maximum Risk	Maximum Concen. pCi/L	Maximum Risk
7.9	Total Pu Base Case With Sediment Kd=22 cm^3/g and Aquifer Basalt Kd=1 cm^3/g	<1.5E+01	3804	3.62E+01	2.43E-04	3585	90500.	211600.	4.	3.22E-01	2.15E-06	1.39E-01	9.54E-07
8.7.1	Total Pu With the Sediment Kd=220 cm^3/g and Aquifer Basalt Kd=8.8 cm^3/g	<1.5E+01	21266	2.25E+00	1.51E-05	1823 3	90500.	211600.	4.	2.68E-04	1.79E-09	2.41E-04	1.61E-09

As indicated in Appendix F, Section 5.2 the primary sources of chromium and H-3 resulted from disposal practices at TRA rather than those at the ICPP. To distinguish the aquifer contamination between the ICPP and TRA areas, Tables 6-13 and 6-14 below present the peak concentrations underlying those local facility areas.

Table 6-13 Aquifer peak concentrations and risk for the ICPP footprint area for the sensitivity analyses runs.

Section of Appendix F	Simulation	Simulation Results For The Period Spanning 1953 Through The Total Simulation Time		Simulation Results For The Year 2025		Simulation Results For The Year 2095	
		Peak Concen. pCi/L	Peak Risk	Maximum Concen. pCi/L	Maximum Risk	Maximum Concen. pCi/L	Maximum Risk
Sr-90 Sensitivity to Kd							
7.10	Sr-90 Base case with A Kd=12 cm^3/g	1.20E+03	1.41E-03	3.54E+01	4.15E-05	8.08E+00	9.48E-06
8.1.1	Sr-90 With A Kd=24 cm^3/g	9.20E+02	1.08E-03	4.56E+01	5.35E-05	4.12E+00	4.83E-06
8.1.2	Sr-90 With A Kd=0 cm^3/g	1.67E+06	8.58E-01	2.18E+05	2.26E-01	2.24E+04	2.59E-02
Sr-90 With Increased Tank Farm Source Mass							
8.2	Sr-90 With Increased Tank Farm Source Mass[a]	9.17E+02	1.08E-03	4.55E+01	5.33E-05	4.16E+00	4.89E-06
Sr-90 With Increased Fire Water Leakage							

Table 6-13 Aquifer peak concentrations and risk for the ICPP footprint area for the sensitivity analyses runs.

Section of Appendix F	Simulation	Simulation Results For The Period Spanning 1953 Through The Total Simulation Time		Simulation Results For The Year 2025		Simulation Results For The Year 2095	
		Peak Concen. pCi/L	Peak Risk	Maximum Concen. pCi/L	Maximum Risk	Maximum Concen. pCi/L	Maximum Risk
8.3	Sr-90 With Increased Fire Water Leakage[a]	9.17E+02	1.08E-03	4.70E+01	5.51E-05	4.20E+00	4.95E-06
	Sr-90 Leakage From The Upper Interbed						
8.4.1	Sr-90 With 1-GPM Leakage From The Upper Interbed[a]	2.27E+05	2.34E-01	2.22E+04	2.58E-02	1.35E+03	1.58E-03
8.4.2	Sr-90 With 5-GPM Leakage From The Upper Interbed[a]	8.26E+05	6.21E-01	1.07E+05	1.18E-01	6.42E+03	7.50E-03
8.4.3	Sr-90 With 10-GPM Leakage From The Upper Interbed[a]	1.24E+06	7.67E-01	2.05E+05	2.14E-01	1.23E+04	1.43E-02
	I-129 Sensitivity to Kd						
7.7	I-129 Base case with Kd=0 cm^3/g	9.71E+01	3.75E-04	8.97E+00	3.46E-05	4.68E+00	1.81E-05
8.5.1	I-129 With A Sediment Kd=0.4 cm^3/g, and Aquifer Basalt Kd=0.016 cm^3/g	8.65E+01	3.34E-04	7.13E+00	2.75E-05	4.98E+00	1.93E-05
8.5.2	I-129 With A Sediment Kd=0.4 cm^3/g, and Aquifer Basalt Kd=0.4 cm^3/g	3.78E+01	1.46E-04	1.27E+01	4.92E-05	6.53E+00	2.52E-05
	Np-237 Sensitivity to Kd						
7.8	Np-237 Base case with Kd=8 cm^3/g	3.05E+01	1.92E-04	8.03E+00	5.06E-05	1.20E+00	7.57E-06
8.6.1	Np-237 With A Kd=0 cm^3/g	9.02E+01	5.68E-04	9.02E+00	5.68E-05	4.82E+00	3.03E-05
	Total Pu Sensitivity to Kd						
7.9	Total Pu Base Case With Sediment Kd=22 cm^3/g and Aquifer Basalt Kd=1 cm^3/g	3.62E+01	2.43E-04	3.22E-01	2.15E-06	1.39E-01	9.54E-07
8.7.1	Total Pu With the Sediment Kd=220 cm^3/g and Aquifer Basalt Kd=8.8 cm^3/g	2.25E+00	1.51E-05	2.68E-04	1.79E-09	2.41E-04	1.61E-09

Table 6-14 Aquifer peak concentrations and risk for the TRA footprint area for the sensitivity analyses runs.

Section of Appendix F	Simulation	Simulation Results For The Period Spanning 1953 Through The Total Simulation Time		Simulation Results For The Year 2025		Simulation Results For The Year 2095	
		Peak Concentration pCi/L	Peak Risk	Maximum Concen. pCi/L	Maximum Risk	Maximum Concen. pCi/L	Maximum Risk
Sr-90 Sensitivity to Kd							
7.10	Sr-90 Base case with A Kd=12 cm^3/g	1.56E-01	1.79E-07	1.39E-01	1.79E-07	9.65E-02	1.19E-07
8.1.1	Sr-90 With A Kd=24 cm^3/g	2.44E-02	2.87E-08	2.44E-02	2.87E-08	1.80E-02	2.12E-08
8.1.2	Sr-90 With A Kd=0 cm^3/g	1.88E+04	2.19E-02	4.03E+03	4.72E-03	1.67E+02	1.96E-04
Sr-90 With Increased Tank Farm Source Mass							
8.2	Sr-90 With Increased Tank Farm Source Mass[a]	2.44E-02	2.87E-08	2.44E-02	2.87E-08	1.91E-02	2.22E-08
Sr-90 With Increased Fire Water Leakage							
8.3	Sr-90 With Increased Fire Water Leakage[a]	5.32E-02	5.96E-08	4.79E-02	5.96E-08	2.39E-02	2.78E-08
Sr-90 Leakage From The Upper Interbed							
8.4.1	Sr-90 With 1-GPM Leakage From The Upper Interbed[a]	1.60E+02	1.87E-04	1.60E+02	1.87E-04	2.31E+01	2.71E-05
8.4.2	Sr-90 With 5-GPM Leakage From The Upper Interbed[a]	8.15E+02	9.56E-04	8.15E+02	9.56E-04	1.13E+02	1.33E-04
8.4.3	Sr-90 With 10-GPM Leakage From The Upper Interbed[a]	1.68E+03	1.97E-03	1.68E+03	1.97E-03	2.27E+02	2.66E-04
I-129 Sensitivity to Kd							
7.7	I-129 Base case with Kd=0 cm^3/g	4.82E-01	1.85E-06	2.56E-02	1.19E-07	1.21E-02	5.96E-08
8.5.1	I-129 With A Sediment Kd=0.4 cm^3/g, and Aquifer Basalt Kd=0.016 cm^3/g	2.17E-01	8.34E-07	1.82E-02	5.96E-08	8.86E-03	4.36E-08
8.5.2	I-129 With A Sediment Kd=0.4 cm^3/g, and Aquifer Basalt Kd=0.4 cm^3/g	1.37E-01	5.36E-07	4.04E-02	1.79E-07	2.05E-02	1.01E-07
Np-237 Sensitivity to Kd							
7.8	Np-237 Base case with Kd=8 cm^3/g	2.33E-02	1.19E-07	2.00E-02	1.19E-07	1.96E-02	1.19E-07
8.6.1	Np-237 With A Kd=0 cm^3/g	4.71E-01	2.98E-06	1.24E-01	7.75E-07	3.33E-02	2.38E-07
Total Pu Sensitivity to Kd							

Table 6-14 Aquifer peak concentrations and risk for the TRA footprint area for the sensitivity analyses runs.

Section of Appendix F	Simulation	Simulation Results For The Period Spanning 1953 Through The Total Simulation Time		Simulation Results For The Year 2025		Simulation Results For The Year 2095	
		Peak Concentration pCi/L	Peak Risk	Maximum Concen. pCi/L	Maximum Risk	Maximum Concen. pCi/L	Maximum Risk
7.9	Total Pu Base Case With Sediment Kd=22 cm^3/g and Aquifer Basalt Kd=1 cm^3/g	2.91E-04	1.94E-09	1.54E-04	1.03E-09	1.37E-04	9.13E-10
8.7.1	Total Pu With the Sediment Kd=220 cm^3/g and Aquifer Basalt Kd=8.8 cm^3/g	2.35E-05	1.57E-10	1.59E-09	1.06E-14	1.24E-08	8.28E-14

For the simulations in which Kd was varied (Sr-90, I-129 and Np-237), it is difficult to assess the relative impact by comparing the peak concentrations only. Appendix F, Section 8 provides the model to field data comparison figures for each variation, which allows assessment of the overall model performance. The results are only summarized in this section. The following summarizes the sensitivity of the modeling results to varying parameters, source estimates, and water leakage.

1. For Sr-90, a Kd of 0 cm^3/g was clearly shown to be unrealistic. However, it is very difficult to determine whether a Kd of 12 cm^3/g (base case) or 24 cm^3/g better predicts the historical data. Aquifer model predictions using both Kd values fit the field data fairly well but for different wells. The vadose zone comparison curves show that the model concentrations are slightly high in both cases. Based on a qualitative evaluation of the field data and predictions, the Kd in the alluvium and sediments was probably underestimated. As a result, the model predictions using a Kd of 12 cm^3/g fit the field data for the aquifer fairly well, while the vadose zone comparison curves show that the model concentrations are high. Neither Kd=12 or 24 cm^3/g are clearly better than the other, therefore, the conservative Kd=12 cm^3/g was chosen.
2. The simulation evaluating the effect of increased mass for Sr-90 shows that because of a relatively short half-life and adsorption occurring in the vadose zone, increasing the mass by a factor of 1.5 results in an insignificant increase in mass entering the aquifer. As a result, the risk associated with Sr-90, or any other adsorbing- short-lived radionuclide, will be insensitive to this magnitude of increase in the mass assumed at the tank farm.
3. Increasing the water losses near the tank farm within the uncertainty allowed by metering errors also results in relatively small changes in the risk in the aquifer for Sr-90.
4. Losses to the aquifer from the vadose zone as a result of potential leaks around well casings has a potentially large impact on the quality of water in the aquifer. A small assumed leakage rate in the highest concentration area of the sediment units in the vadose zone results in extremely high concentrations of Sr-90 in the aquifer. Apparently, this leakage does not occur based on measured field data. If in fact the wells leak in the vadose zone, either the leakage is trapped in a lower sediment unit while still in the vadose zone and allowed to decay, or the leakage rate is much smaller than that assumed in this sensitivity study. This sensitivity simulation placed the leakage directly into the aquifer rather than placing it in a lower vadose zone unit.

5. The Kd for the I-129 base case was 0 cm^3/g. Two larger Kd values were used to evaluate the simulation result's sensitivity to Kd (1. sediment Kd=0.4 cm^3/g and aquifer basalt Kd=0.016 cm^3/g, and 2. Kd=0.4 cm^3/g for both the sediment and aquifer basalt). The change in Kd did not result in significantly different predictions than observed in the base case using a Kd of 0 cm^3/g. This is primarily because the bulk of the I-129 was disposed of directly to the injection well, and thus travels through primarily aquifer basalts. If the I-129 had been discharged into the vadose zone, the higher sediment Kd would have resulted in noticeably different results because the I-129 would have traversed large sections of vadose zone sediments as observed with the Kds used for Sr-90. In contrast, the only aquifer sediment exists in the form of the HI interbed and the bulk of the injected I-129 travels through basalt material.

6. Comparisons of model predicted concentrations in the vadose zone to field data for Np-237 using a Kd of 8 cm^3/g (base case) were better than the results assuming a Kd=0 cm^3/g. The Kd=0 cm^3/g case overprediction of Np-237 concentrations in the vadose zone implied that either the source term was overestimated or that Np-237 should be modeled as an adsorptive species in INEEL sediments. The assumed value used in the base case predicts vadose zone concentrations which are very close to the measured concentrations, indicating that a Kd of 8 cm^3/g is a reasonable estimate of the sediment Kd for Np-237. On the other hand, there was very little aquifer data available for use in comparing model predictions to measured concentrations (data were collected once in 1994). More Np-237 data is needed to evaluate the trends over time. Using this limited information, comparisons of aquifer model predicted concentrations to field data show that predicted concentrations are significantly high in wells very close to the injection well, are underpredicted in wells that are upgradient, but are very close for wells further down gradient from the injection well. As a result of limited data, it is difficult to evaluate whether the comparison using base case Kd=8 cm^3/g is significantly better than the Kd=0 cm^3/g case, for the aquifer basalts.

7. The sensitivity of the Total Pu concentrations was evaluated by increasing the Kd value an order of magnitude. The peak aquifer concentration after 2095 was decreased by slightly more than an order of magnitude (from 36.2 to 2.25 pCi/L) and the time to the peak concentration was increased an order of magnitude (from year 3585 to year 18233). The predictions could not be compared with historical data because past sampling efforts have not found Pu at concentrations greater than the uncertainty of the analytical methods used.

These sensitivity results illustrate that the model predictions are;

- relatively insensitive for short lived radionuclides when the Kd and water fluxes are the varied parameters,
- sensitive to the Pu Kd value, and
- very sensitive to the leakage of water from the upper interbed to the aquifer.

6.8 DISCUSSION OF UNCERTAINTY

There were two major WAG-3 subsurface modeling objectives. The first was to estimate contaminant fate and transport in support of the WAG-3 OU-3-13 (ICPP) Baseline Risk Assessment, and the second was to develop a simulation tool to help evaluate the effectiveness of remedial action alternatives with respect to the groundwater pathway. In order to satisfy the first objective, two subsurface flow and transport conceptual models were devised and implemented. The first model was for the vadose zone, and the second model was for the aquifer. Numerical simulation results were obtained using TETRAD together with observed groundwater quality data to predicted contaminant concentrations in the aquifer.

Numerical predictions of transport in the vadose zone and aquifer were based on a) an analysis of the hydrogeologic data forming the basis of the conceptual models for both the vadose zone and aquifer transport models, b) estimates of natural and anthropogenic recharge water sources, c) estimates of contaminant releases forming the source term information, and d) estimates of the contaminant-soil-basalt chemical interactions. As is always the case in subsurface modeling, the available hydrogeologic data were not used directly, but were subject to interpretation and simplified in order to cast the data into a modeling framework; direct

measurements of all historical sources of recharge and contaminant were not available; and the availability of field data for the purposes of determining the soil-basalt-contaminant interactions was minimal. As a result, the ability of the simulation results presented in Section 7 of Appendix F to represent, or adequately predict, contaminant transport in the subsurface of the ICPP are inherently uncertain. The uncertainties associated with these predictions of transport are primarily functions of 1) the degree to which the conceptual model represents unsaturated and saturated zone flow and transport processes at the ICPP, 2) the choice of the contaminant specific Kd values and ability to refine the Kd estimate based on field data, and 3) the accuracy of the estimated source term.

As discussed below, the uncertainty associated with the conceptual model and its parameterization can be, and has been, qualitatively assessed. This assessment was conducted independently from the influence of Kd, and based on relatively accurate source information. On the other hand, the uncertainty arising from estimating contaminant releases (volume and content) and of estimating the interaction of the contaminant with the soil and basalt (Kds) are virtually impossible to quantify independently, and are potentially orders of magnitude more significant. Jointly estimating the combined source term and Kd requires sufficient historical field data from which the in situ transport can be assessed. This estimation process requires both temporally and spatially variable data. In the case of most of the COPCs disposed of at the ICPP, there are insufficient data available for this process. These three sources of uncertainty are summarized below and discussed in detail in Appendix F, Sections 9 and 10.

6.8.1 CONCEPTUAL MODEL

The ability of the two conceptual models (vadose zone and aquifer) to represent hydraulic conditions and the transport of contaminants was illustrated in Sections 3 and 4 of Appendix F. In those sections, the calibration results indicated that it was possible to parameterize the conceptual models in such a way to accurately represent hydraulic data and the transport of conservative tracers in the 1950-1995 time frame. Calibration to hydraulic data (head in the aquifer, and perched water elevations in the vadose zone) was obtained by adjusting the model equivalent of porosity, hydraulic conductivity, unsaturated permeability characteristics, and infiltration until the numerical predictions adequately reproduced field measurements of the target parameter.

Calibration to transport further refined the physical characteristics such that numerical predictions of chloride and H-3 migration matched observed field data over the time period for which data were available. At the INEEL, it is generally assumed that the adsorption of chloride and H-3 to basalt and sediment is negligible. Therefore, they were treated as conservative tracers and were useful for the purposes of calibration. The results of the calibration exercises indicated that obtaining acceptable agreement was possible between hydraulic head, perched water elevations, and transport in both the vadose and aquifer regions. Due to the complexity of the subsurface and sources of water and contaminants, the excellent matches obtained in the flow model and chloride and tritium transport simulations are believed to address and minimize the inherent uncertainty.

The model predictions can be very sensitive to the model dispersion in the vadose zone. Dispersion is an essential part of a subsurface transport model. It accounts for the natural spreading of a contaminant plume that cannot be simulated with a strictly advective (plug flow) model. Model dispersion comes both from numerical dispersion and dispersion purposely incorporated in the model. For contaminants with long decay half-lives, relative to their vadose zone travel time, the bulk of the mass will be advectively transported through the vadose zone. Dispersion will decrease the predicted peak concentration in the aquifer, but not affect the time to the peak mass flux to the aquifer. In general, for contaminants with short decay half-lives relative to the vadose zone travel time, the contaminant will decay in the vadose zone without any significant mass transfer to the aquifer. However, some mass will be transferred to the aquifer because of dispersive transport in the model. The dispersive transport will be significant if the initial mass of the contaminant is sufficiently large that even though the bulk of the contaminant decays in the vadose zone, a significant mass is transferred to the aquifer through dispersion. At the ICPP, this is the case for Sr-90. A large activity of Sr-90 was discharged at the tank farm. The advective transport time through the vadose zone is estimated to be approximately 800 years (with a Kd of 12 cm^3/g) which is 27 half lives. Virtually all of the Sr-90 will have decayed by that time. However, the

model simulation results show a dispersive mass flux to the aquifer over the next 300 to 400 years that results in predicted aquifer concentrations greater than the MCL. Sufficient field measurements are not available to calibrate Sr-90 transport through the vadose zone, as a result of this dispersive flux. Therefore, it is not possible to calculate the uncertainty associated with the Sr-90 predicted aquifer concentrations, from discharges at the tank farm.

6.8.2 Kd

Given sufficient disposal history and field data, Kds can be estimated through inverse or forward parameter estimation. In the case of most of the COPCs modeled, the source term is uncertain and field data are sparse. As a result, Kd values for this modeling were based on values previously used at the INEEL. Most of these values are not based on field calibrated modeling at other INEEL sites, but are values taken from literature or other sources. In addition, because of the extreme heterogeneity encountered in the subsurface of the ICPP, values were assumed for sediment as well as for basalt units. The Kd values presented in Section 5 of Appendix F were uniformly assigned to all of the interbed and alluvium units with the exception that the Kd in the alluvium underlying the Tank Farm was assumed to be zero because of the pH of the raw effluent. To be conservative, the Kd in the vadose zone basalts was assumed to be zero while the Kd in the aquifer basalts was assumed to be 1/25th the Kd applied to the interbeds (based on laboratory data discussed in Sections 5 and 10 of Appendix F).

Field data for contaminants with sufficient sampling information in the perched water and aquifer were compared to predicted concentrations in order to provide a measure of the accuracy of the predictions. On the basis of the comparison information, there is probably enough vadose zone field data to further refine the original estimates of Kd through additional simulation for mercury, Sr-90, and Tc-99, and in the aquifer for Sr-90 and Tc-99. However, in this work, additional simulations to actually determine the COPC specific Kd were not performed. The sensitivity to the assumed Kds for Sr-90, I-129, Np-237, and Total Pu were assessed in the sensitivity analysis.

The modeling result's sensitivity to the Sr-90 and Pu Kds are of particular importance for this analysis because of the following.

- as explained in Section 6.8.1, the predictions of the Sr-90 peak concentrations in the aquifer are controlled by dispersion in the vadose zone. The dispersive flux from the vadose zone model to the aquifer model is very sensitive to the Sr-90 travel time in the vadose zone and therefore, very sensitive to the Sr-90 Kd. A relatively small uncertainty in the vadose zone Sr-90 sediment Kd could result in large uncertainty in the future (after 2095) peak aquifer concentrations.
- the Kd used for Pu (22 cm^3/g) is recognized as conservative because it is similar to the Kd values used for Sr (12 cm^3/g and 24 cm^3/g), yet based on the field measurements, Sr-90 is moving through the vadose zone much more quickly than the Pu. Laboratory studies are ongoing to improve the understanding of Pu transport at the ICPP.

6.8.3 CONTAMINANT SOURCE

The levels of uncertainty associated with the source term used for modeling depends on the specific source. Two of the primary source components are: a) the chemical composition of the spill site, and b) the temporal discharge history of a given contaminant. As indicated in the source term summary given in Table 5-43, the primary contaminant sources for Am-241, Cs-137, Total Pu, Sr-90, and Tc-99 were grouped into the Tank Farm releases. There is one primary source for H-3 (ICPP injection well), I-129 (ICPP injection well), arsenic (soils), chromium (TRA disposal) and a combination of sources for mercury, Co-60, Np-237, and Total U. The injection well releases, tank farm releases, and contaminated soils are the most significant contributors to the total ICPP COPCs inventory.

6.8.3.1 INJECTION WELL

The injection well provided a direct source of contamination to the aquifer (except when the well failed, backflowing into the vadose zone, or when contaminants were discharged to USGS-50). The disposal history of H-3, Sr-90, and Cs-137 are assumed to be accurate. These discharges were monitored regularly and a reasonably complete time history exists of discharged activity. Although not as accurate as the H-3, Sr-90, and Cs-137 disposal histories, the I-129 disposal quantity is assumed relatively accurate. On the other hand, there is relatively sparse information available for the injection well disposal of the other COPCs. Of most concern is the limited available disposal history for Am-241 and Np-237 and the complete lack of disposal history for Tc-99. Because of limited data availability, the direct discharge history was used to estimate a uniform annual disposal rate for all COPCs except H-3, Sr-90, and Cs-137. COPCs affected most notably include Am-241, Np-237, and Tc-99 because the uncertainty of these estimated rates is unknown. In particular, in the model no Tc-99 was discharged to the injection well. Given that Tc-99 appears in most of the other contaminant source locations, it is probable that Tc-99 was discharged in some quantity into the injection well.

The effects of disposal to the injection well have been monitored over time by sampling wells completed in the aquifer. A comparison of the contaminant concentrations from aquifer predictions to field data provides a means of estimating the accuracy of the source terms used for the injection well. With the exception of arsenic, chromium, and Tc-99, there are records that indicate that all of the COPCs were discharged to the injection well. In theory, comparisons to field data for the other COPCs should provide a means of assessing the accuracy of both the source term and the Kds used in the aquifer model. In practice, field measurements over long periods of time do not exist for contaminants other than Sr-90, and H-3. For the remaining, COPCs, single, or closely spaced, data exists allowing estimation of either the source magnitude or Kd, but not both. As a result, the uncertainty for those contaminants is higher, and virtually impossible to quantify without more temporal data.

6.8.3.2 SURFACE SOURCES

Sources at land surface corresponding to the tank farm releases and contaminated soil have to be transported through the vadose zone prior to reaching the aquifer. Surface sources included primarily the tank farm inventory and contaminated soils outside the tank farm. Because the tank farm releases are the dominant influence on the model predictions, the surface source uncertainty evaluation focused on the tank farm releases and neglected the contribution of the soil sources outside the tank farm.

As explained in Appendix F, Section 5.2.2, there were three tank farm releases used to originally define the tank farm source inventories. These correspond to the CPP-28/79, CPP-31, and 1986 releases. Actual liquid waste composition, volumes, and duration for these releases are unknown. As a result, estimates of volume and chemical composition were based on an assumed liquid waste inventory and on estimated waste stream composition as reported in Rhodes (1972) and Donovan (1989) (see Section 5.2.2.1). The Rhodes (1972) data was used to define the CPP-28/79 release using average concentrations of first cycle raffinate. Rhodes data were based on analytical evaluations of September, 1971 first cycle raffinate. The Donovan (1989) data were used to define the CPP-31 and 1986 releases using average concentrations for second cycle raffinate. The second cycle raffinate data were based on analytical evaluations of August 1989 fuel processing effluent. Average data were used because it was assumed that the releases contained waste from many different fuel compositions. The Rhodes (1972) and Donovan (1989) data were based on samples from tanks containing a cumulation of the effluent of many different fuel processing campaigns, yielding an average over many different fuel compositions. Thus, the averaging approach used in Appendix F, Section 5.2.2.1 was assumed to yield representative inventories for the tank farm releases. However, a primary disadvantage of the Rhodes (1972) and Donovan (1989) data is that the sampling was not done or reported specifically for the purposes of characterizing the tank farm releases. As a result, although the mass and activities of the reported contaminants are assumed to be representative of the inventory in the tank farm releases, particular contaminants that would be expected to be present in the final inventory are absent. At least some of the contaminants are missing from the inventory because they were not analyzed for.

During subsequent investigation, it was discovered that the composition of the CPP-31 release could be defined more accurately than using the Donovan (1989) average second cycle raffinate concentration. It was found that the release resulted from a specific valve leak during the transfer of Tank WM-181 to WM-180 in November, 1972. From the historical records, it was possible to identify the type of fuel processed that contributed to the waste contained in Tank WM-181 during that time period. Based on the fuel types, a computer simulation code (ORIGEN2, Radiation Shielding Information Center, 1991) was used to develop a pseudo inventory of the radionuclides contained in Tank WM-181. The simulation was calibrated using analytical data from Tank WM-181 (from September, 1971) and soil samples taken at the release site in 1975. The ORIGEN2 simulation provides process knowledge by which the expected COPCs could be identified and the CPP-31 source inventory could be reestimated and compared with the estimates used for the modeling and presented in Appendix F, Section 5.2.2. Details of ORIGEN2, the calibration process, COPC identification, and subsequent analysis are presented in Appendix N. Comparison of the ORIGEN2 results to the COPC identification and implications for contaminant transport prediction are presented in Appendix F, Sections 10.3.3 and 10.3.4, for the CPP-31 release. For CPP-28/79 and 1986 Release, no additional information has been identified allowing improvement over the original source inventory estimates.

CPP-28/79: The history of the CPP-28/79 release is much more complex than that of the CPP-31 release. It is known to have been first cycle raffinate, and that it occurred from a small hole in a transfer line throughout the 1956 to 1974 time period. The volume released is unknown because the long term gradual release was not monitored. In addition, the release spanned many different fuel processing campaigns. As a result, analysis of the composition of a single waste tank would not provide reliable estimates of the relative contaminant concentrations. The source inventory estimate presented in Appendix F, Section 5.2.2 was based on average concentrations in the tanks in September 1971 for the contaminants that were analyzed. The first cycle raffinate waste in these tanks represents an integration over the previous years spanning more than 80% of the time period during which the release occurred. In deriving the source term, it was assumed that this average composition provides an acceptable estimate of the radionuclide concentrations released at CPP-28/79. The release volume was calculated given the physical characteristics of the piping and hole size. Based on limited soil characterization data, the estimated volume appears reasonable. However, further characterization of contaminated soil would be required to improve the CPP-28/79 estimate.

1986 Release: The 1986 Release was modeled as a second cycle raffinate released in the same vicinity (with respect to model discretization) as CPP-31. In terms of activity, the 1986 Release was much smaller than that of the CPP-31 release (estimated 44 Ci versus 28,900 Ci) making it a relatively insignificant contributor to the contaminant transport results. Because of the time frame and relative volume, the 1986 Release uncertainty has not been quantified.

The limited information defining the sources at the tank farm do not allow for a reliable uncertainty analysis. However, information found during further investigation into the CPP 31 release allows for a better estimate of the CPP-31 release inventory, using a completely different estimation method. This information can be used to evaluate the original CPP-31 estimate. In addition, the reestimated CPP-31 analysis provides a complete set of radionuclide concentration estimates that would have been present in the release. These radionuclide concentrations were used for a COPC screening in order to identify any COPCs that may have been inadvertently eliminated in the original COPC screening.

There are three primary questions to be answered with the uncertainty analysis of the CPP-31 tank farm source estimates.

1. Were all of the significant COPCs identified in Appendix F, Section 5.1?
2. Were the source inventories used to define CPP-31 conservative?
3. How much would the simulation results change based on the reestimated CPP-31 source estimates?

In order to answer these questions, the CPP-31 contaminant source estimates were reinvestigated and reestimated. The reinvestigation used historical process knowledge, analytical results from the liquid waste in

tank WM-181 previous to the release, and analytical results from contaminated soil samples after the release, to simulate a pseudo source that uses all of the information available. The pseudo source was simulated using the ORIGEN2 computer code. Details of this analysis are presented in Appendix F, Section 10 and Appendix N. As explained in Appendix N, the data available indicates an accuracy within a factor of 2 for the nuclides other than the activation products. The activation products were calibrated with Co-60 from CPP-31 soil samples in from 1975 but there is no independent sample information with which to validate the Co-60 estimates.

Based on the assumptions and results of this uncertainty analysis, the COPCs identified in Appendix F, Section 5.1 included all of the significant COPCs from the CPP-31 release with the exception of Pu-238. Based on the reestimated CPP-31 inventory, the source inventory used for the simulations in Appendix F, Section 7 are conservative with the exception of Sr-90 which was increased by 4%. The aquifer predicted contaminant concentrations that result from tank farm sources would change in the following ways.

- There would be very little change in the simulated transport solutions for Co-60, Cs-137, Sr-90, and Tc-99.
- The Am-241 source term has significant uncertainty but an apparently conservative source term has been used resulting in extremely small predicted concentrations from the tank farm releases. Because the Am-241 decays away in the vadose zone, source uncertainty has little effect on the predictions.
- Based on the reestimated tank farm Np-237 inventory, the Np-237 concentrations from tank farm releases are overestimated by a factor of 10.
- Based on the reestimated tank farm Pu-239 inventory, and the Total Pu isotope distribution in the aquifer, the model predicted Total Pu concentrations from tank farm releases are overestimated by 75%.
- Based on the reestimated tank farm uranium inventory, the Total U concentrations from tank farm releases are overestimated by approximately a factor of 6.

6.8.4 CONTAMINANT SPECIFIC UNCERTAINTY

Each COPC is subject to different levels of uncertainty. In addition, the relative importance of quantifying the uncertainty associated with each COPC varies depending on the ultimate prediction of risk. A summary of this information is presented in Table 6-15. Column 2 contains the base case soil Kd value. Columns 3 and 4 contain the source summary for each COPC. Column 5 is the year of the peak aquifer concentration, Column 6 is the overall maximum risk or HQ (for HQ values, a HQ is added in parenthesis), and Column 7 is the maximum risk or HQ in 2095 or beyond. If the risk or HQ value in Column 7 is for beyond the year 2095, the year of the peak is included in parenthesis.

Table 6-15 Summary of uncertainty information in the aquifer simulated predictions.

COPCs	Base Case Soil Kd Value (cm^3/g)	Source Summary		Year of Predicted Maximum Aquifer Concentration	Simulation Results		Comments
		Injection Well Activity(%)	Other Major Sources (%)		Overall Maximum Risk or HQ	Maximum Risk or HQ in 2095 or Beyond	
Arsenic	3.0	0%	soil (100%)	2479	3.42E-05	3.42E-05 (2479)	Measured concentrations are at essentially background levels.
Chromium	1.2	0%	TRA (99.4%)	1971	4.94 (HQ) (ICPP=0.013)	0.18 (HQ) (ICPP=0.012)	The primary source is at TRA. Concentrations in the ICPP area are low and reports indicate that there was very little chromium released from the ICPP, and the aquifer and vadose zone field data provide verification.
Co-60	10	0.7%	tank farm (39%) soil (60%)	1986	1.03E-05	0.00E+00	The peak risk was predicted to occur in 1986, implying that concentrations should be on the decline from now on. The short half life (~5 years) means that during the 100 years from 1995 until 2095, there are 20 half lives or approximately a factor of one million decay. There could be a large degree of uncertainty in both the Kd and source term before Co-60 will exceed risk based levels at any time beyond 2095.
Cs-137	500	0.1%	tank farm (90%) soil (9%)	1979	5.72E-05	3.92E-06	The peak risk was predicted to occur in 1979, implying that concentrations are declining. This is consistent with measured concentrations in the aquifer which have not exceeded the MCL since the early 1980s. The high Kd assumed for Cs-137 causes Cs-137 to be adsorbed in the vadose zone and aquifer sediments, and allows it to essentially decay in place. Comparison of model predictions to aquifer measurements indicate that the model is underpredicting the Cs-137 aquifer concentrations. Declining concentrations imply that the aquifer source is the injection well rather than the surface sources. Therefore, it is possible that the injection well Cs-137 source was underestimated in the model (or that the Kd was overestimated). Simulations were not performed to assess the impact of either source mass or Kd for Cs-137.
H-3	0	66%	TRA (29%)	1960	3.93E-03	1.34E-07	The peak risk was predicted to occur in 1960. In addition, most of the H-3 discharged near the ICPP was in the aquifer by the time the injection well was closed. H-3 undergoes dilution, dispersion, and decay relatively quickly because of a short half life and lack of adsorption. Because H-3 has been measured in the aquifer and because the aquifer model was calibrated using H-3, there is relatively little uncertainty in the predictions.
I-129	0	91.6%	SWP (5.4%) Soil (2.6%)	1986	3.75E-04	1.81E-05	The peak risk was predicted to occur in 1986. The majority of the I-129 was put into the injection well and is currently moving through the aquifer. I-129 has a relatively long decay half-life so that no significant decay is expected in the aquifer, in the near future. The peak I-129 concentrations are predicted to remain above the MCL (1 pCi/L) until the year 2167 and fall below the 10^{-6} risk based concentration (0.26 pCi/L) in 2435. Because the I-129 has been measured over time in the aquifer at a number of wells and the model predictions are close to the field measurements, the predictions have a relatively high degree of certainty.

Table 6-15 Summary of uncertainty information in the aquifer simulated predictions.

COPCs	Base Case Soil Kd Value (cm^3/g)	Source Summary		Year of Predicted Maximum Aquifer Concentration	Simulation Results		Comments
		Injection Well Activity(%)	Other Major Sources (%)		Overall Maximum Risk or HQ	Maximum Risk or HQ in 2095 or Beyond	
Mercury	100	39%	soil (58%)	1984	2.36	1.33 (HQ)	The peak risk was predicted to occur in 1984 as a result of the injection well source (extrapolated from the 1980-1983 disposal data) rather than the roughly equal soil source term. The soil source contributes very slowly to the aquifer because mercury has a very high Kd, implying that the migration of mercury occurs simply as a result of dispersion. As a result, the contaminated soils add little to the risk even after large time periods because the primary advective force will be removed with the percolation ponds. Because the mercury in the aquifer came from the injection well, the peak concentration will continue to decrease as it migrates very slowly down gradient. There are very few mercury measurements in the aquifer at greater than the estimated background concentration of $1x10^{-4}$ mg/L, however, there was one measurement of $3.2x10^{-4}$ mg/L at well USGS-47 in June of 1995. The predicted maximum concentration is approximately 20 times larger (in 1984) and the predicted concentration at USGS-47 in June of 1995 is approximately 10 times larger. Based on the aquifer measurements, the injection well source may be overestimated. Differences between measured and predicted concentrations could be due to the model predictions indicating that the mercury concentrations should decrease rapidly with distance from the injection well. As a result, the probability of sampling the maximum concentration using an existing well is very low.
Np-237	8	75%	tank farm (15%) soil (9%)	1986	1.92E-04	2.37E-05	The peak risk was predicted to occur in 1986 as a result of Np-237 discharged to the injection well. The source inventory was based on two reported Np-237 concentrations in the injection well discharge which were applied as a constant rate over a large period of time. This could have resulted in significantly overestimating the activity discharged into the injection well. The comparison with the aquifer data close to the injection well supports this. However, there are very few data points with which to make the comparison. Although the uncertainty in the Np-237 predictions cannot be quantified, because the predicted Np-237 concentrations are above a 10^{-6} risk based concentration, the existence of this uncertainty is potentially significant.

Table 6-15 Summary of uncertainty information in the aquifer simulated predictions.

COPCs	Base Case Soil Kd Value (cm^3/g)	Source Summary		Year of Predicted Maximum Aquifer Concentration	Simulation Results		Comments
		Injection Well Activity(%)	Other Major Sources (%)		Overall Maximum Risk or HQ	Maximum Risk or HQ in 2095 or Beyond	
Total Pu	22	0.07%	tank farm (99%)	3585	2.43E-04	2.43E-04 (3585)	The peak concentration is predicted to occur in 3585 as the vast majority of the Pu migrates through the vadose zone from the tank farm. Because there is no Pu measured in the aquifer or perched water at above detection limits, the results could not be compared to measured values. Because the peak concentration is greater than the 10^{-4} risk based concentration, the lack of data is potentially significant. The Pu Kd used was 22 cm^3/g which is considered to be very conservative. Laboratory studies are currently underway to improve this Kd estimate. By obtaining comparable laboratory Kd values for Sr-90 and Pu, and using field measurements to define Sr-90 transport, a field scale Pu Kd value will be estimated in the future. An increase in the Kd of one order of magnitude will decrease the peak aquifer concentration more than an order of magnitude and increase the time to the peak an order of magnitude. There is considerable uncertainty in the overall tank farm release estimates; further increasing the impact of uncertain Kd values.
Sr-90	24	0.12%	tank farm (93%) soil (6%)	1967	1.41E-03	1.87E-05 (2172)	The peak concentration was predicted to occur in 1967. The majority of the Sr-90 source is attributed to the tank farm releases but the Sr-90 currently detected in the aquifer originated from the injection well. Because of its Kd value, Sr-90 is moving through the vadose zone slowly. The comparison of the predicted vadose zone and aquifer concentrations with measured concentrations shows that the model predictions are similar to the measured concentrations. In general, the vadose zone predictions overestimate the concentrations implying that the vadose zone model underestimates the travel time from the ground surface to the aquifer. Five different Sr-90 sensitivity runs were presented in Appendix F, Section 8. The sensitivity runs indicate that leakage from the upper perched water to the aquifer (down a well) could significantly affect the measured concentrations. A comparison of the fits of the predictions using Kd=12 (base case) or 24 cm^3/g (sensitivity case) to the historical data was not conclusive because the model differences are not sufficiently large to identify a best fit to the field data. A much more accurate source term and significantly more field data would be needed to discriminate between the two models. The peak aquifer concentrations after the year 2095 are primarily from releases from the tank farm. A very small amount of the Sr-90 reaches the aquifer because the Sr-90 moves slowly through the vadose zone, relative to its decay half-life. The mass that does reach the aquifer is the result of model dispersion which cannot be calibrated with the field data currently available. Therefore, the predicted future (after 2095) peak concentrations in the aquifer have a relatively large uncertainty. The uncertainty of the near term aquifer concentrations (Sr-90 disposed of to the injection well) is small. However, the uncertainty in the vadose zone concentrations is much larger. Based on the field data currently available, it appears that the simulation model provides conservative predictions as currently parameterized. However, future field data will be needed in order to understand the dispersive Sr-90 transport in the vadose zone, to accurately predict the future affect on aquifer concentrations.

Table 6-15 Summary of uncertainty information in the aquifer simulated predictions.

COPCs	Base Case Soil Kd Value (cm^3/g)	Source Summary		Year of Predicted Maximum Aquifer Concentration	Simulation Results		Comments
		Injection Well Activity(%)	Other Major Sources (%)		Overall Maximum Risk or HQ	Maximum Risk or HQ in 2095 or Beyond	
Tc-99	0.2	0%	tank farm (96%) soil (4%)	1997	5.96E-06	7.03E-07	The peak concentration is predicted to occur in 1997 as a result of migration from the surface. The vast majority of the Tc-99 source was assumed to be from the tank farm and thus has a zero Kd under the primary source in the alluvium, and a small Kd in the other matrix materials. As a result of the small Kd, predicted aquifer concentrations for the 1990s are the result of Tc-99 moving through the vadose zone. However, it is impossible to determine if Tc-99 was actually discharged to the injection well. There are recent Tc-99 field data, but no historical data (in the 1950-1990 time period). In almost all of the perched water wells, the predicted concentrations were higher than observed values. This implies that the tank farm source is overestimated. However, predicted concentrations in the aquifer are fairly accurate for wells near the ICPP, indicating that the surface sources are fairly accurate. It is possible that Tc-99 could have been discharged to the injection well in the 1953-1986 time period and that it has moved downgradient from the ICPP.
Total U	6	13%	tank farm (37%) soil (46%)	1986	1.31E-05 0.13 (HQ)	7.30E-06 0.5 (HQ) (2468)	The peak concentration was predicted to occur in 1986, as a result of U discharged into the injection well. A second local maxima is predicted to occur in the concentration in approximately the year 2468 (at the $7x10^{-6}$ risk level) as a result of the downward migration from contaminated soils. Comparisons are not presented for total U because it was simulated as total U but field data exists for a) random numbers of the various isotopes at a given sample times; b) single isotopes at a given time; or c) total U at a given time. As a result of offset sampling intervals and the combination of isotopic and total data, direct comparison of the model predicted concentration to the field data would be at best subjective, and at the minimum very difficult to interpret. The source term uncertainty analysis indicates that the estimated CPP-31 inventory of Total U mass was overestimated by a factor or 7 to 8 which would decrease the overall tank farm inventory by a factor of 6 (Appendix F, Section 10.6). After year 2095 there is the predicted peak aquifer concentration greater than 10^{-6} risk based concentration, therefore, the uncertainties due to source term estimation, estimated Kd, and inadequate field data are potentially significant.
Am-241	340	0.1%	tank farm (99%)	1986	6.32E-06	4.35E-06	The peak concentration is predicted to have occurred in 1986 as a result of a relatively small injection well source. This source term was estimated based on a single reported Am-241 value and applied to a representative time period. As a result, the injection well source term is uncertain. In addition, the vast majority of the Am-241 source is attributed to the tank farm releases and should currently be moving very slowly through the vadose zone because of its high Kd. After 2095, when the ICPP water sources are assumed to stop, the Am-241 in the vadose zone will basically stop and the Am-241 will decay in place. There is very little evidence of Am-241 in the aquifer, and comparisons of predictions to measured concentrations are not very useful in assessing the accuracy of the estimated source term or the assumed Kd. The peak Am-241 concentration is predicted to remain above the 10^{-6} risk level until the year 2400. However, because of the high Kd, the area within the 10^{-6} risk based concentration plume will be relatively small.

Table 6-15 Summary of uncertainty information in the aquifer simulated predictions.

COPCs	Base Case Soil Kd Value (cm^3/g)	Source Summary		Year of Predicted Maximum Aquifer Concentration	Simulation Results		Comments
		Injection Well Activity(%)	Other Major Sources (%)		Overall Maximum Risk or HQ	Maximum Risk or HQ in 2095 or Beyond	
Total Am-241	340	0.1%	tank farm (99%)	NC	NC	6.00E-06	Pu-241 that has been discharged into the aquifer and vadose zone is and has been decaying into Am-241. This decay provides an additional source of Am-241 in the vadose zone and in the aquifer. The cumulative Am-241 from direct disposal and the decay of Pu-241 is referred to as Total Am-241 and is predicted to be above the 10^{-6} risk level until the year 2500. As with the directly disposed of Am-241, the area within the 10^{-6} risk based concentration plume will be relatively small. The sources of uncertainty for Total Am-241 include those for Pu-241 and those for directly disposed of Am-241.

NC - not calculated because the peak Am-241 is from the injection well before the Pu-241 decays to Am-241.

6.9 References

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Chapter 7

7. HUMAN HEALTH RISK ASSESSMENT METHODOLOGY

The purpose of a Baseline Risk Assessment (BRA) is to evaluate potential adverse impacts to human health and the environment resulting from exposure to site-related radioactive and nonradioactive contamination. Therefore, the major components of a BRA are a Human Health Risk Assessment (HHRA) and an Ecological Risk Assessment (ERA). This section describes the methodology for conducting the HHRA for the waste area group (WAG) 3 Comprehensive Remedial Investigation and Feasibility Study (RI/FS). This methodology will be implemented consistently across all retained sites within WAG 3. The results of the BRA are presented separately for each release site in Sections 8 through 26 of this report. A summary of the methodology and the results of the ERA are found in Section 27.4 of this report.

Generally the goals of an HHRA are to provide:

- An analysis of baseline human health risks in a cumulative manner to help determine the need for action both at a WAG-wide level and at specific release sites
- A basis for determining levels of contaminants that could remain onsite and still be adequately protective of human health
- A basis for comparing potential health impacts of various remedial alternatives
- A consistent process for evaluating and documenting adverse impacts to public health
- Information that helps with risk management decisions.

As detailed in Section 5, the results of the site and chemical screening process identified those sites and contaminants to be evaluated in the WAG 3 human health evaluation. This section will describe the risk assessment framework for conducting the human health portion of WAG 3 cumulative BRA in terms of the exposure assessment, toxicity assessment, risk characterization, and uncertainty analysis. Only the 48 release sites that did not screen out and summarized in Table 5-51 will be evaluated according to this framework. The uncertainty analysis section will qualitatively describe sources of uncertainty that are germane to the risk assessment process. Site-specific sources of uncertainty are described separately for each release site in Sections 8 through 26. Finally, uncertainty in the results of evaluating certain pathways cumulatively is discussed in Section 27.

7.1 Exposure Assessment

An exposure assessment was conducted to estimate the type, timing, and magnitude of exposures that receptors may experience because of contact with site-related chemicals, radioactive and nonradioactive. The primary purpose of the exposure assessment is to estimate total dose for a receptor that can later be compared with chemical-specific dose response data to estimate cancer risk and likelihood of other noncancer adverse health effects. The process of a chemical entering the body occurs in two steps: first an exposure, or contact with the chemical, must take place, and second, actual entry into the receptor must occur. To help demonstrate the link between a contaminant source and a receptor, a conceptual site model (CSM) was prepared and is presented in Figure 7-1. The CSM is a graphical representation of potentially complete exposure pathways and routes under current and future land use conditions. The CSM illustrates the contaminant sources, primary release mechanisms, secondary sources and release mechanisms, exposure pathways, exposure routes, and receptors specific to WAG 3. The assessment is accomplished by means of qualitative and quantitative efforts. The qualitative statements consist primarily of potentially exposed receptor populations under current and future land use conditions and potential exposure pathways. The

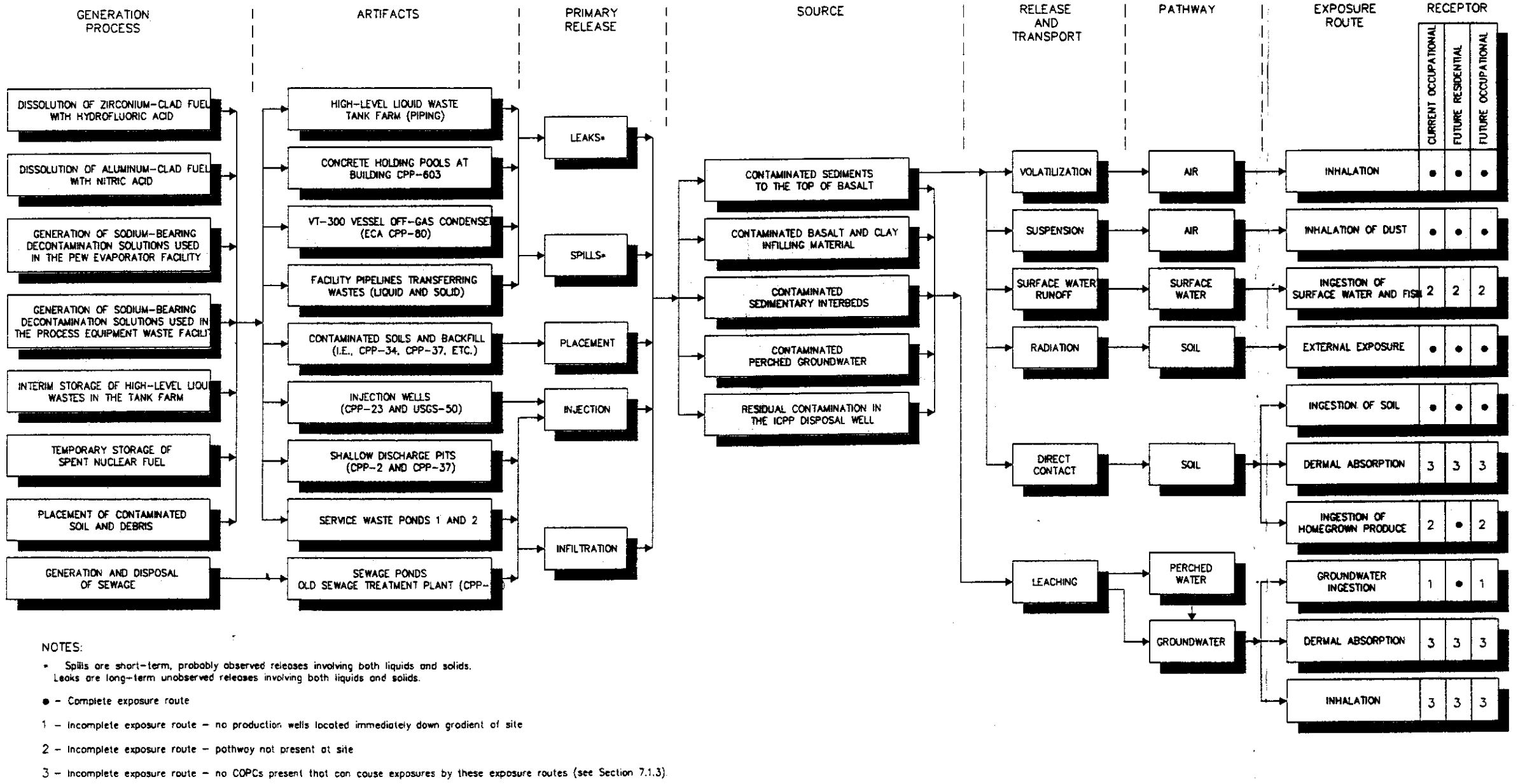

Figure 7-WAG 3 conceptual site model.

Figure 7-1. WAG 3 conceptual site model.

quantitative efforts consist of estimating the exposure point concentrations within each environmental medium and evaluating the levels of chemical exposure associated within each pathway. These tasks are accomplished with the use of the CSM and the data obtained from site characterizations. The qualitative and quantitative features of the exposure assessment are described in more detail in Sections 7.1.1 through 7.1.4.

7.1.1 Identification of Potentially Exposed Receptor Populations

The identification of potentially exposed receptor populations includes consideration of applicable current and future land use scenarios. As shown by the CSM, two potential receptor populations have been identified and will be evaluated in the WAG 3 HHRA. These receptors are occupational site workers and hypothetical future residents. The following sections describe the rationale behind the selection of these receptor populations.

7.1.1.1 Current Land Use. The original mission of the ICPP was to reprocess spent reactor fuel elements to recover highly enriched uranium. In 1992 the mission was changed and the facility no longer reprocesses spent nuclear fuels. The mission of this facility was changed to include providing safe interim storage of spent nuclear fuels; providing research and development support for the disposition of these fuels in a Federal geologic repository; managing other high-level wastes; managing wastes from past reprocessing and decontamination and decommissioning (D&D) activities; and developing improved waste management techniques.

Because the current land use includes continued utilization of operating facilities and access to these facilities is controlled, the only potential receptor is an occupational worker during the current land use scenario.

7.1.1.2 Future Land Use. Future land use scenarios are identified in the *Long-Term Land Use Future Scenarios for the Idaho National Engineering Laboratory*. This document identifies anticipated activities for the next 100 years and projects the current industrial uses to continue at WAG 3. Some of these uses include but are not limited to future D&D of operating facilities and potential construction of new facilities for treatment of radioactive calcine. Therefore, the future land use scenario should include occupational workers. Also, for the purposes of the WAG 3 HHRA it will be assumed that residential development may occur and thus, exposures to hypothetical future onsite residents will be evaluated. The residential receptor is assumed to be an adult for all potentially complete pathways; additionally, a child receptor will be included in the soil ingestion pathway assessment. For this pathway, the child and adult parameters will be averaged on a time-weighted basis. Child exposures are only considered for the soil ingestion exposure route for two reasons. First, the difference in intakes for children as compared to adults is potentially greatest for the soil ingestion exposure route, and second, the majority of toxicity information available in IRIS and HEAST is chronic exposure information that may not be suitable for use in evaluating the relatively short term exposures associated with childhood. The timing for the future land use exposure scenarios will be assumed to be 100 years in the future for both receptor populations.

7.1.2 Identification of Potential Exposure Pathways

The CSM for WAG 3 includes several exposure pathways and associated routes that were selected for further evaluation based on process and release history. These pathways and routes are summarized on Table 7-1 under both current and future land use conditions. It should be noted that the completeness of exposure pathways and routes are expected to vary between release sites according to the absence of site-related chemicals or the presence of engineering features or artifacts that prevent exposure from taking place. Site-specific features that influenced the completeness of pathways and exposure routes will be described separately for each site in Sections 8 through 26 of this report.

Table 7-1. Potentially complete exposure pathways to be quantitatively evaluated for WAG 3 and associated soil depths by exposure route.

Potentially exposed receptor	Scenario	Potentially complete exposure pathways and soil depths by exposure route
Occupational worker	Current land use	Inhalation of volatile organic compounds (VOCs) [0–15 cm (0–6 in.)][a] Inhalation of airborne particulates [0–15 cm (0–6 in.)][a] Ingestion of surface soil [0–15 cm (0–6 in.][a] External radiation [0–1.22 m (0–4 ft)][b]
Residential	Future land use	Inhalation of VOCs [0–3.05 m (0–10 ft)] Inhalation of airborne particulates [0–3.05 m (0–10 ft)] Ingestion of surface soil [0–3.05 m (0–10 ft)] Ingestion of homegrown produce [0–3.05 m (0–10 ft)] Ingestion of groundwater External radiation [0–3.05 m (0–10 ft)]
Occupational worker	Future land use	Inhalation of VOCs [0–15 cm (0–6 in.)][a] Inhalation of airborne particulates [0–15 cm (0–6 in.)][a] Ingestion of surface soil [0–15 cm (0–6 in.)][a] External radiation [0–1.22 m (0–4 ft)][b]

a. Exposure is assumed to be limited to surface soil. Surface soil is considered as the top 0–15cm (0–6 in.).

b. Exposure is assumed to be limited to the 0 to 1.22m (0–4 ft.) Interval for undisturbed soil. Contamination below that depth is assumed to be shielded by the top soil.

c. Exposure is assumed to be possible for all contamination within the 0 to 3.05m (0 to 10 ft.) Interval because of the excavation required for a basement. Conceivably, soils across the interval have the potential to become surface soil thus allowing exposure to occur to the hypothetical resident.

7.1.3 Derivation of Exposure-Point Concentrations

Sections 7.1.3.1 through 7.1.3.3 will describe in detail the methods used to derive exposure concentrations for the routes within each exposure pathway evaluated. Generally, the analytical results of the field investigations conducted since 1991 were used to estimate exposure point concentrations for each site-related chemical. This was accomplished by implementing the measures below for each retained site:

- Extract (by site) contaminant of potential concern (COPC) concentration data from the Environmental Restoration Information System (ERIS) or from appropriate information sources
- Eliminate data that were rejected per the method validation
- Eliminate data that indicated probable blank contamination
- Segregate quality control data (e.g., blanks, duplicates)
- Average duplicate results
- Assume nondetects are one-half the reported sample quantitative limit

- Aggregate data by individual COPC
- Aggregate COPC data by select depths, i.e., surface and surface + subsurface, (see Table 7-1)
- Calculate the 95% upper confidence level (UCL) of the arithmetic mean for each COPC by select depths [Environmental Protection Agency (EPA, 1992a)]
- Assess appropriateness of the 95% UCL versus maximum concentration (EPA, 1992a)
- Select appropriate concentration estimate
- Calculate contaminant concentration and/or contaminant mass.

Maximum concentrations are used when the 95% UCL exceeds the maximum value or when the 95% UCL is not calculated because data from only three or less samples are available. Specific calculations for the 95% UCL are dependent upon data distribution, (i.e., are the data distributed normally or lognormally). If the distribution of the data is unknown it is reasonable to assume that it is lognormally distributed (EPA, 1992a). With the exception of select contaminants for CPP-88 no statistical analyses were performed as part of this BRA to determine the distributions of sampling data sets. The results of distribution testing for CPP-88 are discussed in Section 7.4, Uncertainty Analysis and Table 7-12. The 95% UCLs of the arithmetic mean for single site data sets, assuming lognormally distributed data, were calculated using Equation 7-1 (EPA, 1992a):

$$UCL = e^{(\bar{x} + 0.5s^2 + sH/\sqrt{n-1})} \quad (7\text{-}1)$$

where

UCL = upper confidence limit

e = constant (base of the natural log, equal to 2.718)

$\bar{x}$ = mean of the transformed data

s = standard deviation of the transformed data

H = H-statistic (e.g., from table published in Gilbert, 1987)

n = number of samples.

Several sites were evaluated together as a group. In this event, the contaminant exposure point concentrations were calculated to represent an area weighted value over the entire group. This was accomplished by taking the contaminant 95% UCL at each release site within the group and weighting it according to Equation 7-2 below:

$$UCL_{group} = \frac{\Sigma\, UCL_n\, A_n}{A_T} \quad (7\text{-}2)$$

where

UCL_{group} = area weighted UCL in mg/kg or pCi/g

UCL_n = contaminant soil concentration as the UCL at site n (mg/kg or pCi/g)

A_n = surface area of site n (m^2) (including interstitial area as a site)

A_T = total area of the group ($ft^2 \times 0.093\ m^2/ft^2$)

n = number of sites (including interstitial area as a site).

As described in Section 5, the upper end contaminant average values from CPP-88 were assumed to representative of interstitial soil between release sites within each group. The only exception is at the Tank Farm, where it was suggested by the DOE-ID Project Manager that the sample results of soil taken during an upgrade project would be more representative of contaminant levels from soil in this area. However, it should be noted that the soil removed during the upgrade project is not a CERCLA site.

Concentration estimates to evaluate surface receptor exposure do not account for loss terms other than radioactive decay. The nature of this evaluation is conservative, and loss terms such as biological decay and mass transport (leaching) out of the zone of contamination into deeper soils may be realistic to consider but have not been included in the source estimates for surface exposure.

7.1.3.1 Soil. The soil pathway and associated exposure routes were evaluated within each release site and in some cases within a group consisting of multiple sites under both the current and future land use conditions. As a result, total chemical intake associated with the available routes within the soil pathway will be estimated using the exposure point concentrations for this medium at each site. For soil pathways, an occupational receptor will be assumed to be present at a site for 25 years and a residential receptor for a total of 30 years. The following routes of exposure for the soil pathway will be considered:

- Soil ingestion
- External exposure to radionuclides
- Dermal absorption.

Each of these routes and the assumptions used to calculate exposure concentrations are discussed below. Because there are very few contaminants at WAG 3 that contribute by dermal exposure, the section below will discuss the exposure concentration, the method to calculate absorbed dose, and the results for the few COPCs. Also, an explanation for not estimating dermal contributions from the bulk of the COPCs at WAG 3 is provided.

Soil Ingestion —Using the techniques described in Section 7.1.3., the COPC concentration estimates for evaluation of occupational and future residential exposure will be based on the soil measurements between 0–6 inches and 0–10 feet below ground surface (bgs), respectively. The concentration estimates for radioactive contaminants were corrected for nuclear decay for each of the depth intervals.

External Radiation—Exposure Using the technique described in Section 7.1.3, the COPC concentration estimates for evaluation of occupational and future residential exposure will be based on the soil measurements between 0–4 feet and 0–10 feet bgs, respectively. The concentration estimates for radioactive contaminants will be adjusted to reflect nuclear decay.

Dermal Absorption from Soil—Risks from dermal absorption from soil are controlled by a contaminant's potential for being absorbed through skin. This potential is quantified by a contaminant's dermal absorption factor (i.e., the fraction of a given contaminant that can be absorbed through skin) (ABS). ABS values are not well quantified for many of the contaminants that have been detected at WAG 3; however, EPA Region III has issued general guidelines for default ABS values (EPA, 1995, *Assessing Dermal Exposure from Soil*, EPA/903-K-95-003, December 1995).

Organic contaminants have the greatest potential for producing unacceptable dermal absorption from soil exposures. The reason for this distinction is that, in general, organic contaminants have relatively high ABS values. For example, EPA (1995) recommends assuming an ABS value of 3% for volatile organic contaminants with vapor pressures lower than benzene (i.e., vapor pressure less than 95.2 mm Hg), and an ABS value of 10% for semi-volatile contaminants. Since ABS values are poorly defined for most contaminants, and organic contaminants have the greatest potential for producing unacceptable dermal absorption risks, only organic contaminants are quantitatively evaluated for dermal absorption exposure in this BRA. The recommended ABS values from EPA (1995) are used for this evaluation.

EPA (1995) also recommends that the following equation be used for calculating absorbed dose from dermal contaminants:

$$AD = \frac{C_{soil} \times SA \times AF \times ABS \times EF \times EF \times E \times CF}{BW \times AT}$$

where

AD = absorbed dose (mg/kg-d)

C_{soil} = contaminant soil concentration (mg/kg)

SA = skin surface area available for contact (3,000 cm^2/event)

AF = soil to skin adherence factor (0.5 mg/cm^2)

ABS = absorption factor (unitless)

EF = exposure frequency (350 events/yr for residential exposures)

ED = exposure duration (30 years for residential exposures)

CF = conversion factor (1E-06 kg/mg)

BW = body weight (70 kg)

AT = averaging time (10,950days for noncarcinogens [= 30 yr × 365 d/yr], or 25,550 days for carcinogens [= 70 yr × 365 d/yr]).

Almost all organic contaminants were screened out in Section 5. Benzo(a)pyrene, kepone, and phenanthrene at small concentrations in sites CPP-37B, -14, and -90 are the only organic contaminants remaining in the BRA. Kepone and phenanthrene do not have published health criteria and cannot be evaluated quantitatively. These will be discussed as a source of uncertainty in Section 7.4.7. The ABS used

for BAP is 10%. The excess cancer risk to a future resident from exposure to this contaminant at a maximum soil concentration of 0.34 mg/kg is approximately 1E-06.

EPA (1992c) shows that if the ABS value for a given COPC is less than 10%, then the dermal absorption for soils exposure route for that COPC is likely to produce risks that are less than risks produced by the ingestion of soil exposure route. Since all of the EPA Region III recommended ABS values for WAG 3 COPCs are less than or equal to 10%, the dermal absorption from soil exposure route is likely to produce risks that are less than the soil ingestion exposure route. As discussed above, the soil pathway analysis includes evaluations of soil ingestion risks, homegrown produce ingestion risks, and external radiation exposure risks. These exposure routes will likely dominate the soil pathway exposures.

All COPCs are screened from further analysis under the dermal absorption from soil exposure route for three reasons. First, as discussed above, the dermal absorption from soil exposure route will produce smaller calculated risks than the soil ingestion exposure route for all WAG 3 COPC; second, the ABS values for most WAG 3 COPCs are not well defined and are therefore of limited use in calculating dermal absorption risks; and third, organic contaminants, the class of contaminants that are most likely to produce unacceptable dermal absorption risks are not widespread at WAG 3 as indicated in Chapter 5. Only three organic contaminants survived the screening process: phenanthrene, benzo(a)pyrene, and kepone.

Omitting an evaluation of dermal absorption in BRA could result in an underestimation of risk by a factor of two. This situation could occur at a site that contains one or more contaminants that produce dermal absorption risks that are equal to soil ingestion risks if the contaminants produce the highest risk at the site, and the soil ingestion exposure route is the exposure route with the highest calculated risk for the site. This situation is considered unlikely at WAG 3, so omitting the dermal absorption of soil exposure route from further evaluation is not expected to produce an underestimation of cumulative risk for the WAG.

7.1.3.2 Air. This section describes the methodology used to estimate contaminant air concentrations due to emissions that may result from multiple sites of concern within WAG 3. It is important to note that these concentration terms will be calculated as average values over the entire WAG 3 and therefore, will be the same regardless of location within the ICPP. These values will then be used to assess the cumulative intake and health impacts (cancer risk and noncarcinogenic health effects) to potential receptors in the area. Current and future occupational workers will be assumed to be exposed to those contaminants measured in the upper 6 inches of soil or the next available sample interval, if necessary. Future residential exposure will be based on the chemicals measured in the top 10 feet of soil. All radioactive contaminants will be adjusted to account for nuclear decay for use under future land use conditions. The air exposure point concentrations were estimated assuming that the release mechanisms are fugitive dust emissions and volatization. To this end, the following sections describe how these concentrations were estimated.

Inhalation of Fugitive Dust—A respirable particulate (R) value will be used to estimate the C_{air} for the COPCs. The R value is based on the respirable particulate emissions from wind erosion at WAG 3 (Mitchell, 1994). The emissions will be assumed to be steady state with the concentration of COPCs not depleting with time. Equation (7-3) will be used to estimate this value.

$$C_{air} = CF \; R \; C_{soil} \qquad (7\text{-}3)$$

where

C_{air} = contaminant concentration in the air (mg/m^3 or pCi/m^3)

CF = for nonradionuclides, the conversion factor from kg to µg (CF=1E-09) is used; for radionuclides, the conversion factor from g to ug (CF=1E-06) is used.

R = WAG 3 respirable particulate matter = 14 µg/m^3 (Mitchell, 1994). Value represents the arithmetic near, with 95% confidence interval for the mean, of weekly airborne particulates matter concentration measured by the CPP low value air sampling station.

C_{soil} = contaminant concentration in the soil (mg/kg or pCi/g) weighted by site area.

The air concentration will be derived using area weighted average soil values from the retained release sites within WAG 3. The soil concentration term will be weighted using Equation (7-4).

$$C_{soil} = \frac{\Sigma C_n A_n}{A_T} \qquad (7\text{-}4)$$

where

C_{soil} = area weighted average in mg/kg or pCi/g

C_n = contaminant soil concentration at site n (mg/kg or pCi/g)

A_n = surface area of site n (m^2)

A_T = total area of all release sites (m^2).

It should be noted that the computation of the area weighted soil concentration will include soil measurements from CPP-88 for the areas outside of sites and/or groups and for the interstitial areas between release sites within each group. The exception to this will be for the Tank Farm Group where the average surficial concentration from soil removed during an upgrade project were considered more representative of contaminant levels in that area.

Inhalation of Volatiles—All VOCs in WAG 3 soils have been eliminated as COPCs (see Table 5-51). As a result, the inhalation of volatiles exposure route is incomplete and not evaluated further.

7.1.3.3 Groundwater. The methodology used to estimate groundwater contaminant concentrations is described in detail in Section 6 and Appendix F of this report. It is important to note that these concentration terms were calculated as maximum values to coincide with the 100 year future residential scenario time frame over the entire WAG 3 and therefore, will be the same regardless of location within the ICPP. These values will be used to assess the cumulative intake and health impacts (cancer risk and noncarcinogenic health effects) only to potential future onsite residents. This pathway was assumed to be incomplete for current and future onsite workers because the source of drinking water is the production wells in the northern ICPP that are not subject to site-related contamination because they are located upstream from the areas of contamination. All radioactive contaminants will be adjusted to account for nuclear decay for use under future land use conditions. The exposure routes associated with this pathway are ingestion, dermal absorption during bathing, and inhalation of volatiles from indoor water use. Since the concentrations to evaluate groundwater ingestion and dermal absorption are given in Section 6, the following sections will focus on describing the techniques used to screen (dermal) or derive the exposure point concentrations.

It should be noted that there are significant differences between how the source estimates were calculated for use in evaluating residential surface exposure and groundwater exposure. At many sites this

has led to differences in COPC inventory between the surface evaluation and groundwater sources. The explanation of the occurrences is site-specific in nature and are further discussed for each site in Sections 10 through 26.

Only inorganic COPCs have been retained for the groundwater pathway analysis (see Chapter 6), so there are no COPCs at WAG 3 that would cause exposures by the dermal absorption of groundwater exposure route. The rational for this was explained in the dermal absoprtion potion of Section 7.1.3.1. In addition, all VOCs have been eliminated from evaluation in the groundwater pathway (see Chapter 6). As a result, the inhalation of volatiles from groundwater use exposure route is incomplete and not evaluated further.

7.1.3.4 Homegrown Produce. Exposure to site-related chemicals by future onsite residents from ingestion of vegetables grown on contaminated site soils was evaluated. This route was evaluated by assuming that soil and groundwater (irrigation) contaminants are transferred to a hypothetical vegetable by means of root uptake. The soil concentrations used for root uptake were those measured in the top 10 feet of soil within each site. The contribution from groundwater will be based on those values predicted in Section 6 of this report. The groundwater contribution was based on the assumption that the garden is level and therefore runoff is equal to zero. The soil concentration term that includes the groundwater contribution was estimated using Equation (7-5) (INEL, 1995).

$$C_S(t) = \frac{\frac{\bar{I}_v}{L_i + \lambda}\left(t_e + \frac{e^{-(L_i + \lambda)\, t_e}}{L_i + \lambda}\right) + \frac{C_{so}}{L_i + \lambda}\left(1 - e^{-(L_i + \lambda)\, t_e}\right) - \frac{\bar{I}_v}{(L_i + \lambda)^2}}{t_e} \qquad (7\text{-}5)$$

where

$C_s(t)$ = average concentration of a COPC in soil for the exposure period t_e (mg/kg or pCi/g)

$\bar{I}_v$ = COPC input rate from irrigation (mg/g-d or pCi/g-d)

L_i = leach rate constant $(d)^{-1}$

t_e = exposure period [10,950 d (30 y × 365 d/y)]

λ = radioactive decay rate constant (d^{-1})

C_{so} = concentration term (i.e., 95% UCL or maximum) of COPC in soil at the start of the residential exposure period (mg/kg or pCi/g).

To evaluate the average soil concentration of nonradioactive COPCs, the radioactive decay rate constant is zero. Therefore, Equation (7-5) reduces to

$$C_s(t) = \frac{\frac{\dot{I}_v \times CF}{L_i}\left(t_e + \frac{e^{-(L_i \times t_e)}}{L_i}\right) + \frac{C_{so}}{L_i}\left(1 - e^{-(L_i \times t_e)}\right) - \frac{\dot{I}_v \times CF}{L_i^2}}{t_e} \qquad (7\text{-}6)$$

where

$C_s(t)$ = the average concentration of a COPC in soil for the exposure period (mg/kg)

t_e = exposure period [10,950 d (= 30 yr × 365 d/yr)]

$\dot{I}_v$ = COPC input rate from irrigation (mg/g-d)

L_i = leach rate constant (d^{-1})

C_{so} = concentration term (i.e., 95% UCL or maximum) of COPC in soil (mg/kg)

CF = conversion factor from grams to kilograms (1,000 g/kg).

The radioactive decay rate constant in Equation (7-5) (λ) is calculated using the following equation;

$$\lambda = \frac{\ln 2}{tT_{1/2}}$$

where

$t_{½}$ = the half-life of a radionuclide (d).

The COPC input rate ($\bar{I}_v$) was estimated using Equation (7-7):

$$\bar{I}_v = C_w \times \frac{I_R}{\rho \times T} \qquad (7\text{-}7)$$

where

$\bar{I}_v$ = COPC input rate from irrigation (mg/g-d or pCi/g-d)

C_w = average concentration of a COPC in groundwater during the exposure period (mg/L or pCi/L)

I_R = irrigation rate [2.09 L/m²-d (= {8.47 L/m²-d × 90 d} / 365 d) (Maheras et al., 1994)

ρ = soil density (1.5E+06 g/m³)

T = thickness of root zone (0.2 m).

The leach rate constant (L_i) was estimated using Equation (7-8):

$$L_i = \frac{P}{\theta \times \left(1 + \frac{K_d \times \rho}{\theta_c}\right) \times T} \times CF \qquad (7\text{-}8)$$

where

L_i = leach rate constant (d^{-1})

P = net water percolation rate (0.86 m/y) [equals an infiltration rate of 0.1 m/y, as presented in DOE (1994), plus the infiltration contribution from irrigation. The irrigation contribution is calculated as follows: 0.76 m/yr = 2.09 L/m^2-d × 365 d/yr × 1E-03 m^3/L]

θ_c = volumetric water content in source volume (0.41 m^3/m^3) (Rood, 1994)

K_d = COPC-specific soil-to-water partition coefficient (cm^3/g)

ρ = soil density (1.5 g/cm^3)

T = thickness of root zone (0.2 m).

CF = conversion factor (1 yr / 365 d)

Concentrations of COPCs in affected fruits and vegetables are calculated using Equation 7-9 (EPA, 1995):

$$C_p(t) = C_s(t) \times B_v \qquad (7\text{-}9)$$

where

$C_p(t)$ = concentration of a COPC in fruits and vegetables from root uptake (pCi/g or mg/kg)

$C_s(t)$ = estimated average concentration of a COPC in soil for the exposure period for radionuclides (pCi/g) Equation (7-5) or nonradionuclides (mg/kg) Equation (7-6)

B_v = COPC-specific soil-to-plant uptake coefficient (mass of COPC/dry mass of plant material per mass of COPC/dry mass of soil)

As recommended by EPA (1991b), PUF_v values for different COPCs were taken from Baes et al. (1984). In cases where these values are unavailable, they were calculated based on the method developed by Travis and Arms (1988) using Equation (7-10) and assuming that plant uptake is 100%. The PUF values are summarized in Table 7-2.

$$\log PUF_v = 1.588 - 0.578\ k_{ow} \qquad (7\text{-}10)$$

7.1.4 Development of Chemical Intakes

Route-specific exposures or intakes will be quantified through the use of intake equations, exposure parameters, and exposure concentrations. Intake equations are route-specific, while exposure parameters and exposure concentrations are scenario-specific and route-specific. The exposure point concentrations for each environmental medium were estimated as described in the previous sections. Each chemical intake equation (EPA, 1989) used along with a description of the associated exposure parameters for each scenario is given in Tables 7-3 through 7-7.

Table 7-2. Plant uptake factors.

COPCs	PUF	Reference	COPCs	PUF	Reference
Aroclor-1260	3.93E-03	c	Co-60	2.90E-01	d
Benzo(a)pyrene	1.25E-02	c	Cs-134	4.60E-01	d
Kepone	3.35E-02	c	Cs-137	4.60E-01	d
Phenanthrene	1.02E-01	c	Eu-152	1.00E-02	a
Aluminum	4.00E-03	b	Eu-154	1.00E-02	a
Arsenic	4.00E-02	a	Eu-155	1.00E-02	a
Barium	1.50E-01	d	H-3	NA	
Cadmium	5.50E-01	a	I-129	3.40E-03	d
Calcium	3.50E+00	a	K-40	1.00E+00	a
Chloride	7.00E+01	a	Nb-95	5.00E-02	d
Chromium	1.00E-03	d	Np-237	1.10E-01	d
Lead	2.00E-02	d	Pu-238	4.40E-03	d
Manganese	1.90E+00	d	Pu-239/240	4.40E-03	d
Mercury	9.00E-01	a	Pu-241	4.40E-03	d
Osmium	1.50E-02	a	Pu-242	4.40E-03	d
Nitrate	NA		Ru-106	2.00E-01	d
Sulfate	NA		Sb-125	5.60E-04	d
Thallium	4.00E-03	a	Sr-90	3.00E+00	d
Uranium	1.40E-02	d	Tc-99	7.90E+01	d
Zirconium	1.00E-03	d	U-234	1.40E-02	d
Am-241	2.20E-03	d	U-235	1.40E-02	d
Ce-144	3.00E-02	d	U-236	1.40E-02	d
Co-57	2.90E-01	d	U-238	1.40E-02	d
Co-58	2.90E-01	d			

a. Value from Baes et al. 1984.
b. Value from Baes et al., 1984.
c. Value calculated using equation 5 from Travis and Arms (1988) and a log Kow value from Montgomery and Welkom, 1990.
d. Value from IAEA 1994.
"NA" indicates that a PUF is not available.

Table 7-3. Soil ingestion.[a]

$$\text{Intake (mg/kg-day or pCi)} = C_{soil} \times \frac{\left[\frac{IR_{child} \times EF \times ED_{child}}{BW_{child}}\right] + \left[\frac{IR_{adult} \times EF \times ED_{adult}}{BW_{adult}}\right] \times CF}{AT}$$

Parameter			RME occupational	RME residential adult	RME residential child
C_{soil}	=	contaminant concentration in soil (mg/kg or pCi/g)	95% UCL or maximum value	95% UCL or maximum value	95% UCL or maximum value
IR	=	ingestion rate (mg/d)	50	100	200
FI	=	fraction ingested from contaminated source	1	1	1
EF	=	exposure frequency (d/yr)	200[b]	350	350
ED	=	exposure duration (yr)	25	24	6
CF	=	conversion factor (kg/mg) or (g/mg)	10^{-6} (nonradionuclide) or 10^{-3} (radionuclide)	10^{-6} (nonradionuclide) or 10^{-3} (radionuclide)	10^{-6} (nonradionuclide) or 10^{-3} (radionuclide)
BW	=	body weight (kg)	70	70	15
AT	=	averaging time (d)			
		noncarcinogenic	9,125	10,950	2,190
		carcinogenic	25,550	25,550	25,550

a. Equation for radionuclides does not include denominator (BW × AT).

b. Exposure frequency is based on 4 days per week, (at 10 hr per day), for 50 weeks per year.

c. Values shown are default values for DOE (1994b) unless otherwise noted.

Table 7-4. External radiation exposure.[a,b]

$$\text{Exposure } \left(\frac{\text{pCi}}{\text{g}} \cdot \text{yr}\right) = C_{soil} \times ET \times EF \times ED \times CF$$

Parameter			RME occupational	RME residential
C_{soil}	=	contaminant concentration in soil (pCi/g)	95% UCL or maximum value	95% UCL or maximum value
ET	=	exposure time (hr/d)	10	24
EF	=	exposure frequency (d/yr)	200[a]	350
ED	=	exposure duration (yr)	25	30
CF	=	conversion factor (yr/hr)	1.14×10^{-4}	1.14×10^{-4}

a. Exposure frequency is based on 4 days per week, (at 10 hr per day), for 50 weeks per year.

b. Values shown are default values from DOE (1994b) unless otherwise noted.

Table 7-5. Inhalation of fugitive dust.[a,c]

$$\text{Intake (mg/kg-d or pCi)} = \frac{C_{air} \times IR \times ET \times EF \times ED \times CF}{BW \times AT}$$

		Parameter	RME occupational	RME residential
C_{air}	=	contaminant concentration in air (mg/m^3 or pCi/m^3)	concentration estimated from Equation (7-3)	concentration estimated from Equation (7-3)
IR	=	inhalation rate (m^3/d)	20	20
ET	=	exposure time (hr/d)	10	24
EF	=	exposure frequency (d/yr)	200[b]	350
ED	=	exposure duration (yr)	25	30
CF	=	conversion factor (d/hr)	0.04167	0.04167
BW	=	body weight (kg)	70	70
AT	=	averaging time (day) noncarcinogenic carcinogenic	9,125 25,550	10,950 25,550

a. Equation for radionuclides does not include denominator (BW × AT).

b. Exposure frequency is based on 4 days per week, (at 10 hr per day), for 50 weeks per year.

c. Values shown are default values from DOE (1994b) unless otherwise noted.

Table 7-6. Homegrown produce ingestion for future resident.[a,b]

$$\text{Intake (mg/kg-day or pCi)} = \frac{C_{produce} \times IR_{tot} \times EF \times ED}{AT}$$

Parameter			RME residential
$C_{produce}$	=	contaminant concentration in homegrown fruits and vegetables (mg/kg or pCi/g)	concentration estimated from Equation (7-9)
IR_{tot}	=	intake rate of exposed and protected produce and root vegetables (g/kg-d)	2.76E-01
MIR_{tot}	=	modified intake rate of exposed and protected produce and root vegetables (g/d)	1.67E+01
EF	=	exposure frequency (d/yr)	350
ED	=	exposure duration (yr)	30
AT	=	averaging time (d)	
		noncarcinogenic	10,950
		carcinogenic	25,550

a. Equation for radionuclide substitutes IR_{tot} with a modified IR_{tot}, and does not include denominator (AT).

b. Values shown are presented in LITCO (1994b).

Table 7-7. Groundwater ingestion for future resident.[a,b]

$$\text{Intake (mg/kg-d or pCi)} = \frac{C_W \times IR \times EF \times ED \times FI}{BW \times AT}$$

Parameter			RME residential
C_w	=	contaminant concentration in groundwater (mg/L of pCi/L)	average concentration over the exposure period
IR	=	intake rate (L/d)	2.0
EF	=	exposure frequency (d/yr)	350
ED	=	exposure duration (yr)	30
FI	=	fraction ingested from contaminated source (unitless)	1
BW	=	body weight (kg)	70
AT	=	averaging time (d)	
		noncarcinogenic	10,950
		carcinogenic	25,550

a. Equation for radionuclides does not include denominator (BW × AT).

b. Values shown are default values presented in DOE (1994b).

7.2 Toxicity Assessment

Toxicity values will be used to characterize risk for radioactive and nonradioactive COPCs. Consistent with RAGS (EPA, 1989), the toxicity information will be summarized for two categories of potential effects: carcinogenic and noncarcinogenic. These two categories are selected because of the slightly differing methodologies for estimating potential health effects associated with exposures to carcinogens and noncarcinogens. These effect are discussed in more detail in Sections 7.2.1 and 7.2.2.

The toxicity values that will be used quantitatively in the WAG 3 risk assessment will be obtained from two major sources. The primary source of information is EPA's *Integrated Risk Information System* (IRIS) (EPA, 1995). IRIS contains only those toxicity values that have been verified by EPA's Reference Dose or Carcinogen Risk Assessment Verification Endeavor (CRAVE) Work Groups. The IRIS database is updated monthly and, in accordance with RAGS, supersedes all other sources of toxicity information. If the necessary data are not available in IRIS, EPA's most recent issue of *Health Effects Assessment Summary Tables* (HEAST) will be used. The tables are published annually and updated approximately two times per year with supplements. HEAST contains a comprehensive listing of provisional risk assessment information that has undergone review and has the concurrence of individual EPA Program Offices, but has not had enough review to be recognized as high-quality, agency-wide consensus information (EPA, 1994). HEAST is also the only source for radionuclide slope factors and values that are pending or that have been withdrawn. If toxicity data were not available in IRIS or HEAST, EPA Region III periodically published toxicity data that were also consulted as an alternative information source.

All toxicity values used in the WAG 3 HHRA are summarized in Tables 7-8 and 7-9. It should be noted that Table 7-9 does not include toxicity values for radionuclides since cancer incidence is the critical effect of interest and RfDs are not published. Table 7-10 lists potential contaminants for which toxicity information was not available in IRIS or HEAST.

7.2.1 Carcinogens

Potential carcinogenic risks will be expressed as an estimated probability that an individual might develop cancer from lifetime exposure. This probability is based on projected intakes and chemical-specific, dose-response data called slope factors (SFs). Slope factors (SFs) and the estimated daily intake of a compound, averaged over a lifetime of exposure, are used to estimate the incremental risk that an individual exposed to that compound may develop cancer. There are two classes of potential carcinogens: chemical carcinogens and radionuclides. For the purposes of toxicity assessment, these two classes of elements or compounds are discussed separately.

7.2.1.1 Toxicity Assessment for Chemical Carcinogens. Evidence of chemical carcinogenicity originates primarily from two sources: lifetime studies with laboratory animals and human (epidemiological) studies. For most chemical carcinogens, animal data from laboratory experiments represent the primary basis for the extrapolation. Assumptions relevant to the following issues arise from extrapolating experimental results:

- Across species (i.e., from laboratory animals to humans)
- From high-dose regions (i.e., levels to which laboratory animals are exposed) to low-dose regions (i.e., levels to which humans are likely to be exposed in the environment)
- Across routes of administration (e.g., inhalation versus ingestion).

Table 7-8. Slope Factors for WAG 3 human health risk assessment.

COPCs	Oral CSF[a] (mg/kg-day)$^{-1}$	Source	Inhalation CSF[a] (mg/kg-day)$^{-1}$	Source	External CSF [b] (risk/yr per pCi/g)	Weight of evidence
Aroclor-1260	7.70E+00	I	—	NA	—	B2
Benzo(a)pyrene	7.3E+00	I	6.1E-01	W	—	B2
Kepone	—	NA	—	NA	—	D
Phenanthrene	—	NA	—	NA	—	D
Aluminum	—	NA	—	NA	—	ND
Arsenic	1.5E+00	I	1.2E+00	I	—	A
Barium	—	NA	—	NA	—	ND
Cadmium	—	NA	6.3E+00	I	—	B1
Calcium	—	NA	—	NA	—	D
Chloride	—	NA	—	NA	—	D
Chromium	—	NA	4.2E+01	I	—	A
Lead	—	NA	—	NA	—	D
Manganese	—	NA	—	NA	—	D
Mercury	—	NA	—	NA	—	D
Nitrate	—	NA	—	NA	—	ND
Osmium	—	NA	—	NA	—	D
Sulfate	—	NA	—	NA	—	D
Thallium	—	NA	—	NA	—	D
Uranium [c]	—	NA	—	NA	—	ND
Zirconium	—	NA	—	NA	—	D
Am-241	3.3E-10	H	3.9E-08	H	4.6E-09	A
Ce-144	3.0E-11	H	1.1E-10	H	1.6E-07	A
Co-57	9.7E-13	H	2.9E-12	H	2.1E-07	A
Co-58	2.8E-12	H	5.2E-12	H	3.7E-06	A
Co-60	1.9E-11	H	6.9E-11	H	9.8E-06	A
Cs-134	4.7E-11	H	2.9E-11	H	5.9E-06	A
Cs-137+D	3.2E-11	H	1.9E-11	H	2.1E-06	A
Eu-152	5.7E-12	H	7.9E-11	H	4.1E-06	A
Eu-154	9.4E-12	H	9.2E-11	H	4.7E-06	A
Eu-155	1.7E-12	H	9.6E-12	H	6.1E-08	A
H-3	7.2E-14	H	9.6E-14	H	0.0E+00	A
I-129	1.8E-10	H	1.2E-10	H	2.7E-09	A
K-40	1.3E-11	H	7.5E-12	H	6.1E-07	A
Nb-95	2.3E-12	H	3.1E-12	H	2.9E-06	A
Np-237	3.0E-10	H	3.5E-08	H	4.6E-07	A
Pu-238	3.0E-10	H	2.7E-08	H	1.9E-11	A
Pu-239	3.2E-10	H	2.8E-08	H	1.3E-11	A
Pu-239/240	3.2E-10	H	2.8E-08	H	1.9E-11	A
Pu-241+D	3.3E-10	H	3.9E-08	H	4.6E-09	A
Pu-242	3.0E-10	H	2.6E-08	H	1.6E-11	A
Ru-106+D	3.5E-11	H	1.2E-10	H	7.6E-07	A
Sb-125+D	3.5E-12	H	5.9E-12	H	1.3E-06	A
Sr-90+D	5.6E-11	H	6.9E-11	H	0.0E+00	A
Tc-99	1.4E-12	H	2.9E-12	H	6.2E-13	A
U-233	4.5E-11	H	1.4E-08	H	3.5E-11	A
U-234	4.4E-11	H	1.4E-08	H	2.1E-11	A
U-235+D	4.7E-11	H	1.3E-08	H	2.7E-07	A
U-236	4.2E-11	H	1.3E-08	H	1.7E-11	A
U-238+D	6.2E-11	H	1.2E-08	H	5.3E-08	A

a. Radionuclide units = Risk/pCi.

b. All external radiation exposure slope factors are from HEAST.

c. Conversion: Ci x 2.795E-6 x MW x half-life = mass.

I = IRIS.

H = HEAST.

ND = No data.

NA = Not applicable

W = IRIS or HEAST withdrawn.

Table 7-9. Reference dose values for WAG 3 human health risk assessment.

COPCs	Oral RfD (mg/kg-day)	Source	Inhalation RfD (mg/kg-day)	Source	Target organ/effect
Aroclor-1260	---	NA	---	NA	NA
Benzo(a)pyrene	---	NA	---	NA	NA
Aluminum	1.0E+00	E	---	NA	ND
Arsenic	3.0E-04	I	---	NA	skin; keratosis, hyperpigmentation
Barium	7.0E-02	I	1.4E-04	HA	oral-cardiovascular system; increased blood pressure inhal.-fetus;toxicity
Cadmium (food)	1.0E-03	I	---	NA	kidney; proteinuria
Chromium	5.0E-03	I	---	NA	no effects reported
Manganese (water)	5.0E-03	I	1.4E-05	I	oral-CNS; effects inhal.-CNS; impaired neurobehavioral function
Manganese (food)	1.4E-01	I	1.4E-05	I	oral-CNS; effects inhal.-CNS; impaired neurobehavioral function
Mercury	3.0E-04	NA	8.6E-05	I	oral-kidney; effects inhal.-CNS; neurotoxicity
Nickel	2.0E-02	I	---	NA	whole body; decreased weight, major organs; decreased weight
Nitrate	1.6E+00	I	---	NA	blood; methemoglobinemia
Osmium	---	NA	---	NA	NA
Sulfate	---	NA	---	NA	NA
Thallium	---	I	---	NA	NA
Uranium [a]	3.0E-03	I	---	NA	whole body; weight loss, kidney; nephrotoxicity

a. Conversion: Ci x 2.795E-6 x MW x half-life = mass.
I = IRIS.
E = EPA, provisional.
ND = No data.
NA = Not applicable
Cancer is the critical effect for radionuclides and therefore this table does not include them.

Table 7-10. Potential contaminants without toxicity information in IRIS or HEAST.

Calcium
Chloride
Kepone
Lead
Osmium
Phenanthrene
Sulfate
Thallium
Zirconium

Federal regulatory agencies have traditionally estimated human cancer risks associated with exposure to chemical carcinogens on the administered-dose basis according to the following approach:

- The relationship between the administered dose and the incidence of cancer in animals is based on laboratory animal bioassay results

Since risk at low exposure levels cannot be measured directly either in laboratory animals or human epidemiology studies, various mathematical models have been proposed to extrapolate from high to low doses (i.e., to estimate the dose-response relationship at low doses).

Currently, regulatory decisions are based on the output of the linearized multistage model (EPA, 1989). The basis of the linearized multistage model is that multiple events may be needed to yield tumor induction (Crump et al., 1977). The linearized multistage model reflects the biological variability in tumor frequencies observed in animal or human studies. The dose-response relationship predicted by this model at low doses is essentially linear. Slope factors (SFs) calculated for nonradiological carcinogens using the multistage model represent the 95% UCL on the probability of a carcinogenic response. Consequently, risk estimates based on these SFs are conservative estimates representing upper-bound estimates of risk where there is only a 5% probability that the actual risk is greater than the estimated risk.

Uncertainties in the toxicity assessment for chemical carcinogens are dealt with by classifying each chemical into one of several groups, according to the weight-of-evidence from epidemiological studies and animal studies. These groups are shown in Table 7-11.

The oral and inhalation SFs for the COPCs should be compiled in a table, including the weight-of-evidence, source reference, and date. In addition, as with RfDs, the CRAVE Work Group believes that a unit conversion is required to present inhalation SFs in the units of $(mg/kg\text{-}day)^{-1}$. Consequently, SFs should also be provided for the inhalation route as unit risks in units of "per microgram per cubic meter" $(\mu g/m^3)^{-1}$.

7.2.1.2 Slope Factors for Radionuclides. Extensive literature exists that describes the health effects of radionuclides on humans and animals. Intensive research by national and international commissions has established universally accepted limits to which workers and the public may be exposed without clinically detectable effects. This literature has resulted in EPA classifying all radionuclides as Group A carcinogens because they emit ionizing radiation, which, at high doses, has been associated with increased cancer incidence in humans. For radionuclides, human epidemiological data collected from the survivors of the Hiroshima and Nagasaki bomb attacks form the basis for the most recent extrapolation by the National

Table 7-11. Carcinogen groups.

Weight-of-Evidence	Description
A	Human Carcinogen (sufficient evidence of carcinogenicity in humans)
B	Probable Human Carcinogen (B1–limited evidence of carcinogenicity in humans; B2–sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans)
C	Possible Human Carcinogen (limited evidence of carcinogenicity in animals and inadequate or lack of human data)
D	Not Classifiable as to Human Carcinogenicity (inadequate or no evidence)
E	Evidence of Noncarcinogenicity for Humans (no evidence of carcinogenicity in adequate studies)

Academy of Sciences. Conversely, for most nonradiological carcinogens, animal data from laboratory studies provide the primary basis for the extrapolation. Another fundamental difference between the assessment of potential toxicity associated with exposure to radionuclide and nonradionuclide carcinogens is that SFs for radionuclides are typically best estimates (mean or median values rather than upper 95th percentile values). Furthermore, in the past, risk factors for radionuclides have generally been based on fatalities (i.e., the number of laboratory animals or people who actually died from cancer), while SFs for nonradiological carcinogens are based on incidence (i.e., the number of laboratory animals or people who developed cancer). Finally, the SFs for radionuclides are expressed in different units, i.e., risk per pCi $(pCi)^{-1}$ rather than $(mg/kg\text{-}day)^{-1}$.

Radionuclide SFs will be documented in the same table as chemical carcinogens, however, to avoid confusion they will be grouped separately due to the differences in units. The nonthreshold radionuclide SFs account for:

- Amount of radionuclide transported into the bloodstream
- Decay of radioactive progeny within the body
- Distribution and retention of the radionuclide and its progeny (if any) in the body
- Radiation dose delivered to specific organs and tissues
- Age and sex of the exposed individuals (EPA, 1994).

7.2.2 Noncarcinogens

Potential noncarcinogenic effects will be evaluated in the risk characterization by comparing daily intakes (calculated in the exposure assessment) with chronic reference doses (RfDs) developed by EPA. This section provides a definition of an RfD and discusses how it will be applied in the WAG 3 risk assessment.

A chronic RfD is an estimate (with uncertainty spanning perhaps an order of magnitude) of the daily exposure that can be incurred during a lifetime, without an appreciable risk of a noncancer effect being incurred in human populations, including sensitive subgroups (EPA, 1989). The RfD is based on the assumption that thresholds exist for noncarcinogenic toxic effects (e.g., liver or kidney damage). Chronic references doses (RfDs) are typically calculated by dividing a dose (representing a no-observed-adverse-

affect level or a lowest-observed-adverse-effect level), at which there are no significant measurable effects produced, by an uncertainty or safety factor that typically ranges from 10 to 10,000. The RfD is rounded to one significant figure and is presented in units of mg/kg-day. Thus, there should be no adverse effects associated with chronic daily intakes below the RfD value. Conversely, if chronic daily intakes exceed this threshold level, there is a potential that some adverse noncarcinogenic health effects might be observed in exposed individuals.

7.3 Risk Characterization

Risk characterization involves estimating the magnitude of the potential adverse effects of COPCs under study and summarizing risks to public health. Risk characterization combines the results of the exposure and toxicity assessments to provide numerical estimates of health risk. These estimates are comparisons of exposure levels with RfDs or estimates of the lifetime cancer risk for a given intake. The process of characterizing risk includes the following:

- Calculating and characterizing cancer risk and noncarcinogenic effects
- Conducting qualitative uncertainty analysis
- Conducting quantitative uncertainty analysis.

To quantify the health risks, the intakes are first calculated for each COPC for each applicable pathway and scenario. Intakes are calculated based on measured or modeled concentrations, and use the methodology documented in the RAGS (EPA, 1989). The specific intakes are then compared to the applicable chemical-specific toxicological data to determine the health risks.

The health risks from each potential contaminant will be calculated to first determine potential carcinogenic effects and secondly to determine potential noncarcinogenic effects. Each of these calculations is discussed in the following sections.

7.3.1 Determining Carcinogenic Effects

Equation (7-11) was used to determine carcinogenic effects by obtaining numerical estimates, (i.e., unitless probability) of lifetime cancer risks.

$$RISK = INTAKE \times SF \qquad (7\text{-}11)$$

where

Risk = potential lifetime excess cancer risk (unitless)

SF = slope factor, for chemicals $(mg/kg\text{-}day)^{-1}$, or $(pCi)^{-1}$

Intake = chemical intake (mg/kg-day or pCi).

Inhalation and oral ingestion SFs are used with respective inhalation and ingestion intakes to estimate risks. As discussed earlier, chemical SFs are estimated through the use of mathematical extrapolation models for estimating the largest possible linear slope at low extrapolated doses that is consistent with the data. Radionuclide slope factors are estimates derived from human epidemiological studies. The SF is

characterized as an upperbound estimate. Cancer risks are summed separately across all potential chemical carcinogens and across all radionuclides considered in the risk assessment using the following equation:

$$RISK_T = \sum RISK_i \quad (7\text{-}12)$$

where

$RISK_T$ = total cancer risk, expressed as a unitless probability

$RISK_i$ = risk estimate for the i^{th} contaminant.

This equation is an approximation of the precise equation for combining risks to account for the probability of the same individual developing cancer as a consequence of exposure to two or more carcinogens. As stated in RAGS (EPA, 1989), the difference between the precise equation and this approximation is negligible for total cancer risks less than 0.1. This risk summation assumes independence of action by the compounds involved. Some limitations are posed by using this approach, and they are discussed in RAGS (EPA, 1989). For example, limitations apply when adding potential carcinogenic risk across the pertinent weight-of-evidence cancer classes. A total carcinogenic risk may be summed across weight-of-evidence classifications as an additional point of reference. In accordance with EPA guidance, only one significant digit is retained when summarizing calculated risks (EPA, 1989).

The risk assessment text will reference each table and discuss risks that fall within or exceed the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) risk range of 10^{-4} to 10^{-6} (EPA, 1990). Specifically, the pathways and contaminants driving the risk should be noted and accompanied by any necessary qualifying statements. The text will not repeat the entire table, but will summarize more notable results. In addition, scenario specific bar charts will be created that will represent total risk on a site-by-site basis. The detailed data used to generate the charts will be contained in the tables. Risk isopleths will also be presented for all groundwater associated pathways.

In addition to presenting the incremental cancer risks due to contaminants at the site, perspective may be provided by giving examples of typical background sources of risk such as arsenic or radon and progeny. Because the public is often unaware of the numerous conservative assumptions involved in a risk assessment, the text will note the assumptions associated with the calculations and reference the reader to the uncertainty section. The results of the risk assessment will be summarized in a table for each site.

7.3.1.1 Combining Radionuclide and Chemical Cancer Risks. In evaluations where COPCs consist of radionuclides and chemicals, the EPA recommends tabulating the results separately in the final BRA. This was not done in the WAG 3 BRA for several reasons. First, the exposure routes for both group of contaminants is the same for all receptors so the same individual can receive the maximum radiological and chemical dose. Secondly, the fate and transport models used were the same for both groups. Finally, even though the assumptions to determine health criteria for both groups is different, the radionuclides makeup the vast majority of the contaminants at WAG 3 and thus, tabulating results separately is not useful.

7.3.2 Determining Noncarcinogenic Effects

Health risks associated with exposure to individual noncarcinogenic compounds will be determined by calculating hazard quotients (HQs) and hazard indices (HIs). The noncarcinogenic HQ is the ratio of the intake or exposure level to the RfD, as follows:

$$HQ = INTAKE / RfD \quad (7\text{-}13)$$

where

HQ = noncarcinogen hazard quotient

Intake = chemical intake (mg/kg-day)

RfD = reference dose (mg/kg-day).

Chronic oral and inhalation RfDs will be taken from IRIS and HEAST. Hazard indices (HIs) are obtained by adding the hazard quotients for each chemical across the exposure pathways. If the HI for any chemical exceeds unity, there may be concern for potential health effects. The HI is calculated using Equation (7-14):

$$HI = \sum \frac{E_i}{RfD_i} \quad (7\text{-}14)$$

where

HI = hazard index

E_i = chemical intake for the i^{th} toxicant

RfD_i = reference dose for the i^{th} toxicant.

These HI values can not be interpreted as statistical probabilities of an effect occurring, however, if the HI exceeds unity there may be a concern for potential noncancer effects. In general, the greater the HI above unity, the greater the level of concern. However, the level of concern does not increase linearly as the HI approaches or exceeds unity. Further discussions and limitations on the application of this procedure are contained in RAGS (EPA, 1989).

Noncarcinogenic effects will be presented in the risk assessment text and tables similar to those used in the presentation of carcinogenic risk. Each table will show contaminant and pathway-specific effects if contaminants are presented in rows and pathways are presented by column. After reasonable exposure pathway combinations are identified, the likelihood that the same individuals would consistently be exposed to more than one pathway will be evaluated. In most situations, a receptor could be exposed by several pathways in combination. For these situations, HQs may be subtotaled across pathways for each contaminant.

For a specific receptor scenario, a total HI may also be summed across all pathways and contaminants as an additional point of reference, but is subject to limitations. As is the convention with carcinogenic risk, only one significant digit is retained when summarizing calculated effects (EPA, 1989). The risk assessment text will reference each table and discuss HQs that exceed unity. Specifically, the pathways and contaminants driving the risk will be noted and accompanied by any necessary qualifying statements. The risk assessment text will not repeat the entire table, but summarize more notable results.

A summary table presenting HI subtotals for all scenarios will also be created for presentation in the risk summary section. This may be presented by placing the results for each scenario in rows, and providing information on HIs, dominant COPC, and dominant pathway in columns.

7.4 Uncertainty Analysis

There are many sources of uncertainty introduced during the risk assessment process. These emerge during all aspects of the process beginning with site field investigations and sampling and analysis through risk characterization. The intent of this section is to describe the various aspects within the different steps in the evaluation that may influence the outcome. These aspects are described below along with a qualitative evaluation of the likelihood for a particular feature to overestimate, or underestimate the results. For convenience, these uncertainties are summarized in Table 7-12. Site-specific uncertainty will be discussed separately for each release site in Sections 8 through 26 of this report.

7.4.1 Site Characterization

There are a number of uncertainty sources pertaining to how well a particular soil release has been characterized. These are issues having to do with the available sample population and the lateral and vertical extent of contamination. These features and their impact on the results are discussed in detail for each site in Sections 8 through 26.

7.4.2 Chemicals of Potential Concern

The final list of COPCs that were evaluated in the risk assessment was arrived at by screening the analytical results obtained from field investigations conducted during Track 2 evaluations and RI/FS sampling. The screening process consisted of several steps including background and essential nutrient comparisons, toxicity rankings, and a comparison against soil screening values published by Region III of the EPA. The purpose for screening is to focus the RI/BRA on those COPCs of greatest concern; however, in so doing, chemicals that would otherwise have a small impact on the risk estimates are not evaluated further.

7.4.3 Exposure Pathways

Although this HHRA did not assess every conceivable exposure scenario pathway, or exposure route, generally, pathways and exposure routes were evaluated according to their potential risk contribution. Since total risk to human health is a sum of all exposure routes within all complete pathways known to exist, the lack of quantification of less significant pathways may underestimate the risk. However, those pathways not quantified represent small sources of exposure and are not expected to influence risk management decisions. For example, a potential exposure pathway under future land use that was not quantitatively evaluated at this time is the ingestion of meat from cattle grazing in contaminated areas of WAG 3. The possibility of this type of exposure is acknowledged, but the risk contribution was deemed to be negligible.

Many of the sites are at best only occasionally visited by onsite workers. The exposure time may be significantly lower than the values used in human health risk assessments (i.e., 10 hr/d) and, thus, it is likely that the risk calculations represent an overestimate of the actual risk. Also, some projects at ICPP involve excavations of four feet or deeper however, they seldom occur within a release site. Uncertainties from these unlikely exposures have not been factored into this evaluation.

Plant and animal uptake factors for contaminants were estimated using reported values in literature and analogous procedures of physicochemical properties. All of these uptake factors were taken from studies conducted away from the INEL and therefore are not representative of local conditions. This may result in overestimation or underestimation of potential health impacts.

7.4.4 Contaminant Fate and Transport

With the exception of radionuclides, the evaluation of human health risks assumed that environmental media concentrations determined from sampling will remain at the same levels over the assumed periods of

Table 7-12. Summary of common uncertainty sources.

Uncertainty Source	Effect of uncertainty	Comment
Sampling and analysis		
Contaminant data sets	May overestimate risk	The source concentration (i.e., the maximum concentration value) from Track 1 and 2 were used for some sites in the absence of a complete, electronic data set.
Statistical distribution of site contamination data	May overestimate or underestimate risk	With the exception the CPP-88 COPCs, statistical distribution testing was not conducted. Results of the distribution list indicate that the CPP-88 results for Cs-137 and Sr-90 are lognormally distributed, where As is normally distributed. It was assumed that concentration data were lognormally distributed and 95% UCLs were estimated accordingly. This practice is acceptable per EPA (1992) and is fairly consistent with the distribution tests performed.
Lateral extent of site contamination	May overestimate or underestimate risk	Lateral extent of contamination was defined as part of the nature and extent assessment. In some cases, there is uncertainty associated with the lateral extent assumptions thus affecting the BRA.
Vertical extent of site contamination	May overestimate risk	Contaminant data without corresponding depth information were assumed to occur in all depth intervals. Contaminant data with corresponding depth information that overlapped depths of interest were assumed to occur entirely within depth interval.
Detection limits	May overestimate or underestimate risk	Measurements used to generate 95% UCLs have multiple detection limits from the laboratory analysis. One-half of the detection limit was used.
Concentration-toxicity Screen/RBC Screen	May overestimate or underestimate risk	EPA toxicity values are subject to change resulting in a different output from the COPC screening process.
Radionuclide uncertainty	May overestimate risk	Radionuclide results that were not qualified per the associated uncertainty values could result in some values being treated as detects, when for all practical purposes, these values are nondetects.
Fate and transport estimation		
Water table fluctuations	May overestimate or underestimate risk	The average value is expected to be representative of the depth over the exposure period.
Progeny travel with parent radionuclide in groundwater is not considered	May overestimate or underestimate risk	Progeny was not considered with parent radionuclides because of the number of potential variables that can impact the outcome. Differing travel times for the progeny in groundwater may result in higher or lower risk depending on if the chemical reaches a receptor during the evaluation time frames. Higher or lower SFs for the progeny will also result in overestimating or underestimating the potential risk.

Table 7-12. (continued).

Uncertainty Source	Effect of uncertainty	Comment
Biological degradation/decay of site contamination	May overestimate risk	Degradation of nonradioactive COPCs is not assumed.
Soil concentrations	May overestimate risk	Concentrations of nonradioactive COPCs are assumed to remain constant and are not depleted over time due to leaching, dispersion, etc.
Variability in annual meteorological data	May overestimate or underestimate risk	Although a rigorous statistical analysis on annual variability was not conducted, when annualized, meteorological data is not expected to vary significantly.
Plant concentration estimations	May overestimate or underestimate risk	If specific values are not available, default uptake constants are used. Exterior surface plant concentrations are not considered and depend on assumptions regarding deposition velocity, intercept fraction, and weathering removal rates.
Exposure estimation		
Exposure scenario assumptions	May overestimate risk	The likelihood of future on-site residential development is small. If future residential use of WAG 3 does not occur then the risk estimates for future on-site residents are likely to overestimate risk associated with other future uses.
Exposure parameter assumptions	May overestimate risk	Assumptions regarding media intake, population characteristics, and exposure patterns are intended to be health-protective. A reasonable maximum exposure intake value is estimated by selecting exposure variables so that the combination of all variables results in the maximum exposure that can reasonably be expected to occur.
Exclusion of some hypothetical pathways from the exposure scenarios	May underestimate risk	Exposure pathways were evaluated for each scenario and eliminated if it was determined that they are not realistic or they are incomplete. Dermal exposure is realistic, however, this pathway is not applicable for all soil exposures and some COPCs for water exposure because it is not a significant contributor to risk.
Permeability coefficients	May overestimate or underestimate risk	The EPA method for deriving dermal permeability was algorithmically predicted and has an uncertainty of approximately one order of magnitude.
Plant ingestion rate	May overestimate or underestimate risk	Average plant ingestion rate was used with the assumption that homegrown plants will be consumed year-round.
Model does not consider biotic decay	May overestimate risk	Biotic decay would tend to reduce contamination over time. However, the contamination estimation effort did not account for this process.

Table 7-12. (continued).

Uncertainty Source	Effect of uncertainty	Comment
Multiple chemical exposure	May overestimate or underestimate risk	Currently risks from COPCs are summed regardless of when the exposures take place. Additionally, risks from across weight-of-evidence classifications are summed which is extremely health conservative. The assumption of dose and risk additivity ignores possible synergisms or antagonisms among chemicals, and assumes similarity in mechanisms of action and metabolism. Adding risks would overestimate risk in the presence of antagonisms, in which case the actual risk might be less than the sum of the individual risks. In the presence of synergistic interactions among chemicals, the actual risk might be greater than that estimated by addition of individual risks.
Toxicological data		
Use of cancer slope factors for chemical carcinogens (i.e., nonradionuclides)	May overestimate risk	Potencies are upper 95th percentile confidence limits and are considered unlikely to underestimate true risk.
Critical toxicity values derived primarily from animal studies	May overestimate or underestimate risk	Extrapolation from animal to humans may induce error due to differences in absorption, pharmacokinetics, target organs, enzymes, and population variability.
Critical toxicity values derived primarily from high doses, most exposures are at low doses	May overestimate or underestimate risk	Assumes hazard and risk are linear at low doses. Tend to have conservative exposure assumptions.
Critical toxicity values and classification of carcinogens	May overestimate or underestimate risk	Not all values represent the same degree of certainty and all values are subject to change as new evidence becomes available.
Lack of inhalation slope factors	May underestimate risk	Carcinogenic COPCs without inhalation SFs may or may not be carcinogenic through the inhalation pathway.
Chemicals not evaluated quantitatively due to lack of toxicity values	May underestimate risk	The following chemicals have no toxicity values and were not included in quantitative risk estimates: osmium, phenanthrene, lead, zirconium, thallium, chloride, phosphate, carbonate, sulfate, and kepone.

exposure. This assumption is likely to result in an overestimation of risk, since concentrations are expected to decline over the long-term as natural fate and transport processes degrade, dilute, or remove site contaminants. The rate of the degradation, removal, and/or dilution of chemicals in soil, groundwater, surface water, and sediment are not known; therefore, the magnitude of the overestimate is difficult to determine.

7.4.5 Exposure-Point Concentration

The exposure-point concentrations used for assessing risks associated with the reasonable maximum exposure (RME) case were high end concentrations, which were either the maximum detected value or the upper 95th percentile of the mean value (whichever is less). Nondetected values were treated as

concentrations equal to half the detection limit. This procedure could underestimate or overestimate the risk depending on the actual concentrations (if present) of the chemical below the detection limits. This uncertainty is most likely to occur when estimating concentrations for those chemicals detected infrequently.

7.4.6 Exposure Levels

The amount of exposure that an individual receives is highly dependent on the details related to their human-activity patterns. There is considerable variability regarding the values assumed in calculating human intake factors. For instance, estimates of soil ingestion rates for all populations are subject to ongoing debate. This may again result in overestimating or underestimating the risk on an individual basis. Additionally, exposure levels estimated for this project did not take into account the fact that individuals such as onsite workers would be required to wear personal protective equipment (PPE) when working in contaminated areas. This results in an overestimation of risk for these potential receptors.

7.4.7 Toxicity Values

Quantification of risk from exposure to a chemical cannot be accomplished in the absence of reliable, appropriate toxicity values (reference doses, slope factors) for all routes and exposure periods. For the COPCs at WAG 3, toxicity values are not available for some chemicals by some routes and thus could not be evaluated quantitatively (see Table 7-10). This may result in underestimating the risk.

7.4.8 Cancer-Risk Estimates

The predicted cancer risk due to chemical exposure is often based on cancer-dose response data in animals. There is a long-standing controversy in the scientific community as to the best way by which animal data should be extrapolated to humans. In general, the EPA follows a conservative procedure in the derivation of slope factors, so cancer risk estimates based on these values could be considerably higher than the true risk.

7.4.8 Multiple Chemical Exposure

The risk assessment approach assumes that health risks from multiple chemicals are additive, ignoring both synergistic and antagonistic effects among chemicals. Because of the number of chemicals evaluated at these sites, it is difficult to determine if additivity is a major source of error.

7.4.10 Computer Models

A computer model was used to conservatively estimate exposure concentrations of site-related chemicals in groundwater. These values were subsequently used to estimate chronic daily intakes, and subsequently total cancer risk and noncarcinogenic hazard. The uncertainty associated with the use of a computer model to estimate groundwater exposure concentrations is discussed in more detail in Section 6 of this report.

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Chapter 8

8. SITES OF NEGLIGIBLE SOIL CONTAMINATION (CPP-40, CPP-46, CPP-61, CPP-78, AND WINDBLOWN AREA)

There are a number of release sites within waste area group (WAG) 3 where review of the results of field investigations conducted during Track 1 or Track 2 processes, and/or RI/FS field sampling, shows that the maximum levels of site related contamination are only slightly above background concentrations. This review indicates that most of the data at these sites are either below background concentrations, or below detection limits. The sites where these trends are prevalent are CPP-40, 46, 61, and 78. The Windblown Area is another location that is proposed for inclusion in the group of sites with negligible soil contamination; however, this recommendation is based on the results of the risk assessment in the operable unit (OU) 10-06 RI report. The OU 10-06 investigation found the cancer risk and hazard associated with the Windblown Area to be acceptable. These four sites did not screen out using the techniques of Section 5 and therefore, the following sections describe each site and summarize the field investigation results. These sites were not evaluated quantitatively in the Baseline Risk Assessment (BRA). Instead, these sites will be treated as a source of uncertainty with regards to their contributions to the exposure concentrations for air and groundwater in Section 27. The technical basis leading to the recommendation to only qualitatively carry these sites through the RI/BRA is based on a comparison of the maximum concentrations of contaminants that did not screen out, to the most limiting 100-yr future residential risk-based soil concentrations at the 1E-04 level published in Fromm (1996).

8.1 Site CPP-40

Site CPP-40 is an area of potentially contaminated soils located near the southwest corner of building CPP-601, as shown on Figure 8-1. Site CPP-40 is the location of a historic acid neutralization pit and associated piping.

8.1.1 Site Description

Site CPP-40 consisted of a 18.9-m (62-ft) long drain pipe, a neutralization pit (lime pit), and a discharge pipe. The drain pipe led from a large drip pan in building CPP-601 to the neutralization pit. The drip pan was intended to catch leaks and spills of hydrofluoric acid and other miscellaneous chemicals.

The neutralization pit was a metal-lined concrete box approximately 1.8 × 1.8 m (6 × 6 ft) in area, and 2.1-m (7-ft) deep. Powdered limestone was periodically added to the neutralization pit while it was operational to neutralize hydrofluoric acid. In addition, water was added to the neutralization pit to dilute the hydrofluoric acid. Although discharge from building CPP-601 was reportedly discontinued in 1985, water continued to flow into the neutralization pit until August 22, 1990. Overflow from the neutralization pit was discharged through a pipe to the soil column. The pipe extended to a depth of 0.88-m (2.9-ft) belowground surface (bgs). The drain pipe, neutralization pit, and discharge pipe have been removed, as described below.

8.1.2 Investigative Results

Several characterization activities have been performed at site CPP-40. In August 1990, 28 drums [208 L (55 gal)] of sludge and liquid [total volume of approximately 5,700 L (1,500 gal)] were removed from the pit, sampled, and disposed of as hazardous waste. Radionuclides were not detected in this waste, which adds credibility to reports that no radionuclides were disposed of to the lime pit.

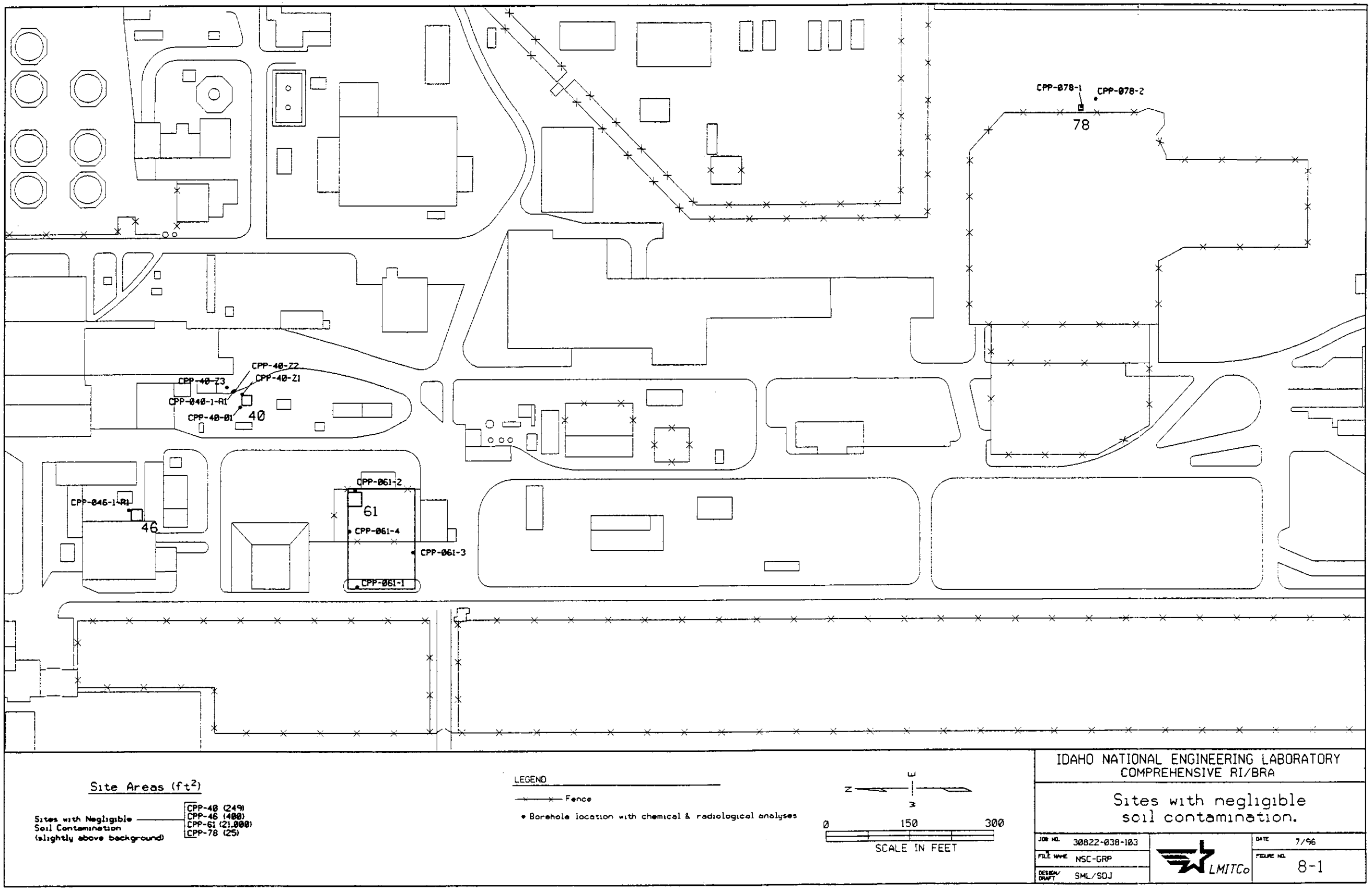

Figure 8-1. Sites with negligible soil contamination.

An investigation was performed in January 1991 to collect information for a Resource Conservation and Recovery Act (RCRA) closure plan. Soil samples were taken from borehole CPP40-01 located next to the neutralization pit. The borehole was drilled and sampled to the soil/basalt interface located at approximately 16.4 m (54 ft). The borehole was located next to the neutralization pit and as close as possible to the discharge pipe where chemical concentrations were expected to be the highest. Soil samples were analyzed for RCRA metals, pH, and VOCs. In addition, the first sample from beneath the discharge pipe [0.9 to 1.5 m (3 to 5 ft) bgs] was analyzed for constituents in a modified 40 Code of Federal Regulations (CFR) Appendix VIII list. A Phase II field investigation was performed in December 1991 to characterize any chemical or radiological contamination in the soils along the transfer lines between CPP-601 and the lime pit. These samples were analyzed for metals and radionuclides.

The Track 1 document concluded that chromium, lead, and fluoride were the only nonradiological chemicals detected at concentrations greater than background levels and were detected at levels of 47 mg/kg, 61.3 mg/kg, and 11 mg/kg, respectively. Sr-90 was detected in this borehole at a concentration of 12.4 pCi/g from the sample collected at 7.9-m (26-ft). Results of the January 1991 sampling are included in the Track 1 Decision Documentation Package for site CPP-40 (WINCO, 1993).

The drain line from building CPP-601 to the neutralization pit was excavated and removed in December 1991 to allow for the construction of a hexone pumping station at the southwest corner of CPP-601. As indicated in the Track 1, the soil along the pipe trench was sampled during construction activities and chromium (71.9 mg/kg) was the only nonradiological contaminant detected at concentrations greater than background levels. Cs-137 (11.8 pCi/g), Sr-90 (42.7 pCi/g), and Pu-238 (0.69 pCi/g) were detected in concentrations above background levels in samples taken along the drain pipe and U-234 was detected in soils near the neutralization pit at concentrations above background levels. The radiological contamination detected in the soil is not believed to be due to or associated with the waste generation processes of releases to the neutralization pit although its origin is not known. Results of the December 1991 sampling are included in the Track 1 Decision Documentation for site CPP-40 (WINCO, 1993).

In August 1992, standing water (from precipitation) inside the pit was pumped out and sampled. Results indicated a pH of 9.6 and a gamma scan indicated no radiation above background levels. The lime pit was also decontaminated at this time by rinsing the interior several times and pumping out the rinsate. The soils around the pit were excavated in September 1992 and stored adjacent to the excavation, and the piping outside the pit was removed.

As part of the implementation of the WAG 3 RI/FS Work Plan (LITCO, 1995), an additional borehole, designated CPP-40-1-R1, was hand-augered at the location indicated on Figure 8-1. The purpose of this borehole was to verify the presence of radioactive contamination measured during earlier Track 1 field investigations and therefore, it was sited as close as possible to the former location of the underground pipes and in the same zone where the previous investigation in December 1991 encountered elevated levels of Cs-137 and Sr-90. Background radiation at the borehole site was measured at 100 counts per minute (cpm) using a Ludlum 2A detector. Samples were collected from the following intervals for radiological analysis: 0.0 to 0.15 m (0.0 to 0.5 ft), 0.8 to 1.5 m (2.5 to 5.0 ft), and 2.3 to 3.0 m (7.5 to 10.0 ft). All samples showed field-screening radiation levels below background. Samples were primarily sandy gravels. Some asphalt fill material was noted in the 0.0- to 0.3-m (0.0- to 1.0-ft) interval, and two clay layers were noted in the 1.2- to 1.4-m (4.0- to 4.5-ft) interval.

A compilation of the 1995 analytical results is presented in Appendix G. However, it should be noted that the RI/FS strategy for CPP-40 as described on page 4-7 of the RI/FS Workplan was to drill a confirmatory borehole and include this site data with that of CPP-88 only if "low-levels" of contamination were measured. Since Cs-137 is the only radionuclide measured above the background value of 0.82 pCi/g it

was determined that this condition does not constitute "low levels" of contamination and this site data was not added to CPP-88. Instead, due to the absence of a definitive source of contamination, it was decided to evaluate this site qualitatively in the RI/BRA. To this end, only the data from the most recent investigation was summarized in Table 8-1. Based on the confirmatory sample results, Cs-137 was the only COPC detected above background in boring CPP-40-1 at an activity of 1.34±0.02 pCi/g in the 0.0- to 0.15-m (0.0- to 0.5-ft) interval. Cs-137 was detected at an activity below the background value of 0.82 pCi/g in the 0.8- to 1.5-m (2.5- to 5.0-ft) interval.

8.1.3 Conclusions

The objective of the RI/FS sampling at this site conducted during the summer of 1995 was to confirm the effectiveness of previous removals and evaluate the presence of this contamination. This recent investigation could not confirm the presence of residual contamination since only two out of three samples measured Cs-137 at levels slightly above background and below the risk-based level (2.3 pCi/g). Therefore, the decision was made not to evaluate this site quantitatively in the BRA.

8.2 Site CPP-46

Site CPP-46 is an area of potentially contaminated soil located in the courtyard north of the Low Bay Laboratory, building CPP-637, as shown on Figure 8-1. Soils in this area were initially contaminated on November 21, 1978 by a 1,700-L (450-gal) spill of simulated zirconium fluoride waste.

8.2.1 Site Description

The simulated zirconium fluoride waste was used as a nonradioactive feed stock for testing processes related to the handling and calcining of radioactive waste produced by the digestion of modern zirconium-clad fuel rods. The simulated zirconium waste was in the process of being transferred to the easternmost of two waste storage tanks located within the courtyard. The release was acidic and contained zirconium and aluminum cations and fluoride and nitrate anions.

8.2.2 Investigative Results

The waste was neutralized and contaminated soils were removed following the release. Soil samples collected from the site in 1987 confirm that most of the affected soils were removed following the discharge. The only remaining soil that was clearly affected by the release was surface soil under the westernmost tank. The affected soil was entirely removed during excavation for footings of the concrete slabs on which the tanks now sit. This excavation occurred in 1987 subsequent to soil sampling.

A driller's report from 1986 indicates that a radioactivity level of 300 cpm over background was noted at this site at a depth of 0.9 m (3 ft). Additional anecdotal accounts indicate that surface radiation readings have been identified in the past, and that a shovel-full of contaminated soil was encountered. The source of the contamination is unknown, and the contaminated soil was bagged and moved offsite.

As part of the WAG 3 RI/FS field sampling program, a surface radiation survey was conducted using a Ludlum 2A detector to assess beta-gamma radiation levels and a Ludlum Model 61 detector to measure alpha radiation levels. In addition, borehole CPP-46-1 was completed at the location shown on Figure 8-1. The purpose of this borehole was to verify the presence of radioactive contamination measured earlier. The radiation survey conducted before drilling indicated no elevated radiation levels above a background radiation

Table 8-1. Summary statistics for CPP-40, lime pit at the base of the CPP-601 berm and french drain.

COPCs	Concentration (mg/kg or pCi/g) Minimum detected	Maximum detected	Arithmetic mean	Standard deviation	Number of samples	Number of detects	Frequency of detection	INEL background (mg/kg or pCi/g)	Number greater than background
Cs-137	0.23 +/-0.02	1.34 +/-0.02	7.85E-01	7.85E-01	4	2	50%	0.82	1

level of less than 100 cpm. The highest radiation reading (80 cpm) was used as the criteria for siting borehole CPP-46-1.

Samples were collected from the following intervals using decontaminated hand augers: 0.0 to 0.15 m (0.0 to 0.5 ft), 0.6 to 1.2 m (2.0 to 4.0 ft), and 2.4 to 3.0 m (8.0 to 10.0 ft). All samples showed field-screening radiation levels below background. All samples were of unconsolidated gravels and sand, and a saturated zone was encountered between 1.4 and 1.7 m (4.5 and 5.5 ft). All samples were analyzed for radiological constituents; results are described below.

The analytical results of the COPCs are summarized in Table 8-2. Based on chemical screening from Section 5.2, the following COPCs were identified for this site: Sr-90, Tc-99, Cs-134, and Cs-137. A compilation of the analytical results is presented in Appendix G. Results from sample boring CPP-46-1 indicate activities above background for Cs-134, Cs-137, Sr-90, and Tc-99, although all detections are at low activity levels. Cs-134, Sr-90,, and Tc-99 were detected in the 0.0- to 0.15-m (0.0- to 0.5-ft) sample at activities of 0.07±0.02, 0.9±0.2, and 1.5±0.5 pCi/g, respectively. Activities from the 0.6- to 1.2-m (2.0- to 4.0-ft) sample were 0.5 and 1.3 pCi/g, respectively for Sr-90 and Tc-99, while Cs-134 activity dropped to below background. Cs-137 was detected in this sample at an activity of 1.76±0.06 pCi/g. All COPCs were at activities below background in the 2.4- to 3.0-m (8.0- to 10.0-ft) sample.

8.2.3 Conclusions

As described previously, the waste at site CPP-46 was neutralized and the contaminated soils removed following the initial release. Soil samples collected in 1987 confirmed that the majority of affected soils have been removed. The investigative results indicate that remaining radionuclides are found at low activities, and that activity levels decrease to below background levels by 2.4-m (8.0-ft) bgs. Furthermore, the maximum values for Cs-137, Cs-134, Sr-90, and Tc-99 are below the most limiting risk-based concentrations derived for future residential conditions using a target cancer risk of 1E-05 (Fromm, 1996). Because of the small area of affected soils, and the low activity levels of radionuclides found within the soil, site CPP-46 is considered to be of negligible soil concern, and therefore will be evaluated qualitatively in the BRA.

8.3 Site CPP-61

CPP-61 is a 7.6- × 7.6-m (25- × 25-ft) area within the CPP-718 transformer yard (Figure 8-1), which is the site of a polychlorinated biphenyl (PCB) oil spill during the approximate timeframe between spring 1982 and July 1985 (WINCO, 1992).

8.3.1 Site Description

The transformer yard is approximately 29 × 47 m (95 × 155 ft) in area and is surrounded by a 2.4-m (8-ft) tall cyclone fence. The spill occurred during the Utilities Replacement and Expansion Project (UREP) when the transformer had to operate with a 30–40% voltage overload. As a result of the voltage overload, heat expansion of the transformer oil caused a leak to occur in one of the transformer fittings. According to the existing documentation, the leak was estimated to total 1,510 L (400 gal) at a PCB concentration of 179 parts per million (ppm). Some of the oil was not contained and spilled beyond the concrete pad and resulted in contaminated soil adjacent to the transformer pad.

8.3.2 Investigation Results

In July 1985, a cleanup of the spill area was initiated. This cleanup effort was poorly documented. Existing documentation consists of PCB and radiological data (collected as the PCB-contaminated soil was

Table 8-2. Summary statistics for CPP-46, CPP-637 courtyard Pilot Plant release.

COPCs	Concentration (mg/kg or pCi/g) Minimum detected	Maximum detected	Arithmetic mean	Standard deviation	Number of samples	Number of detects	Frequency of detection	INEL background (mg/kg or pCi/g)	Number greater than background
Cs-134	0.07 +/-0.07	0.07 +/-0.02	7.00E-02	NA	3	1	33%	NA	NA
Cs-137	0.64 +/-0.03	1.76 +/-0.06	1.20E+00	7.92E-01	3	2	67%	0.82	1
Sr-90	0.5 +/-0.2	0.9 +/-0.2	7.00E-01	2.83E-01	3	2	67%	0.49	2
Tc-99	1.3 +/-0.5	1.5 +/-0.5	1.40E+00	1.41E-01	3	2	67%	NA	NA

NA - Not applicable/available

excavated), sampling maps (not-to-scale), and handwritten notes that document the cleanup effort. The transformer, contaminated soil, and the pad were removed and shipped to a commercial disposal facility. Approximately 40 drums of soil and debris were removed. A new transformer and concrete pad have been installed over the site.

As part of the cleanup, an excavation is reported to have been completed to a depth of 1.8 m (6 ft). The excavation was subsequently backfilled with soil previously removed from portions of the CPP-718 transformer yard. Analysis of the backfill soil showed PCB concentrations up to 10 ppm. Additionally, documentation and analytical results suggest that an area of residual surface radioactive contamination remains adjacent to the excavated area.

Before removal of the contaminated soil associated with the PCB release, surface radiological contamination was detected by ICPP health physics personnel. Nine surface hotspots were surveyed in the area ranging between 400 and 2,500 cpm above a 200-cpm background level, including hotspots of 1,000 and 1,500 cpm near the PCB release. No source for the radiological contamination was identified.

A Track 1 investigation resulted in a no further action recommendation that was approved in January 1993 for the PCB release. This recommendation included further evaluation of the low-level radioactively contaminated soils discovered at the site.

As part of the WAG 3 RI/FS field sampling program, a surface radiation survey was conducted to aid in sample location selection. Hand auger borings were completed at the location of the three highest radiation readings obtained during the surface radiation survey. These hand auger borings are CPP-61-2, CPP-61-3, and CPP-61-4 on Figure 8-1. Surficial soil samples from a depth interval of 0 to 0.15 m (0 to 0.5 ft) were collected at each boring, along with samples from the 0.15-m (0.5-ft) increment below the surficial sample that returned the highest radiation reading.

One borehole, designated as location CPP-61-1 on Figure 8-1, was drilled to a depth of 3 m (10 ft). Borehole CPP-61-1 was located as close as possible to the original PCB spill and the locations of the 1,000 and 1,500 cpm readings detected during the 1985 radiation survey. Samples were collected from 0 to 0.15 m (0 to 0.5 ft), 0.6 to 1.2 m (2 to 4 ft), and 2.4 to 3.0 m (8 to 10 ft). The 0.6- to 1.2-m (2- to 4-ft) sample represented the sample in the 0.15- to 1.2-m (0.5- to 4-ft) interval with the highest field radiation reading. The same criteria were used to select the 2.4- to 3.05-m (8- to 10-ft) sample from the 1.2- to 3.0-m (4- to 10-ft) interval.

The analytical results for the COPCs identified for CPP-61 are summarized in Table 8-3. A compilation of the analytical results is presented in Appendix G. Based on contaminant screening from Section 5.2, the following COPCs were identified for this site: Sr-90, Tc-99, and Cs-137. Cs-137, Sr-90, and Tc-99 were detected at low activities in surficial soil samples from the sample locations. Cs-137, Sr-90, and Tc-99 ranged from maximum activities of 2.51±0.07, 3.0±0.2, and 1.6±0.5 pCi/g respectively, to minimum values of 1.69±0.06, 0.9±0.2, and 1.3±0.4 pCi/g, respectively. Radionuclide detections above background in below-surface samples were limited to Cs-137 (1.1±0.5 pCi/g) in the 0.15- to 0.3-m (0.5- to 1.0-ft) sample at boring CPP-61-3; and Tc-99 at 1.9±0.4 and 1.5±0.4 pCi/g in the 0.6- to 1.5-m (2.0- to 4.0-ft) and 2.4- to 3.0-m (8.0- to 10.0-ft) intervals in the boring CPP-61-1.

8.3.3 Conclusions

This site is the result of a spill of transformer oil that contained PCBs. Before the removal of soil associated with the PCB release, surface radioactive contamination was noted. As part of the WAG 3 RI/FS field program, four borings were completed at site CPP-61. Radiologic constituents were detected in the

Table 8-3. Summary statistics for CPP-61, PCB spill in CPP-718 Transformer Yard.

COPCs	Concentration (mg/kg or pCi/g) Minimum detected	Maximum detected	Arithmetic mean	Standard deviation	Number of samples	Number of detects	Frequency of detection	INEL background (mg/kg or pCi/g)	Number greater than background
Cs-137	0.12 +/-0.02	2.51 +/-0.07	1.40E+00	8.80E-01	9	7	78%	0.82	5
Sr-90	0.3 +/-0.2	3 +/-0.2	1.28E+00	1.05E+00	6	6	100%	0.49	4
Tc-99	1.3 +/-0.4	1.9 +/-0.4	1.53E+00	2.07E-01	6	6	100%	NA	NA

NA - Not applicable/available

surficial sample from each boring, but at low activity levels. Activity levels decrease to below background concentrations at shallow depths, except for Tc-99 at boring 61-1. Furthermore, the maximum values for Tc-99 and Sr-90 are below the most limiting risk-based concentrations derived for future residential land are using a target cancer risk or 1E-05 (Fromm, 1996). The maximum values for Cs-137 (2.5 pCi/g) is near the risk-based value of 2.3 pCi/g and below the lE-04 risk-based value of 2.3 pCi/g. Because of the limited extent of soil with radiation levels above background, site CPP-61 is considered a site of negligible soil contamination and will only be evaluated qualitatively in the BRA.

8.4 Site CPP-78

Site CPP-78 consists of a 2.3 m^2 (25 ft^2) area of potentially radioactively-contaminated soil located west of building CPP-693 and east of the Dry Fuel Storage Area (Figure 8-1). This section describes the site as well as the results of sampling to identify potential contamination.

8.4.1 Site Description

Elevated field radiation measurements in site CPP-78 soil was reportedly detected in May 1987 during trench excavation activities west of CPP-693. Following detection, the trench was backfilled with the potentially contaminated soil and the area roped off and posted. The origin of the contamination is not known, but based on the remote location of the site, it is assumed to have resulted from a spill of radioactively-contaminated material onto surface soils. The depth of potential contamination from a surface spill is assumed to be less than 0.3 m (1 ft), although deeper contamination may be present as a result of the excavation activities.

8.4.2 Investigative Results

A surface radiation survey was performed on October 7, 1993, at site CPP-78. No radioactivity levels above 100 cpm were detected during the survey.

As part of the WAG 3 RI/FS field sampling program, two boreholes, designated CPP-78-1 and CPP-78-2, were drilled at site CPP-78 as shown on Figure 8-1. As discussed in Section 3.3.1.8, a ground-penetrating radar (GPR) survey was performed over the area before drilling so the location of the electrical conduit and other possible obstructions could be determined. The GPR survey also helped locate the subsurface utility that was being installed when the contamination was discovered, thereby increasing the probability of placing the borehole near the suspected contamination.

Since the exact location of the contamination was unknown, the first borehole (CPP-78-1) was located in the center of the Environmentally Controlled Area (ECA) boundary and the second borehole (CPP-78-2) was located adjacent to the subsurface conduit near building CPP-693 (Figure 8-1).

Background radiation levels of approximately 150 cpm were measured at borehole location CPP-78-1 using field-screening equipment. Samples from the following intervals were collected for radiological analysis: 0.0 to 0.15 m (0.0 to 0.5 ft), 0.8 to 1.5 m (2.5 to 5.0 ft), and 2.3 to 3.0 m (7.5 to 10.0 ft). All samples indicated field-screening radiation levels below background.

Background radiation levels of approximately 150 cpm were measured at location CPP-78-2 using a Ludlum 2A detector. Samples from the following intervals were collected for radiological analysis 0.0 to 0.15 m (0.0 to 0.5 ft), 0.8 to 1.5 m (2.5 to 5.0 ft), and 2.3 to 3.0 m (7.5 to 10.0 ft). All samples indicated field-screening radiation levels below background. Samples at both borehole locations were primarily fill

material from approximately 0.0 to 0.6 m (0.0 to 2.0 ft) and sandy gravels (with scattered clay layers) below approximately 0.6 m (2.0 ft).

Based on chemical screening in Section 5.2, Sr-90 was the only COPC identified for this site. The analytical results for Sr-90 are summarized in Table 8-4. A compilation of the analytical results is presented in Appendix G. Sr-90 was the only radionuclide detected at an activity above background in either of the CPP-78 sample borings. Sr-90 was detected at an activity of 0.7±0.2 pCi/g in the 0.8- to 1.5-m (2.0- to 5.0-ft) sample of boring CPP-78-1. Two detections of Cs-137 were noted in CPP-78 sample borings, but activities were below background.

8.4.3 Conclusions

Sr-90 measurements barely exceed background values and are still found to be below the risk-based concentrations published in Fromm, 1996. Because of the small areal extent of potentially contaminated soil [2.3 m^2 (25 ft^2)] and the low activity levels measured, site CPP-78 is considered a site of negligible soil contamination and will not be included in the BRA.

8.5 Windblown Area

The Windblown Area related to the ICPP has been investigated as a portion of OU 10-06, Radionuclide-Contaminated Soils. A detailed description of this investigation is presented in *Remedial Investigation/Feasibility Study Report for Operable Unit 10-06* (LITCO, 1995) with excerpts of the report presented in Appendix A. This section will therefore only summarize the findings of that investigation.

Conclusions in LITCO 1995 indicate that, based on the results of the Radiological and Environmental Sciences Laboratory (RESL) investigation and the method of contaminant deposition, the vertical extent of the radionuclide COPCs detected in the ICPP Windblown Area is believed to be restricted to the upper 10 cm (4 in.) of soil.

The BRA performed for the ICPP Windblown Area evaluated the potential adverse health effects to current workers and hypothetical future residents. The COPCs evaluated in the human health risk assessment (HHRA) portion of the BRA were Am-241, Cs-134, Cs-137, K-40, Pu-238, Pu-239/240, Sr-90, U-233, U-234, and U-235. These radionuclides were COPCs because either they were detected above background concentrations in surface soils at the ICPP Windblown Area or because no background values were available (Cs-134, U-233, and U-235). All exposure pathways identified on the site conceptual site model (CSM) for windblown sites except dermal exposure were evaluated.

Results from the HHRA indicate that food crop ingestion from Sr-90 (2E-05) and external exposure to Cs-137 (1E-06) pose a risk within the National Contingency Plan (NCP) target risk range of 10^{-6} to 10^{-4} for the 30-year residential exposure scenario. The hazard quotient for uranium is below 1. Results from the 100-year residential exposure scenario indicate that Sr-90 has a risk of 2E-06 (LITCO, 1995).

An Ecological Risk Assessment (ERA) was performed to assess the potential risk to ecological receptors in the ICPP Windblown Area. The results of this evaluation indicate that it is unlikely that the COPCs at the ICPP Windblown Area will cause adverse effects to populations of exposed ecological receptors (LITCO, 1995).

The ICPP Windblown Area is not considered to pose an unacceptable health threat to occupational personnel, future residents, or the ecological environment. As a result, the ICPP Windblown Area is

Table 8-4. Summary statistics for CPP-78, contaminated soil west of CPP-693.

COPCs	Concentration (mg/kg or pCi/g) Minimum detected	Maximum detected	Arithmetic mean	Standard deviation	Number of samples	Number of detects	Frequency of detection	INEL background (mg/kg or pCi/g)	Number greater than background
Sr-90	0.7 +/-0.2	0.7 +/-0.2	7.00E-01	NA	1	1	100%	0.49	1

NA - Not applicable/available

considered a site of negligible soil contamination and will not be included in the WAG 3 Comprehensive BRA.

8.6 Uncertainties

The implementation of the chemical screening steps in Section 5 indicate that several contaminants within CPP-40, -46, -61, and -78 are present at sufficiently high enough levels above background where further quantitative evaluation in the BRA would be appropriate. However, these levels are lower than the 100-year future residential risk-based concentrations published in Fromm 1996 or that value of 50 pCi/g for Cs-137 derived from the proposed language in 40 CFR 196. Therefore, it was decided not to quantitatively evaluate these sites further in the RI/BRA. This recommendation will add to the overall uncertainty of this evaluation because the sources at these sites, small as they may be, were assumed to offer no cumulative risk contribution when actually this contribution though very small would not be non-zero. Evaluating these sites qualitatively will not reduce the conservatism of the BRA. Another source of uncertainty is the use of screening levels derived for single routes of exposure. There are other more procedural related sources of uncertainty that together do not merit the effort to be quantified because they are associated with release sites that are of least concern within the WAG 3.

8.7 References

LITCO, 1995, *Remedial Investigation/Feasibility Study for Operable Unit 10-06: Radionuclide-Contaminated Soils at the Idaho National Engineering Laboratory (DRAFT) Volume 1*, Revision 0, February.

WINCO, 1993, *Track 1 Decision Documentation Package Waste Area Group 3, Operable Unit 6, Site CPP-40, Lime Pit at the base of the CPP-601 Berm and French Drain*, Revision 1, August.

WINCO, 1992, *Track 1 Decision Documentation Package Waste Area Group 3, Operable Unit 6, Site CPP-61, PCB Spill in the CPP 718 Transformer Yard*, April.

Chapter 9

9. SITES OF EXCLUSIVE GROUNDWATER CONCERN

This group consists of sites that pose a potential threat to human health and the environment only through the groundwater pathway. This group includes sites CPP-02, CPP-23, CPP-65, CPP-69, CPP-80, CPP-83, CPP-87, and CPP-89 (Figure 9-1). These sites were determined, based on the depth of contamination [i.e., greater than 3.0 m (10 ft)] or their location beneath structures, not to have any complete exposure routes other than those associated with groundwater (Figure 7-1). These sites were incorporated into the vadose zone and groundwater models as appropriate. A description of each of these sites is provided below.

9.1 Site CPP-02

Site CPP-02 is the former location of a French drain west of building CPP-603 that is now beneath the Graphite Storage Facility (GSF) (Figure 9-1). This section describes the nature and extent of contamination associated with the French drain.

9.1.1 Site Description

The French drain was used to dispose of CPP-603 fuel-storage-basin-through-water. The basin water was recirculated through a filter system to clean out dirt and algae. Robertson et al. (1974) reported that an average of 1.4E+07 L/yr were disposed of in the French drain to reduce the chloride and nitrate ion concentrations in the basin water by using a flow through system. Reports indicate that the drain also received low-level radioactive waste from the Fuel Element Cutting Facility (FECF), which is also located in CPP-603. The function of the FECF was to receive, store, and cut aluminum-clad fuel from the test reactor program at Savannah River.

The CPP-02 French drain had a diameter of 1.5 m (5 ft) and was approximately 6.1-m (20-ft) deep. The drain was in use from 1952 until late 1968 when construction of the GSF commenced. The GSF is situated in the southernmost portion of CPP-603. When the GSF building was added onto CPP-603, the drain was decommissioned and an unknown volume of soil was boxed and sent to the RWMC. It is reported that some of the contaminated soil may have been used as construction backfill and/or buried near the Peach Bottom Fuel Storage Facility.

9.1.2 Investigative Results

No analytical data are available for the soil beneath the former location of the French drain. The former location of the French drain is now beneath the GSF that precluded the collection of soil samples. However, the presence of the building over the site prevents exposure of receptors to contaminated soil. To evaluate the groundwater pathway, it was be assumed that 1.8E+08 L (4.8E+07 gal) of fuel storage basin through water was disposed of in the French drain. This estimate is the sum of the annual volume of water disposed of to the French drain. This source was input into the vadose zone and groundwater models (Section 6). Data on the quality of the fuel-storage-basin-through-water is provided in Section 6.

9.1.3 Nature and Extent of Contamination

Based on the nature of release at this site, fuel-storage-basin-through-water migrated downward from the former location of the French drain through the vadose zone. Perched water was first identified beneath

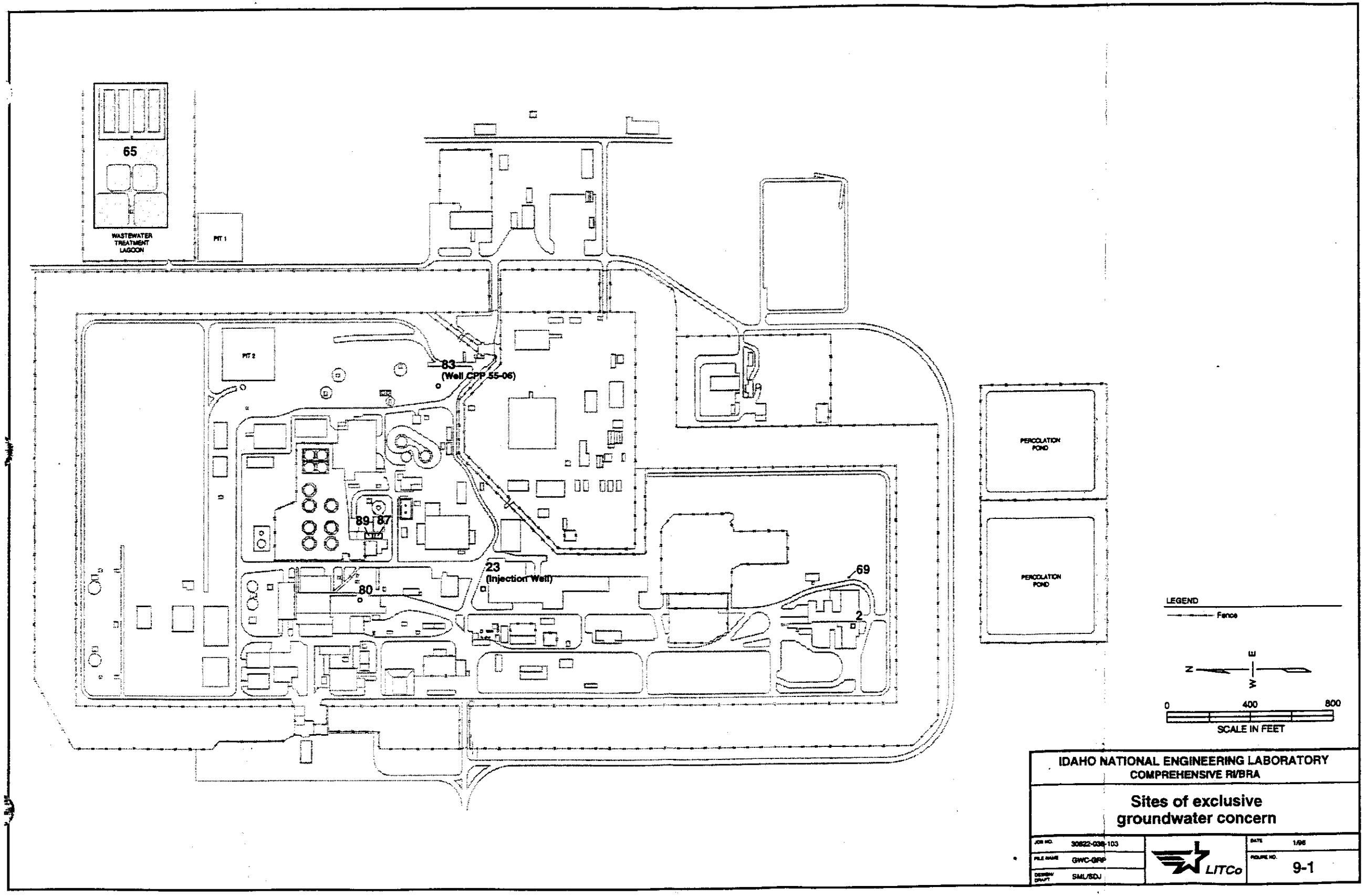

Figure 9-1. Sites of exclusive groundwater concern.

building CPP-603 in the early 1960's and was primarily attributed to discharges to the French drain. The shallow perched water body was investigated by installing 27 observation wells in the alluvium above the basalt. A small zone of perched water was encountered at a depth of 6.7 m-(22-ft) below ground surface (bgs), and a larger zone was encountered directly above the basalt surface at a depth of 9.8-m (32-ft) bgs. This perched water body has not been monitored since 1970 and is believed to have dissipated since the French drain was taken out of use (WINCO,1994a). The extent of perched water is discussed in Section 2 while contamination in perched water is described in Section 4.

9.1.4 Conclusions

Because of the presence of the GSF above the former location of the CPP-02 French drain, the only complete pathway is through the groundwater exposure routes. Therefore, this site is included in the vadose zone and groundwater models (Section 6) and the risk is evaluated cumulatively in Section 27.

9.2 Site CPP-23

CPP-23 is the ICPP injection well (MAH-FE-PL-304) located north of building CPP-666 (Figure 9-1). This section describes the contamination that resulted from use of the injection well.

9.2.1 Site Description

The CPP-23 injection well was originally drilled in 1950 to a depth of 66.6 m (212 ft) and deepened in 1951 to 182 m (597 ft), extending 47 m (140 ft) below the regional water table (WINCO, 1994b). A 61-cm (24-in.) diameter borehole was drilled and cased using 41-cm (16-in) nominal diameter carbon steel casing. The well was perforated from 125.6 to 137.8 m (412 to 452 ft) and 149.4 to 180.7 m (490 to 593-ft) bgs. Portions of the well collapsed and were subsequently reopened in 1971 and in 1982. The collapses were attributed to the warm, salty nature of the injected wastewater that resulted in corrosion of the casing. The corrosion developed to the point that the gravel pack and sediments intruded into the well filling up the casing.

The injection well was used regularly from 1952 to 1984, and then periodically until 1986. The well was used to dispose of ICPP service wastewater that contained radioactive and inorganic contaminants. Based on a comparison to drinking water standards, the most significant radionuclides in the service wastewater were H-3 and Sr-90. According to the Track 2 document, it is estimated that a total of 22,200 Ci (approximately 96% consisting of H-3) has been released in 4.2E+10L (1.1E+10 gal) of water (WINCO, 1994b).

During the operational life of the injection well, several known accidental discharges to the injection well occurred (WINCO, 1994a). These discharges are described below.

- July 25, 1953. The contents of a tank discharged to the wastewater flowing to the well. A postdischarge analysis showed that 51 mCi of radioactive contaminants were released in 923,640 L (244,000 gal) of water.
- December 1958. About 29 Ci of radioactive contaminants, including 7 Ci of Sr-90 were released to the well.
- September 1969. Two separate releases resulted in 19 Ci of fission products being released to the well. Releases included Cs-134, Cs-137, Ce-144, and Sb-125.

- December 1969. Two releases occurred in which the quantity of Sr-90 released was higher than expected. About 1 Ci of radioactivity, including 30% Sr-90, was released.

- March 1981. Mercury was detected during routine monitoring of the ICPP Service Waste System. Mercury in the form of mercuric nitrate was released from CPP-601, through the ICPP Service Waste System to the ICPP injection well. A concentration of 0.207 mg/L of mercury was detected in service wastewater.

The injection well was taken out of routine service on February 7, 1984 and wastewater was routed to Percolation Ponds 1 and 2 (CPP-67). Between 1984 and 1986, the injection well was used as emergency overflow protection for buildings CPP-709, -734, and -797, that contain the vaults from which the service wastewater is monitored and pumped. The overflow protection was only required on a temporary basis if the operating and standby pumps from one of the parallel streams failed simultaneously. No releases to the well have occurred since 1986. In February 1989, it was discovered that the well had filled in with sediment to about 145-m (475-ft) bgs. In October and November 1989, the injection well was sealed by perforating the casing throughout and pumping in cement. This sealing process was performed from the top of the sediment layer up to the ground surface to prevent hydraulic communication between the land surface, perched water, and the Snake River Plain Aquifer (SRPA).

9.2.2 Investigative Results

Before the well abandonment, a sediment sample was collected from the bottom of the open part of the well [about 145-m (475-ft) bgs] and analyzed for radionuclides, inorganics, volatile organic compounds (VOCs), and semivolatile organic compounds (SVOCs). Analysis of the sediment sample detected low concentrations of inorganics, radionuclides, and polychlorinated biphenyls (PCBs). Fourteen inorganics were detected using Method 7000 (total concentrations); however, only barium was detected in the leachate using the Extraction Procedure (EP)-Toxicity extraction (Method 1310) test for leachable metals. The concentration of barium (0.26 mg/L) was well below the regulatory threshold of 100 mg/L. The radionuclide analyses of the sediments show that the gross beta activity was measured at 150 pCi/g. This analysis also measured Ce-137 at 100 pCi/g, Eu-152 at 3.8 pCi/g, and Eu-154 at 2.5 pCi/g. The only organic compound detected above the method detection limit was Aroclor-1260 at 10 μg/kg.

Additionally, upgradient and downgradient water samples were collected from process water supply well CPP-1 (upgradient) and United States Geologic Survey (USGS) monitoring wells 40 and 47 (downgradient) on October 19, 1989 by USGS and Westinghouse Idaho Nuclear Company (WINCO) personnel. Sample results show the value of zinc increased from 0.161 mg/L in the upgradient well, to 0.283 mg/L in downgradient well USGS 40 and to 0.786 mg/L in downgradient well USGS 47. However, the 0.786 mg/L was still only about 1/6 of the secondary water quality standard. Tritium ranged from <0.69 pCi/mL in the upgradient well to 5.6 ± 0.3 pCi/mL in well USGS 40 and 3.1 ± 0.3 pCi/mL in well USGS 47. These values were well below the drinking water standard of 20 pCi/mL. It is generally known from USGS studies and reports that H-3 levels in the aquifer beneath and downgradient from ICPP did increase until ICPP ceased using the injection well in 1986. Since that time, H-3 levels have slowly declined due to taking the injection well out of service and radioactive decay of the existing H-3 that has a half-life of 12.3 years (WINCO, 1990). Water samples collected from 1989 to 1991 in monitoring wells #40 and #47 indicate that concentrations of radionuclides are not increasing and in some cases are slightly decreasing. While these radionuclide concentrations reflect past disposal practices through the injection well, it is not clear that they are indicative of significant leaching from the silt sediment plug in the bottom of the well.

Additional information on contamination in the SRPA is presented in Section 4.3.

9.2.3 Nature and Extent of Contamination

The remaining source of contamination at this site is the sediment plug remaining in the well. For the purpose of risk estimation only, it was assumed that the contaminants detected in the sediment sample at 145 m (475 ft) is representative of the entire vertical interval of the sediment plug. The volume of sediment in the well was estimated at 10.9 m^3 (386 ft^2).

The extent of contamination in the SRPA is discussed in some detail in Section 2.0 of the WAG 3 Work Plan (LITCO, 1995b). The primary contaminants in the aquifer related to the injection well are H-3, Sr-90, and Cs-137. In 1993, Sr-90 concentrations were above the maximum contaminant level (MCL) of 8 pCi/L in an area that extended approximately 2,130 m (7,100 ft) downgradient of the injection well. The plume of H-3 above the MCL of 20,000 pCi/L extended about 2,730 m (9,100 ft) downgradient. Cs-137 concentrations have decreased significantly since the early 1980s. During 1982 to 1985, maximum concentrations in wells USGS-40 and -47 were 237±45 and 200±50 pCi/L, respectively. Between 1986 and 1993, Cs-137 has only been detected in each of these wells once.

9.2.4 Conclusions

The ICPP injection well has been a significant source of contamination to the SRPA. Historical data concerning the amounts of wastewater discharged to the well in conjunction with injected water quality data have been used to simulate this contaminant source in the groundwater model (Section 6). Appendix F present mass calculations. The only complete pathway from this site is through the groundwater exposure routes (Figure 7-1). Groundwater model predictions will be used to estimate the risk from this and other sources of contamination to groundwater in the cumulative risk assessment (Section 27).

9.3 Site CPP-65

The ICPP Sewage Treatment Plant (STP) is located outside the northeast corner of the ICPP (Figure 9-1) and treats sanitary waste from 31 permanent facilities at the ICPP. This section describes the processes associated with the STP.

9.3.1 Site Description

All sanitary waste from 31 facilities at the ICPP is collected by gravity-flow lines and pumped via lift stations to the STP for treatment. The STP is located 200 m (1/8 mi) east of the northeast corner of the ICPP security fence (Figure 9-1). The STP consists of two aerated lagoons, two quiescent faculative stabilization lagoons, four infiltration/percolation (I/P) trenches, and six weir boxes. The aerated lagoons are arranged in series and drain into the faculative lagoons, which are arranged in parallel. From the faculative lagoons, the overflow drains to the I/P trenches. The weir boxes route the wastewater through the lagoons and trenches. The average amount of influent treated by the plant in 1995 was 484,250 L/day [127,940 gallons per day (gpd)].

The aerated lagoons each have a floor area of 607 m^2 (6,534 ft^2), a water surface area of 1,821 m^2 (19,600 ft^2), and a volume of 3,341 m^3 (117,970 ft^3). The faculative lagoons each have floor areas of 162 m^2 (1,744 ft^2), a maximum water surface area of approximately 852 m^2 (9,170 ft^2), and a maximum volume of approximately 1,280 m^3 (45,200 ft^3). All lagoons are lined with geotextile liners (80 mL impermeable liner over polypropylene fabric mat) and are surrounded by dikes. The four unlined I/P trenches are each approximately 890 m^2 (9,580 ft^2) in size. Only one trench is used at a time. Rotation occurs every 2 to 12 weeks.

ICPP sewage consists primarily of wastewater from restrooms and cafeterias. Wastewater has been supplied to the STP since the facility was completed in 1984. Two potential contaminant sources have been identified in addition to sanitary waste; spent water from a decontamination shower that was improperly connected to the sanitary sewer, and waste, possibly including photochemical products, associated with the Graphics Department (CPP-1605) and X-Ray Cave (CPP-695) facilities. The Graphics Department and X-Ray Cave facilities are no longer connected to the sanitary sewer system. Small amounts of radionuclides may have entered the sewer system via the CPP-602 shower stall, which was used for decontamination of personnel. The shower drains were sealed in June 1991.

Measurements of inflow and outflow from the lagoons, corrected for precipitation and evaporation, indicate that the lagoon liners were leaking. Consequently, the lagoon liners were replaced during 1993 and the sewage sludge present in the lagoons was removed and disposed of as part of the liner replacement project. The STP facility is currently operating and periodic removal of sewage sludge will be performed in accordance with State regulations.

The STP is considered to be a significant source of water to the zone of perched water beneath the northern portion of the ICPP. The distribution of perched water beneath the ICPP is discussed in detail in Section 2.5. The nature and extent of contamination in perched water is discussed in Section 4.2.

9.3.2 Investigative Results

Periodic monitoring of sewage lagoon effluent was performed for Sr-90, and Pu-239/240 in the years 1988, 1989, and 1990. Sr-90 was detected at an average concentration of 0.36 pCi/L and Pu-239/240 at an average concentration of 0.0019 pCi/L. Inorganic constituents in the lagoon water were analyzed in September 1992. Inorganics detected include cadmium, zinc, barium, lead, and silver. Concentrations of the inorganics are near background levels in groundwater upgradient of the ICPP. Concentrations of radionuclides and inorganics in water in the sewage lagoon are expected to be higher than in the I/P trenches. Therefore these concentrations are conservative in that they overestimate concentrations in water in the I/P trenches. Organics were not analyzed in the lagoon water but were not detected in a sample of lagoon sludge collected in 1992. Therefore, organic compounds are not believed to be present in significant concentrations in the wastewater.

9.3.3 Nature and Extent of Contamination

Migration of low levels of radionuclides and inorganics in infiltrating treated wastewater is likely to have been significantly retarded due to partitioning onto particulate matter. Infiltrating water must filter through 12.2 to 15.2 m (40 to 50 ft) of sediments that overlie basalt in this area. Sampling data from the ICPP percolation ponds CPP-67 indicate that approximately 90% of inorganic constituents detected beneath the pond were found in the top several inches of soil (WINCO, 1994b). This suggests that a similar pattern of limited migration is probably occurring beneath the I/P trenches at the STP. The actual zone of contamination in the soil, if any, is likely to be very small due to constituent partitioning onto sludge solids in the sewage lagoons before discharge onto soils in the I/P trenches.

9.3.4 Conclusions

The low levels of radionuclides and inorganics detected in lagoon water suggest that the STP is not a significant source of contamination to groundwater. However, an estimated 44,300,000 L/yr (1,170,000 gal/yr) is released to the I/P trenches creating a significant source of water to the vadose zone, and eventually the aquifer. This source of water will be included in the vadose zone model to aid in calibration of the model to existing conditions. Contaminants identified in water samples from the faculative lagoons

include barium, cadmium, Pu-239/240, and Sr-90. However, the faculative lagoons are believed to have significantly higher concentrations of potential contaminants than the water discharged to the I/P trenches. The source input to the model will only include the estimated discharge of water to the I/P trenches and will not include contaminant data.

9.4 Site CPP-69

In the FFA/CO, Site CPP-69 is defined as the SFE-20 Radioactive Liquid Waste Storage Tank and its contents. However, a physical description of the tank waste system would include the surrounding tank vault, access tunnel, and pump pit located to the east of building CPP-603 (Figure 9-1). This section describes the nature of contaminants found in the tank and vaults associated with the tank.

9.4.1 Site Description

The SFE-20 tank is a 2,422-L (640-gal) stainless steel tank with a 1.1-m (3.5-ft) inside diameter. The tank has a 2.3-m (7.5-ft) long cylindrical shell with elliptical ends extending approximately 0.3 m (1 ft) beyond the cylindrical portion of the tank. The concrete tank vault dimensions are 4.0 × 1.8 × 3.0 m (13 × 6 × 10 ft), the floor of the vault is 25 cm (10 in) thick, and the top of the vault is 3.0 m (10 ft) bgs. The concrete pump pit dimensions are 2.1 × 2.1 × 5.2 m (7 × 7 × 17 ft), with a floor thickness of 25 cm (10 in.). The concrete access tunnel dimensions are 2.4 × 0.7 × 0.7 m (8 × 2.5 × 2.5 ft). This system was constructed in 1957 to collect low-level liquid wastes from the newly completed FECF addition of the CPP-603 Fuel Rod Storage Facility (FRSF).

The SFE-20 Radioactive Liquid Waste Tank system was also used during the period from 1966 to 1976 for interim storage of wastes associated with FRSF activities. Between 1951 and 1977, the shielding water was routinely circulated through a diatomaceous earth filter system. When the filter system was backwashed, a slurry was sent to a settling system that separated out the liquids and solids. From 1966 to 1976, the resulting supernatant from this settling system was steam jetted to SFE-20 and eventually pumped to the process equipment waste (PEW) Evaporator Facility.

Because of the low working capacity of the SFE-20 tank [<2,420 L (<640 gal)] and low transfer rate of the associated pump, the decision was made to replace the entire SFE-20 waste holding and transfer system. In 1976, the SFE-20 inlet pipe was disconnected approximately 2.1 m (7 ft) from the vault and connected to a new system (VES-FF-126). The pipe leading to the SFE-20 tank was capped. The pump was also removed from the pump pit and the connections capped.

9.4.2 Investigative Results

In February 1984, liquid and sediment samples were taken from the tank interior, vault floor, and pump pit. The analysis consisted of only Co-60, Cs-137, Cs-134, Eu-152, Eu-154, Eu-155, Sb-125, total strontium, and plutonium and uranium isotopes. The reported concentrations of Cs-137, total strontium, and plutonium isotopes in the single tank liquid sample were 2,050; 9,700; and 17,600 pCi/mL, respectively (WINCO, 1984). For the same radionuclides, the concentrations in the tank sediment sample were reported at 55,400,000; 4,700,000; and 93,500 pCi/mL, respectively. Three samples were collected from the floor (two liquid and one sediment). The reported concentrations in the two liquid floor samples for Cs-137 (analysis for total strontium and plutonium isotopes was not requested) taken from the south and center vault floor locations were 905 and 248,000 pCi/mL, respectively. The reported concentrations of Cs-137, total strontium, and plutonium isotopes in the sediment sample collected on the north end of the vault were 8,920,000; 1,720,000; and 79,200 pCi/g, respectively. For the same radionuclides, the concentrations in the

pump pit sediment sample were 2,290,000; 5,890,000; and 3,010 pCi/g, respectively. Only Cs-137 at a concentration of 76 pCi/mL was reported for the pump pit lqiuid sampling (WINCO, 1984).

There are no data available for nonradioactive constituents; however, the tank contents may contain inorganic and organic consitituents that were associated with the operation of the CPP-603 spent fuel storage pool filtration system. It should be noted that generally, longer lived radionuclides (i.e., those having half lives greater than 10 years) are of most concern and thus, those with shorter half lives were not summarized in this section.

9.4.3 Nature and Extent of Contamination

There is no evidence to indicate that a release to subsurface soils has taken place from the waste tank-vault system. If a release were to have taken place, contamination could be present in soil beneath either the tank vault or the pump pit. Contamination of near-surface soils would not be expected.

9.4.4 Conclusions

The SFE-20 Radioactive Liquid Waste Tank and its contents is an FFA/CO site. However, because of the location and depth of the tank, the contents and vault surface contamination are not available to a future resident on the surface. Since there is no known release out of the vault to the environment, the groundwater pathway cannot be evaluated without making extraordinary assumptions. Therefore, this site has not been included as a source in the vadose zone and groundwater models. These limitations have NOT led to a No Further Action determination. Instead, this site will be carried forward to the Feasibility Study for further evaluation.

9.5 Site CPP-80

Site CPP-80 consists of soil contaminated by leakage of condensate from a corroded cast iron line that serves as a floor drain in the CPP-601 South Vent Tunnel. This section describes the nature and extent of contamination associated with the leak.

9.5.1 Site Description

The cast iron line associated with site CPP-80 transmitted corrosive solutions from the VT-300 vessel off-gas condenser, which condenses all gaseous vapors from the CPP-601 fuel processing equipment, to the PEW tank vault. In 1982, this effluent was rerouted from the original stainless steel line to the cast iron line. The cast iron line penetrated the 0.6-m (2-ft) thick, concrete vent tunnel floor at a depth of about 3.7 m (12 ft) down to a depth of 10.4-m (34-ft) bgs where the line changes to stainless steel and enters the PEW tank vault.

On July 20, 1989 it was discovered that the 10-cm (4-in.) SK-1075T cast iron line had corroded well past the point of failure. The extent of corrosion was so advanced that no physical line remained in the area, with the route from the drain to the vault consisting of a soil conduit. This severe state of corrosion suggests that the line had deteriorated quickly, and probably leaked soon after corrosive condensate wastes were routed to the line in 1982.

9.5.2 Investigative Results

No soil sampling data are available for this site due to its location beneath building CPP-601. The rate and amount of leakage was estimated in the Track 1 (WINCO, 1993) to be approximately 6 L/hr (1.6 gal/hr), or 400,000 L (105,000 gal) of condensate between 1982 and 1989. It was further assumed, based on the composition of waste in tank WM-182, and a dilution factor of 1,000, that the estimated quantity of the radioactive release totaled about 550 Ci. Soil concentrations were estimated based on an assumed mass of

soil of 2.4E+06 kg. The highest estimated radionuclide concentrations were of Cs-137 (86,300 pCi/g) and Sr-90 (85,600 pCi/g) (Table 5-41).

9.5.3 Nature and Extent of Contamination

Leakage of condensate along the path of the cast iron line from the floor drain in the CPP-601 South Vent Tunnel down to the PEW tank vault migrated directly into soil beneath building CPP-601. Condensate probably migrated downward to the "110-ft" perched water body. Water quality data from nearby perched water well 33-2 shows elevated levels of gross beta and Sr-90 in the northern "110-ft" perched water body that may be related to leakage of condensate along the path of the deteriorated pipe. However concentration levels of gross beta and Sr-90 are much higher in the southeastern portion of the northern perched water body to the east of building CPP-601, suggesting that the leak associated with site CPP-80 is not the main source of radionuclides in the "110-ft" perched water body.

9.5.4 Conclusions

Because of the presence of building CPP-601 above the former drain line from the South Vent Tunnel, the only complete exposure route is through the groundwater exposure routes (Figure 7-1). Therefore, this site is included in the groundwater model (Section 6) and the risk associated with the groundwater pathway is evaluated in the cumulative risk assessment (Section 27).

9.6 Site CPP-83

Site CPP-83 consists of perched water being monitored by well CPP 55-06 located approximately 168 m (550 ft) southeast of the Tank Farm Area as well as the entire perched water system at CPP. This section briefly describes contamination in and near well CPP 55-06. A description of the distribution of perched groundwater beneath the ICPP is provided in Section 2.5. The nature and extent of contamination in perched water is discussed in Section 4.2, and the results are presented in Table 4.2.

9.6.1 Site Description

Well CPP 55-06 was installed in 1990 in shallow perched groundwater above the "110-ft" interbed. The contamination in shallow perched groundwater at this location was first discovered during the drilling of a deep borehole to characterize site CPP-55 (mercury-contaminated area) under the Consent Order and Compliance Agreement (COCA). The borehole initially encountered radiological contamination at a depth of 18.5 m (60.7 ft) bgs and the contamination was present in clay infilling in the basalt to a depth of approximately 35.4 m (116 ft) bgs. The total depth of the borehole was 37.4-m (123-ft) bgs. Since water was encountered at this depth, a 5.1-cm (2-in.) diameter monitoring well, designated CPP 55-06, was installed with a screened interval from 28.4 to 34.5 m (93.1 to 113.1-ft) bgs.

The extent of perched water beneath the ICPP is discussed in detail in Section 2.5.

9.6.2 Investigative Results

Well CPP 55-06 has been sampled as part of both RCRA and CERCLA groundwater monitoring programs since its installation. Sampling data from January 1992 through December 1994 are presented in Tables 2-19 through 2-21 in the WAG 3 Work Plan (LITCO, 1995a). Results of the most recent sampling in 1995 are presented in Section 4. The primary contaminants in perched water in well CPP 55-06 are (with 1995 concentrations in parentheses): Sr-90 (66,300±600 pCi/L), Tc-99 (73±1 pCi/L), U-234 (3.5±0.6 pCi/L), and U-238 (2.1±0.5 pCi/L). The concentrations of these radionuclides are higher than in

December of 1994. Gross alpha and beta concentrations in the 1995 sample were 92±9 and 139,000±600 pCi/L, respectively. H-3 was reported at a concentration of 621 pCi/g, which is well below the MCL of 20,000 pCi/L.

9.6.3 Nature and Extent of Contamination

Well CPP 55-06 monitors the southeastern portion of the northern "110-ft" perched water body. Contaminant concentrations are higher in some of the other monitoring wells screened in this perched water body. For example, concentrations of gross beta, Sr-90, and Tc-99 are much higher in well MW-2, which is located on the northwest side of Bin Sets 1 and 2. Contaminant of potential concerns (COPCs) in perched water beneath the Tank Farm include arsenic, barium, chromium, manganese, Am-241, H-3, Pu-238, Pu-239/240, Sr-90, Tc-99, U-234, and U-238. Contamination in perched groundwater is described in more detail in Section 4.2.

9.6.4 Conclusions

The only complete pathway for contamination in perched water is through exposure via the groundwater routes listed in Figure 7-1. The vadose zone model has been calibrated to simulate, to the extent possible, the distribution of perched water beneath the ICPP (including perched water monitored by well 55-06) as well as the measured contaminant concentrations in perched water. The vadose zone model, in conjunction with the aquifer model, will be used to predict contaminant concentrations with time in the aquifer. This information is used in the cumulative risk assessment (Section 27).

9.7 Site CPP-87

Site CPP-87 consists of two sites, described as artifacts, located in the building CPP-604 (Figure 9-1). The extent of contamination associated with this site is described below.

9.7.1 Site Description

Building CPP-604 is the PEW Evaporator System that was originally constructed during 1951 to 1953, with additions in the 1970s and 1980s. CPP-604 has been in operation since 1953. The PEW Evaporator System produces concentrated wastes (bottoms) and condensed vapor overheads (condensates). As part of the process, the PEW Evaporator System tanks vent to the vessel offgas (VOG) system. The VOG system provides a vacuum and filtration to processing vessels in nearby facilities. In 1990, the process waste liquid (PWL) collection system was installed. This system collects hazardous waste from buildings CPP-604, CPP-605, CPP-649, and CPP-708, and transfers the waste to the PEW Evaporator System. CPP-604 wastes are also collected from floor drains, including the floor drain in the VOG Blower Cell (Artifact 1). During construction of the PWL collection system, samples were taken of the soil under a deteriorated portion of concrete in the Blower Cell to determine if the soil was contaminated. Analytical results from two grab samples and the risk estimates presented in the Track 1 (LITCO, 1995b) indicate that concentrations of the chemicals detected were not an unacceptable risk. Therefore, Artifact 1, the VOG Blower Cell Floor Drain/Sump, was recommended for no further action (see Section 5.1).

Artifact 2, the PEW Evaporator Feed Pump Cell, is related to a small hole identified in a weld in the stainless steel liner in the cell. Fluid, assumed to be decontamination liquid, squirted from the hole as a result of normal flexing when personnel walked across the liner. The decontamination liquid was between the liner and the concrete floor of the cell. The liquid was sampled in 1994 before the weld was repaired. Because of the presence of Co-60 and Cs-137 above risk-based concentrations, this artifact was recommended in the Track 1 (LITCO, 1995b) for further evaluation in this Comprehensive RI/FS.

9.7.2 Investigative Results

Artifact 2 was sampled in 1994 when a sample of the liquid present between the liner and the concrete floor was collected using a syringe. Inorganics were detected in the liquid sample but were below risk-based concentrations according to the Track 1 (LITCO, 1995b). Radionuclides detected in the liquid included Co-60 (70,740 pCi/L), Cs-134 (4,018 pCi/L), and Cs-137 (330,480 pCi/L). These concentrations are consistent with the collection of the sample from a known "hot area" (PEW Feed Pump Cell).

9.7.3 Nature and Extent of Contamination

No soil samples have been collected beneath the concrete directly below the liner in the PEW Feed Pump Cell. The physical location of the PEW Feed Pump Cell in the basement of building CPP-604 precludes drilling and sampling of this site. However, none of the liquid found beneath the liner is known to have leaked through the concrete below to the underlying soil. If significant leakage were to have occurred, contamination could extend downward in soil beneath building CPP-604.

9.7.4 Conclusions

Based on the location of this site in the basement of building CPP-604, the only potentially complete pathway for this site is through groundwater exposure routes. Considering that the hole in the stainless steel liner was fixed following its discovery, it does not seem likely that a significant amount of liquid leaked through the both the liner and underlying concrete. Therefore, this site has not been included as a source in the groundwater and vadose zone models.

9.8 Site CPP-89

Site CPP-89 consists of contaminated soil remaining in place underneath building CPP-604/605. This section describes the nature and extent of contamination associated with this site.

9.8.1 Site Description

During 1991 and 1992, an emergency fire exit was installed for egress from the basement area of building CPP-604/605. The tunnel excavation for the fire exit included soil removal from immediately south of building CPP-604 as well as from underneath building CPP-604. The excavated soil was placed in 0.6- × 0.9- × 2.5-m (2- × 3- × 8-ft) waste boxes for storage. The soil in the waste boxes is now part of site CPP-92.

During the initial excavation work on the south side of building CPP-604, contaminated soil related to site CPP-58E was encountered. This contaminated soil is not considered part of site CPP-89. As the excavation progressed beneath building CPP-604, nine abandoned waste lines associated with the PEW Evaporator were encountered beneath the building. Five stainless steel and two carbon steel pipes showed little or no deterioration. However, two carbon steel pipes were significantly deteriorated, suggesting that there had been leaks before their being abandoned in place in the 1970s. Soil adjacent to the deteriorated pipes was removed and placed in boxes. Only soil directly associated with the construction and pipe removal was excavated. The boxed soil is now part of site CPP-92 (Section 25). Construction reports do not indicate that efforts was made to remove all contaminated soils that were encountered. Soil affected by releases from these waste transfer lines that remains in place beneath building CPP-604 is considered to be associated with site CPP-89. Excavation reports indicate the presence of radioactivity above background but specific readings were not recorded in the construction documents.

9.8.2 Investigative Results

Samples have not been collected from soil remaining at this site after the excavation conducted for installation of the fire exit in 1991 and 1992. However, samples were collected from the boxed soil at site CPP-92 that came from the excavation at site CPP-89 to see if it could be used as fill material. Soil samples were analyzed for inorganics, VOCs, SVOCs, and radionuclides. The chemical screening process for site CPP-92 (Table 5-47) is based on the results of samples of soil from site CPP-89. VOCs and SVOCs were not detected in the samples. The only inorganics detected above background were arsenic at 5.9 mg/kg and mercury at 10.4 mg/kg.

Radionuclides that were detected above background in the samples at the following maximum concentrations: Am-241 (23.6 pCi/g), Cs-137 (7,730 pCi/g), Pu-238 (259 pCi/g), Pu-239/240 (24.7 pCi/g), Sr-90 (10,800 pCi/g), and U-234 (5.1 pCi/g). These contaminants are consistent with the soil being contaminated with service wastes and condensates from the PEW Evaporator that typically include nitric acid, mercury, plutonium, cesium, and strontium.

9.8.3 Nature and Extent of Contamination

The only sampling data available for this site are from soil that was removed from the excavation. No samples were collected from the bottom or sides of the excavation. Only soil directly associated with the construction and pipe removal were excavated. Construction reports do not indicate that efforts were made to remove all contaminated soils encountered. Therefore, it is be assumed that contaminated soil remains in place beneath building CPP-604/605 with contaminant concentrations equal to the maximum concentrations detected in the boxed soil.

The vertical and lateral extent of the soil contamination at this site is not known due to the lack of sampling data. The Track 1 (LITCO, 1995b) estimated the volume of contaminated soil by assuming that the volume of contaminated soil remaining was a factor of 20 greater than the amount of soil removed. Using this assumption, it was estimated that 6,475 m^3 (228,654 ft^3) of contaminated soil is present beneath the fire exit and building CPP-604/605.

9.8.4 Conclusions

The contaminated soil remaining at site CPP-89 is located beneath Building 604/605. It has been assumed, therefore, that contaminated soil is shielded from direct human contact by the building and the exit tunnel. The only complete pathway at this site is through groundwater. This site has been included in the groundwater model and the risk from the groundwater exposure routes is included in the cumulative risk assessment (Section 27).

9.9 Uncertainties

This section describes the limitations and uncertainties specific to the site characterization of the Sites of Exclusive Groundwater Concern. These sites are unique in that they are a conglomerate of sites that have differing sources and contaminated media. They have been grouped together because either the depth of contamination or assumptions regarding the contaminant sources precludes exposure via other pathways. For some of the sites, the concentration terms are not based on sampling data. Sources of uncertainty associated with the assumptions used for each site are discussed below, as appropriate. Uncertainties associated with the fate and transport model are described in Section 6. In the risk assessment, the most significant uncertainties are due to the toxicity values used and the assumptions used during the exposure assessment.

Uncertainty sources germane to the risk assessment process such as those associated with the exposure assessment will be discussed in Section 27.

There are no soil data associated with site CPP-02. As described in Section 9.1.2, an estimate of the volume of fuel-storage-basin-through-water was used as the source input to the vadose zone and groundwater model. Given the uncertainty regarding the accuracy of this estimate, this may over or underestimate the predicted concentrations, and as a result, similarly affect the concentration and risk estimates for the groundwater pathway.

The sediments associated with CPP-65 were not evaluated for the soil pathways because (a) CPP-65 is a contributor to the perched water at CPP; however, the water is assumed to contain insignificant contamination; (b) because the water is not contaminated, the sediments are assumed to contain little or no residual contamination; and (c) the sewage treatment facility (i.e., CPP-65) is still in operation and will be assessed during D&D of the facility, if necessary. Although these assumptions are consistent with the Track 1 document for this site, if the assumptions regarding CPP-65 are not accurate, exclusion may underestimate the risk.

CPP-69 was not included in the groundwater model because no release to the environment is known to have occurred. If liquid from the vault seeped into the environment, it would result in an underestimation of the risk, since it was assumed that no such release has occurred.

Similar to CPP-02, there are no soil data associated with site CPP-80. The remaining contamination at this site is located under a building. Soil concentrations and volume of the release were estimated for the source input to the vadose zone and groundwater model (Section 9.5.2). Given the uncertainty regarding the accuracy of this estimate, this may over or underestimate the predicted concentrations, and as a result, similarly affect the concentration and risk estimates for the groundwater pathway.

CPP-87 was not included in the groundwater model because no release to the environment is known to have occurred. The only evidence of any contamination are the results from a sample of liquid present between the cell steel liner and the concrete floor. The uncertainty associated with this site is difficult to qualify with the available information but it would be more likely to lead to an underestimation of the source used in the groundwater model. If the liquid from the vault was released to the environment, it would result in an underestimation of the risk since it was assumed that no such release has occurred.

The only soil data associated with site CPP-89 is from excavated soil stored in boxes at site CPP-92. Most of the remaining contamination at this site is assumed to be located under building CPP-604. Soil contamination on the south side of the building CPP-604 is being evaluated separately as part of CPP-58E. Soil concentrations were estimated for the source input to the vadose zone and groundwater model from soil removed in the area (Section 9.8.2). Given the uncertainty regarding the accuracy of this estimate, this may overestimate or underestimate the predicted concentrations, and as a result, similarly affect the concentration and risk estimates for the groundwater pathway.

9.10 References

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Chapter 9

9. SITES OF EXCLUSIVE GROUNDWATER CONCERN

This group consists of sites that pose a potential threat to human health and the environment only through the groundwater pathway. This group includes sites CPP-02, CPP-23, CPP-65, CPP-69, CPP-80, CPP-83, CPP-87, and CPP-89 (Figure 9-1). These sites were determined, based on the depth of contamination [i.e., greater than 3.0 m (10 ft)] or their location beneath structures, not to have any complete exposure routes other than those associated with groundwater (Figure 7-1). These sites were incorporated into the vadose zone and groundwater models as appropriate. A description of each of these sites is provided below.

9.1 Site CPP-02

Site CPP-02 is the former location of a French drain west of building CPP-603 that is now beneath the Graphite Storage Facility (GSF) (Figure 9-1). This section describes the nature and extent of contamination associated with the French drain.

9.1.1 Site Description

The French drain was used to dispose of CPP-603 fuel-storage-basin-through-water. The basin water was recirculated through a filter system to clean out dirt and algae. Robertson et al. (1974) reported that an average of 1.4E+07 L/yr were disposed of in the French drain to reduce the chloride and nitrate ion concentrations in the basin water by using a flow through system. Reports indicate that the drain also received low-level radioactive waste from the Fuel Element Cutting Facility (FECF), which is also located in CPP-603. The function of the FECF was to receive, store, and cut aluminum-clad fuel from the test reactor program at Savannah River.

The CPP-02 French drain had a diameter of 1.5 m (5 ft) and was approximately 6.1-m (20-ft) deep. The drain was in use from 1952 until late 1968 when construction of the GSF commenced. The GSF is situated in the southernmost portion of CPP-603. When the GSF building was added onto CPP-603, the drain was decommissioned and an unknown volume of soil was boxed and sent to the RWMC. It is reported that some of the contaminated soil may have been used as construction backfill and/or buried near the Peach Bottom Fuel Storage Facility.

9.1.2 Investigative Results

No analytical data are available for the soil beneath the former location of the French drain. The former location of the French drain is now beneath the GSF that precluded the collection of soil samples. However, the presence of the building over the site prevents exposure of receptors to contaminated soil. To evaluate the groundwater pathway, it was be assumed that 1.8E+08 L (4.8E+07 gal) of fuel storage basin through water was disposed of in the French drain. This estimate is the sum of the annual volume of water disposed of to the French drain. This source was input into the vadose zone and groundwater models (Section 6). Data on the quality of the fuel-storage-basin-through-water is provided in Section 6.

9.1.3 Nature and Extent of Contamination

Based on the nature of release at this site, fuel-storage-basin-through-water migrated downward from the former location of the French drain through the vadose zone. Perched water was first identified beneath

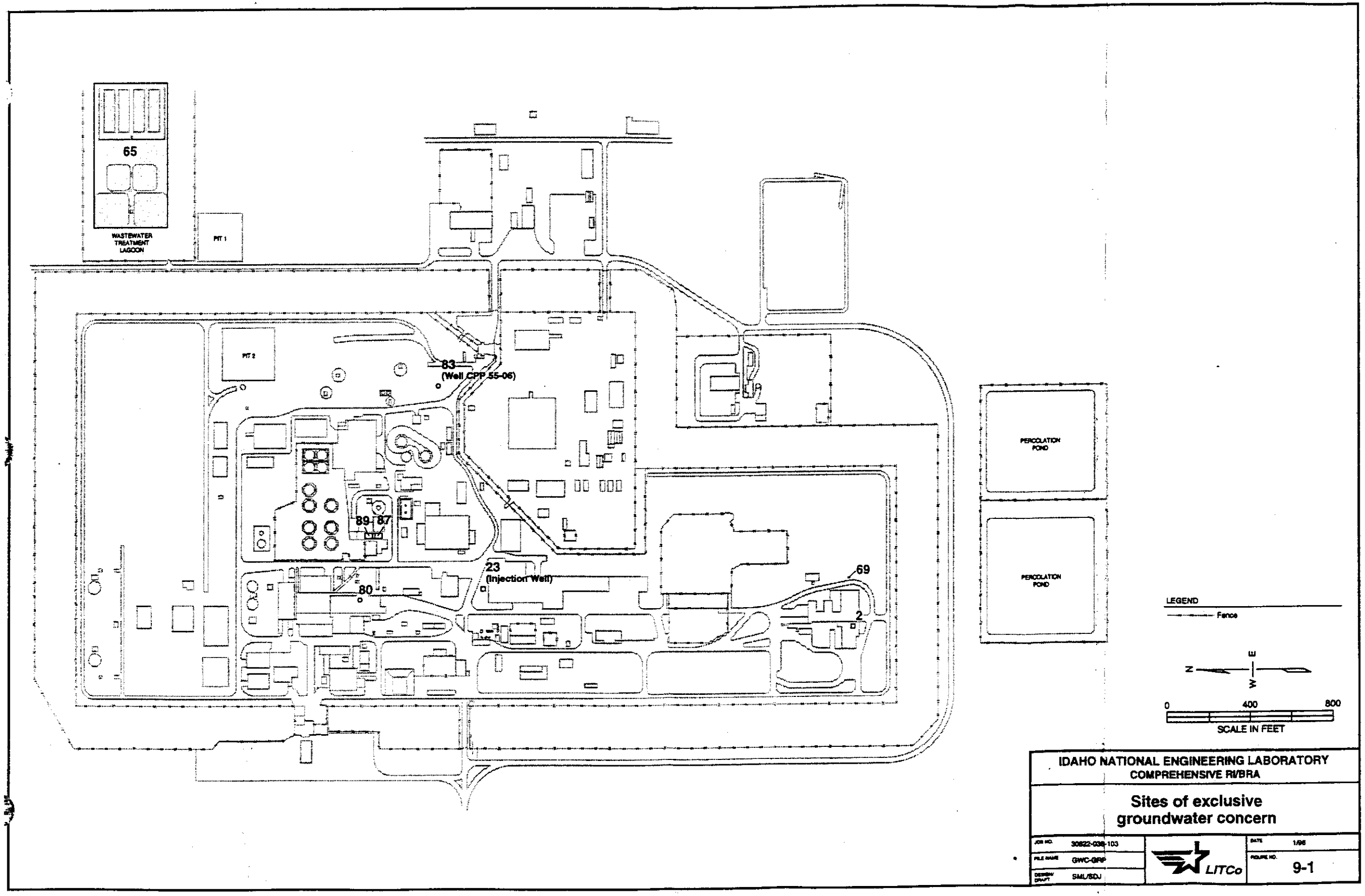

Figure 9-1. Sites of exclusive groundwater concern.

building CPP-603 in the early 1960's and was primarily attributed to discharges to the French drain. The shallow perched water body was investigated by installing 27 observation wells in the alluvium above the basalt. A small zone of perched water was encountered at a depth of 6.7 m-(22-ft) below ground surface (bgs), and a larger zone was encountered directly above the basalt surface at a depth of 9.8-m (32-ft) bgs. This perched water body has not been monitored since 1970 and is believed to have dissipated since the French drain was taken out of use (WINCO,1994a). The extent of perched water is discussed in Section 2 while contamination in perched water is described in Section 4.

9.1.4 Conclusions

Because of the presence of the GSF above the former location of the CPP-02 French drain, the only complete pathway is through the groundwater exposure routes. Therefore, this site is included in the vadose zone and groundwater models (Section 6) and the risk is evaluated cumulatively in Section 27.

9.2 Site CPP-23

CPP-23 is the ICPP injection well (MAH-FE-PL-304) located north of building CPP-666 (Figure 9-1). This section describes the contamination that resulted from use of the injection well.

9.2.1 Site Description

The CPP-23 injection well was originally drilled in 1950 to a depth of 66.6 m (212 ft) and deepened in 1951 to 182 m (597 ft), extending 47 m (140 ft) below the regional water table (WINCO, 1994b). A 61-cm (24-in.) diameter borehole was drilled and cased using 41-cm (16-in) nominal diameter carbon steel casing. The well was perforated from 125.6 to 137.8 m (412 to 452 ft) and 149.4 to 180.7 m (490 to 593-ft) bgs. Portions of the well collapsed and were subsequently reopened in 1971 and in 1982. The collapses were attributed to the warm, salty nature of the injected wastewater that resulted in corrosion of the casing. The corrosion developed to the point that the gravel pack and sediments intruded into the well filling up the casing.

The injection well was used regularly from 1952 to 1984, and then periodically until 1986. The well was used to dispose of ICPP service wastewater that contained radioactive and inorganic contaminants. Based on a comparison to drinking water standards, the most significant radionuclides in the service wastewater were H-3 and Sr-90. According to the Track 2 document, it is estimated that a total of 22,200 Ci (approximately 96% consisting of H-3) has been released in 4.2E+10L (1.1E+10 gal) of water (WINCO, 1994b).

During the operational life of the injection well, several known accidental discharges to the injection well occurred (WINCO, 1994a). These discharges are described below.

- July 25, 1953. The contents of a tank discharged to the wastewater flowing to the well. A postdischarge analysis showed that 51 mCi of radioactive contaminants were released in 923,640 L (244,000 gal) of water.
- December 1958. About 29 Ci of radioactive contaminants, including 7 Ci of Sr-90 were released to the well.
- September 1969. Two separate releases resulted in 19 Ci of fission products being released to the well. Releases included Cs-134, Cs-137, Ce-144, and Sb-125.

- December 1969. Two releases occurred in which the quantity of Sr-90 released was higher than expected. About 1 Ci of radioactivity, including 30% Sr-90, was released.

- March 1981. Mercury was detected during routine monitoring of the ICPP Service Waste System. Mercury in the form of mercuric nitrate was released from CPP-601, through the ICPP Service Waste System to the ICPP injection well. A concentration of 0.207 mg/L of mercury was detected in service wastewater.

The injection well was taken out of routine service on February 7, 1984 and wastewater was routed to Percolation Ponds 1 and 2 (CPP-67). Between 1984 and 1986, the injection well was used as emergency overflow protection for buildings CPP-709, -734, and -797, that contain the vaults from which the service wastewater is monitored and pumped. The overflow protection was only required on a temporary basis if the operating and standby pumps from one of the parallel streams failed simultaneously. No releases to the well have occurred since 1986. In February 1989, it was discovered that the well had filled in with sediment to about 145-m (475-ft) bgs. In October and November 1989, the injection well was sealed by perforating the casing throughout and pumping in cement. This sealing process was performed from the top of the sediment layer up to the ground surface to prevent hydraulic communication between the land surface, perched water, and the Snake River Plain Aquifer (SRPA).

9.2.2 Investigative Results

Before the well abandonment, a sediment sample was collected from the bottom of the open part of the well [about 145-m (475-ft) bgs] and analyzed for radionuclides, inorganics, volatile organic compounds (VOCs), and semivolatile organic compounds (SVOCs). Analysis of the sediment sample detected low concentrations of inorganics, radionuclides, and polychlorinated biphenyls (PCBs). Fourteen inorganics were detected using Method 7000 (total concentrations); however, only barium was detected in the leachate using the Extraction Procedure (EP)-Toxicity extraction (Method 1310) test for leachable metals. The concentration of barium (0.26 mg/L) was well below the regulatory threshold of 100 mg/L. The radionuclide analyses of the sediments show that the gross beta activity was measured at 150 pCi/g. This analysis also measured Ce-137 at 100 pCi/g, Eu-152 at 3.8 pCi/g, and Eu-154 at 2.5 pCi/g. The only organic compound detected above the method detection limit was Aroclor-1260 at 10 μg/kg.

Additionally, upgradient and downgradient water samples were collected from process water supply well CPP-1 (upgradient) and United States Geologic Survey (USGS) monitoring wells 40 and 47 (downgradient) on October 19, 1989 by USGS and Westinghouse Idaho Nuclear Company (WINCO) personnel. Sample results show the value of zinc increased from 0.161 mg/L in the upgradient well, to 0.283 mg/L in downgradient well USGS 40 and to 0.786 mg/L in downgradient well USGS 47. However, the 0.786 mg/L was still only about 1/6 of the secondary water quality standard. Tritium ranged from <0.69 pCi/mL in the upgradient well to 5.6 ± 0.3 pCi/mL in well USGS 40 and 3.1 ± 0.3 pCi/mL in well USGS 47. These values were well below the drinking water standard of 20 pCi/mL. It is generally known from USGS studies and reports that H-3 levels in the aquifer beneath and downgradient from ICPP did increase until ICPP ceased using the injection well in 1986. Since that time, H-3 levels have slowly declined due to taking the injection well out of service and radioactive decay of the existing H-3 that has a half-life of 12.3 years (WINCO, 1990). Water samples collected from 1989 to 1991 in monitoring wells #40 and #47 indicate that concentrations of radionuclides are not increasing and in some cases are slightly decreasing. While these radionuclide concentrations reflect past disposal practices through the injection well, it is not clear that they are indicative of significant leaching from the silt sediment plug in the bottom of the well.

Additional information on contamination in the SRPA is presented in Section 4.3.

9.2.3 Nature and Extent of Contamination

The remaining source of contamination at this site is the sediment plug remaining in the well. For the purpose of risk estimation only, it was assumed that the contaminants detected in the sediment sample at 145 m (475 ft) is representative of the entire vertical interval of the sediment plug. The volume of sediment in the well was estimated at 10.9 m^3 (386 ft^2).

The extent of contamination in the SRPA is discussed in some detail in Section 2.0 of the WAG 3 Work Plan (LITCO, 1995b). The primary contaminants in the aquifer related to the injection well are H-3, Sr-90, and Cs-137. In 1993, Sr-90 concentrations were above the maximum contaminant level (MCL) of 8 pCi/L in an area that extended approximately 2,130 m (7,100 ft) downgradient of the injection well. The plume of H-3 above the MCL of 20,000 pCi/L extended about 2,730 m (9,100 ft) downgradient. Cs-137 concentrations have decreased significantly since the early 1980s. During 1982 to 1985, maximum concentrations in wells USGS-40 and -47 were 237±45 and 200±50 pCi/L, respectively. Between 1986 and 1993, Cs-137 has only been detected in each of these wells once.

9.2.4 Conclusions

The ICPP injection well has been a significant source of contamination to the SRPA. Historical data concerning the amounts of wastewater discharged to the well in conjunction with injected water quality data have been used to simulate this contaminant source in the groundwater model (Section 6). Appendix F present mass calculations. The only complete pathway from this site is through the groundwater exposure routes (Figure 7-1). Groundwater model predictions will be used to estimate the risk from this and other sources of contamination to groundwater in the cumulative risk assessment (Section 27).

9.3 Site CPP-65

The ICPP Sewage Treatment Plant (STP) is located outside the northeast corner of the ICPP (Figure 9-1) and treats sanitary waste from 31 permanent facilities at the ICPP. This section describes the processes associated with the STP.

9.3.1 Site Description

All sanitary waste from 31 facilities at the ICPP is collected by gravity-flow lines and pumped via lift stations to the STP for treatment. The STP is located 200 m (1/8 mi) east of the northeast corner of the ICPP security fence (Figure 9-1). The STP consists of two aerated lagoons, two quiescent faculative stabilization lagoons, four infiltration/percolation (I/P) trenches, and six weir boxes. The aerated lagoons are arranged in series and drain into the faculative lagoons, which are arranged in parallel. From the faculative lagoons, the overflow drains to the I/P trenches. The weir boxes route the wastewater through the lagoons and trenches. The average amount of influent treated by the plant in 1995 was 484,250 L/day [127,940 gallons per day (gpd)].

The aerated lagoons each have a floor area of 607 m^2 (6,534 ft^2), a water surface area of 1,821 m^2 (19,600 ft^2), and a volume of 3,341 m^3 (117,970 ft^3). The faculative lagoons each have floor areas of 162 m^2 (1,744 ft^2), a maximum water surface area of approximately 852 m^2 (9,170 ft^2), and a maximum volume of approximately 1,280 m^3 (45,200 ft^3). All lagoons are lined with geotextile liners (80 mL impermeable liner over polypropylene fabric mat) and are surrounded by dikes. The four unlined I/P trenches are each approximately 890 m^2 (9,580 ft^2) in size. Only one trench is used at a time. Rotation occurs every 2 to 12 weeks.

ICPP sewage consists primarily of wastewater from restrooms and cafeterias. Wastewater has been supplied to the STP since the facility was completed in 1984. Two potential contaminant sources have been identified in addition to sanitary waste; spent water from a decontamination shower that was improperly connected to the sanitary sewer, and waste, possibly including photochemical products, associated with the Graphics Department (CPP-1605) and X-Ray Cave (CPP-695) facilities. The Graphics Department and X-Ray Cave facilities are no longer connected to the sanitary sewer system. Small amounts of radionuclides may have entered the sewer system via the CPP-602 shower stall, which was used for decontamination of personnel. The shower drains were sealed in June 1991.

Measurements of inflow and outflow from the lagoons, corrected for precipitation and evaporation, indicate that the lagoon liners were leaking. Consequently, the lagoon liners were replaced during 1993 and the sewage sludge present in the lagoons was removed and disposed of as part of the liner replacement project. The STP facility is currently operating and periodic removal of sewage sludge will be performed in accordance with State regulations.

The STP is considered to be a significant source of water to the zone of perched water beneath the northern portion of the ICPP. The distribution of perched water beneath the ICPP is discussed in detail in Section 2.5. The nature and extent of contamination in perched water is discussed in Section 4.2.

9.3.2 Investigative Results

Periodic monitoring of sewage lagoon effluent was performed for Sr-90, and Pu-239/240 in the years 1988, 1989, and 1990. Sr-90 was detected at an average concentration of 0.36 pCi/L and Pu-239/240 at an average concentration of 0.0019 pCi/L. Inorganic constituents in the lagoon water were analyzed in September 1992. Inorganics detected include cadmium, zinc, barium, lead, and silver. Concentrations of the inorganics are near background levels in groundwater upgradient of the ICPP. Concentrations of radionuclides and inorganics in water in the sewage lagoon are expected to be higher than in the I/P trenches. Therefore these concentrations are conservative in that they overestimate concentrations in water in the I/P trenches. Organics were not analyzed in the lagoon water but were not detected in a sample of lagoon sludge collected in 1992. Therefore, organic compounds are not believed to be present in significant concentrations in the wastewater.

9.3.3 Nature and Extent of Contamination

Migration of low levels of radionuclides and inorganics in infiltrating treated wastewater is likely to have been significantly retarded due to partitioning onto particulate matter. Infiltrating water must filter through 12.2 to 15.2 m (40 to 50 ft) of sediments that overlie basalt in this area. Sampling data from the ICPP percolation ponds CPP-67 indicate that approximately 90% of inorganic constituents detected beneath the pond were found in the top several inches of soil (WINCO, 1994b). This suggests that a similar pattern of limited migration is probably occurring beneath the I/P trenches at the STP. The actual zone of contamination in the soil, if any, is likely to be very small due to constituent partitioning onto sludge solids in the sewage lagoons before discharge onto soils in the I/P trenches.

9.3.4 Conclusions

The low levels of radionuclides and inorganics detected in lagoon water suggest that the STP is not a significant source of contamination to groundwater. However, an estimated 44,300,000 L/yr (1,170,000 gal/yr) is released to the I/P trenches creating a significant source of water to the vadose zone, and eventually the aquifer. This source of water will be included in the vadose zone model to aid in calibration of the model to existing conditions. Contaminants identified in water samples from the faculative lagoons

include barium, cadmium, Pu-239/240, and Sr-90. However, the faculative lagoons are believed to have significantly higher concentrations of potential contaminants than the water discharged to the I/P trenches. The source input to the model will only include the estimated discharge of water to the I/P trenches and will not include contaminant data.

9.4 Site CPP-69

In the FFA/CO, Site CPP-69 is defined as the SFE-20 Radioactive Liquid Waste Storage Tank and its contents. However, a physical description of the tank waste system would include the surrounding tank vault, access tunnel, and pump pit located to the east of building CPP-603 (Figure 9-1). This section describes the nature of contaminants found in the tank and vaults associated with the tank.

9.4.1 Site Description

The SFE-20 tank is a 2,422-L (640-gal) stainless steel tank with a 1.1-m (3.5-ft) inside diameter. The tank has a 2.3-m (7.5-ft) long cylindrical shell with elliptical ends extending approximately 0.3 m (1 ft) beyond the cylindrical portion of the tank. The concrete tank vault dimensions are 4.0 × 1.8 × 3.0 m (13 × 6 × 10 ft), the floor of the vault is 25 cm (10 in) thick, and the top of the vault is 3.0 m (10 ft) bgs. The concrete pump pit dimensions are 2.1 × 2.1 × 5.2 m (7 × 7 × 17 ft), with a floor thickness of 25 cm (10 in.). The concrete access tunnel dimensions are 2.4 × 0.7 × 0.7 m (8 × 2.5 × 2.5 ft). This system was constructed in 1957 to collect low-level liquid wastes from the newly completed FECF addition of the CPP-603 Fuel Rod Storage Facility (FRSF).

The SFE-20 Radioactive Liquid Waste Tank system was also used during the period from 1966 to 1976 for interim storage of wastes associated with FRSF activities. Between 1951 and 1977, the shielding water was routinely circulated through a diatomaceous earth filter system. When the filter system was backwashed, a slurry was sent to a settling system that separated out the liquids and solids. From 1966 to 1976, the resulting supernatant from this settling system was steam jetted to SFE-20 and eventually pumped to the process equipment waste (PEW) Evaporator Facility.

Because of the low working capacity of the SFE-20 tank [<2,420 L (<640 gal)] and low transfer rate of the associated pump, the decision was made to replace the entire SFE-20 waste holding and transfer system. In 1976, the SFE-20 inlet pipe was disconnected approximately 2.1 m (7 ft) from the vault and connected to a new system (VES-FF-126). The pipe leading to the SFE-20 tank was capped. The pump was also removed from the pump pit and the connections capped.

9.4.2 Investigative Results

In February 1984, liquid and sediment samples were taken from the tank interior, vault floor, and pump pit. The analysis consisted of only Co-60, Cs-137, Cs-134, Eu-152, Eu-154, Eu-155, Sb-125, total strontium, and plutonium and uranium isotopes. The reported concentrations of Cs-137, total strontium, and plutonium isotopes in the single tank liquid sample were 2,050; 9,700; and 17,600 pCi/mL, respectively (WINCO, 1984). For the same radionuclides, the concentrations in the tank sediment sample were reported at 55,400,000; 4,700,000; and 93,500 pCi/mL, respectively. Three samples were collected from the floor (two liquid and one sediment). The reported concentrations in the two liquid floor samples for Cs-137 (analysis for total strontium and plutonium isotopes was not requested) taken from the south and center vault floor locations were 905 and 248,000 pCi/mL, respectively. The reported concentrations of Cs-137, total strontium, and plutonium isotopes in the sediment sample collected on the north end of the vault were 8,920,000; 1,720,000; and 79,200 pCi/g, respectively. For the same radionuclides, the concentrations in the

pump pit sediment sample were 2,290,000; 5,890,000; and 3,010 pCi/g, respectively. Only Cs-137 at a concentration of 76 pCi/mL was reported for the pump pit lqiuid sampling (WINCO, 1984).

There are no data available for nonradioactive constituents; however, the tank contents may contain inorganic and organic consitituents that were associated with the operation of the CPP-603 spent fuel storage pool filtration system. It should be noted that generally, longer lived radionuclides (i.e., those having half lives greater than 10 years) are of most concern and thus, those with shorter half lives were not summarized in this section.

9.4.3 Nature and Extent of Contamination

There is no evidence to indicate that a release to subsurface soils has taken place from the waste tank-vault system. If a release were to have taken place, contamination could be present in soil beneath either the tank vault or the pump pit. Contamination of near-surface soils would not be expected.

9.4.4 Conclusions

The SFE-20 Radioactive Liquid Waste Tank and its contents is an FFA/CO site. However, because of the location and depth of the tank, the contents and vault surface contamination are not available to a future resident on the surface. Since there is no known release out of the vault to the environment, the groundwater pathway cannot be evaluated without making extraordinary assumptions. Therefore, this site has not been included as a source in the vadose zone and groundwater models. These limitations have NOT led to a No Further Action determination. Instead, this site will be carried forward to the Feasibility Study for further evaluation.

9.5 Site CPP-80

Site CPP-80 consists of soil contaminated by leakage of condensate from a corroded cast iron line that serves as a floor drain in the CPP-601 South Vent Tunnel. This section describes the nature and extent of contamination associated with the leak.

9.5.1 Site Description

The cast iron line associated with site CPP-80 transmitted corrosive solutions from the VT-300 vessel off-gas condenser, which condenses all gaseous vapors from the CPP-601 fuel processing equipment, to the PEW tank vault. In 1982, this effluent was rerouted from the original stainless steel line to the cast iron line. The cast iron line penetrated the 0.6-m (2-ft) thick, concrete vent tunnel floor at a depth of about 3.7 m (12 ft) down to a depth of 10.4-m (34-ft) bgs where the line changes to stainless steel and enters the PEW tank vault.

On July 20, 1989 it was discovered that the 10-cm (4-in.) SK-1075T cast iron line had corroded well past the point of failure. The extent of corrosion was so advanced that no physical line remained in the area, with the route from the drain to the vault consisting of a soil conduit. This severe state of corrosion suggests that the line had deteriorated quickly, and probably leaked soon after corrosive condensate wastes were routed to the line in 1982.

9.5.2 Investigative Results

No soil sampling data are available for this site due to its location beneath building CPP-601. The rate and amount of leakage was estimated in the Track 1 (WINCO, 1993) to be approximately 6 L/hr (1.6 gal/hr), or 400,000 L (105,000 gal) of condensate between 1982 and 1989. It was further assumed, based on the composition of waste in tank WM-182, and a dilution factor of 1,000, that the estimated quantity of the radioactive release totaled about 550 Ci. Soil concentrations were estimated based on an assumed mass of

soil of 2.4E+06 kg. The highest estimated radionuclide concentrations were of Cs-137 (86,300 pCi/g) and Sr-90 (85,600 pCi/g) (Table 5-41).

9.5.3 Nature and Extent of Contamination

Leakage of condensate along the path of the cast iron line from the floor drain in the CPP-601 South Vent Tunnel down to the PEW tank vault migrated directly into soil beneath building CPP-601. Condensate probably migrated downward to the "110-ft" perched water body. Water quality data from nearby perched water well 33-2 shows elevated levels of gross beta and Sr-90 in the northern "110-ft" perched water body that may be related to leakage of condensate along the path of the deteriorated pipe. However concentration levels of gross beta and Sr-90 are much higher in the southeastern portion of the northern perched water body to the east of building CPP-601, suggesting that the leak associated with site CPP-80 is not the main source of radionuclides in the "110-ft" perched water body.

9.5.4 Conclusions

Because of the presence of building CPP-601 above the former drain line from the South Vent Tunnel, the only complete exposure route is through the groundwater exposure routes (Figure 7-1). Therefore, this site is included in the groundwater model (Section 6) and the risk associated with the groundwater pathway is evaluated in the cumulative risk assessment (Section 27).

9.6 Site CPP-83

Site CPP-83 consists of perched water being monitored by well CPP 55-06 located approximately 168 m (550 ft) southeast of the Tank Farm Area as well as the entire perched water system at CPP. This section briefly describes contamination in and near well CPP 55-06. A description of the distribution of perched groundwater beneath the ICPP is provided in Section 2.5. The nature and extent of contamination in perched water is discussed in Section 4.2, and the results are presented in Table 4.2.

9.6.1 Site Description

Well CPP 55-06 was installed in 1990 in shallow perched groundwater above the "110-ft" interbed. The contamination in shallow perched groundwater at this location was first discovered during the drilling of a deep borehole to characterize site CPP-55 (mercury-contaminated area) under the Consent Order and Compliance Agreement (COCA). The borehole initially encountered radiological contamination at a depth of 18.5 m (60.7 ft) bgs and the contamination was present in clay infilling in the basalt to a depth of approximately 35.4 m (116 ft) bgs. The total depth of the borehole was 37.4-m (123-ft) bgs. Since water was encountered at this depth, a 5.1-cm (2-in.) diameter monitoring well, designated CPP 55-06, was installed with a screened interval from 28.4 to 34.5 m (93.1 to 113.1-ft) bgs.

The extent of perched water beneath the ICPP is discussed in detail in Section 2.5.

9.6.2 Investigative Results

Well CPP 55-06 has been sampled as part of both RCRA and CERCLA groundwater monitoring programs since its installation. Sampling data from January 1992 through December 1994 are presented in Tables 2-19 through 2-21 in the WAG 3 Work Plan (LITCO, 1995a). Results of the most recent sampling in 1995 are presented in Section 4. The primary contaminants in perched water in well CPP 55-06 are (with 1995 concentrations in parentheses): Sr-90 (66,300±600 pCi/L), Tc-99 (73±1 pCi/L), U-234 (3.5±0.6 pCi/L), and U-238 (2.1±0.5 pCi/L). The concentrations of these radionuclides are higher than in

December of 1994. Gross alpha and beta concentrations in the 1995 sample were 92±9 and 139,000±600 pCi/L, respectively. H-3 was reported at a concentration of 621 pCi/g, which is well below the MCL of 20,000 pCi/L.

9.6.3 Nature and Extent of Contamination

Well CPP 55-06 monitors the southeastern portion of the northern "110-ft" perched water body. Contaminant concentrations are higher in some of the other monitoring wells screened in this perched water body. For example, concentrations of gross beta, Sr-90, and Tc-99 are much higher in well MW-2, which is located on the northwest side of Bin Sets 1 and 2. Contaminant of potential concerns (COPCs) in perched water beneath the Tank Farm include arsenic, barium, chromium, manganese, Am-241, H-3, Pu-238, Pu-239/240, Sr-90, Tc-99, U-234, and U-238. Contamination in perched groundwater is described in more detail in Section 4.2.

9.6.4 Conclusions

The only complete pathway for contamination in perched water is through exposure via the groundwater routes listed in Figure 7-1. The vadose zone model has been calibrated to simulate, to the extent possible, the distribution of perched water beneath the ICPP (including perched water monitored by well 55-06) as well as the measured contaminant concentrations in perched water. The vadose zone model, in conjunction with the aquifer model, will be used to predict contaminant concentrations with time in the aquifer. This information is used in the cumulative risk assessment (Section 27).

9.7 Site CPP-87

Site CPP-87 consists of two sites, described as artifacts, located in the building CPP-604 (Figure 9-1). The extent of contamination associated with this site is described below.

9.7.1 Site Description

Building CPP-604 is the PEW Evaporator System that was originally constructed during 1951 to 1953, with additions in the 1970s and 1980s. CPP-604 has been in operation since 1953. The PEW Evaporator System produces concentrated wastes (bottoms) and condensed vapor overheads (condensates). As part of the process, the PEW Evaporator System tanks vent to the vessel offgas (VOG) system. The VOG system provides a vacuum and filtration to processing vessels in nearby facilities. In 1990, the process waste liquid (PWL) collection system was installed. This system collects hazardous waste from buildings CPP-604, CPP-605, CPP-649, and CPP-708, and transfers the waste to the PEW Evaporator System. CPP-604 wastes are also collected from floor drains, including the floor drain in the VOG Blower Cell (Artifact 1). During construction of the PWL collection system, samples were taken of the soil under a deteriorated portion of concrete in the Blower Cell to determine if the soil was contaminated. Analytical results from two grab samples and the risk estimates presented in the Track 1 (LITCO, 1995b) indicate that concentrations of the chemicals detected were not an unacceptable risk. Therefore, Artifact 1, the VOG Blower Cell Floor Drain/Sump, was recommended for no further action (see Section 5.1).

Artifact 2, the PEW Evaporator Feed Pump Cell, is related to a small hole identified in a weld in the stainless steel liner in the cell. Fluid, assumed to be decontamination liquid, squirted from the hole as a result of normal flexing when personnel walked across the liner. The decontamination liquid was between the liner and the concrete floor of the cell. The liquid was sampled in 1994 before the weld was repaired. Because of the presence of Co-60 and Cs-137 above risk-based concentrations, this artifact was recommended in the Track 1 (LITCO, 1995b) for further evaluation in this Comprehensive RI/FS.

9.7.2 Investigative Results

Artifact 2 was sampled in 1994 when a sample of the liquid present between the liner and the concrete floor was collected using a syringe. Inorganics were detected in the liquid sample but were below risk-based concentrations according to the Track 1 (LITCO, 1995b). Radionuclides detected in the liquid included Co-60 (70,740 pCi/L), Cs-134 (4,018 pCi/L), and Cs-137 (330,480 pCi/L). These concentrations are consistent with the collection of the sample from a known "hot area" (PEW Feed Pump Cell).

9.7.3 Nature and Extent of Contamination

No soil samples have been collected beneath the concrete directly below the liner in the PEW Feed Pump Cell. The physical location of the PEW Feed Pump Cell in the basement of building CPP-604 precludes drilling and sampling of this site. However, none of the liquid found beneath the liner is known to have leaked through the concrete below to the underlying soil. If significant leakage were to have occurred, contamination could extend downward in soil beneath building CPP-604.

9.7.4 Conclusions

Based on the location of this site in the basement of building CPP-604, the only potentially complete pathway for this site is through groundwater exposure routes. Considering that the hole in the stainless steel liner was fixed following its discovery, it does not seem likely that a significant amount of liquid leaked through the both the liner and underlying concrete. Therefore, this site has not been included as a source in the groundwater and vadose zone models.

9.8 Site CPP-89

Site CPP-89 consists of contaminated soil remaining in place underneath building CPP-604/605. This section describes the nature and extent of contamination associated with this site.

9.8.1 Site Description

During 1991 and 1992, an emergency fire exit was installed for egress from the basement area of building CPP-604/605. The tunnel excavation for the fire exit included soil removal from immediately south of building CPP-604 as well as from underneath building CPP-604. The excavated soil was placed in 0.6- × 0.9- × 2.5-m (2- × 3- × 8-ft) waste boxes for storage. The soil in the waste boxes is now part of site CPP-92.

During the initial excavation work on the south side of building CPP-604, contaminated soil related to site CPP-58E was encountered. This contaminated soil is not considered part of site CPP-89. As the excavation progressed beneath building CPP-604, nine abandoned waste lines associated with the PEW Evaporator were encountered beneath the building. Five stainless steel and two carbon steel pipes showed little or no deterioration. However, two carbon steel pipes were significantly deteriorated, suggesting that there had been leaks before their being abandoned in place in the 1970s. Soil adjacent to the deteriorated pipes was removed and placed in boxes. Only soil directly associated with the construction and pipe removal was excavated. The boxed soil is now part of site CPP-92 (Section 25). Construction reports do not indicate that efforts was made to remove all contaminated soils that were encountered. Soil affected by releases from these waste transfer lines that remains in place beneath building CPP-604 is considered to be associated with site CPP-89. Excavation reports indicate the presence of radioactivity above background but specific readings were not recorded in the construction documents.

9.8.2 Investigative Results

Samples have not been collected from soil remaining at this site after the excavation conducted for installation of the fire exit in 1991 and 1992. However, samples were collected from the boxed soil at site CPP-92 that came from the excavation at site CPP-89 to see if it could be used as fill material. Soil samples were analyzed for inorganics, VOCs, SVOCs, and radionuclides. The chemical screening process for site CPP-92 (Table 5-47) is based on the results of samples of soil from site CPP-89. VOCs and SVOCs were not detected in the samples. The only inorganics detected above background were arsenic at 5.9 mg/kg and mercury at 10.4 mg/kg.

Radionuclides that were detected above background in the samples at the following maximum concentrations: Am-241 (23.6 pCi/g), Cs-137 (7,730 pCi/g), Pu-238 (259 pCi/g), Pu-239/240 (24.7 pCi/g), Sr-90 (10,800 pCi/g), and U-234 (5.1 pCi/g). These contaminants are consistent with the soil being contaminated with service wastes and condensates from the PEW Evaporator that typically include nitric acid, mercury, plutonium, cesium, and strontium.

9.8.3 Nature and Extent of Contamination

The only sampling data available for this site are from soil that was removed from the excavation. No samples were collected from the bottom or sides of the excavation. Only soil directly associated with the construction and pipe removal were excavated. Construction reports do not indicate that efforts were made to remove all contaminated soils encountered. Therefore, it is be assumed that contaminated soil remains in place beneath building CPP-604/605 with contaminant concentrations equal to the maximum concentrations detected in the boxed soil.

The vertical and lateral extent of the soil contamination at this site is not known due to the lack of sampling data. The Track 1 (LITCO, 1995b) estimated the volume of contaminated soil by assuming that the volume of contaminated soil remaining was a factor of 20 greater than the amount of soil removed. Using this assumption, it was estimated that 6,475 m^3 (228,654 ft^3) of contaminated soil is present beneath the fire exit and building CPP-604/605.

9.8.4 Conclusions

The contaminated soil remaining at site CPP-89 is located beneath Building 604/605. It has been assumed, therefore, that contaminated soil is shielded from direct human contact by the building and the exit tunnel. The only complete pathway at this site is through groundwater. This site has been included in the groundwater model and the risk from the groundwater exposure routes is included in the cumulative risk assessment (Section 27).

9.9 Uncertainties

This section describes the limitations and uncertainties specific to the site characterization of the Sites of Exclusive Groundwater Concern. These sites are unique in that they are a conglomerate of sites that have differing sources and contaminated media. They have been grouped together because either the depth of contamination or assumptions regarding the contaminant sources precludes exposure via other pathways. For some of the sites, the concentration terms are not based on sampling data. Sources of uncertainty associated with the assumptions used for each site are discussed below, as appropriate. Uncertainties associated with the fate and transport model are described in Section 6. In the risk assessment, the most significant uncertainties are due to the toxicity values used and the assumptions used during the exposure assessment.

Uncertainty sources germane to the risk assessment process such as those associated with the exposure assessment will be discussed in Section 27.

There are no soil data associated with site CPP-02. As described in Section 9.1.2, an estimate of the volume of fuel-storage-basin-through-water was used as the source input to the vadose zone and groundwater model. Given the uncertainty regarding the accuracy of this estimate, this may over or underestimate the predicted concentrations, and as a result, similarly affect the concentration and risk estimates for the groundwater pathway.

The sediments associated with CPP-65 were not evaluated for the soil pathways because (a) CPP-65 is a contributor to the perched water at CPP; however, the water is assumed to contain insignificant contamination; (b) because the water is not contaminated, the sediments are assumed to contain little or no residual contamination; and (c) the sewage treatment facility (i.e., CPP-65) is still in operation and will be assessed during D&D of the facility, if necessary. Although these assumptions are consistent with the Track 1 document for this site, if the assumptions regarding CPP-65 are not accurate, exclusion may underestimate the risk.

CPP-69 was not included in the groundwater model because no release to the environment is known to have occurred. If liquid from the vault seeped into the environment, it would result in an underestimation of the risk, since it was assumed that no such release has occurred.

Similar to CPP-02, there are no soil data associated with site CPP-80. The remaining contamination at this site is located under a building. Soil concentrations and volume of the release were estimated for the source input to the vadose zone and groundwater model (Section 9.5.2). Given the uncertainty regarding the accuracy of this estimate, this may over or underestimate the predicted concentrations, and as a result, similarly affect the concentration and risk estimates for the groundwater pathway.

CPP-87 was not included in the groundwater model because no release to the environment is known to have occurred. The only evidence of any contamination are the results from a sample of liquid present between the cell steel liner and the concrete floor. The uncertainty associated with this site is difficult to qualify with the available information but it would be more likely to lead to an underestimation of the source used in the groundwater model. If the liquid from the vault was released to the environment, it would result in an underestimation of the risk since it was assumed that no such release has occurred.

The only soil data associated with site CPP-89 is from excavated soil stored in boxes at site CPP-92. Most of the remaining contamination at this site is assumed to be located under building CPP-604. Soil contamination on the south side of the building CPP-604 is being evaluated separately as part of CPP-58E. Soil concentrations were estimated for the source input to the vadose zone and groundwater model from soil removed in the area (Section 9.8.2). Given the uncertainty regarding the accuracy of this estimate, this may overestimate or underestimate the predicted concentrations, and as a result, similarly affect the concentration and risk estimates for the groundwater pathway.

9.10 References

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Chapter 10

10. TANK FARM GROUP RESULTS (CPP-20, CPP-25, CPP-26, CPP-28, CPP-31, CPP-32E&W AND CPP-79)

This group consists of release sites associated with the High-Level Liquid Waste Tank Farm (HLLWTF), which is OU 3-07. The HLLWTF has been in operation since 1954 and provides interim storage for HLLW until it can be sent to the New Waste Calcining Facility (NWCF) or, before 1982, the Waste Calcining Facility (WCF), for solidification. After processing, the calcined granular solids are then subsequently stored in stainless steel bins. The HLLW is regularly transferred between tanks when necessitated by space requirements, or in preparation for calcination. The Tank Farm consists of 18 underground stainless steel tanks with volume capacities ranging from 69,644 to 1,135,500 L (18,400 to 300,000 gal). The tops of the largest tanks are located approximately 3.1-m (10-ft) bgs, with their bases located approximately 15.2-m (50-ft) bgs. Only sites in OU 3-07 that were retained after the screening process (Section 5) are included in the Tank Farm Group. These sites consist of CPP-20, CPP-25, CPP-26, CPP-28, CPP-31, CPP-32W and CPP-32E, and CPP-79 (Figure 10-1). The sites within the Tank Farm Group are described in Sections 10.1 through 10.8. The risk assessment for this group is described in Section 10.9.

10.1 Site CPP-20

Site CPP-20 is the location of the Radioactive Waste Unloading Area north of building CPP-604 (Figure 10-1), which was used before 1978. This section describes the nature and extent of contamination in the vicinity of the unloading area.

10.1.1 Site Description

Waste from INEL facilities were transported to the unloading area at the ICPP where it was unloaded at this location via transfer hoses. The liquids were transferred to an underground storage tank before concentration in the process equipment waste (PEW) Evaporator. It is known that the liquid contained radioactive contaminants and was required to have a pH of less than 2. It has been reported that occasional spills occurred during the unloading process as a result of leaks in the hoses. The spills were reportedly cleaned up as they occurred.

The entire area was excavated in 1982 and 1983–1984 during Phase 1 and 2 of the Fuel Processing Facility Upgrade Project. During Phase I, the entire area was excavated down to 12.2 m (40 ft). Based upon personnel interviews, the first 3.1 m (10 ft) of soils were backfilled with 5 mR dirt that was then covered with 9.1 m (30 ft) of clean fill. The source of the clean fill is unknown. During Phase II, portions of the area were excavated again. Based on personnel interviews, soils were excavated down to 12.2 m (40 ft) in the eastern sections of sites CPP-20 and CPP-25. Only at the location of valve box C-30 were soils found to be contaminated and subsequently removed. The excavated soils were stockpiled and contaminated soils separated and later placed in trenches in the northeast corner of the ICPP outside of the security fence (site CPP-34). Materials used to backfill the excavation consisted of 3 mR soil placed in the bottom 3.1 m (10 ft) and clean soils placed in the upper 9.1 m (30 ft). The source of the clean fill material included soils excavated from a sand and gravel pit located at the CFA.

10.1.2 Investigative Results

No soil sampling data were collected at the CPP-20 site due to the area being excavated during the Phase 1 and 2 Fuel Processing Facility Upgrade Project. Although there are no records to verify the cleanup

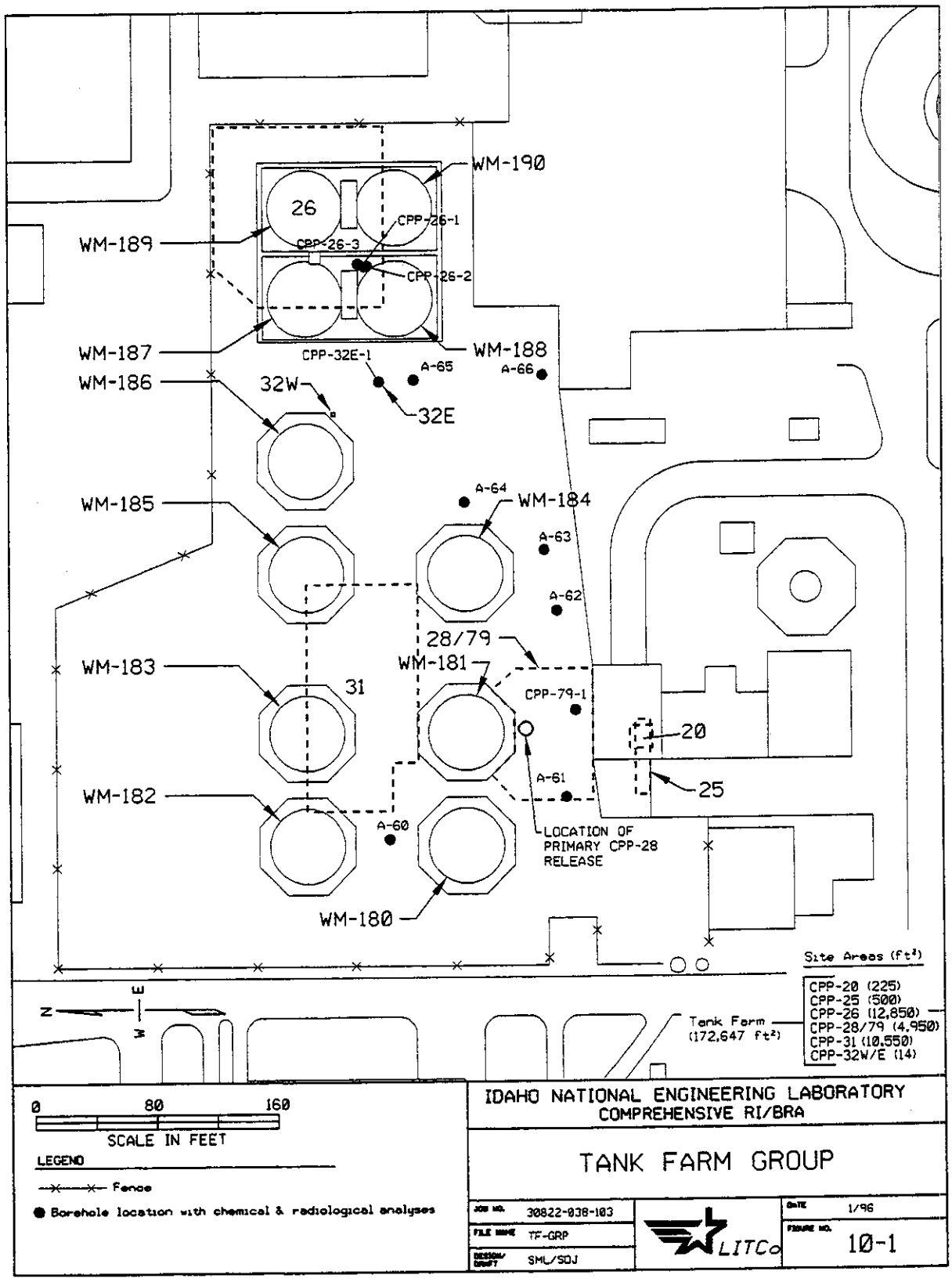


Figure 10-1. Tank Farm Group.

of this area, the radiological survey of this area in 1990–1991 did not detect surface radiation levels above background.

Because of the lack of confirmatory soil samples it was conservatively assumed, for the purposes of the BRA, that concentrations of inorganics and radionuclides in the upper 12.2 m (40 ft) of soil at site CPP-20 are similar to concentrations in soil previously excavated from areas within the Tank Farm as part of a Tank Farm Upgrade. Valve boxes and pipelines are being provided with secondary containment to comply with RCRA requirements. In June 1995, 11 samples were collected from this contaminated soil to characterize concentrations of inorganics and radionuclides. The results of these analyses are summarized in Table 10-1. A complete set of the results is provided in Appendix G. The sampling program included analysis for antimony, thallium, nitrate, toluene, Ce-144, Co-58, Eu-155, Nb-95, Ru-103, Ru-106, Sb-125, and U-235, however, these were not detected in any samples and were not added to the chemical screening in Section 5. Based on the chemical screening in Section 5.2, the following chemicals are considered to be contaminants of potential concern (COPCs) at site CPP-20: arsenic, Am-241, Cs-134, Cs-137, Co-60, Eu-154, Np-237, Pu-238, Sr-90, and Tc-99. The maximum detected concentration of arsenic, 5.9 mg/kg, is just above the background concentration of 5.8 mg/kg.

Of the radionuclide COPCs, Sr-90 and Cs-137 had the highest average and maximum activities of the radionuclides. The maximum Sr-90 and Cs-137 activities were 330±3 and 114±1 pCi/g, respectively. None of the other radionuclides detected had maximum activities greater than 2.2 pCi/g.

10.1.3 Nature and Extent of Contamination

Contaminated soils at site CPP-20 are believed to be confined to soil with gross radiation readings of 3 to 5 mR placed at depths between 9.1 to 12.2 m (30 to 40 ft) during upgrade projects in the 1980's. Soil above a depth of 9.1 m (30 ft) was reportedly clean fill. Because of the lack of confirmatory soil sampling in the area, soil concentrations from previously excavated Tank Farm soil were assumed representative of the soil beneath both sites (CPP-20 and CPP-25). This assumption was made even though the fill soil is believed to be uncontaminated because it was common practice to use backfill containing trace quantities of radioactivity during the 1980's. It should be noted that the previously excavated Tank Farm soil is not a CERCLA site.

10.2 Site CPP-25

Site CPP-25 is the location of a ruptured transfer line that released an unknown quantity of liquid waste adjacent to the north side of building CPP-604 (Figure 10-1). This section describes the soil contamination resulting from the ruptured transfer line.

10.2.1 Site Description

The eastern portion of site CPP-25 overlaps the area of site CPP-20 (Figure 10-1). The transfer line that was being used to transfer liquid waste from WC-119 to WL-102, ruptured on August 28, 1960 contaminating the soil adjacent to the building. According to direct radiation readings at the time of the incident, the soil was initially contaminated to levels of 2–4 R/hr. Approximately 7 m^3 (9 yd^3) of contaminated soil was removed and taken to the RWMC for disposal. No records exist to verify the effectiveness of these cleanup activities. However, during 1981 and 1983 the entire site was excavated during Phases 1 and 2 of the Fuel Processing Facility Upgrade Project. This excavation included the eastern portion of sites CPP-20 and CPP-25 as discussed above in Section 10.1.1.

Table 10-1. Summary statistics for CPP-20 and CPP-25, radioactive waste unloading area.

COPCs	Concentration (mg/kg or pCi/g)		Arithmetic mean	Standard deviation	Number of samples	Number of detects	Frequency of detection	INEL background (mg/kg or pCi/g)	Number greater than background
	Minimum detected	Maximum detected							
Am-241	0.06 +/- 0.03	0.17 +/- 0.04	1.15E-01	7.78E-02	11	2	18%	0.011	2
Co-60	0.09 +/- 0.02	0.09 +/- 0.02	9.00E-02	N/A	11	1	9%	N/A	N/A
Cs-134	0.13 +/- 0.03	0.19 +/- 0.03	1.60E-01	4.24E-02	11	2	18%	N/A	N/A
Cs-137	3.81 +/- .08	114 +/- 1	3.40E+01	3.25E+01	11	11	100%	0.82	11
Eu-154	0.48 +/- 0.1	0.48 +/- 0.1	4.80E-01	N/A	11	1	9%	N/A	N/A
Np-237	0.1 +/- 0.04 J	0.17 +/- 0.04 J	1.27E-01	2.93E-02	11	7	64%	N/A	N/A
Pu-238	0.11 +/- 0.03 J	0.43 +/- 0.05 J	2.20E-01	1.12E-01	11	9	82%	0.0049	7
Sr-90	60.6 +/- 0.3	330 +/- 3 J	5.89E+01	9.39E+01	11	11	100%	0.49	11
Tc-99	0.9 +/- 0.4	20.2 +/- 0.5	1.46E+00	4.25E-01	11	11	100%	N/A	N/A

NA - Not applicable/available

Fill materials placed back into the excavation consisted of 3 mR material in the bottom of the excavation and clean soils in the upper 9.1 m (30 ft).

10.2.2 Investigative Results

As with site CPP-20, no soil sampling data are available for site CPP-25 because contamination was reportedly removed during excavations conducted for upgrades of the fuel processing facilities in the early 1980s. The excavations were reportedly filled with clean fill in the upper 9.1 m (30 ft) and with 3 mR to 5 mR soil from 9.1 to 12.2 m (30 to 40 ft). Because of the lack of confirmatory soil samples of the clean fill, it will be conservatively assumed that concentrations of inorganics and radionuclides in the upper 12.2 m (40 ft) of soil at sites CPP-20 and CPP-25 are similar to concentrations in contaminated soil previously excavated from the Tank Farm as part of an upgrade project. Summary statistics for this soil are presented in Table 10-1. Based on the chemical screening in Section 5.2, the following chemicals are considered to be COPCs at site CPP-25: arsenic, Am-241, Cs-134, Cs-137, Co-60, Eu-154, Np-237, Pu-238, Sr-90, and Tc-99.

10.2.3 Nature and Extent of Contamination

Contaminated soils at site CPP-25 are believed to be confined to soil with gross radiation readings of 3 to 5 mR placed at depths between 9.1 to 12.2 m (30 to 40 ft) during upgrade projects in the 1980's. Soil above a depth of 9.1 m (30 ft) was reportedly clean fill. Because of the lack of confirmatory soil sampling in the area, sample results from previously excavated Tank Farm soil will be assumed, for the purposes of the BRA, to be representative of the soil beneath both sites CPP-20 and CPP-25. It should be noted that the previously excavated Tank Farm soil is not a CERCLA site.

10.3 Site CPP-26

CPP-26 consists of soil potentially contaminated by a release of radioactive steam that was inadvertently released to the air through a faulty hose coupling on the decontamination header. The nature and extent of contamination associated with this site is described below.

10.3.1 Site Description

The volume of radioactively-contaminated steam that was released at site CPP-26 is unknown. The release is assumed to have contaminated the land surface of approximately 13 acres to the northeast of building CPP-635. However, in an approved Track 2 NFA recommendation, the scope of the CERCLA investigation was limited to that portion of the site inside the Tank Farm. Since this release, the contaminated area within the Tank Farm has been covered with 0.6 m (2 ft) of soil, a 20-mil thick membrane liner, and an additional 15 cm (6 in.) of soil to prevent the liner from blowing away. Therefore, the contamination from the steam release would be expected to be approximately 0.8-m (2.5-ft) bgs in the Tank Farm area. This liner has not been removed.

According to the release report, the contamination from this release consisted primarily of fission products with a sample of the mud collected near the spill containing approximately 27% Cs-137, 69% Ce-144, and 3% Ru-106 (by activity). Based upon the radionuclide concentrations from the "hottest" sample analyzed at the time of the incident, only Cs-137 and Pu-242 would potentially be present in the soil at detectable levels following 28 years of radioactive decay. Based on radioactive decay, it is expected that the present day concentrations of Cs-137 from this release would be less than 300 pCi/g. Pu-242 would not have decayed significantly since the release, however, the expected present day concentration is at or below the laboratory detection limit. Therefore, it is uncertain whether Pu-242 is present at this site below the detection limit of 0.04 pCi/g (WINCO, 1993).

Since the steam release in 1964, the site boundary has been reduced due to significant construction with the area. The portion of the release site nearest to the decontamination header was excavated during the construction of buildings CPP-699 and CPP-654, and Storage Bin Sets 4, 5, and 6, and a portion of the site has been covered by the construction of Hemlock Street.

10.3.2 Investigative Results

During the Track 2 investigation for OU 3-07, three soil borings were drilled in the alluvium near the location of the steam release to determine the nature and concentration of the residual contamination. These three soil borings are located to the east and northeast of building CPP-635 and are shown on Figure 10-1. A total of six soil samples plus three duplicate samples were collected from the three borings at depths ranging from 0.3 to 1.8 m (1.0 to 6.0 ft) below the Tank Farm membrane liner. All depths herein are relative to the liner as 0 datum. Samples were analyzed for VOCs, a select list of metals, fluoride, nitrate/nitrite, pH, and radionuclides. COPCs identified as a result of the chemical screening (Section 5.2) are Am-241, Cs-137, Eu-154, Pu-238, Pu-239, Sr-90, U-234, and U-235, and are summarized in Table 10-2.

Soil samples were collected for laboratory analysis from the intervals having the highest gross beta-gamma radiation measured using field instruments. The highest levels of beta-gamma radiation were detected in boreholes CPP-26-1 and CPP-26-2 at depths greater than 1.2-m (4-ft) bgs. In borehole CPP-26-1, the highest radiation levels [greater than 50,000 counts per minute (cpm) above background] were detected at 1.2 to 1.4-m (2.8- to 4.7-ft) bgs with the radiation levels decreasing to 20,000 cpm above background at a depth of 1.8-m (6-ft) bgs. In borehole CPP-26-2, the highest radiation levels (50,000 cpm above background) were detected at a depth of 1.5-m (4.8-ft) bgs and continued to the bottom of the borehole at a depth of 1.8-m (6-ft) bgs. The highest beta-gamma radiation detected in borehole CPP-26-3 was 2,000 cpm above background at a depth of 0.5- to 0.8-m (1.8- to 2.7-ft) bgs and decreased to 500 cpm above background to the bottom of the borehole at a depth of 1.2-m (4-ft) bgs. Since an increase in radioactivity was noted in the other boreholes at 1.2-m (4-ft) bgs, this borehole may not have extended deep enough to encounter the highest potential contamination.

The radionuclides detected in soil consist primarily of Sr-90, Cs-137, Eu-154, and very low levels of Pu-238, Pu-239, and Am-241. The highest concentrations (Cs-137 concentrations up to 6,730 pCi/g and Sr-90 concentrations up to 15,800 pCi/g) were measured in samples collected between 1.2 to 1.5 m (4 to 5 ft) bgs in borings CPP-26-1 and CPP-26-2.

10.3.3 Nature and Extent of Contamination

The radionuclides detected in the soil during the Track 2 investigation consist primarily of Sr-90, Cs-137, Eu-154, with lower levels of Pu-238, Pu-239, and Am-241. The maximum concentration detected for Cs-137 was 6,730 pCi/g, approximately one order of magnitude higher than what would be expected based on radioactive decay of the "hottest" sample at the time of release. In addition, a significant increase in gross beta-gamma radioactivity was measured at a depth of approximately 1.2 m (4 ft) bgs. The original land surface at the time of the release (prior to membrane installation) is now located at a depth of 0.7 m (2.5 ft) bgs. Given the abrupt change in the gross radioactivity at a depth of 1.2 m (4 ft), it does not appear likely that the radionuclides have migrated downward from the original land surface. This is because if contaminant migration were occurring, a gradual increase in concentrations with depth would be expected rather than the abrupt increase as noted at this site. It is possible that the upper 2 ft of soil was removed following the incident, however, there is no documentation supporting this conclusion. Based upon the above discussion, it is uncertain whether the contamination detected from the three boreholes is from the CPP-26 steam release.

Table 10-2. Summary statistics for CPP-26, contaminated soil in the Tank Farm area steam flushing operation inside the tank perimeter.

COPCs	Concentration (mg/kg or pCi/g) Minimum detected	Maximum detected	Arithmetic mean	Standard deviation	Number of samples	Number of detects	Frequency of detection	INEL background (mg/kg or pCi/g)	Number greater than background
Am-241	0.144 +/- 0.0401	1.34 +/- 0.0866	5.01E-01	3.88E-01	8	8	100%	0.011	8
Cs-137	108 +/- 9.08	6730 +/- 485	2.45E+03	2.85E+03	9	9	100%	0.82	9
Eu-154	0.163 +/- 0.0436	10.7 +/- 0.92	3.40E+00	3.85E+00	9	9	100%	NA	NA
Pu-238	0.189 +/- 0.0511 J	3.58 +/- 0.279 J	1.58E+00	1.39E+00	8	8	100%	0.0049	8
Pu-239	0.013 +/- 0.001	0.84 +/- 0.121	3.10E-01	2.61E+00	8	8	100%	0.10	4
Sr-90	33.8 +/- 2.31 J	15800 +/- 106 J	5.69E+03	6.48E+03	9	9	100%	0.49	9
U-234	0.979 +/- 0.107	2.21 +/- 0.138	1.30E+00	3.91E-01	8	8	100%	1.44	1
U-235	0.0454 +/- 0.0143	0.104 +/- 0.0255	6.43E-02	2.34E-02	8	6	75%	NA	NA

NA - Not applicable/available

For the area of contamination outside the Tank Farm, the original area release was estimated to have contaminated 13 acres to the northeast of building CPP-635 based upon air dispersion. Surface radiation surveys outside the Tank Farm boundary following the incident in 1964 detected between 2 and 10 mR/hr in the soil, with one area having as high as 200 mR/hr of gross radioactivity. The surface radiation survey and cleanup program performed in 1991 by the ICPP maintenance program did not detect elevated gross beta-gamma radiation in the soil outside the Tank Farm, which has not been disturbed since the steam release. Based upon radioactive decay since the time of the release and the results from recent surface radiation surveys, it does not appear that surface contamination remains in the soil outside the Tank Farm. Therefore, the site area shown in Figure 10-1 has been revised from that shown in Figure 5-2 to reflect the lack of contamination related to the steam release outside the area of the Tank Farm. The zone of contamination in the Tank Farm area is estimated to occur at 0.7- to 1.2-m (2.5- to 4-ft) bgs.

10.4 Site CPP-28

This section describes the nature and extent of contaminated soil at site CPP-28 that resulted from a leak in a HLLW transfer line south of WM-181 near valve box A-6 (Figure 10-1).

10.4.1 Site Description

The contamination at site CPP-28 was discovered in 1974 during the installation of a cathodic protection electrode in the Tank Farm area. Soil with radioactive contamination up to 40 R/hr was encountered at a depth of about 1.8 m (6 ft) bgs. The leak was later determined to be from a 0.3 cm (1/8 in.) diameter hole inadvertently drilled through one side of the 7.6-cm (3-in.) diameter stainless steel pipe during original construction in 1955. High-level liquid waste (HLLW) consisting of first-cycle raffinate most likely leaked through secondary containment to the surrounding soil and may have occurred as early as 1955. According to a report entitled *ICPP Tank Farm Contaminated Soil Incident, October 1, 1974*, an estimated 454 L (120 gal) of first-cycle raffinate waste containing an estimated 6,000 Ci of gross radioactivity was released from the pipe between 1955 and 1974. This estimate is now considered to be low as discussed below in Section 10.4.2.

In late 1974, approximately 45 m^3 (56 yd^3) of contaminated soil having an estimated 3,000 Ci of gross radioactivity was removed from the area above the pipeline leak and transported to the RWMC in 28 Dempster-Dumpster (D-D) loads. Samples taken from several of the D-D containers had the following distribution of radionuclides (by activity): 0.2% Mn-54, 0.5% Co-60, 3.2% Ru/Rh-106, 1.4% Cs-134, 12.2% Cs-137, 21.4% Ce-144, 1.3% Eu-154, 0.8% Eu-155, and 59% Sr/Y-90. No contaminated soil was removed from below the pipe encasement due to high levels of radioactivity in the soil. The excavated area was subsequently backfilled.

The primary purpose of the ICPP Tank Farm Upgrades project was to provide secondary containment for the waste transfer lines and valve boxes within the Tank Farm. Installation of secondary containment was mandated by a Federal Consent Order. Construction activities on the project began in September of 1993 and were completed in June of 1996. The scope of work included removing out of service transfer lines and replacing existing valves with remotely removable valves along with installation of secondary containment and leak detection for the service waste transfer lines and valve boxes. Excavation and removal of vadose zone material was performed during the Tank Farm Upgrades project. The depth of excavation ranged from 0–35 ft bls, with the majority of the excavation taking place at approximately 15 ft bls. The excavation encompassed portions of several Environmentally Controlled Areas, including 20, 25, 28, and 79. Field radiation measurements encountered during excavation ranged from 0–5 R/hr.

10.4.2 Investigative Results

Following the discovery of contaminated soil, six soil borings were drilled on October 10, 1994, and one soil sample was collected from the bottom of each borehole. The depth of sample collection for the beta-gamma radiation measurements ranged from 2.0 to 3.0 m (6.5 to 10 ft) bgs. Only the soil sample from boring BH-4 indicated radiological contamination at a level of 40 R/hr beta-gamma on contact. Isotopic analyses were not performed on any of the soil samples. It is now believed that most of these boreholes were not drilled deep enough to intercept soil contamination.

As discussed below in Section 10.5, soil contamination was discovered at a depth of about 9.1 m (30 ft) in boring 79-1, which located approximately 9.1 m (30 ft) southeast of the location of the pipeline leak at site CPP-28 (Figure 10-1). The nature of the contamination in boring 79-1 strongly suggests that it was related to a leak of HLLW. Based on the proximity of boring 79-1 to the known leak at site CPP-28, it was decided to reevaluate the size of the leak through the hole in the pipeline at site CPP-28. Bounding calculations were conducted to estimate the amount of HLLW that leaked through the hole in the pipeline. Using an estimated amount of HLLW that was transferred through the pipeline during its operational lifetime, it was estimated that the release volume of HLLW was on the order of 13,600 L (3,600 gal). The calculation leading to this estimate is included as Appendix H. The concentration of the HLLW in the soil was estimated by converting radiological field screening readings to the concentration of Cs-137 required to produce that reading. A field reading of 90 R/hr was measured at a depth of 2.4 m (8 ft) in a borehole near the release while a reading of 400 R/hr was made on a sample from a depth of about 9.1 m (30 ft) in boring 79-1. Using the more conservative value of 400 R/hr, a Cs-137 activity of 2.4 Ci/L (9 Ci/gal) for the released HLLW was estimated. Using the release estimate of 13,600 L (3,600 gal), it was estimated that the total release from the pipeline was on the order of 32,000 Ci. Soil containing an estimated 3,000 Ci was reportedly excavated from the area. Therefore, a release of 29,000 Ci in the vicinity of the pipeline release (Figure 10-1) was used in the vadose zone and groundwater models (described in Section 6.0 and Appendix F).

Because of the lack of soil sampling data in the area of the pipeline release of the HLLW, the OU 3-07 Track 2 report (WINCO, 1993) estimated contaminant concentrations in soil based on a release of first-cycle raffinate waste. To estimate the activity for the individual isotopes, the average percent distribution of the radionuclides present in the first-cycle raffinate wastes as measured in tanks WM-185, WM-187, and WM-188 on September 15, 1971 was used [Memorandum dated August 7, 1972 from D. W. Rhodes to Distribution (Rhod-4-72)]. The activity for each isotope was then calculated using the average percent distribution of the waste within these tanks multiplied by the total soil activity of 435.6 μCi/g. The 1992 activities were determined from the calculated 1974 activities and adjusted for 18 years of radioactive decay. The calculated 1992 soil activities from the Track 2 report are used in the summary statistics for site CPP-28 (Table 10-3). It should be noted that the values in this table represent estimates and not actual measurements. These estimates did not include Pu-238, the value of 276,000 pCi/g measured in nearby borehole CPP-79-1 at about 40 ft bgs was added to Table 10-3. This measure was taken because this contaminant is expected to be present since it has been measured in adjacent areas and it is known to be part of the process that led to this release. For purpose of risk computations, this value was assumed at 10 ft bgs.

In the process of reassessing site CPP-28, further evaluation of the 1986 PEW release (Section 10.7) and borehole A-61 was conducted. The exact location of the release was never determined. However, the approximate location is assumed to be east of valve box A-2 near the 3-in. PWA 1013 line. Because of an improper valve configuration, 2,500 gallons of PEW backed up through the drain lines in the valve box and drained into the clay tile encasement. It is believed that the liquid drained out of the encasement through cracks or breaks. The release may have traveled along the adjacent sand-packed process piping. The assumption is that contamination at borehole A-61 may be attributed to the PEW release. The observed

Table 10-3. Summary statistics for CPP-28, contaminated soil in the Tank Farm area south of WM-181 by valve box A-6.

COPCs	Estimated concentration (pCi/g)	Arithmetic mean	Standard deviation	Number of samples	Number of detects	Frequency of detection	INEL background (mg/kg or pCi/g)	Number greater than background
Ce-144	1.44E+01	NA	NA	NA	NA	NA	NA	NA
Co-60	2.27E+04	NA	NA	NA	NA	NA	NA	NA
Cs-134	7.55E+04	NA	NA	NA	NA	NA	NA	NA
Cs-137	1.02E+08	NA	NA	NA	NA	NA	NA	NA
Eu-154	5.65E+05	NA	NA	NA	NA	NA	NA	NA
H-3	2.49E+04	NA	NA	NA	NA	NA	NA	NA
Np-237	1.63E+00	NA	NA	NA	NA	NA	NA	NA
Pu-238	2.76E+05	NA	NA	NA	NA	NA	NA	NA
Pu-241	1.05E+06	NA	NA	NA	NA	NA	NA	NA
Pu-242	3.20E+01	NA	NA	NA	NA	NA	NA	NA
Ru-106	5.41E+01	NA	NA	NA	NA	NA	NA	NA
Sr-90	5.68E+07	NA	NA	NA	NA	NA	NA	NA
U-234	2.12E+01	NA	NA	NA	NA	NA	NA	NA
U-235	2.41E-01	NA	NA	NA	NA	NA	NA	NA
U-236	7.55E-01	NA	NA	NA	NA	NA	NA	NA

Note: The values in this table represent estimated concentrations and not actual measurements except for Pu-238, which is a value measured at 40 feet in CPP-79-1 but assumed for CPP-28 at 10 feet bgs.
NA - Not applicable/available

borehole A-61 activity concentrations are consistent with PEW waste solution concentrations. Although, one exception appears in the borehole A-61 data. No Pu-241 is detected in the borehole A-61 samples; however, Am-241 was detected in the borehole A-61 data and Am-241 is a by-product of Pu-241. The age of the fission products is assumed to be the reason for the absence of Pu-241.

A maximum concentration of radioactivity in the PEW liquid transfer is 10^7 disintegrations/minute/milliliter. When converted to Ci/gal, a contaminant concentration of 1.712×10^{-2} Ci/gal is achieved. When 1.712×10^{-2} Ci/g is multiplied by the 2,500-gal volume, a total of 43 Ci of PEW released into the soil is estimated. Combined with the 29,000 Ci estimate from the pipeline leak described above yields a total estimated release at site CPP-28 of 29,043 Ci.

No attempt was made to estimate the soil concentration of metals or organic compounds that may have been released at this site. However, data concerning the concentrations of metals and radionuclides were used to provide a source estimate of the masses of individual metals and radionuclides. This source estimate was used in the groundwater model and is described in detail in Appendix F.

10.4.3 Nature and Extent of Contamination

Insufficient sampling data are available to accurately delineate the extent of contaminated soil in the vicinity of site CPP-28. Assuming the high levels of radiological contamination at 9.1 m (30 ft) in boring 79-1 are related to the release at site CPP-28, it appears that contamination extends downward and laterally from the location of the pipeline leak at a depth of 2.0 m (6.5 ft). Contaminants have likely migrated further to the south than to the north due to the presence of tank WM-181 immediately north of site CPP-28. It is also possible, if not likely, that preferential migration pathways may be present in the form of sandy backfill commonly placed in pipeline excavations. Considering the high radiation levels on the 9.1-m (30-ft) sample in boring 79-1, it is also likely that contamination extends downward to the soil/basalt interface at a depth of about 12.8 (42 ft). The lateral extent of contamination related to the release of HLLW does not appear to extend as far east as boring A-62 but may extend as far west as boring A-61 (see Section 10.7).

10.5 Site CPP-31

CPP-31 consists of contaminated soil south of tank WM-183 (Figure 10-1), which was discovered on September 18, 1975 during drilling operations. This section describes the nature and extent of contaminated soil in the site CPP-31 area.

10.5.1 Site Description

An investigation of the source of contamination at site CPP-31 revealed that in November 1972, HLLW was released to the surrounding soil during a transfer between tanks WM-181 and WM-180. The release was caused by a failure of a 8-cm (3-in) diameter carbon steel waste transfer line where it was speculated that the highly acidic HLLW corroded the transfer line. This transfer line is located about 2 ft bgs. In the *Investigation Report for the ICPP Contaminated Soil Incident*, dated September 18, 1975, it was estimated that approximately 460 to 610 m^3 (600 to 800 yd^3) of soil was contaminated by approximately 53,000 L (14,000 gal) of HLLW that contained 28,000 Ci of fission products (primarily Cs-137, Sr-90, and Y-90). According to the incident report, the Ci content was estimated by assuming that 800 yd^3 of soil was contaminated with the 53,000 L (14,00 gal) of HLLW wash that leaked during the transfer of waste noted below.

10.5.2 Investigative Results

In 1975, 33 "observation wells" were installed to investigate the release at this site. Following installation, direct radiation readings were obtained in the wells by lowering a string of thermo-luminescent detector (TLD) chips down the pipe and exposing them for a period of 1 hour. The highest radiation readings were beneath and adjacent to the waste transfer line which is located at an approximate depth of 7 ft bgs. Based on these measurements, the volume of the contaminated soil was estimated to be approximately 150 m^3 (200 yd^3) in the 10 R/hr range and 300 m^3 (400 yd^3) in the 1 R/hr range.

One soil sample from each borehole was collected in 1975 and analyzed for radionuclides. The soil samples were collected from the soil that was brought to the surface from around the auger flights. As a result of the sample collection technique, considerable mixing of the contaminated soil with potentially uncontaminated soil probably occurred. Additional exploratory work was performed in 1975 to further define the limits of the contaminated soil body. Pipes were driven into the soil rather than drilled, to reduce the possibility of contaminated soil being brought to the surface from around the auger flights and therefore obtain more credible measurements of radiation fields. Radiation readings from these additional locations showed elevated levels from depths of 4.3 to 5.2 m (14 to 17 feet), with the exception of Location A-53-18 (just north of Value Box A-6). Significantly higher radiation fields, up to 4 R /hr, were measured at depths of 0.6 to 3 m (2 to 10 feet) in the general vicinity of Valve Box A-6. Using this data, 1992 soil concentrations were calculated based on 18 years of radioactive decay. These results are summarized in Table 10-4. Estimated 1992 radionuclide concentrations include Cs-137 (at up to 2,190,000 pCi/g), Sr-90 (up to 710,000 pCi/g), Pu-239/Pu-240 (up to 1,500 pCi/g), and U-235 (up to 9,000 pCi/g). Other radionuclides estimated to be present at lesser concentrations are Co-60, Cs-134, and Ru-106. The source estimate used in the groundwater model is described in Section 5.2.2 of Appendix F and also in Appendix H.

In August 1992, subsurface radiation profile surveys were performed on selected "observation wells" as part of the OU 3-07 Track 2 investigation. It is inconclusive, based on a comparison of these results to previous radiation measurements in the wells, whether migration has occurred since the time of the release or if the radiation levels in the soil are increasing or decreasing over time.

10.5.3 Nature and Extent of Contamination

Depth-discrete soil sample data are not available to delineate the vertical and lateral extent of contamination. However, conclusions can be made assuming that the direct radiation measurements in the "observation wells" is reflective of subsurface contamination levels (localized around Valve Box A-6) and subsurface contamination levels.. Most of the soil contamination appears to be concentrated between depths of about 3 to 7 m (10 to 25 ft) in the area of HLLW transfer line PWA-1005. Based on the measurements from the last set of observation wells, it is evident that a smaller but shallower zone of high soil contamination is present in the immediate area surrounding Valve Box A-6.

10.6 Site CPP-32

CPP-32 consists of two small areas, CPP-32 east (CPP-32E) and CPP-32 west (CPP-32W), which are located near valve box B-4 (Figure 10-1). This section describes the nature and extent of contamination at site CPP-32.

10.6.1 Site Description

Site CPP-32E is an area of contaminated soil southwest of valve box B-4. This area is approximately 0.7 m^2 (8 ft^2) and about 0.3 m (1 ft) deep with radiological contamination up to 2 R/hr. The contaminated soil appeared to have originated from the stand pipe (air vent tube and view port pipe) that extended out of

Table 10-4. Summary statistics for CPP-31, contaminated soil in the Tank Farm area south of tank WM-183.

COPCs	Concentration (mg/kg or pCi/g) Minimum detected	Maximum detected	Arithmetic mean	Standard deviation	Number of samples	Number of detects	Frequency of detection	INEL background (mg/kg or pCi/g)	Number greater than background
Co-60	24.5	336	7.16E+01	8.97E+01	11	11	100%	NA	NA
Cs-134	0.985	24	8.85E+00	8.81E+00	11	11	100%	NA	NA
Cs-137	1180	2190000	5.64E+05	7.62E+05	16	16	100%	0.82	16
Eu-154	192	2750	1.01E+03	8.28E+02	11	11	100%	NA	NA
Pu-239/240	94.6	1500	4.91E+02	6.06E+02	5	5	100%	0.1	5
Ru-106	0.0666	0.0666	6.66E-02	NA	1	1	100%	NA	NA
Sr-90	165000	710000	3.25E+05	2.20E+05	5	5	100%	0.49	4
U-235	549	9000	2.93E+03	3.63E+03	5	5	100%	NA	NA

NA - Not applicable/available

the valve box. It is likely that the contamination from the stand pipe at this site was the result of condensation of humidity in valve box B-4.

CPP-32W is located about 15 m (50 ft) northwest of valve box B-4 and consists of soil contaminated to 2 R/hr covering an area of about 0.6 m^2 (6 ft^2) to a depth of about 0.3 m (1 ft). The contaminated material apparently originated from a 5.1-cm (2-in.) diameter aboveground line. The line was used to pump water from tank sumps to the PEW Evaporator. It is likely that the contaminated area was the result of a leak that occurred from this line during a transfer of water that contained radionuclides.

10.6.2 Investigative Results

Soil samples were only collected at site CPP-32E. Soil samples were not collected at site CPP-32W because the location of the release was only approximately known and a significant number of boreholes would need to be drilled to define the location of the release and thus damage the membrane over the HLLWTF. These results from site CPP-32E are assumed to be representative of the contaminant concentrations at site CPP-32W. Contaminants of potential concern (COPCs) identified for these sites per the chemical screening process (Section 5.2) are Cs-137, Eu-154, and Sr-90.

The contamination at site CPP-32E is suspected to have originated from a surface release of condensate originating from a vent tube in valve box B-4. The area of contamination was originally identified as 8 ft^2 and extended to a depth of 0.3 m (12 in.) bgs. Since the discovery of the contamination, the area has been covered with approximately 0.6 m (2 ft) of soil, the Tank Farm membrane, and an additional 15 cm (6 in.) of soil. All depths referenced in this discussion and Table 10-5 are based on the 0 datum being the Tank Farm membrane.

One soil boring was drilled during the OU 3-07 Track 2 adjacent to the vent tube to a maximum depth of 1.5 m (5 ft) below the membrane. The field team was unable to advance the soil boring to the projected depth of 1.8 m (6 ft) due to encountering a concrete valve box. From this borehole, soil samples were collected and measured in the field for gross beta-gamma radiation using a hand-held Ludlum-2A probe. The results from this sampling are summarized in Table 10-5. This field screening detected the highest radiation at 900 cpm above background between 0.43 and 0.88 m (1.4 and 2.9 ft) below the membrane, roughly equivalent to the depth of the original land surface at the time of the release. At the bottom of the borehole, the beta-gamma radiation had decreased to 250 cpm above background. Based upon the field radiation measurements, one soil sample was collected at a depth of 0.43 to 0.70 m (1.4 to 2.3 ft) and two soil samples were collected at a depth of 0.67 to 0.88 m (2.2 to 2.9 ft).

The gross alpha concentrations from the three samples ranged from 14.8±2.10 pCi/g to 21.5±2.97 pCi/g and were within normal background concentrations. Therefore, no isotopic analysis of the alpha-emitting radionuclides was performed. The gross beta concentrations from the three samples range from 350±28.7 pCi/g to 724±58.6 pCi/g with the subsequent isotopic analysis of Sr-90 ranging from 153±9.56 pCi/g to 278±14.6 pCi/g. Of the manmade gamma-emitting radionuclides, only Cs-137 at concentrations ranging from 133±11.2 pCi/g to 277±21.1 pCi/g and Eu-154 at concentrations ranging from 0.456±0.066 pCi/g to 0.811±0.092 pCi/g were detected (WINCO, 1993).

10.6.3 Nature and Extent of Contamination

The release at sites CPP-32E and CPP-32W are both localized releases at the surface. Only two depths were sampled in one boring at CPP-32E and no samples were collected at CPP-32W. The bottom of the contamination was not reached in the boring at site CPP-32E. However, considering the localized nature of the release and the decrease in the gross beta-gamma radiation readings between 0.88 to 1.5 m (2.9 to 5 ft), it appears that contamination is primarily present between 0.4 to 0.9 m (1.4 to 2.9 ft) below the Tank Farm membrane or roughly 0.5 to 1.0 m (1.9 to 3.4 ft) below the current ground surface.

Table 10-5. Summary statistics for CPP-32E/W, contaminated soil in the Tank Farm area of valve box B-4.

COPCs	Concentration (mg/kg or pCi/g)		Arithmetic mean	Standard deviation	Number of samples	Number of detects	Frequency of detection	INEL background (mg/kg or pCi/g)	Number greater than background
	Minimum detected	Maximum detected							
Cs-137	133 +/- 11.2	277 +/- 21.1 J	1.87E+02	7.85E+01	3	3	100%	0.82	3
Eu-154	0.456 +/- 0.0659 J	0.811 +/- 0.0925	6.01E-01	1.86E-01	3	3	100%	NA	NA
Sr-90	152 +/- 9.56	278 +/- 14.6 J	2.25E+02	6.52E+01	3	3	100%	0.49	3

NA - Not applicable/available

10.7 Site CPP-79

CPP-79 was originally defined as soil contaminated by the releases of waste solutions in July and August of 1986 due to an obstruction in a transfer line. A second, deeper zone of contamination at this site is believed to be related to the release of HLLW at site CPP-28. This section describes the nature and extent of the two zones of soil contamination at site CPP-79.

10.7.1 Site Description

During ICPP operations, waste solutions are routinely transferred from the WCF sump tank, WC-119, to the PEW feed tank, WL-102. The releases occurred when the liquid waste was obstructed in the transfer line and backed up through an open drain line and into valve box A-2. Approximately 9,500 L (2,500 gal) of low-level radioactively contaminated liquid leaked out of the valve box and into underlying cracks in the split tile encasement around the transfer lines exiting the valve box. The transfer line and valve box were buried approximately 3.0 m (10 ft) bgs and the condensate probably moved downward from this level.

As discussed below, a second deeper zone of contamination was discovered during the drilling of boring CPP-79-1 at a depth of 9.1 m (30 ft) bgs. This deeper zone of contamination has much higher concentrations of radionuclides than the shallower zone and appears to be related to the known release of HLLW at site CPP-28.

10.7.2 Investigative Results

During the OU 3-07 Track 2 investigation, one soil boring was drilled in the alluvium near the release to determine the type and concentration of the residual contamination and to characterize the deeper soils in the Tank Farm area. The borehole location was on a berm approximately 2.4 m (8 ft) above the land surface in the Tank Farm. As a result, the original land surface elevation corresponds to a depth of 2.4-m (8-ft) bgs in the borehole.

A total of 15 split-spoon samples were collected from the borehole. The split-spoon samples were screened in the field for gross beta-gamma radiation and a total of seven samples were selected from the zones having the highest radiation for further analysis. Two of the soil samples admitted for analysis were duplicates collected between 9.8 to 11.0 m (32 to 36 ft) bgs and one sample collected from 12.6 to 12.8 m (41.5 to 42.0 ft) bgs was too radioactive to be transported offsite. The remaining samples were analyzed for VOCs, mercury, cadmium, nitrate/nitrite, pH, and radionuclides. These results are summarized on Table 10-6. Contaminants of potential concern (COPCs) identified for the site per the chemical screening process in Section 5.2 were Am-241, Cs-137, Pu-238, Pu-239, Sr-90, U-234, and U-235.

All samples were analyzed for gross alpha- and gross beta-emitting radionuclides, with the exception of the deepest sample, which was too radioactive to analyze. Samples collected above 11.0 m (36 ft) bgs had relatively low activities, consistent with a release of low-level condensate. The highest gross alpha, beta, and Cs-137 activities were from the sample collected from 6.7 to 7.3 m (22 to 24 ft). The Cs-137 concentration in this sample was 20.9±1.5 pCi/g and the concentration of Sr-90 was 54.4±3.46 pCi/g. This sample also had detectable levels of U-238 and U-235 near background levels and Pu-238 and Pu-239 slightly above background concentrations.

Gross alpha activity was below background levels in samples collected below 7.3 m (24 ft) and above 11 m (36 ft). Gross beta and Cs-137 activities remained above background levels from 6.7 to 9.1 m (22 to 30 ft). The soil samples collected from 9.7 to 11 m (32 to 36 ft) contained radionuclides near or below background levels, suggesting that the contamination associated with the leak of condensate has not migrated below 9.7 m (32 ft).

Table 10-6. Summary statistics for CPP-79, Tank Farm release near valve box A-2.

COPCs	Concentration (mg/kg or pCi/g)		Arithmetic mean	Standard deviation	Number of samples	Number of detects	Frequency of detection	INEL background (mg/kg or pCi/g)	Number greater than background
	Minimum detected	Maximum detected							
Am-241	0.332 +/- 0.0583	16600 +/- 2180 J	8.30E+03	1.17E+04	2	2	100%	0.011	2
Cs-137	0.0478 +/- 0.00583	3.37E+07 +/- 1.06E+06	5.62E+06	1.38E+07	6	6	100%	0.82	3
Pu-238	0.13 +/- 0.0271	0.13 +/- 0.0271	1.30E-01	NA	1	1	100%	0.0049	1
Sr-90	12 +/- 1.2	5410000 +/- 4910	1.80E+06	3.12E+06	3	3	100%	0.49	3
U-234	5.55 +/- .246	50.55 +/- 0.246	5.55E+00	NA	1	1	100%	1.44	1
U-235	0.16 +/- 0.0267	0.16 +/- 0.0267	1.60E-01	NA	1	1	100%	NA	NA

NA - Not applicable/available

The original sampling plan called for drilling the borehole through the zone of contamination or, if no contamination was detected, to a maximum depth of 7.6 m (25 ft). During the field investigation, it was decided to continue drilling and sampling to the top of basalt to collect as much subsurface information as possible. At a depth of 11.9 m (39 ft), however, the drill cuttings yielded a sharp increase in radioactivity (>10,000 cpm above background). On September 4, 1992, a California split-spoon sampler was opened under an air hood. The sample had a contact surface radiation level of ±400 R/hr beta-gamma. The sample material was then transferred to two, 250-mL glass jars: one sample jar filled with the soil from 12.2 to 12.3 m (40 to 4.5 ft) bgs and one sample jar filled with soil from 12.6 to 12.8 m (41.5 to 42 ft) bgs. After the sample was containerized, the 12.2 to 12.3 m (40 to 40.5 ft) sample had a surface contact radiation of ±280 R/hr. Since this level of radioactivity was above that allowed for chemical analytical laboratory (TCT—St. Louis), it was shipped to the onsite Babcock & Wilcox laboratory for radionuclide analysis. The sample collected from 12.6 to 12.8 m (41.5 to 42 ft) bgs had radiation levels too high to be analyzed by either laboratory and was subsequently disposed back to the borehole as close as possible to where the contamination originated.

The radionuclide analyses from the sample collected from 12.2 to 12.3 m (40 to 40.5 ft) measured significantly higher gross alpha and gross beta activities (8.09E+05±9.71E+04 pCi/g and 1.89E+07±1.52E+06 pCi/g, respectively) than were measured in the above sample intervals above 9.7 m (32 ft). Isotopic analysis of this soil also detected significantly higher concentrations of Cs-137 (3.37E+07 ±1.06E+06 pCi/g), Sr-90 (5.41E+06±4.91E+03 pCi/g), and Am-241 (1.66E+04±2.18E+03 pCi/g) than were detected in the shallower sample intervals. Based upon the significant difference in concentrations and isotopes, it does not appear that the contamination detected at depth is from the same release as the contamination detected above.

As discussed in Section 10.4, the deeper zone of contamination appears to be the result of a release of HLLW. It is believed that the HLLW released at site CPP-28 migrated to the south to the deep soil with high radionuclide concentrations encountered in boring 79-1.

Information on the lateral extent of the deep zone of contamination at boring CPP-79-1 is provided by the results of samples from borings A-61 and A-62. These borings were drilled to the west and east, respectively, of boring CPP-79-1 (Figure 10-1). Soil samples were collected and analyzed from depths of 8.7 to 9.3 m (28.5 to 30.5 ft) and 11.7 to 12.3 m (38.5 to 40.3 ft) in boring A-61 and from 0.6 to 1.2 m (2.0 to 4.0 ft) and 12.3 to 12.7 m (40.3 to 41.8 ft) in boring A-62. The results are presented in Table 3.1 in the *Report of 1993/1994 Tank Farm Drilling and Sampling Investigation at the Idaho Chemical Processing Plant* (LITCO, 1995__). The highest gross alpha (1,230±20 pCi/g), gross beta (20,500±50 pCi/g), Sr-90 (3,360±30 pCi/g), and Cs-137 (25,000±2,000 pCi/g) concentrations were in the 8.7- to 9.3-m (28.5- to 30.5 ft) sample from boring A-61. Other radionuclides detected in this sample include Am-241 (46±4 pCi/g), Pu-239/240 (319±10 pCi/g), and U-234 (2.1±0.1 pCi/g). Concentrations of these same constituents in the 11.7- to 12.3-m (38.5- to 40.3-ft) sample were one to four orders of magnitude lower than in the shallower sample. Concentrations of Sr-90 and Cs-137 in the near surface soil sample from boring A-62 were 305±3 pCi/g and 730±5 pCi/g, respectively. Concentrations of these radionuclides were below background in the deeper sample from boring A-62. The high concentrations in the 8.7- to 9.3-m (28.5- to 30.5-ft) sample from boring A-61 appear to be related to the leak of PEW condensate possibly associated with site CPP-28 as described in Section 10.4.2.

10.7.3 Nature and Extent of Contamination

Based on the Track 2 investigation, there appears to be two distinct radionuclide-contaminated zones that probably originated from different releases. The uppermost zone was encountered between 6.7 to 9.1 m (22 to 30 ft) bgs in borehole CPP-79-1. This zone is characterized by gross alpha emission slightly in excess of background levels, and by gross beta emissions up to eight times the background level. The low level of radionuclides found in this zone is likely the result of the release of overhead condensate with dilute radioactivity that occurred at site CPP-79, and which was the original subject of the CPP-79 investigation.

The top of the second radionuclide-contaminated zone was encountered in boring CPP-79-1 at a depth of approximately 11.9 m (39 ft) in boring CPP-79-1 or about 9.1 m (30 ft) bgs. Concentrations in this zone are reflective of a leak of HLLW believed to be associated with site CPP-28. The vertical extent of this deeper zone of contamination has not been defined. The nearest borings to boring CPP-79-1 are borings A-61 and A-62, which are located west and east of boring CPP-79-1, respectively (Figure 10-1). The contamination associated with a leak of HLLW does not appear to extend to the west to boring A-61 or to the east to boring A-62. Consequently, the areas of sites CPP-28 and CPP-79 on Figure 5-2 have been combined on Figure 10-1 to reflect the estimated area of the deeper zone of contamination at site CPP-79, which is believed to be related to the leak at site CPP-28 and the leak of PEW from the PWA-1013 line, which appears to affect boring A-61.

10.8 Risk Assessment

The methodology for conducting the HHRA for WAG 3 was detailed in Section 7. As presented, the purpose of the HHRA is to develop a quantitative description and assessment of the human health risk posed by the COPCs present at WAG 3. This section only contains the results of the HHRA for the Tank Farm Group with respect to the soil pathway. The results for the air and groundwater pathways are detailed in Sections 27.1 and 27.2, respectively. The risk assessment at each group and site will become cumulative when the contributions from the air and groundwater pathways are added to that due to the soil pathway. The following sections discuss the complete exposure routes, exposure- point concentrations, and cancer risk and noncarcinogenic health hazard estimates for the Tank Farm Group under the three exposure scenarios evaluated. Section 10.9.3 describes the difference in estimating sources of contamination for use in evaluating surface exposure and fate and transport modeling to the SRPA. It also describes the use of the screened ORIGEN runs (see Section 4.4) to help identify contaminants potentially missing from the soil or groundwater source estimate.

10.8.1 Complete Exposure Routes

Potentially complete pathways from the source to a human receptor were described in Section 7 and illustrated on Figure 7-1. For the Tank Farm Group, the complete exposure routes within each pathway are summarized in Table 10-7. An exposure route is considered complete if the contaminated zone (as characterized in the previous sections and summarized on the table) occurs within the depth intervals specified for a given exposure route. All exposure routes as described in Section 7 are considered complete for the Tank Farm Group.

10.8.2 Exposure-Point Concentrations

Specific steps in calculating exposure-point concentrations for each of the applicable scenarios are described in Section 7. The COPC soil value used for an individual site was the smaller of the 95% upper control limit (UCL) or maximum concentration. The soil values for the Tank Farm Group were estimated using the individual site concentration terms for CPP-20, CPP-25, CPP-26, CPP-28, CPP-31, CPP-32 E&W and CPP-79. The individual site concentration terms were used to provide an area-weighted estimate. Concentrations for the interstitial area within the group [i.e., the non-environmentally Controlled Areas (ECAs) areas] were assumed to be similar to sample results from contaminated soil previously excavated within the Tank Farm during an upgrade project. Concentration terms for the radionuclides were adjusted to account for decay for each exposure scenario. These values were subsequently averaged over the exposure duration. The concentration terms in the 0–1.2 m (0–4 ft) and the 0–3.0 m (0–10 ft) depth intervals, are presented in Tables 10-8 and 10-9. Contaminant of potential concern (COPC) concentrations were not detected in the 0–15 cm (0–0.5 ft) depth range. Exposures from all complete exposure routes were estimated based on the exposure-point concentrations in Table 10-10. Homegrown produce concentrations are presented in Table 10-11. The values for air and groundwater are presented in Sections 27.1 and 27.2, respectively.

Table 10-7. Complete exposure routes for the Tank Farm Group and associated exposure route depths.

Receptor	Scenario	Potentially complete exposure routes and exposure route depths used for exposure-point concentration estimates	Characterized zone of contamination[a]	Complete exposure route?
Onsite worker	Current land use	Inhalation of VOCs 0–15 cm (0–6 in.)	0 to 15.2 m (0 to 50 ft)	No
		Inhalation of airborne particulates 0–15 cm (0–6 in.)		Yes
		Ingestion of surface soil 0–15 cm (0–6 in.)		Yes
		External radiation 0–1.22 m (0–4 ft)		Yes
Residential	Future land use	Inhalation of VOCs 0–3.05 m (0–10 ft)	0 to 15.2 m (0 to 50 ft)	No
		Inhalation of airborne particulates 0–3.05 m (0–10 ft)		Yes
		Ingestion of surface soil 0–3.05 m (0–10 ft)		Yes
		Ingestion of homegrown produce 0–3.05 m (0–10 ft)		Yes
		Ingestion of groundwater		Yes
		Dermal contact with groundwater		No
		Inhalation of VOCs from groundwater		No
		External radiation 0–3.05 m (0–10 ft)		Yes
On-site worker	Future land use	Inhalation of VOCs 0–15 cm (0–6 in.)	0 to 15.2 m (0 to 50 ft)	No
		Inhalation of airborne particulates 0–15 cm (0–6 in.)		Yes
		Ingestion of surface soil 0–15 cm (0–6 in.)		Yes
		External radiation 0–1.22 m (0–4 ft)		Yes

a. Zone of contamination based on the following previously characterized zones:

CPP-20/25	=	0 to 12 m (0 to 40 ft)
CPP-26	=	0.76 to 1.2 m (2.5 to 4 ft)
CPP-28	=	2 to 2.7 m (6.5 to 9 ft)
CPP-31	=	0.6 to 3m (2 to 10 ft)
CPP-32E/W	=	0.58 to 1.04 m (1.9 to 3.4 ft)
CPP-79	=	4.3 to 7.3 m (14 to 24 ft) and 12 to 15 m (40 to 50 ft).

Table 10-8. Area-weighted soil concentrations for the Tank Farm Group (0 to 4 ft).

COPCs	Site							Weighted average concentration (mg/kg or pCi/g)
	CPP-20/-25	CPP-26	CPP-28	CPP-31 [a]	CPP-32E/W	CPP-79	Excavated	
Area (square feet)	560	12850	64	10550	14	4950	143659	
Area (square meters)	52.03	1193.83	5.95	980.15	1.30	459.88	13346.68	
Aroclor-1260	----	----	----	----	----	----	----	0.00E+00
Benzo(a)pyrene	----	----	----	----	----	----	----	0.00E+00
Aluminum	----	----	----	----	----	----	----	0.00E+00
Arsenic	----	----	----	----	----	----	----	0.00E+00
Manganese	----	----	----	----	----	----	----	0.00E+00
Mercury	----	----	----	----	----	----	----	0.00E+00
Uranium	----	----	----	----	----	----	----	0.00E+00
Am-241	0.106	0.9895	----	----	----	----	0.106	1.62E-01
Ce-144	----	----	----	----	----	----	----	0.00E+00
Co-57	----	----	----	----	----	----	----	0.00E+00
Co-58	----	----	----	----	----	----	----	0.00E+00
Co-60	0.09	----	----	121	----	----	0.09	7.47E+00
Cs-134	0.19	----	----	13.7	----	----	0.19	9.96E-01
Cs-137	88	6460	----	899000	277	----	88	5.55E+04
Eu-152	----	----	----	----	----	----	----	0.00E+00
Eu-154	0.48	10.7	----	1460	0.673	----	0.48	9.04E+01
Eu-155	----	----	----	----	----	----	----	0.00E+00
H-3	----	----	----	----	----	----	----	0.00E+00
I-129	----	----	----	----	----	----	----	0.00E+00
K-40	----	----	----	----	----	----	----	0.00E+00
Nb-95	----	----	----	----	----	----	----	0.00E+00
Np-237	0.152	----	----	----	----	----	0.152	1.27E-01
Pu-238	0.43	3.58	----	----	----	----	0.43	6.26E-01
Pu-239/240	----	0.841	----	1070	----	----	----	6.54E+01
Pu-241	----	----	----	----	----	----	----	0.00E+00
Pu-242	----	----	----	----	----	----	----	0.00E+00
Rh-106	----	----	----	----	----	----	----	0.00E+00
Ru-106	----	----	----	6.66E-02	----	----	----	4.07E-03
Sb-125	----	----	----	----	----	----	----	0.00E+00
Sr-90	198.9	8390	----	535000	278	----	198.9	3.35E+04
Tc-99	2.2	----	----	----	----	----	2.2	1.84E+00
U-234	----	1.815	----	----	----	----	----	1.35E-01
U-235	----	0.07685	----	6990	----	----	----	4.27E+02
U-236	----	----	----	----	----	----	----	0.00E+00
U-238	----	----	----	----	----	----	----	0.00E+00

Total group area = 172647 square feet
Excavated soil area = 143659 square feet
a. The actual area of CPP-31 is 10,550 ft^2, however, only 3,165 ft^2 near valve box A-6 is known to be contaminated from 2 to 10 ft bgs.

Table 10-9. Area-weighted soil concentrations for the Tank Farm Group (0 to 10 ft).

COPCs	Site							Weighted average concentration (mg/kg or pCi/g)
	CPP-20/-25	CPP-26	CPP-28	CPP-31 [a]	CPP-32E/W	CPP-79	Excavated	
Area (square feet)	560	12850	64	10550	14	4950	143659	
Area (square meters)	52.03	1193.83	5.95	980.15	1.30	459.88	13346.68	
Aroclor-1260	----	----	----	----	----	----	----	0.00E+00
Benzo(a)pyrene	----	----	----	----	----	----	----	0.00E+00
Aluminum	----	----	----	----	----	----	----	0.00E+00
Arsenic	----	----	----	----	----	----	----	0.00E+00
Manganese	----	----	----	----	----	----	----	0.00E+00
Mercury	----	----	----	----	----	----	----	0.00E+00
Uranium	----	----	----	----	----	----	----	0.00E+00
Am-241	0.106	0.9895	----	----	----	----	0.106	1.62E-01
Ce-144	----	----	14.4	----	----	----	----	5.34E-03
Co-57	----	----	----	----	----	----	----	0.00E+00
Co-58	----	----	----	----	----	----	----	0.00E+00
Co-60	0.09	----	22700	121	----	----	0.09	1.59E+01
Cs-134	0.19	----	75500	13.7	----	----	0.19	2.90E+01
Cs-137	88	6460	102000000	899000	277	----	88	9.33E+04
Eu-152	----	----	----	----	----	----	----	0.00E+00
Eu-154	0.48	10.7	565000	1460	0.673	----	0.48	3.00E+02
Eu-155	----	----	----	----	----	----	----	0.00E+00
H-3	----	----	24900	----	----	----	----	9.23E+00
I-129	----	----	----	----	----	----	----	0.00E+00
K-40	----	----	----	----	----	----	----	0.00E+00
Nb-95	----	----	----	----	----	----	----	0.00E+00
Np-237	0.152	----	1.63	----	----	----	0.152	1.28E-01
Pu-238 [b]	0.43	3.58	276000	----	----	----	0.43	1.03E+02
Pu-239/240	----	0.841	12600	1070	----	----	----	7.01E+01
Pu-241	----	----	1050000	----	----	----	----	3.89E+02
Pu-242	----	----	32	----	----	----	----	1.19E-02
Ru/Rh-106	----	----	54.1	6.66E-02	----	----	----	2.41E-02
Sb-125	----	----	----	----	----	----	----	0.00E+00
Sr-90	198.9	15550	56800000	535000	278	----	198.9	5.51E+04
Tc-99	2.2	----	----	----	----	----	2.2	1.84E+00
U-234	----	1.63	21.2	----	----	----	----	1.29E-01
U-235	----	0.07685	0.241	6990	----	----	----	4.27E+02
U-236	----	----	0.755	----	----	----	----	2.80E-04
U-238	----	----	----	----	----	----	----	0.00E+00

Total group area = 172647 square feet
Excavated soil area = 143659 square feet

a. The actual area of CPP-31 is 10,550 ft^2, however, only 3,165 ft^2 near valve box A-6 is known to be contaminated from 2 to 10 ft bgs. The 0-10 ft COPCs for this site were taken from Table 4-12 of the OU 3-07 Track 2 Summary Report (WINCO 1993). These values are 95% upper confidence levels of the mean concentrations, and were decayed to 1992.
b. The value for CPP-28 was taken from borehole CPP-79-1 and is assumed at 10 ft bgs.

Table 10-10. Average soil exposure-point concentrations (mg/kg or pCi/g) for land use scenarios.

	Current occupational worker year 0 to year 25		Future occupational worker year 100 to year 125		Future resident year 100 to year 130
COPCs	(0 - 0.5 ft)	(0 - 4 ft)	(0 - 0.5 ft)	(0 - 4 ft)	(0 - 10 ft)
Aroclor-1260	—	—	—	—	—
Benzo(a)pyrene	—	—	—	—	—
Aluminum	—	—	—	—	—
Arsenic	—	—	—	—	—
Manganese	—	—	—	—	—
Mercury	—	—	—	—	—
Uranium	—	—	—	—	—
Am-241	—	1.59E-01	—	1.35E-01	1.35E-01
Ce-144	—	—	—	—	4.13E-43
Co-57	—	—	—	—	—
Co-58	—	—	—	—	—
Co-60	—	2.19E+00	—	4.27E-06	7.70E-06
Cs-134	—	1.18E-01	—	2.91E-16	7.05E-15
Cs-137	—	4.22E+04	—	4.25E+03	6.78E+03
Eu-152	—	—	—	—	—
Eu-154	—	3.95E+01	—	1.50E-02	4.37E-02
Eu-155	—	—	—	—	—
H-3	—	—	—	—	1.59E-02
I-129	—	—	—	—	—
K-40	—	—	—	—	—
Nb-95	—	—	—	—	—
Np-237	—	1.27E-01	—	1.27E-01	1.28E-01
Pu-238	—	5.68E-01	—	2.58E-01	4.16E+01
Pu-239/240	—	6.54E+01	—	6.52E+01	6.99E+01
Pu-241	—	—	—	—	1.67E+00
Pu-242	—	—	—	—	1.19E-02
Ru/Rh-106	—	2.37E-04	—	3.77E-34	1.86E-33
Sb-125	—	—	—	—	—
Sr-90	—	2.52E+04	—	2.33E+03	3.64E+03
Tc-99	—	1.84E+00	—	1.84E+00	1.84E+00
U-234	—	1.35E-01	—	1.35E-01	1.29E-01
U-235	—	4.27E+02	—	4.27E+02	4.27E+02
U-236	—	—	—	—	2.80E-04
U-238	—	—	—	—	—

Table 10-11. Concentrations of COPCs in homegrown produce.

COPCs	Homegrown produce (mg/kg or pCi/g)	Kd (cm^3/g)	COPC input rate from irrigation (mg/g-d or pCi/g-d)	Leach rate constant (d^{-1})
Aroclor-1260	—	7.89E+03	0.00E+00	9.95E-07
Benzo(a)pyrene	—	1.19E+03	0.00E+00	6.57E-06
Aluminum	—	0.00E+00	0.00E+00	2.87E-02
Arsenic	1.40E-04	3.00E+00	8.71E-09	2.40E-03
Manganese	—	5.00E+01	0.00E+00	1.56E-04
Mercury	1.10E-01	1.00E+02	2.91E-08	7.83E-05
Uranium	7.30E-05	6.00E+00	7.04E-09	1.25E-03
Am-241	2.44E-05	3.40E+02	6.08E-06	2.31E-05
Ce-144	1.27E-48	5.00E+02	0.00E+00	1.57E-05
Co-57	—	1.00E+01	0.00E+00	7.64E-04
Co-58	—	1.00E+01	0.00E+00	7.64E-04
Co-60	1.54E-09	1.00E+01	0.00E+00	7.64E-04
Cs-134	8.80E-19	5.00E+02	0.00E+00	1.57E-05
Cs-137	1.24E+01	5.00E+02	4.12E-05	1.57E-05
Eu-152	—	3.40E+02	0.00E+00	2.31E-05
Eu-154	5.07E-07	3.40E+02	0.00E+00	2.31E-05
Eu-155	—	3.40E+02	0.00E+00	2.31E-05
H-3	—	0.00E+00	6.22E-04	2.87E-02
I-129	3.85E-06	0.00E+00	3.26E-05	2.87E-02
K-40	—	1.50E+01	0.00E+00	5.14E-04
Nb-95	—	0.00E+00	0.00E+00	2.87E-02
Np-237	7.65E-05	0.00E+00	8.36E-06	2.87E-02
Pu-238	2.03E-03	2.20E+01	0.00E+00	3.53E-04
Pu-239/240	7.25E-02	2.20E+01	5.84E-07	3.53E-04
Pu-241	1.39E-05	2.20E+01	9.37E-08	3.53E-04
Pu-242	1.32E-05	2.20E+01	3.88E-10	3.53E-04
Ru/Rh-106	4.76E-38	0.00E+00	0.00E+00	2.87E-02
Sb-125	—	5.00E+01	0.00E+00	1.56E-04
Sr-90	4.08E+01	1.20E+01	5.63E-05	6.40E-04
Tc-99	9.18E-01	0.00E+00	1.67E-04	2.87E-02
U-234	1.59E-04	6.00E+00	2.63E-06	1.25E-03
U-235	4.36E-01	6.00E+00	9.27E-08	1.25E-03
U-236	9.79E-07	6.00E+00	6.68E-08	1.25E-03
U-238	2.44E-05	6.00E+00	2.35E-06	1.25E-03

10.8.3 Description of Source Estimates for Surface Exposure and Groundwater Modeling Use

The purpose of this subsection is two-fold. First, to compare the approach to defining the source estimate for use in both the surface exposure assessment and the groundwater model. This comparison was done for each site within this group and was accomplished by comparing the site soil data in Table 10-9 to the soil data used to estimate the source for use in the groundwater model, which can be found in Tables 5-39 and 5-40 of Appendix F. For sites CPP-28 and -31, this comparison was done between Table 10-9 and Tables 5-19 and 5-24 of Appendix F. The benefit of these comparisons is to relate both source estimates and explain any apparent differences. Secondly, the results of the screened ORIGEN runs summarized in Section 4.4 were used to help identify any potential soil-related data gaps by comparing ORIGEN results to the field investigation soil results and/or the contaminant inventory at each site. This comparison was based on the full inventory of contaminants in the screening tables in Section 5 before implementing the screening steps shown therein. The results of these comparisons are described for each site in the following paragraphs. The results of this comparison for perched water and SRPA are reported at the end of Section 4.4.

The same soil COPC's in Tables 5-13 and 5-14 for sites CPP-20 and CPP-25, respectively, were used to develop the source estimate for groundwater use. Based on a comparison of the radionuclides that were analyzed in site soils against the potential inventory as defined by the screened ORIGEN results (Table 4-7), only Pu-241 was not part of the soil sampling analytical suite. The implication is that this radionuclide may be present and is currently not part of the soil contaminant inventory of sites CPP-20 and -25.

The CPP-26 source estimate for groundwater use was based on the same soil COPC's in Table 10-9 with the exceptions of Sr-90 and U-234. The reason for this difference is that the total depth interval to evaluate future residential intrusion exposure is 0 to 10 feet bgs., while the soil source estimate for groundwater use was based on the actual zone of contamination as defined by the vertical distribution of the available data against the known depth of the release. Only the concentrations for Sr-90 and U-234 were affected by these depth assumptions. Based on a comparison of the radionuclides that were analyzed in site soils (Table 5-15) against the potential inventory as defined by the screened ORIGEN results (Table 4-7), Pu-240 and Pu-241 were not part of the soil sampling analysis performed at this site. The implication is that these radionuclides may be present and are currently not part of the soil contaminant inventory.

Approximately 3600 gallons of HLW were released at CPP-28 at an approximate depth of 7 feet bgs. between 1955 and 1974. There are no speciated soil sample results for this site and therefore, it was necessary to determine the source estimate for both surface pathway evaluation and groundwater use based on historical release information. This release information included the use of tank farm HLW composition data from several tanks. The soil source estimate for use in the surface evaluation is the same prepared in the Track 2 document and was based on the composition of the HLW in tanks WM-185, WM-187, and WM-188 in 1971. The source estimate used in the groundwater model was prepared during the RI/BRA Report. Both estimates were based on the same 1971 HLW composition data and therefore, there are no differences in contaminant inventory (except Zr-95 and Sb-125). However, based on a comparison of the radionuclides assumed present in both source estimates against the potential inventory as defined by the screened ORIGEN results (Table 4-7), only Am-241 and Pu-238 were notably absent. The implication is that these radionuclides may be present and are currently not part of either source estimate.

It is estimated that 14,000 gallons of HLW were released at CPP-31 at an approximate depth of 7 feet bgs. A review of the field radiation measurements from the 33 observation wells indicates that most of the contaminated soil is below a depth of 10 feet bgs. (WINCO, 1993). In addition, soil sample results are available from samples collected during drilling of the observation wells in 1975. The depth of these samples are unknown however, it is more likely that the samples were taken as the auger flights were advanced beyond 10 feet bgs. since field radiation measurements would have indicated that these soils were more contaminated than the shallower soils. These sample results were decayed to 1992 and are summarized in Table 10-4.

Since the depth is unknown, for use in the risk assessment, they were assumed to be representative of contamination at 7 ft bgs; thus, the 95% UCL values are included in Table 10-9. On the other hand, the source for groundwater model use was based on historical release information that is more complete compared to the available soil contaminant measurements. This release information included the use of tank farm HLW composition data from several tanks reported in 1989. The source estimate for groundwater use summarized in Table 5-24 of Appendix F includes all radionuclides measured in site soils and used in the source estimate for surface exposure. Finally, based on a comparison of the radionuclides assumed present in the groundwater source against the potential inventory as defined by the screened ORIGEN results (Table 4-7) only Pu-238 was not part of the groundwater source estimate. The implication is that this radionuclide could have been part of the release of HLW and was not evaluated in the fate and transport model.

With the exception of mercury and toluene, the same soil COPCs in Table 10-9 for site CPP-32E/W were used to develop the source estimate for groundwater use. Mercury and toluene are not included in the soil source estimate for surface residential intrusion exposure because they were screened out in Section 5 (see Table 5-18). Based on a comparison of the radionuclides that were analyzed in site soils against the potential inventory as defined by the screened ORIGEN results (Table 4-7), Am-241, Pu-238, Pu-239/240, and Pu-241 were not part of the soil sampling analytical suite. The implication is that these radionuclides may be present and are currently not part of the soil contaminant inventory.

The release at CPP-79 and CPP-28 are believed to be the same. The available soil sample results from this area indicate that there are two zones of contamination but both are below 10 ft bgs and therefore there was no source to evaluate residential intrusion surface exposure. For this reason, Table 10-9 does not show a source contribution for surface evaluation. On the other hand, the source for groundwater model use was based on historical release information that is more complete compared to the available soil sample results. This release information included the use of tank farm HLW composition data from several tanks reported in 1971. With the exception of Am-241 and Pu-238, the source estimate for groundwater use summarized in Table 5-19 of Appendix F includes all radionuclides measured in site soils and reported in Table 10-6. Finally, based on a comparison of the radionuclides assumed present in the groundwater source against the potential inventory as defined by the screened ORIGEN results (Table 4-7) Pu-238 and Am-241 were not part of the groundwater source estimate. The implication is that these radionuclides could have been part of the release of HLW and were not evaluated in the fate and transport model.

10.8.4 Risk Estimates

The results of this evaluation under current and future land use are presented in Sections 10.9.4.1 and 10.9.4.2. For each receptor, the results are summarized in Tables 10-12 through 10-17.

10.8.4.1 Current Land Use. As indicated in Table 10-12, total cancer risk to the current onsite worker from exposure to site-related chemicals in surface soil was estimated to be 5E-01. The risk is attributed to external radiation exposure, with the primary contaminants of concern (COCs) being Cs-137 (5E-01), Eu-154 (1E-03), and U-235 (6E-04). Table 10-13 indicates that the total noncarcinogenic hazard index to the current worker is estimated to be 0E+00. There are no hazard indices above unity for the current onsite worker.

10.8.4.2 Future Land Use. As Table 10-14 indicates, the total cancer risk to the future onsite worker from exposure to site-related chemicals surface soil is estimated to be 5E-02. The risk is attributed to external radiation exposure, with the primary COC driving the risk being Cs-137 (5E-02). Table 10-15 indicates the total noncarcinogenic hazard index to the future onsite worker is 0E+00. There are no hazard indices above unity for the future onsite worker. As indicated in Table 10-16, the total cancer risk to the

Table 10-12. Soil pathway cancer risk to the current on-site worker. [a]

COPCs	Ingestion of soil	External radiation exposure	Total risks
Aroclor-1260	----	----	----
Benzo(a)pyrene	----	----	----
Aluminum	----	----	----
Arsenic	----	----	----
Manganese	----	----	----
Mercury	----	----	----
Uranium	----	----	----
Am-241	----	4E-09	4E-09
Ce-144	----	----	----
Co-57	----	----	----
Co-58	----	----	----
Co-60	----	1E-04	1E-04
Cs-134	----	4E-06	4E-06
Cs-137	----	5E-01	5E-01
Eu-152	----	----	----
Eu-154	----	1E-03	1E-03
Eu-155	----	----	----
H-3	----	----	----
I-129	----	----	----
K-40	----	----	----
Nb-95	----	----	----
Np-237	----	3E-07	3E-07
Pu-238	----	6E-11	6E-11
Pu-239/240	----	7E-09	7E-09
Pu-241	----	----	----
Pu-242	----	----	----
Ru/Rh-106	----	1E-09	1E-09
Sb-125	----	----	----
Sr-90	----	NTD	----
Tc-99	----	6E-12	6E-12
U-234	----	2E-11	2E-11
U-235	----	6E-04	6E-04
U-236	----	----	----
U-238	----	----	----
Total cancer risks by route:	0E+00	5E-01	5E-01

"----" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 10-13. Soil pathway noncarcinogenic hazard to the current on-site worker.[a,b]

COPCs	Ingestion of soil	External radiation exposure	Total HIs
Aroclor-1260	---	---	---
Benzo(a)pyrene	---	---	---
Aluminum	---	---	---
Arsenic	---	---	---
Manganese	---	---	---
Mercury	---	---	---
Uranium	---	---	---
Am-241	---	---	---
Ce-144	---	---	---
Co-57	---	---	---
Co-58	---	---	---
Co-60	---	---	---
Cs-134	---	---	---
Cs-137	---	---	---
Eu-152	---	---	---
Eu-154	---	---	---
Eu-155	---	---	---
H-3	---	---	---
I-129	---	---	---
K-40	---	---	---
Nb-95	---	---	---
Np-237	---	---	---
Pu-238	---	---	---
Pu-239/240	---	---	---
Pu-241	---	---	---
Pu-242	---	---	---
Ru/Rh-106	---	---	---
Sb-125	---	---	---
Sr-90	---	---	---
Tc-99	---	---	---
U-234	---	---	---
U-235	---	---	---
U-236	---	---	---
U-238	---	---	---
Total hazard indices by route:	0E+00	0E+00	0E+00

"---" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. All noncarcinogenic contamination at the Tank Farm Group is buried deeper than 0.5 ft bls, so there is no calculated hazard index for workers at the site.
b. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 10-14. Soil pathway cancer risk to the future on-site worker. [a]

COPCs	Ingestion of soil	External radiation exposure	Total risks
Aroclor-1260	----	----	----
Benzo(a)pyrene	----	----	----
Aluminum	----	----	----
Arsenic	----	----	----
Manganese	----	----	----
Mercury	----	----	----
Uranium	----	----	----
Am-241	----	4E-09	4E-09
Ce-144	----	----	----
Co-57	----	----	----
Co-58	----	----	----
Co-60	----	2E-10	2E-10
Cs-134	----	1E-20	1E-20
Cs-137	----	5E-02	5E-02
Eu-152	----	----	----
Eu-154	----	4E-07	4E-07
Eu-155	----	----	----
H-3	----	----	----
I-129	----	----	----
K-40	----	----	----
Nb-95	----	----	----
Np-237	----	3E-07	3E-07
Pu-238	----	3E-11	3E-11
Pu-239/240	----	7E-09	7E-09
Pu-241	----	----	----
Pu-242	----	----	----
Ru/Rh-106	----	2E-39	2E-39
Sb-125	----	----	----
Sr-90	----	NTD	----
Tc-99	----	6E-12	6E-12
U-234	----	2E-11	2E-11
U-235	----	6E-04	6E-04
U-236	----	----	----
U-238	----	----	----
Total cancer risks by route:	0E+00	5E-02	5E-02

"----" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 10-15. Soil pathway noncarcinogenic hazard to the future on-site worker.[a,b]

COPCs	Ingestion of soil	External radiation exposure	Total HIs
Aroclor-1260	----	----	----
Benzo(a)pyrene	----	----	----
Aluminum	----	----	----
Arsenic	----	----	----
Manganese	----	----	----
Mercury	----	----	----
Uranium	----	----	----
Am-241	----	----	----
Ce-144	----	----	----
Co-57	----	----	----
Co-58	----	----	----
Co-60	----	----	----
Cs-134	----	----	----
Cs-137	----	----	----
Eu-152	----	----	----
Eu-154	----	----	----
Eu-155	----	----	----
H-3	----	----	----
I-129	----	----	----
K-40	----	----	----
Nb-95	----	----	----
Np-237	----	----	----
Pu-238	----	----	----
Pu-239/240	----	----	----
Pu-241	----	----	----
Pu-242	----	----	----
Ru/Rh-106	----	----	----
Sb-125	----	----	----
Sr-90	----	----	----
Tc-99	----	----	----
U-234	----	----	----
U-235	----	----	----
U-236	----	----	----
U-238	----	----	----
Total hazard indices by route:	0E+00	0E+00	0E+00

"----" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. All noncarcinogenic contamination at the Tank Farm Group is buried deeper than 0.5 ft bls, so there is no calculated hazard index for workers at the site.
b. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 10-16. Soil pathway cancer risk to the future on-site resident. [a]

COPCs	Ingestion of soil	Ingestion of homegrown	External radiation exposure	Total risks
Aroclor-1260	—	—	—	—
Benzo(a)pyrene	—	—	—	—
Aluminum	—	—	—	—
Arsenic	—	2E-08	—	2E-08
Manganese	—	—	—	—
Mercury	—	NTD	—	—
Uranium	—	NTD	—	—
Am-241	6E-08	1E-09	2E-08	7E-08
Ce-144	2E-50	7E-54	2E-48	2E-48
Co-57	—	—	—	—
Co-58	—	—	—	—
Co-60	2E-13	5E-15	2E-09	2E-09
Cs-134	4E-22	7E-24	1E-18	1E-18
Cs-137	3E-04	7E-05	3E-01	3E-01
Eu-152	—	—	—	—
Eu-154	5E-10	8E-13	6E-06	6E-06
Eu-155	—	—	—	—
H-3	1E-12	—	NTD	1E-12
I-129	—	1E-10	—	1E-10
K-40	—	—	—	—
Nb-95	—	—	—	—
Np-237	5E-08	4E-09	2E-06	2E-06
Pu-238	2E-05	1E-07	2E-08	2E-05
Pu-239/240	3E-05	4E-06	4E-08	3E-05
Pu-241	7E-07	8E-10	2E-07	9E-07
Pu-242	4E-09	7E-10	5E-12	5E-09
Ru/Rh-106	8E-41	3E-43	4E-38	4E-38
Sb-125	—	—	—	—
Sr-90	3E-04	4E-04	NTD	7E-04
Tc-99	3E-09	2E-07	3E-11	2E-07
U-234	7E-09	1E-09	8E-11	9E-09
U-235	3E-05	4E-06	3E-03	3E-03
U-236	1E-11	7E-12	1E-13	2E-11
U-238	—	3E-10	—	3E-10
Total cancer risks by route:	6E-04	5E-04	3E-01	3E-01

"—" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 10-17. Soil pathway noncarcinogenic hazard to the future onsite resident. [a]

COPCs	Ingestion of soil	Ingestion of homegrown	External radiation exposure	Total HIs
Aroclor-1260	—	—	—	—
Benzo(a)pyrene	—	—	—	—
Aluminum	—	—	—	—
Arsenic	—	1E-04	—	1E-04
Manganese	—	—	—	—
Mercury	—	1E-01	—	1E-01
Uranium	—	6E-06	—	6E-06
Am-241	—	—	—	—
Ce-144	—	—	—	—
Co-57	—	—	—	—
Co-58	—	—	—	—
Co-60	—	—	—	—
Cs-134	—	—	—	—
Cs-137	—	—	—	—
Eu-152	—	—	—	—
Eu-154	—	—	—	—
Eu-155	—	—	—	—
H-3	—	—	—	—
I-129	—	—	—	—
K-40	—	—	—	—
Nb-95	—	—	—	—
Np-237	—	—	—	—
Pu-238	—	—	—	—
Pu-239/240	—	—	—	—
Pu-241	—	—	—	—
Pu-242	—	—	—	—
Ru/Rh-106	—	—	—	—
Sb-125	—	—	—	—
Sr-90	—	—	—	—
Tc-99	—	—	—	—
U-234	—	—	—	—
U-235	—	—	—	—
U-236	—	—	—	—
U-238	—	—	—	—
Total hazard indices by route:	0E+00	1E-01	0E+00	1E-01

"—" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

future resident from exposure to site-related chemicals in soil is estimated to be 3E-01. The risks from Cs-137 (3E-01), the major contributor for the external radiation exposure route. Within the homegrown produce ingestion exposure route, the major contributor is Sr-90 (4E-04). The risks from Cs-137 (3E-04) and Sr-90 (3E-04) are the major contributors to soil ingestion exposure. As shown on Table 10-17, the total noncarcinogenic hazard index to the future resident is estimated to be 1E-01. There are no hazard indices above unity for the future resident.

10.9 Uncertainties

This section describes the limitations and uncertainties specific to the site characterization of the Tank Farm Group. Sources of uncertainty associated with site characterization include data quality, COPC identification, concentration term estimation, and assumptions regarding the lateral and vertical extent of COPC occurrence. In the risk assessment, the most significant uncertainties are due to the selection process of COPCs, the toxicity values used, and the assumptions used during the exposure assessment. The following paragraphs will discuss important sources of site-specific uncertainty in greater detail.

Sampling and analysis uncertainties are related to quality problems that may result in qualified and rejected results (Section 3.5). Qualified results are considered estimates of the concentration in the sample and, for all practical purposes, useable for their intended purpose although they could be biased high or low. Rejected results are considered unusable, thus limiting the size of the useable data set. For the Tank Farm Group, no data points were rejected based on the method validation as documented in the Limitations and Validation (L&V) Reports, thus making this possible source of uncertainty insignificant.

Uncertainty associated with the chemical screening process (Section 5.2) results from using the maximum concentration for chemicals detected in the ECAs in the background comparison step, retaining chemicals detected as COPCs because there is not a corresponding background value, and retaining chemicals as COPCs for which there is no toxicity information available.

In most cases, the COPC identification process used the maximum concentration for a chemical detected in the background comparison step, regardless of its magnitude above background. The use of the maximum can result in the identification of COPCs that have concentrations only slightly above background. For the Tank Farm Group, arsenic was the only COPC that fell into this category. Arsenic at sites CPP-20 and CPP-25 was observed at 5.9 mg/kg. The background value for arsenic is 5.8 mg/kg. In this case, arsenic was removed from further consideration and noted on the screening table. The impact to the risk assessment is almost negligible but would tend to underestimate the risk somewhat by removing arsenic.

Another source of uncertainty related to the background comparison step in the chemical screening process relates to chemicals for which no background concentration exists. For example, fluoride, nitrate, and several radionuclides were not characterized as part of the Rood et al. (1995) background study. For the Tank Farm Group, the following COPCs have no corresponding background concentration: nitrate, Ce-144, Co-60, Cs-134, Eu-154, H-3, Np-237, Tc-99, Pu-241, Pu-242, Ru-106, U-235, and U-236. This results in an increase in the number of COPCs considered in the RI/BRA and a possible overestimation of risk because the observed concentrations may be within the background population.

Some concentration estimates are based on the 95% UCL for the site, or the area-weighted average 95% UCLs for sites that have been grouped. When the 95% UCL (i.e., the concentration term estimate) of a COPC is below the corresponding background value, this results in an increase in the number of COPCs in the RI/BRA and a possible overestimation of risk because the results are likely within the background range. This source of uncertainty stems from the use of maximum concentrations when identifying the COPCs for a specific site. For the Tank Farm Group, arsenic was the only COPC with a concentration estimate below background. The area-weighted UCL used for arsenic was 4.79 mg/kg. The arsenic background value is 5.8 mg/kg. This results in an increase in the number of COPCs considered in the RI/BRA and a possible

overestimation of risk because of inclusion of arsenic concentrations that are likely within the true background population. For the Tank Farm Group, all COPCs identified had toxicity values available for use in the HHRA.

In relation to the nature and extent assessment, the lack of definitive data on lateral and vertical extent of contamination at several sites within the Tank Farm Group contributes uncertainty to the concentration term estimates and the risk assessment. At sites CPP-20 and CPP-25, sampling data from previously excavated tank from soil were used to estimate the concentration of contaminants at these sites. This may overestimate the contaminant source at these sites as contaminated soil was reportedly removed during fuel upgrade projects and contaminant concentrations in this soil are thought to be higher than concentrations in the backfilled soil. At sites CPP-28 and CPP-79, conservative bounding calculations were used to estimate the amount of HLLW that leaked through the small hole in the pipeline at site CPP-28. These calculations are believed to be conservative and thus may overestimate the contaminant source at these sites; however, because they are estimates, there is an equal potential for underestimation. The nature of metals contamination at release sites CPP-28 and -31 has not been fully characterized. This would lead to a relatively small underestimation of risk especially given that radionuclides are the risk drivers.

It is important to note that the scope of the risk assessment was limited to the known releases that have occurred during Tank Farm operations. The contents of the 18 HLLW tanks are not included in the exposure estimates within the group because no other releases have been identified. However, the large volume of HLLW contained inside these tanks are not being disregarded and are addressed under other initiatives. On October 16, 1995, an agreement was reached between the State of Idaho, the Department of Energy (DOE), and the Department of the Navy on several strategic waste management issues at the Idaho National Engineering Laboratory (INEL). With regard to the high-level wastes residing within WAG 3, the decision was made that the high-level waste evaporator would operate in such a manner as to reduce the total liquid waste volume by no less than 330,000 gallons by December 31, 1997. It was also agreed that DOE would complete calcination of all nonsodium and sodium bearing liquid wastes by June 30, 1998 and December 31, 2012, respectively.

The transfer of HLLW between tanks within the Tank Farm Group has led to significant releases to the surrounding soils over the past 40 years of operation. The results of the risk assessment under current land use for this group indicates that the estimated increased cancer risk from exposure to group-related contaminants is well above the Environmental Protection Agency (EPA) recommended target range and therefore, unacceptable. The increased cancer risk to hypothetical future onsite workers and residents was also found to be well above the EPA recommended target range. The noncarcinogenic hazard for all receptors was found to be well below the EPA hazard index goal of one. These estimates do not include the contributions associated with the air and groundwater pathways. The total increased cancer and hazard incidence to humans will be reported in Section 27. It should be noted that the cancer risk and hazard estimates in this group may be overestimated. As pointed out in Section 10.10, many of the exposure point concentrations were estimated with the use of process information and/or data collected from other locations within the Tank Farm. In addition, the evaluation of exposure to current onsite workers did not consider the benefits of a radiation protection program currently implemented at the INEL that limits worker exposure to an acceptable level. Given these limitations, the exposure from direct soil pathways alone is still expected to be severe enough that some type of future response action should be considered to mitigate adverse impacts to human health and environment.

Another source of uncertainty may be associated with the contaminant inventories used for groundwater modeling and residential intrusion exposure evaluation of each site. Section 10.9.3 identifies radionuclides potentially missing from these inventories. This was determined through a comparison of sources used to evaluate surface exposure as opposed to those used for fate and transport modeling and subsequently comparing both sources to screened ORIGEN simulations. This process identified Pu-238, -240, -241, and Am-241 as potentially missing from some site within this group (see Section 10.9.3). The implication of

these potential data gaps is that in some cases the source estimates may be underestimated. Based on the results of the groundwater modeling (Section 10.1.3 of Appendix F), these radionuclides except Pu-239 were shown to have a low enough half-life and a large travel time to the SRPA that they are not of concern south of the ICPP anytime after the year 2095.

10.10 References

Golder Associates, 1991, *Report for the Idaho Chemical Processing Plant Drilling and Sampling Program at the HLLW Tank Farm and Land Disposal Unit CPP-33*, Prepared for EG&G Idaho, Inc./Westinghouse Idaho Nuclear Company, Idaho Falls, Idaho.

WINCO, 1993, *Track 2 Summary Report for Operable Unit 3-07 (Tank Farm Area I)*, Revision 2, May.

Chapter 11

11. TANK FARM SOUTH GROUP RESULTS

The Tank Farm South Group consists of sites CPP-15, CPP-27, CPP-33, and CPP-58E and CPP-58W (Figure 11-1). This group of sites is located around the perimeter of the process equipment waste (PEW) Evaporator that is located in building CPP-604. Process low- and intermediate-level liquid wastes are concentrated in the PEW Evaporator. Waste is fed to the evaporator until a predetermined specific gravity is reached or the supply tank is empty. The concentrated "bottoms" solution from the PEW is sent to the Tank Farm as incidental liquid waste and the "overhead" condensate is sent to the Liquid Effluent Treatment and Disposal Process (LET&D) for further treatment. The LET&D fractionates the PEW overhead condensate into overhead gaseous stream and a concentrated nitric acid bottoms stream. The nitric acid is then sent to the Tank Farm or used in place of fresh acid for various plant operations. The overhead gaseous stream is superheated, filtered, and discharged through the ICPP stack.

The Tank Farm South Group sites are related to leaks or spills of wastes associated with the Tank Farm, PEW Evaporator, and a former solvent burner near the PEW Evaporator. A description of these release sites and contamination associated with these releases is provided below followed by the human health risk assessment (HHRA) for the Tank Farm South Group.

11.1 Site CPP-15

Site CPP-15 was the location of the solvent burner building CPP-629, which was located immediately southeast of the PEW Evaporator in building CPP-604 (Figure 11-1). This section describes the nature and extent of contamination in the area of the former solvent burner.

11.1.1 Site Description

The solvent burner at site CPP-15 began operation in the late 1950's and was dismantled in 1983. Before the solvent burner, a stack preheater was located at this site. On March 28, 1974, it was reported that during maintenance of the solvent burner, liquid, assumed to be solvent, was found on the ground inside and outside the solvent burner building. The leak was determined to be from a flange on the top of the solvent tank (LE-102). Radiation levels of the contaminated soil ranged up to 3 R/hr. The contaminated soil was removed and placed in drums. Clean soil was used to fill the excavated areas.

Waste solvent, primarily kerosene and tributyl phosphate degradation products contaminated with low levels of radionuclides were held in the tank and piped to the solvent burner for disposal. Gases from the combustion process were routed directly to the Main ICPP Plant Stack with no filtration.

Additional contamination to the east of the solvent burner building resulted from a continual leakage of combustion products from the solvent burner flue during system operation. Predominantly low-level alpha contamination was released.

Demolition of the solvent burner occurred in late 1983, during the refurbishing of the main stack. Demolition included removal of the furnace/burner unit, furnace duct, control shed, piping, valves and controls within the shed, and piping penetrating the shed. In addition, an unknown amount of contaminated soil was removed along with the solvent tank.

11.1.2 Investigative Results

The OU 3-08 Track 2 report (WINCO, 1993) recommended no further action at site CPP-15, based on reports that contaminated soil had been removed from the site by decontamination and decommissioning

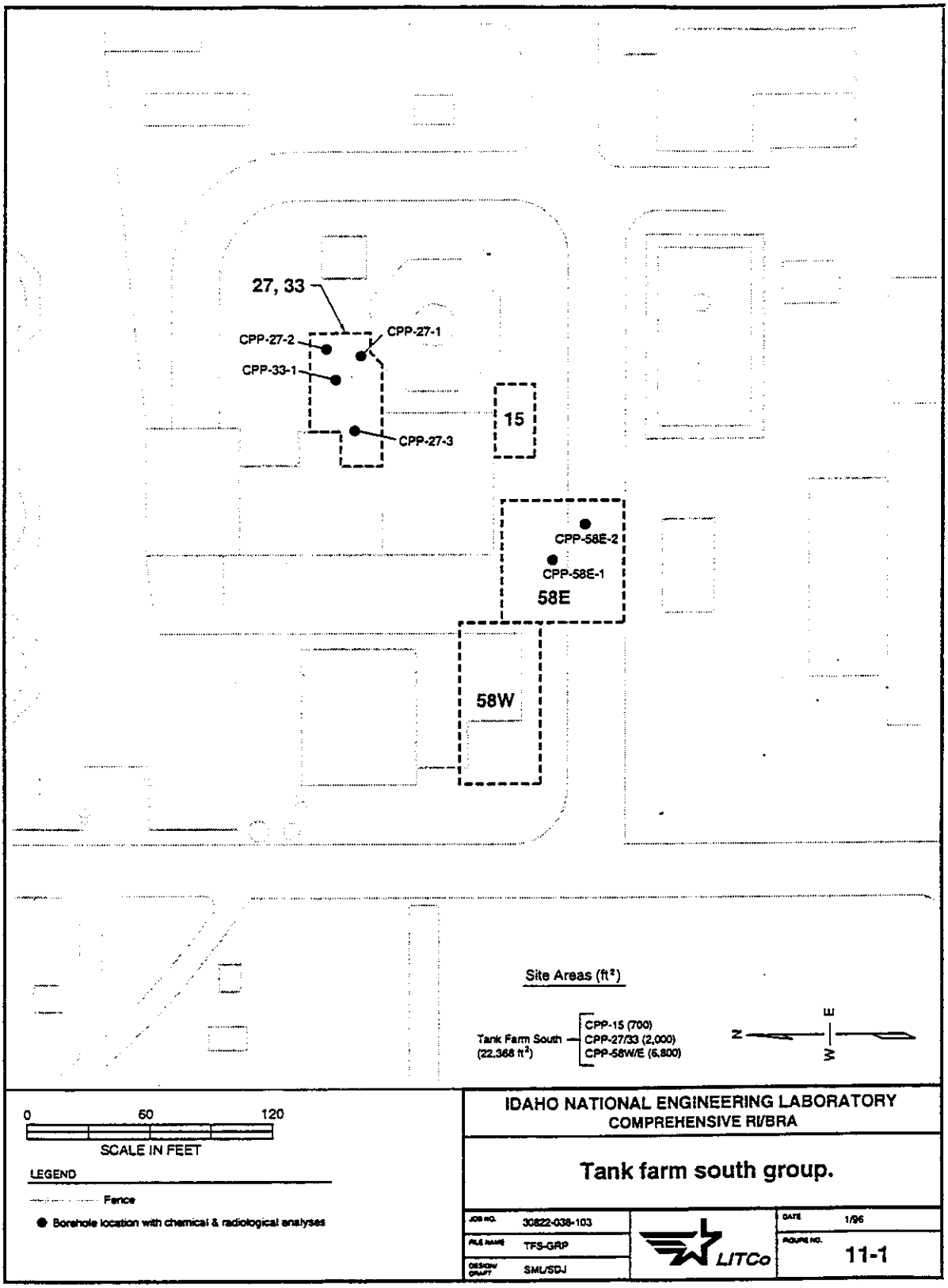


Figure 11-1. Tank Farm South Group.

(D&D) personnel during demolition of the solvent burner. No sampling data existed at the time of the Track 2 report to support the recommendation. In September 1995, LMITCO construction personnel encountered elevated radiological readings while conducting an excavation in the western half of the site. The excavation was being conducted in preparation for an electrical duct bank and transformer pad installation. The footprint of the pad was to extend over the western portion of site CPP-15. The depth of the excavation varied from 1.2 to 3.0 m (4 to 10 ft). During the excavation, contaminated soil was encountered at a depth of 0.6 m (2 ft). Beneath the contaminated soil was a concrete footing with a hotspot reading of 1.5 R/hr. The footing was a remnant of the old stack preheater. Six soil samples were collected in the area of the contaminated footing. As discussed in Section 3, samples were collected from a stockpile of excavated soil in a dump truck (sample CPP-15-1), from the soil 0.46 m (1.5 ft), footing (CPP-15-2), soil directly below the footing (CPP-15-3), and soil 1.2 m (4 ft) below the footing (CPP-15-4). A duplicate sample (CPP-15-5) was collected below the footing. Lastly, a sample (CPP-15-4D) was collected from 3.2-m (10.5-ft) bgs, which was 2.6 m (8.5 ft) below the footing.

The results of the samples collected in the excavation are summarized on Table 11-1. It should be noted that most VOCs, antimony, selenium, nitrate, silver, mercury, Cs-134, Co-60, I-129, Ru-103, Sr-90, U-234, U-238, and Ru-106 were analyzed for but not detected and therefore do not appear on Table 5-21. Based on the chemical screening in Section 5, contaminants of potential concern (COPCs) identified for this site include thallium, zirconium, Am-241, Cs-137, Eu-154, Np-237, Pu-238, Pu-239/240, Tc-99, and U-235.

Radiological analyses on the soil samples collected above 3.2-m (10.5-ft) bgs included gross alpha, gross beta, and Cs-137. The sample collected at the bottom of the excavation at 3.2-m (10.5-ft) bgs was analyzed for gross alpha and beta, and a full suite of radioisotopes. The highest activities were detected in the 3.2-m (10.5-ft) sample. This sample contained 5,680 pCi/g gross alpha, 778,000 pCi/g gross beta, and 586,000±17,000 pCi/g Cs-137. This sample also contained Am-241 (538±35 pCi/g), Eu-154 (243±24 pCi/g), Pu-238 (4,570±320 pCi/g), Pu-239 (825±63 pCi/g), and total strontium (3,605 mg/kg). Gross alpha, gross beta, and Cs-137 activities were lower in the shallower samples. Samples collected near and beneath the footing had Cs-137 activities ranging from 2,350±120 to 43,300±1,800 pCi/g.

The only VOCs detected in the samples were trichloroethene and methylene chloride that were detected in very low concentrations (<0.01 mg/kg). Methylene chloride was detected in all five samples but was also detected in the method blanks.

11.1.3 Nature and Extent of Contamination

Based on the results of the excavation for the transformer pad and the duct bank, only some of the contaminated soils have been removed from the western portion of site CPP-15. The contaminants in the upper portion of the excavation were distributed in small pockets that did not appear to be laterally or vertically connected. The uneven distribution suggests that the contamination encountered in the upper portions of the 1995 excavation are remnants of the 1983 excavation and cleanup. However, the results of the sample collected at 3.2-m (10.5-ft) bgs suggest that contamination remains in place at depth in the site CPP-15 area.

No sampling data are available for the eastern portion of site CPP-15, which was not part of the recent excavation. Therefore, for the purposes of the BRA, it will be assumed that contamination encountered in the excavation is representative of contamination remaining beneath the eastern portion of site CPP-15. Soil contamination will be assumed to be present in the eastern half of site CPP-15 from a depth of 0.6 m (2 ft), the depth that contamination was initially encountered in the 1995 excavation, to an assumed depth of 6.1 m (20 ft). The extent of soil contamination in the western portion of site CPP-15 is assumed to extend from the bottom of the excavation, that varied from 1.2- to 3.2-m (4- to 10.5-ft) bgs down to 6.1 m (20 ft), which is the maximum depth of contamination in the excavation. The conservatively estimated volume of contaminated soil is 307 m^3 (10,850 ft^3) assuming an area of 65 m^2 (700 ft^2) and the depths discussed above.

Table 11-1. Summary statistics for CPP-15, solvent burner east of CPP-605.

COPCs	Concentration (mg/kg or pCi/g) Minimum detected	Maximum detected	Arithmetic mean	Standard deviation	Number of samples	Number of detects	Frequency of detection	INEL background (mg/kg or pCi/g)	Number greater than background
Thallium	4.84878	4.84878	4.85E+00	NA	6	1	17%	0.43	1
Zirconium	5.13091	13.9757	8.66E+00	3.18E+00	6	6	100%	NA	NA
Am-241	538 +/- 35	538 +/- 35	5.38E+02	NA	1	1	100%	0.011	1
Cs-137	44.5 +/- 7.7	586000 +/- 17000	1.08E+05	2.35E+05	6	6	100%	0.82	6
Eu-154	243 +/- 24	243 +/- 24	2.43E+02	NA	1	1	100%	NA	NA
Np-237	0.63	0.63	6.30E-01	NA	1	1	100%	NA	NA
Pu-238	4570 +/- 320	4570 +/- 320	4.57E+03	NA	1	1	100%	0.0049	1
Pu-239/240	825 +/- 63	825 +/- 63	8.25E+02	NA	1	1	100%	0.1	1
Tc-99	36.7	36.7	3.67E+01	NA	1	1	100%	NA	NA
U-235	0.0203	0.0203	2.03E-02	NA	1	1	100%	NA	NA

NA - Not applicable/available

11.2 Sites CPP-27 and CPP-33

Sites CPP-27 and CPP-33 consist of contaminated soil associated with subsurface releases of high-level liquid waste (HLLW) from the Tank Farm transfer system near the northeast corner of building CPP-604 (Figure 11-1). This section describes the nature and extent of contamination associated with these collocated sites.

11.2.1 Site Description

Sites CPP-27 and CPP-33 were determined to be related to releases from the same source and, therefore, are being addressed as a single release site. The release associated with site CPP-27 was discovered in 1974 and was attributed to a 30-cm (12-in.) transfer line buried 3.7-m (12-ft) bgs that may have leaked since the early 1960s. It was estimated that 1,135 L (300 gal) of radioactive waste containing between 1,000 and 3,000 Ci of activity was released into the soil. Cleanup efforts in 1974 removed approximately 230 m^3 (300 yd^3) of contaminated soil. Following cleanup, it was estimated that 25 mCi of radioactivity in soil remained in place (WINCO, 1993).

In 1983, additional contaminated soil was discovered while excavating WL-102, which was located near the northeast corner of building CPP-604. This additional contamination, thought to be the result of a separate release from the same transfer line, was designated CPP-33. Cleanup efforts in 1983 removed approximately 10,710 m^3 (14,000 yd^3) of contaminated soil. Of this total, approximately 1,530 m^3 (2,000 yd^3) exceeding 30 mR/hr of beta-gamma radiation was removed and disposed of at the Radioactive Waste Management Complex (RWMC). The remaining 9,180 m^3 (12,000 yd^3) was disposed of in trenches located in the northeast corner of the ICPP. The soil in these trenches is addressed separately as site CPP-34 (Section 18). After the 1983 excavation, the area was backfilled and trace amounts of radioactively contaminated soils were reportedly left in place below, and lateral to the excavated area (WINCO, 1993).

11.2.2 Investigative Results

Results of soil samples collected in the excavation in 1974 indicated that the primary contaminants are Cs-137, Sr-90, Cs-134, Eu-154, and Ru-106 with minor concentrations of Pu-239/240. Of these contaminants, only Cs-137, Sr-90, and Pu-239/240 would be present today at detectable concentrations due to radioactive decay (WINCO, 1993).

Before the Track 2 investigation, two characterization efforts were performed at this site to assist in determining the extent of contamination. The first investigation was performed in 1987 and involved drilling 10 boreholes to the top of basalt, and measuring direct radiation levels in each borehole using field instruments. Radiation measurements ranged from 200 up to 50,000 counts per minute (cpm) with most readings between 200 and 2,000 cpm. The highest readings were measured at depths of 2.1 to 7.6 m (7 to 25 ft). The high radiation levels decreased with depth based on the field readings. Soil samples for laboratory analysis were not collected during this investigation.

The second investigation was performed in late 1990 and involved the drilling and sampling of borehole 33-1 (Figure 11-1). From this borehole, 16 soil samples were collected from the alluvium above the basalt and two soil samples were collected from the 110-ft interbed. These samples were analyzed for VOCs, semivolatile organic compounds (SVOCs), pesticides, polychlorinated biphenyls (PCBs), herbicides, dioxins, furans, metals, cyanide, pH, and radionuclides (Golder Associates, 1991). The Track 2 investigation at this site involved drilling and sampling three boreholes (designated CPP-27-1 through CPP-27-3 in Figure 11-1). One borehole, CPP-27-1, was drilled to 14.0-m (46-ft) bgs and two boreholes, CPP-27-2 and CPP-27-3 were drilled to 3.7 m (12 ft) bgs. From these boreholes, 20 soil samples were collected and analyzed for VOCs,

metals, fluoride, nitrate, nitrite, pH, and radionuclides. The results from the 1990 investigation and the 1993 Track 2 investigations are summarized in Table 11-2. Contaminants of potential concern (COPCs) identified in the chemical screening process in Section 5 are arsenic, Am-241, Cs-137, Eu-154, Np-237, Pu-238, Pu-239/240, Sr-90, and U-235.

Measurements of beta-gamma radiation were made in the field to assist in the selection of soil sample locations and subsequent sample collection for laboratory analysis. For the boreholes drilled as part of the Track 2 investigation, the highest measured radioactivity was 2,600 cpm above background with the levels typically being less than 1,000 cpm above background. The soil samples having the highest measured beta-gamma radiation were then selected for laboratory analysis. For drilled intervals without radioactivity above background, samples were selected for laboratory analysis to provide representation for the entire drilled interval.

Gross alpha activity in the samples ranged from 3.44±0.525 to 79.3±9.77 pCi/g with the results from seven samples exceeding background (20 pCi/g). Elevated alpha activity was detected in borehole CPP-27-1 at depths from 1.8- to 4.9-m (6- to 16-ft) bgs and in borehole CPP-27-3 at depths from 1.2-m (4-ft) bgs to the total drilled depth of 3.7-m (12-ft) bgs. Elevated alpha activity was not detected in borehole CPP-27-2. Isotopic analysis on these seven samples measured U-235, Pu-238, Pu-239, and Am-241 at activities slightly above background. It should be noted that isotopic analysis was not performed on sample number 30801101, even though it had an alpha activity of 63.0±0.3 pCi/g. Instead, it appears that isotopic analysis was performed on sample number 30800901 (collected from the same borehole), which had an alpha activity of 3.44±0.525 pCi/g.

The results from the gamma analysis detected Cs-137 and K-40 in all samples and Eu-154 in seven of the samples analyzed. The concentrations for K-40 were near background levels. Cs-137 concentrations ranged from 0.58±0.04 to 1,370±100 pCi/g with 16 samples exceeding background (1.08 pCi/g). Elevated Cs-137 concentrations were measured in borehole CPP-27-1 at depths from 0.6- to 6.9-m (2- to 22.5-ft) bgs, in borehole CPP-27-2 at depths from 1.2- to 3.0-m (4- to 10-ft) bgs, and in borehole CPP-27-3 at depths from 0.6-m (2-ft) bgs to the total drilled depth of 3.7-m (12-ft) bgs. In addition, Cs-137 concentrations in borehole 33-1 ranged from not detected to 606±3 pCi/g with the highest concentrations detected from 2.1- to 11.3- m (7- to 37- ft) bgs. Eu-154 concentrations varied from 0.386±0.07 to 4.23±0.335 pCi/g. Elevated concentrations were detected in borehole CPP-27-1 at depths from 1.8 to 4.9 m (6 to 16 ft) bgs and in boreholes CPP-27-2 and CPP-27-3 at depths from 1.2- to 1.8-m (4- to 6-ft) bgs. Eu-154 was not detected in the soil samples collected from borehole 33-1.

11.2.3 Nature and Extent of Contamination

The subsurface radiation levels measured in 1987 and from boreholes CPP-27-1 through CPP-27-3 and CPP-33-1 were evaluated to estimate the extent of residual contamination at this site. From the 1987 radiation profiles, it appears that the majority of contamination is located in the southwest portion of the site where levels as high as 30 mR/hr were measured below a depth of 6.1 m (20 ft).

The contamination detected in radiation borehole #4, and borings CPP-27-2 and CPP-33-1 is likely related to the contaminated soil that was used as backfill. According to project records, soil contaminated to levels of 25 mR/hr was used as backfill in the excavation. If the contamination is not from the backfill, it is unlikely that this contamination is from the suspect release source for the following reasons. First, the contamination detected in this borehole was initially encountered at a depth of 2.1 m (7 ft) bgs, which is approximately 1.5 m (5 ft) higher than the elevation of the reported release from the pressure relief line. Second, lower levels of radioactivity (based on field instruments) were measured in 1987 borehole #5, and in

Table 11-2. Summary statistics for CPP-27/33, contaminated soil in the Tank Farm Area northeast of CPP-604.

COPCs	Concentration (mg/kg or pCi/g)		Arithmetic mean	Standard deviation	Number of samples	Number of detects	Frequency of detection	INEL background (mg/kg or pCi/g)	Number greater than background
	Minimum detected	Maximum detected							
Arsenic	2.8 J	6.8 J	4.30E+00	9.49E-01	34	34	100%	5.80	2
Am-241	0.118 +/- 0.0343	9.59 +/- 1.59	2.10E+00	3.21E+00	41	15	37%	0.011	11
Cs-137	0.12 +/- 0.07	1370 +/- 100	2.14E+02	3.14E+02	54	46	85%	0.82	28
Eu-154	0.386 +/- 0.07	4.23 +/- 0.335	1.38E+00	1.33E+00	7	7	100%	NA	NA
Np-237	0.38 +/- 0.17	1.14 +/- 0.6	8.04E-01	3.30E-01	33	5	15%	NA	NA
Pu-238	0.06 +/- 0.04	1.41 +/- .0832	3.79E-01	4.01E-01	41	12	29%	0.0049	9
Pu-239/240	0.0467 +/- 0.0157	0.34 +/- 0.12	1.99E-01	1.23E-01	41	7	17%	0.10	4
Sr-90	0.16 +/- 0.08	506 +/- 16.4	1.16E+02	1.39E+02	48	46	96%	0.49	27
U-235	0.0425 +/- 0.0124	0.069 +/- 0.015	6.18E-02	1.29E-02	25	4	16%	NA	NA

NA - Not applicable/available

Track 2 boreholes CPP-27-2 and CPP-33-1 than in 1987 borehole #4. These locations are closer to the release than 1987 borehole #4 and subsequently should have higher radiation levels.

The contamination detected in borehole CPP-27-1 is probably from a different release than the original releases included in sites CPP-27 and CPP-33. This borehole encountered contamination at a depth of 1.8 m (6 ft) bgs, which is approximately 1.8-m (6-ft) higher than the reported release, and was drilled in an area that was not previously excavated.

The subsurface radiation profiles indicate that low levels of beta-gamma contamination are present at depths typically greater than 2.1 m (7 ft) bgs. Levels of beta-gamma radiation below background were again encountered at depths greater than 6.1 m (20 ft) bgs and continued to the total depth of the borehole for CPP-27-1, and at depths greater than 11.6 m (38 ft) and continued to the top of basalt in borehole CPP-33-1. From the 1987 data, however, higher levels of beta-gamma radiation were measured at the bottom of the boreholes located in the southwest portion of the site. It is uncertain whether the contamination continues below this depth since the total depth of the boreholes drilled in 1987 were not reported.

The extent of soil contamination at this site appears to be limited to the north and east by the 1983 excavations, to the west by building CPP-604, and to the south by building CPP-605 and the ICPP stack (CPP-08). The main source of contamination occurs between 2.1-m (7-ft) and 9.8-m (32-ft) bgs as shown in the analytical data from borehole CPP-27-1. The area of sites CPP-27 and CPP-33 in Figure 5-2 has been revised on Figure 11-1 based on maps in the OU 3-08 Track 2 report (WINCO, 1993). It is conservatively estimated that the contaminated surface area is 186 m^2 (2,000 ft^2), and using a contaminant thickness of 7.6 m (25 ft), the approximate source volume is 1,416 m^3 (1,850 yd^3). The results of all samples collected at the 110-ft interbed indicate that migration to this depth has not occurred; all data were undetected or at background levels.

11.3 Site CPP-58

Site CPP-58 consists of two areas of soil contaminated by leaks of PEW condensate (Figure 11-1). This section describes the results of investigations to evaluate the nature and extent of contamination at this site.

11.3.1 Site Description

Site CPP-58 was partitioned into two separate units (CPP-58E and CPP-58W) for evaluation because there were two separate discharges that affected soils in separate areas. The condensate originates from the PEW where acidic liquids containing metals and volatile organics are evaporated and condensed as part of the PEW process.

Site CPP-58W consists of soil affected by a release of PEW condensate in 1954. An occurrence report from August 30 to September 1, 1954 documents a leak of condensate from a buried transfer pipeline to the soil in a ditch between buildings CPP-604 and CPP-601. The pipe is located approximately 1.8- to 2.4-m (6- to 8-ft) bgs. Available information does not indicate the volume of solution released or the length, width, or depth of contamination. It is unknown how often transfers would have taken place or how long the pipe leaked.

Site CPP-58E consists of soil affected by a leak of PEW condensate in 1976. On September 30, 1976, an investigation of a low-sample-flow alarm led to the discovery of a subsurface release of approximately 75,700 L (20,000 gal) of PEW Evaporator condensate. According to Operating Occurrence Report No. 76-28, the release was caused by a failure of the condensate transfer line between the PEW Evaporator

and the Service Waste Diversion System monitoring station at building CPP-751. The failure was located at a depth of 1.8 m (6 ft) where the line turns 90 degrees and the diameter of the line narrows from 8 to 5 cm (3 to 2 in.). This incident released approximately 51 mCi of H-3, 2 mCi of Sr-90, 4 mCi of Ru-106, 2 mCi of Cs-137, and 1 mCi of Ce-144. The damaged section of the line was repaired on October 2, 1976. There are no records indicating that any of the contaminated soil was removed at the time of the line repair. Based on available information, the contaminated soil was left in place and was covered with several feet of clean fill.

11.3.2 Investigative Results

Only site CPP-58E has been investigated with respect to collecting soil samples to characterize the nature and extent of contamination. Site 58W is now located beneath building CPP-649. The minimum placement for footings for building CPP-649 was 3.7 m (12 ft). The presence of the building precluded the collection of soil samples at site CPP-58W. Samples from site CPP-58E will be used for assessing the nature of contamination at site CPP-58W.

Site CPP-58E was sampled during the Track 2 investigation for Operable Unit 3-11 (WINCO, 1993). The field investigation for CPP-58E consisted of collecting 13 soil samples for laboratory analysis. Samples were collected from boreholes CPP-58E-1 and CPP-58E-2 that were drilled to depths of 14.0 m (46 ft) and 3.7 m (12 ft), respectively. The borehole locations (Figure 11-1) were selected such that borehole CPP-58E-1 was drilled approximately 3.7 m (12 ft) from the release site and borehole CPP-58E-2 was drilled approximately 9.1 m (30 ft) southeast of the release site. Borings were drilled using a hollow stem auger rig equipped with California split-spoon samplers. Nine samples from borehole CPP-58E-1 and four samples from CPP-58E-2 were analyzed for VOCs, a targeted analyte list of metals, fluoride, pH, nitrate/nitrite, and radionuclides. The results of these analyses are summarized in Table 11-3. Results of the chemical screening in Section 5 indicate that COPCs for this site are Am-241, Cs-137, Eu-154, Pu-238, Sr-90, and U-235.

According to the Sampling and Analysis Plan (SAP), soil samples were to be taken when field screening identified radioactivity greater than background levels. No samples were collected on this basis because areas of radiation above background were not detected with field instruments. Instead, samples were collected to provide representative sampling of the entire drilled intervals.

Gross alpha activity ranged from 3.92±0.67 pCi/g to 24.4±3.28 pCi/g. Only the sample collected from 2.4 to 3.0 m (8 to 10 ft) in CPP-58E-1 exceeded the background activity of 20 pCi/g. Subsequent isotopic analyses for alpha-emitting radionuclides on this sample detected U-234 and U-238 below background concentrations and Pu-238, U-235, Pu-239, and Am-241 above background concentrations.

Gross beta activity ranged from 31.3±2.78 pCi/g to 271±22.1 pCi/g with all samples exceeding background activity of 30 pCi/g. Subsequent isotopic analysis for Sr-90 detected concentrations ranging from 0.877±0.276 pCi/g to 33.4±3.17 pCi/g. In general, lower concentrations of Sr-90 were measured in borehole CPP-58E-2 than in CPP-58E-1. This is consistent with CPP-58E-1 being closer to the location of the release.

The results of the gamma analysis detected only Cs-137 and K-40. The concentrations of K-40 are within normal background ranges. Cs-137 concentrations ranged from 0.269±0.211 pCi/g to 63.1±4.57 pCi/g with the higher concentrations detected at a depth of less than 6.7 m (22 ft) in borehole CPP-58E-1, and at depths less than 3.0 m (10 ft) in borehole CPP-58E-2.

Table 11-3. Summary statistics for CPP-58E/W, subsurface release of PEW overhead condensate.

COPCs	Concentration (mg/kg or pCi/g)		Arithmetic mean	Standard deviation	Number of samples	Number of detects	Frequency of detection	INEL background (mg/kg or pCi/g)	Number greater than background
	Minimum detected	Maximum detected							
Am-241	0.101 +/- 0.0295 J	0.101 +/- 0.0295 J	1.01E-01	NA	1	1	100%	0.011	1
Cs-137	0.269 +/- 0.0211	63.6 +/- 4.57	1.83E+01	2.14E+01	13	13	100%	0.82	10
Eu-154	.154 +/- .042 J	.248 +/- .0643	2.01E-01	6.65E-02	2	2	100%	NA	
Pu-238	0.295 +/- 0.0379	0.295 +/- 0.0379	2.95E-01	NA	1	1	100%	0.0049	1
Sr-90	0.877 +/- 0.276	95.6 +/- 1.16	2.50E+01	3.05E+01	13	13	100%	0.49	13
U-235	0.0679 +/- 0.0158	0.0679 +/- 0.0158	6.79E-02	NA	1	1	100%	NA	

NA - Not applicable/available

11.3.3 Nature and Extent of Contamination

No soil samples were collected at depths of less than 1.8 m (6 ft), because the release occurred at that depth and the area was subsequently excavated to repair the ruptured pipeline. Below this depth, the primary contaminants detected at this site, Cs-137 and Sr-90, are consistent with the waste stream that was reported to have been released. Cs-137 concentrations are generally higher than Sr-90 concentrations above 6.7 m (22 ft) in borehole CPP-58E-1 and above 3.7 m (12 ft) in borehole CPP-58E-2. Below these depths, Sr-90 concentrations are higher than Cs-137 concentrations. This relationship is believed to be the result of the greater mobility of Sr-90 relative to Cs-137, given that these two radionuclides were likely in roughly equal concentrations in the released condensate. The contaminated zone for this site is estimated as being present from 1.8- to 14.0-m (6- to 46-ft) bgs. The volume of contaminated soil is estimated as 7,702 m^3 (272,000 ft^3).

11.4 Risk Assessment

The methodology for conducting the HHRA for WAG 3 was detailed in Section 7. As presented, the purpose of the HHRA is to develop a quantitative description and assessment of the human health risk posed by the COPCs present at WAG 3. This section only contains the results of the HHRA for the Tank Farm South Group with respect to the soil pathway. The results for the air and groundwater pathways are detailed in Sections 27.1 and 27.2, respectively. The risk assessment at each group will become cumulative when the contributions from the air and groundwater pathways are added to the results of the soil pathway. The following sections discuss the complete exposure routes, exposure-point concentrations, methods used to estimate contaminant sources, and cancer risk and noncarcinogenic health hazard estimates for the Tank Farm South Group under the three exposure scenarios evaluated. Section 11.4.3 describes the difference in estimating sources of contamination for use in evaluating surface exposure and groundwater modeling to the SRPA. It also describes the use of the screened ORIGEN runs (see Section 4.4) to help identify contaminants potentially missing from the soil or groundwater source estimate.

11.4.1 Complete Exposure Routes

Potentially complete pathways from the source to a human receptor were described in Section 7 and illustrated on Figure 7-1. For the Tank Farm South Group, the complete exposure routes within each pathway are summarized in Table 11-4. An exposure route is considered complete if the contaminated zone (as characterized in the previous sections and summarized on the table) occurs within the depth intervals specified for a given exposure route. All exposure routes, as described in Section 7, are considered complete for the Tank Farm South Group.

11.4.2 Exposure-Point Concentrations

Specific steps in calculating exposure-point concentrations for each of the applicable scenarios are described in Section 7. The COPC soil value used for an individual site was the smaller of the 95% upper confidence limit (UCL) or maximum concentration. The soil values for the Tank Farm South Group were estimated using the individual site concentration terms for CPP-15, CPP-27/33, and CPP-58. The individual site concentration terms were used to provide an area-weighted estimate. Concentrations for the interstitial area within the group [i.e., the non-Environmentally Controlled Area (ECA)] were assumed to be similar to site CPP-88. The concentration terms for the radionuclides were adjusted to account for decay for each exposure scenario. These values were subsequently averaged over the exposure duration. The concentration terms by depth interval, are presented in Tables 11-5 through 11-7. Exposures from all complete exposure routes were estimated based on the exposure-point concentrations in Table 11-8. Homegrown produce concentrations are presented in Table 11-9. The values for air and groundwater are presented in Sections 27.1 and 27.2, respectively.

Table 11-4. Complete exposure routes for the Tank Farm South Group and associated exposure route depths.

Receptor	Scenario	Potentially complete exposure route and exposure route depths used for exposure-point concentration estimates	Characterized zone of contamination[a]	Complete exposure route?
Onsite worker	Current land use	Inhalation of VOCs 0–15 cm (0–6 in.)	0.6 to 14 m	No
		Inhalation of airborne particulates 0–15 cm (0–6 in.)	(2 to 46 ft)	Yes
		Ingestion of surface soil 0–15 cm (0–6 in.)		Yes
		External radiation 0–1.22 m (0–4 ft)		Yes
Residential	Future land use	Inhalation of VOCs 0–3.05 m (0–10 ft)	0.6 to 14 m	No
		Inhalation of airborne particulates 0–3.05 m (0–10 ft)	(2 to 46 ft)	Yes
		Ingestion of surface soil 0-3.05 m (0–10 ft)		Yes
		Ingestion of homegrown produce 0–3.05 m (0–10 ft)		Yes
		Ingestion of groundwater		Yes
		Dermal contact with groundwater		No
		Inhalation of VOCs from groundwater		No
		External radiation 0–3.05 m (0–10 ft)		Yes
Onsite worker	Future land use	Inhalation of VOCs 0–15 cm (0–6 in.)	0.6 to 14 m	No
		Inhalation of airborne particulates 0–15 cm (0–6 in.)	(2 to 46 ft)	Yes
		Ingestion of surface soil 0-15 cm (0–6 in.)		Yes
		External radiation 0-1.22 m (0–4 ft)		Yes

a. Zone of contamination based on the following previously characterized zones:

CPP-15	=	0.6 to 6.1 m (2 to 20 ft)
CPP-27/33	=	2.1 to 9.8 m (7 to 32 ft)
CPP-58	=	1.8 to 14.0 m (6 to 46 ft).

Table 11-5. Area-weighted concentration terms—Tank Farm South Group (0 to 0.5 ft).

COPCs	Site				Area weighted concentration (mg/kg or pCi/g)
	CPP-15	CPP-27/-33[a]	CPP-58	CPP-88	
Area (ft^2)	700	2000	6800	12868	
Area (m^2)	65.03	185.81	631.76	1195.51	
Aroclor-1260	----	----	----	----	0.00E+00
Benzo(a)pyrene	----	----	----	----	0.00E+00
Aluminum	----	----	----	----	0.00E+00
Arsenic	----	----	----	----	0.00E+00
Manganese	----	----	----	----	0.00E+00
Mercury	----	----	----	----	0.00E+00
Uranium	----	----	----	----	0.00E+00
Am-241	----	----	----	----	0.00E+00
Ce-144	----	----	----	----	0.00E+00
Co-57	----	----	----	----	0.00E+00
Co-58	----	----	----	----	0.00E+00
Co-60	----	----	----	----	0.00E+00
Cs-134	----	----	----	----	0.00E+00
Cs-137	----	----	----	1.41E+01	8.14E+00
Eu-152	----	----	----	----	0.00E+00
Eu-154	----	----	----	----	0.00E+00
Eu-155	----	----	----	----	0.00E+00
H-3	----	----	----	----	0.00E+00
I-129	----	----	----	----	0.00E+00
K-40	----	----	----	----	0.00E+00
Nb-95	----	----	----	----	0.00E+00
Np-237	----	----	----	----	0.00E+00
Pu-238	----	----	----	----	0.00E+00
Pu-239/240	----	----	----	----	0.00E+00
Pu-241	----	----	----	----	0.00E+00
Pu-242	----	----	----	----	0.00E+00
Rh-106	----	----	----	----	0.00E+00
Ru-106	----	----	----	----	0.00E+00
Sb-125	----	----	----	----	0.00E+00
Sr-90	----	----	----	3.55E+00	2.04E+00
Tc-99	----	----	----	----	0.00E+00
U-234	----	----	----	----	0.00E+00
U-235	----	----	----	----	0.00E+00
U-236	----	----	----	----	0.00E+00
U-238	----	----	----	----	0.00E+00

Total Group Area (ft^2) =	22368
CPP-88 area (ft^2) =	12868

a. No contaminant concentrations are reported for CPP-27/33 because the zone of contamination at the site extends from 7 ft to 32 ft bls.

Table 11-6. Area-weighted concentration terms—Tank Farm South Group (0 to 4 ft).

COPCs	Site				Area weighted concentration (mg/kg or pCi/g)
	CPP-15	CPP-27/-33[a]	CPP-58	CPP-88	
Area (ft^2)	700	2000	6800	12868	
Area (m^2)	65.03	185.81	631.76	1195.51	
Aroclor-1260	----	----	----	----	0.00E+00
Benzo(a)pyrene	----	----	----	----	0.00E+00
Aluminum	----	----	----	----	0.00E+00
Arsenic	----	----	----	6.43E+00	3.70E+00
Manganese	----	----	----	----	0.00E+00
Mercury	----	----	----	----	0.00E+00
Uranium	----	----	----	----	0.00E+00
Am-241	----	----	----	----	0.00E+00
Ce-144	----	----	----	----	0.00E+00
Co-57	----	----	----	----	0.00E+00
Co-58	----	----	----	----	0.00E+00
Co-60	----	----	----	----	0.00E+00
Cs-134	----	----	----	----	0.00E+00
Cs-137	4.34E+04	----	----	1.27E+01	1.37E+03
Eu-152	----	----	----	----	0.00E+00
Eu-154	----	----	----	----	0.00E+00
Eu-155	----	----	----	----	0.00E+00
H-3	----	----	----	----	0.00E+00
I-129	----	----	----	----	0.00E+00
K-40	----	----	----	----	0.00E+00
Nb-95	----	----	----	----	0.00E+00
Np-237	----	----	----	----	0.00E+00
Pu-238	----	----	----	----	0.00E+00
Pu-239/240	----	----	----	----	0.00E+00
Pu-241	----	----	----	----	0.00E+00
Pu-242	----	----	----	----	0.00E+00
Rh-106	----	----	----	----	0.00E+00
Ru-106	----	----	----	----	0.00E+00
Sb-125	----	----	----	----	0.00E+00
Sr-90	----	----	----	2.47E+00	1.42E+00
Tc-99	----	----	----	----	0.00E+00
U-234	----	----	----	----	0.00E+00
U-235	----	----	----	----	0.00E+00
U-236	----	----	----	----	0.00E+00
U-238	----	----	----	----	0.00E+00

Total Group Area (ft^2) =	22368
CPP-88 area (ft^2) =	12868

a. No contaminant concentrations are reported for CPP-27/33 because the zone of contamination at the site extends from 7 ft to 32 ft bls.

Table 11-7. Area-weighted concentration terms—Tank Farm South Group (0 to 10 ft).

COPCs	Site				Area weighted concentration (mg/kg or pCi/g)
	CPP-15	CPP-27/-33	CPP-58	CPP-88	
Area (ft^2)	700	2000	6800	12868	
Area (m^2)	65.03	185.81	631.76	1195.51	
Aroclor-1260	—	—	—	—	0.00E+00
Benzo(a)pyrene	—	—	—	—	0.00E+00
Aluminum	—	—	—	—	0.00E+00
Arsenic	—	4.38E+00	—	5.90E+00	3.79E+00
Manganese	—	—	—	—	0.00E+00
Mercury	—	—	—	—	0.00E+00
Uranium	—	—	—	—	0.00E+00
Am-241	—	2.91E+00	1.01E-01	—	2.91E-01
Ce-144	—	—	—	—	0.00E+00
Co-57	—	—	—	—	0.00E+00
Co-58	—	—	—	—	0.00E+00
Co-60	—	—	—	—	0.00E+00
Cs-134	—	—	—	—	0.00E+00
Cs-137	4.34E+04	1.37E+03	4.85E+01	1.18E+01	1.50E+03
Eu-152	—	—	—	—	0.00E+00
Eu-154	—	4.23E+00	1.54E-01	—	4.25E-01
Eu-155	—	—	—	—	0.00E+00
H-3	—	—	—	—	0.00E+00
I-129	—	—	—	—	0.00E+00
K-40	—	—	—	—	0.00E+00
Nb-95	—	—	—	—	0.00E+00
Np-237	—	—	—	—	0.00E+00
Pu-238	—	1.41E+00	2.95E-01	—	2.16E-01
Pu-239/240	—	3.40E-01	4.03E-02	—	4.27E-02
Pu-241	—	—	—	—	0.00E+00
Pu-242	—	—	—	—	0.00E+00
Rh-106	—	—	—	—	0.00E+00
Ru-106	—	—	—	—	0.00E+00
Sb-125	—	—	—	—	0.00E+00
Sr-90	—	4.17E+02	3.34E+01	1.57E+00	4.83E+01
Tc-99	—	—	—	—	0.00E+00
U-234	—	—	—	—	0.00E+00
U-235	—	5.30E-02	6.79E-02	—	2.54E-02
U-236	—	—	—	—	0.00E+00
U-238	—	—	—	—	0.00E+00

Total Group Area (ft^2) = 22368

CPP-88 area (ft^2) = 12868

Table 11-8. Average soil exposure-point concentrations (mg/kg or pCi/g) for land use scenarios.

	Current occupational worker year 0 to year 25		Future occupational worker year 100 to year 125		Future resident year 100 to year 130
COPCs	(0 - 0.5 ft)	(0 - 4 ft)	(0 - 0.5 ft)	(0 - 4 ft)	(0 - 10 ft)
Aroclor-1260	---	---	---	---	---
Benzo(a)pyrene	---	---	---	---	---
Aluminum	---	---	---	---	---
Arsenic	---	3.70E+00	---	3.70E+00	3.79E+00
Manganese	---	---	---	---	---
Mercury	---	---	---	---	---
Uranium[a]	---	---	---	---	1.17E-02
Am-241	---	---	---	---	2.42E-01
Ce-144	---	---	---	---	---
Co-57	---	---	---	---	---
Co-58	---	---	---	---	---
Co-60	---	---	---	---	---
Cs-134	---	---	---	---	---
Cs-137	6.19E+00	1.04E+03	6.23E-01	1.05E+02	1.09E+02
Eu-152	---	---	---	---	---
Eu-154	---	---	---	---	6.19E-05
Eu-155	---	---	---	---	---
H-3	---	---	---	---	---
I-129	---	---	---	---	---
K-40	---	---	---	---	---
Nb-95	---	---	---	---	---
Np-237	---	---	---	---	---
Pu-238	---	---	---	---	8.73E-02
Pu-239/240	---	---	---	---	4.25E-02
Pu-241	---	---	---	---	---
Pu-242	---	---	---	---	---
Ru/Rh-106	---	---	---	---	---
Sb-125	---	---	---	---	---
Sr-90	1.54E+00	1.07E+00	1.42E-01	9.89E-02	3.19E+00
Tc-99	---	---	---	---	---
U-234	---	---	---	---	---
U-235	---	---	---	---	2.54E-02
U-236	---	---	---	---	---
U-238	---	---	---	---	---

a. mg/kg of uranium calculated from pCi/g of uranium isotopes using the equation
mg/kg = pCi/g * 2.795E-12 (mg-mole/kg-pCi-yr) * MW (g/mole) * $t_{1/2}$ (yr).

Table 11-9. Concentrations of COPCs in homegrown produce.

COPCs	Homegrown produce (mg/kg or pCi/g)	Kd (cm^3/g)	COPC input rate from irrigation (mg/g-d or pCi/g-d)	Leach rate constant (d^{-1})
Aroclor-1260	---	7.89E+03	0.00E+00	9.95E-07
Benzo(a)pyrene	---	1.19E+03	0.00E+00	6.57E-06
Aluminum	---	0.00E+00	0.00E+00	2.87E-02
Arsenic	5.91E-03	3.00E+00	8.71E-09	2.40E-03
Manganese	---	5.00E+01	0.00E+00	1.56E-04
Mercury	1.10E-01	1.00E+02	2.91E-08	7.83E-05
Uranium	8.50E-05	6.00E+00	7.04E-09	1.25E-03
Am-241	3.76E-05	3.40E+02	6.08E-06	2.31E-05
Ce-144	---	5.00E+02	0.00E+00	1.57E-05
Co-57	---	1.00E+01	0.00E+00	7.64E-04
Co-58	---	1.00E+01	0.00E+00	7.64E-04
Co-60	---	1.00E+01	0.00E+00	7.64E-04
Cs-134	---	5.00E+02	0.00E+00	1.57E-05
Cs-137	2.00E-01	5.00E+02	4.12E-05	1.57E-05
Eu-152	---	3.40E+02	0.00E+00	2.31E-05
Eu-154	7.18E-10	3.40E+02	0.00E+00	2.31E-05
Eu-155	---	3.40E+02	0.00E+00	2.31E-05
H-3	---	0.00E+00	6.22E-04	2.87E-02
I-129	3.85E-06	0.00E+00	3.26E-05	2.87E-02
K-40	---	1.50E+01	0.00E+00	5.14E-04
Nb-95	---	0.00E+00	0.00E+00	2.87E-02
Np-237	3.19E-05	0.00E+00	8.36E-06	2.87E-02
Pu-238	4.25E-06	2.20E+01	0.00E+00	3.53E-04
Pu-239/240	4.93E-05	2.20E+01	5.84E-07	3.53E-04
Pu-241	8.49E-09	2.20E+01	9.37E-08	3.53E-04
Pu-242	3.60E-09	2.20E+01	3.88E-10	3.53E-04
Ru/Rh-106	---	0.00E+00	0.00E+00	2.87E-02
Sb-125	---	5.00E+01	0.00E+00	1.56E-04
Sr-90	4.26E-02	1.20E+01	5.63E-05	6.40E-04
Tc-99	4.56E-01	0.00E+00	1.67E-04	2.87E-02
U-234	2.73E-05	6.00E+00	2.63E-06	1.25E-03
U-235	2.69E-05	6.00E+00	9.27E-08	1.25E-03
U-236	6.93E-07	6.00E+00	6.68E-08	1.25E-03
U-238	2.44E-05	6.00E+00	2.35E-06	1.25E-03

11.4.3 Description of Source Estimates for Surface Exposure and Groundwater Modeling Use

The purpose of this subsection is two-fold. First, to compare the approach to defining the source estimate for use in both the surface exposure assessment and the groundwater model. This comparison was done for each site within this group and was accomplished by comparing the site soil data in Table 11-7 to the soil data used to estimate the source for use in the groundwater model, which can be found in Tables 5-39 and 5-40 of Appendix F. The benefit of these comparisons is to relate both source estimates and explain any apparent differences. Secondly, the results of the screened ORIGEN runs summarized in Section 4.4 were used to help identify any potential soil-related data gaps comparing ORIGEN results to the field investigation soil results and/or the contaminant inventory at each site. This comparison was based on the full inventory of contaminants in the screening tables in Section 5 before implementing the screening steps shown therein. The results of these comparisons are described for each site in the following paragraphs. The results of this comparison for perched water and the SRPA are reported at the end of Section 4.4.

The soil concentration for Cs-137 in Table 11-7 for site CPP-15 was used to develop the zone 1W and zone 1E source estimate for groundwater use, since the Cs-137 detection occurred within the defined depth range of 2 to 10 ft below ground surface. The CPP-15 zone 2 concentration of Cs-137 (5.86E+05 pCi/g) was detected within the 10 to 20 ft (3.05-6.10 m) depth range. As shown in Table 5-40 of Appendix F, the zone 2 source estimate for groundwater use also included Am-241, Eu-154, Np-237, Pu-238, Pu-239/240, Sr-90 [added], Tc-99, and U-235 which were measured at depths that fell out of the 0 to 10 ft. residential intrusion depth interval for soil source estimation. Based on a comparison of the radionuclides that were analyzed in site soils against the potential inventory as defined by the screened ORIGEN results (Table 4-7), Pu-241 was not part of the soil sampling analytical suite. The implication is that this radionuclide may be present and is currently not part of the soil contaminant inventory.

The CPP-27/33 source estimate for groundwater model use defined in Table 5-40 of Appendix F was based on almost the same soil COPC's in Table 11-7. The surface soil source estimate did not include cadmium, chromium, and mercury because these screened out in Table 5-22. The soil concentrations used to estimate both sources differ in some cases mainly because the total depth interval to evaluate future residential intrusion exposure is 0 to 10 feet bgs., while the soil source estimate for groundwater use was based on a thicker depth interval that included soil contaminant measurements of samples collected deeper than 10 feet bgs. It should be noted that the soil source estimate in Table 5-40 of Appendix F includes cadmium and Eu-154 but these were not included in the model because they failed the groundwater screening process. Based on a comparison of the radionuclides that were analyzed in site soils against the potential inventory as defined by the screened ORIGEN results (Table 4-7) Pu-241 was not part of the soil sampling performed at this site. The implication is that this radionuclide may be present and is currently not part of the soil contaminant inventory.

The CPP-58 source estimate for groundwater model use defined in Table 5-40 of Appendix F was based on the same soil COPC's in Table 11-7. The surface soil source estimate did not include mercury because it screened out in Table 5-40. The soil concentrations used to estimate both sources differ in some cases mainly because the total depth interval to evaluate future residential intrusion exposure is 0 to 10 feet bgs., while the soil source estimate for groundwater use was based on a thicker depth interval that included soil contaminant measurements of samples collected deeper than 10 feet bgs. The concentrations for Am-241, Cs-137, Eu-154, and Sr-90 were affected by these depth assumptions. Based on a comparison of the radionuclides that were analyzed in site soils against the potential inventory as defined by the screened ORIGEN results (Table 4-7), Pu-241 was not part of the soil sampling suite, which implies that this radionuclide may be present but is currently not part of the soil contaminant inventory.

11.4.4 Risk Estimates

The results of this evaluation under current and future land use are presented in Sections 11.4.4.1 and 11.4.4.2. For each receptor, the results are summarized in Tables 11-10 through 11-15.

11.4.4.1 Current Land Use. As indicated in Table 11-10, total cancer risk to the current onsite worker from exposure to site-related chemicals in surface soil is estimated to be 1E-02. The risk is attributed to external radiation exposure with the primary contaminant of concern (COC) being Cs-137 (1E-02). Table 11-11 indicates that the total noncarcinogenic hazard index to the current worker is estimated to be 0E+00. There are no hazard indices above unity for the current onsite worker.

11.4.4.2 Future Land Use. As Table 11-12 indicates, the total cancer risk to the future onsite worker from exposure to site-related chemicals in surface soil is estimated to be 1E-03. The risk is attributed to external radiation exposure with the primary COC being Cs-137 (1E-03). Table 11-13 indicates the total noncarcinogenic hazard index to the future onsite worker is 0E+00. There are no hazard indices above unity from the soil ingestion exposure route for the future onsite worker. As indicated in Table 11-14, the total cancer risk for the future resident from exposure to site-related chemicals in soil is estimated to be 6E-03. Within the soil ingestion exposure route, the major contributor is Cs-137 (4E-06). The major risk from ingestion of homegrown produce is from Cs-137 (9E-04) and Sr-90 (1E-04). External radiation exposure has Cs-137 (6E-03) as the primary contributor to risk. As shown in Table 11-15, the total noncarcinogenic hazard index to the future resident is estimated to be 1E-01. There are no hazard indices above unity for the future resident.

11.5 Uncertainties

This section describes the limitations and uncertainties specific to the site characterization of the Tank Farm South Group. Sources of uncertainty associated with site characterization include data quality, COPC identification, concentration term estimation, and assumptions regarding the lateral and vertical extent of COPC occurrence. In the risk assessment, the most significant uncertainties are due to the selection process of COPCs, the toxicity values used, and the assumptions used during the exposure assessment. The following paragraphs will discuss important sources of site-specific uncertainty in greater detail.

Sampling and analysis uncertainties are related to quality problems that may result in qualified and rejected results (Section 3). Qualified results are considered estimates of the concentration in the sample and, for all practical purposes, useable for their intended purpose although they could be biased high or low. Rejected results are considered unusable, thus limiting the size of the useable data set. For the Tank Farm South Group, no data points were rejected based on the method validation as documented in the Limitation and Validation (L&V) Reports, thus making this possible source of uncertainty insignificant.

Uncertainty associated with the chemical screening process (Section 5.2) results from using the maximum concentration for chemicals detected in the ECAs in the background comparison step, retaining chemicals detected as COPCs because there is not a corresponding background value, and retaining chemicals as COPCs for which there is no toxicity information available.

In most cases, the COPC identification process used the maximum concentration for a chemical detected in the background comparison step, regardless of its magnitude above background. The use of the maximum can result in the identification of COPCs that have concentrations only slightly above background. For the Tank Farm South Group, arsenic was the only COPC that fell into this category. The maximum arsenic concentration for the Tank Farm South Group was observed at site CPP-33 (6.8 mg/kg). The background value for arsenic is 5.8 mg/kg. This results in an increase in the number of COPCs considered in

Table 11-10. Cancer risk to the current onsite worker.

COPCs	Ingestion of soil	External radiation exposure	Total risks
Aroclor-1260	---	---	---
Benzo(a)pyrene	---	---	---
Aluminum	---	---	---
Arsenic	---	---	---
Manganese	---	---	---
Mercury	---	---	---
Uranium	---	---	---
Am-241	---	---	---
Ce-144	---	---	---
Co-57	---	---	---
Co-58	---	---	---
Co-60	---	---	---
Cs-134	---	---	---
Cs-137	5E-08	1E-02	1E-02
Eu-152	---	---	---
Eu-154	---	---	---
Eu-155	---	---	---
H-3	---	---	---
I-129	---	---	---
K-40	---	---	---
Nb-95	---	---	---
Np-237	---	---	---
Pu-238	---	---	---
Pu-239/240	---	---	---
Pu-241	---	---	---
Pu-242	---	---	---
Ru/Rh-106	---	---	---
Sb-125	---	---	---
Sr-90	2E-08	NTD	2E-08
Tc-99	---	---	---
U-234	---	---	---
U-235	---	---	---
U-236	---	---	---
U-238	---	---	---
Total cancer risks by route:	7E-08	1E-02	1E-02

"---" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 11-11. Noncarcinogenic hazard to the current onsite worker.

COPCs	Ingestion of soil	External radiation exposure	Total HIs
Aroclor-1260	----	----	----
Benzo(a)pyrene	----	----	----
Aluminum	----	----	----
Arsenic	----	----	----
Manganese	----	----	----
Mercury	----	----	----
Uranium	----	----	----
Am-241	----	----	----
Ce-144	----	----	----
Co-57	----	----	----
Co-58	----	----	----
Co-60	----	----	----
Cs-134	----	----	----
Cs-137	----	----	----
Eu-152	----	----	----
Eu-154	----	----	----
Eu-155	----	----	----
H-3	----	----	----
I-129	----	----	----
K-40	----	----	----
Nb-95	----	----	----
Np-237	----	----	----
Pu-238	----	----	----
Pu-239/240	----	----	----
Pu-241	----	----	----
Pu-242	----	----	----
Ru/Rh-106	----	----	----
Sb-125	----	----	----
Sr-90	----	----	----
Tc-99	----	----	----
U-234	----	----	----
U-235	----	----	----
U-236	----	----	----
U-238	----	----	----
Total hazard indices by route:	0E+00	0E+00	0E+00

"----" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. All noncarcinogenic contamination at the Tank Farm South Group is buried more than 0.5 ft bls, so there is no calculated hazard index for workers at the site.
b. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 11-12. Cancer risk to the future onsite worker.

COPCs	Ingestion of soil	External radiation exposure	Total risks
Arocior-1260	—	—	—
Benzo(a)pyrene	—	—	—
Aluminum	—	—	—
Arsenic	—	—	—
Manganese	—	—	—
Mercury	—	—	—
Uranium	—	—	—
Am-241	—	—	—
Ce-144	—	—	—
Co-57	—	—	—
Co-58	—	—	—
Co-60	—	—	—
Cs-134	—	—	—
Cs-137	5E-09	1E-03	1E-03
Eu-152	—	—	—
Eu-154	—	—	—
Eu-155	—	—	—
H-3	—	—	—
I-129	—	—	—
K-40	—	—	—
Nb-95	—	—	—
Np-237	—	—	—
Pu-238	—	—	—
Pu-239/240	—	—	—
Pu-241	—	—	—
Pu-242	—	—	—
Ru/Rh-106	—	—	—
Sb-125	—	—	—
Sr-90	2E-09	NTD	2E-09
Tc-99	—	—	—
U-234	—	—	—
U-235	—	—	—
U-236	—	—	—
U-238	—	—	—
Total cancer risks by route:	7E-09	1E-03	1E-03

"—" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 11-13. Noncarcinogenic hazard to the future onsite worker.

COPCs	Ingestion of soil	External radiation exposure	Total HIs
Aroclor-1260	---	---	---
Benzo(a)pyrene	---	---	---
Aluminum	---	---	---
Arsenic	---	---	---
Manganese	---	---	---
Mercury	---	---	---
Uranium	---	---	---
Am-241	---	---	---
Ce-144	---	---	---
Co-57	---	---	---
Co-58	---	---	---
Co-60	---	---	---
Cs-134	---	---	---
Cs-137	---	---	---
Eu-152	---	---	---
Eu-154	---	---	---
Eu-155	---	---	---
H-3	---	---	---
I-129	---	---	---
K-40	---	---	---
Nb-95	---	---	---
Np-237	---	---	---
Pu-238	---	---	---
Pu-239/240	---	---	---
Pu-241	---	---	---
Pu-242	---	---	---
Ru/Rh-106	---	---	---
Sb-125	---	---	---
Sr-90	---	---	---
Tc-99	---	---	---
U-234	---	---	---
U-235	---	---	---
U-236	---	---	---
U-238	---	---	---
Total hazard indices by route:	0E+00	0E+00	0E+00

"---" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. All noncarcinogenic contamination at the Tank Farm South Group is buried more than 0.5 ft bls, so there is no calculated hazard index for workers at the site.
b. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 11-14. Cancer risk to the future onsite resident.

COPCs	Ingestion of soil	Ingestion of homegrown produce	External radiation exposure	Total risks
Aroclor-1260	—	—	—	—
Benzo(a)pyrene	—	—	—	—
Aluminum	—	—	—	—
Arsenic	9E-06	1E-06	—	1E-05
Manganese	—	—	—	—
Mercury	—	NTD	—	—
Uranium	NTD	NTD	—	—
Am-241	1E-07	2E-09	3E-08	1E-07
Ce-144	—	—	—	—
Co-57	—	—	—	—
Co-58	—	—	—	—
Co-60	—	—	—	—
Cs-134	—	—	—	—
Cs-137	4E-06	1E-06	6E-03	6E-03
Eu-152	—	—	—	—
Eu-154	7E-13	1E-15	8E-09	8E-09
Eu-155	—	—	—	—
H-3	—	—	—	—
I-129	—	1E-10	—	1E-10
K-40	—	—	—	—
Nb-95	—	—	—	—
Np-237	—	2E-09	—	2E-09
Pu-238	3E-08	2E-10	5E-11	3E-08
Pu-239/240	2E-08	3E-09	2E-11	2E-08
Pu-241	—	5E-13	—	5E-13
Pu-242	—	2E-13	—	2E-13
Ru/Rh-106	—	—	—	—
Sb-125	—	—	—	—
Sr-90	2E-07	4E-07	NTD	6E-07
Tc-99	—	1E-07	—	1E-07
U-234	—	2E-10	—	2E-10
U-235	2E-09	2E-10	2E-07	2E-07
U-236	—	5E-12	—	5E-12
U-238	—	3E-10	—	3E-10
Total cancer risks by route:	1E-05	3E-06	6E-03	6E-03

"—" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 11-15. Noncarcinogenic hazard to the future onsite resident.

COPCs	Ingestion of soil	Ingestion of homegrown	External radiation exposure	Total HIs
Aroclor-1260	—	—	—	—
Benzo(a)pyrene	—	—	—	—
Aluminum	—	—	—	—
Arsenic	4E-09	5E-03	—	5E-03
Manganese	—	—	—	—
Mercury	—	1E-01	—	1E-01
Uranium	1E-10	7E-06	—	7E-06
Am-241	—	—	—	—
Ce-144	—	—	—	—
Co-57	—	—	—	—
Co-58	—	—	—	—
Co-60	—	—	—	—
Cs-134	—	—	—	—
Cs-137	—	—	—	—
Eu-152	—	—	—	—
Eu-154	—	—	—	—
Eu-155	—	—	—	—
H-3	—	—	—	—
I-129	—	—	—	—
K-40	—	—	—	—
Nb-95	—	—	—	—
Np-237	—	—	—	—
Pu-238	—	—	—	—
Pu-239/240	—	—	—	—
Pu-241	—	—	—	—
Pu-242	—	—	—	—
Ru/Rh-106	—	—	—	—
Sb-125	—	—	—	—
Sr-90	—	—	—	—
Tc-99	—	—	—	—
U-234	—	—	—	—
U-235	—	—	—	—
U-236	—	—	—	—
U-238	—	—	—	—
Total hazard indices by route:	4E-09	1E-01	0E+00	1E-01

"—" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

the remedial investigation/Baseline Risk Assessment (RI/BRA) and a possible overestimation of risk because of inclusion of COPCs with concentrations that are likely within the true background population.

One source of uncertainty related to the background comparison step in the chemical screening process relates to chemicals for which no background concentration exists. For example, fluoride, nitrate, and several radionuclides were not characterized as part of the Rood et al., background study. For the Tank Farm South Group, the following COPCs have no corresponding background concentration: Eu-154, Np-237, Tc-99, and U-235. This results in an increase in the number of COPCs considered in the RI/BRA and a possible overestimation of risk because the observed concentrations may be within the background population.

Some concentration estimates are based on the 95% UCL for the site, or the area-weighted average 95% UCLs for sites that have been grouped. When the 95% UCL (i.e., the concentration term estimate) of a COPC is below the corresponding background value, this results in an increase in the number of COPCs in the RI/BRA and a possible overestimation of risk because the results are likely within the background range. This source of uncertainty stems from the use of maximum concentrations when identifying the COPCs for a specific site. For the Tank Farm South Group, arsenic and Pu-239/240 concentration estimates were below background but included as COPCs in the RI/BRA. The area-weighted 95% UCL for arsenic was 3.9 mg/kg. The background value for arsenic is 5.8 mg/kg. The area-weighted 95% UCL for Pu-239/240 was 0.04 pCi/g. The background value for Pu-239/240 is 1 pCi/g. This results in an increase in the number of COPCs considered in the RI/BRA and a possible overestimation of risk because of inclusion of COPCs with concentrations that are likely within the true, background population.

For the Tank Farm South Group, thallium and zirconium were retained as COPCs for the RI/BRA. There are no toxicity values in Integrated Risk Information System (IRIS), Health Effects Assessment Summary Tables (HEAST), or EPA Region III publications for these chemicals. Uses of thallium include thallium salts, mercury alloys, low-melting glasses, rodenticides, photoelectric applications, and electrodes in dissolved oxygen analyzers (Sax and Lewis, 1987). Zirconium is used in coating nuclear-fuel rods, corrosion-resistant alloys, special welding fluxes, and laboratory crucibles. Excluding thallium and zirconium from the BRA may underestimate the risk. The impact is not quantifiable because there are no toxicity values for these chemicals.

With respect to nature and extent, a source of uncertainty for the Tank Farm South Group is related to the extrapolation of sampling results from one portion of a site to the other. For example, at site CPP-15, sampling results from an excavation in the western half of the site were projected to the eastern half of the site due to the lack of sampling data. Likewise, sampling results from site CPP-58E were used to estimate contaminant concentrations at site CPP-58W as the latter site is now located beneath a building. This use of sampling data may overestimate or underestimate the source of contamination at these sites.

Another source of uncertainty may be associated with the contaminant inventories used for the groundwater modeling and residential intrusion exposure at every sub-area. Section 11.4.3 identifies radionuclides potentially missing from these inventories. The implication of these potential data gaps is that the source estimates could be underestimated. Pu-241 is the only contaminant shown by the screened ORIGEN results to be potentially missing from both source estimates. This is a minor concern because the results of the groundwater model show that contaminants with large travel times to the SRPA that also have short half-lives (i.e., 14.4. years) are not of groundwater concern.

11.6 Conclusions and Recommendations

The transfer of HLLW between tanks within the Tank Farm Group has led to significant releases to the surrounding soils over the past 40 years of operation. The results of the risk assessment under current land

use for the Tank Farm South Group indicate that the estimated increased cancer risk from exposure to group-related contaminants is well above the EPA-recommended target range and therefore, unacceptable. The increased cancer risk to hypothetical future onsite workers and residents were also found to be well above the EPA-recommended target range. The noncarcinogenic hazard for all receptors was found to be below the EPA hazard index goal of one. These estimates do not include the contributions associated with the air and groundwater pathways. The total increased cancer and hazard incidence to humans will be reported in Section 27. It should be noted that the cancer risk and hazard estimates at this group may be overestimated for reasons discussed in Sections 7 and 11.5. For example, the soil exposure point concentrations for CPP-15 were formulated using data from one end of the site to represent contaminant levels in the opposite end knowing that some or most of the soil in that portion of the site may have been removed during a recent electrical upgrade project. This is of particular concern because the risk estimates for the group are driven by the conservative source estimate at this site. Likewise, data from CPP-58E were used at CPP-58W for purposes of estimating soil exposure point concentrations. In addition, the evaluation of exposure to current onsite workers did not consider the benefits of a radiation protection program currently implemented at the INEL that limits worker exposure to an acceptable level. Given these limitations and uncertainties, the exposure from direct soil pathways alone is still expected to be severe enough that some type of future response action should be considered to mitigate adverse impacts to human health and the environment. However, the response action should be designed so that it is protective of human and environmental receptors under future land use.

11.7 References

Golder Associates, 1991, *Report for the Idaho Chemical Processing Plant Drilling and Sampling Program at the HLLW Tank Farm and Land Disposal Unit CPP-33*, Prepared for EG&G Idaho, Inc./Westinghouse Idaho Nuclear Company, Idaho Falls, Idaho.

Rood, S. M., G. A. Harris, and G. J. White, 1995, *Background Dose Equivalent Rates and Surficial Soil Metal and Radionuclide Concentrations for the Idaho National Engineering Laboratory*, INEL-94/0250, Revision 0, February.

WINCO, 1993, *Final Track 2 Summary Report for Operable Unit 3-08 (Tank Farm Area II)*, Revision 3, July.

Chapter 12

12. WASTE CALCINING FACILITY (WCF) GROUP RESULTS (CPP-35, CPP-36, CPP-85, and CPP-91)

The Waste Calcining Facility (WCF) group includes sites CPP-35, CPP-36, CPP-85, and CPP-91 (Figure 12-1). The sites generally consist of areas of soil contaminated by releases of radioactive wastes associated with the WCF. This section describes the nature and extent of contamination at the sites within the WCF group as well as provides the results of the human health risk assessment (HHRA) for the group.

12.1 Site CPP-35

Site CPP-35 consists of soil contaminated by a release of decontamination solution into the air from the calcine vessel. This section describes the nature and extent of contamination from this release.

12.1.1 Site Description

The release of decontamination solution through the air transport system occurred during the decontamination operation of calcine vessel WC-102 on May 16, 1972. According to a letter describing the incident ("Summary of WCF Incident," June 14, 1972), approximately 40 L (10 gal) of decontamination solution that contained an estimated 10 Ci of beta activity was released. The release resulted in radiation levels in the soil as high as 20 to 25 R/hr (beta-gamma) near the decontamination line and decreased to 100 mR/hr (beta-gamma) at a distance of approximately 15.2 m (50 ft) from the line. Radiation levels at a distance of a few hundred feet from the release were at background levels (WINCO, 1993).

12.1.2 Investigative Results

The cleanup undertaken after the spill involved the removal of approximately 7.5 Ci of activity in 10 tons of gravel that was disposed of at the Radioactive Waste Management Complex (RWMC). During the removal operation, the highest concentration of activity was located approximately 1.2 to 1.8 m (4 to 6 ft) from the end of the pipe and had penetrated greater than 0.6 m (2 ft) into the gravel. Following cleanup, the residual radiation levels in the soil were generally in the range of 5 to 25 mR/hr with highs of 100 to 200 mR/hr. It was estimated that approximately 2.5 Ci of radioactivity remained at the site.

Following the release, samples were collected of the contaminated soil. The results of the analyses from the soil had the following radionuclide abundances:

Radionuclide	Percent
Sr-90	31
Ru-106	2
Cs-134	4
Cs-137	55
Ce-144	8

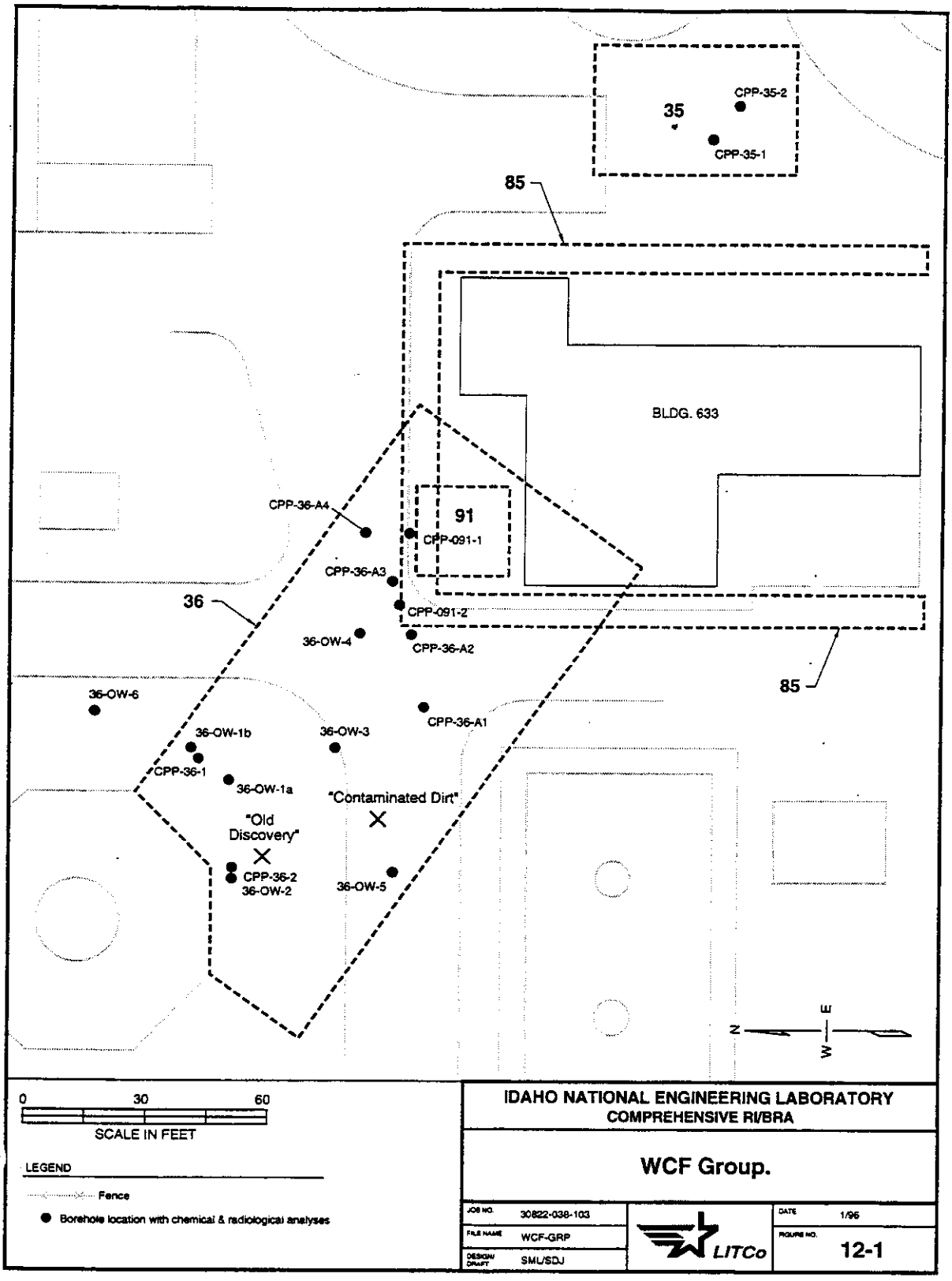


Figure 12-1. WCF group.

Based on these results, only Sr-90 and Cs-137 would have a present day concentration that is detectable due to radioactive decay. It is estimated that approximately 1.4 Ci of these two isotopes may be present at the site from this release (WINCO, 1993).

During the Track 2 investigation, two boreholes (CPP-35-1 and CPP-35-2) were drilled to collect soil samples for analysis and five screening boreholes (35-AD-1 through 35-AD-5) were drilled to collect subsurface measurements of beta-gamma radiation and organic vapors. The soil samples collected from the two boreholes were analyzed for target analytical list (TAL) metals, fluoride, pH, nitrate/nitrite, and radionuclides.

Soil samples for laboratory analysis were collected from boreholes CPP-35-1 and CPP-35-2 with the sample intervals corresponding to the zones having the highest measured beta-gamma radiation. The results from these boring are summarized in Table 12-1. Based on chemical screening in Section 5.2, the following COPCs were identified for site CPP-35: Sr-90, Cs-137, Eu-154, U-235, Pu-238, Pu-239, and Am-241. In general, the higher levels of contamination were detected from the land surface to approximately 1.8-m (6-ft) below ground surface (bgs), with significantly lower contamination detected to a depth of 55 m (18 ft). Below a depth of 18 ft, the concentrations for all contaminants were near, or below, background levels.

The gross alpha activity ranged from 3.65±0.653 to 202±24.3 pCi/g with the results from nine samples exceeding the background concentration of 20 pCi/g. The isotopic analysis for Sr-90 detected concentrations ranging from 7.52±0.707 to 3,240±25.8 pCi/g with the highest concentrations occurring at depths less than 1.8 m (6 ft).

The results from gamma analysis detected Cs-137 in all samples and Eu-154 in five of the samples analyzed. Cs-137 and Eu-154 were detected above background levels: Cs-137 concentrations ranged from 0.214+0.017 to 8,640+622 pCi/g and Eu-154 concentrations ranged from 0.318+0.076 to 11.8+0.937 pCi/g.

Other radiological COPCs detected were U-235, Pu-238, Pu-239, and Am-241. Activities reached maximum levels of 0.0716±0.0129, 13.2±0.542, 0.725±9,9514, and 1.21±0.08 pCi/g, respectively. None of these COPCs were detected above background at depths below 2.1 m (7 ft).

12.1.3 Nature and Extent of Soil Contamination

The results of the field radiation surveys from the five screening boreholes are shown in Figure 4-5 of the *Final Track 2 Summary Report for Operable Unit 3-08 (Tank Farm Area II)* (WINCO, 1993). From these profiles, it appears that elevated radiation levels, as high as 2.5 mR/hr, are present near the surface. These radiation levels decrease to near background levels (±0.1 mR/hr beta-gamma) at a depth of approximately 1.8- to 2.1-m (6- to 7-ft) bgs. The presence of shallow contamination is consistent with the surface release where some downward migration of contamination has occurred.

Based on investigative results, several radiological COPCs, some at high activity/concentration levels, were identified for site CPP-35 in Section 5.2. Sr-90 and Cs-137 are the most widely distributed COPCs; maximum activities of these COPCs range as high as 3,240±25.8 pCi/g and 8,640±622 pCi/g, respectively. Other radionuclides detected include Eu-154 and Pu-238, at maximum activity levels of 11.8±0.937 pCi/g and 13.2±0.542 pCi/g, respectively.

Table 12-1. Summary statistics for CPP-35, CPP-633 decontamination spill.

COPCs	Concentration (mg/kg or pCi/g)		Arithmetic mean	Standard deviation	Number of samples	Number of detects	Frequency of detection	INEL background (mg/kg or pCi/g)	Number greater than background
	Minimum detected	Maximum detected							
Am-241	0.138 +/- 0.028	1.21 +/- .085	5.17E-01	6.01E-01	3	3	100%	0.011	3
Cs-137	0.214 +/- 0.017	8640 +/- 622	6.63E+02	2.14E+03	16	16	100%	0.82	10
Eu-154	0.318 +/- 0.076	11.8 +/- 0.937	3.37E+00	4.81E+00	5	5	100%	NA	NA
Pu-238	0.793 +/- 0.051	13.2 +/- 0.542	5.44E+00	6.77E+00	3	3	100%	0.0049	3
Pu-239/240	0.0524 +/- 0.01	0.725 +/- 0.05	3.21E-01	NA	3	3	100%	0.1	2
Sr-90	7.52 +/- 0.707	3240 +/- 25.8	5.22E+02	1.04E+03	9	9	100%	0.49	9
U-235	0.0516 +/- 0.00918	0.0716 +/- 0.0129	6.03E-02	1.03E-02	3	3	100%	NA	NA

NA - Not applicable/available

The zone of contamination at CPP-35 is estimated to be 6.1 m (20.0 ft) thick, extending from the ground surface down to 6.1 m (20.0 ft) bgs. The area of CPP-35, shown on Figure 12-1 is 150 m^2 (1,620 ft^2).

12.2 Site CPP-36

Site CPP-36 consists of contaminated soil southeast of the ICPP stack (Figure 12-1). This section describes the nature and extent of contamination related to this site.

12.2.1 Site Description

The contamination at site CPP-36 is the result of at least three separate releases that were discovered on four different occasions. A summary of the historical releases at this site is:

- The earliest documented reports of contaminated soil are from May 1968 when three men were contaminated while digging near the ICPP stack. The contamination was apparently in the vicinity of the spot marked as "Old Discovery" in Figure 12-1. No indication of the depth at which the contamination was encountered was provided in the reports. The ensuing investigation suggested that the contaminated soil may be the result of an earlier leak from a nearby contaminated pipe.

- In 1970, the calciner offgas lines between the WCF and the stack were excavated. Highly contaminated soil (up to 20 R/hr) was encountered at a depth of 1.8 m (6 ft) beneath Olive Avenue. The exact location of the release is unknown. According to records, the contaminated soil was excavated from the site and disposed of at the RWMC. Clean fill was then used as backfill.

- In October 1974, contamination was again encountered under Olive Avenue during excavation for installation of replacement lines for PSA-3001 and PWA-3002. This contamination apparently was the result of waste that flowed out of a model orifice corroded by nitric acid. The waste was probably from liquids being transferred from tank WC-119 (Sump Tank at Waste Calcining Facility) and tank WC-102 [process equipment waste (PEW) Evaporator].

- In November 1974, 2,840 L (750 gal) of solution containing an estimated 4 Ci of total activity leaked into valve pit MAH-OGF-P-04.

12.2.2 Investigative Results

Two quantitative sampling events were undertaken at this site before the Track 2 investigation. These sampling events are summarized as follows:

- In 1974, three samples were collected from the excavation and analyzed for radionuclides. The locations of two of these samples are designated with an "X" in Figure 12-1. The location of the third sample and the depths from which any of the samples were collected cannot be established from available reports. As a result, these analyses are of limited use.

- Nine samples were collected from four boreholes during a 1991assessment of the potential risk from excavating soils in the area (Golder Associates, 1991). These boreholes are designated as A1 through A4 in Figure 12-1. The four boreholes were drilled to a maximum depth of 1.8 m (6 ft). The samples were analyzed for VOCs, metals, and radionuclides. VOCs were not measured above detection levels.

The Track 2 investigation involved installing seven "observation wells" to measure subsurface radiation levels and the drilling and sampling of two boreholes. The seven "observation wells" were installed throughout the site to better define the extent of contamination (Figure 12-1). These "observation wells" were installed at depths ranging from 3.2- to 12.6-m (10.5- to 41.3-ft) bgs. Boreholes CPP-36-1 and CPP-36-2 were then drilled to 3.6-m (11.8-ft) and 4.7-m (15.5-ft) bgs, respectively; and were drilled adjacent to "observation wells" CPP-36-OW-1 and CPP-36-OW-2, respectively (Figure 12-1). Samples from the boreholes were analyzed for selected metals, nitrate and nitrite, fluoride, pH, and radionuclides. The results of the analyses for the COPCs identified in the chemical screening are summarized in Table 12-2. Based on the screening in Section 5.2, the following COPCs were identified for site CPP-36: K-40, Sr-90, Cs-134, Cs-137, Eu-154, U-234, U-235, U-238, Pu-238, Pu-239, and Am-241.

The relationship between the radiation levels measured in "observation wells" CPP-36-OW-1b and CPP-36-OW-2 to the Cs-137 concentrations in the samples from boreholes CPP-36-1 and CPP-36-2 is shown in Figure 4-7 in the OU 3-08 Track 2 Report (WINCO, 1993). The best fit line to these data has a slope of 164 pCi/g (Cs-137) per mR/hr gamma and a correlation coefficient of 0.96. This relationship is consistent with the waste stream where the primary gamma-emitting radionuclide is Cs-137.

Gross alpha activity in the samples collected from the boreholes ranged from 8.43- to 27,500 pCi/g. The results from four samples exceeded background (20 pCi/g). Elevated alpha activity was detected in one sample from borehole CPP-36-1 between 3.0- to 3.6-m (10- and 11.8-ft) bgs (27,500 pCi/g), and in three samples from CPP-36-2 between 3.0- to 3.6-m (10- to 12-ft) bgs, 3.6- to 4.0-m (12- to 13-ft) bgs, and 4.3- to 4.6-m (14- to 15-ft) bgs. Isotopic analysis of these samples detected U-234, U-235, U-238, Pu-238, Pu-239, and Am-241. U-238 and U-234 concentrations were near normal background values (1.3 pCi/g each) in all samples. Gross beta activity ranged from 78.7 to 251,000 pCi/g. The results from all samples exceeded background (30 pCi/g). Isotopic analysis detected Sr-90 at concentrations between 11.4 and 51,300 pCi/g.

Gamma analysis detected K-40 and Cs-137 in all samples, and Eu-154 in all samples except one. K-40 levels were at expected background values. Cs-137 concentrations ranged from 20.4 to 408,000 pCi/g, and all samples were above background (1.08 pCi/g). Eu-154 concentrations varied from 0.11 to 4,740 pCi/g with the higher Eu-154 concentrations correlating with the higher concentrations from other gamma-emitting isotopes.

As discussed earlier, the contamination at CPP-36 appears to be the result of a series of releases. The data collected during the Track 2 investigation indicate that three basic types of contamination can be distinguished:

Type 1: Low activity contamination
Type 2: High activity contamination in boring CPP-36-2
Type 3: High activity contamination in boring CPP-36-1.

Table 12-2. Summary statistics for CPP-36, transfer line leak from CPP-633 to W1-102.

COPCs	Concentration (mg/kg or pCi/g) Minimum detected	Maximum detected	Arithmetic mean	Standard deviation	Number of samples	Number of detects	Frequency of detection	INEL background (mg/kg or pCi/g)	Number greater than background
Am-241	1.03 +/- 0.0659	763 +/- 24.3	3.36E+02	3.95E+02	5	5	100%	0.011	4
Cs-134	0.384[a]	868.8[a]	3.03E+02	4.90E+02	3	3	100%	NA	NA
Cs-137	20.4 +/- 1.56	5174400[a]	2.75E+05	1.08E+06	23	23	100%	0.82	23
Eu-154	0.0875 +/- 0.017	5037[a]	7.98E+02	1.76E+03	14	14	100%	NA	NA
K-40	14.4 +/- 0.798	33.7 +/- 7.62	2.04E+01	4.90E+00	12	12	100%	NA	NA
Pu-238	5.11 +/- 0.223	8180 +/- 272	2.27E+03	3.96E+03	4	4	100%	0.0049	4
Pu-239/240	0.86 +/- 0.059	324.0 +/- 10.9	9.25E+01	3.70E+00	4	4	100%	0.1	4
Sr-90	0.29[a]	139750[a]	8.84E+03	2.99E+04	24	24	100%	0.49	23
U-234	0.967 +/- 0.0545	2.81 +/- 0.143	1.58E+00	8.52E-01	4	4	100%	1.44	2
U-235	0.0444 +/- 0.0111	0.0995 +/- 0.0289	6.99E-02	2.56E-02	4	4	100%	NA	NA
U-238	0.948 +/- 0.0538	1.84 +/- 0.108	1.24E+00	4.07E-01	4	4	100%	1.4	1

NA - Not applicable/available

a. Value taken from page 4-40 of the OU 3-08 Track 2 document (WINCO, 1993)

These types of contamination are distinguished on the following basis:

- Isotopic ratios for a single element are not readily fractionated by physical or chemical means, and should remain fairly constant for a given discharge. Pu-238/Pu-239 ratios from the most contaminated intervals in boreholes CPP-36-1 and CPP-36-2 were 25.2 and 20.7, respectively. The Pu-238/Pu-239 ratios from two samples having low activity contamination from CPP-36-2 collected between 3.0- and 4.0-m (10- and 13-ft) bgs were 5.8 and 5.9. This indicates that the high activity contamination detected in this borehole (Type 2) is probably from a different source than the low activity contamination detected in the same borehole (Type 1).

- Isotopic ratios of different elements may vary as the radioactive contaminated solutions migrate in the subsurface. This fractionation of the different isotopes can be qualitatively predicted. Cs-137/Eu-154 and Cs-137/Sr-90 ratios are calculated in Table 4-13 of the OU 3-08 Track 2 report (WINCO, 1993). The Cs-137/Sr-90 ratio should decrease away from the source because Cs-137 has a lower mobility in soil than Sr-90. The Cs-137/Sr-90 ratio for the contamination detected from 3.0- to 3.6-m (10- to 11.8-ft) bgs in borehole CPP-36-1 is 148. The ratio in the other sample intervals ranged between 1.0 and 3.6, and the ratios from the pre-Track 2 samples ranged between 0.35 and 7.2 except for the 1.8-m (6-ft) sample in borehole A3 where the ratio was 93. The high Cs-137/Sr-90 ratio in the soil between 3.0 to 3.6 m (10 to 11.8 ft) in borehole CPP-36-1 suggests that this contamination may be from a nearby source.

The three types of contamination described above probably represent separate discharges, and may correlate with the discharges that are documented in historical records. The correlation of historical release to current contamination may have a high degree of uncertainty due to the condition described below for each waste type.

Type 1: The low activity soils in boring CPP-36-2 and across the site may be the result of excavation, mixing, and redistribution of contaminated soils before May 1968 (Source 1).

Type 2: The high activity soils in boring CPP-36-2 may be the result of the November 1974 discharge since this borehole is located close to the site of the release.

Type 3: The high activity, high Cs-137/Sr-90 ratio, contamination in boring CPP-36-1 does not appear to correlate with any of the historic releases. Cs-137 is relatively immobile in soils and therefore, the source of contamination must be close to the borehole. The most likely source would appear to be an undocumented discharge from an underground pipe near the boring CPP-36-1 or from subsequent transport and placement of fill material that may have been contaminated.

12.2.3 Nature and Extent of Soil Contamination

Low activity Cs-137 contamination is widespread in the shallow soils at this site. Cs-137 concentrations at least 20 times the background concentration were found in all soil samples collected in 1991 and during the Track 2 investigation. The "observation wells" show gamma radiation levels up to 11 mR/hr

in the uppermost 3.0 m (10 ft) of soil. This would equate to approximately 1,800 pCi/g of Cs-137 in the soil using the relationship presented in Figure 4-7 of the OU 3-08 Track 2 Report (WINCO, 1993).

High activity Cs-137 contamination is also present, but appears to exist at depths greater than 3.0 m (10 ft) bgs. The high level of Cs-137 contamination is likely from multiple sources, but may have coalesced into a continuous layer of contaminated soil. Four of the "observation wells" installed during the Track 2 investigation encountered radiation levels of 600 to 3,700 mR/hr at depths greater than 3.0 m (10 ft). The approximate depths of the high-level contamination are shown in Table 12-3.

The approximate extent of contamination was estimated on the basis of the data from the "observation wells." Although data from the "observation wells" were used, uncertainty exists in that historic releases could exist at depths greater than the depths penetrated by the "observation wells." The highest measured radiation in "observation well" CPP-36-OW-5 was 28 mR/hr between 3.0- to 3.4-m (10- to 11-ft) bgs, and no activity was found in "observation wells" CPP-36-OW-4 and CPP-36-OW-6.

Based on the results of investigations conducted at site CPP-36, the zone of contamination is assumed to extend from the ground surface to the soil/basalt interface at about 12.8 m (42 ft). This depth is based on large activity levels measured in the deepest samples collected from borings CPP-36-1 and CPP-36-2. Results from "observation wells" show elevated radiation levels to at least 7.6 m (25 ft) bgs.

The area of CPP-36 indicated on Figure 5-2 has been expanded as shown on Figure 12-1. The initial area has been expanded because "observation wells" located at the boundaries of the old area indicate radiation levels well above background. In addition, the site CPP-36 area has been extended to the southeast to incorporate site CPP-91. Investigative results indicate contamination at CPP-91 to be indistinguishable from that from site CPP-36. The revised area of site CPP-36 is about 748 m^2 (8,052 ft^2) in size.

12.3 Site CPP-85

Site CPP-85 is the WCF blower corridor that runs along the outside of building CPP-633. This section describes the processes associated with the blower corridor and the potential for contamination related to its use.

Table 12-3. Depths of high-level contamination.

Observation well	Top of Contamination >11 mR/hr	Bottom of Contamination >11 mR/hr
CPP-36-OW-1a	3.4 m (11 ft)	> 4.5 m (14.8 ft)
CPP-36-OW-1b	3.0 m (10 ft)	7.3 m [24 ft (3 mR/hr)]
CPP-36-OW-2	3.8 M (12.5 ft)	4.6 m (15 ft)
CPP-36-OW-3	3.8 m (12.5 ft)	6.1 m [20 ft (0 mR/hr)]
CPP-36-OW-4	none	none
CPP-36-OW-5	3.0 m [10 ft (28 mR/hr)]	3.6 [12 ft (2 mR/hr)]
CPP-36-OW-6	none	none

12.3.1 Site Description

The WCF Blower Corridor (CPP-85) is a 0.46- to 0.6-m (18- to 24-in.) vitrified clay pipeline surrounded by a roughly 0.9- × 1.1-m, (3- × 3.5-ft) poured square concrete envelope. The blower corridor runs in a "U" shape on the east, north, and west sides of building CPP-633 (Figure 12-1). The corridor extends in length approximately 33.5 m (110 ft) along the east and west sides of the building, and 21.3 m (70 ft) on the north side. Exact dimensions of the envelope depend on the pipe size and configuration. The blower corridor centerline is approximately 2.3-m (7.5-ft) bgs. The blower corridor was used for keeping a negative pressure of 1.9 cm (0.75 in.) (water column) in the WCF hot cells. Vent gases from the WCF hot cells were drawn through the blower corridor to the blower pit located at the northwest corner of CPP-633, and then blown to building CPP-649 for high-efficiency particulate air (HEPA) filtering and discharge.

The WCF (CPP-633) calcined highly radioactive liquid spent fuel dissolution process effluent from 1963 to 1981, at which time it was replaced by the New Waste Calcining Facility (NWCF). Before going "hot" (processing radioactive waste), a series of 10 runs was conducted in 1961 and 1962 to test the system using simulated feed solutions.

In the calcination process, liquid radioactive wastes are evaporated and the dissolved metals are converted to salts and oxides. The key step in the calcination process is evaporation and solidification of the liquid wastes in a heated bed of fluidized particles. Feed is atomized by air and sprayed into a heated bed of spherical particles. Dissolved metals, including fission products, oxidize to solids as they coat the surfaces of bed particles. Combustion and solid products build up in layers on the bed particles while the gaseous products are swept from the vessel with the fluidized gases.

The various process cells that the air was extracted from and drawn through the blower corridor are as follows: waste hold tank cell (380 cfm), offgas cell (3,520 cfm), calciner cell (1,565 cfm), sample room cell (900 cfm), transport air blower cell (380 cfm), south adsorber cell (720 cfm), north adsorber cell (720 cfm), off-gas filter cell (170 cfm); and off-gas/equipment vent blower cell (2,670 cfm). Occasionally the air drawn from these cells was moist during operation of the calciner, especially during deconning operations.

12.3.2 Investigative Results

No samples have been collected from the interior surface of the WCF blower corridor (CPP-85) or from the surrounding soil. Samples of sediment/sludge were collected from the base of the blower pit (site CPP-91) into which the blower corridor terminates. Based on toxicity characterization leaching procedure (TCLP) results, Co-60, Cs-134, Cs-137, and Eu-154 were detected in the sample collected from the blower pit. The concentrations of Co-60, Cs-134, Cs-137, and Eu-154 were 57.8, 50.1, 49,600, and 218 pCi/g, respectively.

In the Track 1 risk assessment for CPP-85, it was assumed that some contamination is present in the blower corridor (LITCO, 1995). It was assumed that contaminants present in the air being drawn through the corridor would, over time, generate surface contamination on the interior surfaces of the corridor. It was assumed that a thin film, 0.025-cm (0.01-in.) thick, would coat the interior surfaces of the corridor. The volume of contaminated material was calculated to be 0.043 m^3 (1.5 ft^3). This film was assigned concentrations based on the results of the blower pit samples referenced above. Based on the chemical

screening process on the blower pit samples presented in Section 5.2, the following COPCs were identified for this site: Co-60, Sr-90, Cs-134, Cs-137, and Eu-154.

A video of the blower corridor interior taken in 1994 did not show any evidence of deterioration of the pipeline; therefore, there is no evidence of contamination on or migration of contaminants from the CPP-85 blower corridor. The videotape showed the interior walls of the blower corridor to be nonuniformly discolored, especially at pipeline section seams and where feeder ventilation ducts from the individual hot cells jointed the blower corridor. The discolorations appeared to be the elastomer joint compound between the individual pipe sections and cement finishing mortar. The interior of the blower corridor did not contain debris. Additionally, the corridor operated under a negative pressure, which induces airborne contaminants to be drawn through the corridor and the blower to the HEPA filters in CPP-649.

12.3.3 Conclusions

Site CPP-85 is a vitrified clay pipeline surrounded by a poured concrete envelope. A video of the blower corridor taken in 1994 indicated no evidence of deterioration of the pipeline, nor debris within the pipeline. In addition, the pipeline was operated under a negative pressure, likely precluding migration of contaminants to the surrounding soil even if deterioration of the pipeline had taken place. For these reasons, no release is believed to have occurred from the blower corridor and site CPP-85 was not evaluated further in the vadose zone and groundwater models or in the Baseline Risk Assessment (BRA).

12.4 Site CPP-91

Site CPP-91 consists of soil potentially contaminated by discharges from the drain at the base of a blower pit located on the north side of the WCF (CPP-633). This section describes the nature and extent of contamination associated with site CPP-91.

12.4.1 Site Description

The WCF blower pit at site CPP-91 is a 4.16- × 2.72-m (13.67- × 8.92-ft) (inside dimensions) concrete vault located just below ground surface. The pit contains blowers that are used to provide a negative pressure of 1.91 cm (0.75 in.) water to hot cells in building CPP-633 for ventilation purposes. The blower pit contains a drain that is believed to discharge to the sediments approximately 3.1 m (10 ft) below the blower pit floor, which is approximately 3.1 m (10 ft) bgs. In 1992, a cleanup of the blower pit revealed elevated contamination levels on the blower pit walls and floor. During the cleanup, water from rain and snowmelt had entered the blower pit and was observed to be flowing into the blower pit drain. A sample of the 10 cm (4 in) of dirt on the blower pit floor showed elevated levels of Cs-137, Cs-134, Co-60, Eu-154, and mercury. This indicates that a release of radioactive contamination may have occurred through the blower pit drain to the environment over the 25+ years since the WCF became operational. Upon discovery of the water and drain in 1992, the drain and blower pit were both sealed to prevent further infiltration of snowmelt and subsequent draining of liquids through the blower pit to the environment.

12.4.2 Investigative Results

The sample of the soil/sludge obtained from the blower pit floor was analyzed for TCLP metals and radionuclides. Mercury was detected in the sample at a total concentration of 0.19 mg/kg. Results for TCLP

samples also showed elevated levels of Co-60, Cs-134, Cs-137, and Eu-154. Approximate concentrations of Co-60, Cs-134, Cs-137, and Eu-154 were 57.8, 50.1, 2,481, and 218 pCi/g, respectively.

As discussed in Section 3.3.1.13, two borings were drilled as part of the WAG 3 RI/FS field work. The borings were located in close proximity to the blower pit in order to assess potential leakage from the pit. The locations of borings CPP-91-1 and CPP-91-2 are shown on Figure 12-1.

The background radiation level at boring CPP-91-1 was measured at approximately 200 counts per minute (cpm) using a Ludlum 2A hand-held meter. Samples were collected from the following intervals (field-screen radiation levels given in parentheses): 0.0 to 0.15 m (0.0 to 0.5 ft) (200 cpm), 0.8 to 1.5 m (2.5 to 5.0 ft) (250 cpm), 2.3 to 3.0 m (7.5 to 10.0 ft) (300 cpm), 5.3 to 6.1 m (17.5 to 20 ft) (8,000 cpm), and at the soil/basalt interface at 14.0 to 14.2 m (46.0 to 46.5 ft) (<200 cpm). While a radiation level of approximately 5,000 cpm was noted at 13.7 m (45.0 ft), the radiation level returned to below background at 14.0 to 14.2 m (46 to 46.5 ft). Samples were analyzed for metals and radiological constituents. Sample material was primarily sandy gravels typical of the ICPP area. The material at the soil/basalt interface was described as brown clay. The 8,000 cpm radiation level measured for the 5.3- to 6.1-m (17.5- to 20-ft) interval was measured on a clay layer within that interval.

The background radiation level at boring CPP-91-2 was measured at approximately 250 cpm using a Ludlum 2A hand-held meter. Samples were collected from the following intervals (field-screen radiation levels given in parentheses): 0.0 to 0.15 m (0.0 to 0.5 ft) (250 cpm), 0.8 to 1.5 m (0.5 to 2.5 ft) (250 cpm), 1.5 to 2.3 m (5.0 to 7.5 ft) (275 cpm), 11.4 to 12.2 m (37.5 to 40 ft) (10,000 cpm), and just above the soil/basalt interface at 12.1 to 13.0 m (40.0 to 42.5 ft) (15 mR). The top of the basalt was evidently contacted at 13.0 m (42.7 ft) when the auger was refused. Samples were analyzed for metals and radiological constituents. Sample material was primarily sandy gravels typical of the ICPP area. The material at the soil/basalt interface was described as light gray and brown clay. An additional sample was collected from the 9.9 to 10.7 m (32.5 to 35.0 ft) for VOC and semivolatile organic compound (SVOC) analyses, based on field-screening measurement of total organics of greater than 300 ppm.

The results of the analysis for the COPCs are summarized on Table 12-4. Based on chemical screening from Section 5.2, Sr-90, Cs-137, arsenic, thallium, and manganese were identified as COPCs for this site. Inorganic and organic COPC detections at concentrations above background were generally isolated, with the exception of arsenic. Arsenic was detected in six of the 11 samples collected, with concentrations ranging up to 10.3 mg/kg and arsenic concentrations increased with depth. Manganese was also detected at a maximum concentration of 534 mg/kg, relative to a background concentration of 490 mg/kg. Thallium was detected at a maximum concentration of 1.8 mg/kg, which is above the background level of 0.43 mg/kg.

Cs-137 was detected at activity above background in five of the 11 samples collected. Cs-137 was detected at activity levels up to 140±1 pCi/g. Cs-137 activities generally increased from surface to approximately 0.8- to 2.3-m (2.5- to 7.5-ft) bgs, then decreased with greater depth. Sr-90 was detected at activities above background in four samples collected and reached a maximum activity of 7,580±6 pCi/g at a depth of 12.2 m (40.0 ft) in boring CPP-91-2.

Table 12-4. Summary statistics for CPP-91, CPP-633 blower pit drain.

COPCs	Concentration (mg/kg or pCi/g) Minimum detected	Maximum detected	Arithmetic mean	Standard deviation	Number of samples	Number of detects	Frequency of detection	INEL background (mg/kg or pCi/g)	Number greater than background
Arsenic	3.6 P	10.3 P	6.1700001	2.19547527	10	10	100%	5.8	5
Manganese	167 P	534 P	261.6	128.430872	10	10	100%	490	1
Thallium	1.8 B P	1.8 B P	1.799999952	NA	10	1	10%	0.43	1
Cs-137	.06 +/- .01	140 +/- 1	30.81333366	45.92392852	11	9	82%	0.82	6
Sr-90	20 +/- 0.4	7580 +/- 7	2286.925	3597.13856	4	4	100%	0.49	4

12.4.3 Nature and Extent of Contamination

Based on investigative results, Cs-137, Sr-90, and arsenic are the primary COPCs at site CPP-91. Cs-137 was the most widely distributed radiological COPC and reached a maximum activity of 140±1 pCi/g. Sr-90 activity reached a maximum activity of 7,580±6 pCi/g. Sr-90 detections also occurred at greater depths than Cs-137, with detections above background up to 12.2-m (40-ft) bgs. Arsenic was the most widely distributed inorganic COPC. It ranged to a maximum of 10.3 mg/kg relative to the background concentration of 5.8 mg/kg. For purposes of the risk assessment, site CPP-91 has been combined with site CPP-36. This is due to the fact that the zones of contamination from the two sites are indistinguishable. The thickness of the zone of contamination and area of contamination are discussed in Section 12.2.3.

12.5 Risk Assessment

The methodology for conducting the HHRA for WAG 3 was detailed in Section 7. As presented, the purpose of the HHRA is to develop a quantitative description and assessment of the human health risk posed by the COPCs present at WAG 3. This section only contains the results of the HHRA for the WCF Group with respect to the soil pathway. The results for the air and groundwater pathways are detailed in Sections 27.1 and 27.2, respectively. The risk assessment for the group will become cumulative when the contributions from the air and groundwater pathways are added to the soil pathway. The following sections discuss the complete exposure routes, exposure-point concentrations, methods and assumptions used to estimate contaminant sources, and cancer risk and noncarcinogenic health hazard estimates for the WCF Group under the three exposure scenarios evaluated. Section 12.5.3 describes the difference in estimating sources of contamination for use in evaluating surface exposures and fate and transport modeling to the SRPA. It also describes the use of the screened ORIGEN runs (see Section 4.4) to help identify contaminants potentially missing from the soil source estimate.

12.5.1 Complete Exposure Routes

Potentially complete pathways from the source to a human receptor are described in Section 7 and illustrated on Figure 7-1. For the WCF Group, the complete exposure routes within each pathway are summarized in Table 12-5. An exposure route is considered complete if the contaminated zone (as characterized in the previous sections and summarized on the table) occurs within the depth intervals specified for a given exposure route. All exposure routes, as described in Section 7, are considered complete for the WCF Group.

12.5.2 Exposure-Point Concentrations

Specific steps in calculating exposure-point concentrations for each of the applicable scenarios are described in Section 7. The COPC soil values used for an individual site was the smaller of the 95% upper confidence limit (UCL) or maximum concentration. The soil values for the WCF Group were estimated using the individual site concentration terms for CPP-35, CPP-36 and CPP-91. The individual site concentration terms were used to provide an area-weighted estimate. Concentrations for the interstitial area within the group [i.e., the non-Environmentally Controlled Areas (ECAs)] were assumed to be similar to site CPP-88. The concentration terms for the radionuclides were adjusted to account for decay for each exposure scenario. These values were averaged over the exposure duration. The concentration terms, by depth interval, are presented in Tables 12-6 through 12-8. The sample results from the 1974 excavation were included at an

Table 12-5. Complete exposure routes for the WCF Group and associated exposure route depths.

Receptor	Scenario	Potentially complete exposure route and exposure route depths used for exposure-point concentration estimates	Characterized zone of contamination[a]	Complete exposure route?
Onsite worker	Current land use	Inhalation of VOCs [0–15 cm (0–6 in.)]	0 to 12.2 m	No
		Inhalation of airborne particulates [0–15 cm (0–6 in.)]	(0 to 40 ft)	Yes
		Ingestion of surface soil [0–15 cm (0–6 in.)]		Yes
		External radiation [0–1.22 m (0–4 ft)]		Yes
Residential	Future land use	Inhalation of VOCs [0–3.05 m (0–10 ft)]	0 to 12.2 m	No
		Inhalation of airborne particulates [0–3.05 m (0–10 ft)]	(0 to 40 ft)	Yes
		Ingestion of surface soil [0–3.05 m (0–10 ft)]		Yes
		Ingestion of homegrown produce [0–3.05 m (0–10 ft)]		Yes
		Ingestion of groundwater		Yes
		Dermal contact with groundwater		No
		Inhalation of VOCs from groundwater		No
		External radiation [0–3.05 m (0–10 ft)]		Yes
Onsite worker	Future land use	Inhalation of VOCs [0–15 cm (0–6 in.)]	0 to 12.2 m	No
		Inhalation of airborne particulates [0–15 cm (0–6 in.)]	(0 to 40 ft)	Yes
		Ingestion of surface soil [0–15 cm (0–6 in.)]		Yes
		External radiation [0–1.22 m (0–4 ft)]		Yes

a. Zone of contamination based on the following previously characterized zones:

CPP-35 = 0 to 6.1 m (0 to 20 ft)
CPP-36/91 = 0 to 12.2 m (0 to 40 ft).

Table 12-6. Area-weighted soil concentrations for the WCF Group (0 to 0.5 ft).

COPCs	Site			Area weighted concentration (mg/kg or pCi/g)
	CPP-35	CPP-36/-91	CPP-88	
Area (ft^2)	1620	8052	5923	
Area (m^2)	150.51	748.07	550.28	
Aroclor-1260	---	---	---	0.00E+00
Benzo(a)pyrene	---	---	---	0.00E+00
Aluminum	---	---	---	0.00E+00
Arsenic	---	5.40E+00	---	2.79E+00
Manganese	---	2.13E+02	---	1.10E+02
Mercury	---	---	---	0.00E+00
Uranium	---	---	---	0.00E+00
Am-241	1.21E+00	---	---	1.26E-01
Ce-144	---	---	---	0.00E+00
Co-57	---	---	---	0.00E+00
Co-58	---	---	---	0.00E+00
Co-60	---	---	---	0.00E+00
Cs-134	---	---	---	0.00E+00
Cs-137	8.64E+03	1.66E+01	1.41E+01	9.11E+02
Eu-152	---	---	---	0.00E+00
Eu-154	1.18E+01	---	---	1.23E+00
Eu-155	---	---	---	0.00E+00
H-3	---	---	---	0.00E+00
I-129	---	---	---	0.00E+00
K-40	---	---	---	0.00E+00
Nb-95	---	---	---	0.00E+00
Np-237	---	---	---	0.00E+00
Pu-238	1.32E+01	---	---	1.37E+00
Pu-239/240	7.25E-01	---	---	7.53E-02
Pu-241	---	---	---	0.00E+00
Pu-242	---	---	---	0.00E+00
Ru/Rh-106	---	---	---	0.00E+00
Sb-125	---	---	---	0.00E+00
Sr-90	3.24E+03	---	3.55E+00	3.38E+02
Tc-99	---	---	---	0.00E+00
U-234	---	---	---	0.00E+00
U-235	5.77E-02	---	---	5.99E-03
U-236	---	---	---	0.00E+00
U-238	---	---	---	0.00E+00

Total Group Area (ft^2) =	15595
CPP-88 area (ft^2) =	5923

Table 12-7. Area-weighted soil concentrations for the WCF Group (0 to 4 ft).

COPCs	Site			Area weighted concentration (mg/kg or pCi/g)
	CPP-35	CPP-36/-91	CPP-88	
Area (ft^2)	1620	8052	5923	
Area (m^2)	150.51	748.07	550.28	
Aroclor-1260	---	---	---	0.00E+00
Benzo(a)pyrene	---	---	---	0.00E+00
Aluminum	---	---	---	0.00E+00
Arsenic	---	6.30E+00	6.43E+00	5.70E+00
Manganese	---	2.13E+02	---	1.10E+02
Mercury	---	---	---	0.00E+00
Uranium	---	---	---	0.00E+00
Am-241	1.21E+00	---	---	1.26E-01
Ce-144	---	---	---	0.00E+00
Co-57	---	---	---	0.00E+00
Co-58	---	---	---	0.00E+00
Co-60	---	---	---	0.00E+00
Cs-134	---	---	---	0.00E+00
Cs-137	8.64E+03	9.26E+01	1.27E+01	9.50E+02
Eu-152	---	---	---	0.00E+00
Eu-154	1.18E+01	6.90E+01	---	3.69E+01
Eu-155	---	---	---	0.00E+00
H-3	---	---	---	0.00E+00
I-129	---	---	---	0.00E+00
K-40	---	2.03E+01	---	1.05E+01
Nb-95	---	---	---	0.00E+00
Np-237	---	---	---	0.00E+00
Pu-238	1.32E+01	---	---	1.37E+00
Pu-239/240	7.25E-01	---	---	7.53E-02
Pu-241	---	---	---	0.00E+00
Pu-242	---	---	---	0.00E+00
Ru/Rh-106	---	---	---	0.00E+00
Sb-125	---	---	---	0.00E+00
Sr-90	3.24E+03	3.77E+01	2.47E+00	3.57E+02
Tc-99	---	---	---	0.00E+00
U-234	---	---	---	0.00E+00
U-235	7.16E-02	---	---	7.44E-03
U-236	---	---	---	0.00E+00
U-238	---	---	---	0.00E+00

Total Group Area (ft^2) =	15595
CPP-88 area (ft^2) =	5923

Table 12-8. Area-weighted soil concentrations for the WCF Group (0 to 10 ft).

COPCs	Site			Area weighted concentration (mg/kg or pCi/g)
	CPP-35	CPP-36/-91	CPP-88	
Area (ft^2)	1620	8052	5923	
Area (m^2)	150.51	748.07	550.28	
Aroclor-1260	---	---	---	0.00E+00
Benzo(a)pyrene	---	---	---	0.00E+00
Aluminum	---	---	---	0.00E+00
Arsenic	---	6.30E+00	5.90E+00	5.49E+00
Manganese	---	2.26E+02	---	1.17E+02
Mercury	---	---	---	0.00E+00
Uranium	---	---	---	0.00E+00
Am-241	1.21E+00	7.63E+02	---	3.94E+02
Ce-144	---	---	---	0.00E+00
Co-57	---	---	---	0.00E+00
Co-58	---	---	---	0.00E+00
Co-60	---	---	---	0.00E+00
Cs-134	---	8.69E+02	---	4.49E+02
Cs-137	8.64E+03	1.10E+06	1.18E+01	5.69E+05
Eu-152	---	---	---	0.00E+00
Eu-154	1.18E+01	5.04E+03	---	2.60E+03
Eu-155	---	---	---	0.00E+00
H-3	---	---	---	0.00E+00
I-129	---	---	---	0.00E+00
K-40	---	2.03E+01	---	1.05E+01
Nb-95	---	---	---	0.00E+00
Np-237	---	---	---	0.00E+00
Pu-238	1.32E+01	---	---	1.37E+00
Pu-239/240	7.25E-01	---	---	7.53E-02
Pu-241	---	---	---	0.00E+00
Pu-242	---	---	---	0.00E+00
Ru/Rh-106	---	---	---	0.00E+00
Sb-125	---	---	---	0.00E+00
Sr-90	3.24E+03	5.67E+04	1.57E+00	2.96E+04
Tc-99	---	---	---	0.00E+00
U-234	---	---	---	0.00E+00
U-235	7.16E-02	---	---	7.44E-03
U-236	---	---	---	0.00E+00
U-238	---	---	---	0.00E+00

Total Group Area (ft^2) =	15595
CPP-88 area (ft^2) =	5923

assumed depth of 9-ft bgs. The rationale for this is that even though the depth of these samples is unknown, they are likely to coincide with similar levels of contamination measured at approximately 10-ft bgs during the 1992 Track 2 field investigation. Exposures from all complete exposure routes were estimated based on the exposure-point concentrations in Table 12-9. Homegrown produce concentrations are presented in Table 12-10. The values for air and groundwater are presented in Sections 27.1 and 27.2, respectively.

12.5.3 Description of Source Estimates for Surface Exposure and Groundwater Modeling Use

The purpose for this subsection is two-fold. First, to compare the approach to defining the source estimate for use in both the surface exposure assessment and the groundwater model. This comparison was accomplished by comparing the soil data in Table 12-8 to the soil data used to estimate the source for use in the groundwater model, which can be found in Tables 5-39 and 5-40 of Appendix F. The benefit of these comparisons is to relate both source estimates and explain any apparent differences. Secondly, the results of the screened ORIGEN runs summarized in Section 4.4 were used to help identify any potential soil-related data gaps by comparing ORIGEN results to the field investigation soil results and\ or the contaminant inventory at each site. This comparison was based on the full inventory of contaminants in the screening tables in Section 5 before implementing the screening steps shown therein. The results of these comparisons are described for each site in the following paragraphs. The results of this comparison for perched water and the SRPA are reported at the end of Section 4.4.

The same soil COPC's and concentrations in Table 12-8 for site CPP-35 were used to develop the source estimate for groundwater model use. Based on a comparison of the radionuclides that were analyzed in site soils against the potential inventory as defined by the screened ORIGEN results (Table 4-7), Pu-241 was not part of the soil sampling analytical suite. The implication is that this radionuclide may be present and is currently not part of the soil contaminant inventory.

The source estimation for site CPP-36/91 groundwater use was divided into two portions (zone 1 and zone 2). Based on the results of radiation measurements from 7 observation wells, the maximum concentrations found in boreholes CPP-36-1 and CPP-36-2 are assumed to be representative of the soil concentrations in CPP36/91-Zone 1. The maximum concentrations found at the remaining wells (i.e., CPP-35-A1, A2, A3, and A4, and CPP-91-1 and 2) were assumed to be representative of the soil concentrations in CPP-36/91-Zone 2. Therefore, the CPP-36/91 source estimate for groundwater use implemented different soil COPC's and concentrations than those provided for future residential intrusion surface exposure in Table 12-8. The concentration for Cs-137, Eu-154, K-40, and Sr-90 were affected by these assumptions and are presented in Table 5-40 of Appendix F. The additional soil COPC's listed for CPP-36/91 on Table 5-40 of Appendix F (i.e., Pu-238, Pu-239, U-234, U-235, U-238) arise from inclusion of COPC soil concentrations measured at depths greater than 10 feet bgs, which is the assumption used to evaluate residential intrusion exposure. Based on a comparison of the radionuclides that were analyzed in site soils against the potential inventory as defined by the screened ORIGEN results (Table 4-7), Pu-241 was not part of the soil sampling analytical suite. The implication is that this radionuclide may be present and is currently not part of the soil contaminant inventory.

12.5.4 Risk Estimates

The results of this evaluation under current and future land use are presented in Sections 12.5.4.1 and 12.5.4.2. For each receptor, the results are summarized in Tables 12-11 through 12-16.

Table 12-9. Average soil exposure-point concentrations (mg/kg or pCi/g) for land use scenarios.

	Current occupational worker year 0 to year 25		Future occupational worker year 100 to year 125		Future resident year 100 to year 130
COPCs	(0 - 0.5 ft)	(0 - 4 ft)	(0 - 0.5 ft)	(0 - 4 ft)	(0 - 10 ft)
Aroclor-1260	----	----	----	----	----
Benzo(a)pyrene	----	----	----	----	----
Aluminum	----	----	----	----	----
Arsenic	2.79E+00	5.70E+00	2.79E+00	5.70E+00	5.49E+00
Manganese	1.10E+02	1.10E+02	1.10E+02	1.10E+02	1.17E+02
Mercury	----	----	----	----	----
Uranium[a]	----	----	----	----	----
Am-241	1.23E-01	1.23E-01	1.05E-01	1.05E-01	3.28E+02
Ce-144	----	----	----	----	----
Co-57	----	----	----	----	----
Co-58	----	----	----	----	----
Co-60	----	----	----	----	----
Cs-134	----	----	----	----	1.09E-13
Cs-137	6.93E+02	7.23E+02	6.97E+01	7.27E+01	4.14E+04
Eu-152	----	----	----	----	----
Eu-154	5.36E-01	1.61E+01	2.04E-04	6.12E-03	3.79E-01
Eu-155	----	----	----	----	----
H-3	----	----	----	----	----
I-129	----	----	----	----	----
K-40	----	1.05E+01	----	1.05E+01	1.05E+01
Nb-95	----	----	----	----	----
Np-237	----	----	----	----	----
Pu-238	1.24E+00	1.24E+00	5.65E-01	5.65E-01	5.55E-01
Pu-239/240	7.53E-02	7.53E-02	7.51E-02	7.51E-02	7.51E-02
Pu-241	----	----	----	----	----
Pu-242	----	----	----	----	----
Ru/Rh-106	----	----	----	----	----
Sb-125	----	----	----	----	----
Sr-90	2.55E+02	2.69E+02	2.35E+01	2.49E+01	1.96E+03
Tc-99	----	----	----	----	----
U-234	----	----	----	----	----
U-235	5.99E-03	7.44E-03	5.99E-03	7.44E-03	7.44E-03
U-236	----	----	----	----	----
U-238	----	----	----	----	----

a. mg/kg of uranium calculated from pCi/g of uranium isotopes using the equation
mg/kg = pCi/g * 2.795E-12 (mg-mole/kg-pCi-yr) * MW (g/mole) * $t_{1/2}$ (yr).

Table 12-10. Concentrations of COPCs in homegrown produce.

COPCs	Homegrown produce (mg/kg or pCi/g)	Kd (cm^3/g)	COPC input rate from irrigation (mg/g-d or pCi/g-d)	Leach rate constant (d^{-1})
Aroclor-1260	---	7.89E+03	0.00E+00	9.95E-07
Benzo(a)pyrene	---	1.19E+03	0.00E+00	6.57E-06
Aluminum	---	0.00E+00	0.00E+00	2.87E-02
Arsenic	8.50E-03	3.00E+00	8.71E-09	2.40E-03
Manganese	1.06E+02	5.00E+01	0.00E+00	1.56E-04
Mercury	1.10E-01	1.00E+02	2.91E-08	7.83E-05
Uranium	7.30E-05	6.00E+00	7.04E-09	1.25E-03
Am-241	4.05E-02	3.40E+02	6.08E-06	2.31E-05
Ce-144	---	5.00E+02	0.00E+00	1.57E-05
Co-57	---	1.00E+01	0.00E+00	7.64E-04
Co-58	---	1.00E+01	0.00E+00	7.64E-04
Co-60	---	1.00E+01	0.00E+00	7.64E-04
Cs-134	1.36E-17	5.00E+02	0.00E+00	1.57E-05
Cs-137	7.56E+01	5.00E+02	4.12E-05	1.57E-05
Eu-152	---	3.40E+02	0.00E+00	2.31E-05
Eu-154	4.40E-06	3.40E+02	0.00E+00	2.31E-05
Eu-155	---	3.40E+02	0.00E+00	2.31E-05
H-3	---	0.00E+00	6.22E-04	2.87E-02
I-129	3.85E-06	0.00E+00	3.26E-05	2.87E-02
K-40	1.86E+00	1.50E+01	0.00E+00	5.14E-04
Nb-95	---	0.00E+00	0.00E+00	2.87E-02
Np-237	3.19E-05	0.00E+00	8.36E-06	2.87E-02
Pu-238	2.70E-05	2.20E+01	0.00E+00	3.53E-04
Pu-239/240	8.30E-05	2.20E+01	5.84E-07	3.53E-04
Pu-241	8.49E-09	2.20E+01	9.37E-08	3.53E-04
Pu-242	3.60E-09	2.20E+01	3.88E-10	3.53E-04
Ru/Rh-106	---	0.00E+00	0.00E+00	2.87E-02
Sb-125	---	5.00E+01	0.00E+00	1.56E-04
Sr-90	2.19E+01	1.20E+01	5.63E-05	6.40E-04
Tc-99	4.56E-01	0.00E+00	1.67E-04	2.87E-02
U-234	2.73E-05	6.00E+00	2.63E-06	1.25E-03
U-235	8.56E-06	6.00E+00	9.27E-08	1.25E-03
U-236	6.93E-07	6.00E+00	6.68E-08	1.25E-03
U-238	2.44E-05	6.00E+00	2.35E-06	1.25E-03

Table 12-11. Soil pathway cancer risk to the current onsite worker. [a]

COPCs	Ingestion of soil	External radiation exposure	Total risks
Aroclor-1260	---	---	---
Benzo(a)pyrene	---	---	---
Aluminum	---	---	---
Arsenic	6E-07	---	6E-07
Manganese	NTD	---	---
Mercury	---	---	---
Uranium	---	---	---
Am-241	1E-08	3E-09	1E-08
Ce-144	---	---	---
Co-57	---	---	---
Co-58	---	---	---
Co-60	---	---	---
Cs-134	---	---	---
Cs-137	5E-06	8E-03	8E-03
Eu-152	---	---	---
Eu-154	1E-09	4E-04	4E-04
Eu-155	---	---	---
H-3	---	---	---
I-129	---	---	---
K-40	---	4E-05	4E-05
Nb-95	---	---	---
Np-237	---	---	---
Pu-238	9E-08	1E-10	9E-08
Pu-239/240	6E-09	8E-12	6E-09
Pu-241	---	---	---
Pu-242	---	---	---
Ru/Rh-106	---	---	---
Sb-125	---	---	---
Sr-90	4E-06	NTD	4E-06
Tc-99	---	---	---
U-234	---	---	---
U-235	7E-11	1E-08	1E-08
U-236	---	---	---
U-238	---	---	---
Total cancer risks by route:	1E-05	9E-03	9E-03

"---" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 12-12. Soil pathway noncarcinogenic hazard to the current onsite worker. [a]

COPCs	Ingestion of soil	External radiation exposure	Total HIs
Aroclor-1260	----	----	----
Benzo(a)pyrene	----	----	----
Aluminum	----	----	----
Arsenic	3E-10	----	3E-10
Manganese	6E-06	----	6E-06
Mercury	----	----	----
Uranium	----	----	----
Am-241	----	----	----
Ce-144	----	----	----
Co-57	----	----	----
Co-58	----	----	----
Co-60	----	----	----
Cs-134	----	----	----
Cs-137	----	----	----
Eu-152	----	----	----
Eu-154	----	----	----
Eu-155	----	----	----
H-3	----	----	----
I-129	----	----	----
K-40	----	----	----
Nb-95	----	----	----
Np-237	----	----	----
Pu-238	----	----	----
Pu-239/240	----	----	----
Pu-241	----	----	----
Pu-242	----	----	----
Ru/Rh-106	----	----	----
Sb-125	----	----	----
Sr-90	----	----	----
Tc-99	----	----	----
U-234	----	----	----
U-235	----	----	----
U-236	----	----	----
U-238	----	----	----
Total hazard indices by route:	6E-06	0E+00	6E-06

"----" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 12-13. Soil pathway cancer risk to the future onsite worker. [a]

COPCs	Ingestion of soil	External radiation exposure	Total risks
Aroclor-1260	---	---	---
Benzo(a)pyrene	---	---	---
Aluminum	---	---	---
Arsenic	6E-07	---	6E-07
Manganese	NTD	---	---
Mercury	---	---	---
Uranium	---	---	---
Am-241	9E-09	3E-09	1E-08
Ce-144	---	---	---
Co-57	---	---	---
Co-58	---	---	---
Co-60	---	---	---
Cs-134	---	---	---
Cs-137	6E-07	9E-04	9E-04
Eu-152	---	---	---
Eu-154	5E-13	2E-07	2E-07
Eu-155	---	---	---
H-3	---	---	---
I-129	---	---	---
K-40	---	4E-05	4E-05
Nb-95	---	---	---
Np-237	---	---	---
Pu-238	4E-08	6E-11	4E-08
Pu-239/240	6E-09	8E-12	6E-09
Pu-241	---	---	---
Pu-242	---	---	---
Ru/Rh-106	---	---	---
Sb-125	---	---	---
Sr-90	3E-07	NTD	3E-07
Tc-99	---	---	---
U-234	---	---	---
U-235	7E-11	1E-08	1E-08
U-236	---	---	---
U-238	---	---	---
Total cancer risks by route:	2E-06	9E-04	9E-04

"---" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 12-14. Soil pathway noncarcinogenic hazard to the future onsite worker. [a]

COPCs	Ingestion of soil	External radiation exposure	Total HIs
Aroclor-1260	----	----	----
Benzo(a)pyrene	----	----	----
Aluminum	----	----	----
Arsenic	3E-10	----	3E-10
Manganese	6E-06	----	6E-06
Mercury	----	----	----
Uranium	----	----	----
Am-241	----	----	----
Ce-144	----	----	----
Co-57	----	----	----
Co-58	----	----	----
Co-60	----	----	----
Cs-134	----	----	----
Cs-137	----	----	----
Eu-152	----	----	----
Eu-154	----	----	----
Eu-155	----	----	----
H-3	----	----	----
I-129	----	----	----
K-40	----	----	----
Nb-95	----	----	----
Np-237	----	----	----
Pu-238	----	----	----
Pu-239/240	----	----	----
Pu-241	----	----	----
Pu-242	----	----	----
Ru/Rh-106	----	----	----
Sb-125	----	----	----
Sr-90	----	----	----
Tc-99	----	----	----
U-234	----	----	----
U-235	----	----	----
U-236	----	----	----
U-238	----	----	----
Total hazard indices by route:	6E-06	0E+00	6E-06

"----" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 12-15. Soil pathway cancer risk to the future onsite resident. [a]

COPCs	Ingestion of soil	Ingestion of homegrown	External radiation exposure	Total risks
Aroclor-1260	—	—	—	—
Benzo(a)pyrene	—	—	—	—
Aluminum	—	—	—	—
Arsenic	1E-05	1E-06	—	1E-05
Manganese	NTD	NTD	—	—
Mercury	—	NTD	—	—
Uranium	—	NTD	—	—
Am-241	1E-04	2E-06	4E-05	2E-04
Ce-144	—	—	—	—
Co-57	—	—	—	—
Co-58	—	—	—	—
Co-60	—	—	—	—
Cs-134	7E-21	1E-22	2E-17	2E-17
Cs-137	2E-03	4E-04	9E-01	9E-01
Eu-152	—	—	—	—
Eu-154	4E-09	7E-12	5E-05	5E-05
Eu-155	—	—	—	—
H-3	—	—	—	—
I-129	—	1E-10	—	1E-10
K-40	2E-07	4E-06	2E-04	2E-04
Nb-95	—	—	—	—
Np-237	—	2E-09	—	2E-09
Pu-238	2E-07	1E-09	3E-10	2E-07
Pu-239/240	3E-08	5E-09	4E-11	3E-08
Pu-241	—	5E-13	—	5E-13
Pu-242	—	2E-13	—	2E-13
Ru/Rh-106	—	—	—	—
Sb-125	—	—	—	—
Sr-90	1E-04	2E-04	NTD	4E-04
Tc-99	—	1E-07	—	1E-07
U-234	—	2E-10	—	2E-10
U-235	4E-10	7E-11	6E-08	6E-08
U-236	—	5E-12	—	5E-12
U-238	—	3E-10	—	3E-10
Total cancer risks by route:	2E-03	6E-04	9E-01	9E-01

"—" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 12-16. Soil pathway noncarcinogenic hazard to the future onsite resident. [a]

COPCs	Ingestion of soil	Ingestion of homegrown	External radiation exposure	Total HIs
Aroclor-1260	—	—	—	—
Benzo(a)pyrene	—	—	—	—
Aluminum	—	—	—	—
Arsenic	6E-09	7E-03	—	7E-03
Manganese	6E-05	2E-01	—	2E-01
Mercury	—	1E-01	—	1E-01
Uranium	—	6E-06	—	6E-06
Am-241	—	—	—	—
Ce-144	—	—	—	—
Co-57	—	—	—	—
Co-58	—	—	—	—
Co-60	—	—	—	—
Cs-134	—	—	—	—
Cs-137	—	—	—	—
Eu-152	—	—	—	—
Eu-154	—	—	—	—
Eu-155	—	—	—	—
H-3	—	—	—	—
I-129	—	—	—	—
K-40	—	—	—	—
Nb-95	—	—	—	—
Np-237	—	—	—	—
Pu-238	—	—	—	—
Pu-239/240	—	—	—	—
Pu-241	—	—	—	—
Pu-242	—	—	—	—
Ru/Rh-106	—	—	—	—
Sb-125	—	—	—	—
Sr-90	—	—	—	—
Tc-99	—	—	—	—
U-234	—	—	—	—
U-235	—	—	—	—
U-236	—	—	—	—
U-238	—	—	—	—
Total hazard indices by route:	6E-05	3E-01	0E+00	3E-01

"—" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

12.5.4.1 Current Land Use. As indicated in Table 12-11, total cancer risk to the current onsite worker from exposure to site-related chemicals in surface soil is estimated to be 9E-03. The risk is attributed to the soil exposure ingestion route and to external radiation exposure. The primary contaminants of concern (COCs) for the ingestion of soil route are Cs-137 (5E-06), and Sr-90 (4E-06). The primary COCs for external radiation exposure are Cs-137 (8E-03), Eu-154 (4E-04), and K-40 (4E-05). Table 12-12 indicates that the total noncarcinogenic hazard index to the current worker is estimated to be 6E-06. There are no hazard indices above unity for the current onsite worker.

12.5.4.2 Future Land Use. As Table 12-13 indicates, the total cancer risk to the future onsite worker from exposure to site-related chemicals in surface soil is estimated to be 9E-04. The risk is attributed to external radiation exposure with the primary COCs being Cs-137 (9E-04), and K-40 (4E-05). Table 12-14 indicates the total noncarcinogenic hazard index to the future onsite worker is 6E-06. There are no hazard indices above unity for the future onsite worker. As indicated in Table 12-15, the total cancer risk for the future resident from exposure to site-related chemicals in soil is estimated to be 9E-01. Within the soil ingestion exposure route, the major contributors are arsenic (1E-05), Am-241 (1E-04), Cs-137 (2E-03), and Sr-90 (1E-04). The risk from ingestion of homegrown produce is driven by Cs-137 (4E-04) and Sr-90 (2E-04). External radiation exposure has Cs-137 (9E-01) and K-40 (2E-04) as the primary contributors to the risk. As shown in Table 12-16, the total noncarcinogenic hazard index to the future resident is estimated to be 3E-01. There are no hazard indices above unity for the future resident.

12.6 Uncertainties

This section describes the limitations and uncertainties specific to the site characterization of the WCF Group. Sources of uncertainty associated with site characterization include data quality, COPC identification, concentration term estimation, and assumptions regarding the lateral and vertical extent of COPC occurrence. In the risk assessment, the most significant uncertainties are due to the selection process of COPCs, the toxicity values used, and the assumptions used during the exposure assessment. The following paragraphs discuss important sources of site-specific uncertainty in greater detail.

Sampling and analysis uncertainties are related to quality problems that may result in qualified and rejected results (Section 3.5). Qualified results are considered estimates of the concentration in the sample and, for all practical purposes, useable for their intended purpose although they could be biased high or low. Rejected results are considered unusable, thus limiting the size of the useable data set. For the WCF Group, 12 data points were rejected based on the method validation as documented in the Limitations and Validation (L&V) Reports. The rejected data points consisted of Sr-90 in four samples and Tc-99 in eight samples, which were all located at CPP-91. These rejected data points affect the overall WCF Group data set by reducing the number of useable points from 41 to 37 for Sr-90. However, for Tc-99, no useable data exist within the group, thus leaving Tc-99 uncharacterized. This likely underestimates the risk for the group.

Uncertainty associated with the chemical screening process (Section 5.2) results from using the maximum concentration for chemicals detected in the ECAs in the background comparison step, retaining chemicals detected as COPCs because there is not a corresponding background value, and retaining chemicals as COPCs for which there is no toxicity information available.

In most cases, the COPC identification process used the maximum concentration for a chemical detected in the background comparison step, regardless of its magnitude above background. The use of the maximum can result in the identification of COPCs that have concentrations only slightly above background. Manganese, with a maximum concentration of 534 mg/kg, is only slightly elevated (8%) above the background value of 490 mg/kg. Additionally, the maximum value indicated is the only manganese value out of ten samples at a concentration greater than the background value (see Table 12-4). Similarly, K-40 was included as a COPC with a maximum activity of 33.7 pCi/g and a background value of 24 pCi/g. This results in an increase in the number of COPCs considered in the RI/BRA and a possible overestimation of risk because of inclusion of COPCs with concentrations that are likely within the true background population.

Another source of uncertainty related to the background comparison step in the chemical screening process relates to chemicals for which no background concentration exists. For example, fluoride, nitrate, and several radionuclides were not characterized as part of the Rood et al., background study. For the WCF Group, the following COPCs have no corresponding background concentration: Co-60, Cs-134, Eu-154, and U-235. This results in an increase in the number of COPCs considered in the RI/BRA and a possible overestimation of risk because the observed concentrations may be within the background population.

Some concentration estimates are based on the 95% UCL for the site, or the area-weighted average 95% UCLs for sites that have been grouped. When the 95% UCL (i.e., the concentration term estimate) of a COPC is below the corresponding background value, this results in an increase in the number of COPCs in the RI/BRA and a possible overestimation of risk because the results are likely within the background range. This source of uncertainty stems from the use of maximum concentrations when identifying the COPCs for a specific sites. For the WCF Group, arsenic, cadmium, chromium, manganese, nickel, K-40, and Pu-239/240 fell into this category. This results in an increase in the number of COPCs considered in the RI/BRA and a possible overestimation of risk because the observed concentrations may be within the background population.

An additional source of uncertainty is due to the use of sample results obtained during an excavation activity at CPP-36 during 1974. The depth of the samples collected during this excavation activity are unknown, however, the results were assumed to be representative of soil contamination at 9 ft bgs. As a result, the concentration estimates for Cs-137, Sr-90, Cs-134, and Eu-154 evaluated in the risk assessment may have been overestimated. A similar uncertainty related to use of available data involves the assumption that under residential land use, exposures are assumed to occur only to a depth of ten feet. At this site elevated levels of Pu-238 and Pu-239 (8180 and 1324 pCi/g) were measured at a depth of 11.8 feet bgs but were not included in the surface evaluation. This condition may lead to underestimating the excess cancer risk contribution from these COPCs.

For the WCF Group, thallium was retained as a COPC for the RI/BRA. There are no toxicity values in Integrated Risk Information System (IRIS), Health Effects Assessment Summary Tables (HEAST), or EPA Region III publications for thallium. Uses of thallium include thallium salts, mercury alloys, low-melting glasses, rodenticides, photoelectric applications, and electrodes in dissolved oxygen analyzers. The impact of not including thallium in the RI/BRA may underestimate the risk; however, the impact is not quantifiable because of the lack of toxicity information.

With respect to the nature and extent assessment, some uncertainty is associated with each of the sites within the WCF Group and additional uncertainty is generated by combining the sites into the WCF Group. Site CPP-35 is the location of an underground release of decontamination solution through the air transport system. The true shape of the soil mass affected by the release is unknown; it has been approximated as a block with an area equivalent to the ECA boundary and as deep as the zone of contamination. This approximation may either overestimate or underestimate the true soil mass affected by the release. The lateral extent may currently be underestimated, as observation wells drilled near the ECA boundaries indicated elevated radiation levels.

The precise shape and lateral extent of contamination at CPP-36 is currently unknown. Although the ECA boundary has been enlarged, observation borings near the new boundaries indicated radiation levels above background. The vertical extent of the zone of contamination is assumed to extend to the soil/basalt interface at approximately 12.8-m (42-ft) bgs. The deepest samples were collected from 4.7-m (15.5-ft) bgs, and while these samples did contain COPCs at large activities, if the activity levels decreased to background above the soil/basalt interface, the current assumption regarding the zone would lead to an overestimation of the contaminated soil mass. Some of the observation wells at the site indicate that radiation levels return to background below approximately 6.1-m (20-ft) bgs, however observation well 36-OW-1b indicates a radiation level above background at approximately 6.7- to 7.0-m (22- to 23-ft) bgs. No surficial samples were collected at CPP-36, therefore surficial risks may be either overestimated or underestimated based on the activity levels of surficial material in comparison to deeper samples.

CPP-85 is assumed to be a nonrelease site. This assumption is based on the construction of the blower corridor (vitrified clay pipe surrounded by a poured concrete envelope) and its mode of operation (operated under negative pressure, thus precluding leakage). CPP-85 was not included in the groundwater model or the risk assessment because no release is known to have occurred. This makes the model and risk estimates more representative of actual conditions, thus influence to uncertainty is insignificant (i.e., it does not result in an overestimation or underestimation of risk).

Site CPP-91 was incorporated into the revised ECA boundary for CPP-36, based on proximity to CPP-36 and similarity of COPCs. The precise lateral extent of contamination from CPP-91 is unknown, however the expanded CPP-36 boundary probably incorporates any contamination associated with CPP-91, especially if drainage from the blower pit at site CPP-91 was primarily vertical rather than lateral.

Combining the three sites into a group may lead to on overestimation of risk for portions of the group. Large activity levels associated with CPP-35 and CPP-36 are found primarily at depths less than approximately 4.7 m (15.5 ft), while at CPP-91 large activity levels are not indicated until below a depth of approximately 5.3 m (17.5 ft) bgs. Combining these data may lead to a conclusion that the entire group area is contaminated with large activity levels from surface to the soil/basalt interface when this is not supported by the results.

A source of uncertainty may be associated with the contaminant inventories used for the groundwater modeling and residential intrusion surface exposure at every sub-area. Section 12.5.3 identifies radionuclides potentially missing from these inventories. The implication of these potential data gaps in that the source estimates could be underestimated. Pu-241 may be missing from both source estimates (surface exposure

and groundwater model); however, since it has a short half-life (14.4 years) and a long travel time to the SRPA (K_d = 22), if present, it would not be expected to be of concern at the year 2095 and beyond.

12.7 Conclusions and Recommendations

The results of the risk assessment under current land use for the WCF Group indicate that the increased cancer risk from exposure to group-related contaminants is well above the EPA-recommended target range and therefore, unacceptable. The increased cancer risk to hypothetical future onsite workers and residents were also found to be well above the EPA-recommended target range. The noncarcinogenic hazard for all receptors was found to be below the EPA hazard index goal of one. These estimates do not include the contributions associated with the air and groundwater pathways. The total increased cancer and hazard incidence to humans is reported in Section 27. It should be noted that the cancer risk and hazard estimates of this group may be overestimated. As pointed out in Section 12.6, some of the exposure point concentrations were estimated with the use of data collected during earlier upgrade projects near CPP-36. These data were used however, professional judgement was necessary to place the sample locations and depths. In addition, the evaluation of exposure to current onsite workers did not consider the benefits of a radiation protection program currently implemented at the INEL that limits worker exposure to an acceptable level. Given these limitations, the exposure from direct soil pathways alone is expected to be severe enough that some type of future response action should be considered to mitigate adverse impacts to human health and the environment. The response action should be designed so that it is protective of human and environmental receptors under future land use.

12.8 References

Golder Associates, 1991, *Report for the Idaho Chemical Processing Plant Drilling and Sampling Program at the HLLW Tank Farm and Land Disposal Unit CPP-33*, Prepared for EG&G Idaho, Inc./Westinghouse Idaho Nuclear Company, Idaho Falls, Idaho.

LITCO, 1995, *Track 1 Decision Documentation Package, Waste Calcining Facility (WCF) Hot Cell Blower Corridor, Operable Unit 3-13*.

Rood, S. M., G. A. Harris, and G. J. White, 1995, *Background Dose Equivalent Rates and Surficial Soil Metal and Radionuclide Concentrations for the Idaho National Engineering Laboratory*, INEL-94/0250, Revision 0, February.

WINCO, 1993, *Final Track 2 Summary Report for Operable Unit 3-08 (Tank Farm Area II)*, Revision 3, July.

Chapter 13

13. OLD STORAGE POOL GROUP RESULTS (CPP-01, CPP-04, CPP-05, CPP-08, CPP-09, CPP-10, AND CPP-11)

This group includes seven sites of small areal extent, to the east of and adjacent to building CPP-603. Most of the sites are locations of potentially contaminated soil, usually the result of a spill of radioactive material. The seven sites are CPP-01, CPP-04, CPP-05, CPP-08, CPP-09, CPP-10, and CPP-11 (Figure 13-1). The following sections present site descriptions, investigative results, and an assessment of the nature and extent of contamination for these sites. For purposes of this report, sites CPP-04 and CPP-05 will be considered together, as will sites CPP-08 and CPP-09. The human health risk assessment (HHRA) for the group follows.

13.1 Site CPP-01

Site CPP-01 is a portion of the fuel storage basin cleanup support system, and consists of a concrete horizontal settling basin (CPP-740), concrete vertical settling pit (CPP-301), and two dry wells (CPP-303 and MAH-SFE-SW-048) east of building CPP-603 (Figure 13-1).

13.1.1 Site Description

The purpose of the fuel storage basin cleanup support system at site CPP-01 was to receive the backwash slurry of filter aid material (diatomaceous earth) from the filter system associated with the Fuel Receiving and Storage Facility (FRSF) activities. The shielding water in the fuel storage basins was recirculated through the filters to prevent accumulations of dirt and algae. The filtered solids and filter aid material were periodically backwashed from the filters and pumped to CPP-301, which is a 1.5 × 1.5 × 5.8 m (5 × 5 × 19 ft) vertical settling vault. When the slurry in the vault settled, the supernatant was drained from the vault to a deep dry well, CPP-303, where the effluent percolated into the surrounding soil. The filter backwash settling system operated from 1951 to 1962. A horizontal settling system, consisting of horizontal settling basin CPP-740 and dry well SW-048, was constructed in 1962 to expedite the slow settling rate of the original system, and CPP-301 was valved out of service at this time. CPP-740 included a 1.2 × 1.6 × 9.1 m (4 × 5.3 × 30 ft) horizontal settling system of weir compartments and an access manhole. This system was used to settle slurry solids and drain the supernatant to dry well SW-048 and subsequently, the surrounding soils. The total volume [18,925 L (5,000 gal)] of sludge and liquid in the horizontal settling basin CPP-740 and the vertical settling pit CPP-301 was removed in the fall of 1993 under a removal action. The liquid removed was sent to the process equipment waste (PEW) Evaporator Facility and the sludge was dried and sent to the Radioactive Waste Management Complex (RWMC).

Use of the dry wells was discontinued in 1966 due to internal administrative controls. This decision prompted the reactivation of CPP-301 as a settling pit. Upon reactivation, steam jetting was used to transfer the supernatant to a waste storage tank, SFE-20 (site CPP-69 in OU 3-09). In March 1969, several Experimental Breeder Reactor No. 2 (EBR-II) fuel canisters ruptured, which added contamination to the basin water. Use of the CPP-740 settling facilities was terminated in 1977 when the filters were replaced by a system of pressurized sand filters.

13.1.2 Investigative Results

The contents of the horizontal settling basin, vertical settling pit, and dry well SW-048 were sampled in 1981. During sampling of the sludge in the horizontal settling basin, it was determined that weir compartment number 1 was essentially filled with sludge and covered by a 0.15-m (6-in.) layer of water.

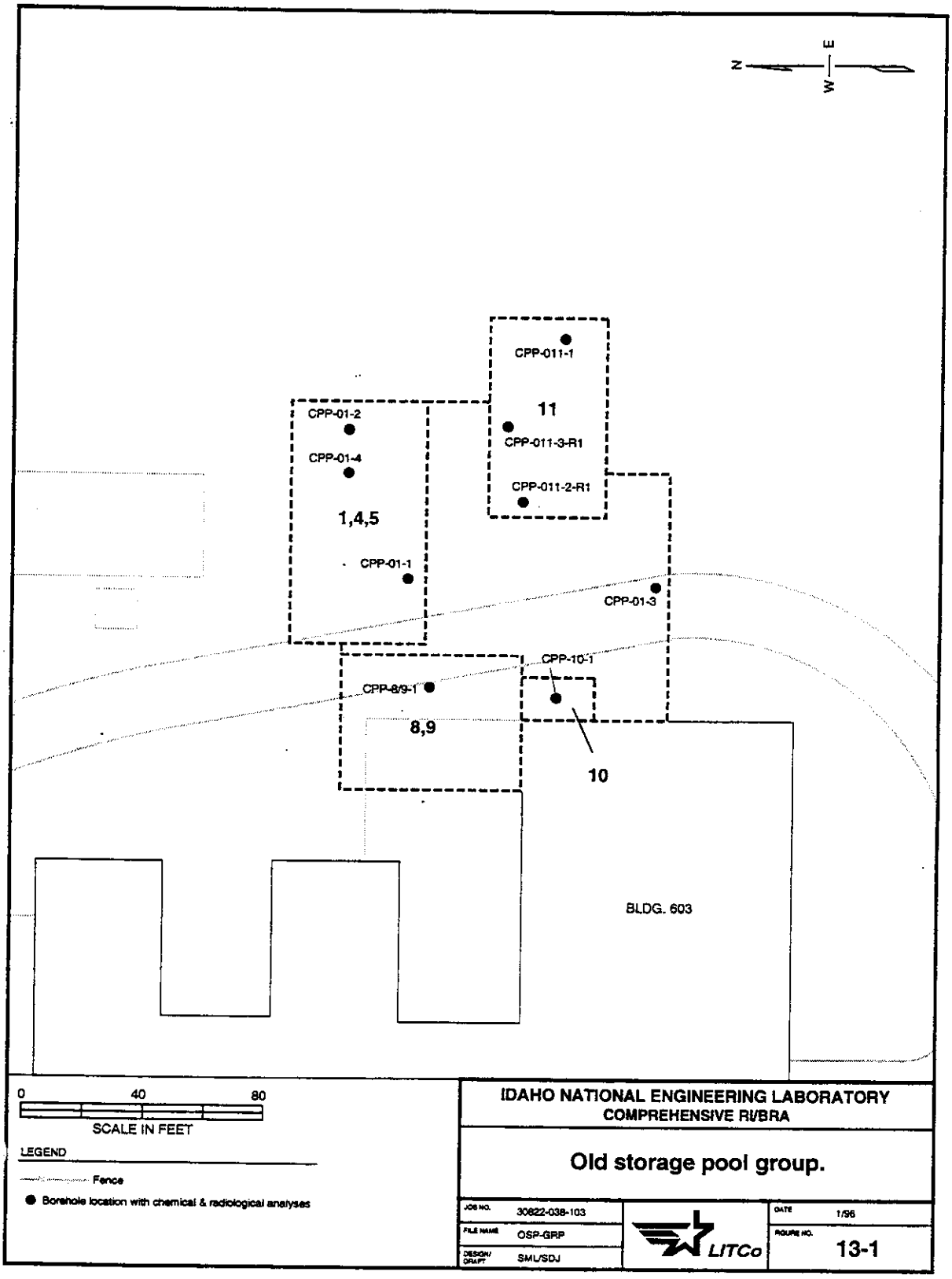


Figure 13-1. Old storage pool group.

Only minimal amounts of diatomaceous earth material were found in the center weir, and a 0.15-m (6-in.) layer of water was also present. The vertical settling vault CPP-301 was also inspected and found to contain a considerable amount of sludge and water. It was determined the vault contained approximately 1.8 m (6 ft) of sludge or diatomaceous earth deposits, which had settled to the bottom and was covered by a 1.5-m (5-ft) layer of water. Dry well SW-048 was also inspected and found to be dry and free of solids and filter aid material.

Sludge samples collected in 1981 from the settling facilities and dry well were sent to the ICPP radiochemistry laboratory to determine quantitative and qualitative isotopic distribution. The alpha, beta, and gamma activity measured in the vertical settling pit CPP-301 was several orders of magnitude higher than activity in the horizontal settling basin CPP-740 and dry well SW-048 [see Tables 3-1 and 3-2 in *Draft Preliminary Scoping Track 2 Summary Report for Operable Unit 3-09* (WINCO, 1994)].

A second sampling effort was performed in 1993 on the horizontal settling basin CPP-740, vertical settling pit CPP-301, and dry well CPP-303. Water samples collected appeared clear, and the sludge sampler was lowered to the bottom of the settling basin [approximately 3.6-m (12-ft) below ground surface (bgs)] and a sample collected. The sampler contained 1.3 m (4.3 ft) of water and 0.64 cm (0.25 in.) of rust-colored sludge. Dry well CPP-303 was sampled by lowering a hand auger to the bottom of the well at 5.5 m (18 ft) bgs and removing approximately 0.2 m (8 in.) of soil.

During sampling of the vertical settling pit CPP-301, the water level was measured at 2.7 m (9 ft) below the top of the manhole cover at ground level. Water samples were collected from a depth of 3.4 m (11 ft) below the humanhole cover, and the liquid appeared clear. Sludge samples were collected between 4.3- to 5.2-m (14- to 17-ft) bgs where two layers of sludges were encountered. The first layer was approximately 0.15-m (6-in.) thick and rust colored. The second layer was a thicker, white, diatomaceous sludge and 0.10-m (4-in.) thick. The sample team estimated the sludge continued down an additional 0.6 m (2 ft). Results for samples collected from the horizontal settling basin, dry well CPP-303, and the vertical settling pit are listed in Tables 3-1 through 3-3 of *Draft Preliminary Scoping Track 1 Summary Report for Operable Unit 3-09* (WINCO, 1994).

As part of the operable unit (OU) 3-09 Track 2 characterization activities at CPP-01, three soil borings were drilled: one adjacent to dry well SW-048 (CPP-01-2), one at horizontal settling basin CPP-740 and vertical settling pit CPP-303 (CPP-01-01), and one at the dry well CPP-303 (CPP-01-3) (Figure 13-1). A sample was also collected from the bottom of dry well SW-048 using a hand auger. This sample is designated as CPP-01-4.

In each of the three boreholes, a sample was collected between 0- to 0.15-m (0- to 0.5-ft) bgs. Continuous samples were taken between 0.15- to 1.2-m (0.5- to 4-ft) bgs using split-spoon samplers, and the sample collected from the interval having the highest radiation level was sent for laboratory analyses. Continuous samples were also taken between 1.2 to 3.0 m (4 to 10 ft), and one sample collected from the interval having the highest radiation level was also sent for laboratory analyses. Samples were then taken at 1.5-m (5-ft) intervals from 3.0-m (10-ft) bgs to the soil/basalt interface and screened using field radiation instruments. The sample having the highest radioactivity, greater than 100 counts per minute (cpm) above background, was sent for analyses.

Soil borings CPP-01-1, CPP-01-2, and CPP-01-3 were drilled to the soil/basalt interface located approximately 9.1 to 9.8 m (30 to 32 ft) bgs. Radiation surveys taken on the sample collected in borehole CPP-01-1 at the soil/basalt interface at 9.1- to 9.3-m (30- to 30.5-ft) bgs showed radiation levels at background. Borehole CPP-01-1 was then backfilled with bentonite. Radiation surveys taken on the sample collected at the soil/basalt interface at 9.8-m (31-ft) bgs in borehole CPP-01-2 had radiation levels at 2 mR/hr

and the sample collected at the soil/basalt interface at 9.8 m (32 ft) bgs in borehole CPP-01-3 had a radiation level surveyed at 0.4 mR/hr. Because radiation levels were above background levels at the soil/basalt interface in boreholes CPP-01-2 and CPP-01-3, a decision was made by the WAG 3 Project Managers to extend the two boreholes to the first interbed located approximately 32.0-m (105-ft) bgs. The samples collected immediately above the interbed in both boreholes were surveyed at 0 cpm above background.

The analytical results for the contaminants of potential concern (COPCs) are summarized in Table 13-1. A compilation of the analytical results is presented in Appendix G. Based on the chemical screening in Section 5.2, the following COPCs were retained for site CPP-01: Co-57, Co-60, Sr-90, Cs-137, Eu-152, Eu-154, Eu-155, U-235, Pu-239, and Am-241. No organic or inorganic COPCs were identified for CPP-01. Results discussed below are based on five samples; four samples collected during the WAG 3 remedial investigation (RI) field program, and one soil sample collected from the base of dry well CPP-303 on April 30, 1993. Sample results for sludge samples collected from horizontal settling tank CPP-740 and vertical settling pit CPP-301 are not discussed as the sludge was removed from those two structures in the fall of 1993. Discussion of results is further broken down between samples CPP-01-1 (located in proximity to the two settling structures); CPP-01-2, and CPP-01-4 (a sample of the material at the base of dry well CPP-048 and a nearby boring); and sample CPP-01-3 (located adjacent to dry well CPP-303) and the soil sample from the base of dry well CPP-303. These sampling locations are indicated on Figure 13-1.

13.1.2.1 Boring CPP-01-1 Near Settling Structures. Cs-137 is the most widely distributed COPC based on samples collected in boring CPP-01-1. Cs-137 was detected at activity levels above background in each sample analyzed. Cs-137 levels measured 25.6 pCi/g at the surface, dropped to less than 10 pCi/g in the 0.6- to 1.2-m (2.0- to 4.0-ft) and 1.8- to 2.4-m (6.0- to 8.0-ft) intervals, rose to 3,430 pCi/g in the 4.6- to 5.2-m (15.0- to 17.0-ft) interval, then dropped again to 5.62 pCi/g at the soil/basalt interface at 9.1 m (30.0 ft). Sr-90 activity levels follow the same pattern: 58.5 pCi/g at the surface, dropping from 12 pCi/g in the 0.6- to 1.2-m (2.0- to 4.0-ft) to below background in the 1.8- to 2.4-m (6.0- to 8.0-ft) intervals, 2,640 pCi/g in the 4.6- to 5.2-m (15.0- to 17.0-ft) interval, and 24.8 pCi/g at the soil/basalt interface at 9.1 m (30.0 ft). The increase in activity levels for Cs-137 and Sr-90 at the 4.6- to 5.2-m (15.0- to 17.0-ft) interval may indicate that leakage occurred from one or both of the settling structures over their periods of use. Isolated detections of Eu-152, Co-57, and U-235 were also noted in sample boring CPP-01-1.

13.1.2.2 Dry Well SW-048 Samples. Sample CPP-01-4, collected at the base of dry well SW-048, indicated large activity levels for seven radionuclides, including Cs-137 (13,800 pCi/g), Sr-90 (587 pCi/g), Co-60 (332 pCi/g) and both Eu-152 and Eu-154 (104 and 79.7 pCi/g, respectively). As this well was found to be dry and clear of filter material, the increased activity levels are evidently due to water disposed of in the well. In nearby boring CPP-01-2, Cs-137 increases with depth from 13.2 pCi/g at the surface to 3,920 pCi/g in the 2.4- to 3.0-m (8.0- to 10.0-ft) interval, before dropping to 2.52 pCi/g at the soil/basalt interface at 9.8 m (31 ft). Sr-90 activity levels increase with depth from 11.1 pCi/g at the surface to 4,850 pCi/g just above the soil/basalt interface before dropping to 3,420 pCi/g at the soil/basalt interface. It seems likely that water disposed of in dry well SW-048 carried radiologic COPCs into soils later sampled at CPP-01-2. The higher activity of Sr-90 in comparison to Cs-137 in the sample collected from just above the soil/basalt interface is likely due to the greater mobility of Sr-90 relative to that of Cs-137. Samples collected in sample boring CPP-01-2 from just above the first sedimentary interbed at approximately 32.0 m (105 ft) were screened at 0 cpm above background, suggesting that significant quantities of radiological COPCs have not migrated as deep as the interbed.

13.1.2.3 Dry Well CPP-303 Samples. Activity levels from the sample collected from the base of dry well CPP-303 on April 30, 1993 indicate large activity levels of 10 radiological COPCs, including Cs-137, total strontium, three isotopes of europium, and two of plutonium. Because this well was found to be

Table 13-1. Summary statistics for CPP-01, horizontal settling basin and vertical settling pit adjacent to SW-048 dry well and CPP-303 dry well.

COPCs	Concentration (mg/kg or pCi/g) Minimum detected	Maximum detected	Arithmetic mean	Standard deviation	Number of samples	Number of detects	Frequency of detection	INEL background (mg/kg or pCi/g)	Number greater than background
Am-241	1.78 J	1.78 J	1.78E+00	NA	1	1	100%	0.011	1
Co-57	1.02	1.02	1.02E+00	NA	1	1	100%	NA	NA
Co-60	1.38	332	7.12E+01	1.46E+02	5	5	100%	NA	NA
Cs-137	1.29	46000	4.35E+03	1.16E+04	16	16	100%	0.82	16
Eu-152	2.23	104	5.37E+01	4.98E+01	5	5	100%	NA	NA
Eu-154	4	79.7	5.03E+01	4.06E+01	3	3	100%	NA	NA
Eu-155	5.57	8.81	7.19E+00	2.29E+00	2	2	100%	NA	NA
Sr-90	11.1	4850	8.95E+02	1.43E+03	17	17	100%	0.49	17
U-235	0.00934	0.0394	2.42E-02	8.27E-03	12	12	100%	NA	NA

NA - Not applicable/available

dry and free of filter material at the time of sampling, the increased activity levels are evidently the result of water disposed of to the well. Results from nearby boring CPP-01-3 show increasing trends in activity for Cs-137, Sr-90, and U-235 from surface to 6.1 to 6.7 m (20.0 to 22.0 ft). Cs-137 increases with depth from 83.2 pCi/g at surface to 217 pCi/g in the 0.6- to 1.2-m (2.0- to 4.0-ft) interval, to 1,800 pCi/g in the 2.4- to 3.0-m (8.0- to 10.0-ft) interval, and to 46,000 pCi/g in the 6.1- to 6.7-m (20- to 22-ft) interval. Sr-90 activity levels increased from 40.5 pCi/g to 90.3 pCi/g to 650 pCi/g before dropping to 381 pCi/g over the same sample intervals. While U-235 and Cs-137 decrease below a depth of 6.1 to 6.7 m (20 to 22 ft), Sr-90 activity continues to increase down to the soil/basalt interface at 9.8 m (32 ft). Sr-90 activity was measured at 580 pCi/g in the sample collected from just above the soil/basalt interface. This boring was continued to the first sedimentary interbed at approximately 32.0 m (105 ft). A sample from the interbed yielded a field-screening radiation level of 0 cpm above background (and was not analyzed), but the sample collected from 19.8 to 22.9 m (68 to 75 ft) returned a Sr-90 activity of 69.8 pCi/g.

Previous borings for the group indicate contamination that is primarily concentrated from depths of 8.0 to 22 ft. Two boreholes, CPP-603-01 and CPP-603-02, were drilled during the RI to further delineate the extent of contamination of the Old Storage Pool Group. The locations are illustrated on Figure 13-1. Both boreholes were drilled to the soil/basalt interface encountered at approximately 32 ft bgs. For both boreholes samples were collected from the following intervals: 0 to 0.5 ft, 2.5 to 5.0 ft, 5 to 7.5 ft, 22.5 to 25 ft, 31.5 to 32 ft. The samples were analyzed for CLP metals, gross alpha/beta, select alpha and beta emitting isotopes (Am-241, Np-237, Pu-239/240, U isotopes, Sr-90, Tc-99) and gamma spectroscopy. Results are summarized in Appendix G.

Analytical results for the CPP-603 boreholes do not replicate the contamination patterns observed in other CPP-01 boreholes which show increasing trends in activities from the surface to 22 ft. Results for Cs-137 in borehole CPP-603-01 for the two samples collected from 0 to 5 ft are slightly above background at concentrations of 7.33 pCi/g and 1.44 pCi/g. Results for the CLP metals and other radionuclides are also not indicative of contamination. Similarly, results for Cs-137 in borehole CPP-603-02 do not indicate that contamination extends to the location of the new borehole. Cs-137 was detected in the two samples from 0 to 5 ft at concentrations of 23.9 pCi/g and 0.11 pCi/g. As noted above, this does not correlate with the contamination pattern defined by previous sampling for CPP-01. The levels of contaminants in these boring is similar to that of CPP-88, the radioactively contaminated soils that are not attributed to any release site.

13.1.3 Nature and Extent of Soil Contamination

Based on investigative results, numerous radiological COPCs are present in soils at site CPP-01. Cs-137 is the most widely distributed, with activities ranging as high as 46,000 pCi/g. Maximum Eu-152, Eu-154, and Eu-155 activities were 35,000 pCi/g, 35,000 pCi/g, and 7,600 pCi/g, respectively. Samples collected at the soil/basalt interface contained Cs-137, Sr-90, and U-235 at activities above background.

For purposes of the risk assessment, the analytical data from site CPP-01 will be combined with data from sites CPP-04 and CPP-05 due to a common source, and close proximity of the sites. Data from the CPP-603 borings will not be incorporated because the results indicate that these borings are not affected by the lateral and vertical extent of contamination at the site. It is assumed that the zone of contamination extends from ground surface to the soil/basalt interface, at 9.8-m (32.0-ft) bgs. The area of CPP-01, CPP-04, and CPP-05 shown on Figure 5-2 has been expanded based on results from borings CPP-01-1 and CPP-01-2, which showed radiologic COPCs at activities well above background. The adjusted area of sites CPP-01, CPP-04, and CPP-05 is shown on Figure 13-1, and measures 335 m^2 (3,608 ft^2).

13.2 Site CPP-04 and CPP-05

Site CPP-04 was identified in the Westinghouse Idaho Nuclear Company (WINCO) Environmental Restoration ICPP Environmentally Controlled Areas Reference Guide as a 10.0- × 20.4-m (33- × 67-ft) area of contaminated soil above the horizontal settling basin CPP-740 (Figure 13-1). Site CPP-05 was identified in the *WINCO Reference Guide* as the 10.0- × 20.4-m (33- × 67-ft) area of contaminated soil above the vertical settling pit CPP-301 (Figure 13-1). Because the soil associated with sites CPP-04 and CPP-05 is the same area of contamination, the two sites were combined together as one site in the Track 2 Preliminary Scoping Package (PSP) (WINCO, 1994) and this report.

13.2.1 Site Description

The soil above the horizontal settling basin (CPP-04) and vertical settling pit (CPP-05) reportedly became contaminated from unintentional releases during sludge removal activities from the two structures in 1978. The releases of the contaminated sludge had left the area contaminated to such an extent that 0.6 m (2 ft) of soil was used to cover the area.

13.2.2 Investigative Results

As part of the characterization activities of the horizontal settling basin CPP-740, 51 soil samples were collected in 1981 in the area identified as sites CPP-04 and CPP-05. To characterize the contaminated area listed as CPP-04 and CPP-05, the area was sectioned into 1.5- × 1.5-m (5- × 5-ft) grids. At each grid intersection, a boring was drilled and four soil samples were collected. A total of 204 samples were collected from 51 boring locations shown on Figure 13 in *Radioactive Waste Characterization of CPP-603 Cleanup Basin-CPP-740* (EG&G, 1982). The samples were packaged and sent to the Test Reactor Area (TRA) Radiation Measurements Laboratory (RML) for gamma spectroscopy and fissile material assaying. Sample results are summarized in Tables 6 and 7 of EG&G (1982). For the purposes of this remedial investigation/Baseline Risk Assessment (RI/BRA), the maximum concentrations reported in WINCO (1994) were used in the data summary.

The analytical results for the COPCs for sites CPP-04 and CPP-05 are summarized in Table 13-2. Based on the chemical screening in Section 5.2, the following COPCs were retained for sites CPP-04 and CPP-05: Co-60, Cs-134, Cs-137, Ce-144, Eu-152, Eu-154, Eu-155, and U-235. No organic or inorganic COPCs were identified. Seven major gamma-emitting isotopes were detected: Co-60, Cs-134, Cs-137, Ce-144, Eu-152, Eu-154, and Eu-155. Cs-137 was the most widely distributed of the radionuclides detected. Cs-137 was detected at levels above 1,000 pCi/g in 30 of the samples collected. Cs-137 ranged to a maximum activity of 26,500 pCi/g in a 0.3-m (1.0-ft) deep sample from near the CPP-740 manway access. Eu-152 and Eu-154 were found at activities above 1,000 pCi/g in 28 of the samples collected, while Eu-155 was found above 1,000 pCi/g in 10 of the samples collected. Eu-152 reached a maximum activity of 35,000 pCi/g, and Eu-154 reached a maximum activity of 35,000 pCi/g, which was also in the 0.3-m (1.0-ft) sample near the CPP-740 manway access. Ce-144 was found above 1,000 pCi/g in six samples, while Cs-134 and Co-60 were not detected above this activity.

Surficial and 0.3-m (1.0-ft) deep samples containing total gamma activity of greater than 1,000 pCi/g occur throughout CPP-04 and CPP-05, although some clustering near the CPP-740 manway access and the CPP-301 vault access can be seen. A total of 18 surficial samples and 23 0.3-m (1.0-ft) depth samples indicated total gamma activity above 1,000 pCi/g. In contrast, only two samples from a 0.6-m (2.0-ft) depth, and five samples from a 0.9-m (3.0-ft) depth indicated total gamma activity above 1,000 pCi/g. These deeper samples indicating high activity were collected from locations in proximity to the CPP-301 vault access and the SW-048 dry well humanhole.

Table 13-2. Summary statistics for CPP-04/05, contaminated soil around CPP-603 settling tank.

COPCs	Concentration (mg/kg or pCi/g) Minimum detected	Maximum detected	Arithmetic mean	Standard deviation	Number of samples	Number of detects	Frequency of detection	INEL background (mg/kg or pCi/g)	Number greater than background
Ce-144	1400	2390	2.06E+03	5.72E+02	3	3	100%	NA	NA
Co-60	620	2390	1.80E+03	1.02E+03	3	3	100%	NA	NA
Cs-134	152	1450	1.02E+03	7.49E+02	3	3	100%	NA	NA
Cs-137	23500	26500	2.55E+04	1.73E+03	3	3	100%	0.82	2
Eu-152	15500	35000	2.85E+04	1.13E+04	3	3	100%	NA	NA
Eu-154	14300	35000	2.81E+04	1.20E+04	3	3	100%	NA	NA
Eu-155	3520	7600	6.24E+03	2.36E+03	3	3	100%	NA	NA
U-235	.238	.302	2.81E-01	3.70E-02	3	3	100%	NA	NA

NA - Not applicable/available

A fissile material assay was completed in conjunction with the gamma analysis. A comparison of the gamma analysis and fissile material results showed a very close correlation in the depths and locations of radionuclides detected. It is noted the material assay, unlike the isotopic fissile material assay, cannot distinguish the neutron sources. Therefore, a plutonium and uranium source separation is not possible with this type of analysis (EG&G, 1982).

13.2.3 Nature and Extent of Soil Contamination

Based on investigative results, Cs-137, Eu-152, and Eu-154 are considered the primary COPCs because they are the most widely distributed of the radionuclides detected. Cs-137 was found at activities greater than 1,000 pCi/g in 30 of the samples collected and ranged to a maximum of 26,500 pCi/g. Eu-152 and Eu-154 were found at activities above 1,000 pCi/g in 28 of the samples collected. Eu-152 ranged to as high as 35,000 pCi/g and Eu-154 varied to as high as 35,000 pCi/g. Samples with high activity generally came from borings drilled in close proximity to the CPP-301 vault access and the SW-048 dry well humanhole. This trend was more noticeable in deeper samples.

For purposes of the BRA, CPP-04 and CPP-05 are considered together with CPP-01 due to a common source for the contaminants and close proximity of the sites. Discussion of depth and area of the contaminated zone associated with these sites was provided earlier in Section 13.1.3.

13.3 Site CPP-08 and CPP-09

Sites CPP-08 and CPP-09 consist of soil contaminated by a leak of radiologically contaminated liquid from a recirculation line in the CPP-603 basin. This section describes the nature and extent of contamination in the vicinity of the leak.

13.3.1 Site Description

During April 22 to April 30, 1973, the water level in the CPP-603 basin was observed to be decreasing much faster than could be accounted for by operations in progress or evaporation. CPP-603 personnel concluded the most likely explanation appeared to be a leak of basin water to the surrounding subsurface soils. The rate of leakage for the 7-day period averaged approximately 11,350 L (3,000 gal)/day. Normal activities of receiving and unloading fuel were performed during the period and the basin filtering system was in service. No abnormal operations were being conducted within the CPP-603 facility that could account for the decrease in the basin water level.

Additional observations revealed excessive leakage occurred only during basin filter operation. It was concluded an underground carbon steel line in the filter system most likely failed due to corrosion. The basin water circulation and filter system was taken out of service when the leak was traced to the circulation line. A blind flange was placed on the recirculation line on the south side of building CPP-603 after the leak was discovered, and the line was replaced with an aboveground line.

The exact location of the leak in the recirculation line was never pinpointed, but contaminated soil is known to be present on the east side of building CPP-603 where a section of the recirculation line was located. The contaminated soil was encountered while construction crews were replacing a leaking fire water line at CPP-603. The contaminated soil on the east side of building CPP-603 is identified in the Federal Facility Agreement and Consent Order (FFA/CO) as site CPP-09. It was determined by personnel replacing the line that the leaking water from the fire water line was not the source of the contaminated soil. Based on the circumstantial evidence discovered during preparation of the Track 2 PSPs, the contaminated soil

identified as site CPP-09 is believed to be associated with the release identified as site CPP-08. The location of contamination associated with CPP-08 was arbitrarily chosen beneath the basin area of CPP-603, because the exact location of the leak in the recirculation line was never pinpointed.

13.3.2 Investigative Results

Sites CPP-08 and CPP-09 were combined as one site based on information gathered during preparation of the Track 2 PSPs for each site. The area of contaminated soil was discovered during the replacement of a fire water line adjacent to the eastern side of CPP-603. The area of contamination was identified by radiological survey instruments, and no soil samples were collected after the contamination was detected.

One sample boring (CPP-8/9-1 on Figure 13-1) was drilled for site CPP-08 and CPP-09 as part of the OU 3-09 Track 2 characterization activities. The boring was located to identify possible contaminants and concentrations for the area identified during replacement of the fire water line. As-built drawings of building CPP-603 indicated the basin water underground line exited beneath CPP-603 along the southern edge of the building and continued along the eastern side of the building where it reentered CPP-603 to the fuel storage basins. An attempt was made during the OU 3-09 Track 2 investigation to find the recirculation line located at the southeastern corner of CPP-603. A ground-penetrating radar (GPR) survey was performed along the southern side of CPP-603 and a trench was excavated at the southeastern corner of CPP-603 to help locate the recirculation line. WINCO personnel were unable to locate the recirculation line alongside CPP-603, and no additional soil borings were drilled as part of the CPP-08 and CPP-09 investigation.

A sample was collected from the 0.0- and 0.15-m (0- and 0.5-ft) interval in boring CPP-8/9-1 and sent for laboratory analyses. The field-screening radiation level was measured at 100 cpm. The sample collected between 0.6 to 1.2 m (2 to 4 ft) was measured at 3,000 cpm, which was the highest radioactivity level measured for the 0.15- to 1.2-m (0.5- to 4-ft) interval. A sample was collected at 1.8- to 2.4-m (6- to 8-ft) bgs and screened at 1,000 to 2,200 cpm. The sample collected at 4.3- to 4.9-m (14- to 16-ft) bgs contained the highest field-screening radioactivity level in the interval between 3.0-m (10-ft) bgs and the soil/basalt interface. Field screening of samples taken between 4.9- and 8.8-m (16- and 29-ft) bgs showed radiation levels near 150 cpm. An attempt to collect a sample at the soil/basalt interface was not successful.

The analytical results of the COPCs are summarized in Table 13-3. A compilation of the analytical results is presented in Appendix G. Based on the chemical screening in Section 5.2, the following COPCs were retained for sites CPP-08 and CPP-09: Sr-90, Cs-137, Eu-152, Eu-154, and U-235. The only COPCs detected at activity levels above background in samples from boring CPP-08/09 were Cs-137 and Sr-90. None of the other site COPCs have published background concentrations. Cs-137 and Sr-90 were found at activity levels of 42.2 and 25.2 pCi/g, respectively, in the surficial sample. Both increased to maximum values of 1,080 and 140 pCi/g, respectively, in the 1.8- to 2.4-m (6.0- to 8.0-ft) interval, before decreasing to 14.9 and 90.8 pCi/g, respectively, in the 4.3- to 4.9-m (14.0- to 16.0-ft) interval. Although no samples were collected for analysis below that depth, the sample retrieved from the 8.8- to 9.4-m (29.0- to 31.0-ft) interval gave a field-screening radiation level of 50 cpm above background. Eu-152, Eu-154, were detected at activities less than 5 pCi/g while U-235 was detected at activities less than 0.1 pCi/g.

13.3.3 Nature and Extent of Soil Contamination

Based on the investigative results, Cs-137 and Sr-90 are the primary COPCs for CPP-08 and CPP-09. Cs-137 and Sr-90 activities reach maximum valves of 1,080 pCi/g and 140 pCi/g, respectively, in the 1.8- to 2.4-m (6.0- to 8.0-ft) interval of boring CPP-08/09.

Table 13-3. Summary statistics for CPP-08/09, basin filter system line failure and soil contamination near the northeast corner of CPP-603 south basin.

COPCs	Concentration (mg/kg or pCi/g) Minimum detected	Maximum detected	Arithmetic mean	Standard deviation	Number of samples	Number of detects	Frequency of detection	INEL background (mg/kg or pCi/g)	Number greater than background
Cs-137	14.9	1080	5.32E+02	5.83E+02	4	4	100%	0.82	4
Eu-152	4.38	4.38	4.38E+00	NA	1	1	100%	NA	NA
Eu-154	0.778	2.95	1.86E+00	1.54E+00	2	2	100%	NA	NA
Sr-90	25.2 J	140	8.53E+01	5.76E+01	3	3	100%	0.49	3
U-235	0.0193	0.0261	2.27E-02	4.81E-03	2	2	100%	NA	NA

NA - Not applicable/available

The zone of contamination extends from surface to the soil/basalt interface at 8.8 to 9.4 m (29 to 31 ft) bgs. No sample from the soil/basalt interface was analyzed for radiological constituents, however, field-screening radiation measurements indicated activity levels of 50 cpm over a 150 cpm background. The area of CPP-08 and CPP-09, shown on Figure 13-1, measures 251 m^2 (2,700 ft^2).

13.4 Site CPP-10

Site CPP-10, east of CPP-603, is the location of a release of radioactively-contaminated fluid (Figure 13-1). This section describes the results of the field investigation in this area.

13.4.1 Site Description

The CPP-10 release occurred at approximately 10 a.m. on December 30, 1976, when the CPP-603 fuel storage basin water filter system was started up. After approximately 5 min of operation, the system shutdown automatically due to standing water in the sump. It was discovered the water was coming from behind the shielding wall where a 1.90-cm (3/4-in.) polyvinyl chloride (PVC) line had broken. It was estimated approximately 3,030 L (800 gal) of basin water drained onto the shield area floor. A small quantity of basin water also drained through a personnel access door and contaminated a small area of an asphalt road and dirt adjacent to building CPP-603. Filter effluent and block valves were manually closed to minimize drainage. Following the release, radiological control technicians (RCTs) were notified. The contaminated area was cordoned off and surveyed by the RCTs. There is no documentation of any remedial actions at this location other than the placement of several inches of clean soil over the contaminated area.

13.4.2 Investigative Results

No soil samples were collected from the area of contamination on the date of the release of radioactively-contaminated liquid. Radiological control technicians (RCTs) cordoned off the area following the release and performed a radiological survey. Remedial actions at this site included the placement of several inches of clean soil over the contamination.

As part of the Track 2 investigation for site CPP-10 (WINCO, 1994), soil boring CPP-10-1 was drilled adjacent to building CPP-603 at the release site (Figure 13-1). The sample data were used to determine contaminant concentrations and identify risks for pathways identified in the conceptual site model (CSM).

One surface soil sample was collected between 0.0 and 0.15 m (0 and 0.5 ft) bgs and sent for radiological analysis. Surface radiation readings taken on the soil during collection of the sample were recorded at 1,000 cpm above a background of 150 cpm. The sample collected between 0.6 to 1.2 m (2 to 4 ft) bgs had the highest level of radioactivity for the 0.15- to 1.2-m (0.5- to 4-ft) interval and was surveyed at 20,000 cpm above background. The sample from 1.2- to 1.8-m (4- to 6-ft) bgs screened between 1,800 cpm and 4,000 cpm above background. Radiation readings taken 3.0-m (10-ft) bgs were significantly above background, therefore, the soil boring was continued to the soil/basalt interface and a sample collected from the interval of the highest radiation between 3.0 m (10 ft) bgs and the soil/basalt interface. The sample was collected between 6.1- to 6.7-m (20- to 22-ft) bgs and screened at 4,000 cpm. Based on field-screened radiological levels of 500 and 700 cpm in the sample collected at the soil/basalt interface, the borehole was extended down to the first sedimentary interbed located 32.3-m (106-ft) bgs. A soil sample was collected at the interbed, surveyed, and sent for radiological analysis. Radiological survey levels for the sample were below background, and the borehole was completed as a monitoring well.

The analytical results for COPCs at site CPP-10 are summarized in Table 13-4. A compilation of the analytical results is presented in Appendix G. Based on the chemical screening in Section 5.2, the following

Table 13-4. Summary statistics for CPP-10, CPP-603 plastic pipeline break.

COPCs	Concentration (mg/kg or pCi/g) Minimum detected	Maximum detected	Arithmetic mean	Standard deviation	Number of samples	Number of detects	Frequency of detection	INEL background (mg/kg or pCi/g)	Number greater than background
Co-60	3.18	3.18	3.18E+00	NA	1	1	100%	NA	NA
Cs-137	2.15	1190	4.91E+02	5.36E+02	6	6	100%	0.82	6
Eu-152	9.16	9.16	9.16E+00	NA	1	1	100%	NA	NA
Eu-154	5.7	5.7	5.70E+00	NA	1	1	100%	NA	NA
Eu-155	1.48	1.48	1.48E+00	NA	1	1	100%	NA	NA
Sr-90	41.7	58.3 J	5.00E+01	1.17E+01	6	2	33%	0.49	2
U-235	0.0113	0.0142	1.28E-02	1.46E-03	3	3	100%	NA	NA

NA - Not applicable/available

COPCs were identified for site CPP-10: Co-60, Sr-90, Cs-137, Eu-152, Eu-154, Eu-155, and U-235. The results are based on one borehole drilled as part of the Track 2 investigation. Cs-137 and U-235 were the most commonly detected radionuclides in boring CPP-10-1. Cs-137 activity levels ranged from 386 pCi/g in the surficial sample to a maximum of 1,190 pCi/g in the 0.6- to 1.2-m (2.0- to 4.0-ft) sample before decreasing to 1,130 pCi/g, 196 pCi/g, and 2.15 pCi/g in the 1.2- to 1.8-m (4.0- to 6.0-ft), 6.1- to 6.7-m (20.0- to 22.0-ft), and 9.1- to 10.3-m (30.0- to 33.9-ft) samples, respectively. U-235 was not detected above background in the surficial sample, ranged from 0.011 to 0.014 pCi/g in the intermediate-depth samples, and then dropped to below background levels in the 9.1- to 10.3-m (30.0- to 33.9-ft) sample. Although Sr-90 was not detected in any near-surface samples, it was detected at 58.3 pCi/g in the 9.10- to 10.3-m (30.0- to 33.9-ft) sample from just above the soil/basalt interface. As field-screening radiation measurements remained above background at the soil/basalt interface at 9.1 to 10.3 m (30.0 to 33.9 ft) bgs, the borehole was extended to the first sedimentary interbed located at 32.3 m (106 ft) bgs. A sample collected just above the sedimentary interbed contained six radionuclides at activities above background. These radionuclides were (activity level in parentheses) Cs-137 (39.7 pCi/g), Co-60 (3.18 pCi/g), Eu-152 (9.16 pCi/g), Eu-154 (5.7 pCi/g), Eu-155 (1.48 pCi/g), and Sr-90 (41.7 pCi/g). It is unlikely, due to the small volume of the spill and the composition of radionuclides detected in near-surface samples, that the activity levels seen in the interbed sample are due to the spill associated with site CPP-10. Effects of the CPP-10 spill are likely limited to soils above the soil/basalt interface at 9.1 to 10.3 m (30.0 to 33.9 ft).

13.4.3 Nature and Extent of Soil Contamination

Based on investigative results, the primary COPCs for CPP-10 are Cs-137 and Sr-90. Cs-137 ranged to a maximum activity of 1,190 pCi/g in a near-surface 0.6- to 1.2-m (2.0- to 4.0-ft) sample, then decreased. Cs-137 and Sr-90 were detected at activities above background at the soil/basalt interface. Numerous radiological constituents were noted in a sample collected from just above the first sedimentary interbed at 32.3 m (106 ft). Because of the small volume of the release at site CPP-10 and the different composition of radiological constituents in the 32.3-m (106-ft) sample, it does not appear that the contamination at 32.3 m (106 ft) is due to the release at site CPP-10.

The zone of contamination is assumed to extend from the surface down to the soil/basalt interface at 9.1 to 10.3 m (30.0 to 33.9 ft). The area of site CPP-10, as shown on Figure 13-1, measures 31 m^2 (336 ft^2).

13.5 Site CPP-11

Site CPP-11 is a surface spill of CPP-603 fuel storage basin sludge and liquids. The dimensions of the contaminated area are approximately 8.5 × 17.1 m (28 × 56 ft). The spill area is located directly above the basin liquid waste tank SFE-106, which is east of CPP-603 (Figure 13-1).

13.5.1 Site Description

It was reported on February 8, 1978 that between 1,130 to 1,890 L (300 to 500 gal) of waste-containing sludge and basin water were released to the ground during basin cleanup activities. Reports of the spill indicate that localized areas having radiation levels of 1 R/hr or greater were removed immediately. The remainder of the area was roped off until further decontamination efforts could be accomplished. Interviews with personnel working at CPP-603 indicate contamination from the 1978 spill at site CPP-11 has been cleaned up. The contamination present today in the soils above the SFE-106 tank is suspected to be present from small spills associated with sludge removal activities in recent years.

The 94,625-L (25,000-gal) SFE-106 tank is located approximately 1.8-m (6-ft) bgs and is still in service. Liquid waste from the CPP-603 basin is stored here before being transferred to the PEW Evaporator

Facility. Radionuclides detected in the tank are Ce-144, Co-60, Cs-134, Cs-137, Eu-152, Eu-154, Nb-95, and Sb-125.

13.5.2 Investigative Results

As discussed in Section 3, samples were collected from three borings as part of the OU 3-13 field investigation. The locations of borings CPP-11-1, CPP-11-2, and CPP-11-3 are shown on Figure 13-1. Samples were collected in order to estimate source volume and evaluate risks associated with contamination present at the site.

Samples collected from borehole CPP-11-1 were removed from the borehole location before field-screening measurements due to high surficial radiation (250 cpm) at the borehole site. Drill cuttings from the 0- to 0.8-m (0- to 2.5-ft) interval measured 300-400 cpm. Samples were collected from 0 to 0.15 m (0 to 0.5 ft), 0.15 to 0.8 m (0.5 to 2.5 ft), and 2.3 to 3.0 m (7.5 to 10.0 ft), and sent for radiological and Contract Laboratory Program (CLP) metals analysis. Field-screening radiation levels for the three samples were measured at 200, 200, and 1,000 cpm, respectively. As the field-screening radiation level was still above background at 3.0 m (10.0 ft) bgs, boring CPP-11-1 was advanced to a total depth of 4.6 m (15.0 ft), at which depth field-screening radiation levels had returned to background. An additional sample was collected from 3.0- to 3.8-m (10.0- to 12.5-ft) bgs; the radiation level for that sample measured 400 cpm.

Samples were collected from boring CPP-11-2 from the following intervals and sent for radiological and CLP metals analysis: 0 to 0.15 m (0 to 0.5 ft), 0.15 to 0.8 m (0.5 to 2.5 ft), and 2.3 to 3.0 m (7.5 to 10.0 ft). Field-screening radiation levels for the three samples were measured at 2,000 cpm, 2,000 cpm, and approximately 150 cpm, respectively. Samples were primarily sand and gravel.

Samples were collected from boring CPP-11-3 from the following intervals and sent for radiological and CLP metals analysis: 0 to 0.15 m (0 to 0.5 ft), 0.15 to 0.8 m (0.5 to 2.5 ft), 1.5 to 2.3 m (5.0 to 7.5 ft), and 6.8 to 7.6 m (22.5 to 25 ft). The four samples measured field-screening radiation levels of approximately 270 cpm, approximately 275 cpm, <200 cpm, and <150 cpm, respectively. Samples consisted primarily of sandy gravels.

The analytical results for the COPCs for CPP-11 are summarized in Table 13-5. A compilation of the analytical results is presented in Appendix G. Ce-144, Co-58, Ru-103, Rh-106, Sb-125, Eu-155, and Nb-95 were analyzed for but not detected and therefore do not appear in Table 5-32. Based on the chemical screening in Section 5.2, the following COPCs were identified for site CPP-11: arsenic, thallium, Co-60, Sr-90, Cs-137, Eu-154, and Np-237. These results are based on three borings drilled as part of the WAG 3 RI field program, as shown on Figure 13-1.

Two inorganic COPCs, arsenic and thallium, were detected at concentrations above background. However, both were detected at concentrations only slightly above background. Arsenic was detected at 6.4 mg/kg relative to background of 5.8 mg/kg and thallium was detected at 1.3 mg/kg relative to a background value of 0.43 mg/kg.

Cs-137 was the most widely detected radionuclide in samples collected at CPP-11. Surficial Cs-137 activities ranged from 23.7±0.3 pCi/g in boring CPP-11-1 to 28.5±0.3 pCi/g in boring CPP-11-2. Cs-137 activities increased with depth in these two borings to approximately 70 pCi/g in samples collected between 0.6 to 3.0 m (2.0 to 10.0 ft) before declining to between approximately 2 and 12 pCi/g. Cs-137 activity levels in CPP-11-3 decreased from 23.7±0.3 pCi/g in the surficial sample to 3.51±0.08 pCi/g in a sample collected from 1.8 to 2.4 m (6.0 to 8.0 ft). Eu-154 was detected in seven samples. Activity levels for Eu-154 ranged from 0.36±0.08 pCi/g to 1.8±0.2 pCi/g. Detections of Co-60 and Np-237 were isolated, and at

Table 13-5. Summary statistics for CPP-11, CPP-603 sludge and water release.

COPCs	Concentration (mg/kg or pCi/g) Minimum detected	Maximum detected	Arithmetic mean	Standard deviation	Number of samples	Number of detects	Frequency of detection	INEL background (mg/kg or pCi/g)	Number greater than background
Arsenic	2.8 P	6.4 P	4.77E+00	1.27E+00	10	10	100%	5.8	2
Thallium	1.3 B P	1.3 B P	1.30E+00	NA	10	1	10%	0.43	1
Co-60	0.11 +/- 0.03	0.61 +/- 0.04	2.93E-01	2.75E-01	11	3	27%	NA	NA
Cs-137	0.29 +/- 0.03	72.7 +/- 0.7	2.44E+01	2.54E+01	11	11	100%	0.82	10
Eu-154	0.36 +/- 0.08	1.8 +/- 0.2	7.04E-01	5.31E-01	11	7	64%	NA	NA
Np-237	0.15 +/- 0.05	0.15 +/- 0.05	1.50E-01	NA	1	1	100%	NA	NA
Sr-90	13.1 +/- 0.3 J	13.1 +/- 0.3 J	1.31E+01	NA	1	1	100%	0.49	1

NA - Not applicable/available

activities of less than 1 pCi/g. Sr-90 was found in one sample, at an activity of 13.1±0.3 pCi/g in the surficial sample at boring CPP-11-2.

13.5.3 Nature and Extent of Soil Contamination

Based on investigative results, Cs-137 and Eu-154 are the primary COPCs associated with site CPP-11. Cs-137 was the most widely-distributed radionuclide and reached a maximum activity of 72.7±0.7 pCi/g. Eu-154 was detected at activities less than 2 pCi/g. Detections above background of arsenic, thallium, Co-60, and Np-237 were isolated.

The zone of contamination is estimated to extend from surface to 5.5 m (18 ft). This is based on radionuclide activities above background in borings as deep as 3.8 m (12.5 ft). While radionuclide activities were still higher than background at that depth, sample results indicate that COPC activities are decreasing with depth.

The initial area of site CPP-11, shown on Figure 5-2 was expanded to the east, based on results from boring CPP-11-1, and to the north based on results from borings CPP-11-2 and CPP-11-3. The revised site area, shown on Figure 13-1, measures 208 m^2 (2,244 ft^2).

13.6 Risk Assessment

The methodology for conducting the HHRA for WAG 3 was detailed in Section 7. As presented, the purpose of the HHRA is to develop a quantitative description and assessment of the human health risk posed by the COPCs present at WAG 3. The results for the air and groundwater pathways are detailed in Sections 27.1 and 27.2, respectively. The risk assessment at this group will become cumulative when the contributions from the air and groundwater pathways are added to that from the soil pathway. The following sections discuss the complete exposure routes, exposure-point concentrations, and cancer risk and noncarcinogenic health hazard estimates for the Old Storage Pool Group under the three exposure scenarios evaluated. Section 13.6.3 will describe the difference in estimating sources of contamination for use in evaluating surface exposure and fate and transport modeling to the SRPA. This section will also describe the use of the screened ORIGEN runs (see Section 4.4) to help identify contaminants potentially missing from the soil source estimate.

13.6.1 Complete Exposure Routes

Potentially complete pathways from the source to a human receptor were described in Section 7 and illustrated on Figure 7-1. For the Old Storage Pool Group, the complete exposure routes within each pathway are summarized in Table 13-6. An exposure route is considered complete if the contaminated zone (as characterized in the previous sections and summarized on the table) occurs within the depth intervals specified for a given exposure route. All exposure routes, as described in Section 7, are considered complete for the Old Storage Pool Group.

13.6.2 Exposure-Point Concentrations

Specific steps in calculating exposure-point concentrations for each of the applicable scenarios were described in Section 7. The COPC soil value used for an individual site was the smaller of the 95% upper confidence limit (UCL) or maximum concentration. The soil values for the Old Storage Pool Group were estimated using the individual site concentration terms for CPP-01/04/05, CPP-08/09, CPP-10, and CPP-11. The individual site concentration terms were used to provide an area-weighted estimate. Concentrations for the interstitial area within the group [i.e., the non-Environmentally Controlled Area (ECA) areas] were assumed to be similar to site CPP-88. The concentration terms for the radionuclides were adjusted to account

Table 13-6. Complete exposure routes for the Old Storage Pool Group and associated exposure route depths.

Receptor	Scenario	Potentially complete exposure routes and exposure route depths used for exposure-point concentration estimates	Characterized zone of contamination[a]	Complete exposure route?
Onsite worker	Current land use	Inhalation of VOCs	0 to 10.4 m	No
		[0–15 cm (0–6 in.)]	(0 to 34 ft)	Yes
		Inhalation of airborne particulates [0–15 cm (0–6 in.)]		Yes
		Ingestion of surface soil [0–15 cm (0–6 in.)]		Yes
		External radiation [0–1.22 m (0–4 ft)]		
Residential	Future land use	Inhalation of VOCs [0–3.05 m (0–10 ft)]	0 to 10.4 m	No
		Inhalation of airborne particulates [0–3.05 m (0–10 ft)]	(0 to 34 ft)	Yes
		Ingestion of surface soil [0–3.05 m (0–10 ft)]		Yes
		Ingestion of homegrown produce [0–3.05 m (0–10 ft)]		Yes
		Ingestion of groundwater		Yes
		Dermal contact with groundwater		No
		Inhalation of VOCs from groundwater		No
		External radiation [0–3.05 m (0–10 ft)]		Yes
Onsite worker	Future land use	Inhalation of VOCs [0–15 cm (0–6 in.)]	0 to 10.4 m	No
		Inhalation of airborne particulates [0–15 cm (0–6 in.)]	(0 to 34 ft)	Yes
		Ingestion of surface soil [0–15 cm (0–6 in.)]		Yes
		External radiation [0–1.22 m (0–4 ft)]		Yes

a. Zone of contamination based on the following previously characterized zones:

CPP-01/04/05	= 0 to 9.8 m (0 to 32 ft)
CPP-08/09	= 0 to 9.4 m (0 to 31 ft)
CPP-10	= 1 to 10.4 m (0 to 34 ft)
CPP-11	= 0 to 5.5 m (0 to 18 ft).

for decay for each exposure scenario. These values were subsequently averaged over the exposure duration. The concentration terms, by depth interval, are presented in Tables 13-7 through 13-9. Exposures from all complete exposure routes were estimated based on the exposure-point concentration in Table 13-10. Homegrown produce concentrations are presented in Table 13-11. The values for air and groundwater are presented in Sections 27.1 and 27.2, respectively.

13.6.3 Description of Source Estimates for Surface Exposure and Groundwater Modeling Use

The purpose for this subsection is two-fold. First, to compare the approach to defining the source estimate for use in both the surface exposure assessment and the groundwater model. This comparison was accomplished by comparing the soil data in Table 13-9 to the soil data used to estimate the source for use in the groundwater model, which can be found in Tables 5-39 and 5-40 of Appendix F. The benefit of these comparisons is to relate both source estimates and explain any apparent differences. Secondly, the results of the screened ORIGEN runs summarized in Section 4.4 were used to help identify any potential soil-related data gaps by comparing ORIGEN results to the field investigation soil results. This comparison was based on the full inventory of contaminants in the screening tables in Section 5 before implementing the screening steps shown therein. The results of these comparisons are described for each site in the following paragraphs. The results of this comparison for perched water and the SRPA are reported at the end of Section 4.4.

The CPP-01/04/05 source estimate for groundwater use was based on the same soil COPC's summarized in Table 13-9 (except Am-241). In a few cases the concentrations were different because the total depth interval to evaluate future residential intrusion exposure is 0 to 10 feet bgs., while the soil source estimate for groundwater use included soil measurements of samples collected deeper than 10 feet. The concentrations of Cs-137, Pu-239/240, Sr-90, and U-238 were affected by these depth assumptions and therefore differ between those provided in Table 13-9 and Table 5-40 of Appendix F. Based on a comparison of the radionuclides that were analyzed in site soils against the potential inventory as defined by the screened ORIGEN results (Table 4-7) Pu-238 and Pu-241 were not part of the soil sampling performed at this site. The implication is that these radionuclides may be present and are currently not part of the soil contaminant inventory.

The CPP-08/09 source estimate for groundwater use was based on the same soil COPC's and concentrations summarized in Table 13-9. Based on a comparison of the radionuclides that were analyzed in site soils against the potential inventory as defined by the screened ORIGEN results (Table 4-7), Am-241, Pu-238, Pu-239, Pu-240, and Pu-241 were not part of the soil sampling performed at this site. The implication is that these radionuclides may be present and are currently not part of the soil contaminant inventory.

The CPP-10 source estimate for groundwater modeling use includes several radionuclides that are not summarized in Table 13-9 because the total depth interval to evaluate future residential intrusion exposure is 0 to 10 feet bgs., while the soil source estimate for groundwater use included soil measurements of samples collected deeper than 10 feet. The site geometry used in the groundwater model assumed a contamination thickness of 33 feet (0-33 ft. bgs.) even though soil samples were collected at a depth of 104 ft bgs. However, all available data was used to estimate the mass of each contaminant based on this source. The groundwater model source estimate also included Co-60, Eu-152, Eu-154, Eu-155, and Sr-90. Based on a comparison of the radionuclides that were analyzed in site soils against the potential inventory as defined by the screened ORIGEN results (Table 4-7), Am-241, Pu-238, Pu-239, Pu-240 and Pu-241 were not part of the soil sampling performed at this site. The implication is that these radionuclides may be present and are currently not part of the soil contaminant inventory.

Table 13-7. Area-weighted soil concentrations for the Old Storage Pool Group (0 to 0.5 ft).

COPCs[a]	Site					Area weighted concentration (mg/kg or pCi/g)
	CPP-01/-04/-05	CPP-08/09	CPP-10	CPP-11	CPP-88	
Area (ft^2)	3608	2700	336	2244	4489	
Area (m^2)	335.20	250.84	31.22	208.48	417.05	
Aroclor-1260	----	----	----	----	----	0.00E+00
Benzo(a)pyrene	----	----	----	----	----	0.00E+00
Aluminum	----	----	----	----	----	0.00E+00
Arsenic	----	----	----	6.40E+00	----	1.07E+00
Manganese	----	----	----	----	----	0.00E+00
Mercury	----	----	----	----	----	0.00E+00
Uranium	----	----	----	----	----	0.00E+00
Am-241	----	----	----	----	----	0.00E+00
Ce-144	1.40E+03	----	----	----	----	3.78E+02
Co-57	----	----	----	----	----	0.00E+00
Co-58	----	----	----	----	----	0.00E+00
Co-60	2.39E+03	----	----	1.60E-01	----	6.45E+02
Cs-134	1.45E+03	----	----	----	----	3.91E+02
Cs-137	2.65E+04	4.22E+01	3.86E+02	2.85E+01	1.41E+01	7.18E+03
Eu-152	3.50E+04	----	----	----	----	9.44E+03
Eu-154	3.50E+04	7.78E-01	----	1.00E+00	----	9.44E+03
Eu-155	7.60E+03	----	----	----	----	2.05E+03
H-3	----	----	----	----	----	0.00E+00
I-129	----	----	----	----	----	0.00E+00
K-40	----	----	----	----	----	0.00E+00
Nb-95	----	----	----	----	----	0.00E+00
Np-237	----	----	----	----	----	0.00E+00
Pu-238	----	----	----	----	----	0.00E+00
Pu-239/240	----	----	----	----	----	0.00E+00
Pu-241	----	----	----	----	----	0.00E+00
Pu-242	----	----	----	----	----	0.00E+00
Ru/Rh-106	----	----	----	----	----	0.00E+00
Sb-125	----	----	----	----	----	0.00E+00
Sr-90	5.85E+01	2.52E+01	----	1.31E+01	3.55E+00	2.43E+01
Tc-99	----	----	----	----	----	0.00E+00
U-234	----	----	----	----	----	0.00E+00
U-235	3.02E-01	----	----	----	----	8.15E-02
U-236	----	----	----	----	----	0.00E+00
U-238	----	----	----	----	----	0.00E+00

Total Group Area (ft^2) = 13377

CPP-88 area (ft^2) = 4489

a. Concentration terms are not calculated for thallium because it does not have available human toxicity data.

Table 13-8. Area-weighted soil concentrations for the Old Storage Pool Group (0 to 4 ft).

COPCs[a]	Site					Area weighted concentration (mg/kg or pCi/g)
	CPP-01/-04/-05	CPP-08/09	CPP-10	CPP-11	CPP-88	
Area (ft^2)	3608	2700	336	2244	4489	
Area (m^2)	335.20	250.84	31.22	208.48	417.05	
Aroclor-1260	---	---	---	---	---	0.00E+00
Benzo(a)pyrene	---	---	---	---	---	0.00E+00
Aluminum	---	---	---	---	---	0.00E+00
Arsenic	---	---	---	6.40E+00	6.43E+00	3.23E+00
Manganese	---	---	---	---	---	0.00E+00
Mercury	---	---	---	---	---	0.00E+00
Uranium	---	---	---	---	---	0.00E+00
Am-241	---	---	---	---	---	0.00E+00
Ce-144	2.39E+03	---	---	---	---	6.45E+02
Co-57	1.02E+00	---	---	---	---	2.75E-01
Co-58	---	---	---	---	---	0.00E+00
Co-60	2.39E+03	---	---	1.60E-01	---	6.45E+02
Cs-134	1.45E+03	---	---	---	---	3.91E+02
Cs-137	2.65E+04	9.92E+02	1.19E+03	7.27E+01	1.27E+01	7.39E+03
Eu-152	3.50E+04	4.38E+00	---	---	---	9.44E+03
Eu-154	3.50E+04	2.95E+00	---	9.46E-01	---	9.44E+03
Eu-155	7.60E+03	---	---	---	---	2.05E+03
H-3	---	---	---	---	---	0.00E+00
I-129	---	---	---	---	---	0.00E+00
K-40	---	---	---	---	---	0.00E+00
Nb-95	---	---	---	---	---	0.00E+00
Np-237	---	---	---	1.50E-01	---	2.52E-02
Pu-238	---	---	---	---	---	0.00E+00
Pu-239/240	---	---	---	---	---	0.00E+00
Pu-241	---	---	---	---	---	0.00E+00
Pu-242	---	---	---	---	---	0.00E+00
Ru/Rh-106	---	---	---	---	---	0.00E+00
Sb-125	---	---	---	---	---	0.00E+00
Sr-90	9.03E+01	2.52E+01	---	1.31E+01	2.47E+00	3.25E+01
Tc-99	---	---	---	---	---	0.00E+00
U-234	---	---	---	---	---	0.00E+00
U-235	3.02E-01	2.61E-02	1.30E-02	---	---	8.70E-02
U-236	---	---	---	---	---	0.00E+00
U-238	---	1.56E-01	---	---		3.15E-02

Total Group Area (ft^2) = 13377

CPP-88 area (ft^2) = 4489

a. Concentration terms are not calculated for thallium because it does not have available human toxicity data.

Table 13-9. Area-weighted soil concentrations for the Old Storage Pool Group (0 to 10 ft).

COPCs[a]	Site					Area weighted concentration (mg/kg or pCi/g)
	CPP-01/-04/-05	CPP-08/09	CPP-10	CPP-11	CPP-88	
Area (ft^2)	3608	2700	336	2244	4489	
Area (m^2)	335.20	250.84	31.22	208.48	417.05	
Aroclor-1260	----	----	----	----	----	0.00E+00
Benzo(a)pyrene	----	----	----	----	----	0.00E+00
Aluminum	----	----	----	----	----	0.00E+00
Arsenic	----	----	----	5.90E+00	5.90E+00	2.97E+00
Manganese	----	----	----	----	----	0.00E+00
Mercury	----	----	----	----	----	0.00E+00
Uranium	----	----	----	----	----	0.00E+00
Am-241	----	----	----	----	----	0.00E+00
Ce-144	2.39E+03	----	----	----	----	6.45E+02
Co-57	1.02E+00	----	----	----	----	2.75E-01
Co-58	----	----	----	----	----	0.00E+00
Co-60	2.39E+03	----	----	6.10E-01	----	6.45E+02
Cs-134	1.45E+03	----	----	----	----	3.91E+02
Cs-137	2.65E+04	1.08E+03	1.19E+03	7.27E+01	1.18E+01	7.41E+03
Eu-152	3.50E+04	4.38E+00	----	----	----	9.44E+03
Eu-154	3.50E+04	2.95E+00	----	1.87E+00	----	9.44E+03
Eu-155	7.60E+03	----	----	----	----	2.05E+03
H-3	----	----	----	----	----	0.00E+00
I-129	----	----	----	----	----	0.00E+00
K-40	----	----	----	----	----	0.00E+00
Nb-95	----	----	----	----	----	0.00E+00
Np-237	----	----	----	1.50E-01	----	2.52E-02
Pu-238	----	----	----	----	----	0.00E+00
Pu-239/240	9.19E+00	----	----	----	----	2.48E+00
Pu-241	----	----	----	----	----	0.00E+00
Pu-242	----	----	----	----	----	0.00E+00
Ru/Rh-106	----	----	----	----	----	0.00E+00
Sb-125	----	----	----	----	----	0.00E+00
Sr-90	1.67E+03	1.40E+02	----	1.31E+01	1.57E+00	4.81E+02
Tc-99	----	----	----	----	----	0.00E+00
U-234	----	----	----	----	----	0.00E+00
U-235	3.02E-01	2.61E-02	1.42E-02	----	----	8.71E-02
U-236	----	----	----	----	----	0.00E+00
U-238	----	----	----	----	----	0.00E+00

Total Group Area (ft^2) = 13377

CPP-88 area (ft^2) = 4489

a. Concentration terms are not calculated for thallium because it does not have available human toxicity data.

Table 13-10. Average soil exposure-point concentrations (mg/kg or pCi/g) for land use scenarios.

	Current occupational worker year 0 to year 25		Future occupational worker year 100 to year 125		Future resident year 100 to year 130
COPCs	(0 - 0.5 ft)	(0 - 4 ft)	(0 - 0.5 ft)	(0 - 4 ft)	(0 - 10 ft)
Aroclor-1260	----	----	----	----	----
Benzo(a)pyrene	----	----	----	----	----
Aluminum	----	----	----	----	----
Arsenic	1.07E+00	3.23E+00	1.07E+00	3.23E+00	2.97E+00
Manganese	----	----	----	----	----
Mercury	----	----	----	----	----
Uranium[a]	3.77E-02	1.34E-01	3.77E-02	1.34E-01	4.03E-02
Am-241	----	----	----	----	----
Ce-144	1.70E+01	2.89E+01	3.51E-38	5.98E-38	4.99E-38
Co-57	----	1.18E-02	----	3.23E-43	2.69E-43
Co-58	----	----	----	----	----
Co-60	1.89E+02	1.89E+02	3.68E-04	3.68E-04	3.13E-04
Cs-134	4.65E+01	4.65E+01	1.14E-13	1.14E-13	9.51E-14
Cs-137	5.46E+03	5.63E+03	5.49E+02	5.66E+02	5.39E+02
Eu-152	5.34E+03	5.34E+03	3.27E+01	3.27E+01	2.96E+01
Eu-154	4.13E+03	4.13E+03	1.57E+00	1.57E+00	1.38E+00
Eu-155	5.69E+02	5.69E+02	4.87E-04	4.87E-04	4.12E-04
H-3	----	----	----	----	----
I-129	----	----	----	----	----
K-40	----	----	----	----	----
Nb-95	----	----	----	----	----
Np-237	----	2.52E-02	----	2.52E-02	2.52E-02
Pu-238	----	----	----	----	----
Pu-239/240	----	----	----	----	2.47E+00
Pu-241	----	----	----	----	----
Pu-242	----	----	----	----	----
Ru/Rh-106	----	----	----	----	----
Sb-125	----	----	----	----	----
Sr-90	1.83E+01	2.45E+01	1.69E+00	2.26E+00	3.18E+01
Tc-99	----	----	----	----	----
U-234	----	----	----	----	----
U-235	8.14E-02	8.70E-02	8.14E-02	8.70E-02	8.71E-02
U-236	----	----	----	----	----
U-238	----	3.15E-02	----	3.15E-02	----

a. mg/kg of uranium calculated from pCi/g of uranium isotopes using the equation
mg/kg = pCi/g * 2.795E-12 (mg-mole/kg-pCi-yr) * MW (g/mole) * $t_{1/2}$ (yr).

Table 13-11. Concentrations of COPCs in homegrown produce.

COPCs	Homegrown produce (mg/kg or pCi/g)	Kd (cm^3/g)	COPC input rate from irrigation (mg/g-d or pCi/g-d)	Leach rate constant (d^{-1})
Aroclor-1260	---	7.89E+03	0.00E+00	9.95E-07
Benzo(a)pyrene	---	1.19E+03	0.00E+00	6.57E-06
Aluminum	---	0.00E+00	0.00E+00	2.87E-02
Arsenic	4.66E-03	3.00E+00	8.71E-09	2.40E-03
Manganese	---	5.00E+01	0.00E+00	1.56E-04
Mercury	1.10E-01	1.00E+02	2.91E-08	7.83E-05
Uranium	1.14E-04	6.00E+00	7.04E-09	1.25E-03
Am-241	7.76E-06	3.40E+02	6.08E-06	2.31E-05
Ce-144	1.53E-43	5.00E+02	0.00E+00	1.57E-05
Co-57	7.63E-48	1.00E+01	0.00E+00	7.64E-04
Co-58	---	1.00E+01	0.00E+00	7.64E-04
Co-60	6.26E-08	1.00E+01	0.00E+00	7.64E-04
Cs-134	1.19E-17	5.00E+02	0.00E+00	1.57E-05
Cs-137	9.85E-01	5.00E+02	4.12E-05	1.57E-05
Eu-152	5.31E-04	3.40E+02	0.00E+00	2.31E-05
Eu-154	1.60E-05	3.40E+02	0.00E+00	2.31E-05
Eu-155	2.69E-09	3.40E+02	0.00E+00	2.31E-05
H-3	----	0.00E+00	6.22E-04	2.87E-02
I-129	3.85E-06	0.00E+00	3.26E-05	2.87E-02
K-40	---	1.50E+01	0.00E+00	5.14E-04
Nb-95	---	0.00E+00	0.00E+00	2.87E-02
Np-237	4.07E-05	0.00E+00	8.36E-06	2.87E-02
Pu-238	---	2.20E+01	0.00E+00	3.53E-04
Pu-239/240	2.57E-03	2.20E+01	5.84E-07	3.53E-04
Pu-241	8.49E-09	2.20E+01	9.37E-08	3.53E-04
Pu-242	3.60E-09	2.20E+01	3.88E-10	3.53E-04
Ru/Rh-106	---	0.00E+00	0.00E+00	2.87E-02
Sb-125	---	5.00E+01	0.00E+00	1.56E-04
Sr-90	3.63E-01	1.20E+01	5.63E-05	6.40E-04
Tc-99	4.56E-01	0.00E+00	1.67E-04	2.87E-02
U-234	2.73E-05	6.00E+00	2.63E-06	1.25E-03
U-235	8.99E-05	6.00E+00	9.27E-08	1.25E-03
U-236	6.93E-07	6.00E+00	6.68E-08	1.25E-03
U-238	2.44E-05	6.00E+00	2.35E-06	1.25E-03

The CPP-11 source estimate for groundwater modeling use was based on the same soil COPC's and concentrations summarized in Table 13-9 with the exception of thallium. Based on a comparison of the radionuclides that were analyzed in site soils against the potential inventory as defined by the screened ORIGEN results (Table 4-7) Pu-241 was not part of the soil sampling performed at this site. The implication is that this radionuclide may be present and is currently not part of the soil contaminant inventory.

13.6.4 Risk Estimates

The results of this evaluation under current and future land use are presented in Sections 13.6.4.1 and 13.6.4.2. For each receptor, the results are summarized in Tables 13-12 through 13-17.

13.6.4.1 Current Land Use. As indicated in Table 13-12, total cancer risk to the current onsite worker from exposure to site-related chemicals in surface soil is estimated to be 3E-01. The risk is attributed to ingestion of soil and external radiation exposure. The primary COCs for the soil ingestion exposure route are Cs-137 (4E-05) and Eu-154 (1E-05). The risk from external radiation exposure is mainly attributed to Co-60 (1E-02), Cs-134 (2E-03), Cs-137 (6E-02), Eu-152 (1E-01), and Eu-154 (1E-01). Table 13-13 indicates that the total noncarcinogenic hazard index to the current worker is estimated to be 2E-10. There are no hazard indices above unity for the current onsite worker.

13.6.4.2 Future Land Use. As Table 13-14 indicates, the total cancer risk to the future onsite worker from exposure to site-related chemicals in surface soil is estimated to be 7E-03. The risk is attributed to ingestion of soil with the primary COC being Cs-137 (4E-06) and to external radiation exposure with the primary COCs being Cs-137 (7E-03), Eu-152 (8E-04), and Eu-154 (4E-05). Table 13-15 indicates that the total noncarcinogenic hazard index to the future onsite worker is 2E-10. There are no hazard indices above unity for the future onsite worker. As indicated in Table 13-16, the total cancer risk for the future resident from exposure to site-related chemicals in soil is estimated to be 4E-02. Within the soil ingestion exposure route, the major contributor is Cs-137 (2E-05). The risk from ingestion of homegrown produce is driven by Cs-137 (5E-06). External radiation exposure has Cs-137 (3E-02), Eu-152 (3E-03), and Eu-154 (2E-04) as the primary contributors to risk. As shown in Table 13-17, the total noncarcinogenic hazard to the future resident is estimated to be 1E-01. There are no hazard indices above unity for the future resident.

13.7 Uncertainties

This section describes the limitations and uncertainties specific to the site characterization of the Old Storage Pool Group. Sources of uncertainty associated with site characterization include data quality, COPC identification, concentration term estimation, and assumptions regarding the lateral and vertical extent of COPC occurrence. In the risk assessment, the most significant uncertainties are due to the selection process of COPCs, the toxicity values used, and the assumptions used during the exposure assessment. The following paragraphs will discuss important sources of site-specific uncertainty in greater detail.

Sampling and analysis uncertainties are related to quality problems that may result in qualified and rejected results (Section 3.5). Qualified results are considered estimates of the concentration in the sample and, for all practical purposes, useable for their intended purpose, although they could be biased high or low. Rejected results are considered unusable, thus limiting the size of the useable data set. For the Old Storage Pool Group, several data points were rejected based on the method validation as documented in the Limitations and Validation (L&V) Reports. The rejected data points and possible impacts are summarized as follows:

- Am-241 in three of the four samples from CPP-01 was rejected. This reduced the number of useable data points to one. As a result, the concentration term estimate may be underestimated.

Table 13-12. Soil pathway cancer risk to the current onsite worker. [a]

COPCs	Ingestion of soil	External radiation exposure	Total risks
Aroclor-1260	----	----	----
Benzo(a)pyrene	----	----	----
Aluminum	----	----	----
Arsenic	2E-07	----	2E-07
Manganese	----	----	----
Mercury	----	----	----
Uranium	NTD	----	----
Am-241	----	----	----
Ce-144	1E-07	3E-05	3E-05
Co-57	----	1E-08	1E-08
Co-58	----	----	----
Co-60	9E-07	1E-02	1E-02
Cs-134	5E-07	2E-03	2E-03
Cs-137	4E-05	6E-02	6E-02
Eu-152	8E-06	1E-01	1E-01
Eu-154	1E-05	1E-01	1E-01
Eu-155	2E-07	2E-04	2E-04
H-3	----	----	----
I-129	----	----	----
K-40	----	----	----
Nb-95	----	----	----
Np-237	----	7E-08	7E-08
Pu-238	----	----	----
Pu-239/240	----	----	----
Pu-241	----	----	----
Pu-242	----	----	----
Ru/Rh-106	----	----	----
Sb-125	----	----	----
Sr-90	3E-07	NTD	3E-07
Tc-99	----	----	----
U-234	----	----	----
U-235	1E-09	1E-07	1E-07
U-236	----	----	----
U-238	----	9E-09	9E-09
Total cancer risks by route:	6E-05	3E-01	3E-01

"----" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 13-13. Soil pathway noncarcinogenic hazard to the current onsite worker. [a]

COPCs	Ingestion of soil	External radiation exposure	Total HIs
Aroclor-1260	----	----	----
Benzo(a)pyrene	----	----	----
Aluminum	----	----	----
Arsenic	1E-10	----	1E-10
Manganese	----	----	----
Mercury	----	----	----
Uranium	4E-11	----	4E-11
Am-241	----	----	----
Ce-144	----	----	----
Co-57	----	----	----
Co-58	----	----	----
Co-60	----	----	----
Cs-134	----	----	----
Cs-137	----	----	----
Eu-152	----	----	----
Eu-154	----	----	----
Eu-155	----	----	----
H-3	----	----	----
I-129	----	----	----
K-40	----	----	----
Nb-95	----	----	----
Np-237	----	----	----
Pu-238	----	----	----
Pu-239/240	----	----	----
Pu-241	----	----	----
Pu-242	----	----	----
Ru/Rh-106	----	----	----
Sb-125	----	----	----
Sr-90	----	----	----
Tc-99	----	----	----
U-234	----	----	----
U-235	----	----	----
U-236	----	----	----
U-238	----	----	----
Total hazard indices by route:	2E-10	0E+00	2E-10

"----" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 13-14. Soil pathway cancer risk to the future onsite worker. [a]

COPCs	Ingestion of soil	External radiation exposure	Total risks
Aroclor-1260	----	----	----
Benzo(a)pyrene	----	----	----
Aluminum	----	----	----
Arsenic	2E-07	----	2E-07
Manganese	----	----	----
Mercury	----	----	----
Uranium	NTD	----	----
Am-241	----	----	----
Ce-144	3E-46	5E-44	5E-44
Co-57	----	4E-49	4E-49
Co-58	----	----	----
Co-60	2E-12	2E-08	2E-08
Cs-134	1E-21	4E-18	4E-18
Cs-137	4E-06	7E-03	7E-03
Eu-152	5E-08	8E-04	8E-04
Eu-154	4E-09	4E-05	4E-05
Eu-155	2E-13	2E-10	2E-10
H-3	----	----	----
I-129	----	----	----
K-40	----	----	----
Nb-95	----	----	----
Np-237	----	7E-08	7E-08
Pu-238	----	----	----
Pu-239/240	----	----	----
Pu-241	----	----	----
Pu-242	----	----	----
Ru/Rh-106	----	----	----
Sb-125	----	----	----
Sr-90	2E-08	NTD	2E-08
Tc-99	----	----	----
U-234	----	----	----
U-235	1E-09	1E-07	1E-07
U-236	----	----	----
U-238	----	9E-09	9E-09
Total cancer risks by route:	5E-06	7E-03	7E-03

"----" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 13-15. Soil pathway noncarcinogenic hazard to the future onsite worker. [a]

COPCs	Ingestion of soil	External radiation exposure	Total HIs
Aroclor-1260	---	---	---
Benzo(a)pyrene	---	---	---
Aluminum	---	---	---
Arsenic	1E-10	---	1E-10
Manganese	---	---	---
Mercury	---	---	---
Uranium	4E-11	---	4E-11
Am-241	---	---	---
Ce-144	---	---	---
Co-57	---	---	---
Co-58	---	---	---
Co-60	---	---	---
Cs-134	---	---	---
Cs-137	---	---	---
Eu-152	---	---	---
Eu-154	---	---	---
Eu-155	---	---	---
H-3	---	---	---
I-129	---	---	---
K-40	---	---	---
Nb-95	---	---	---
Np-237	---	---	---
Pu-238	---	---	---
Pu-239/240	---	---	---
Pu-241	---	---	---
Pu-242	---	---	---
Ru/Rh-106	---	---	---
Sb-125	---	---	---
Sr-90	---	---	---
Tc-99	---	---	---
U-234	---	---	---
U-235	---	---	---
U-236	---	---	---
U-238	---	---	---
Total hazard indices by route:	2E-10	0E+00	2E-10

"---" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 13-16. Soil pathway cancer risk to the future onsite resident. [a]

COPCs	Ingestion of soil	Ingestion of homegrown	External radiation exposure	Total risks
Aroclor-1260	—	—	—	—
Benzo(a)pyrene	—	—	—	—
Aluminum	—	—	—	—
Arsenic	7E-06	8E-07	—	8E-06
Manganese	—	—	—	—
Mercury	—	NTD	—	—
Uranium	NTD	NTD	—	—
Am-241	—	4E-10	—	4E-10
Ce-144	2E-45	8E-49	2E-43	2E-43
Co-57	3E-52	1E-54	2E-48	2E-48
Co-58	—	—	—	—
Co-60	7E-12	2E-13	9E-08	9E-08
Cs-134	6E-21	1E-22	2E-17	2E-17
Cs-137	2E-05	5E-06	3E-02	3E-02
Eu-152	2E-07	5E-10	3E-03	3E-03
Eu-154	2E-08	3E-11	2E-04	2E-04
Eu-155	9E-13	8E-16	7E-10	7E-10
H-3	—	—	—	—
I-129	—	1E-10	—	1E-10
K-40	—	—	—	—
Nb-95	—	—	—	—
Np-237	1E-08	2E-09	3E-07	3E-07
Pu-238	—	—	—	—
Pu-239/240	1E-06	1E-07	1E-09	1E-06
Pu-241	—	5E-13	—	5E-13
Pu-242	—	2E-13	—	2E-13
Ru/Rh-106	—	—	—	—
Sb-125	—	—	—	—
Sr-90	2E-06	4E-06	NTD	6E-06
Tc-99	—	1E-07	—	1E-07
U-234	—	2E-10	—	2E-10
U-235	5E-09	7E-10	7E-07	7E-07
U-236	—	5E-12	—	5E-12
U-238	—	3E-10	—	3E-10
Total cancer risks by route:	3E-05	1E-05	4E-02	4E-02

"—" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 13-17. Soil pathway noncarcinogenic hazard to the future onsite resident. [a]

COPCs	Ingestion of soil	Ingestion of homegrown	External radiation exposure	Total HIs
Aroclor-1260	—	—	—	—
Benzo(a)pyrene	—	—	—	—
Aluminum	—	—	—	—
Arsenic	3E-09	4E-03	—	4E-03
Manganese	—	—	—	—
Mercury	—	1E-01	—	1E-01
Uranium	4E-10	1E-05	—	1E-05
Am-241	—	—	—	—
Ce-144	—	—	—	—
Co-57	—	—	—	—
Co-58	—	—	—	—
Co-60	—	—	—	—
Cs-134	—	—	—	—
Cs-137	—	—	—	—
Eu-152	—	—	—	—
Eu-154	—	—	—	—
Eu-155	—	—	—	—
H-3	—	—	—	—
I-129	—	—	—	—
K-40	—	—	—	—
Nb-95	—	—	—	—
Np-237	—	—	—	—
Pu-238	—	—	—	—
Pu-239/240	—	—	—	—
Pu-241	—	—	—	—
Pu-242	—	—	—	—
Ru/Rh-106	—	—	—	—
Sb-125	—	—	—	—
Sr-90	—	—	—	—
Tc-99	—	—	—	—
U-234	—	—	—	—
U-235	—	—	—	—
U-236	—	—	—	—
U-238	—	—	—	—
Total hazard indices by route:	4E-09	1E-01	0E+00	1E-01

"—" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

- Sr-90 in one of the 18 samples from CPP-01 was rejected. This reduced the number of useable data points to 17. The impact to the concentration term estimate is likely to be insignificant.

- Sr-90 in one of the four samples from CPP-08/09 was rejected. This reduced the number of useable data points to three. The rejected data point was 145 pCi/g. The useable maximum was 140 pCi/g. Given this, the impact to the concentration term estimate is likely to be insignificant.

- Sr-90 in four of the six samples from CPP-10 was rejected. This reduced the number of useable data points to two. Most of the rejected results were significantly greater than the remaining values. This may indicate that the concentration term has been underestimated.

- Sr-90 in five of the six samples from CPP-11 was rejected. This reduced the number of useable data points to one. Most of the rejected results were significantly greater than the remaining values. This may indicate that the concentration term has been underestimated.

- Tc-99 in all six of the CPP-11 samples was rejected. As a result, Tc-99 has not been characterized. This underestimates the risk estimates for the site.

Uncertainty associated with the chemical screening process (Section 5.2) results from using the maximum concentration for chemicals detected in the ECAs in the background comparison step, retaining chemicals detected as COPCs because there is not a corresponding background value, and retaining chemicals as COPCs for which there is no toxicity information available.

In most cases, the COPC identification process used the maximum concentration for a chemical detected in the background comparison step, regardless of its magnitude above background. The use of the maximum concentration can result in the identification of COPCs that have concentrations only slightly above background. For the Old Storage Pool Group arsenic was the only COPC that fell into this category. The maximum arsenic concentrations for the Old Storage Pool Group were observed at site CPP-11 (6.4 mg/kg). The background value for arsenic is 5.8 mg/kg. This results in an increase in the number of COPCs considered in the RI/BRA and a possible overestimation of risk because of inclusion of COPCs with concentrations that are likely within the true background population.

One source of uncertainty related to the background comparison step in the chemical screening process relates to chemicals for which no background concentration exists. For example, fluoride, nitrate, and several radionuclides were not characterized as part of the Rood et al. (1995) background study. For the Old Storage Pool Group, the following COPCs have no corresponding background concentration: Ce-144, Co-57, Co-60, Cs-137, Eu-152, Eu-154, Eu-155, Np-237, and U-235. This results in an increase in the number of COPCs considered in the RI/BRA and a possible overestimation of risk because the observed concentrations may be within the background population.

Some concentration estimates are based on the 95% UCL for the site, or the area-weighted average 95% UCLs for sites that have been grouped. When the 95% UCL (i.e., the concentration term estimate) of a COPC is below the corresponding background value, this results in an increase in the number of COPCs in the RI/BRA and a possible overestimation of risk because the results are likely within the background range. This source of uncertainty stems from the use of maximum concentrations when identifying the COPCs for a specific site. For the Old Storage Pool Group, arsenic, U-234, and U-238 concentration estimates were below background but included as COPCs in the RI/BRA. This results in an increase in the number of COPCs considered in the RI/BRA and a possible overestimation of risk because of inclusion of COPCs with concentrations that are likely within the true, background population.

For the Old Storage Pool Group, thallium was retained as a COPC for the RI/BRA. There are no toxicity values in integrated Risk Information System (IRIS), Health Effects Assessment Summary Tables (HEAST), or EPA Region III publications for thallium. Uses of thallium include thallium salts, mercury alloys, low-melting glasses, rodenticides, photoelectric applications, and electrodes in dissolved oxygen analyzers. The impact of not including thallium may underestimate the risk; however, the impact is not quantifiable because of the lack of toxicity information.

Although the area of CPP-01/04/05 has been expanded, the precise lateral extent of contamination is not known. Borings CPP-01-1 and CPP-01-2 and numerous CPP-04/05 samples located near the ECA boundaries indicated COPC constituents above background. As well, the lateral extent of contaminated soil associated with dry well CPP-303 has not been delineated.

The lateral extent of contamination at CPP-08/09 has not been precisely described, and calculations based on the current ECA boundaries may either overestimate or underestimate the true mass of affected soil. The zone of contamination is assumed to extend from surface to the soil/basalt interface. This assumption is based on elevated field-screening radiation levels in boring CPP-08/09-1, however no sample was collected for radiological analysis from the soil/basalt interface. The deepest sample collected at CPP-08/09 to indicate COPC activities above background was collected at 4.9-m (16-ft) bgs. If COPC activities decrease to less than background below 4.9 m (16 ft), the current estimate of affected soil is too large. All source concentration values for CPP-08/09 are based on results from one boring. If this boring were drilled at the location of highest COPC concentrations, site-wide values based on this boring would overestimate the true mass of affected soil.

The current ECA boundaries at CPP-10 may overestimate the lateral extent of contamination, based on the small volume of contaminated water believed to have been released. Accurate lateral extent of contamination has not been assessed.

Another source of uncertainty may be associated with the contaminant inventories used for the groundwater modeling and residential intrusion surface exposure at every sub-area. Section 13.6.3 identifies radionuclides potentially missing from these inventories. The implication of these potential data gaps in that the source estimates could be underestimated. Based on the results of the groundwater modeling, the potentially missing Pu-238 and -241, which have half-lives of 87.7 and 14.4 years, respectively, would be expected to decay away due to their long travel time to the SRPA. Am-241 is potentially missing from the source estimates, but would not be expected to be a concern because the vast majority of Am-241 is accounted for in the tank farm area and this condition was shown to be protective. For a discussion of uncertainty associated with Pu-239, see Section 10 of Appendix F. The potential uncertainty is recognized in this report, but no information is available to quantify the uncertainty.

13.8 Conclusions and Recommendations

The results of the risk assessment under current land use for the Old Storage Pool Group indicate that the increased cancer risk from exposure to group-related contaminants is well above the EPA-recommended target range and therefore, unacceptable. The increased cancer risk to hypothetical future onsite workers and residents was also found to be well above the EPA-recommended target range. The noncarcinogenic hazard for all receptors was found to be below the EPA hazard index goal of one. These estimates do not include the contributions associated with the air and groundwater pathways. The total increased cancer and hazard incidence to humans is reported in Section 27. The risk estimates of this group are likely to be overestimated for reasons described in Sections 7 and 13.7. It should be noted that the evaluation of exposure to current onsite workers did not consider the benefits of a radiation protection program currently implemented at the INEL that limits worker exposure to an acceptable level. Given these limitations, the exposure from direct

soil pathways alone is still expected to be severe enough that some type of future response action should be considered to mitigate adverse impacts to human health and the environment. However, the response action should be designed so that it is protective of human and environmental receptors under future land use.

13.9 References

EG&G Idaho, Inc., 1982, *Radioactive Waste Characterization of CPP-603 Cleanup Basin System CPP-740, Revision 1*, May.

Rood, S. M., G. A. Harris, and G. J. White, 1995, *Background Dose Equivalent Rates and Surficial Soil Metal and Radionuclide Concentrations for the Idaho National Engineering Laboratory*, INEL-94/0250, Revision 0, February.

WINCO, 1994, *Draft Preliminary Scoping Track 2 Summary Report For Operable Unit 3-09, Revision 1*, September.

Chapter 14

14. STORAGE YARD EAST OF CPP-603 GROUP RESULTS (CPP-03, CPP-17a, and CPP-17b)

This group includes three sites that were previously used as storage areas for old and abandoned equipment or piles of soil, asphalt, concrete, or metal debris. The three sites are identified as CPP-03, CPPs-17a, and -17b, and are shown on Figure 14-1. Sections 14.1 and 14.2 provide site descriptions, investigative results, and an assessment of nature and extent of contamination for the sites. The human health risk assessment (HHRA) for the group follows. The results of the field investigations at the three sites indicate that the source estimates may show the group to pose an excess cancer risk within or slightly higher than the EPA recommended range. Therefore, to avoid recommending an action where one is not needed, the results of the risk assessment are presented for the group (Section 14.3) and again for each site individually (Section 14.4).

14.1 Site CPP-03

Site CPP-03 is the location of a former temporary storage area southeast of the Fuel Receiving and Storage Facility (FRSF) at building CPP-603 (Figure 14-1). This section presents the results of investigations conducted to determine the nature and extent of contamination at this site.

14.1.1 Site Description

The dimensions of site CPP-03 are approximately 45.7 × 152.4 m (150 × 500 ft). The area, commonly referred to as the "boneyard," was used to store old and abandoned, radioactively-contaminated equipment such as tanks, valves, and fuel casks. The storage area was decommissioned in the late 1970s, and all contaminated equipment was packed into standard wooden radioactive-waste boxes and taken to the Radioactive Waste Management Complex (RWMC). The top several inches of underlying soil was contaminated due to the storage of equipment in the area. Most of the contaminated soil was removed, boxed, and sent to the RWMC for disposal. Approximately 0.3 m (11 in.) of uncontaminated soil has been placed over the area and graded to a level surface.

During the summer of 1983, radioactively-contaminated soil was encountered when workers began to replace Tank WL-102 (in the Tank Farm area of the ICPP). Approximately 340 m^3 (12,000 yd^3) of excavated contaminated soil (less than 30 mR/hr) from the WL-102 tank replacement project was temporarily stored at site CPP-03. The contaminated soil was moved later the same year and placed in a trench in the northeast corner of the ICPP (CPP-34). The contaminated soil was characterized after it was placed in the trench and was shown to contain concentrations of lead, mercury, and silver above background levels, but not exceeding extraction procedure (EP)-toxicity levels. The soil also contained bis (2-ethylhexyl) phthalate. Radiological analyses performed indicated low concentrations of Pu-238, Np-237, U-234, U-238, Cs-137, and Sr-90.

14.1.2 Investigative Results

A radiation survey was performed on October 18 and 19, 1993, in the temporary storage area adjacent to building CPP-603. The survey was conducted using a Ludlum 2A portable survey instrument and 14C-Geiger Muller (GM) counter. The eastern 20% of the CPP-03 area measuring 30.5 × 45.7 m (100 × 150 ft) was divided into 176, 3.0- × 3.0-m (10- × 10-ft) grids and surveyed. The remaining 80% of the area measuring 121.9 × 45.7 m (400 × 150 ft) was divided into 112, 7.6- × 7.6-m (25- × 25-ft) grids and surveyed. Information exists stating the most contaminated material was stored in the eastern 20% of site CPP-03. Background levels in the eastern 20% area ranged between 80 counts per minute (cpm) and 200 cpm, while a majority of the surface readings taken in the grids ranged between 100 cpm and 400 cpm. Two locations in the northeastern corner of the area showed surface radioactivity of 1,000 cpm and 4,400 cpm.

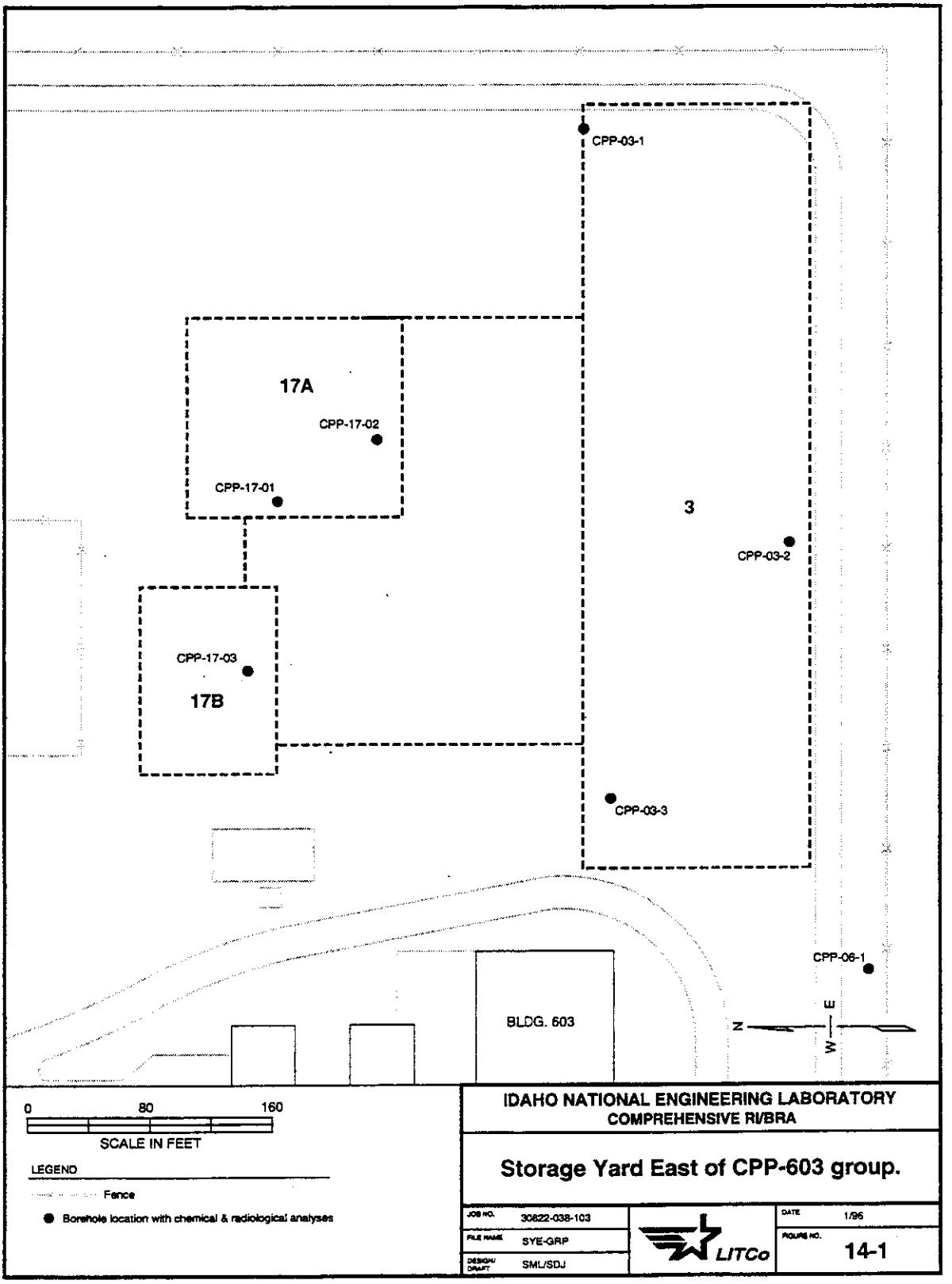


Figure 14-1. Storage yard east of CPP-603 Group.

Radiation levels in the remaining western 80% of site CPP-03 ranged between 60 cpm and 1,000 cpm, with a majority of the readings between 100 cpm and 200 cpm. With the exception of several small hotspots, most of the surface survey readings ranged between 100 cpm and 1,000 cpm. Three hotspots located in the northwestern corner of the 7.6- × 7.6-m (25- × 25-ft) gridded area included readings of 7,000, 13,000, and 20,000 cpm, and one hotspot located near the center of the gridded area had a reading of 4 mR/hr. Results of the field radiation survey are included in the *OU 3-09 Preliminary Scoping Track 2 Summary Report* (WINCO, 1994).

The results of the field survey may be influenced by the 0.3 m (11 in.) of soil placed over site CPP-03. The soil may be providing an unknown amount of shielding and higher levels of radiation may be encountered below the 0.3-m (11-in.) depth. If an even layer of soil was placed over the area, it can be assumed the soil would be providing an even amount of shielding and the hotspots identified from the field survey would still represent the areas of highest contamination.

A decision was made to resurvey the northeastern corner of site CPP-03 to determine if contamination extended to the north of the Environmentally Controlled Area (ECA). There was concern contamination may be present outside the area covered by the October survey. A 6.0- × 9.1-m (20- × 30-ft) area was surveyed on December 9, 1993, and radiation levels were only slightly above background levels. Personnel performing the field survey had to scrape away several inches of snowfall covering the ground at each location before radiation measurements could be taken. Since the two radiation surveys were taken at separate times and under different field conditions, the data from the December survey can only be used for comparison to the October data. The results of the survey are included in Appendix B of the OU 3-09 Track 2 Sampling and Analysis Plan (SAP).

Three Track 2 soil borings in site CPP-03 were located based on the results of the October 1993 radiological survey. One soil boring was drilled in the eastern 20% of the 45.7- × 152.4-m (150- × 500-ft) area. The other two sample borings were drilled in the remaining area of site CPP-03. The three soil borings were extended to an approximate depth of 3.0-m (10-ft) below ground surface (bgs) and are shown in Figure 14-1.

A ground-penetrating radar (GPR) survey was performed by Westinghouse Idaho Nuclear Company (WINCO) personnel over the eastern one-half of site CPP-03 on June 27, 1994, to determine whether pieces of construction debris may have been buried in a trench in the area. The GPR survey was spaced at 7.6-m (25-ft) intervals, and the survey equipment could detect subsurface anomalies to approximately 2.4-m (8-ft) bgs. No large pieces of debris were detected, and the GPR equipment observed only small miscellaneous debris (small pieces of pipe, etc.).

A soil sample was collected between 0- to 1.5-m (0- to 0.5-ft) bgs in each of the three boreholes. Continuous samples were taken between 0.15- to 1.2-m (0.5- to 4-ft) bgs using split-spoon samplers, and the sample collected from the interval having the highest radiation level was sent for laboratory analyses. Continuous samples were also taken between 1.2 to 3.0 m (4 to 10 ft), and the sample collected from the interval having the highest radiation level was also sent for laboratory analyses. Radiation levels of soils at 3.0-m (10-ft) bgs were at or below background levels for each of the three CPP-03 boreholes; therefore, the boreholes were not extended to the soil/basalt interface.

Results of the nine samples collected in boreholes CPP-03-1, CPP-03-2, and CPP-03-3 are summarized in Table 14-1. Based on the chemical screening in Section 5.2, the following contaminants of potential concern (COPCs) were identified for site CPP-03: Sr-90, Cs-137, and Eu-152. Cs-137 was the most widely distributed radionuclide in samples from CPP-03. Cs-137 was detected at activity levels above background in surficial samples from each sample boring at CPP-03 at activities ranging from 65.1 pCi/g at CPP-03-2 to 1.4 pCi/g at CPP-03-1. Cs-137 was also detected at activities above background in samples collected from

Table 14-1. Summary statistics for CPP-03, temporary storage area of CPP-603 stockpile soil.

COPCs	Concentration (mg/kg or pCi/g) Minimum detected	Maximum detected	Arithmetic mean	Standard deviation	Number of samples	Number of detects	Frequency of detection	INEL background (mg/kg or pCi/g)	Number greater than background
Cs-137	0.253	65.1	2.47E+01	2.80E+01	8	8	100%	0.82	7
Eu-152	2.13	2.13	2.13E+00	NA	1	1	100%	NA	NA
Sr-90	15.6	43.9 J	2.52E+01	1.62E+01	3	3	100%	0.49	3

NA - Not applicable/available

0.15 to 0.6 m (0.5 to 2.0 ft) in borings CPP-03-1 and CPP-03-3, and from 0.15 to 0.45 m (0.5 to 1.5 ft) at boring CPP-03-2. Cs-137 activities in those samples ranged from 24.4 pCi/g at CPP-03-2 to 1.96 pCi/g at CPP-03-1. Sr-90 was also detected in surficial samples from CPP-03-2 and CPP-03-3, at activities ranging from 43.9 pCi/g to 16 pCi/g.

14.1.3 Nature and Extent of Soil Contamination

Based on investigative results, the primary COPC at this site is Cs-137. Cs-137 was detected at activity levels greater than background in all six surface or near-surface samples collected at site CPP-03. The zone of contamination is assumed to extend from ground surface to a depth of 1.2 m (4.0 ft). This conservative assumption is based on the presence of Cs-137 at low activities in samples collected extending to as deep as 0.6-m (2.0-ft) bgs and the decrease in Cs-137 activities with depth. The area of contamination at CPP-03 is assumed to be 6,970 m^2 (75,000 ft^2) based on the previously defined extent of the site, as shown on Figure 14-1.

14.2 Site CPP-17a and CPP-17b

Site CPP-17 consists of two areas east of building CPP-603 and south of the CPP Peach Bottom Fuel Storage area (Figure 14-1). This section describes the nature and extent of contamination at the two areas that comprise site CPP-17.

14.2.1 Site Description

Site CPP-17 is divided into Area 17a and Area 17b. Area 17a measures approximately 37.8 × 39.7 m (125 × 135 ft) and Area 17b approximately 38.8 × 23.0 m (130 × 78 ft). These areas were once used for storing piles of soil, asphalt, concrete, metal debris, and other items during a period of at least 5 yr. The stored material reportedly came from a variety of construction and maintenance activities within the ICPP perimeter fence. It has been reported that before these sites were used for storing construction soil and debris, sludge/liquids generated during CPP-603 fuel storage basin maintenance activities may have been deposited in these areas, resulting in contamination of the underlying soils. The areas were classified as radioactive Zone 1 and roped off to prevent entry.

14.2.2 Investigative Results

During the summer of 1991, a Department of Energy (DOE) Tiger Team identified the soil/debris pile areas as radioactively-contaminated surface soils that were exposed to wind and water erosion. In July 1991, surveys were conducted on the two piles, and radiological contamination was detected ranging from 100 to 22,000 cpm above background. Because of these results, a decision was made to control and containerize the contaminated soil and debris. The Work Plan called for removing the soil/debris mounds without excavating belowgrade. Removal of the soil piles at Site CPP-17 was initiated on October 16, 1991, and completed on February 13, 1992. The mounds were sprayed with a light water mist to reduce transport of dust from wind erosion.

The soil was containerized into approximately 640 standard radioactive waste boxes, each measuring 0.6 × 1.2 × 2.4 m (2 × 4 × 8 ft). The soil was monitored during removal using an RO-2A survey meter; however, no radiological contamination was detected during the project using this survey method. Results of gamma spectroscopy analyses indicated that low levels of Cs-137 were present. The volume of contaminated soil is approximately 1,160 m^3 (40,960 ft^3). During containerization of the soil, four composite grab samples were collected and analyzed for toxicity characteristic leaching procedure (TCLP) metals and radioactive constituents. The results indicated the soil samples did not exhibit the toxicity characteristic for heavy metals

(D004-D011) in accordance with 40 Code of Federal Regulations (CFR) 261, and that low levels of Cs-137, Sr-90, Eu-152, Eu-154, Pu-238, and Pu-239 were present. After the contaminated soil was removed from site CPP-17, the area was leveled to grade.

Radiation surveys were performed in October 1993 on the two areas in CPP-17. The survey was conducted using a Ludlum 2A portable survey instrument and a 14C-GM counter. Area 17a was divided into 182, 3.0- × 3.0-m (10- × 10-ft) grids and surveyed. Area 17b was divided into 112, 3.0- × 3.0-m (10- × 10-ft) grids and surveyed. Background levels in Area 17a ranged between 80 and 220 cpm, while background levels in Area 17b ranged between 140 and 240 cpm.

The majority of the readings taken in Area 17a ranged between 100 and 240 cpm, but two locations with elevated levels of radioactivity were identified. One location along the western edge of Area 17a showed radiation readings near 1,200 cpm; while radioactivity levels of 1,000 cpm were recorded along the south-central edge of Area 17a. While most of the readings taken in Area 17b ranged between 160 and 240 cpm, one location showed radioactivity levels near 400 cpm along the south-central boundary of the area.

A decision was made to resurvey the two areas to determine if contamination extended outside the boundaries of two areas. Several of the isopleths on the plot produced for CPP-17a were not bounded and there was concern that contamination may be present outside the areas covered by the October 1993 surveys. An additional 6.1- × 21-m (20- × 70-ft) area was surveyed along the southern edge of Area CPP-17a on December 9, 1993 and radiation levels were near background levels with the exception of one reading of 4,500 cpm. The location of the 4,500 cpm reading detected in the December survey was approximately 3.0 m (10 ft) from the 1,200 cpm reading detected during the October survey. The coordinates of the second borehole (Figure 14-1) were based on the location of the 4,500 cpm survey reading. The second borehole location lies slightly outside the arbitrary boundary of CPP-17a. An additional 6.1- × 24-m (20- × 80-ft) area along the southern edge of Area CPP-17b was also surveyed to verify that no surface contamination was present outside the boundaries of CPP-17b. With the exception of one reading of 500 cpm, all surface radiation readings were only slightly above background. The location of the CPP-17b soil boring was based on the October 1993 survey results. As was the case at site CPP-03, several inches of snow covering the ground had to be scraped away from the location of each field reading before radiation measurements could be taken.

As part of the OU 3-09 Track 2 characterization activities at CPP-17, three soil borings were sampled to characterize Areas 17a and 17b (Figure 14-1). Soil boring locations were based on the October and December 1993 radiological surveys. Borehole CPP-17-1 was drilled in Area 17a at the south-central location that surveyed at 1,000 cpm, while borehole CPP-17-2 was drilled at the location along the western edge of Area 17a that surveyed at 1,200 cpm. Borehole CPP-17-3 was drilled at the south-central boundary in Area 17b at the location surveyed at 400 cpm.

A sample was collected between 0 and 0.15 m (0- and 0.5-ft) bgs in each of the three boreholes. Continuous samples were taken between 0.15 and 1.2 m (0.5- and 4-ft) bgs using split-spoon samplers, and the sample collected from the interval having the highest radiation level was sent for laboratory analyses. Continuous samples were also taken between 1.2- and 3.0-m (4- and 10-ft) bgs, and the sample collected from the interval having the highest radiation level was also sent for laboratory analyses. Radiation levels in soils at 3.0 m (10 ft) bgs were at or below background levels for each of the three CPP-17 boreholes, therefore, the boreholes were not extended down to the soil/basalt interface.

The analytical results of COPCs identified for CPP-17a and CPP-17b are summarized in Tables 14-2 and 14-3. Results of the nine samples collected in boreholes CPP-17-1, CPP-17-2, and CPP-17-3 are presented in Appendix G. Based on the chemical screening in Section 5.2, the following COPCs were identified for site CPP-17a: Sr-90, Cs-137, Eu-152, and Eu-154.

Cs-137 and Sr-90 were the most widely distributed COPCs at CPP-17a. Cs-137 activity ranged from 19.4 pCi/g to 3.19 pCi/g in surficial samples, and from 1.83 pCi/g to below background in samples collected in the 0.15- to 0.6-m (0.5- to 2.0-ft) bgs interval. Sr-90 was not detected above background in surficial samples, it was detected at activities ranging from 2.72 pCi/g to 0.875 pCi/g in samples collected from 0.15 to 0.6 m (0.5 to 2.0 ft) bgs. Sr-90 was also detected at an activity of 0.627 pCi/g in a sample from 2.4 to 2.9 m (8.0 to 10.0 ft).

Based on the chemical screening, the COPCs at site CPP-17b are Cs-137 and Co-57. Cs-137 was detected at activities of 10.5 and 1.83 pCi/g in samples from boring CPP-17-3. An isolated detection of Co-57 at 0.543 pCi/g was noted in a sample from the same boring.

14.2.3 Nature and Extent of Soil Contamination

Based on investigative results, the primary COPCs at CPP-17 are Cs-137 and Sr-90. These radionuclides were detected at activities above background in most surface and near-surface samples collected, however, activities of these radionuclides decreased with depth and were at low activity levels in samples collected at 0.6-m (2.0-ft) bgs. The depth of contamination at Areas CPP-17a and CPP-17b is therefore estimated to be 1.2-m (4.0-ft). The initial area of CPP-17a, shown on Figure 5-2, has been expanded to the south due to the presence of COPCs at activities above background in boring CPP-17-2. CPP-17a now covers an area of 1,570 m^2 (16,900 ft^2). The initial area of CPP-17b has been expanded to the south due to the presence of COPCs at activities above background in boring CPP-17-03. CPP-17b now covers an area of 940 m^2 (10,120 ft^2).

14.3 Risk Assessment for the Group

The methodology for conducting the HHRA for WAG 3 is detailed in Section 7. As presented, the purpose of the HHRA is to develop a quantitative description and assessment of the human health risk posed by the COPCs present at WAG 3. This section only contains the results of the HHRA for the storage yard east of CPP-603 Group with respect to the soil pathway as well as individual site risk for the sites within the group. The results for the air and groundwater pathways are detailed in Sections 27.1 and 27.2, respectively. The risk assessment for the group will become cumulative when the contributions from the air and groundwater pathways are added to that due to the soil pathways. The following sections discuss the complete exposure routes, exposure-point concentrations, and cancer risk and noncarcinogenic health hazard estimates for the storage yard east of CPP-603 Group under the three exposure scenarios evaluated. Section 14.3.3 describes the difference in estimating sources of contamination for use in evaluating surface exposure and fate and transport modeling to the SRPA. It also describes the use of the screened ORIGEN runs (see Section 4.4) to help identify contaminants potentially missing from the soil source estimate.

14.3.1 Storage Yard East Group Complete Exposure Routes

Potentially complete pathways from the source to a human receptor are described in Section 7 and illustrated on Figure 7-1. For the storage yard east of CPP-603 Group, the complete exposure routes within each pathway are summarized in Table 14-4. An exposure route is considered complete if the contaminated zone (as characterized in the previous sections and summarized on the table) occurs within the depth intervals specified for a given exposure route. All exposure routes, as described in Section 7, are considered complete for the storage yard east of CPP-603 Group.

Table 14-2. Summary statistics for CPP-17A soil storage area south of CPP Peach Bottom fuel storage area.

COPCs	Concentration (mg/kg or pCi/g) Minimum detected	Maximum detected	Arithmetic mean	Standard deviation	Number of samples	Number of detects	Frequency of detection	INEL background (mg/kg or pCi/g)	Number greater than background
Cs-137	.351	19.4	5.38E+00	7.93E+00	5	5	100%	0.82	4
Eu-152	2.07	2.07	2.07E+00	NA	1	1	100%	NA	NA
Eu-154	1.88	1.88	1.88E+00	NA	1	1	100%	NA	NA
Sr-90	0.627	2.72	1.70E+00	1.10E+00	4	4	100%	0.49	4

NA - Not applicable/available

Table 14-3. Summary statistics for CPP-17B, soil storage area south of CPP Peach Bottom fuel storage area.

COPCs	Concentration (mg/kg or pCi/g) Minimum detected	Maximum detected	Arithmetic mean	Standard deviation	Number of samples	Number of detects	Frequency of detection	INEL background (mg/kg or pCi/g)	Number greater than background
Co-57	0.543	0.543	5.43E-01	NA	1	1	100%	NA	NA
Cs-137	1.83	10.5	6.17E+00	6.13E+00	2	2	100%	0.82	2

NA - Not applicable/available

Table 14-4. Complete exposure routes for the storage yard east of CPP-603 Group and associated exposure route depths.

Receptor	Scenario	Potentially complete exposure routes and exposure route depths used for exposure-point concentration estimates	Characterized zone of contamination[a]	Complete exposure route?
Onsite worker	Current land use	Inhalation of VOCs	0 to 1.2 m	No
		[0–15 cm (0–6 in.)]	(0 to 4 ft)	Yes
		Inhalation of airborne particulates [0–15 cm (0–6 in.)]		Yes
		Ingestion of surface soil [0–15 cm (0–6 in.)]		Yes
		External radiation [0–1.22 m (0–4 ft)]		
Residential	Future land use	Inhalation of VOCs [0–3.05 m (0–10 ft)]	0 to 1.2 m	No
		Inhalation of airborne particulates [0–3.05 m (0–10 ft)]	(0 to 4 ft)	Yes
		Ingestion of surface soil [0–3.05 m (0–10 ft)]		Yes
		Ingestion of homegrown produce [0–3.05 m (0–10 ft)]		Yes
		Ingestion of groundwater		Yes
		Dermal contact with groundwater		No
		Inhalation of VOCs from groundwater		No
		External radiation [0–3.05 m (0–10 ft)]		Yes
Onsite worker	Future land use	Inhalation of VOCs [0–15 cm (0–6 in.)]	0 to 1.2 m	No
		Inhalation of airborne particulates [0–15 cm (0–6 in.)]	(0 to 4 ft)	Yes
		Ingestion of surface soil [0–15 cm (0–6 in.)]		Yes
		External radiation [0–1.22 m (0–4 ft)]		Yes

a. Zone of contamination based on the following previously characterized zones:

CPP-03 = 0 to 1.2 m (0 to 4 ft)
CPP-17a = 0 to 1.2 m (0 to 4 ft)
CPP-17b = 0 to 1.2 m (0 to 4 ft).

14.3.2 Exposure-Point Concentrations

Specific steps in calculating exposure-point concentrations for each of the applicable scenarios are described in Section 7. The COPC soil value used for an individual site was the smaller of the 95% upper confidence limit (UCL) or maximum concentration. The soil values for the storage yard east of CPP-603 Group were estimated using the individual site concentration terms for CPP-03, CPP-17a, and CPP-17b. The individual site concentration terms were used to provide an area-weighted estimate. Concentrations for the interstitial area within the group (i.e., the non-ECA areas) were assumed to be similar to site CPP-88. Site CPP-88 soil concentrations were included in the storage yard east of CPP-603 Group concentration term estimates. The concentration terms for the radionuclides were adjusted to account for decay for each exposure scenario. These values were subsequently averaged over the exposure duration. The concentration terms, by depth interval, are presented in Tables 14-5 through 14-7. Exposures from all complete exposure routes were estimated based on the exposure-point concentrations in Table 14-8. Homegrown produce concentrations are presented in Table 14-9. The values for air and groundwater are presented in Sections 27.1 and 27.2, respectively.

14.3.3 Description of Source Estimates for Surface Exposure and Groundwater Modeling Use

The purpose for this subsection is two-fold. First, to compare the approach to defining the source estimate for use in both the surface exposure assessment and the groundwater model. This comparison was accomplished by comparing the soil data in Table 14-7 to the soil data used to estimate the source for use in the groundwater model, which can be found in Tables 5-39 and 5-40 of Appendix F. The benefit of these comparisons is to relate both source estimates and explain any apparent differences. Secondly, the results of the screened ORIGEN runs summarized in Section 4.4 were used to help identify any potential soil-related data gaps by comparing ORIGEN results to the field investigation soil results and\ or the contaminant inventory at each site. This comparison was based on the full inventory of contaminants in the screening tables in Section 5 before implementing the screening steps shown therein. The results of these comparisons are described for each site in the following paragraphs.

The same soil COPC's in Table 14-7 for site CPP-03 were used to develop the source estimate for groundwater modeling use as depicted in Table 5-40 of Appendix F. Based on a comparison of the radionuclides that were analyzed in site soils against the potential inventory as defined by the screened ORIGEN results (Table 4-7), Am-241, Eu-154, Pu-238, Pu-239/240 and Pu-241 were not part of the soil sampling analytical suite. The implication is that these radionuclides may be present and are currently not part of the soil contaminant inventory.

The same soil COPC's in Table 14-7 for site CPP-17A and CPP-17B were used to develop the source estimate for groundwater modeling use as depicted in Table 5-40 of Appendix F. Based on a comparison of the radionuclides that were analyzed in site soils against the potential inventory as defined by the high enrichment ORIGEN run (Table 4-7), Am-241, Pu-238, Pu-239/240, and Pu-241, were not part of the soil sampling analytical suite for CPP-17A; and Am-241, Eu-154, Pu-238, Pu-239/240, Pu-241, and Sr-90 were not part of the soil sampling analytical suite site CPP-17B. The implication is that these radionuclides may be present and are currently not part of the soil contaminant inventory.

14.3.4 Risk Estimates

The results of this evaluation under current and future land use are presented in Sections 14.3.4.1 and 14.3.4.2. For each receptor, the results are summarized in Tables 14-10 through 14-15.

Table 14-5. Area-weighted soil concentrations for the Storage Yard Group (0 to 0.5 ft).

COPCs	Site				Area weighted concentration (mg/kg or pCi/g)
	CPP-03	CPP-17a	CPP-17b	CPP-88	
Area (ft^2)	75000	16900	10120	50744	
Area (m^2)	6967.90	1570.10	940.20	4714.39	
Aroclor-1260	—	—	—	—	0.00E+00
Benzo(a)pyrene	—	—	—	—	0.00E+00
Aluminum	—	—	—	—	0.00E+00
Arsenic	—	—	—	—	0.00E+00
Manganese	—	—	—	—	0.00E+00
Mercury	—	—	—	—	0.00E+00
Uranium	—	—	—	—	0.00E+00
Am-241	—	—	—	—	0.00E+00
Ce-144	—	—	—	—	0.00E+00
Co-57	—	—	5.43E-01	—	3.60E-02
Co-58	—	—	—	—	0.00E+00
Co-60	—	—	—	—	0.00E+00
Cs-134	—	—	—	—	0.00E+00
Cs-137	6.34E+01	1.94E+01	1.05E+01	1.41E+01	3.86E+01
Eu-152	2.13E+00	2.07E+00	—	—	1.27E+00
Eu-154	—	1.88E+00	—	—	2.08E-01
Eu-155	—	—	—	—	0.00E+00
H-3	—	—	—	—	0.00E+00
I-129	—	—	—	—	0.00E+00
K-40	—	—	—	—	0.00E+00
Nb-95	—	—	—	—	0.00E+00
Np-237	—	—	—	—	0.00E+00
Pu-238	—	—	—	—	0.00E+00
Pu-239/240	—	—	—	—	0.00E+00
Pu-241	—	—	—	—	0.00E+00
Pu-242	—	—	—	—	0.00E+00
Ru/Rh-106	—	—	—	—	0.00E+00
Sb-125	—	—	—	—	0.00E+00
Sr-90	4.39E+01	2.58E+00		3.55E+00	2.30E+01
Tc-99	—	—	—	—	0.00E+00
U-234	—	—	—	—	0.00E+00
U-235	—	—	—	—	0.00E+00
U-236	—	—	—	—	0.00E+00
U-238	—	—	—	—	0.00E+00

Total Group Area (ft^2) =	152764
CPP-88 area (ft^2) =	50744

Table 14-6. Area-weighted soil concentrations for the Storage Yard Group (0 to 4 ft).

COPCs	Site				Area weighted concentration (mg/kg or pCi/g)
	CPP-03	CPP-17a	CPP-17b	CPP-88	
Area (ft^2)	75000	16900	10120	50744	
Area (m^2)	6967.90	1570.10	940.20	4714.39	
Aroclor-1260	----	----	----	----	0.00E+00
Benzo(a)pyrene	----	----	----	----	0.00E+00
Aluminum	----	----	----	----	0.00E+00
Arsenic	----	----	----	6.43E+00	2.14E+00
Manganese	----	----	----	----	0.00E+00
Mercury	----	----	----	----	0.00E+00
Uranium	----	----	----	----	0.00E+00
Am-241	----	----	----	----	0.00E+00
Ce-144	----	----	----	----	0.00E+00
Co-57	----	----	5.43E-01	----	3.60E-02
Co-58	----	----	----	----	0.00E+00
Co-60	----	----	----	----	0.00E+00
Cs-134	----	----	----	----	0.00E+00
Cs-137	6.34E+01	1.94E+01	1.05E+01	1.27E+01	3.82E+01
Eu-152	2.13E+00	2.07E+00	----	----	1.27E+00
Eu-154	----	1.88E+00	----	----	2.08E-01
Eu-155	----	----	----	----	0.00E+00
H-3	----	----	----	----	0.00E+00
I-129	----	----	----	----	0.00E+00
K-40	----	----	----	----	0.00E+00
Nb-95	----	----	----	----	0.00E+00
Np-237	----	----	----	----	0.00E+00
Pu-238	----	----	----	----	0.00E+00
Pu-239/240	----	----	----	----	0.00E+00
Pu-241	----	----	----	----	0.00E+00
Pu-242	----	----	----	----	0.00E+00
Ru/Rh-106	----	----	----	----	0.00E+00
Sb-125	----	----	----	----	0.00E+00
Sr-90	4.39E+01	2.72E+00	----	2.47E+00	2.27E+01
Tc-99	----	----	----	----	0.00E+00
U-234	----	----	----	----	0.00E+00
U-235	----	----	----	----	0.00E+00
U-236	----	----	----	----	0.00E+00
U-238	----	----	----	----	0.00E+00
Total Group Area (ft^2) =	152764				
CPP-88 area (ft^2) =	50744				

Table 14-7. Area-weighted soil concentrations for the Storage Yard Group (0 to 10 ft).

COPCs	Site				Area weighted concentration (mg/kg or pCi/g)
	CPP-03	CPP-17a	CPP-17b	CPP-88	
Area (ft^2)	75000	16900	10120	50744	
Area (m^2)	6967.90	1570.10	940.20	4714.39	
Aroclor-1260	----	----	----	----	0.00E+00
Benzo(a)pyrene	----	----	----	----	0.00E+00
Aluminum	----	----	----	----	0.00E+00
Arsenic	----	----	----	5.90E+00	1.96E+00
Manganese	----	----	----	----	0.00E+00
Mercury	----	----	----	----	0.00E+00
Uranium	----	----	----	----	0.00E+00
Am-241	----	----	----	----	0.00E+00
Ce-144	----	----	----	----	0.00E+00
Co-57	----	----	5.43E-01	----	3.60E-02
Co-58	----	----	----	----	0.00E+00
Co-60	----	----	----	----	0.00E+00
Cs-134	----	----	----	----	0.00E+00
Cs-137	6.34E+01	1.94E+01	1.05E+01	1.18E+01	3.78E+01
Eu-152	2.13E+00	2.07E+00	----	----	1.27E+00
Eu-154	----	1.88E+00	----	----	2.08E-01
Eu-155	----	----	----	----	0.00E+00
H-3	----	----	----	----	0.00E+00
I-129	----	----	----	----	0.00E+00
K-40	----	----	----	----	0.00E+00
Nb-95	----	----	----	----	0.00E+00
Np-237	----	----	----	----	0.00E+00
Pu-238	----	----	----	----	0.00E+00
Pu-239/240	----	----	----	----	0.00E+00
Pu-241	----	----	----	----	0.00E+00
Pu-242	----	----	----	----	0.00E+00
Ru/Rh-106	----	----	----	----	0.00E+00
Sb-125	----	----	----	----	0.00E+00
Sr-90	4.39E+01	2.72E+00	----	1.57E+00	2.24E+01
Tc-99	----	----	----	----	0.00E+00
U-234	----	----	----	----	0.00E+00
U-235	----	----	----	----	0.00E+00
U-236	----	----	----	----	0.00E+00
U-238	----	----	----	----	0.00E+00

Total Group Area (ft^2) =	152764
CPP-88 area (ft^2) =	50744

Table 14-8. Average soil exposure-point concentrations (mg/kg or pCi/g) for land use scenarios.

	Current occupational worker year 0 to year 25		Future occupational worker year 100 to year 125		Future resident year 100 to year 130
COPCs	(0 - 0.5 ft)	(0 - 4 ft)	(0 - 0.5 ft)	(0 - 4 ft)	(0 - 10 ft)
Aroclor-1260	---	---	---	---	---
Benzo(a)pyrene	---	---	---	---	---
Aluminum	---	---	---	---	---
Arsenic	---	2.14E+00	---	2.14E+00	1.96E+00
Manganese	---	---	---	---	---
Mercury	---	3.32E-01	---	3.32E-01	---
Uranium	---	---	---	---	---
Am-241	---	---	---	---	---
Ce-144	---	---	---	---	---
Co-57	1.54E-03	1.54E-03	4.23E-44	4.23E-44	3.49E-44
Co-58	---	---	---	---	---
Co-60	---	---	---	---	---
Cs-134	---	---	---	---	---
Cs-137	2.94E+01	2.91E+01	2.95E+00	2.92E+00	2.75E+00
Eu-152	7.18E-01	7.18E-01	4.40E-03	4.40E-03	4.00E-03
Eu-154	9.09E-02	9.09E-02	3.45E-05	3.46E-05	3.03E-05
Eu-155	---	---	---	---	---
H-3	---	---	---	---	---
I-129	---	---	---	---	---
K-40	---	---	---	---	---
Nb-95	---	---	---	---	---
Np-237	---	---	---	---	---
Pu-238	---	---	---	---	---
Pu-239/240	---	---	---	---	---
Pu-241	---	---	---	---	---
Pu-242	---	---	---	---	---
Ru/Rh-106	---	---	---	---	---
Sb-125	---	---	---	---	---
Sr-90	1.73E+01	1.71E+01	1.60E+00	1.58E+00	1.48E+00
Tc-99	---	---	---	---	---
U-234	---	---	---	---	---
U-235	---	---	---	---	---
U-236	---	---	---	---	---
U-238	---	---	---	---	---

Table 14-9. Concentrations of COPCs in homegrown produce.

COPCs	Homegrown produce (mg/kg or pCi/g)	Kd (cm^3/g)	COPC input rate from irrigation (mg/g-d or pCi/g-d)	Leach rate constant (d^{-1})
Aroclor-1260	---	7.89E+03	0.00E+00	9.95E-07
Benzo(a)pyrene	---	1.19E+03	0.00E+00	6.57E-06
Aluminum	---	0.00E+00	0.00E+00	2.87E-02
Arsenic	3.12E-03	3.00E+00	8.71E-09	2.40E-03
Manganese	---	5.00E+01	0.00E+00	1.56E-04
Mercury	1.10E-01	1.00E+02	2.91E-08	7.83E-05
Uranium	7.30E-05	6.00E+00	7.04E-09	1.25E-03
Am-241	7.76E-06	3.40E+02	6.08E-06	2.31E-05
Ce-144	---	5.00E+02	0.00E+00	1.57E-05
Co-57	9.88E-49	1.00E+01	0.00E+00	7.64E-04
Co-58	---	1.00E+01	0.00E+00	7.64E-04
Co-60	---	1.00E+01	0.00E+00	7.64E-04
Cs-134	---	5.00E+02	0.00E+00	1.57E-05
Cs-137	5.84E-03	5.00E+02	4.12E-05	1.57E-05
Eu-152	7.16E-08	3.40E+02	0.00E+00	2.31E-05
Eu-154	3.51E-10	3.40E+02	0.00E+00	2.31E-05
Eu-155	---	3.40E+02	0.00E+00	2.31E-05
H-3	----	0.00E+00	6.22E-04	2.87E-02
I-129	3.85E-06	0.00E+00	3.26E-05	2.87E-02
K-40	---	1.50E+01	0.00E+00	5.14E-04
Nb-95	---	0.00E+00	0.00E+00	2.87E-02
Np-237	3.19E-05	0.00E+00	8.36E-06	2.87E-02
Pu-238	---	2.20E+01	0.00E+00	3.53E-04
Pu-239/240	5.15E-06	2.20E+01	5.84E-07	3.53E-04
Pu-241	8.49E-09	2.20E+01	9.37E-08	3.53E-04
Pu-242	3.60E-09	2.20E+01	3.88E-10	3.53E-04
Ru/Rh-106	---	0.00E+00	0.00E+00	2.87E-02
Sb-125	---	5.00E+01	0.00E+00	1.56E-04
Sr-90	2.35E-02	1.20E+01	5.63E-05	6.40E-04
Tc-99	4.56E-01	0.00E+00	1.67E-04	2.87E-02
U-234	2.73E-05	6.00E+00	2.63E-06	1.25E-03
U-235	9.61E-07	6.00E+00	9.27E-08	1.25E-03
U-236	6.93E-07	6.00E+00	6.68E-08	1.25E-03
U-238	2.44E-05	6.00E+00	2.35E-06	1.25E-03

Table 14-10. Soil pathway cancer risk to the current onsite worker. [a]

COPCs	Ingestion of soil	External radiation exposure	Total risks
Aroclor-1260	----	----	----
Benzo(a)pyrene	----	----	----
Aluminum	----	----	----
Arsenic	----	----	----
Manganese	----	----	----
Mercury	----	----	----
Uranium	----	----	----
Am-241	----	----	----
Ce-144	----	----	----
Co-57	4E-13	2E-09	2E-09
Co-58	----	----	----
Co-60	----	----	----
Cs-134	----	----	----
Cs-137	2E-07	3E-04	3E-04
Eu-152	1E-09	2E-05	2E-05
Eu-154	2E-10	2E-06	2E-06
Eu-155	----	----	----
H-3	----	----	----
I-129	----	----	----
K-40	----	----	----
Nb-95	----	----	----
Np-237	----	----	----
Pu-238	----	----	----
Pu-239/240	----	----	----
Pu-241	----	----	----
Pu-242	----	----	----
Ru/Rh-106	----	----	----
Sb-125	----	----	----
Sr-90	2E-07	NTD	2E-07
Tc-99	----	----	----
U-234	----	----	----
U-235	----	----	----
U-236	----	----	----
U-238	----	----	----
Total cancer risks by route:	5E-07	4E-04	4E-04

"----" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 14-11. Soil pathway noncarcinogenic hazard to the current onsite worker.[a,b]

COPCs	Ingestion of soil	External radiation exposure	Total HIs
Aroclor-1260	----	----	----
Benzo(a)pyrene	----	----	----
Aluminum	----	----	----
Arsenic	----	----	----
Manganese	----	----	----
Mercury	----	----	----
Uranium	----	----	----
Am-241	----	----	----
Ce-144	----	----	----
Co-57	----	----	----
Co-58	----	----	----
Co-60	----	----	----
Cs-134	----	----	----
Cs-137	----	----	----
Eu-152	----	----	----
Eu-154	----	----	----
Eu-155	----	----	----
H-3	----	----	----
I-129	----	----	----
K-40	----	----	----
Nb-95	----	----	----
Np-237	----	----	----
Pu-238	----	----	----
Pu-239/240	----	----	----
Pu-241	----	----	----
Pu-242	----	----	----
Ru/Rh-106	----	----	----
Sb-125	----	----	----
Sr-90	----	----	----
Tc-99	----	----	----
U-234	----	----	----
U-235	----	----	----
U-236	----	----	----
U-238	----	----	----
Total hazard indices by route:	0E+00	0E+00	0E+00

"----" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. All noncarcinogenic contamination at the Storage Yard Group is buried more than 0.5 bls, so there is no calculated hazard index for workers at the site.
b. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 14-12. Soil pathway cancer risk to the future onsite worker. [a]

COPCs	Ingestion of soil	External radiation exposure	Total risks
Aroclor-1260	----	----	----
Benzo(a)pyrene	----	----	----
Aluminum	----	----	----
Arsenic	----	----	----
Manganese	----	----	----
Mercury	----	----	----
Uranium	----	----	----
Am-241	----	----	----
Ce-144	----	----	----
Co-57	1E-53	5E-50	5E-50
Co-58	----	----	----
Co-60	----	----	----
Cs-134	----	----	----
Cs-137	2E-08	3E-05	3E-05
Eu-152	6E-12	1E-07	1E-07
Eu-154	8E-14	9E-10	9E-10
Eu-155	----	----	----
H-3	----	----	----
I-129	----	----	----
K-40	----	----	----
Nb-95	----	----	----
Np-237	----	----	----
Pu-238	----	----	----
Pu-239/240	----	----	----
Pu-241	----	----	----
Pu-242	----	----	----
Ru/Rh-106	----	----	----
Sb-125	----	----	----
Sr-90	2E-08	NTD	2E-08
Tc-99	----	----	----
U-234	----	----	----
U-235	----	----	----
U-236	----	----	----
U-238	----	----	----
Total cancer risks by route:	5E-08	3E-05	3E-05

"----" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 14-13. Soil pathway nnoncarcinogenic hazard to the future onsite worker.[a,b]

COPCs	Ingestion of soil	External radiation exposure	Total HIs
Aroclor-1260	---	---	---
Benzo(a)pyrene	---	---	---
Aluminum	---	---	---
Arsenic	---	---	---
Manganese	---	---	---
Mercury	---	---	---
Uranium	---	---	---
Am-241	---	---	---
Ce-144	---	---	---
Co-57	---	---	---
Co-58	---	---	---
Co-60	---	---	---
Cs-134	---	---	---
Cs-137	---	---	---
Eu-152	---	---	---
Eu-154	---	---	---
Eu-155	---	---	---
H-3	---	---	---
I-129	---	---	---
K-40	---	---	---
Nb-95	---	---	---
Np-237	---	---	---
Pu-238	---	---	---
Pu-239/240	---	---	---
Pu-241	---	---	---
Pu-242	---	---	---
Ru/Rh-106	---	---	---
Sb-125	---	---	---
Sr-90	---	---	---
Tc-99	---	---	---
U-234	---	---	---
U-235	---	---	---
U-236	---	---	---
U-238	---	---	---
Total hazard indices by route:	0E+00	0E+00	0E+00

"---" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. All noncarcinogenic contamination at the Storage Yard Group is buried more than 0.5 bls, so there is no calculated hazard index for workers at the site.
b. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 14-14. Soil pathway cancer risk to the future onsite resident. [a]

COPCs	Ingestion of soil	Ingestion of homegrown	External radiation exposure	Total risks
Aroclor-1260	—	—	—	—
Benzo(a)pyrene	—	—	—	—
Aluminum	—	—	—	—
Arsenic	5E-06	5E-07	—	5E-06
Manganese	—	—	—	—
Mercury	—	NTD	—	—
Uranium	—	NTD	—	—
Am-241	—	4E-10	—	4E-10
Ce-144	—	—	—	—
Co-57	4E-53	2E-55	2E-49	2E-49
Co-58	—	—	—	—
Co-60	—	—	—	—
Cs-134	—	—	—	—
Cs-137	1E-07	3E-08	2E-04	2E-04
Eu-152	3E-11	7E-14	5E-07	5E-07
Eu-154	4E-13	6E-16	4E-09	4E-09
Eu-155	—	—	—	—
H-3	—	—	—	—
I-129	—	1E-10	—	1E-10
K-40	—	—	—	—
Nb-95	—	—	—	—
Np-237	—	2E-09	—	2E-09
Pu-238	—	—	—	—
Pu-239/240	—	3E-10	—	3E-10
Pu-241	—	5E-13	—	5E-13
Pu-242	—	2E-13	—	2E-13
Ru/Rh-106	—	—	—	—
Sb-125	—	—	—	—
Sr-90	1E-07	2E-07	NTD	3E-07
Tc-99	—	1E-07	—	1E-07
U-234	—	2E-10	—	2E-10
U-235	—	8E-12	—	8E-12
U-236	—	5E-12	—	5E-12
U-238	—	3E-10	—	3E-10
Total cancer risks by route:	5E-06	9E-07	2E-04	2E-04

"—" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 14-15. Soil pathway noncarcinogenic hazard to the future onsite resident. [a]

COPCs	Ingestion of soil	Ingestion of homegrown	External radiation exposure	Total HIs
Aroclor-1260	---	---	---	---
Benzo(a)pyrene	---	---	---	---
Aluminum	---	---	---	---
Arsenic	2E-09	3E-03	---	3E-03
Manganese	---	---	---	---
Mercury	---	1E-01	---	1E-01
Uranium	---	6E-06	---	6E-06
Am-241	---	---	---	---
Ce-144	---	---	---	---
Co-57	---	---	---	---
Co-58	---	---	---	---
Co-60	---	---	---	---
Cs-134	---	---	---	---
Cs-137	---	---	---	---
Eu-152	---	---	---	---
Eu-154	---	---	---	---
Eu-155	---	---	---	---
H-3	---	---	---	---
I-129	---	---	---	---
K-40	---	---	---	---
Nb-95	---	---	---	---
Np-237	---	---	---	---
Pu-238	---	---	---	---
Pu-239/240	---	---	---	---
Pu-241	---	---	---	---
Pu-242	---	---	---	---
Ru/Rh-106	---	---	---	---
Sb-125	---	---	---	---
Sr-90	---	---	---	---
Tc-99	---	---	---	---
U-234	---	---	---	---
U-235	---	---	---	---
U-236	---	---	---	---
U-238	---	---	---	---
Total hazard indices by route:	2E-09	1E-01	0E+00	1E-01

"---" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

14.3.4.1 Current Land Use. As indicated in Table 14-10, total cancer risk to the current onsite worker from exposure to site-related chemicals in surface soil is estimated to be 4E-04. The risk is attributed to external radiation exposure with the primary contaminants of concern (COCs) being Cs-137 (3E-04), Eu-152 (2E-05), and Eu-154 (2E-06). Table 14-11 indicates that the total noncarcinogenic hazard index to the current worker is estimated to be 0E+00. There are no hazard indices above unity for the current onsite worker.

14.3.4.2 Future Land Use. As Table 14-12 indicates, the total cancer risk to the future onsite worker from exposure to site-related chemicals in surface soil is estimated to be 3E-05. The risk is attributed to external radiation exposure, with the primary COC driving the risk being Cs-137 (3E-05). Table 14-13 indicates the total noncarcinogenic hazard index to the future onsite worker is 0E+00. There are no hazard indices above unity for the future onsite worker. As indicated in Table 14-14, the total cancer risk for the future resident from exposure to site-related chemicals in soil is estimated to be 2E-04. The primary contributor to risk from the soil ingestion route is arsenic (5E-06). The risk from ingestion of homegrown produce is driven by arsenic (5E-06). External radiation exposure has Cs-137 (2E-04) as the primary contributor to risk. As shown in Table 14-15, the total noncarcinogenic hazard index to the future resident is estimated to be 1E-01. There are no hazard indices above unity for the future resident.

14.4 Risk Assessment for Each Site

Based on the group assessment, the Storage Yard East Group results in a risk that is near 1E-04 (external radiation exposure due to Cs-137 in surface and shallow subsurface soils). This implies that an action may be necessary for the group, which includes the three sites when actually it may be a single site within the group that drives the risk. To this end, the sites within the Storage Yard East Group were evaluated individually to asses their contribution to the group risk estimate and therefore avoid taking an action on a site that doesn't warrant it. The following subsections describe the evaluation conducted in this manner.

14.4.1 Complete Exposure Routes

As for the Storage Yard East of CPP-603 Group estimate, potentially complete pathways from the source to a human receptor for the individual sites were described in Section 7 and are summarized on Table 14-4.

14.4.2 Exposure-Point Concentrations

Specific steps in calculating exposure-point concentrations for each of the applicable scenarios were described in Section 7. The COPC soil value used for an individual site was the smaller of the 95% UCL or maximum concentration. The individual site concentration terms by depth interval are presented in Tables 14-5 through 14-7. The concentration terms for the radionuclides were adjusted to account for decay for each exposure scenario. These values were subsequently averaged over the exposure duration. Exposures from all complete exposure routes for sites CPP-03, CPP-17a, and CPP-17b were estimated based on the exposure-point concentrations in Tables 14-16, 14-17, and 14-18. Homegrown produce concentrations for each of the sites are presented in Tables 14-19, 14-20, and 14-21. The values for air and groundwater which are not assessed on a site-specific basis, are presented in Section 27.1 and 27.2, respectively.

14.4.3 Risk Estimates

The results of this evaluation under current and future land use are presented in Section 14.3.2.3.1 and 14.3.2.3.2. For each receptor, the results are summarized in Tables 14-22 through 14-30. It should be noted

Table 14-16. Average soil exposure-point concentrations (mg/kg or pCi/g) for land use scenarios at CPP-03.

	Current occupational worker year 0 to year 25		Future occupational worker year 100 to year 125		Future resident year 100 to year 130
COPCs	(0 - 0.5 ft)	(0 - 4 ft)	(0 - 0.5 ft)	(0 - 4 ft)	(0 - 10 ft)
Aroclor-1260	—	—	—	—	—
Benzo(a)pyrene	—	—	—	—	—
Aluminum	—	—	—	—	—
Arsenic	—	—	—	—	—
Manganese	—	—	—	—	—
Mercury	—	—	—	—	—
Uranium	—	—	—	—	—
Am-241	—	—	—	—	—
Ce-144	—	—	—	—	—
Co-57	—	—	—	—	—
Co-58	—	—	—	—	—
Co-60	—	—	—	—	—
Cs-134	—	—	—	—	—
Cs-137	4.82E+01	4.82E+01	4.85E+00	4.85E+00	4.60E+00
Eu-152	1.20E+00	1.20E+00	7.37E-03	7.37E-03	6.68E-03
Eu-154	—	—	—	—	—
Eu-155	—	—	—	—	—
H-3	—	—	—	—	—
I-129	—	—	—	—	—
K-40	—	—	—	—	—
Nb-95	—	—	—	—	—
Np-237	—	—	—	—	—
Pu-238	—	—	—	—	—
Pu-239/240	—	—	—	—	—
Pu-241	—	—	—	—	—
Pu-242	—	—	—	—	—
Rh-106	—	—	—	—	—
Ru-106	—	—	—	—	—
Sb-125	—	—	—	—	—
Sr-90	3.31E+01	3.31E+01	3.06E+00	3.06E+00	2.90E+00
Tc-99	—	—	—	—	—
U-234	—	—	—	—	—
U-235	—	—	—	—	—
U-236	—	—	—	—	—
U-238	—	—	—	—	—

Table 14-17. Average soil exposure-point concentrations (mg/kg or pCi/g) for land use scenarios at CPP-17A.

	Current occupational worker year 0 to year 25		Future occupational worker year 100 to year 125		Future resident year 100 to year 130
COPCs	(0 - 0.5 ft)	(0 - 4 ft)	(0 - 0.5 ft)	(0 - 4 ft)	(0 - 10 ft)
Aroclor-1260	—	—	—	—	—
Benzo(a)pyrene	—	—	—	—	—
Aluminum	—	—	—	—	—
Arsenic	—	—	—	—	—
Manganese	—	—	—	—	—
Mercury	—	—	—	—	—
Uranium	—	—	—	—	—
Am-241	—	—	—	—	—
Ce-144	—	—	—	—	—
Co-57	—	—	—	—	—
Co-58	—	—	—	—	—
Co-60	—	—	—	—	—
Cs-134	—	—	—	—	—
Cs-137	1.48E+01	1.48E+01	1.48E+00	1.48E+00	1.41E+00
Eu-152	1.17E+00	1.17E+00	7.17E-03	7.17E-03	6.49E-03
Eu-154	8.22E-01	8.22E-01	3.12E-04	3.12E-04	2.74E-04
Eu-155	—	—	—	—	—
H-3	—	—	—	—	—
I-129	—	—	—	—	—
K-40	—	—	—	—	—
Nb-95	—	—	—	—	—
Np-237	—	—	—	—	—
Pu-238	—	—	—	—	—
Pu-239/240	—	—	—	—	—
Pu-241	—	—	—	—	—
Pu-242	—	—	—	—	—
Rh-106	—	—	—	—	—
Ru-106	—	—	—	—	—
Sb-125	—	—	—	—	—
Sr-90	1.94E+00	2.05E+00	1.80E-01	1.89E-01	1.80E-01
Tc-99	—	—	—	—	—
U-234	—	—	—	—	—
U-235	—	—	—	—	—
U-236	—	—	—	—	—
U-238	—	—	—	—	—

Table 14-18. Average soil exposure-point concentrations (mg/kg or pCi/g) for land use scenarios at CPP-17B.

COPCs	Current occupational worker year 0 to year 25		Future occupational worker year 100 to year 125		Future resident year 100 to year 130
	(0 - 0.5 ft)	(0 - 4 ft)	(0 - 0.5 ft)	(0 - 4 ft)	(0 - 10 ft)
Aroclor-1260	—	—	—	—	—
Benzo(a)pyrene	—	—	—	—	—
Aluminum	—	—	—	—	—
Arsenic	—	—	—	—	—
Manganese	—	—	—	—	—
Mercury	—	—	—	—	—
Uranium	—	—	—	—	—
Am-241	—	—	—	—	—
Ce-144	—	—	—	—	—
Co-57	2.33E-02	2.33E-02	6.38E-43	6.38E-43	5.32E-43
Co-58	—	—	—	—	—
Co-60	—	—	—	—	—
Cs-134	—	—	—	—	—
Cs-137	7.99E+00	7.99E+00	8.03E-01	8.03E-01	7.63E-01
Eu-152	—	—	—	—	—
Eu-154	—	—	—	—	—
Eu-155	—	—	—	—	—
H-3	—	—	—	—	—
I-129	—	—	—	—	—
K-40	—	—	—	—	—
Nb-95	—	—	—	—	—
Np-237	—	—	—	—	—
Pu-238	—	—	—	—	—
Pu-239/240	—	—	—	—	—
Pu-241	—	—	—	—	—
Pu-242	—	—	—	—	—
Rh-106	—	—	—	—	—
Ru-106	—	—	—	—	—
Sb-125	—	—	—	—	—
Sr-90	—	—	—	—	—
Tc-99	—	—	—	—	—
U-234	—	—	—	—	—
U-235	—	—	—	—	—
U-236	—	—	—	—	—
U-238	—	—	—	—	—

Table 14-19. Concentrations of COPCs in homegrown produce at CPP-03.

COPCs	Homegrown produce (mg/kg or pCi/g)	Kd (cm^3/g)	Deposition to soil at year 100 (mg/g-d or pCi/g-d)	Leach rate constant (d^{-1})
Aroclor-1260	—	7.89E+03	0.00E+00	9.95E-07
Benzo(a)pyrene	—	1.19E+03	0.00E+00	6.57E-06
Aluminum	—	0.00E+00	0.00E+00	2.87E-02
Arsenic	—	3.00E+00	0.00E+00	2.40E-03
Manganese	—	5.00E+01	0.00E+00	1.56E-04
Mercury	—	1.00E+02	0.00E+00	7.83E-05
Uranium	—	6.00E+00	0.00E+00	1.25E-03
Am-241	—	3.40E+02	0.00E+00	2.31E-05
Ce-144	—	5.00E+02	0.00E+00	1.57E-05
Co-57	—	1.00E+01	0.00E+00	7.64E-04
Co-58	—	1.00E+01	0.00E+00	7.64E-04
Co-60	—	1.00E+01	0.00E+00	7.64E-04
Cs-134	—	5.00E+02	0.00E+00	1.57E-05
Cs-137	1.95E+00	5.00E+02	0.00E+00	1.57E-05
Eu-152	5.90E-05	3.40E+02	0.00E+00	2.31E-05
Eu-154	—	3.40E+02	0.00E+00	2.31E-05
Eu-155	—	3.40E+02	0.00E+00	2.31E-05
H-3	—	0.00E+00	0.00E+00	2.87E-02
I-129	—	0.00E+00	0.00E+00	2.87E-02
K-40	—	1.50E+01	0.00E+00	5.14E-04
Nb-95	—	0.00E+00	0.00E+00	2.87E-02
Np-237	—	0.00E+00	0.00E+00	2.87E-02
Pu-238	—	2.20E+01	0.00E+00	3.53E-04
Pu-239/240	—	2.20E+01	0.00E+00	3.53E-04
Pu-241	—	2.20E+01	0.00E+00	3.53E-04
Pu-242	—	2.20E+01	0.00E+00	3.53E-04
Rh-106	—	0.00E+00	0.00E+00	2.87E-02
Ru-106	—	0.00E+00	0.00E+00	2.87E-02
Sb-125	—	5.00E+01	0.00E+00	1.56E-04
Sr-90	2.38E+00	2.40E+01	0.00E+00	3.24E-04
Tc-99	—	0.00E+00	0.00E+00	2.87E-02
U-234	—	6.00E+00	0.00E+00	1.25E-03
U-235	—	6.00E+00	0.00E+00	1.25E-03
U-236	—	6.00E+00	0.00E+00	1.25E-03
U-238	—	6.00E+00	0.00E+00	1.25E-03

Table 14-20. Concentrations of COPCs in homegrown produce at CPP-17A.

COPCs	Homegrown produce (mg/kg or pCi/g)	Kd (cm^3/g)	Deposition to soil at year 100 (mg/g-d or pCi/g-d)	Leach rate constant (d^{-1})
Aroclor-1260	—	7.89E+03	0.00E+00	9.95E-07
Benzo(a)pyrene	—	1.19E+03	0.00E+00	6.57E-06
Aluminum	—	0.00E+00	0.00E+00	2.87E-02
Arsenic	—	3.00E+00	0.00E+00	2.40E-03
Manganese	—	5.00E+01	0.00E+00	1.56E-04
Mercury	—	1.00E+02	0.00E+00	7.83E-05
Uranium	—	6.00E+00	0.00E+00	1.25E-03
Am-241	—	3.40E+02	0.00E+00	2.31E-05
Ce-144	—	5.00E+02	0.00E+00	1.57E-05
Co-57	—	1.00E+01	0.00E+00	7.64E-04
Co-58	—	1.00E+01	0.00E+00	7.64E-04
Co-60	—	1.00E+01	0.00E+00	7.64E-04
Cs-134	—	5.00E+02	0.00E+00	1.57E-05
Cs-137	5.96E-01	5.00E+02	0.00E+00	1.57E-05
Eu-152	5.74E-05	3.40E+02	0.00E+00	2.31E-05
Eu-154	2.42E-06	3.40E+02	0.00E+00	2.31E-05
Eu-155	—	3.40E+02	0.00E+00	2.31E-05
H-3	—	0.00E+00	0.00E+00	2.87E-02
I-129	—	0.00E+00	0.00E+00	2.87E-02
K-40	—	1.50E+01	0.00E+00	5.14E-04
Nb-95	—	0.00E+00	0.00E+00	2.87E-02
Np-237	—	0.00E+00	0.00E+00	2.87E-02
Pu-238	—	2.20E+01	0.00E+00	3.53E-04
Pu-239/240	—	2.20E+01	0.00E+00	3.53E-04
Pu-241	—	2.20E+01	0.00E+00	3.53E-04
Pu-242	—	2.20E+01	0.00E+00	3.53E-04
Rh-106	—	0.00E+00	0.00E+00	2.87E-02
Ru-106	—	0.00E+00	0.00E+00	2.87E-02
Sb-125	—	5.00E+01	0.00E+00	1.56E-04
Sr-90	1.48E-01	2.40E+01	0.00E+00	3.24E-04
Tc-99	—	0.00E+00	0.00E+00	2.87E-02
U-234	—	6.00E+00	0.00E+00	1.25E-03
U-235	—	6.00E+00	0.00E+00	1.25E-03
U-236	—	6.00E+00	0.00E+00	1.25E-03
U-238	—	6.00E+00	0.00E+00	1.25E-03

Table 14-21. Concentrations of COPCs in homegrown produce at CPP-17B.

COPCs	Homegrown produce (mg/kg or pCi/g)	Kd (cm^3/g)	Deposition to soil at year 100 (mg/g-d or pCi/g-d)	Leach rate constant (d^{-1})
Aroclor-1260	—	7.89E+03	0.00E+00	9.95E-07
Benzo(a)pyrene	—	1.19E+03	0.00E+00	6.57E-06
Aluminum	—	0.00E+00	0.00E+00	2.87E-02
Arsenic	—	3.00E+00	0.00E+00	2.40E-03
Manganese	—	5.00E+01	0.00E+00	1.56E-04
Mercury	—	1.00E+02	0.00E+00	7.83E-05
Uranium	—	6.00E+00	0.00E+00	1.25E-03
Am-241	—	3.40E+02	0.00E+00	2.31E-05
Ce-144	—	5.00E+02	0.00E+00	1.57E-05
Co-57	1.84E-44	1.00E+01	0.00E+00	7.64E-04
Co-58	—	1.00E+01	0.00E+00	7.64E-04
Co-60	—	1.00E+01	0.00E+00	7.64E-04
Cs-134	—	5.00E+02	0.00E+00	1.57E-05
Cs-137	3.22E-01	5.00E+02	0.00E+00	1.57E-05
Eu-152	—	3.40E+02	0.00E+00	2.31E-05
Eu-154	—	3.40E+02	0.00E+00	2.31E-05
Eu-155	—	3.40E+02	0.00E+00	2.31E-05
H-3	—	0.00E+00	0.00E+00	2.87E-02
I-129	—	0.00E+00	0.00E+00	2.87E-02
K-40	—	1.50E+01	0.00E+00	5.14E-04
Nb-95	—	0.00E+00	0.00E+00	2.87E-02
Np-237	—	0.00E+00	0.00E+00	2.87E-02
Pu-238	—	2.20E+01	0.00E+00	3.53E-04
Pu-239/240	—	2.20E+01	0.00E+00	3.53E-04
Pu-241	—	2.20E+01	0.00E+00	3.53E-04
Pu-242	—	2.20E+01	0.00E+00	3.53E-04
Rh-106	—	0.00E+00	0.00E+00	2.87E-02
Ru-106	—	0.00E+00	0.00E+00	2.87E-02
Sb-125	—	5.00E+01	0.00E+00	1.56E-04
Sr-90	—	2.40E+01	0.00E+00	3.24E-04
Tc-99	—	0.00E+00	0.00E+00	2.87E-02
U-234	—	6.00E+00	0.00E+00	1.25E-03
U-235	—	6.00E+00	0.00E+00	1.25E-03
U-236	—	6.00E+00	0.00E+00	1.25E-03
U-238	—	6.00E+00	0.00E+00	1.25E-03

that none of the COPCs for sites CPP-03, CPP-17a, and CPP-17b cause noncarcinogenic health effects thus tables summarizing these values were not provided. The only noncarcinogenic effect is due to mercury in the groundwater simulations at the year 2095 and beyond and is the same for all sites. The Hazard Index from this exposure under future residential conditions is 0.1.

14.4.4 Current Land Use

As indicated in Table 14-22, total cancer risk to the current on-site worker from exposure to site-related chemicals surface soil at CPP-03 is estimated to be 6E-04. The risk is attributed to external radiation exposure with the primary COCs being Cs-137 (6E-04) and Eu-152 (3E-05. Table 4-23 summarizes the cancer risk for CPP-17a. For the on-site worker, the risk is 2E-04 and is attributed to external radiation exposure with the primary COCs being Cs-137 (2E-04), Eu-154 (3E-05, and Eu-155 (2E-05). Cancer risk estimates for CPP-17b are summarized on Table 14-24. External radiation exposure dominates the risk (9E-5) due to Cs-137.

14.4.5 Future Land Use

As Table 14-25 indicates, the total cancer risk to the future on-site worker at CPP-03 is estimated to be 6E-05. The risk is attributed to external radiation exposure, with the primary COC driving the risk being Cs-137. For CPP-17a, Table 14-26 presents the cancer risk to the future on-site worker is 2E-05. Again, the risk driver is Cs-137. Cancer risk for the future on-site worker at site CPP-17b is 9E-06 (Table 14-27) and is attributed to external radiation exposure to Cs-137.

As indicated in Tables 14-28, 14-29, and 14-30 the total cancer risk for the future resident from exposure to site related chemicals in soil at sites CPP-03, CPP-17a, and CPP-17b is estimated to be 4E-04, 1E-04, and 5E-05, respectively. Ingestion of homegrown produce and external radiation exposure are the major exposure routes contributing to this risk. For site CPP-03, the risk from ingestion of homegrown produce is driven by Cs-137 (4E-05) and Sr-90 (8E-05). External radiation exposure at CPP-03 has Cs-137 (3E-04) as the primary contributor to risk. For site CPP-17a, the risk from ingestion of homegrown produce is driven by Cs-137 (1E-05) and Sr-90 (5E-06). External radiation exposure at CPP-17a has Cs-137 (8E-05) as the primary contributor to risk. For site CPP-17b, the risk from ingestion of homegrown produce is driven by Cs-137 (6E-06). As for CPP-03 and CPP-17a, external radiation exposure at CPP-17b also has Cs-137 (5E-05) as the primary contributor to risk.

14.5 Uncertainties

This section describes the limitations and uncertainties specific to the site characterization of the storage yard east of CPP-603 Group. Sources of uncertainty associated with site characterization include data quality, COPC identification, concentration term estimation, and assumptions regarding the lateral and vertical extent of COPC occurrence. In the risk assessment, the most significant uncertainties are due to the selection process of COPCs, the toxicity values used, and the assumptions used during the exposure assessment. The following paragraphs will discuss important sources of site-specific uncertainty in greater detail.

Sampling and analysis uncertainties are related to quality problems that may result in qualified and rejected results (Section 3.5). Qualified results are considered estimates of the concentration in the sample and, for all practical purposes, useable for their intended purpose although they could be biased high or low. Rejected results are considered unusable, thus limiting the size of the useable data set. For the storage yard

Table 14-22. Cancer risk to the current on-site worker at CPP-03.

COPCs	Ingestion of soil	External radiation exposure	Total risks
Aroclor-1260	—	—	—
Benzo(a)pyrene	—	—	—
Aluminum	—	—	—
Arsenic	—	—	—
Manganese	—	—	—
Mercury	—	—	—
Uranium	—	—	—
Am-241	—	—	—
Ce-144	—	—	—
Co-57	—	—	—
Co-58	—	—	—
Co-60	—	—	—
Cs-134	—	—	—
Cs-137	4E-07	6E-04	6E-04
Eu-152	2E-09	3E-05	3E-05
Eu-154	—	—	—
Eu-155	—	—	—
H-3	—	—	—
I-129	—	—	—
K-40	—	—	—
Nb-95	—	—	—
Np-237	—	—	—
Pu-238	—	—	—
Pu-239/240	—	—	—
Pu-241	—	—	—
Pu-242	—	—	—
Rh-106	—	—	—
Ru-106	—	—	—
Sb-125	—	—	—
Sr-90	5E-07	NTD	5E-07
Tc-99	—	—	—
U-234	—	—	—
U-235	—	—	—
U-236	—	—	—
U-238	—	—	—
Total cancer risks by route:	8E-07	6E-04	6E-04

"—" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.

Table 14-23. Cancer risk to the current on-site worker at CPP-17A.

COPCs	Ingestion of soil	External radiation exposure	Total risks
Aroclor-1260	—	—	—
Benzo(a)pyrene	—	—	—
Aluminum	—	—	—
Arsenic	—	—	—
Manganese	—	—	—
Mercury	—	—	—
Uranium	—	—	—
Am-241	—	—	—
Ce-144	—	—	—
Co-57	—	—	—
Co-58	—	—	—
Co-60	—	—	—
Cs-134	—	—	—
Cs-137	1E-07	2E-04	2E-04
Eu-152	2E-09	3E-05	3E-05
Eu-154	2E-09	2E-05	2E-05
Eu-155	—	—	—
H-3	—	—	—
I-129	—	—	—
K-40	—	—	—
Nb-95	—	—	—
Np-237	—	—	—
Pu-238	—	—	—
Pu-239/240	—	—	—
Pu-241	—	—	—
Pu-242	—	—	—
Rh-106	—	—	—
Ru-106	—	—	—
Sb-125	—	—	—
Sr-90	3E-08	NTD	3E-08
Tc-99	—	—	—
U-234	—	—	—
U-235	—	—	—
U-236	—	—	—
U-238	—	—	—
Total cancer risks by route:	1E-07	2E-04	2E-04

"—" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.

Table 14-24. Cancer risk to the current on-site worker at CPP-17B.

COPCs	Ingestion of soil	External radiation exposure	Total risks
Aroclor-1260	—	—	—
Benzo(a)pyrene	—	—	—
Aluminum	—	—	—
Arsenic	—	—	—
Manganese	—	—	—
Mercury	—	—	—
Uranium	—	—	—
Am-241	—	—	—
Ce-144	—	—	—
Co-57	6E-12	3E-08	3E-08
Co-58	—	—	—
Co-60	—	—	—
Cs-134	—	—	—
Cs-137	6E-08	9E-05	9E-05
Eu-152	—	—	—
Eu-154	—	—	—
Eu-155	—	—	—
H-3	—	—	—
I-129	—	—	—
K-40	—	—	—
Nb-95	—	—	—
Np-237	—	—	—
Pu-238	—	—	—
Pu-239/240	—	—	—
Pu-241	—	—	—
Pu-242	—	—	—
Rh-106	—	—	—
Ru-106	—	—	—
Sb-125	—	—	—
Sr-90	—	—	—
Tc-99	—	—	—
U-234	—	—	—
U-235	—	—	—
U-236	—	—	—
U-238	—	—	—
Total cancer risks by route:	6E-08	9E-05	9E-05

"—" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.

Table 14-25. Cancer risk to the future on-site worker at CPP-03.

COPCs	Ingestion of soil	External radiation exposure	Inhalation of fugitive dust	Inhalation of volatiles	Total risks
Aroclor-1260	—	—	—	—	—
Benzo(a)pyrene	—	—	2E-14	1E-17	—
Aluminum	—	—	—	—	—
Arsenic	—	—	1E-15	—	—
Manganese	—	—	NTD	—	—
Mercury	—	—	—	—	—
Uranium	—	—	NTD	—	—
Am-241	—	—	3E-15	—	—
Ce-144	—	—	2E-57	—	—
Co-57	—	—	8E-64	—	—
Co-58	—	—	—	—	—
Co-60	—	—	2E-23	—	—
Cs-134	—	—	2E-33	—	—
Cs-137	4E-08	6E-05	2E-17	—	6E-05
Eu-152	1E-11	2E-07	1E-18	—	2E-07
Eu-154	—	—	8E-20	—	—
Eu-155	—	—	3E-24	—	—
H-3	—	—	2E-24	—	—
I-129	—	—	9E-18	—	—
K-40	—	—	—	—	—
Nb-95	—	—	—	—	—
Np-237	—	—	1E-15	—	—
Pu-238	—	—	2E-15	—	—
Pu-239/240	—	—	1E-15	—	—
Pu-241	—	—	—	—	—
Pu-242	—	—	—	—	—
Rh-106	—	—	—	—	—
Ru-106	—	—	1E-48	—	—
Sb-125	—	—	3E-31	—	—
Sr-90	4E-08	NTD	3E-17	—	4E-08
Tc-99	—	—	4E-20	—	—
U-234	—	—	7E-16	—	—
U-235	—	—	2E-17	—	—
U-236	—	—	—	—	—
U-238	—	—	5E-16	—	—
Total cancer risks by route:	8E-08	6E-05	3E-14	1E-17	6E-05

"—" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.

Table 14-26. Cancer risk to the future on-site worker at CPP-17A.

COPCs	Ingestion of soil	External radiation exposure	Total risks
Aroclor-1260	—	—	—
Benzo(a)pyrene	—	—	—
Aluminum	—	—	—
Arsenic	—	—	—
Manganese	—	—	—
Mercury	—	—	—
Uranium	—	—	—
Am-241	—	—	—
Ce-144	—	—	—
Co-57	—	—	—
Co-58	—	—	—
Co-60	—	—	—
Cs-134	—	—	—
Cs-137	1E-08	2E-05	2E-05
Eu-152	1E-11	2E-07	2E-07
Eu-154	7E-13	8E-09	8E-09
Eu-155	—	—	—
H-3	—	—	—
I-129	—	—	—
K-40	—	—	—
Nb-95	—	—	—
Np-237	—	—	—
Pu-238	—	—	—
Pu-239/240	—	—	—
Pu-241	—	—	—
Pu-242	—	—	—
Rh-106	—	—	—
Ru-106	—	—	—
Sb-125	—	—	—
Sr-90	3E-09	NTD	3E-09
Tc-99	—	—	—
U-234	—	—	—
U-235	—	—	—
U-236	—	—	—
U-238	—	—	—
Total cancer risks by route:	1E-08	2E-05	2E-05

"—" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.

Table 14-27. Cancer risk to the future on-site worker at CPP-17B.

COPCs	Ingestion of soil	External radiation exposure	Total risks
Aroclor-1260	—	—	—
Benzo(a)pyrene	—	—	—
Aluminum	—	—	—
Arsenic	—	—	—
Manganese	—	—	—
Mercury	—	—	—
Uranium	—	—	—
Am-241	—	—	—
Ce-144	—	—	—
Co-57	2E-52	8E-49	8E-49
Co-58	—	—	—
Co-60	—	—	—
Cs-134	—	—	—
Cs-137	6E-09	9E-06	9E-06
Eu-152	—	—	—
Eu-154	—	—	—
Eu-155	—	—	—
H-3	—	—	—
I-129	—	—	—
K-40	—	—	—
Nb-95	—	—	—
Np-237	—	—	—
Pu-238	—	—	—
Pu-239/240	—	—	—
Pu-241	—	—	—
Pu-242	—	—	—
Rh-106	—	—	—
Ru-106	—	—	—
Sb-125	—	—	—
Sr-90	—	—	—
Tc-99	—	—	—
U-234	—	—	—
U-235	—	—	—
U-236	—	—	—
U-238	—	—	—
Total cancer risks by route:	6E-09	9E-06	9E-06

"—" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.

Table 14-28. Cancer risk to the future on-site resident at CPP-03.

COPCs	Ingestion of soil	Ingestion of homegrown	External radiation exposure	Total risks
Aroclor-1260	—	—	—	—
Benzo(a)pyrene	—	—	—	—
Aluminum	—	—	—	—
Arsenic	—	—	—	—
Manganese	—	—	—	—
Mercury	—	—	—	—
Uranium	—	—	—	—
Am-241	—	—	—	—
Ce-144	—	—	—	—
Co-57	—	—	—	—
Co-58	—	—	—	—
Co-60	—	—	—	—
Cs-134	—	—	—	—
Cs-137	2E-07	4E-05	3E-04	3E-04
Eu-152	5E-11	2E-10	8E-07	8E-07
Eu-154	—	—	—	—
Eu-155	—	—	—	—
H-3	—	—	—	—
I-129	—	—	—	—
K-40	—	—	—	—
Nb-95	—	—	—	—
Np-237	—	—	—	—
Pu-238	—	—	—	—
Pu-239/240	—	—	—	—
Pu-241	—	—	—	—
Pu-242	—	—	—	—
Rh-106	—	—	—	—
Ru-106	—	—	—	—
Sb-125	—	—	—	—
Sr-90	2E-07	8E-05	NTD	8E-05
Tc-99	—	—	—	—
U-234	—	—	—	—
U-235	—	—	—	—
U-236	—	—	—	—
U-238	—	—	—	—
Total cancer risks by route:	4E-07	1E-04	3E-04	4E-04

"—" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.

Table 14-29. Cancer risk to the future on-site resident at CPP-17A.

COPCs	Ingestion of soil	Ingestion of homegrown	External radiation exposure	Total risks
Aroclor-1260	—	—	—	—
Benzo(a)pyrene	—	—	—	—
Aluminum	—	—	—	—
Arsenic	—	—	—	—
Manganese	—	—	—	—
Mercury	—	—	—	—
Uranium	—	—	—	—
Am-241	—	—	—	—
Ce-144	—	—	—	—
Co-57	—	—	—	—
Co-58	—	—	—	—
Co-60	—	—	—	—
Cs-134	—	—	—	—
Cs-137	6E-08	1E-05	8E-05	1E-04
Eu-152	5E-11	2E-10	8E-07	8E-07
Eu-154	3E-12	1E-11	4E-08	4E-08
Eu-155	—	—	—	—
H-3	—	—	—	—
I-129	—	—	—	—
K-40	—	—	—	—
Nb-95	—	—	—	—
Np-237	—	—	—	—
Pu-238	—	—	—	—
Pu-239/240	—	—	—	—
Pu-241	—	—	—	—
Pu-242	—	—	—	—
Rh-106	—	—	—	—
Ru-106	—	—	—	—
Sb-125	—	—	—	—
Sr-90	1E-08	5E-06	NTD	5E-06
Tc-99	—	—	—	—
U-234	—	—	—	—
U-235	—	—	—	—
U-236	—	—	—	—
U-238	—	—	—	—
Total cancer risks by route:	7E-08	2E-05	8E-05	1E-04

"—" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.

Table 14-30. Cancer risk to the future on-site resident at CPP-17B.

COPCs	Ingestion of soil	Ingestion of homegrown	External radiation exposure	Total risks
Aroclor-1260	—	—	—	—
Benzo(a)pyrene	—	—	—	—
Aluminum	—	—	—	—
Arsenic	—	—	—	—
Manganese	—	—	—	—
Mercury	—	—	—	—
Uranium	—	—	—	—
Am-241	—	—	—	—
Ce-144	—	—	—	—
Co-57	7E-52	1E-50	3E-48	3E-48
Co-58	—	—	—	—
Co-60	—	—	—	—
Cs-134	—	—	—	—
Cs-137	3E-08	6E-06	5E-05	5E-05
Eu-152	—	—	—	—
Eu-154	—	—	—	—
Eu-155	—	—	—	—
H-3	—	—	—	—
I-129	—	—	—	—
K-40	—	—	—	—
Nb-95	—	—	—	—
Np-237	—	—	—	—
Pu-238	—	—	—	—
Pu-239/240	—	—	—	—
Pu-241	—	—	—	—
Pu-242	—	—	—	—
Rh-106	—	—	—	—
Ru-106	—	—	—	—
Sb-125	—	—	—	—
Sr-90	—	—	—	—
Tc-99	—	—	—	—
U-234	—	—	—	—
U-235	—	—	—	—
U-236	—	—	—	—
U-238	—	—	—	—
Total cancer risks by route:	3E-08	6E-06	5E-05	5E-05

"—" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.

east of CPP-603 Group, no data points were rejected based on the method validation as documented in the Limitations and Validation (L&V) Reports, thus impact from the possible source of uncertainty is insignificant.

Uncertainty associated with the chemical screening process (Section 5.2) results from using the maximum concentration for chemicals detected in the ECAs in the background comparison step, retaining chemicals detected as COPCs because there is not a corresponding background value, and retaining chemicals as COPCs for which there is no toxicity information available.

In most cases, the COPC identification process used the maximum concentration for a chemical detected in the background comparison step, regardless of its magnitude above background. The use of the maximum can result in the identification of COPCs that have concentrations only slightly above background. For the storage yard east of CPP-603 Group, all COPC concentrations as well as the 95% UCLs were significantly above the background values.

A source of uncertainty related to the background comparison step in the chemical screening process relates to chemicals for which no background concentration exists. For example, fluoride, nitrate, and several radionuclides were not characterized as part of the Rood et al. (1995) background study. For the storage yard east of CPP-603 Group, the following COPCs have no corresponding background concentration: Co-57, Eu-152, and Eu-154. This results in an increase in the number of COPCs considered in the remedial investigation/Baseline Risk Assessment (RI/BRA) and a possible overestimation of risk because the observed concentrations may be within the background population.

The lateral extent of potential contamination at CPP-03 has not been precisely assessed. Borings based off of radiation surveys are located near the current boundaries of the ECA. The vertical extent of contamination at CPP-03 is assumed to range from surface to 1.2-m (4-ft) bgs. This assumption is based on COPC activities above background in surface to 0.6-m (2.0-ft) samples, and below background COPC levels in deeper samples. As well, there is nothing in the work practice history at CPP-03 to lead to a conclusion that deep penetration of COPCs should be expected.

For the storage yard east of CPP-603 Group, toxicity information was available for all COPCs in the HHRA.

With respect to nature and extent, soil boring locations at CPP-03 were based on results of a surface radiation survey. Soil borings were drilled at locations of high radiation readings. Distribution of results from these boring locations to the site as a whole may lead to overestimation of the contaminant due to the use of biased sampling results.

As at CPP-03, the lateral extent of potential contamination at site CPP-17 has not been precisely assessed. No fence line or concrete pad area is apparent on which to base an assumption as to the size of the storage area. Borings based off of radiation surveys are located near the current boundaries of the ECA. The boundaries of the ECA were expanded based on results from borings CPP-17-02 and CPP-17-03, which indicated COPC results above background. The vertical extent of contamination at CPP-03 is assumed to range from surface to 1.2-m (4-ft) bgs. This assumption is based on decreasing but above background COPC activities in surface to 0.6-m (2.0-ft) samples. One sample collected from below the assumed zone of contamination contained a COPC above background. This occurred for Sr-90 in the 2.4- to 3.0-m (8- to 10-ft) sample of boring CPP-17-02. The affected soil mass may be underestimated if contamination is continuous to this depth in this boring.

Soil boring locations at site CPP-17 were based on results of a surface radiation survey. Soil borings were drilled at locations of high radiation readings. Distribution of results from these boring locations to the CPP as a whole may lead to overestimation of the contaminant concentrations in affected soil.

Another other source of uncertainty may be associated with the contaminant inventories used for the groundwater modeling and residential intrusion exposure at every sub-area. Section 14.3 identifies radionuclides potentially missing from these inventories. The implication of these potential data gaps, is that the source estimates could be underestimated. Based on the results of the groundwater model, the potentially missing Pu-238, Pu-241, and Eu-154, which have half-lives of 87.7, 14.4, and 8.6 years, respectively would not be expected to be of concern because of their long travel times to the aquifer. Am-241 is potentially missing from the source estimates but would not be expected to be a concern because most of the Am-241 activity has been accounted for in the tank farm area and shown that the source assumptions are conservative. For a discussion of uncertainty associated with Pu-239 and Pu-240, see Section 10 of Appendix F. The potentially uncertainty is recognized in this report but no information is available to quantify the uncertainty.

14.6 Conclusions and Recommendations

The results of the risk assessment under current land use for this group indicates that the increased cancer risk from exposure to group-related contaminants is only slightly above the EPA-recommended target range. The increased cancer risk to hypothetical future onsite workers is within the EPA target range and for future onsite residents it was found to be slightly above the EPA-recommended target range. The noncarcinogenic hazard for all receptors was found to be below the EPA hazard index goal of one. The results of the risk assessment as presented separately for each site indicate that the increased cancer risk to a future resident at the year 2095 and beyond is greater than the recommended target range only at site CPP-03. It should be noted that the group and individual site estimates do not include the contributions associated with the air and groundwater pathways. The total increased cancer and hazard incidence to humans is reported in Section 27 of this report. The results for the group and for each site indicate that a response is not necessary for the entire group. An action to lower the excess cancer risk to a future resident at site CPP-03 to within the EPA recommended range would be sufficient at this group.

14.7 References

Rood, S. M., G. A. Harris, and G. J. White, 1995, *Background Dose Equivalent Rates and Surficial Soil Metal and Radionuclide Concentrations for the Idaho National Engineering Laboratory*, INEL-94/0250, Revision 0, February.

WINCO, 1994, *Draft Preliminary Scoping Track 2 Summary Report For Operable Unit 3-09. Revision 1*, September.

15. SITE CPP-37 RESULTS

Site CPP-37 consists of Gravel Pits #1 and #2, which are located in the northeast corner of the Idaho Chemical Processing Plant (ICPP) (Figure 15-1). This section describes the results of investigations conducted to define the extent of contamination associated with this site as well as the results of the human health risk assessment (HHRA).

15.1 Site Description

Pit #1 (CPP-37A) is located outside of the ICPP security fence and measures approximately 43 m (140 ft) in width × 64 m (210 ft) in length and is 4.3 m (14 ft) in depth. No information is available on the date pit usage began; however, Pit #1 was used for decontamination of radiologically-contaminated construction equipment during July and October 1983. In addition, during 1982 and 1983, the pit was used as a percolation pond for ICPP service wastewater while the injection well was being refitted. Grab samples from the service waste contained no radionuclides or hazardous chemicals (Sehlke, 1990). This pit currently receives stormwater runoff from the ICPP.

Pit #2 (CPP-37B) is located inside the ICPP security fence (Figure 15-1) and before being backfilled was approximately 79 m (260 ft) in width × 116 m (380 ft) in length and was 7.9-m (26-ft) deep. Before 1982, this pit was often used for the disposal of waters released from the sludge dewatering pit of the old Sewage Treatment Plant (CPP-715). The exact volume of water effluent discharged to this gravel pit is unknown, but the volumes are believed to be low. The sludge from the dewatering pit was known to be radioactively contaminated. As a result, the waters discharged to the pit were likely to have contained radionuclides. After 1982, the pit was used to dispose of construction debris, some of which may have been radioactively contaminated. Anecdotal information suggests that Pit #2 may have also been used for the disposal of chemical wastes. Additionally, the pit was open in 1964 when the release of radioactive steam associated with site CPP-26 (Section 10.3) occurred. Radioactive steam containing Cs-137 was released from a decontamination header in the High-level Liquid Waste Tank Farm (HLLWTF). The year this pit was backfilled is unknown, but it is believed to have been backfilled to grade shortly after its use as a construction debris landfill was discontinued.

The dimensions of the pits as reported in the Track 2 (WINCO, 1994) are reflected in Figure 15-1. However, the exact location of Pit #2 is not well-defined and the location shown on Figure 15-1 should be considered approximate.

15.2 Investigative Results

Soil samples were collected from Pit #1 and Pit #2 in 1991. For the purpose of collecting near-surface soil samples, Pit #1 was divided into three areas. Three shallow borings were drilled in each area and samples were collected at depths of 0 to 0.3 m (0 to 0.5 ft), 0.3 to 0.6 m (1 to 2 ft), and 1.5 to 1.8 m (5 to 6 ft) below the bottom of the pit in each boring. Samples were composited from the same depths in each area for analysis. In addition to the near surface soil samples, one deeper borehole was drilled in the center of the pit from which soil samples were collected at 1.5-m (5-ft) intervals. The results are summarized in Table 15-1. It should be noted that I-129 and silver were analyzed for but not detected and therefore, were not added to Table 5-4. Based on the contaminant screening conducted in Section 5.2, contaminants of potential concern (COPCs) identified for Pit #1 were arsenic, Co-60, Am-241, Cs-137, Np-237, Pu-238, Sr-90, U-235, and U-238.

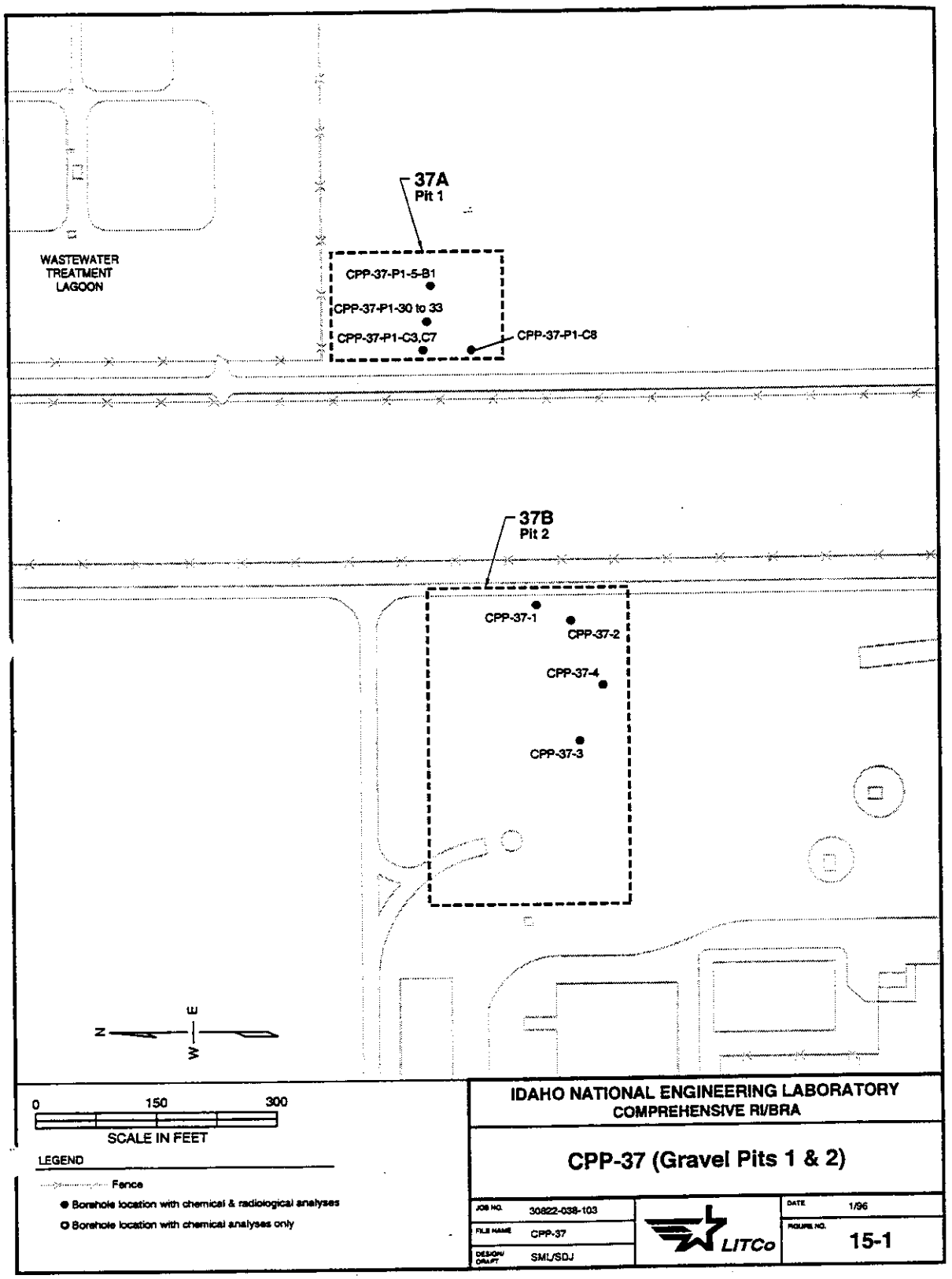


Figure 15-1. CPP-37 (Gravel Pits 1 & 2).

Table 15-1. Summary statistics for CPP-37A, CPP Gravel Pit #1.

COPCs	Concentration (mg/kg or pCi/g) Minimum detected	Maximum detected	Arithmetic mean	Standard deviation	Number of samples	Number of detects	Frequency of detection	INEL background (mg/kg or pCi/g)	Number greater than background
Arsenic	4.1	8.7	5.83E+00	1.20E+00	14	14	100%	5.8	6
Am-241	0.23 +/- 0.1	0.99 +/- 0.65	4.76E-01	2.56E-01	14	8	57%	0.011	7
Co-60	0.55 +/- 0.12	0.55 +/- 0.12	5.50E-01	NA	13	1	8%	NA	NA
Cs-137	0.14 +/- 0.07	3.82 +/- 0.23	1.13E+00	1.22E+00	14	10	71%	0.82	4
Np-237	0.32 +/- 0.26	1.07 +/- 0.11	6.62E-01	2.49E-01	14	12	86%	NA	NA
Pu-238	0.1 +/- 0.04	0.12 +/- 0.04	1.10E-01	1.41E-02	14	3	21%	0.0049	2
Sr-90	0.17 +/- 0.16	0.69 +/- 0.12	3.70E-01	1.69E-01	14	10	71%	0.49	2
U-235	0.05 +/- 0.03	0.05 +/- 0.03	5.00E-02	NA	13	1	8%	NA	NA
U-238	0.07 +/- 0.03	3.99 +/- 0.25	7.27E-01	1.00E+00	13	13	100%	1.4	1

NA - Not applicable/available

The Track 2 investigation for site CPP-37 (WINCO, 1994) Pit #1 indicated that arsenic was detected above background in eight out of 14 samples collected. However, the maximum arsenic concentration was only 8.7 mg/kg relative to the background value for arsenic of 5.8 mg/kg.

Radionuclides detected above background (Rood et al., 1995) in soil samples collected in Pit #1 were Am-241, Cs-137, Np-237, Pu-238, and Sr-90. Other radionuclides that do not have a background value were detected at low concentrations including (maximum concentrations in parentheses): Co-60 (0.55 pCi/g), U-235 (0.05 pCi/g), and U-238 (3.99 pCi/g). No radionuclides were detected in the 0- to 0.3-m (0- to 0.5-ft) samples except for Sr-90 at 0.69±0.12 pCi/g in Area 3 in the southwestern portion of the pit. Radionuclides were not detected above background in the deep borehole below 4.6 m (15 ft).

Before drilling and sampling Pit #2, a geophysical survey was conducted to determine the lateral extent of, and deeper portions of, the backfilled pit. Three boreholes were drilled to the top of basalt in the deeper areas of the former pit. A fourth borehole was drilled to the interbed at approximately 34 m (110 ft) and completed as a perched monitoring well. Samples were not collected at depths less than 1.5 m (5 ft) due to the presence of backfill in the pit. The results are summarized in Table 15-2. Based on the contaminant screening conducted in Section 5.2, COPCs identified for Pit #2 were arsenic, kepone, Arochlor-1260, Am-241, Cs-137, I-129, Np-237, Pu-238, Sr-90, U-235, and U-238.

Radionuclides detected above background in soil samples collected in Pit #2 were Am-241, Cs-137, Pu238, Sr-90, and U-238. Other radionuclides that have no background value were detected including (maximum concentrations in parentheses): I-129 (1.57 pCi/g), Np-237 (0.86 pCi/g), and U-235 (0.07 pCi/g). Cs-137, Np-237, and Sr-90 were detected most frequently in the samples from the four boreholes. Concentrations of Cs-137 and Sr-90 typically decrease with depth below the base of the fill at 6.4 to 7.9 m (21 to 26 ft). Cs-137 was not detected above background below a depth of 6.1 m (20 ft) while Sr-90 was detected in several samples below a depth of 6.1 m (20 ft) below ground surface (bgs). The presence of Sr-90 and not Cs-137 in the deeper samples is likely due to the increased mobility of Sr-90 relative to Cs-137.

15.3 Nature and Extent of Contamination

The reported releases to the pits included wastewater discharge, potentially contaminated construction debris, decontamination operations, and possibly chemical waste. The extent of contamination related to these releases would be expected to remain within the lateral boundaries of the pit. Liquids discharged to one or both of the pits included service wastes and effluent from the sludge dewatering pit of the old Sewage Treatment Plant. Currently, stormwater runoff drains into Pit #1. The more mobile contaminants (i.e., those that would migrate with infiltrating water) may have already migrated downward. However, the only radionuclide detected between a depth of 6.1 m (20 ft) and the top of basalt was Sr-90 in two of the four borings at Pit #2. No radionuclides were detected in the sample from the "110-ft" interbed beneath Pit #2. The contaminated zone for Pit #2 is assumed to be from 1.5 to 10.1 m (5 to 33 ft). Soil samples deeper than 1.8 m (6 ft) were only collected in one boring at Pit #1. Radionuclides were not detected above background from samples collected below a depth of 3.1 m (10 ft). The contaminated zone at Pit #1 is assumed to extend from 0 to 3.0 m (10 ft). The areas of Pit #1 and Pit #2 are 2,731 m^2 (29,400 ft^2) and 9,179 m^2 (98,800 ft^2) based on the dimensions reported in the Track 2 (WINCO, 1994). Contaminated soil volumes in the pits were estimated for the purposes of calculating source terms for the model based on the above depth intervals and the reported dimensions of the pits.

15.4 Risk Assessment

The methodology for conducting the HHRA for WAG 3 is detailed in Section 7. As presented, the purpose of the HHRA is to develop a quantitative description and assessment of the human

Table 15-2. Summary statistics for CPP-37B, CPP Gravel Pit #2.

COPCs	Concentration (mg/kg or pCi/g) Minimum detected	Maximum detected	Arithmetic mean	Standard deviation	Number of samples	Number of detects	Frequency of detection	INEL background (mg/kg or pCi/g)	Number greater than background
Arsenic	1.2 B	11.4 J	4.42E+00	1.84E+00	28	28	100%	5.8	3
Aroclor-1260	0.42	0.42	4.20E-01	NA	1	1	100%	NA	NA
Kepone	0.4	0.4	4.00E-01	NA	1	1	100%	NA	NA
Am-241	0.37 +/- 0.17	1.09 +/- 0.47	7.30E-01	5.09E-01	28	4	14%	0.011	2
Cs-137	0.14 +/- 0.07	6.31 +/- 0.27	2.04E+00	1.67E+00	28	19	68%	0.82	11
I-129	1.57 +/- 0.82	1.57 +/- 0.82	1.57E+00	NA	26	1	4%	NA	NA
Np-237	0.32 +/- 0.13	0.86 +/- 0.29	5.13E-01	1.26E-01	28	28	100%	NA	NA
Pu-238	0.06 +/- 0.04	0.5 +/- 0.02	1.99E-01	1.57E-01	28	10	36%	0.0049	7
Sr-90	0.08 +/- 0.13	4.31 +/- 0.33	9.72E-01	1.13E+00	28	23	82%	0.49	11
U-235	0.05 +/- 0.02	0.07 +/- 0.04	5.75E-02	9.57E-03	28	6	21%	NA	NA
U-238	0.16 +/- 0.03	7.44 +/- 0.35	7.87E-01	1.46E+00	26	26	100%	1.4	3

NA - Not applicable/available

health risk posed by the COPCs present at WAG 3. This section only contains the results of the HHRA for sites CPP-37A and CPP-37B with respect to the soil pathways. The results for the air and groundwater pathways are detailed in Sections 27.1 and 27.2, respectively. The risk assessment at each gravel pit will become cumulative when the contributions from the air and groundwater pathways are added to that from the soil pathway. The following sections discuss the complete exposure routes, exposure-point concentrations, and cancer risk and noncarcinogenic health hazard estimates for site CPP-37 under the three exposure scenarios evaluated. Section 15.4.3 will describe any differences in estimating the contamination sources used to evaluate surface exposure and that used for the groundwater model. This section will also describe the use of the screened ORIGEN results (Sec. 4.4) to help identify contaminants potentially missing from the soil source inventory.

15.4.1 Complete Exposure Routes

Potentially complete pathways from the source to a human receptor are described in Section 7 and illustrated on Figure 7-1. For sites CPP-37A and CPP-37B, the complete exposure routes within each pathway are summarized in Table 15-3. An exposure route is considered complete if the contaminated zone (as characterized in the previous sections and summarized on the table) occurs within the depth intervals specified for a given exposure route. All exposure routes are considered complete for site CPP-37.

15.4.2 Exposure-Point Concentrations

Specific steps in calculating exposure-point concentrations for each of the applicable scenarios are described in Section 7. The COPC soil value used was the smaller of the 95% upper confidence limit (UCL) or maximum concentration. The soil values for site CPP-37 were estimated using the individual site concentration terms for CPP-37A (Pit 1) and CPP-37B (Pit 2). The concentration terms for the radionuclides were adjusted to account for decay for each exposure scenario. These values were subsequently averaged over the exposure duration. The concentration terms, by depth interval, are presented in Tables 15-4 and 15-5 for CPP-37A and CPP-37B, respectively. Exposures from all complete exposure routes were estimated based on the exposure-point concentrations in Tables 15-6 and 15-7. Homegrown produce concentrations for CPP-37A and CPP-37B are presented in Tables 15-8 and 15-9. The values for air and groundwater are presented in Sections 27.1 and 27.2, respectively.

15.4.3 Description of Source Estimates for Surface Exposure and Groundwater Modeling Use

The purpose for this subsection is two-fold. First, to compare the approach to defining the source estimate for use in both the surface exposure assessment and the groundwater model. This comparison was done for each subarea within this site and was accomplished by comparing the soil data in Tables 15-4 and 15-5 to the soil data used to estimate the source for use in the groundwater model, which can be found in Tables 5-39 and 5-40 of Appendix F. The benefit of these comparisons is to relate both source estimates and explain any apparent differences. Secondly, the results of the screened ORIGEN runs summarized in Section 4.4 were used to help identify any potential soil-related data gaps by comparing ORIGEN results to the field investigation results at each gravel pit. This comparison was based on the full inventory of contaminants in the screening tables in Section 5 before implementing the screening steps shown therein. The results of these comparisons are described for each site in the following paragraphs. The results of this comparison for perched water and SRPA are reported at the end of Section 4.4.

The CPP-37A source estimate for groundwater use was based on the same soil COPC's in Table 15-4 with the exception of mercury since it screened out in Table 5-4 but was included in the groundwater model. Based on a comparison of the radionuclides that were analyzed in site soils against the potential inventory as defined by the screened ORIGEN results (Table 4-7), Eu-154 Pu-239/240 and Pu-241 were not part of the soil sampling analysis performed at this site. The implication is that these radionuclides may be present and are currently not part of the soil contaminant inventory.

Table 15-3. Complete exposure routes for site CPP-37 and associated exposure route depths.

Receptor	Scenario	Potentially complete exposure routes and exposure route depths used for exposure-point concentration estimates	Characterized zone of contamination[a]	Complete exposure route?
Onsite worker	Current land use	Inhalation of VOCs	0 to 10.1 m	No
		[0–15 cm (0–6 in.)]	(0 to 33 ft)	Yes
		Inhalation of airborne particulates [0–15 cm (0–6 in.)]		Yes
		Ingestion of surface soil [0–15 cm (0–6 in.)]		Yes
		External radiation [0–1.22 m (0–4 ft)]		
Residential	Future land use	Inhalation of VOCs [0–3.05 m (0–10 ft)]	0 to 10.1 m	No
		Inhalation of airborne particulates [0–3.05 m (0–10 ft)]	(0 to 33 ft)	Yes
		Ingestion of surface soil [0–3.05 m (0–10 ft)]		Yes
		Ingestion of homegrown produce [0–3.05 m (0–10 ft)]		Yes
		Ingestion of groundwater		Yes
		Dermal contact with groundwater		No
		Inhalation of VOCs from groundwater		No
		External radiation [0–3.05 m (0–10 ft)]		Yes
Onsite worker	Future land use	Inhalation of VOCs [0–15 cm (0–6 in.)]	0 to 10.1 m	No
		Inhalation of airborne particulates [0–15 cm (0–6 in.)]	(0 to 33 ft)	Yes
		Ingestion of surface soil [0–15 cm (0–6 in.)]		Yes
		External radiation [0–1.22 m (0–4 ft)]		Yes

a. Zone of contamination based on the following previously characterized zones:

CPP-37 (Pit 1) = 0 to 3.04 m (0 to 10 ft)
CPP-37 (Pit 2) = 1.5 to 10.1 m (5 to 33 ft).

Table 15-4. Soil concentration terms by depth interval at CPP-37A.

COPCs	Soil concentrations (mg/kg or pCi/g) (0 - 0.5 ft)	(0 - 4 ft)	(0 - 10 ft)
Aroclor-1260	----	----	----
Benzo(a)pyrene	----	----	----
Aluminum	----	----	----
Arsenic	7.30E+00	6.70E+00	6.05E+00
Manganese	----	----	----
Mercury	----	----	----
Uranium[a]	1.72E+00	1.93E+00	5.75E+00
Am-241	5.20E-01	5.40E-01	9.90E-01
Ce-144	----	----	----
Co-57	----	----	----
Co-58	----	----	----
Co-60	----	----	----
Cs-134	----	----	----
Cs-137	1.28E+00	2.31E+00	3.82E+00
Eu-152	----	----	----
Eu-154	----	----	----
Eu-155	----	----	----
H-3	----	----	----
I-129	----	----	----
K-40	----	----	----
Nb-95	----	----	----
Np-237	5.40E-01	7.60E-01	8.93E-01
Pu-238	----	----	6.07E-02
Pu-239/240	----	----	----
Pu-241	----	----	----
Pu-242	----	----	----
Ru/Rh-106	----	----	----
Sb-125	----	----	----
Sr-90	6.90E-01	6.90E-01	6.90E-01
Tc-99	----	----	----
U-234	----	----	----
U-235	----	----	3.08E-02
U-236	----	----	----
U-238	5.80E-01	6.50E-01	1.93E+00

a. mg/kg of uranium calculated from pCi/g of uranium isotopes using the equation mg/kg = pCi/g * 2.795E-12 (mg-mole/kg-pCi-yr) * MW (g/mole) * $t_{1/2}$ (yr).

Table 15-5. Soil concentration terms by depth interval at CPP-37B.

COPCs	Soil concentrations (mg/kg or pCi/g) (0 - 0.5 ft)	(0 - 4 ft)	(0 - 10 ft)
Aroclor-1260	----	----	----
Benzo(a)pyrene	----	----	----
Aluminum	----	----	----
Arsenic	----	----	4.54E+00
Manganese	----	----	----
Mercury	----	----	----
Uranium[a]	----	----	1.33E+00
Am-241	----	----	1.09E+00
Ce-144	----	----	----
Co-57	----	----	----
Co-58	----	----	----
Co-60	----	----	----
Cs-134	----	----	----
Cs-137	----	----	4.20E+00
Eu-152	----	----	----
Eu-154	----	----	----
Eu-155	----	----	----
H-3	----	----	----
I-129	----	----	----
K-40	----	----	----
Nb-95	----	----	----
Np-237	----	----	5.23E-01
Pu-238	----	----	5.00E-01
Pu-239/240	----	----	----
Pu-241	----	----	----
Pu-242	----	----	----
Ru/Rh-106	----	----	----
Sb-125	----	----	----
Sr-90	----	----	2.95E+00
Tc-99	----	----	----
U-234	----	----	----
U-235	----	----	3.58E-02
U-236	----	----	----
U-238	----	----	4.40E-01

a. mg/kg of uranium calculated from pCi/g of uranium isotopes using the equation
mg/kg = pCi/g * 2.795E-12 (mg-mole/kg-pCi-yr) * MW (g/mole) * $t_{1/2}$ (yr).

Table 15-6. Average soil exposure-point concentrations (mg/kg or pCi/g) for land use scenarios at CPP-37A.

	Current occupational worker year 0 to year 25		Future occupational worker year 100 to year 125		Future resident year 100 to year 130
COPCs	(0 - 0.5 ft)	(0 - 4 ft)	(0 - 0.5 ft)	(0 - 4 ft)	(0 - 10 ft)
Aroclor-1260	----	----	----	----	----
Benzo(a)pyrene	----	----	----	----	----
Aluminum	----	----	----	----	----
Arsenic	7.30E+00	6.70E+00	7.30E+00	6.70E+00	6.05E+00
Manganese	----	----	----	----	----
Mercury	----	----	----	----	----
Uranium	1.72E+00	1.93E+00	1.72E+00	1.93E+00	5.75E+00
Am-241	5.10E-01	5.29E-01	4.34E-01	4.51E-01	8.23E-01
Ce-144	----	----	----	----	----
Co-57	----	----	----	----	----
Co-58	----	----	----	----	----
Co-60	----	----	----	----	----
Cs-134	----	----	----	----	----
Cs-137	9.74E-01	1.76E+00	9.79E-02	1.77E-01	2.78E-01
Eu-152	----	----	----	----	----
Eu-154	----	----	----	----	----
Eu-155	----	----	----	----	----
H-3	----	----	----	----	----
I-129	----	----	----	----	----
K-40	----	----	----	----	----
Nb-95	----	----	----	----	----
Np-237	5.40E-01	7.60E-01	5.40E-01	7.60E-01	8.93E-01
Pu-238	----	----	----	----	2.45E-02
Pu-239/240	----	----	----	----	----
Pu-241	----	----	----	----	----
Pu-242	----	----	----	----	----
Ru/Rh-106	----	----	----	----	----
Sb-125	----	----	----	----	----
Sr-90	5.20E-01	5.20E-01	4.81E-02	4.81E-02	4.56E-02
Tc-99	----	----	----	----	----
U-234	----	----	----	----	----
U-235	----	----	----	----	3.08E-02
U-236	----	----	----	----	----
U-238	5.80E-01	6.50E-01	5.80E-01	6.50E-01	1.93E+00

a. mg/kg of uranium calculated from pCi/g of uranium isotopes using the equation
mg/kg = pCi/g * 2.795E-12 (mg-mole/kg-pCi-yr) * MW (g/mole) * $t_{1/2}$ (yr).

Table 15-7. Average soil exposure-point concentrations (mg/kg or pCi/g) for land use scenarios at CPP-37B.

	Current occupational worker year 0 to year 25		Future occupational worker year 100 to year 125		Future resident year 100 to year 130
COPCs	(0 - 0.5 ft)	(0 - 4 ft)	(0 - 0.5 ft)	(0 - 4 ft)	(0 - 10 ft)
Aroclor-1260	----	----	----	----	----
Benzo(a)pyrene	----	----	----	----	----
Aluminum	----	----	----	----	----
Arsenic	----	----	----	----	4.54E+00
Manganese	----	----	----	----	----
Mercury	----	----	----	----	----
Uranium[a]	----	----	----	----	1.33E+00
Am-241	----	----	----	----	9.06E-01
Ce-144	----	----	----	----	----
Co-57	----	----	----	----	----
Co-58	----	----	----	----	----
Co-60	----	----	----	----	----
Cs-134	----	----	----	----	----
Cs-137	----	----	----	----	3.05E-01
Eu-152	----	----	----	----	----
Eu-154	----	----	----	----	----
Eu-155	----	----	----	----	----
H-3	----	----	----	----	----
I-129	----	----	----	----	----
K-40	----	----	----	----	----
Nb-95	----	----	----	----	----
Np-237	----	----	----	----	5.23E-01
Pu-238	----	----	----	----	2.02E-01
Pu-239/240	----	----	----	----	----
Pu-241	----	----	----	----	----
Pu-242	----	----	----	----	----
Ru/Rh-106	----	----	----	----	----
Sb-125	----	----	----	----	----
Sr-90	----	----	----	----	1.95E-01
Tc-99	----	----	----	----	----
U-234	----	----	----	----	----
U-235	----	----	----	----	3.58E-02
U-236	----	----	----	----	----
U-238	----	----	----	----	4.40E-01

a. mg/kg of uranium calculated from pCi/g of uranium isotopes using the equation
mg/kg = pCi/g * 2.795E-12 (mg-mole/kg-pCi-yr) * MW (g/mole) * $t_{1/2}$ (yr).

Table 15-8. Concentrations of COPCs in homegrown produce at CPP-37A.

COPCs	Homegrown produce (mg/kg or pCi/g)	Kd (cm^3/g)	COPC input rate from irrigation (mg/g-d or pCi/g-d)	Leach rate constant (d^{-1})
Aroclor-1260	---	7.89E+03	0.00E+00	9.95E-07
Benzo(a)pyrene	---	1.19E+03	0.00E+00	6.57E-06
Aluminum	---	0.00E+00	0.00E+00	2.87E-02
Arsenic	9.35E-03	3.00E+00	8.71E-09	2.40E-03
Manganese	---	5.00E+01	0.00E+00	1.56E-04
Mercury	1.10E-01	1.00E+02	2.91E-08	7.83E-05
Uranium	5.94E-03	6.00E+00	7.04E-09	1.25E-03
Am-241	1.30E-04	3.40E+02	6.08E-06	2.31E-05
Ce-144	---	5.00E+02	0.00E+00	1.57E-05
Co-57	---	1.00E+01	0.00E+00	7.64E-04
Co-58	---	1.00E+01	0.00E+00	7.64E-04
Co-60	---	1.00E+01	0.00E+00	7.64E-04
Cs-134	---	5.00E+02	0.00E+00	1.57E-05
Cs-137	7.80E-03	5.00E+02	4.12E-05	1.57E-05
Eu-152	---	3.40E+02	0.00E+00	2.31E-05
Eu-154	---	3.40E+02	0.00E+00	2.31E-05
Eu-155	---	3.40E+02	0.00E+00	2.31E-05
H-3	---	0.00E+00	6.22E-04	2.87E-02
I-129	3.85E-06	0.00E+00	3.26E-05	2.87E-02
K-40	---	1.50E+01	0.00E+00	5.14E-04
Nb-95	---	0.00E+00	0.00E+00	2.87E-02
Np-237	3.44E-04	0.00E+00	8.36E-06	2.87E-02
Pu-238	2.96E-06	2.20E+01	0.00E+00	3.53E-04
Pu-239/240	5.15E-06	2.20E+01	5.84E-07	3.53E-04
Pu-241	8.49E-09	2.20E+01	9.37E-08	3.53E-04
Pu-242	3.60E-09	2.20E+01	3.88E-10	3.53E-04
Ru/Rh-106	---	0.00E+00	0.00E+00	2.87E-02
Sb-125	---	5.00E+01	0.00E+00	1.56E-04
Sr-90	1.46E-02	1.20E+01	5.63E-05	6.40E-04
Tc-99	4.56E-01	0.00E+00	1.67E-04	2.87E-02
U-234	2.73E-05	6.00E+00	2.63E-06	1.25E-03
U-235	3.24E-05	6.00E+00	9.27E-08	1.25E-03
U-236	6.93E-07	6.00E+00	6.68E-08	1.25E-03
U-238	1.99E-03	6.00E+00	2.35E-06	1.25E-03

Table 15-9. Concentrations of COPCs in homegrown produce at CPP-37B.

COPCs	Homegrown produce (mg/kg or pCi/g)	Kd (cm^3/g)	COPC input rate from irrigation (mg/g-d or pCi/g-d)	Leach rate constant (d^{-1})
Aroclor-1260	---	7.89E+03	0.00E+00	9.95E-07
Benzo(a)pyrene	---	1.19E+03	0.00E+00	6.57E-06
Aluminum	---	0.00E+00	0.00E+00	2.87E-02
Arsenic	7.06E-03	3.00E+00	8.71E-09	2.40E-03
Manganese	---	5.00E+01	0.00E+00	1.56E-04
Mercury	1.10E-01	1.00E+02	2.91E-08	7.83E-05
Uranium	1.43E-03	6.00E+00	7.04E-09	1.25E-03
Am-241	1.42E-04	3.40E+02	6.08E-06	2.31E-05
Ce-144	---	5.00E+02	0.00E+00	1.57E-05
Co-57	---	1.00E+01	0.00E+00	7.64E-04
Co-58	---	1.00E+01	0.00E+00	7.64E-04
Co-60	---	1.00E+01	0.00E+00	7.64E-04
Cs-134	---	5.00E+02	0.00E+00	1.57E-05
Cs-137	8.50E-03	5.00E+02	4.12E-05	1.57E-05
Eu-152	---	3.40E+02	0.00E+00	2.31E-05
Eu-154	---	3.40E+02	0.00E+00	2.31E-05
Eu-155	---	3.40E+02	0.00E+00	2.31E-05
H-3	----	0.00E+00	6.22E-04	2.87E-02
I-129	3.85E-06	0.00E+00	3.26E-05	2.87E-02
K-40	---	1.50E+01	0.00E+00	5.14E-04
Nb-95	---	0.00E+00	0.00E+00	2.87E-02
Np-237	2.15E-04	0.00E+00	8.36E-06	2.87E-02
Pu-238	2.44E-05	2.20E+01	0.00E+00	3.53E-04
Pu-239/240	5.15E-06	2.20E+01	5.84E-07	3.53E-04
Pu-241	8.49E-09	2.20E+01	9.37E-08	3.53E-04
Pu-242	3.60E-09	2.20E+01	3.88E-10	3.53E-04
Ru/Rh-106	---	0.00E+00	0.00E+00	2.87E-02
Sb-125	---	5.00E+01	0.00E+00	1.56E-04
Sr-90	3.99E-02	1.20E+01	5.63E-05	6.40E-04
Tc-99	4.56E-01	0.00E+00	1.67E-04	2.87E-02
U-234	2.73E-05	6.00E+00	2.63E-06	1.25E-03
U-235	3.75E-05	6.00E+00	9.27E-08	1.25E-03
U-236	6.93E-07	6.00E+00	6.68E-08	1.25E-03
U-238	4.74E-04	6.00E+00	2.35E-06	1.25E-03

The CPP-37B source estimate for groundwater use was based on the soil COPC's and concentrations found between 5.0 to 33 feet bgs., rather than the COPC's and soil concentrations found on Table 15-5. The reason for this difference is that the total depth interval assumption to evaluate future residential intrusion exposure is 0 to 10 feet bgs., while the soil source estimate for groundwater use was based on the measured contamination through the soil column. Therefore, the COPC soil concentrations in Table 15-5 and Table 5-40 of Appendix F do not match. Also, the groundwater model source includes Aroclor 1260 and the surface source does not because it was measured below 10 feet bgs. Based on a comparison of the radionuclides that were analyzed in site soils against the potential inventory as defined by the screened ORIGEN results (Table 4-7) Eu-154, Pu-239/240 and Pu-241 were not part of the soil sampling analysis performed at this site. The implication is that these radionuclides may be present and are currently not part of the soil contaminant inventory.

15.4.4 Risk Estimates

The results of this evaluation under current and future land use are presented in Sections 15.4.4.1 and 15.4.4.2. For each receptor, the results are summarized in Tables 15-10 through 15-21.

15.4.4.1 Current Land Use. As indicated in Table 15-10, total cancer risk to the current onsite worker at site CPP-37A from exposure to site-related chemicals in surface soil is estimated to be 2E-05. The risk is attributed to the ingestion of soil exposure route and to external radiation exposure. The primary contaminant of concern (COC) contributing to risk from soil ingestion is arsenic (2E-06). The primary COCs contributing to risk associated with external radiation exposure are Cs-137 (2E-05) and Np-237 (2E-06). Table 15-11 indicates that the total noncarcinogenic hazard index to the current worker at site CPP-37A is estimated to be 3E-09. There are no hazard indices above unity for the current onsite worker.

Table 15-12 indicates that the total cancer risk to the current onsite worker at CPP-37B is 0E+00. There are no significant risks to this receptor at this site. Table 15-13 indicates that the total noncarcinogenic hazard index to the current worker at CPP-37B is estimated to be 0E+00. There are no hazard indices above unity for the current onsite worker at this location.

15.4.4.2 Future Land Use. As Table 15-14 indicates, the total cancer risk to the future onsite worker, at site CPP-37A, from exposure to site-related chemicals in surface soil is estimated to be 6E-06. The risk is attributed to ingestion of soil with the primary COC being arsenic (2E-06) and to external radiation exposure with the primary COCs being Cs-137 (2E-06) and Np-237 (2E-06). Table 15-15 indicates the total noncarcinogenic hazard index to the future onsite worker at site CPP-37A is estimated to be 3E-09. There are no hazard indices above unity for the future onsite worker. As indicated in Table 15-18, the total cancer risk to the future resident at site CPP-37A from exposure to site-related chemicals in soil is estimated to be 5E-05. The primary COC for the ingestion of soil exposure route is arsenic (1E-05). The primary COCs for the ingestion of homegrown produce exposure route is arsenic (2E-06). The primary COCs for external radiation exposure are Cs-137 (2E-05), Np-237 (1E-05), and U-238 (3E-06). As shown on Table 15-19, the total noncarcinogenic hazard index to the future resident at site CPP-37A is estimated to be 1E-01. There are no hazard indices above unity for the future resident at this location.

Table 15-16 indicates that the total cancer risk to the future onsite worker at site CPP-37B is 0E+00. There are no significant risks to this receptor at this location. Table 15-17 indicates that the total noncarcinogenic hazard index to the future worker at site CPP-37B is estimated to be 0E+00. There are no hazard indices above unity for the future onsite worker. As indicated in Table 15-20, the total cancer risk to the future resident at site CPP-37B from exposure to site-related chemicals in soil is estimated to be 4E-05. The primary COC for the ingestion of soil route is arsenic (1E-05). The primary COCs for the ingestion of homegrown produce route is arsenic (1E-06). The primary COCs for external radiation exposure are Cs-137

Table 15-10. Soil pathway cancer risk to the current onsite worker at CPP-37A. [a]

COPCs	Ingestion of soil	External radiation exposure	Total risks
Aroclor-1260	----	----	----
Benzo(a)pyrene	----	----	----
Aluminum	----	----	----
Arsenic	2E-06	----	2E-06
Manganese	----	----	----
Mercury	----	----	----
Uranium	NTD	----	----
Am-241	4E-08	1E-08	6E-08
Ce-144	----	----	----
Co-57	----	----	----
Co-58	----	----	----
Co-60	----	----	----
Cs-134	----	----	----
Cs-137	8E-09	2E-05	2E-05
Eu-152	----	----	----
Eu-154	----	----	----
Eu-155	----	----	----
H-3	----	----	----
I-129	----	----	----
K-40	----	----	----
Nb-95	----	----	----
Np-237	4E-08	2E-06	2E-06
Pu-238	----	----	----
Pu-239/240	----	----	----
Pu-241	----	----	----
Pu-242	----	----	----
Ru/Rh-106	----	----	----
Sb-125	----	----	----
Sr-90	7E-09	NTD	7E-09
Tc-99	----	----	----
U-234	----	----	----
U-235	----	----	----
U-236	----	----	----
U-238	9E-09	2E-07	2E-07
Total cancer risks by route:	2E-06	2E-05	2E-05

"----" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 15-11. Soil pathway noncarcinogenic hazard to the current onsite worker at CPP-37A. [a]

COPCs	Ingestion of soil	External radiation exposure	Total HIs
Aroclor-1260	----	----	----
Benzo(a)pyrene	----	----	----
Aluminum	----	----	----
Arsenic	9E-10	----	9E-10
Manganese	----	----	----
Mercury	----	----	----
Uranium	2E-09	----	2E-09
Am-241	----	----	----
Ce-144	----	----	----
Co-57	----	----	----
Co-58	----	----	----
Co-60	----	----	----
Cs-134	----	----	----
Cs-137	----	----	----
Eu-152	----	----	----
Eu-154	----	----	----
Eu-155	----	----	----
H-3	----	----	----
I-129	----	----	----
K-40	----	----	----
Nb-95	----	----	----
Np-237	----	----	----
Pu-238	----	----	----
Pu-239/240	----	----	----
Pu-241	----	----	----
Pu-242	----	----	----
Ru/Rh-106	----	----	----
Sb-125	----	----	----
Sr-90	----	----	----
Tc-99	----	----	----
U-234	----	----	----
U-235	----	----	----
U-236	----	----	----
U-238	----	----	----
Total hazard indices by route:	3E-09	0E+00	3E-09

"—" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 15-12. Soil pathway cancer risk to the current onsite worker at CPP-37B.[a,b]

COPCs	Ingestion of soil	External radiation exposure	Total risks
Aroclor-1260	----	----	----
Benzo(a)pyrene	----	----	----
Aluminum	----	----	----
Arsenic	----	----	----
Manganese	----	----	----
Mercury	----	----	----
Uranium	----	----	----
Am-241	----	----	----
Ce-144	----	----	----
Co-57	----	----	----
Co-58	----	----	----
Co-60	----	----	----
Cs-134	----	----	----
Cs-137	----	----	----
Eu-152	----	----	----
Eu-154	----	----	----
Eu-155	----	----	----
H-3	----	----	----
I-129	----	----	----
K-40	----	----	----
Nb-95	----	----	----
Np-237	----	----	----
Pu-238	----	----	----
Pu-239/240	----	----	----
Pu-241	----	----	----
Pu-242	----	----	----
Ru/Rh-106	----	----	----
Sb-125	----	----	----
Sr-90	----	----	----
Tc-99	----	----	----
U-234	----	----	----
U-235	----	----	----
U-236	----	----	----
U-238	----	----	----
Total cancer risks by route:	0E+00	0E+00	0E+00

"----" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. All contamination at CPP-37B is buried deeper than 4 ft bls, so there is no calculated risk to workers at the site.
b. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 15-13. Soil pathway noncarcinogenic hazard to the current onsite worker at CPP-37B.[a,b]

COPCs	Ingestion of soil	External radiation exposure	Total HIs
Aroclor-1260	---	---	---
Benzo(a)pyrene	---	---	---
Aluminum	---	---	---
Arsenic	---	---	---
Manganese	---	---	---
Mercury	---	---	---
Uranium	---	---	---
Am-241	---	---	---
Ce-144	---	---	---
Co-57	---	---	---
Co-58	---	---	---
Co-60	---	---	---
Cs-134	---	---	---
Cs-137	---	---	---
Eu-152	---	---	---
Eu-154	---	---	---
Eu-155	---	---	---
H-3	---	---	---
I-129	---	---	---
K-40	---	---	---
Nb-95	---	---	---
Np-237	---	---	---
Pu-238	---	---	---
Pu-239/240	---	---	---
Pu-241	---	---	---
Pu-242	---	---	---
Ru/Rh-106	---	---	---
Sb-125	---	---	---
Sr-90	---	---	---
Tc-99	---	---	---
U-234	---	---	---
U-235	---	---	---
U-236	---	---	---
U-238	---	---	---
Total hazard indices by route:	0E+00	0E+00	0E+00

"---" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. All contamination at CPP-37B is buried deeper than 4 ft bls, so there is no calculated risk to workers at the site.
b. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 15-14. Soil pathway cancer risk to the future onsite worker at CPP-37A. [a]

COPCs	Ingestion of soil	External radiation exposure	Total risks
Aroclor-1260	---	---	---
Benzo(a)pyrene	---	---	---
Aluminum	---	---	---
Arsenic	2E-06	---	2E-06
Manganese	---	---	---
Mercury	---	---	---
Uranium	NTD	---	---
Am-241	4E-08	1E-08	5E-08
Ce-144	---	---	---
Co-57	---	---	---
Co-58	---	---	---
Co-60	---	---	---
Cs-134	---	---	---
Cs-137	8E-10	2E-06	2E-06
Eu-152	---	---	---
Eu-154	---	---	---
Eu-155	---	---	---
H-3	---	---	---
I-129	---	---	---
K-40	---	---	---
Nb-95	---	---	---
Np-237	4E-08	2E-06	2E-06
Pu-238	---	---	---
Pu-239/240	---	---	---
Pu-241	---	---	---
Pu-242	---	---	---
Ru/Rh-106	---	---	---
Sb-125	---	---	---
Sr-90	7E-10	NTD	7E-10
Tc-99	---	---	---
U-234	---	---	---
U-235	---	---	---
U-236	---	---	---
U-238	9E-09	2E-07	2E-07
Total cancer risks by route:	2E-06	4E-06	6E-06

"---" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 15-15. Soil pathway noncarcinogenic hazard to the future onsite worker at CPP-37A. [a]

COPCs	Ingestion of soil	External radiation exposure	Total HIs
Aroclor-1260	---	---	---
Benzo(a)pyrene	---	---	---
Aluminum	---	---	---
Arsenic	9E-10	---	9E-10
Manganese	---	---	---
Mercury	---	---	---
Uranium	2E-09	---	2E-09
Am-241	---	---	---
Ce-144	---	---	---
Co-57	---	---	---
Co-58	---	---	---
Co-60	---	---	---
Cs-134	---	---	---
Cs-137	---	---	---
Eu-152	---	---	---
Eu-154	---	---	---
Eu-155	---	---	---
H-3	---	---	---
I-129	---	---	---
K-40	---	---	---
Nb-95	---	---	---
Np-237	---	---	---
Pu-238	---	---	---
Pu-239/240	---	---	---
Pu-241	---	---	---
Pu-242	---	---	---
Ru/Rh-106	---	---	---
Sb-125	---	---	---
Sr-90	---	---	---
Tc-99	---	---	---
U-234	---	---	---
U-235	---	---	---
U-236	---	---	---
U-238	---	---	---
Total hazard indices by route:	3E-09	0E+00	3E-09

"---" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 15-16. Soil pathway cancer risk to the future onsite worker at CPP-37B.[a,b]

COPCs	Ingestion of soil	External radiation exposure	Total risks
Aroclor-1260	----	----	----
Benzo(a)pyrene	----	----	----
Aluminum	----	----	----
Arsenic	----	----	----
Manganese	----	----	----
Mercury	----	----	----
Uranium	----	----	----
Am-241	----	----	----
Ce-144	----	----	----
Co-57	----	----	----
Co-58	----	----	----
Co-60	----	----	----
Cs-134	----	----	----
Cs-137	----	----	----
Eu-152	----	----	----
Eu-154	----	----	----
Eu-155	----	----	----
H-3	----	----	----
I-129	----	----	----
K-40	----	----	----
Nb-95	----	----	----
Np-237	----	----	----
Pu-238	----	----	----
Pu-239/240	----	----	----
Pu-241	----	----	----
Pu-242	----	----	----
Ru/Rh-106	----	----	----
Sb-125	----	----	----
Sr-90	----	----	----
Tc-99	----	----	----
U-234	----	----	----
U-235	----	----	----
U-236	----	----	----
U-238	----	----	----
Total cancer risks by route:	0E+00	0E+00	0E+00

"----" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. All contamination at CPP-37B is buried deeper than 4 ft bls, so there is no calculated risk to workers at the site.
b. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 15-17. Soil pathway noncarcinogenic hazard to the future onsite worker at CPP-37B.[a,b]

COPCs	Ingestion of soil	External radiation exposure	Total HIs
Aroclor-1260	----	----	----
Benzo(a)pyrene	----	----	----
Aluminum	----	----	----
Arsenic	----	----	----
Manganese	----	----	----
Mercury	----	----	----
Uranium	----	----	----
Am-241	----	----	----
Ce-144	----	----	----
Co-57	----	----	----
Co-58	----	----	----
Co-60	----	----	----
Cs-134	----	----	----
Cs-137	----	----	----
Eu-152	----	----	----
Eu-154	----	----	----
Eu-155	----	----	----
H-3	----	----	----
I-129	----	----	----
K-40	----	----	----
Nb-95	----	----	----
Np-237	----	----	----
Pu-238	----	----	----
Pu-239/240	----	----	----
Pu-241	----	----	----
Pu-242	----	----	----
Ru/Rh-106	----	----	----
Sb-125	----	----	----
Sr-90	----	----	----
Tc-99	----	----	----
U-234	----	----	----
U-235	----	----	----
U-236	----	----	----
U-238	----	----	----
Total hazard indices by route:	0E+00	0E+00	0E+00

"----" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. All contamination at CPP-37B is buried deeper than 4 ft bls, so there is no calculated risk to workers at the site.
b. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 15-18. Soil pathway cancer risk to the future onsite resident at CPP-37A. [a]

COPCs	Ingestion of soil	Ingestion of homegrown	External radiation exposure	Total risks
Aroclor-1260	—	—	—	—
Benzo(a)pyrene	—	—	—	—
Aluminum	—	—	—	—
Arsenic	1E-05	1E-06	—	2E-05
Manganese	—	—	—	—
Mercury	—	NTD	—	—
Uranium	NTD	NTD	—	—
Am-241	3E-07	2E-09	1E-07	5E-07
Ce-144	—	—	—	—
Co-57	—	—	—	—
Co-58	—	—	—	—
Co-60	—	—	—	—
Cs-134	—	—	—	—
Cs-137	1E-08	1E-06	2E-05	2E-05
Eu-152	—	—	—	—
Eu-154	—	1E-15	—	1E-15
Eu-155	—	—	—	—
H-3	—	—	—	—
I-129	—	1E-10	—	1E-10
K-40	—	—	—	—
Nb-95	—	—	—	—
Np-237	3E-07	2E-09	1E-05	1E-05
Pu-238	9E-09	2E-10	1E-11	9E-09
Pu-239/240	—	3E-09	—	3E-09
Pu-241	—	5E-13	—	5E-13
Pu-242	—	2E-13	—	2E-13
Ru/Rh-106	—	—	—	—
Sb-125	—	—	—	—
Sr-90	3E-09	4E-07	NTD	4E-07
Tc-99	—	1E-07	—	1E-07
U-234	—	2E-10	—	2E-10
U-235	2E-09	2E-10	2E-07	2E-07
U-236	—	5E-12	—	5E-12
U-238	2E-07	3E-10	3E-06	3E-06
Total cancer risks by route:	2E-05	3E-06	3E-05	5E-05

"—" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 15-19. Soil pathway noncarcinogenic hazard to the future onsite resident at CPP-37A. [a]

COPCs	Ingestion of soil	Ingestion of homegrown	External radiation exposure	Total HIs
Aroclor-1260	---	---	---	---
Benzo(a)pyrene	---	---	---	---
Aluminum	---	---	---	---
Arsenic	7E-09	5E-03	---	5E-03
Manganese	---	---	---	---
Mercury	---	1E-01	---	1E-01
Uranium	6E-08	7E-06	---	8E-06
Am-241	---	---	---	---
Ce-144	---	---	---	---
Co-57	---	---	---	---
Co-58	---	---	---	---
Co-60	---	---	---	---
Cs-134	---	---	---	---
Cs-137	---	---	---	---
Eu-152	---	---	---	---
Eu-154	---	---	---	---
Eu-155	---	---	---	---
H-3	---	---	---	---
I-129	---	---	---	---
K-40	---	---	---	---
Nb-95	---	---	---	---
Np-237	---	---	---	---
Pu-238	---	---	---	---
Pu-239/240	---	---	---	---
Pu-241	---	---	---	---
Pu-242	---	---	---	---
Ru/Rh-106	---	---	---	---
Sb-125	---	---	---	---
Sr-90	---	---	---	---
Tc-99	---	---	---	---
U-234	---	---	---	---
U-235	---	---	---	---
U-236	---	---	---	---
U-238	---	---	---	---
Total hazard indices by route:	7E-08	1E-01	0E+00	1E-01

"---" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 15-20. Soil pathway cancer risk to the future onsite resident at CPP-37B. [a]

COPCs	Ingestion of soil	Ingestion of homegrown	External radiation exposure	Total risks
Aroclor-1260	—	—	—	—
Benzo(a)pyrene	—	—	—	—
Aluminum	—	—	—	—
Arsenic	1E-05	1E-06	—	1E-05
Manganese	—	—	—	—
Mercury	—	NTD	—	—
Uranium	NTD	NTD	—	—
Am-241	4E-07	8E-09	1E-07	5E-07
Ce-144	—	—	—	—
Co-57	—	—	—	—
Co-58	—	—	—	—
Co-60	—	—	—	—
Cs-134	—	—	—	—
Cs-137	1E-08	5E-08	2E-05	2E-05
Eu-152	—	—	—	—
Eu-154	—	—	—	—
Eu-155	—	—	—	—
H-3	—	—	—	—
I-129	—	1E-10	—	1E-10
K-40	—	—	—	—
Nb-95	—	—	—	—
Np-237	2E-07	1E-08	7E-06	7E-06
Pu-238	8E-08	1E-09	1E-10	8E-08
Pu-239/240	—	3E-10	—	3E-10
Pu-241	—	5E-13	—	5E-13
Pu-242	—	2E-13	—	2E-13
Ru/Rh-106	—	—	—	—
Sb-125	—	—	—	—
Sr-90	1E-08	4E-07	NTD	4E-07
Tc-99	—	1E-07	—	1E-07
U-234	—	2E-10	—	2E-10
U-235	2E-09	3E-10	3E-07	3E-07
U-236	—	5E-12	—	5E-12
U-238	3E-08	5E-09	7E-07	7E-07
Total cancer risks by route:	1E-05	2E-06	3E-05	4E-05

"—" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 15-21. Soil pathway noncarcinogenic hazard to the future onsite resident

COPCs	Ingestion of soil	Ingestion of homegrown produce	External radiation exposure	Total HIs
Aroclor-1260	----	----	----	----
Benzo(a)pyrene	----	----	----	----
Aluminum	----	----	----	----
Arsenic	5E-09	6E-03	----	6E-03
Manganese	----	----	----	----
Mercury	----	1E-01	----	1E-01
Uranium	1E-08	1E-04	----	1E-04
Am-241	----	----	----	----
Ce-144	----	----	----	----
Co-57	----	----	----	----
Co-58	----	----	----	----
Co-60	----	----	----	----
Cs-134	----	----	----	----
Cs-137	----	----	----	----
Eu-152	----	----	----	----
Eu-154	----	----	----	----
Eu-155	----	----	----	----
H-3	----	----	----	----
I-129	----	----	----	----
K-40	----	----	----	----
Nb-95	----	----	----	----
Np-237	----	----	----	----
Pu-238	----	----	----	----
Pu-239/240	----	----	----	----
Pu-241	----	----	----	----
Pu-242	----	----	----	----
Ru/Rh-106	----	----	----	----
Sb-125	----	----	----	----
Sr-90	----	----	----	----
Tc-99	----	----	----	----
U-234	----	----	----	----
U-235	----	----	----	----
U-236	----	----	----	----
U-238	----	----	----	----
Total hazard indices by route:	2E-08	1E-01	0E+00	1E-01

"----" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

(2E-05) and Np-237 (7E-06). As shown on Table 15-21, the total noncarcinogenic hazard index to the future resident at site CPP-37B is estimated to be 1E-01. There are no hazard indices above unity for the future resident at this location.

15.5 Uncertainties

This section describes the limitations and uncertainties specific to the site characterization of sites CPP-37A and CPP-37B. Sources of uncertainty associated with site characterization include data quality, COPC identification; concentration term estimation; and assumptions, regarding the lateral and vertical extent of COPC occurrence. In the risk assessment, the most significant uncertainties are due to the selection process of COPCs, the toxicity values used, and the assumptions, used during the exposure assessment. The following paragraphs will discuss important sources of site-specific uncertainty in greater detail.

Sampling and analysis uncertainties are related to quality problems that may result in qualified and rejected results (Section 3.5). Qualified results are considered estimates of the concentration in the sample and, for all practical purposes, useable for their intended purpose although they could be biased high or low. Rejected results are considered unusable, thus limiting the size of the useable data set. For the sites CPP-37A and CPP-37B, no data points were rejected based on the method validation as documented in the Limitations and Validation (L&V) Reports, thus making this possible source of uncertainty insignificant.

Uncertainty associated with the chemical screening process (Section 5.2) results from using the maximum concentration for chemicals detected in the Environmentally Controlled Areas (ECAs) in the background comparison step, retaining chemicals detected as COPCs because there is not a corresponding background value, and retaining chemicals as COPCs for which there is no toxicity information available.

In most cases, the COPC identification process used the maximum concentration for a chemical detected in the background comparison step, regardless of its magnitude above background. The use of the maximum concentrations can result in the identification of COPCs that have concentrations only slightly above background. For sites CPP-37A and CPP-37B, arsenic was the only COPC that fell into this category. This results in an increase in the number of COPCs considered in the remedial investigation/Baseline Risk Assessment (RI/BRA) and a possible overestimation of risk because of inclusion of COPCs with concentrations that are likely within the true background population.

Another source of uncertainty related to the background comparison step in the chemical screening process relates to chemicals for which no background concentration exists. For example, fluoride, nitrate, and several radionuclides were not characterized as part of the Rood et al., background study. For sites CPP-37A and CPP-37B, Np-237 had no corresponding background concentration. This results in an increase in the number of COPCs considered in RI/BRA and a possible overestimation of risk because the observed concentrations may be within the background population.

Some concentration estimates are based on the 95% UCL for the site, or the area-weighted average 95% UCLs for sites that have been grouped. When the 95% UCL (i.e., the concentration term estimate) of a COPC is below the corresponding background value, this results in an increase in the number of COPCs in the RI/BRA and a possible overestimation of risk because the results are likely within the background range. This source of uncertainty stems from the use of maximum concentrations when identifying the COPCs for a specific sites. For sites CPP-37A and CPP-37B, arsenic and U-238 concentration estimates were below background for at least one of the two sites.

For site CPP-37B, kepone (i.e., chlordecone) was retained as a COPC for the RI/BRA. There are no toxicity values in Integrated Risk Information System (IRIS), Health Effects Assessment Summary Tables

(HEAST), or EPA Region III publications for kepone. Kepone is used as an insecticide. The impact of not including kepone in the BRA may underestimate the risk; however, the impact is not quantifiable because toxicity information is not available.

Another source of uncertainty for sites CPP-37A and CPP-37B is related to the estimation of the site areas and contaminated source volumes. The areal dimensions of the pits were estimated using the maximum dimensions of the pits. This method overestimates the size of the pits because the irregular shape of the pits. The resulting contaminated soil volume and contaminant mass estimates for the models are also likely overestimated. As a result, the risk associated with these two sites is considered to be conservative.

Another source of uncertainty may be associated with the contaminant inventories used for the groundwater modeling and residential intrusion exposure at each unit. Section 15.4.3 identifies radionuclides potentially missing from these inventories. The implication of these potential data gaps in that the source estimates could be underestimated. Based on the results of the groundwater model, the potentially missing Pu-238 and Eu-154, which have half-lives of 87.7 and 8.6 years, respectively, would not be expected to be of concern because of their short half lives and long travel times to the aquifer. Pu-239 and Pu-240 may be missing as well and their uncertainty is recognized (see Section 10 of Appendix F), but no information is available to quantify the uncertainty.

15.6 Conclusions and Recommendations

The results of the risk assessment under current land use at site CPP-37A indicate that the increased cancer risk from exposure to site-related contaminants is within the EPA-recommended target range. The increased cancer risk to hypothetical future onsite workers and residents were found within the EPA target range. The results under current land use at site CPP-37B indicate that the increased cancer risk from exposure to site-related contaminants is well below the EPA-recommended target range. The increased cancer risk to hypothetical future onsite workers was found to be below the target range and for future residents it is within the EPA target range. The noncarcinogenic hazard for all receptors was found to be below the EPA hazard index goal of one. It should be noted that these estimates do not include the contributions associated with the air and groundwater pathways. The total increased cancer and hazard incidence to humans is reported in Section 27. The risk estimates at this site are likely to be somewhat overestimated for reasons described in Sections 7 and 15.5 of this report. Despite the slightly elevated risk estimates at this site, future response actions to mitigate adverse impacts to human health and the environment are not warranted at either unit within this site.

15.7 References

Sehlke, G., 1990, *Unit Background Information for Land Disposal Units CPP-37, CPP-40, CPP-47, CPP-63, and Solid Waste Management Unit CPP-36*, May 11.

WINCO, 1994, *Track 2 Preliminary Scoping Package, CPP-37 Gravel Pits #1 and #2, Operable Unit 3-02*, May 5.

Chapter 16

16. SITE CPP-67 RESULTS (Percolation Ponds 1 & 2)

Site CPP-67 consists of two unlined service waste percolation ponds (SWPs). The ponds receive service wastewater consisting primarily of cooling water and condensed steam generated by various Idaho Chemical Processing Plant (ICPP) operations. ICPP wastewater that contains only traces of radioactivity (or none at all) passes through the service waste system. The waste consists primarily of cooling water and steam condensates. This waste is monitored for radioactivity before being discharged to SWP-1 or SWP-2. There are three main service waste systems at ICPP: the eastside system, the westside system, and the CPP-604 Process Equipment Waste (PEW) process condensate monitor/shutdown system. Figure 16-1 shows the relative location of the ponds, which are fenced to exclude entry of large wildlife and unauthorized personnel. The following sections provide site description, investigative results, and an assessment of nature and extent of contamination. The human health risk assessment (HHRA) follows.

16.1 Site Description

16.1.1 Service Waste Percolation Pond No. 1 (SWP-1)

SWP-1 is located outside the south ICPP security fence, southeast of CPP-603 (Figure 16-1), and was established in 1984. The pond is approximately 125.0-m (410-ft) long in the east-west direction and 146.3 m (480 ft) in the north-south direction and approximately 5.5-m (18-ft) deep. The pond was excavated in gravelly alluvium that is approximately 7.6- to 9.1-m (25- to 30-ft) thick and is underlain by basalt. Additional details regarding site background, operational history, physical setting, and extent of previous investigations may be found in the *Draft Work Plan for Idaho Chemical Processing Plant Percolation Pond Investigation* (Ebasco, 1991).

In 1984, a total of 1,794 M L (474 M gal) of wastewater was discharged to SWP-1. A total of 1,476 M L (390 M gal) of wastewater was discharged to SWP-1 between January 1 and October 16, 1985. On October 17, 1985 the wastewater was diverted to SWP-2 due to a decrease in infiltration rate in SWP-1, which was attributed to sedimentation, algae, and silica gel forming on the bottom of the pond.

Under normal conditions, radioactivity is not present in any of the service waste streams except the PEW Evaporator overhead condensate, which routinely contains trace quantities of radionuclides. This waste is monitored for radioactivity and discharged to service waste percolation ponds SWP-1 and SWP-2.

16.1.2 Service Waste Percolation Pond No. 2 (SWP-2)

SWP-2 is located outside the south ICPP security fence, southeast of CPP-603 (Figure 16-1). SWP-2 was established in 1985 when it became apparent that the infiltration capacity of SWP-1 had decreased and water levels began to rise. The pit bottom is approximately 152.4-m (500-ft) square and 3.6- to 4.3-m (12- to 14-ft) deep. The pit was excavated in gravelly alluvium approximately 6.1- to 10.7-m (20- to 35-ft) thick, underlain with basalt. The pond is designed to accommodate continuous disposal of approximately 11.4 M L (3 M gal) of water per day.

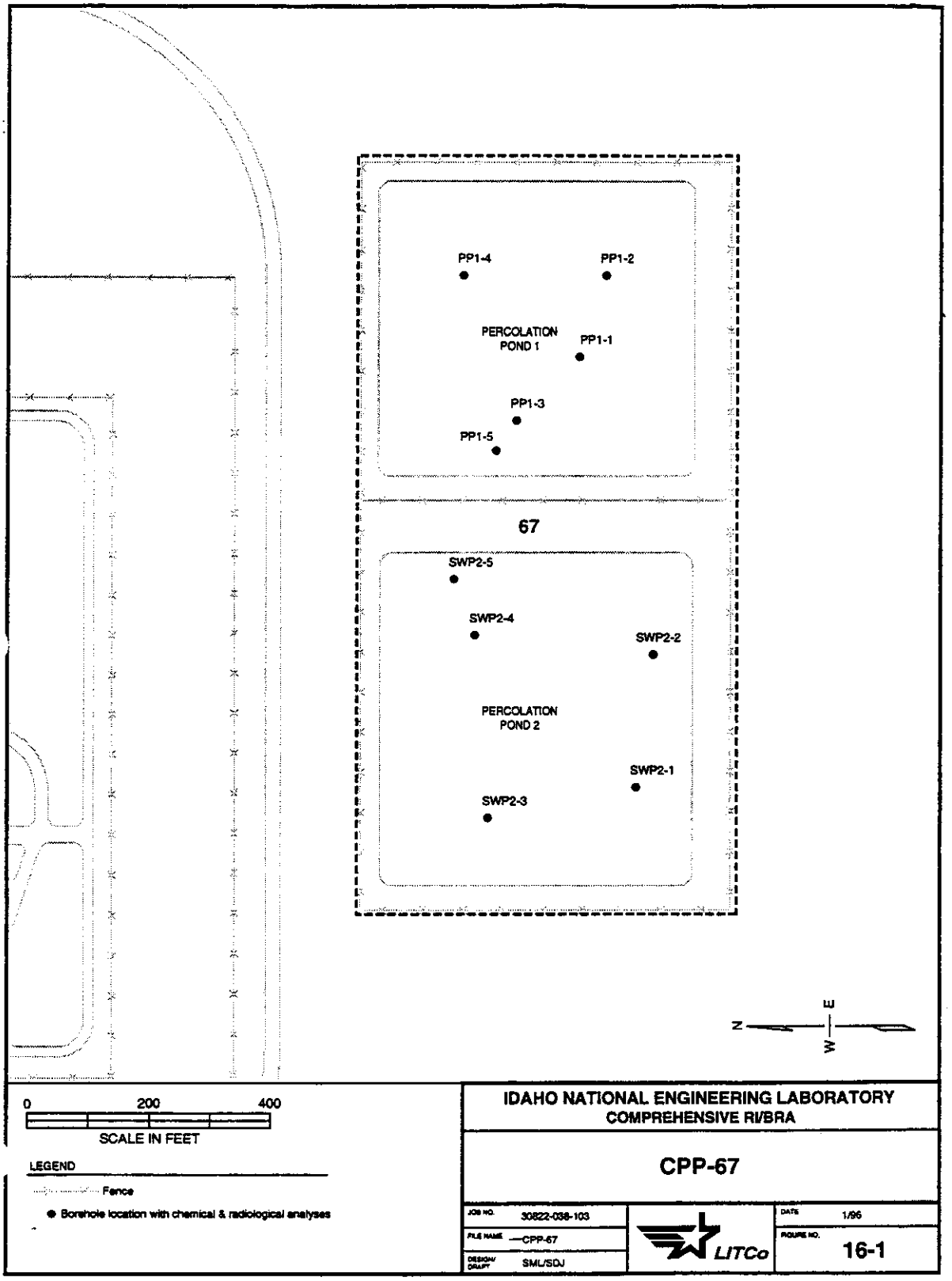


Figure 16-1. CPP-67.

Resource Conservation and Recovery Act (RCRA) clean-closure equivalency was achieved for metals contamination in Pond #1 in April 1994 and Pond #2 in May 1995; therefore only radiological contamination will be assessed as part of the waste area group (WAG) 3 remedial investigation/Baseline Risk Assessment (RI/BRA).

16.2 Investigative Results

Based on sampling conducted during 1991 and reported in 1992 (Golder Associates, 1992), RCRA clean-closure equivalency was achieved for metals contamination in the ponds as indicated above. The remainder of this section discusses the 1991/1992 investigation results related to potential radionuclide contamination.

Site CPP-67 is considered to be a significant source of the perched water beneath the southern portion of the ICPP. The distribution of perched water beneath the ICPP is discussed in detail in Section 2. The nature and extent of contamination in perched water is discussed in Section 4.

16.2.1 Service Waste Percolation Pond No. 1 (SWP-1)

The objectives of the sampling program at SWP-1 were to evaluate the nature and extent of soil contaminated by service waste effluent and to determine the presence of any hazardous constituents in the soils on or underlying the bottom of the percolation pond to a depth of approximately 1.8 m (6 ft).

To meet the objectives of the sampling program at SWP-1, an initial test pit was excavated in the center of the pond, followed by the excavation of five test pits (PP1-1 through PP1-5) for sample collection (Figure 16-1). Samples were collected in pits PP1-1 through PP1-5 both at the surface and at a greater depth based on visual examination of the initial test pits.

The visual inspection of the initial center excavation revealed a sand and gravel layer to approximately 1.7-m (5.7-ft) below ground surface (bgs), with fine sand, silt, and clay from 1.7 m (5.7 ft) to the bottom of the pit at 2.2 m (7.4 ft). The sand, silt, and clay unit was the targeted sample interval for pits 1–5 as the fine grained sediments are expected to preferentially absorb potential contaminants. At completion of sampling, the center excavation was deepened from 2.2 to 3.6 m (7.4 to 11.7 ft) to obtain additional geologic information. The test pits were subsequently backfilled with soils removed from the pits. Test pit logs with detailed geologic information are summarized in Appendix A of the *Report for the ICPP Sampling and Analysis Program at Service Waste Percolation Pond #1* (Golder Associates, 1992).

After collection of a surface sample, the pits were advanced with the backhoe to target the fine-grained unit that was identified in the center excavation. The fine-grained unit was encountered in pits PP1-1, PP1-3, and PP1-4 at 1.7-, 1.5-, and 1.6-m (5.5-, 5.0-, and 5.3-ft) bgs, respectively. Samples were subsequently obtained by lowering a decontaminated stainless steel hand auger into the excavation, collecting the sample and retrieving the sample to the surface for processing. At locations PP1-2 and PP1-5, basalt was encountered at 0.7 and 0.8 m (2.4 and 2.7 ft), respectively. No fine-grained unit was observed in pit PP1-5 with samples collected from coarse-grained sediment above the basalt surface. At pit PP1-2, samples were collected from a silty clay layer located from 0.6 to 0.7 m (2.1 to 2.4 ft). Samples were collected in pits 2 and 5 with decontaminated stainless steel spoons.

A Westinghouse Idaho Nuclear Company (WINCO) health physicist (HP) performed field screening with beta-gamma instrumentation during the field investigation. A general survey of the percolation pond bottom showed a range of activity from 100 to 300 counts per minutes (cpm) (relative to the background of 100 cpm) with a reading of 4,000 cpm for sediments below the discharge pipe. It should be noted that the ice and frozen condition of the sediments may have partially shielded the radioactivity to bias screening results low.

The analytical results for the contaminants of potential concern (COPCs) are summarized in Table 16-1. A compilation of the analytical results for site CPP-67 is included in Appendix G. It should be noted that cadmium, chromium, mercury, selenium, silver, Co-58, and Y-90 were analyzed for but not detected and thus, were not included in Table 5-6. Based on the chemical screening in Section 5.2, the following COPCs were identified for site CPP-67: H-3, Co-60, Sr-90, Rh-106, Ru-106, Sb-125, I-129, Cs-134, Cs-137, Ce-144, U-234, U-235, U-238, Np-237, Pu-238, Pu-239/240, and Am-241. It should be noted that even though metals and other inorganic contaminants have been measured in the pond sediments, these contaminants are not included in Table 16-1 because they were evaluated as part of a separate RCRA closure equivalency activity.

16.2.1.1 Radionuclides—Surficial Samples. . Am-241 and Sr-90 were detected at four of the five sampling locations within SWP-1; neither was detected in the surficial sample at location PP1-2. Cs-137 was found at the highest activity level at each of the borings, ranging from 80.8±11.1 pCi/g at PP1-3 to 11.7±1.2 pCi/g at PP1-2. Pu-238 ranged from a high of 13±2.3 pCi/g at PP1-3 to a low of 1.61±0.43 pCi/g at PP1-1. Am-241 and Sr-90 activities ranged from highs of 7.8±1.13 pCi/g at PP1-3 and 16.3±1.9 pCi/g at PP1-5, respectively, to lows of 0.56±0.12 pCi/g (PP1-4) and 1.21±0.58 pCi/g (PP1-5). Samples from locations PP1-3 and PP1-1 each indicated detections above background for 11 radionuclides. Ce-144 was not detected at PP1-3 and U-238 was detected at below background at location PP1-3. All other radionuclides were detected at activities ranging from approximately 1 to 10 pCi/g.

16.2.1.2 Radionuclides—Deeper Samples. Deeper samples were collected at each sampling location. Samples were collected at depths of 1.7 m (5.7 ft), 0.7 m (2.3 ft), 1.5 to 1.6 m (5.0 to 5.3 ft), 1.7 m (5.7 ft), and 0.8 m (2.7 ft) for locations PP1-1 through PP1-5, respectively. Sr-90 was one of only two radionuclides detected above background, at activities of 1.14±0.49 pCi/g and 1.09±0.5 pCi/g in deeper samples from locations PP1-3 and PP1-1, respectively. U-234 was detected at location PP1-4 at an activity of 1.54±0.34 pCi/g.

16.2.1.3 Conclusions—Distribution. Activities for all radionuclides detected decreased with depth, with the exception of U-234 at location PP1-4, which increased slightly from 1.34±0.3 pCi/g (below background) in the surface sample to 1.54±0.34 pCi/g in the sample at 1.7 m (5.7 ft) bgs. All other radionuclides decreased to activities either below detection limits, or below background in the deeper samples. Samples collected from PP1-3 and PP1-1, which are located closer to the center of the pond, showed both the greatest number of radionuclides at activities above background, and the highest activities for Sr-90, which is the most widely detected radionuclide.

16.2.2 Service Waste Percolation Pond No. 2 (SWP-2)

The objectives of the sampling program at SWP-2 were to evaluate the nature and extent of soil contaminated by service waste effluent and to determine the presence of potential contaminants in the soils

Table 16-1. Summary statistics for CPP-67, CPP Percolation Ponds #1 and #2 - sediments.

COPCs	Concentration (mg/kg or pCi/g) Minimum detected	Maximum detected	Arithmetic mean	Standard deviation	Number of samples	Number of detects	Frequency of detection	INEL background (mg/kg or pCi/g)	Number greater than background
Am-241	0.08 +/- 0.04 J	7.8 +/- 10.13	1.23E+00	2.49E+00	20	9	45%	0.011	9
Ce-144	0.4 +/- 0.21	1.5 +/- 0.54	9.23E-01	5.52E-01	20	3	15%	NA	NA
Co-60	0.16 +/- 0.05	2.35 +/- 0.27	7.29E-01	8.28E-01	20	7	35%	NA	NA
Cs-134	0.05 +/- 0.03	3.5 +/- 0.08	1.80E+00	9.75E-01	21	8	38%	NA	NA
Cs-137	0.14 +/- 0.04	93.6 +/- 0.4	3.02E+01	3.10E+01	21	16	76%	0.82	11
H-3	0.61 +/- 0.32 J	0.61 +/- 0.32 J	6.10E-01	NA	10	1	10%	NA	NA
I-129	1.46 +/- 0.26	3.7 +/- 0.26	2.50E+00	9.67E-01	20	4	20%	NA	NA
Np-237	0.63 +/- 0.21	1.63 +/- 0.24	1.10E+00	2.81E-01	11	11	100%	NA	NA
Pu-238	0.11 +/- 0.04	13 +/- 2.3	2.73E+00	3.49E+00	21	12	57%	0.0049	12
Pu-239/240	0.05 +/- 0.04	2.07 +/- 0.52	5.39E-01	7.07E-01	20	7	35%	0.1	6
Ru/Rh-106	1.4 +/- 0.6	5.97 +/- 1.66	3.45E+00	1.91E+00	20	7	35%	NA	NA
Sb-125	0.31 +/- 0.13	1.89 +/-0.34	8.95E-01	6.00E-01	20	6	30%	NA	NA
Sr-90	0.11 +/- 0.09	16.3 +/- 1.9	2.85E+00	4.99E+00	21	13	62%	0.49	8
U-234	0.19 +/- 0.07	2.75 +/- 0.53	1.04E+00	7.14E-01	21	21	100%	1.44	4
U-235	0.07 +/- 0.03	0.07 +/- 0.03	7.00E-02	NA	10	1	10%	NA	NA
U-238	0.09 +/- 0.05	2.6 +/- 0.5	8.58E-01	5.95E-01	21	21	100%	1.4	3

NA - Not applicable/available

underlying the bottom of the percolation pond to a depth of approximately 1.8 m (6 ft). Excavation and sampling activities were conducted from July 23 to July 26, 1991.

To meet the objectives of the sampling program at SWP-2, an initial test pit was excavated in the center of the pond, followed by the excavation of five test pits (SWP2-1 through SWP2-5) for sample collection (Figure 16-1). The initial pit was excavated to a depth of 2.0 m (6.7 ft) and visually inspected to determine sampling intervals for the five test pits.

The visual inspection revealed no evidence of layers that would provide preferential accumulation of contaminants in the soil profile. Therefore, the sampling intervals in the test pits were selected at 0.0 to 0.6 m (0 to 2 ft) and 1.2 to 1.8 m (4 to 6 ft) to represent the surface and bottom of the excavation. The test pit log and borehole logs are presented in Appendix A of the *Report for the ICPP Sampling and Analysis Program at Service Waste Percolation Pond #1* (Golder Associates, 1992).

All samples from locations 1 through 5 and excavated sediment from the center pit were screened by the WINCO HP with beta-gamma hand-held instrumentation. In addition, the HP traversed the center of the pond along a north-south transient and surveyed surficial sediments at arbitrary locations with results ranging from 200 cpm to a maximum of 1,200 cpm.

The analytical results for the COPCs are summarized in Table 16-1. A compilation of the analytical results for CPP-67 is included in Appendix G. All 16 of the COPCs for site CPP-67 were identified in samples from SWP-2 except for U-234.

16.2.2.1 Radionuclides—Surficial Samples. Surficial samples were collected over the 0.0- to 0.6-m (0.0- to 2.0-ft) interval. Most of the COPCs were found at activities above background in the majority of the five surficial samples collected at SWP-2. Exceptions were U-235 and U-238, which were each detected above background only at location SWP2-3. Ce-144 was also detected at location SWP2-5. Cs-137 was the radionuclide detected at the highest activity in all five surficial samples collected. Cs-137 activity ranged from a high of 93.6±0.4 pCi/g at SWP2-5 to a low of 38.1±0.3 pCi/g at SWP2-3. Five other radionuclides, Co-60, Cs-134, Np-237, Pu-238, and Rh-106, were detected at activity levels above background at all five surficial sample locations. Np-237 activity ranged from a high 1.63±0.24 pCi/g at SWP2-5 to a low of 1.09±0.16 pCi/g at SWP2-1. All other radionuclide detections in surficial samples were at activity levels of less than approximately 5.0 pCi/g.

16.2.2.2 Radionuclides—Deep Samples. Deep samples were collected over the 1.2- to 1.8-m (4.0- to 6.0-ft) interval. Np-237 was detected at all five deep sample locations. Np-237 activity levels ranged from 1.11±0.12 pCi/g at SWP2-3 to 0.63±0.21 pCi/g at SWP2-5. The only other detections of COPCs at above background were detections of Pu-238 (0.11±0.04 pCi/g) and Pu-239/240 (0.5±0.08 pCi/g) at location SWP2-5.

16.2.2.3 Conclusions—Distribution. Activities for all radionuclides detected decreased with depth, with the exception of Pu-239/240 at location SWP2-5. Pu-239/240 increased slightly from 0.27±0.06 to 0.5±0.08 pCi/g. All other COPCs detected in surficial samples decreased to below detection or below background levels except Np-237 as described above. Cs-137 was detected in most samples, but decreased in activity with distance from sample location SWP2-5, which is near the location of the outfall pipe to SWP-2.

16.3 Nature and Extent of Soil Contamination

16.3.1 Service Waste Percolation Pond No. 1 (SWP-1)

Numerous radionuclides were detected at activities above background in surficial samples from CPP-67 SWP-1. Cs-137 and U-238 were the only radionuclides detected above background in all surficial samples. Cs-137 was detected at the highest activity level, at a value of 80.8±11.1 pCi/g. Activities for all radionuclides decreased with depth, with one exception. Samples collected from 0.7 m (2.3 ft) to 1.7 m (5.7 ft) indicated all radionuclides except Sr-90 and U-234 had decreased to activity levels below background. Samples collected closer to the center of the pond showed both the greatest number of radionuclides at activities above background, and the highest activity for Sr-90, which was the most commonly detected radionuclide.

Based on the investigative results, the zone of contamination is estimated to be about 1.8 m (6.0 ft) thick, and extends from the surface to 1.8-m (6.0-ft) bgs. Based on the dimensions of CPP-67 SWP-1, the volume of contaminated soil beneath SWP-1 was estimated to be 32,922 m^3 (1,180,800 ft^3).

16.3.2 Service Waste Percolation Pond No. 2 (SWP-2)

Numerous radionuclides were present at activities above background at CPP-67 SWP-2. The majority of the radionuclides were detected in most of the surficial samples collected. Cs-137 was detected at the highest activity, at a value of 93.6±0.4 pCi/g. The only detections of radionuclides in the 1.2 to 1.8 m (4.0 to 6.0 ft) samples were Np-237, which was detected in all five samples, and Pu-238 and Pu-239/240, which were detected in one sample only.

Based on the investigative results, the zone of contamination is assumed to be 1.8-m (6.0-ft) thick, and extends from the surface to 1.8-m (6.0-ft) bgs. This depth is based on the decrease in radionuclide COPCs with depth, and the low activities measured in deeper samples. Based on the dimensions of the pit, the volume of contaminated soil beneath the pit was estimated to be 14,814 m^3 (1,500,000 ft^3).

16.4 Risk Assessment

The methodology for conducting the HHRA for WAG 3 is detailed in Section 7. As presented, the purpose of the HHRA is to develop a quantitative description and assessment of the human health risk posed by the COPCs present at WAG 3. This section only contains the results of the HHRA for site CPP-67 with respect to the soil pathways. The results for the air and groundwater pathways are detailed in Sections 27.1 and 27.2, respectively. The risk assessment at this site will become cumulative when the contributions from the air and groundwater pathways are added to that from the soil pathway. The following sections discuss the complete exposure routes, exposure-point concentrations, and cancer risk and noncarcinogenic health hazard estimates for site CPP-67 under the three exposure scenarios evaluated. Section 16.4.3 explains any differences in estimating the contaminant sources used to evaluate surface exposure and that used in the groundwater model. It also describes the use of the screened ORIGEN results (Section 4.4) to help identify contaminants potentially missing from the soil source inventory.

16.4.1 Complete Exposure Routes

Potentially complete pathways from the source to a human receptor are described in Section 7 and illustrated on Figure 7-1. For site CPP-67, the complete exposure routes within each pathway are

summarized in Table 16-2. An exposure route is considered complete if the contaminated zone (as characterized in the previous sections and summarized on the table) occurs within the depth intervals specified for a given exposure route. All exposure routes, as described in Section 7, are considered complete for site CPP-67.

16.4.2 Exposure-Point Concentrations

Specific steps in calculating exposure-point concentrations for each of the applicable scenarios are described in Section 7. The COPC soil value used was the smaller of the 95% upper confidence limit (UCL) or maximum concentration. The concentration terms for the radionuclides were adjusted to account for decay for each exposure scenario. These values were subsequently averaged over the exposure duration. The concentration terms, by depth interval, are presented in Table 16-3. Exposures from all complete exposure routes were estimated based on the exposure-point concentrations in Table 16-4. Homegrown produce concentrations are presented in Table 16-5. The values for air and groundwater are presented in Sections 27.1 and 27.2, respectively.

16.4.3 Description of Source Estimates for Surface Exposure and Groundwater Modeling Use

The purpose for this subsection is two-fold. First, to compare the approach to defining the source estimate for use in both the surface exposure assessment and the groundwater model. This comparison was accomplished by comparing the soil data in Table 16-3 to the soil data used to estimate the source for use in the groundwater model, which can be found in Tables 5-39 and 5-40 of Appendix F. The benefit of these comparisons is to relate both source estimates and explain any apparent differences. Secondly, the results of the screened ORIGEN runs summarized in Section 4.4 were used to help identify any potential soil-related data gaps by comparing ORIGEN results to the field investigation soil results at this site. This comparison was based on the full inventory of contaminants in the screening tables in Section 5 before implementing the screening steps shown therein. The results of these comparisons are described for each site in the following paragraphs. The results of this comparison for perched water and SRPA are reported at the end of Section 4.4.

The source estimates used to evaluate surface exposure differed from the source used to evaluate groundwater exposure because the surface soil was based on soil measurements while the groundwater model source was estimated using discharge records obtained the RWMIS. Arsenic, chromium, mercury, and Tc-99 are part of the source estimate for groundwater use but are not included in the surface exposure source. These metals screened out in Table 5-6 and Tc-99 was not part of the analytical suite for soil samples at this site. However, based on a comparison of the radionuclides that were reported in site soils and discharges to the ponds, against the potential inventory as defined by the screened ORIGEN results (Table 4-7) Eu-154 and Pu-241 were not part of the soil sampling analytical suite or the discharge inventory to both ponds. The implication is that these radionuclides may be present and are currently not part of the soil and groundwater contaminant inventories.

16.4.4 Risk Estimates

The results of this evaluation under current and future land use are presented in Sections 16.4.4.1 and 16.4.4.2. For each receptor, the results are summarized in Tables 16-6 through 16-11.

Table 16-2. Complete exposure routes for site CPP-67 and associated exposure route depths.

Receptor	Scenario	Potentially complete exposure routes and exposure route depths used for exposure-point concentration estimates	Characterized zone of contamination[a]	Complete exposure route?
Onsite worker	Current land use	Inhalation of VOCs	0 to 1.8 m	No
		[0–15 cm (0–6 in.)]	(0 to 6 ft)	Yes
		Inhalation of airborne particulates [0–15 cm (0–6 in.)]		Yes
		Ingestion of surface soil [0–15 cm (0–6 in.)]		Yes
		External radiation [0–1.22 m (0–4 ft)]		
Residential	Future land use	Inhalation of VOCs [0–3.05 m (0–10 ft)]	0 to 1.8 m	No
		Inhalation of airborne particulates [0–3.05 m (0–10 ft)]	(0 to 6 ft)	Yes
		Ingestion of surface soil [0–3.05 m (0–10 ft)]		Yes
		Ingestion of homegrown produce [0–3.05 m (0–10 ft)]		Yes
		Ingestion of groundwater		Yes
		Dermal contact with groundwater		No
		Inhalation of VOCs from groundwater		No
		External radiation [0–3.05 m (0–10 ft)]		Yes
Onsite worker	Future land use	Inhalation of VOCs [0–15 cm (0–6 in.)]	0 to 1.8 m	No
		Inhalation of airborne particulates [0–15 cm (0–6 in.)]	(0 to 6 ft)	Yes
		Ingestion of surface soil [0–15 cm (0–6 in.)]		Yes
		External radiation [0–1.22 m (0–4 ft)]		Yes

a. Zone of contamination based on the following previously characterized zones:

CPP-67 = 0 to 1.8 m (0 to 6 ft).

Table 16-3. Soil concentration terms by depth interval.

COPCs	Soil concentrations (mg/kg or pCi/g) (0 - 0.5 ft)	(0 - 4 ft)	(0 - 10 ft)
Aroclor-1260	---	---	---
Benzo(a)pyrene	---	---	---
Aluminum	---	---	---
Arsenic	---	---	---
Manganese	---	---	---
Mercury	---	---	---
Uranium[a]	5.71E+00	4.27E+00	4.14E+00
Am-241	5.56E+00	2.69E+00	1.67E+00
Ce-144	1.08E+00	1.50E+00	1.50E+00
Co-57	---	---	---
Co-58	---	---	---
Co-60	1.46E+00	2.24E+00	1.74E+00
Cs-134	3.05E+00	3.50E+00	3.50E+00
Cs-137	8.48E+01	9.36E+01	9.36E+01
Eu-152	---	---	---
Eu-154	---	---	---
Eu-155	---	---	---
H-3	6.10E-01	2.19E-01	2.19E-01
I-129	3.70E+00	2.18E+00	1.43E+00
K-40	---	---	---
Nb-95	---	---	---
Np-237	1.59E+00	1.34E+00	1.34E+00
Pu-238	7.21E+00	1.30E+01	1.20E+01
Pu-239/240	2.07E+00	1.12E+00	8.89E-01
Pu-241	---	---	---
Pu-242	---	---	---
Ru/Rh-106	5.97E+00	3.95E+00	2.74E+00
Sb-125	1.29E+00	1.55E+00	1.21E+00
Sr-90	1.63E+01	1.63E+01	9.97E+00
Tc-99	---	---	---
U-234	2.51E+00	1.69E+00	1.60E+00
U-235	6.54E-02	3.62E-02	3.62E-02
U-236	---	---	---
U-238	1.91E+00	1.43E+00	1.39E+00

a. mg/kg of uranium calculated from pCi/g of uranium isotopes using the equation
mg/kg = pCi/g * 2.795E-12 (mg-mole/kg-pCi-yr) * MW (g/mole) * $t_{1/2}$ (yr).

Table 16-4. Average soil exposure-point concentrations (mg/kg or pCi/g) for land use scenarios.

	Current occupational worker year 0 to year 25		Future occupational worker year 100 to year 125		Future resident year 100 to year 130
COPCs	(0 - 0.5 ft)	(0 - 4 ft)	(0 - 0.5 ft)	(0 - 4 ft)	(0 - 10 ft)
Aroclor-1260	----	----	----	----	----
Benzo(a)pyrene	----	----	----	----	----
Aluminum	----	----	----	----	----
Arsenic	----	----	----	----	----
Manganese	----	----	----	----	----
Mercury	----	----	----	----	----
Uranium[a]	5.71E+00	4.27E+00	5.71E+00	4.27E+00	4.14E+00
Am-241	5.45E+00	2.64E+00	4.65E+00	2.25E+00	1.39E+00
Ce-144	4.85E-02	6.74E-02	1.00E-40	1.39E-40	1.16E-40
Co-57	----	----	----	----	----
Co-58	----	----	----	----	----
Co-60	4.29E-01	6.55E-01	8.36E-07	1.28E-06	8.43E-07
Cs-134	3.63E-01	4.16E-01	8.91E-16	1.02E-15	8.51E-16
Cs-137	6.45E+01	7.12E+01	6.49E+00	7.16E+00	6.80E+00
Eu-152	----	----	----	----	----
Eu-154	----	----	----	----	----
Eu-155	----	----	----	----	----
H-3	3.27E-01	1.17E-01	1.17E-03	4.19E-04	3.77E-04
I-129	3.70E+00	2.18E+00	3.70E+00	2.18E+00	1.43E+00
K-40	----	----	----	----	----
Nb-95	----	----	----	----	----
Np-237	1.59E+00	1.34E+00	1.59E+00	1.34E+00	1.34E+00
Pu-238	6.54E+00	1.18E+01	2.97E+00	5.36E+00	4.87E+00
Pu-239/240	2.07E+00	1.12E+00	2.06E+00	1.12E+00	8.86E-01
Pu-241	----	----	----	----	----
Pu-242	----	----	----	----	----
Ru/Rh-106	3.48E-01	2.30E-01	5.53E-31	3.66E-31	2.12E-31
Sb-125	2.06E-01	2.47E-01	2.81E-12	3.36E-12	2.20E-12
Sr-90	1.23E+01	1.23E+01	1.14E+00	1.14E+00	6.58E-01
Tc-99	----	----	----	----	----
U-234	2.51E+00	1.69E+00	2.51E+00	1.69E+00	1.59E+00
U-235	6.54E-02	3.62E-02	6.54E-02	3.62E-02	3.62E-02
U-236	----	----	----	----	----
U-238	1.91E+00	1.43E+00	1.91E+00	1.43E+00	1.39E+00

a. mg/kg of uranium calculated from pCi/g of uranium isotopes using the equation
mg/kg = pCi/g * 2.795E-12 (mg-mole/kg-pCi-yr) * MW (g/mole) * $t_{1/2}$ (yr).

Table 16-5. Concentrations of COPCs in homegrown produce.

COPCs	Homegrown produce (mg/kg or pCi/g)	Kd (cm^3/g)	COPC input rate from irrigation (mg/g-d or pCi/g-d)	Leach rate constant (d^{-1})
Aroclor-1260	—	7.89E+03	0.00E+00	9.95E-07
Benzo(a)pyrene	—	1.19E+03	0.00E+00	6.57E-06
Aluminum	—	0.00E+00	0.00E+00	2.87E-02
Arsenic	1.40E-04	3.00E+00	8.71E-09	2.40E-03
Manganese	—	5.00E+01	0.00E+00	1.56E-04
Mercury	1.10E-01	1.00E+02	2.91E-08	7.83E-05
Uranium	4.30E-03	6.00E+00	7.04E-09	1.25E-03
Am-241	2.14E-04	3.40E+02	6.08E-06	2.31E-05
Ce-144	4.61E-06	5.00E+02	0.00E+00	1.57E-05
Co-57	—	1.00E+01	0.00E+00	7.64E-04
Co-58	—	1.00E+01	0.00E+00	7.64E-04
Co-60	3.48E-04	1.00E+01	0.00E+00	7.64E-04
Cs-134	4.37E-04	5.00E+02	0.00E+00	1.57E-05
Cs-137	1.72E-01	5.00E+02	4.12E-05	1.57E-05
Eu-152	—	3.40E+02	0.00E+00	2.31E-05
Eu-154	—	3.40E+02	0.00E+00	2.31E-05
Eu-155	—	3.40E+02	0.00E+00	2.31E-05
H-3	—	0.00E+00	6.22E-04	2.87E-02
I-129	1.93E-05	0.00E+00	3.26E-05	2.87E-02
K-40	—	1.50E+01	0.00E+00	5.14E-04
Nb-95	—	0.00E+00	0.00E+00	2.87E-02
Np-237	5.00E-04	0.00E+00	8.36E-06	2.87E-02
Pu-238	5.87E-04	2.20E+01	0.00E+00	3.53E-04
Pu-239/240	9.28E-04	2.20E+01	5.84E-07	3.53E-04
Pu-241	8.49E-09	2.20E+01	9.37E-08	3.53E-04
Pu-242	3.60E-09	2.20E+01	3.88E-10	3.53E-04
Ru/Rh-106	7.00E-05	0.00E+00	0.00E+00	2.87E-02
Sb-125	2.47E-07	5.00E+01	0.00E+00	1.56E-04
Sr-90	1.19E-01	1.20E+01	5.63E-05	6.40E-04
Tc-99	4.56E-01	0.00E+00	1.67E-04	2.87E-02
U-234	1.65E-03	6.00E+00	2.63E-06	1.25E-03
U-235	3.80E-05	6.00E+00	9.27E-08	1.25E-03
U-236	6.93E-07	6.00E+00	6.68E-08	1.25E-03
U-238	1.44E-03	6.00E+00	2.35E-06	1.25E-03

Table 16-6. Soil pathway cancer risk to the current onsite worker. [a]

COPCs	Ingestion of soil	External radiation exposure	Total risks
Aroclor-1260	---	---	---
Benzo(a)pyrene	---	---	---
Aluminum	---	---	---
Arsenic	---	---	---
Manganese	---	---	---
Mercury	---	---	---
Uranium	NTD	---	---
Am-241	4E-07	7E-08	5E-07
Ce-144	4E-10	6E-08	6E-08
Co-57	---	---	---
Co-58	---	---	---
Co-60	2E-09	4E-05	4E-05
Cs-134	4E-09	1E-05	1E-05
Cs-137	5E-07	8E-04	8E-04
Eu-152	---	---	---
Eu-154	---	---	---
Eu-155	---	---	---
H-3	6E-12	NTD	6E-12
I-129	2E-07	3E-08	2E-07
K-40	---	---	---
Nb-95	---	---	---
Np-237	1E-07	4E-06	4E-06
Pu-238	5E-07	1E-09	5E-07
Pu-239/240	2E-07	1E-10	2E-07
Pu-241	---	---	---
Pu-242	---	---	---
Ru/Rh-106	3E-09	1E-06	1E-06
Sb-125	2E-10	2E-06	2E-06
Sr-90	2E-07	NTD	2E-07
Tc-99	---	---	---
U-234	3E-08	2E-10	3E-08
U-235	8E-10	5E-08	6E-08
U-236	---	---	---
U-238	3E-08	4E-07	5E-07
Total cancer risks by route:	2E-06	9E-04	9E-04

"---" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 16-7. Soil pathway noncarcinogenic hazard to the current onsite worker. [a]

COPCs	Ingestion of soil	External radiation exposure	Total HIs
Aroclor-1260	---	---	---
Benzo(a)pyrene	---	---	---
Aluminum	---	---	---
Arsenic	---	---	---
Manganese	---	---	---
Mercury	---	---	---
Uranium	7E-09	---	7E-09
Am-241	---	---	---
Ce-144	---	---	---
Co-57	---	---	---
Co-58	---	---	---
Co-60	---	---	---
Cs-134	---	---	---
Cs-137	---	---	---
Eu-152	---	---	---
Eu-154	---	---	---
Eu-155	---	---	---
H-3	---	---	---
I-129	---	---	---
K-40	---	---	---
Nb-95	---	---	---
Np-237	---	---	---
Pu-238	---	---	---
Pu-239/240	---	---	---
Pu-241	---	---	---
Pu-242	---	---	---
Ru/Rh-106	---	---	---
Sb-125	---	---	---
Sr-90	---	---	---
Tc-99	---	---	---
U-234	---	---	---
U-235	---	---	---
U-236	---	---	---
U-238	---	---	---
Total hazard indices by route:	7E-09	0E+00	7E-09

"---" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 16-8. Soil pathway cancer risk to the future onsite worker. [a]

COPCs	Ingestion of soil	External radiation exposure	Total risks
Aroclor-1260	----	----	----
Benzo(a)pyrene	----	----	----
Aluminum	----	----	----
Arsenic	----	----	----
Manganese	----	----	----
Mercury	----	----	----
Uranium	NTD	----	----
Am-241	4E-07	6E-08	4E-07
Ce-144	8E-49	1E-46	1E-46
Co-57	----	----	----
Co-58	----	----	----
Co-60	4E-15	7E-11	7E-11
Cs-134	1E-23	3E-20	3E-20
Cs-137	5E-08	8E-05	8E-05
Eu-152	----	----	----
Eu-154	----	----	----
Eu-155	----	----	----
H-3	2E-14	NTD	2E-14
I-129	2E-07	3E-08	2E-07
K-40	----	----	----
Nb-95	----	----	----
Np-237	1E-07	4E-06	4E-06
Pu-238	2E-07	6E-10	2E-07
Pu-239/240	2E-07	1E-10	2E-07
Pu-241	----	----	----
Pu-242	----	----	----
Ru/Rh-106	5E-39	2E-36	2E-36
Sb-125	2E-21	2E-17	2E-17
Sr-90	2E-08	NTD	2E-08
Tc-99	----	----	----
U-234	3E-08	2E-10	3E-08
U-235	8E-10	5E-08	6E-08
U-236	----	----	----
U-238	3E-08	4E-07	5E-07
Total cancer risks by route:	1E-06	9E-05	9E-05

"----" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 16-9. Soil pathway noncarcinogenic hazard to the future onsite worker. [a]

COPCs	Ingestion of soil	External radiation exposure	Total HIs
Aroclor-1260	---	---	---
Benzo(a)pyrene	---	---	---
Aluminum	---	---	---
Arsenic	---	---	---
Manganese	---	---	---
Mercury	---	---	---
Uranium	7E-09	---	7E-09
Am-241	---	---	---
Ce-144	---	---	---
Co-57	---	---	---
Co-58	---	---	---
Co-60	---	---	---
Cs-134	---	---	---
Cs-137	---	---	---
Eu-152	---	---	---
Eu-154	---	---	---
Eu-155	---	---	---
H-3	---	---	---
I-129	---	---	---
K-40	---	---	---
Nb-95	---	---	---
Np-237	---	---	---
Pu-238	---	---	---
Pu-239/240	---	---	---
Pu-241	---	---	---
Pu-242	---	---	---
Ru/Rh-106	---	---	---
Sb-125	---	---	---
Sr-90	---	---	---
Tc-99	---	---	---
U-234	---	---	---
U-235	---	---	---
U-236	---	---	---
U-238	---	---	---
Total hazard indices by route:	7E-09	0E+00	7E-09

"---" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 16-10. Soil pathway cancer risk to the future onsite resident. [a]

COPCs	Ingestion of soil	Ingestion of homegrown	External radiation exposure	Total risks
Aroclor-1260	—	—	—	—
Benzo(a)pyrene	—	—	—	—
Aluminum	—	—	—	—
Arsenic	—	2E-08	—	2E-08
Manganese	—	—	—	—
Mercury	—	NTD	—	—
Uranium	NTD	NTD	—	—
Am-241	6E-07	1E-08	2E-07	8E-07
Ce-144	4E-48	2E-11	5E-46	2E-11
Co-57	—	—	—	—
Co-58	—	—	—	—
Co-60	2E-14	1E-09	2E-10	1E-09
Cs-134	5E-23	4E-09	1E-19	4E-09
Cs-137	3E-07	1E-06	4E-04	4E-04
Eu-152	—	—	—	—
Eu-154	—	—	—	—
Eu-155	—	—	—	—
H-3	3E-14	—	NTD	3E-14
I-129	3E-07	6E-10	1E-07	4E-07
K-40	—	—	—	—
Nb-95	—	—	—	—
Np-237	5E-07	3E-08	2E-05	2E-05
Pu-238	2E-06	3E-08	3E-09	2E-06
Pu-239/240	4E-07	5E-08	5E-10	4E-07
Pu-241	—	5E-13	—	5E-13
Pu-242	—	2E-13	—	2E-13
Ru/Rh-106	9E-39	4E-10	5E-36	4E-10
Sb-125	1E-20	2E-13	8E-17	2E-13
Sr-90	5E-08	1E-06	NTD	1E-06
Tc-99	—	1E-07	—	1E-07
U-234	9E-08	1E-08	1E-09	1E-07
U-235	2E-09	3E-10	3E-07	3E-07
U-236	—	5E-12	—	5E-12
U-238	1E-07	2E-08	2E-06	2E-06
Total cancer risks by route:	4E-06	2E-06	4E-04	4E-04

"—" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 16-11. Soil pathway noncarcinogenic hazard to the future onsite resident. [a]

COPCs	Ingestion of soil	Ingestion of homegrown	External radiation exposure	Total HIs
Aroclor-1260	—	—	—	—
Benzo(a)pyrene	—	—	—	—
Aluminum	—	—	—	—
Arsenic	—	1E-04	—	1E-04
Manganese	—	—	—	—
Mercury	—	1E-01	—	1E-01
Uranium	5E-08	4E-04	—	4E-04
Am-241	—	—	—	—
Ce-144	—	—	—	—
Co-57	—	—	—	—
Co-58	—	—	—	—
Co-60	—	—	—	—
Cs-134	—	—	—	—
Cs-137	—	—	—	—
Eu-152	—	—	—	—
Eu-154	—	—	—	—
Eu-155	—	—	—	—
H-3	—	—	—	—
I-129	—	—	—	—
K-40	—	—	—	—
Nb-95	—	—	—	—
Np-237	—	—	—	—
Pu-238	—	—	—	—
Pu-239/240	—	—	—	—
Pu-241	—	—	—	—
Pu-242	—	—	—	—
Ru/Rh-106	—	—	—	—
Sb-125	—	—	—	—
Sr-90	—	—	—	—
Tc-99	—	—	—	—
U-234	—	—	—	—
U-235	—	—	—	—
U-236	—	—	—	—
U-238	—	—	—	—
Total hazard indices by route:	5E-08	1E-01	0E+00	1E-01

"—" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

16.4.4.1 Current Land Use. As indicated in Table 16-6, total cancer risk to the current onsite worker from exposure to site-related chemicals in surface soil is estimated to be 9E-04. The primary contaminants of concern (COCs) and associated risk estimates for external radiation exposure are Co-60 (4E-05), Cs-134 (1E-05), Cs-137 (8E-04), and Np-237 (4E-06). For the soil ingestion exposure route, no single COPC resulted in a risk equal to or greater than 1E-06, however, the sum of all applicable COPCs resulted in a risk of 2E-06. Table 16-7 indicates that the total noncarcinogenic hazard index to the current worker is estimated to be 7E-09. There are no hazard indices above unity for the current onsite worker.

16.4.4.2 Future Land Use. As Table 16-8 indicates, the total cancer risk to the future onsite worker from exposure to site-related chemicals in surface soil is estimated to be 9E-05. The risk is attributed to external radiation exposure with the primary COCs being Cs-137 (8E-05) and Np-237 (4E-06). Table 16-9 indicates the total noncarcinogenic hazard index to the future onsite worker is estimated to be 7E-09. There are no hazard indices above unity for the future onsite worker. As indicated in Table 16-10, the total cancer risk to the future resident from exposure to site related chemicals in soil is estimated to be 4E-04. The primary COC for the ingestion of soil exposure route is Pu-238 (2E-06). The major contributors to the ingestion of homegrown produce pathway are Cs-137 (1E-05) and Sr-90 (1E-06). The primary contributors to the external radiation exposure pathway are Cs-137 (4E-04) and Np-237 (2E-05). As shown on Table 16-11, the total noncarcinogenic hazard index to the future resident is estimated to be 1E-01. There are no hazard indices above unity for the future resident.

Upon examination of the risk assessment results for both ponds evaluated together as a unit, it was decided to go back and check the results as if the evaluation was conducted separately for each pond. This step was taken to avoid making an unnecessary remedial decision at one of the ponds if the results at either pond showed the excess cancer risk to be acceptable despite the group evaluation indicating that both ponds should be considered for some type of response. The results of this step indicated that there was no appreciable difference in the results regardless of whether the ponds were evaluated separately or together. The excess cancer risk under a group approach was estimated to be 4E-04 compared to 4E-04 and 5E-04 for ponds 1 and 2, respectively if evaluated separately.

16.5 Uncertainties

This section describes the limitations and uncertainties specific to the site characterization of site CPP-67. Sources of uncertainty associated with site characterization include data quality, COPC identification, concentration term estimation, and assumptions regarding the lateral and vertical extent of COPC occurrence. In the risk assessment, the most significant uncertainties are due to the selection process of COPCs, the toxicity values used, and the assumptions used during the exposure assessment. The following paragraphs will discuss important sources of site-specific uncertainty in greater detail.

Sampling and analysis uncertainties are related to quality problems that may result in qualified and rejected results (Section 3.5). Qualified results are considered estimates of the concentration in the sample and, for all practical purposes, useable for their intended purpose although they could be biased high or low. Rejected results are considered unusable, thus limiting the size of the useable data set. For site CPP-67, no data points were rejected based on the method validation as documented in the Limitations and Validation (L&V) Reports, thus making this possible source of uncertainty insignificant.

Uncertainty associated with the chemical screening process (Section 5.2) results from using the maximum concentration for chemicals detected in the Environmentally Controlled Areas (ECAs) in the

background comparison step, retaining chemicals detected as COPCs because there is not a corresponding background value, and retaining chemicals as COPCs for which there is no toxicity information available.

In most cases, the COPC identification process used the maximum concentration for a chemical detected in the background comparison step, regardless of its magnitude above background. The use of the maximum concentration can result in the identification of COPCs that have concentrations only slightly above background. For site CPP-67, all COPCs had concentrations significantly above background.

Another source of uncertainty related to the background comparison step in the chemical screening process relates to chemicals for which no background concentration exists. For example, fluoride, nitrate, and several radionuclides were not characterized as part of the Rood et al. background study. For site CPP-67, the following COPCs have no corresponding background concentration: Ce-144, Co-60, Cs-134, H-3, I-129, Np-237, Ru-106, Sb-125, and U-235. This results in an increase in the number of COPCs considered in the RI/BRA and a possible overestimation of risk because the observed concentrations may be within the background population.

Some concentration estimates are based on the 95% UCL for the site. When the 95% UCL (i.e., the concentration term estimate) of a COPC is below the corresponding background value, this results in an increase in the number of COPCs in the RI/BRA and a possible overestimation of risk because the results are likely within the background range. This source of uncertainty stems from the use of maximum concentrations when identifying the COPCs for a specific site. For site CPP-67, the U-238 was the only COPC that the concentration estimate was below background but was included as a COPC in the RI/BRA. For site CPP-67, all COPCs identified had toxicity values available for use in the HHRA.

With respect to the nature and extent assessment, it is also noted that the precise lateral extent of contamination at CPP-67 is currently unknown. The assumed extent of contamination was reduced to that of the base of the ponds themselves, rather than the pond plus the bermed areas. The vertical extent of contamination of 1.8 m (6 ft) is based on samples with decreasing, but above background COPC readings. If COPC activities do not decrease to below background below 1.8 m (6 ft) bgs, the mass of affected soil may be underestimated.

Risk calculations for the 0-to 3.0-m (0- to 10-ft) interval are based on samples collected no deeper than 1.8 m (6 ft). If COPC activities decrease with depth in the manner seen in shallower samples, then the risks for the 0-to 3.0-m (0- to 10-ft) interval are likely to be overestimated.

One other source of uncertainty may be associated with the contaminant inventories used for the groundwater modeling and residential intrusion exposure at every sub-area. Section 16.4.3 identifies radionuclides potentially missing from these inventories. The implication of these potential data gaps, is that the source estimates could be underestimated. The potentially missing Eu-154 and Pu-241 have half-lives of 8.6 and 14.7 years, respectively, and are therefore not expected to be of concern to a surface receptor at the year 2095 and beyond. The uncertainty is recognized in this report, but no information is available to quantify the uncertainty.

16.6 Conclusions and Recommendations

The results of the risk assessment under current land use at the Percolation Ponds indicates that the increased cancer risk from exposure to site-related contaminants is above the Environmental Protection

Agency (EPA)-recommended target range. The increased cancer risk to hypothetical future onsite workers is within the EPA target range and for future onsite residents it was found to be above the EPA-recommended target range. The noncarcinogenic hazard for all receptors was found to be well below the EPA hazard index goal of one. It should be noted that these estimates do not include the contributions associated with the air and groundwater pathways. The total increased cancer and hazard incidence to humans is reported in Section 27. The risk estimates at this site are likely to be overestimated for reasons described in Sections 7 and 16.5 of this report. Risk estimates at this site indicate that future response actions to mitigate adverse impacts to human health and the environment may be warranted.

16.7 References

Ebasco, 1991, *Work Plan for Idaho Chemical Processing Plant Percolation Pond Investigation*, Ebasco Environmental, Bellevue, Washington.

Golder Associates, 1992, *Report for the Idaho Chemical Processing Plant Sampling and Analysis Program at Service Waste Percolation Pond No. 1*, November.

Rood, S. M., G. A. Harris, and G. J. White, 1995, *Background Dose Equivalent Rates and Surficial Soil Metal and Radionuclide Concentrations for the Idaho National Engineering Laboratory*, INEL-94/0250, Revision 0, February.

Chapter 17

17. SITE CPP-14 RESULTS

Site CPP-14 is the site of a decommissioned sewage treatment plant that operated during the period 1951 through 1982. The treatment plant processed sanitary wastes from nine facilities at the Idaho Chemical Processing Plant (ICPP). Site CPP-14 is located in the north-central portion of the ICPP, south of Cypress Avenue, east of Beech Street, and north of the ICPP Tank Farm as shown on Figure 17-1. This section presents a site description, the investigative results, and an assessment of the nature and extent of contamination followed by the human health risk assessment (HHRA) for site CPP-14.

17.1 Site Description

The principal features of the treatment plant consisted of two Imhoff digestion tanks, a trickling filter, a chlorine contact basin, sludge drying beds, and a drain field as shown in Figure 17-1. Raw sewage was initially digested in the Imhoff tank followed by secondary treatment of the effluent in the trickling filter. The digested sludge was transferred to the sludge drying beds, while liquid effluent from the trickling filter was chlorinated and discharged to the drain field.

The sewage treatment facility was demolished as part of the Utility Replacement and Expansion Project (UREP) to upgrade the INEL facilities. Demolition was completed in September 1983 and reportedly consisted of:

- Removal of the wastewater treatment facilities and associated equipment to a depth of 1.5-m (5- ft) belowgrade
- Removal and disposal of all remaining sludge in the drying beds
- Removal of all buried piping, with the exception of the 0.3-m (12-in.) influent line and the 0.15-m (6-in.) effluent lines from the chlorine contact basin to the drain field.

Demolition planning documents stated that salvageable items would be removed and stored, any remaining sludge would be pumped to the new sewage treatment plant, and any structures that were removed would be dismantled and disposed of in the INEL landfill. The excavated area was backfilled and graded to match the surrounding ground surface.

The influent manhole, ejector pit, Imhoff tanks, final tank, and chlorination tank extended to as deep as 6.1-m (20-ft) belowgrade. The lower portions of these facilities were left abandoned in place. Demolition planning documents stated that drainage holes approximately 0.09 m^2 (1 ft^2) would be cut in the bottoms of all abandoned structures to prevent accumulation of infiltrating surface water. Also left in place were the 0.3-m (12-in.) diameter influent line, the 0.15-m (6-in.) effluent line to the drain field, and the drain field distribution piping.

According to the plot plan for the facility, the "Y" branch in the piping in the drain field is positioned approximately 54.9-m (180-ft) southeast of the former location of the chlorination tank. This would place the drain field piping either directly under, or immediately south of building T-6, which is a temporary

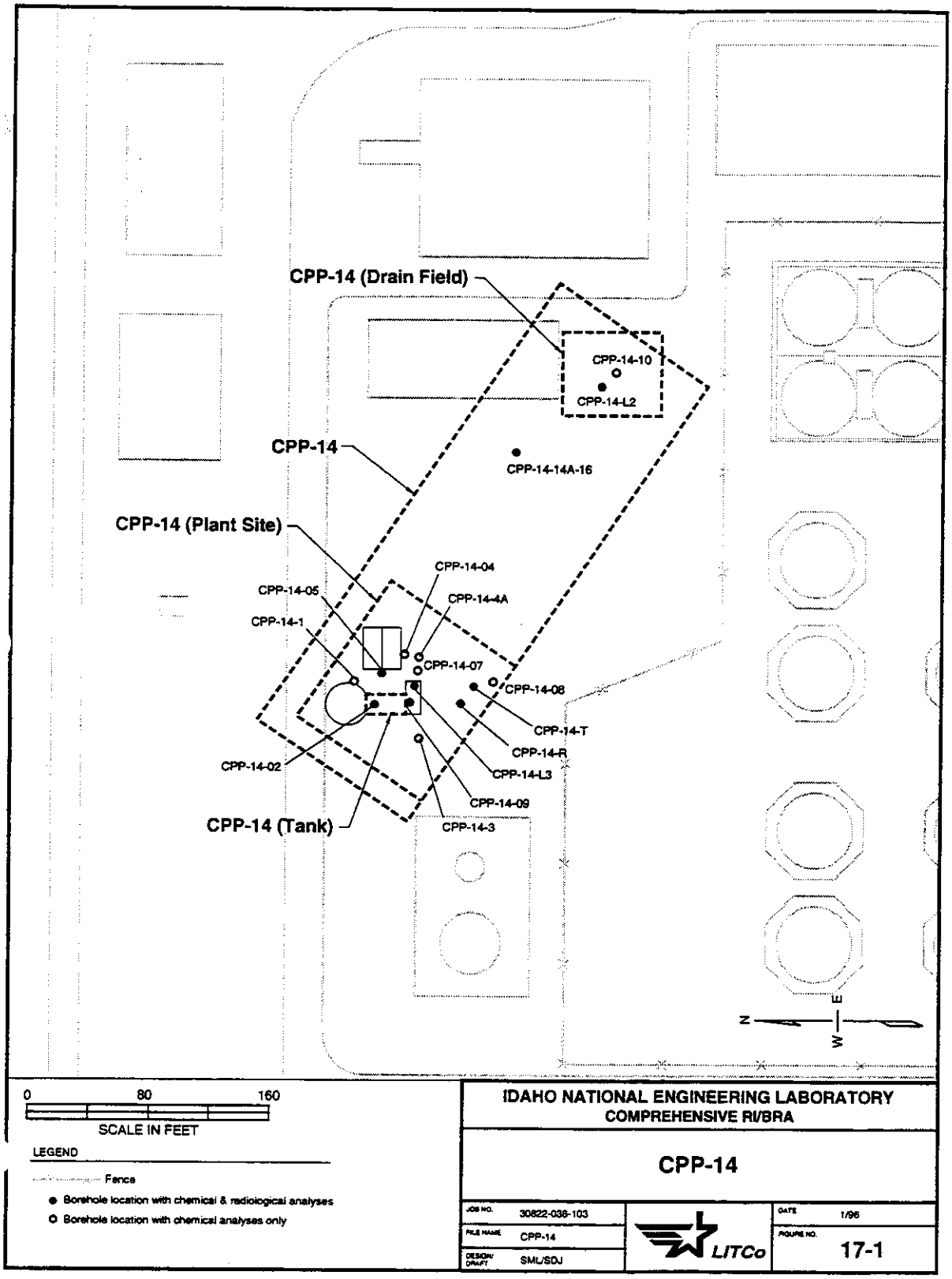


Figure 17-1. CPP-14 and borehole locations.

structure located south of building CPP-664. A 2.4 kV power line, water and sewer lines, as well as a propane tank, are all located within the boundaries of the presumed location of the drain field.

Based on the chemical screening in Section 5.2, the following contaminants of potential concerns (COPCs) were identified for site CPP-14.

Imhoff Tanks	Plant Site	Drain Field
Aroclor-1260	Aroclor-1260	
Benzo(a)pyrene	Cesium-137	
Cesium-137	Neptunium-237	
Neptunium-237	Strontium-90	
Strontium-90	Uranium-234	
Uranium-235	Uranium-238	

Note that several contaminants that do not appear above or on Tables 5-7, 5-8, and 5-9 were analyzed for but not detected. The specific contaminants are mentioned at the bottom of each screening table in Section 5.

17.2 Investigative Results

As noted above, site CPP-14 was the site of a sewage treatment facility designed to treat sanitary wastes from nine facilities at the ICPP. The treatment facility was not designed to receive or process hazardous or radioactive wastes. However, during removal and disposal of the sludges during the demolition project in 1982, the sludges from the drying beds were found to be contaminated with low-level radioactivity and were removed and sent to the Radioactive Waste Management Complex (RWMC). The source of contamination in the sludges was not determined, but it has been suggested that the personnel decontamination showers were the most probable source of contamination, because during demolition the decontamination shower drains were found to be connected to the sewage treatment facility. No specific information has been provided on levels of radioactivity detected. Radiochemical analysis and chemical analysis for hazardous constituents were evidently not conducted on the sludges or on any of the waste streams disposed of at the treatment plant. A likely scenario is that while the plant was being decommissioned, field screening instruments indicated radioactivity measurements above background, and so the sludge was containerized and sent for disposal at the RWMC. Two boreholes were drilled in the sludge drying beds during characterization. The field logbook indicates that during the drilling of borehole 7, all field screening measurements of radioactivity of the samples and the auger were at background. During the drilling of borehole 5, one sample had measured activity at above background levels.

Characterization of site CPP-14 was initiated under the Consent Order and Compliance Agreement (COCA). Because the COCA stemmed from RCRA authority, site investigation objectives were to gather adequate characterization information to determine closure methods (i.e., clean closure or waste left in place with postclosure monitoring).

The CPP-14 investigation was carried out in three phases. Phase 1 consisted of a series of geophysical surveys performed in the winter of 1990. The surveys were performed over the area to determine locations of structures within the sewage treatment facility so that borehole locations could be placed within the structures (i.e., the Imhoff tanks, ejector pit, sludge drying beds, and drain field). Results of the geophysical surveys are

described in *Report on Surface Geophysical Surveys at the Idaho Chemical Processing Plant* (Golder Associates, 1991). Phase 2 was performed during the summer of 1991 and involved sampling during the excavation and removal of pipelines associated with the facility. Phase 3 consisted of borehole drilling and sampling performed in the fall and winter of 1991 (WINCO, 1993).

A total of 17 soil samples were collected for chemical and radiological analyses from five pipe excavation locations and 10 boreholes. Of these soil samples, five were collected as biased grab samples, and 12 as biased composites. Results from soil sampling were intended to determine the presence or absence of radiological contamination at each area and to increase the overall reliability of the exposure concentrations for any contaminants detected in the soil.

Investigative results will be discussed for the three areas of CPP-14, based on the COPCs identified in the chemical screening in Section 5.2.

The first area, comprised of the Imhoff Tanks, was evaluated separately because the material under investigation at this location is remnant sludge most likely contained within the Imhoff Tanks with little or no migration outside of the tanks. As stated previously, these tanks digested raw sewage.

The plant site area, as referred to herein, consists of contamination in the remaining facilities: the trickling filter, ejector pit, final tank, chlorine contact basin, sludge drying beds, and associated piping. This area was evaluated separately because the material under investigation is soil and residual sewage treatment plant contaminants.

The drain field was evaluated separately because it is physically separated from the main sewage treatment plant facilities. The drain field is located approximately 54.9 m (180 ft) to the southeast of the main facility.

17.2.1 Imhoff Tanks

The analytical results for COPCs in the Imhoff Tanks portion of CPP-14 are summarized in Table 17-1. A compilation of the analytical results are presented in Appendix G. Results are based on two samples collected of the sludge within the tanks. These samples were collected at depths ranging from approximately 3.0 to 3.6 m (approximately 10 to 12 ft) below ground surface (bgs). These sample locations are identified as CPP-14-02 and CPP-14-09 on Figure 17-1. Organic COPCs found in one or both samples included Aroclor-1260, phenanthrene, and benzo(a)pyrene. Aroclor was the only organic COPC detected in both samples at concentration above 1.0 mg/kg. It was detected in sample CPP-14-02 at 23 mg/kg and sample CPP-14-09 at 6 mg/kg. Organic COPCs benzo(a)pyrene and phenanthrene were detected at concentrations below 1.0 mg/kg.

Radiological COPCs found in the samples were Cs-137, Np-237, Sr-90, and U-235. Of these, Cs-137 was detected at the highest activity levels, which were 6.21±0.16 pCi/g and 4.94±0.18 pCi/g in samples CPP-14-02 and CPP-14-09, respectively. Neptunium was also detected at activity above 1.0 pCi/g in both samples.

Table 17-1. Summary statistics for CPP-14, Imhoff Tanks.

COPCs	Concentration (mg/kg or pCi/g) Minimum detected	Maximum detected	Arithmetic mean	Standard deviation	Number of samples	Number of detects	Frequency of detection	INEL background (mg/kg or pCi/g)	Number greater than background
Aroclor-1260[a]	6 X	23 X	1.45E+01	1.20E+01	2	2	100%	NA	NA
Benzo(a)Pyrene	0.34 J	0.34 J	3.40E-01	NA	1	1	100%	NA	NA
Phenanthrene	0.15 J	0.37 J	2.60E-01	1.56E-01	2	2	100%	NA	NA
Cs-137	4.94 +/- 0.18	6.21 +/- 0.16	5.58E+00	8.98E-01	2	2	100%	0.82	2
Np-237	1.7 +/- 0.34	1.98 +/- 0.45	1.84E+00	1.98E-01	2	2	100%	NA	NA
Sr-90	0.71 +/- 0.15	1.07 +/- 0.17	8.90E-01	2.55E-01	2	2	100%	0.49	2
U-235	0.05 +/- 0.02	0.05 +/- 0.02	5.00E-02	NA	2	1	50%	NA	NA

NA - Not applicable/available
a. 'X' indicates the value was manually entered into the result form.

17.2.2 Plant Site

The analytical results for the COPCs in the Plant Site portion of CPP-14 are summarized in Table 17-2. A compilation of the analytical results is presented in Appendix G. Results are based on samples collected from 10 boreholes within the remaining tanks, basins, and sludge drying beds. These samples were collected at depths ranging from approximately 1.1- to 11.6-m (3.5- to 38-ft) bgs. These boreholes are shown on Figure 17-1. Numerous inorganic, organic, and radionuclide COPCs were detected at concentrations/activities above background in these samples.

Organic COPC detections in Plant Site samples were limited to isolated detections of Aroclor 1254 and Aroclor 1260. These COPCs were identified in samples from borings CPP-14-4T, CPP-14-4R, CPP-14-L3, and CPP-14-05. All detections were at concentrations below 1.0 mg/kg, and were limited to depths less than approximately 5.2 m (17.0 ft).

Numerous radiologic COPCs were detected in multiple Plant Site area samples, including Cs-137, Sr-90, U-234, U-238, and Np-237. Isolated detections of U-235 and Am-241 were also noted. Cs-137 ranged up to 3.89±0.31 pCi/g and Np-237 was detected at 5.5±2.1 pCi/g. Maximum U-234 and U-238 activities of 6.89±0.71 and 52.1±1.97, respectively, were detected in a sample from approximately 9.8-m (32-ft) deep in boring CPP-14-1. U-234 and U-238 were also detected at activities at or near background in deep [over approximately 9.1-m (30-ft)] samples from sample borings CPP-14-4A and CPP-14-08.

17.2.3 Drain Field

The analytical results for the COPCs in the Drain Field portion of CPP-14 are summarized in Table 17-3. A compilation of the analytical results is presented in Appendix G. Results are based on samples collected from two boreholes within the drain field area. These samples were collected at depths ranging from approximately 4.6- to 13.1-m (15- to 43-ft) bgs. These boreholes are shown on Figure 17-1. Arsenic was the only inorganic constituent detected above background in the three samples collected. Arsenic was detected at 8.6 mg/kg in one sample, which is slightly above background. Organic COPC detections were limited to phenanthrene at a concentration below 0.1 mg/kg.

Radiological COPCs detected in samples from the drain field were Np-237 and Sr-90. Np-237 activity was less than 1.5 pCi/g and Sr-90 activity was less than 1.0 pCi/g in the samples in which they were detected.

17.3 Nature and Extent of Soil Contamination

The extent of contamination at the location of the former sewage treatment plant was evaluated based on the results of sampling. The zone of contamination in the area of the Imhoff Tanks is assumed to be 0.9 m (3.0 ft) thick, and extends from 2.4 to 3.4 m (8 to 11-ft) bgs. This thickness is based on the initial depth at which sludge was encountered in sampling, and the depth of the base of the tanks. The area of the tanks is 18.6 m^2 (200 ft^2). Radiological COPCs at this subsite include Cs-137, Np-237, U-235, and Sr-90. Of these,

Table 17-2. Summary statistics for CPP-14, Plant Site.

COPCs	Concentration (mg/kg or pCi/g) Minimum detected	Maximum detected	Arithmetic mean	Standard deviation	Number of samples	Number of detects	Frequency of detection	INEL background (mg/kg or pCi/g)	Number greater than background
Aroclor-1260	0.1 JX	.57 DJX	2.93E-01	2.46E-01	3	3	100%	NA	NA
Am-241	1.15 +/- 0.23	1.15 +/- 0.23	1.15E+00	NA	11	1	9%	0.011	1
Cs-137	0.31 +/- 0.18	3.89 +/- .31	1.80E+00	1.40E+00	11	5	45%	0.82	3
Np-237	0.45 +/- 0.14	5.5 +/- 2.1	2.19E+00	1.47E+00	12	10	83%	NA	NA
Sb-125	0.1 +/- 0.1 J	.1 +/- .1 J	1.00E-01	NA	11	1	9%	NA	NA
Sr-90	0.07 +/- 0.06	.57 +/- .11	2.39E-01	1.71E-01	11	7	64%	0.49	1
U-234	0.09 +/- 0.03 J	6.89 +/- 0.71	8.45E-01	1.91E+00	12	12	100%	1.44	1
U-235	0.05 +/- 0.03	0.68 +/- 0.22	3.65E-01	4.45E-01	11	2	18%	NA	NA
U-238	0.1 +/- 0.03 J	52.1 +/- 1.97	4.75E+00	1.49E+01	12	12	100%	1.4	2

NA - Not applicable/available

a. 'X' indicates the value was manually entered into the result form.

Table 17-3. Summary statistics for CPP-14, Drain Field.

COPCs	Concentration (mg/kg or pCi/g)			Standard deviation	Number of samples	Number of detects	Frequency of detection	INEL background (mg/kg or pCi/g)	Number greater than background
	Minimum detected	Maximum detected	Arithmetic mean						
Arsenic	1.1 J	8.6	4.80E+00	3.75E+00	3	3	100%	5.8	1
Phenanthrene	0.087 J	0.087 J	8.70E-02	NA	1	1	100%	NA	NA
Np-237	0.59 +/- 0.5	1.4 +/- 0.3	1.04E+00	4.12E-01	3	3	100%	NA	NA
Sr-90	0.09 +/- 0.1	0.88 +/- 0.15	5.00E-01	3.96E-01	3	3	100%	0.49	2

NA - Not applicable/available

Cs-137, Np-237, and Sr-90 were detected at activities above 1.0 pCi/g. Cs-137 activity ranged as high as 6.21±0.16 pCi/g.

The zone of contamination at CPP-14 Plant Site was assumed to be 8.2 m (27 ft) thick. This zone extends from 1.5- to 9.7-m (5.0- to 32.0-ft) bgs. The area of CPP-14 Plant Site is indicated on Figure 17-1, and measures 900 m^2 (9,860 ft^2). This area is smaller than that indicated on Figure 5-2. This reduction in size is based on below background activities/concentrations for COPCs in boring CPP-14-14A, and lack of evidence that the area between the Plant Site and Drain Field contains contaminated soil. Numerous radiological COPCs were detected in multiple Plant Site area samples. These include Cs-137, U-234, U-238, and Np-237. Of these, U-234 and U-238 were detected at the highest activities, 6.89±0.71 pCi/g and 52.1±1.97 pCi/g, respectively. Cs-137 and Sr-90 detections were also common, but at lower activities.

The zone of contamination at the drain field is assumed to extend from 4.3-m (14-ft) to 7.6-m (25- ft) bgs. The top of this interval is based on the depth of the drain field piping. The area of CPP-14 Drain Field is estimated to be 306 m^2 (3,300 ft^2), as shown on Figure 17-1. Radiological COPCs at the drain field are Np-237 and Sr-90. Of these COPCs, only Np-237 was detected above 1 pCi/g. Np-237 reached a maximum activity level of 1.4±0.3 pCi/g.

17.4 Risk Assessment

The methodology for conducting the HHRA for WAG 3 is detailed in Section 7. As presented, the purpose of the HHRA is to develop a quantitative description and assessment of the human health risk posed by the COPCs present at WAG 3. This section only contains the results of the HHRA for site CPP-14 with respect to the soil pathways. The results for the air and groundwater pathways are detailed in Sections 27.1 and 27.2, respectively. This risk assessment at this site becomes cumulative when the contributions from air and groundwater pathways are added to that from the soil pathway. The following sections discuss the complete exposure routes, exposure-point concentrations, and cancer risk and noncarcinogenic health hazard estimates for site CPP-14 under the three exposure scenarios evaluated. Section 17.4.3 explains the difference in estimating contaminant sources for use in evaluating surface exposure and fate and transport modeling to the SRPA. It also describes the use of the screened ORIGEN runs (Section 4.4) to help identify contaminants potentially missing from the contaminant inventory.

17.4.1 Complete Exposure Routes

Potentially complete pathways from the source to a human receptor are described in Section 7 and illustrated on Figure 7-1. For site CPP-14, the complete exposure routes within each pathway are summarized in Table 17-4. An exposure route is considered complete if the contaminated zone (as characterized in the previous sections and summarized on the table) occurs within the depth intervals specified for a given exposure route. All exposure routes, as described in Section 7, are considered complete for site CPP-14.

17.4.2 Exposure-Point Concentrations

Specific steps in calculating exposure-point concentrations for each of the applicable scenarios are described in Section 7. The COPC soil value used for an individual site was the smaller of the 95% upper confidence limit (UCL) or maximum concentration. The soil values for site CPP-14 were estimated using the

Table 17-4. Complete exposure routes for site CPP-14 and associated exposure route depths.

Receptor	Scenario	Potentially complete exposure routes and exposure route depths used for exposure-point concentration estimates	Characterized zone of contamination[a]	Complete exposure route?
Onsite worker	Current land use	Inhalation of VOCs	1.5 to 9.6 m	No
		[0–15 cm (0–6 in.)]	(5 to 32 ft)	No
		Inhalation of airborne particulates [0–15 cm (0–6 in.)]		No
		Ingestion of surface soil [0–15 cm (0–6 in.)]		No
		External radiation [0–1.22 m (0–4 ft)]		
Residential	Future land use	Inhalation of VOCs [0–3.05 m (0–10 ft)]	1.5 to 9.6 m	No
		Inhalation of airborne particulates [0–3.05 m (0–10 ft)]	(5 to 32 ft)	Yes
		Ingestion of surface soil [0–3.05 m (0–10 ft)]		Yes
		Ingestion of homegrown produce [0–3.05 m (0–10 ft)]		Yes
		Ingestion of groundwater		Yes
		Dermal contact with groundwater		No
		Inhalation of VOCs from groundwater		No
		External radiation [0–3.05 m (0–10 ft)]		Yes
Onsite worker	Future land use	Inhalation of VOCs [0–15 cm (0–6 in.)]	1.5 to 9.6 m	No
		Inhalation of airborne particulates [0–15 cm (0–6 in.)]	(5 to 32 ft)	No
		Ingestion of surface soil [0–15 cm (0–6 in.)]		No
		External radiation [0–1.22 m (0–4 ft)]		No

a. Zone of contamination based on the following previously characterized zones:

CPP-14 (Imhoff Tanks) = 2.4 to 3.4 m (8 to 11 ft)
CPP-14 (Plant Site) = 1.5 to 9.6 m (5 to 32 ft)
CPP-14 (Drain Field) = 4.3 to 7.6 m (14 to 25 ft).

individual site UCLs for CPP-14 (Imhoff Tanks), CPP-14 (Plant Site), and CPP-14 (Drain Field). The individual site concentration terms were used to provide an area-weighted estimate. The concentration terms for the radionuclides were adjusted to account for decay for each exposure scenario. These values were subsequently averaged over the exposure duration. The concentration terms, by depth interval, are presented in Tables 17-5 through 17-7. Exposures from all complete exposure routes were estimated based on the exposure-point concentrations, presented in Table 17-8, and homegrown produce concentrations presented in Table 17-9. The values for air and groundwater are presented in Sections 27.1 and 27.2, respectively.

17.4.3 Description of Source Estimates for Surface Exposure and Groundwater Modeling Use

The purpose for this subsection is two-fold. First, to compare the approach to defining the source estimate for use in both the surface exposure assessment and the groundwater model. This comparison was done for each subarea within this site and was accomplished by comparing the soil data in Table 17-7 to the soil data used to estimate the source for use in the groundwater model, which can be found in Tables 5-39 and 5-40 of Appendix F. The benefit of these comparisons is to relate both source estimates and explain any apparent differences. Secondly, the results of the screened ORIGEN runs summarized in Section 4.4 were used to help identify any potential soil-related data gaps by comparing ORIGEN results to the field investigation soil results at each subarea. This comparison was based on the full inventory of contaminants in the screening tables in Section 5 (Tables 5-7 through 5-9) before implementing the screening steps shown therein. The results of these comparisons are described for each site in the following paragraphs. The results of this comparison for perched water and SRPA are reported at the end of Section 4.4.

The same soil COPC's and concentrations in Table 17-7 for Imhoff sub-area of site CPP-14 were used to develop the source estimate for groundwater use with the exception of cadmium and phenanthrene which were screened in Table 5-7. Based on a comparison of the radionuclides that were analyzed in the Imhoff tanks against the potential inventory as defined by the screened ORIGEN results (Table 4-7) Eu-154 and Pu-241 were not part of the soil sampling analytical suite. The implication is that these radionuclides may be present and are currently not part of the soil contaminant inventory.

The CPP-14 Plant Site source estimate for groundwater modeling use was based on almost the same soil COPC's and concentrations in Table 17-7. The exceptions were copper, mercury, silver (mercury and silver screened out in Table 5-8), Sb-125, and U-235. The reason for this difference is that the total depth interval assumption to evaluate future residential intrusion exposure is 0 to 10 feet bgs., while the soil source estimate for groundwater use was based on all samples taken including those deeper than 10 feet. Only the concentrations for Np-237, Sb-125, U-235, and U-238 were slightly affected by these depth assumptions. Based on a comparison of the radionuclides that were analyzed in site soils against the potential inventory as defined by the screened ORIGEN results (Table 4-7) Eu-154 and Pu-241 were not part of the soil sampling analysis performed at the plant site. The implication is that these radionuclides may be present and are currently not part of the soil contaminant inventory.

The CPP-14 Drain Field source estimate for groundwater modeling was based on analytical results of soil samples collected between 15 and 43 feet bgs. Table 17-7 does not show a source to evaluate surface exposure because all measurements were taken at depths below the 0–10 foot residential intrusion depth

Table 17-5. Area-weighted soil concentrations for the CPP-14 Group (0 to 0.5 ft).

COPCs[a]	Site				Weighted average concentration (mg/kg or pCi/g)
	CPP-14 Imhoff	CPP-14 Plant	CPP-14 Drain	CPP-88	
Area (square feet)	200	9680	3300	28980	
Area (square meters)	18.58	899.32	306.59	2692.40	
Aroclor-1260	---	---	---	---	0.00E+00
Benzo(a)pyrene	---	---	---	---	0.00E+00
Aluminum	---	---	---	---	0.00E+00
Arsenic	---	---	---	---	0.00E+00
Manganese	---	---	---	---	0.00E+00
Mercury	---	---	---	---	0.00E+00
Uranium	---	---	---	---	0.00E+00
Am-241	---	---	---	---	0.00E+00
Ce-144	---	---	---	---	0.00E+00
Co-57	---	---	---	---	0.00E+00
Co-58	---	---	---	---	0.00E+00
Co-60	---	---	---	---	0.00E+00
Cs-134	---	---	---	---	0.00E+00
Cs-137	---	---	---	1.41E+01	9.72E+00
Eu-152	---	---	---	---	0.00E+00
Eu-154	---	---	---	---	0.00E+00
Eu-155	---	---	---	---	0.00E+00
H-3	---	---	---	---	0.00E+00
I-129	---	---	---	---	0.00E+00
K-40	---	---	---	---	0.00E+00
Nb-95	---	---	---	---	0.00E+00
Np-237	---	---	---	---	0.00E+00
Pu-238	---	---	---	---	0.00E+00
Pu-239/240	---	---	---	---	0.00E+00
Pu-241	---	---	---	---	0.00E+00
Pu-242	---	---	---	---	0.00E+00
Ru/Rh-106	---	---	---	---	0.00E+00
Sb-125	---	---	---	---	0.00E+00
Sr-90	---	---	---	3.55E+00	2.44E+00
Tc-99	---	---	---	---	0.00E+00
U-234	---	---	---	---	0.00E+00
U-235	---	---	---	---	0.00E+00
U-236	---	---	---	---	0.00E+00
U-238	---	---	---	---	0.00E+00

Total Group Area (ft^2) = 42160

CPP-88 area (ft^2) = 28980

a. Concentration terms are not calculated for phenanthrene because it does not have available human toxicity data.

Table 17-6. Area-weighted soil concentrations for the CPP-14 Group (0 to 4 ft).

COPCs[a]	Site				Weighted average concentration (mg/kg or pCi/g)
	CPP-14 Imhoff	CPP-14 Plant	CPP-14 Drain	CPP-88	
Area (square feet)	200	9680	3300	28980	
Area (square meters)	18.58	899.32	306.59	2692.40	
Aroclor-1260	---	1.00E-01	---	---	2.30E-02
Benzo(a)pyrene	---	---	---	---	0.00E+00
Aluminum	---	---	---	---	0.00E+00
Arsenic	---	---	---	6.43E+00	4.42E+00
Manganese	---	---	---	---	0.00E+00
Mercury	---	---	---	---	0.00E+00
Uranium	---	---	---	---	0.00E+00
Am-241	---	---	---	---	0.00E+00
Ce-144	---	---	---	---	0.00E+00
Co-57	---	---	---	---	0.00E+00
Co-58	---	---	---	---	0.00E+00
Co-60	---	---	---	---	0.00E+00
Cs-134	---	---	---	---	0.00E+00
Cs-137	---	7.70E-01	---	1.27E+01	8.90E+00
Eu-152	---	---	---	---	0.00E+00
Eu-154	---	---	---	---	0.00E+00
Eu-155	---	---	---	---	0.00E+00
H-3	---	---	---	---	0.00E+00
I-129	---	---	---	---	0.00E+00
K-40	---	---	---	---	0.00E+00
Nb-95	---	---	---	---	0.00E+00
Np-237	---	3.50E+00	---	---	8.04E-01
Pu-238	---	---	---	---	0.00E+00
Pu-239/240	---	---	---	---	0.00E+00
Pu-241	---	---	---	---	0.00E+00
Pu-242	---	---	---	---	0.00E+00
Ru/Rh-106	---	---	---	---	0.00E+00
Sb-125	---	---	---	---	0.00E+00
Sr-90	---	1.90E-01	---	2.47E+00	1.74E+00
Tc-99	---	---	---	---	0.00E+00
U-234	---	1.70E-01	---	---	3.90E-02
U-235	---	---	---	---	0.00E+00
U-236	---	---	---	---	0.00E+00
U-238	---	1.40E-01	---	---	3.21E-02

Total Group Area (ft^2) = 42160

CPP-88 area (ft^2) = 28980

a. Concentration terms are not calculated for phenanthrene because it does not have available human toxicity data.

Table 17-7. Area-weighted soil concentrations for the CPP-14 Group (0 to 10 ft).

COPCs[a]	Site				Weighted average concentration (mg/kg or pCi/g)
	CPP-14 Imhoff	CPP-14 Plant	CPP-14 Drain	CPP-88	
Area (square feet)	200	9680	3300	28980	
Area (square meters)	18.58	899.32	306.59	2692.40	
Aroclor-1260	2.30E+01	5.70E-01	---	---	2.40E-01
Benzo(a)pyrene	3.40E-01	---	---	---	1.61E-03
Aluminum	---	---	---	---	0.00E+00
Arsenic	---	---	---	5.90E+00	4.06E+00
Manganese	---	---	---	---	0.00E+00
Mercury	---	---	---	---	0.00E+00
Uranium	---	---	---	---	0.00E+00
Am-241	---	---	---	---	0.00E+00
Ce-144	---	---	---	---	0.00E+00
Co-57	---	---	---	---	0.00E+00
Co-58	---	---	---	---	0.00E+00
Co-60	---	---	---	---	0.00E+00
Cs-134	---	---	---	---	0.00E+00
Cs-137	6.21E+00	3.89E+00	---	1.18E+01	9.00E+00
Eu-152	---	---	---	---	0.00E+00
Eu-154	---	---	---	---	0.00E+00
Eu-155	---	---	---	---	0.00E+00
H-3	---	---	---	---	0.00E+00
I-129	---	---	---	---	0.00E+00
K-40	---	---	---	---	0.00E+00
Nb-95	---	---	---	---	0.00E+00
Np-237	1.98E+00	3.50E+00	---	---	8.13E-01
Pu-238	---	---	---	---	0.00E+00
Pu-239/240	---	---	---	---	0.00E+00
Pu-241	---	---	---	---	0.00E+00
Pu-242	---	---	---	---	0.00E+00
Ru/Rh-106	---	---	---	---	0.00E+00
Sb-125	---	---	---	---	0.00E+00
Sr-90	1.07E+00	5.70E-01	---	1.57E+00	1.21E+00
Tc-99	---	---	---	---	0.00E+00
U-234	---	4.30E-01	---	---	9.87E-02
U-235	5.00E-02	---	---	---	2.37E-04
U-236	---	---	---	---	0.00E+00
U-238	---	3.80E-01	---	---	8.72E-02

Total Group Area (ft^2) = 42160

CPP-88 area (ft^2) = 28980

a. Concentration terms are not calculated for phenanthrene because it does not have available human toxicity data.

Table 17-8. Average soil exposure-point concentrations (mg/kg or pCi/g) for land use scenarios.

	Current occupational worker year 0 to year 25		Future occupational worker year 100 to year 125		Future resident year 100 to year 130
COPCs	(0 - 0.5 ft)	(0 - 4 ft)	(0 - 0.5 ft)	(0 - 4 ft)	(0 - 10 ft)
Aroclor-1260	----	2.30E-02	----	2.30E-02	2.40E-01
Benzo(a)pyrene	----	----	----	----	1.61E-03
Aluminum	----	----	----	----	----
Arsenic	----	4.42E+00	----	4.42E+00	4.06E+00
Manganese	----	----	----	----	----
Mercury	----	----	----	----	----
Uranium[a]	----	9.56E-02	----	9.56E-02	2.60E-01
Am-241	----	----	----	----	----
Ce-144	----	----	----	----	----
Co-57	----	----	----	----	----
Co-58	----	----	----	----	----
Co-60	----	----	----	----	----
Cs-134	----	----	----	----	----
Cs-137	7.39E+00	6.77E+00	7.44E-01	6.81E-01	6.54E-01
Eu-152	----	----	----	----	----
Eu-154	----	----	----	----	----
Eu-155	----	----	----	----	----
H-3	----	----	----	----	----
I-129	----	----	----	----	----
K-40	----	----	----	----	----
Nb-95	----	----	----	----	----
Np-237	----	8.04E-01	----	8.04E-01	8.13E-01
Pu-238	----	----	----	----	----
Pu-239/240	----	----	----	----	----
Pu-241	----	----	----	----	----
Pu-242	----	----	----	----	----
Ru/Rh-106	----	----	----	----	----
Sb-125	----	----	----	----	----
Sr-90	1.84E+00	1.31E+00	1.70E-01	1.21E-01	7.99E-02
Tc-99	----	----	----	----	----
U-234	----	3.90E-02	----	3.90E-02	9.87E-02
U-235	----	----	----	----	2.37E-04
U-236	----	----	----	----	----
U-238	----	3.21E-02	----	3.21E-02	8.72E-02

a. mg/kg of uranium calculated from pCi/g of uranium isotopes using the equation
mg/kg = pCi/g * 2.795E-12 (mg-mole/kg-pCi-yr) * MW (g/mole) * $t_{1/2}$ (yr).

Table 17-9. Concentrations of COPCs in homegrown produce.

COPCs	Homegrown produce (mg/kg or pCi/g)	Kd (cm^3/g)	COPC input rate from irrigation (mg/g-d or pCi/g-d)	Leach rate constant (d^{-1})
Aroclor-1260	9.37E-04	7.89E+03	0.00E+00	9.95E-07
Benzo(a)pyrene	1.95E-05	1.19E+03	0.00E+00	6.57E-06
Aluminum	---	0.00E+00	0.00E+00	2.87E-02
Arsenic	1.40E-04	3.00E+00	8.71E-09	2.40E-03
Manganese	---	5.00E+01	0.00E+00	1.56E-04
Mercury	1.10E-01	1.00E+02	2.91E-08	7.83E-05
Uranium	7.30E-05	6.00E+00	7.04E-09	1.25E-03
Am-241	7.76E-06	3.40E+02	6.08E-06	2.31E-05
Ce-144	---	5.00E+02	0.00E+00	1.57E-05
Co-57	---	1.00E+01	0.00E+00	7.64E-04
Co-58	---	1.00E+01	0.00E+00	7.64E-04
Co-60	---	1.00E+01	0.00E+00	7.64E-04
Cs-134	---	5.00E+02	0.00E+00	1.57E-05
Cs-137	2.51E-03	5.00E+02	4.12E-05	1.57E-05
Eu-152	---	3.40E+02	0.00E+00	2.31E-05
Eu-154	---	3.40E+02	0.00E+00	2.31E-05
Eu-155	---	3.40E+02	0.00E+00	2.31E-05
H-3	---	0.00E+00	6.22E-04	2.87E-02
I-129	3.85E-06	0.00E+00	3.26E-05	2.87E-02
K-40	---	1.50E+01	0.00E+00	5.14E-04
Nb-95	---	0.00E+00	0.00E+00	2.87E-02
Np-237	3.16E-04	0.00E+00	8.36E-06	2.87E-02
Pu-238	---	2.20E+01	0.00E+00	3.53E-04
Pu-239/240	5.15E-06	2.20E+01	5.84E-07	3.53E-04
Pu-241	8.49E-09	2.20E+01	9.37E-08	3.53E-04
Pu-242	3.60E-09	2.20E+01	3.88E-10	3.53E-04
Ru/Rh-106	---	0.00E+00	0.00E+00	2.87E-02
Sb-125	---	5.00E+01	0.00E+00	1.56E-04
Sr-90	8.41E-03	1.20E+01	5.63E-05	6.40E-04
Tc-99	4.56E-01	0.00E+00	1.67E-04	2.87E-02
U-234	1.28E-04	6.00E+00	2.63E-06	1.25E-03
U-235	1.20E-06	6.00E+00	9.27E-08	1.25E-03
U-236	6.93E-07	6.00E+00	6.68E-08	1.25E-03
U-238	1.13E-04	6.00E+00	2.35E-06	1.25E-03

assumption. Based on a comparison of the radionuclides that were analyzed in site soils against the potential inventory as defined by the high enrichment ORIGEN run (Table 4-7), Eu-154 and Pu-241 were not part of the soil sampling analysis performed at the drain field. The implication is that these radionuclides may be present and are currently not part of the soil contaminant inventory.

17.4.4 Risk Estimates

The results of this evaluation under current and future land use are presented in Sections 17.4.4.1 and 17.4.4.2. For each receptor, the results are summarized in Tables 17-10 through 17-15.

17.4.4.1 Current Land Use. As indicated in Table 17-10, total cancer risk to the current onsite worker from exposure to site-related chemicals in surface soil is estimated to be 4E-06. The risk is attributed to external radiation exposure. The primary contaminants of concern (COCs) for this exposure route are Cs-137 (2E-06) and Np-237 (2E-06). Table 17-11 indicates that the total noncarcinogenic hazard index to the current worker is estimated to be 0E+00.

17.4.4.2 Future Land Use. As Table 17-12 indicates, the total cancer risk to the future onsite worker from exposure to site-related chemicals in surface soil is estimated to be 2E-06. The risk is attributed to external radiation exposure, with the primary COC being Np-237 (2E-06). Table 17-13 indicates the total noncarcinogenic hazard index to the future onsite worker is estimated to be 0E+00. As indicated in Table 17-14, the total cancer risk to the future resident from exposure to site-related chemicals in soil is estimated to be 2E-05 at CPP-14 . The primary COCs applicable to the soil ingestion exposure route are Aroclor 1260 (3E-06). The major contributors to the ingestion of homegrown produce exposure route is Aroclor-1260 (8E-07). The primary contributors to the risk associated with external radiation exposure are Cs-137 (4E-06) and Np-237 (1E-05). As shown on Table 17-15, the total noncarcinogenic hazard index to the future resident is estimated to be 1E-01 at CPP-14.

17.5 Uncertainties

This section describes the limitations and uncertainties specific to the site characterization of the site CPP-14. Sources of uncertainty associated with site characterization include data quality, COPC identification, concentration term estimation, and assumptions regarding the lateral and vertical extent of COPC occurrence. In the risk assessment, the most significant uncertainties are due to the selection process of COPCs, the toxicity values used, and the assumptions used during the exposure assessment. The following paragraphs will discuss important sources of site-specific uncertainty in greater detail.

Sampling and analysis uncertainties are related to quality problems that may result in qualified and rejected results (Section 3.5). Qualified results are considered estimates of the concentration in the sample and, for all practical purposes, useable for their intended purpose although they could be biased high or low. Rejected results are considered unusable, thus limiting the size of the useable data set. For the site CPP-14, no data points were rejected based on the method validation as documented in the Limitations and Validation (L&V) Reports, thus making this possible source of uncertainty insignificant.

Uncertainty associated with the chemical screening process (Section 5.2) results from using the maximum concentration for chemicals detected in the Environmentally Controlled Areas (ECAs) in the

Table 17-10. Soil pathway cancer risk to the current onsite worker. [a]

COPCs	Ingestion of soil	External radiation exposure	Total risks
Aroclor-1260	----	----	----
Benzo(a)pyrene	----	----	----
Aluminum	----	----	----
Arsenic	----	----	----
Manganese	----	----	----
Mercury	----	----	----
Uranium	----	----	----
Am-241	----	----	----
Ce-144	----	----	----
Co-57	----	----	----
Co-58	----	----	----
Co-60	----	----	----
Cs-134	----	----	----
Cs-137	----	2E-06	2E-06
Eu-152	----	----	----
Eu-154	----	----	----
Eu-155	----	----	----
H-3	----	----	----
I-129	----	----	----
K-40	----	----	----
Nb-95	----	----	----
Np-237	----	2E-06	2E-06
Pu-238	----	----	----
Pu-239/240	----	----	----
Pu-241	----	----	----
Pu-242	----	----	----
Ru/Rh-106	----	----	----
Sb-125	----	----	----
Sr-90	----	NTD	----
Tc-99	----	----	----
U-234	----	5E-12	5E-12
U-235	----	----	----
U-236	----	----	----
U-238	----	1E-08	1E-08
Total cancer risks by route:	0E+00	4E-06	4E-06

"----" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 17-11. Soil pathway noncarcinogenic hazard to the current onsite worker.[a,b]

COPCs	Ingestion of soil	External radiation exposure	Total HIs
Aroclor-1260	---	---	---
Benzo(a)pyrene	---	---	---
Aluminum	---	---	---
Arsenic	---	---	---
Manganese	---	---	---
Mercury	---	---	---
Uranium	---	---	---
Am-241	---	---	---
Ce-144	---	---	---
Co-57	---	---	---
Co-58	---	---	---
Co-60	---	---	---
Cs-134	---	---	---
Cs-137	---	---	---
Eu-152	---	---	---
Eu-154	---	---	---
Eu-155	---	---	---
H-3	---	---	---
I-129	---	---	---
K-40	---	---	---
Nb-95	---	---	---
Np-237	---	---	---
Pu-238	---	---	---
Pu-239/240	---	---	---
Pu-241	---	---	---
Pu-242	---	---	---
Ru/Rh-106	---	---	---
Sb-125	---	---	---
Sr-90	---	---	---
Tc-99	---	---	---
U-234	---	---	---
U-235	---	---	---
U-236	---	---	---
U-238	---	---	---
Total hazard indices by route:	0E+00	0E+00	0E+00

"---" indicates that the contaminant is not a COPC in the medium, or at the site.
NTD indicates that toxicity data is not available.
a. All noncarcinogenic contamination at CPP-14 is buried deeper than 0.5 ft bls, so there is no calculated hazard index for workers at the site.
b. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 17-12. Soil pathway cancer risk to the future onsite worker. [a]

COPCs	Ingestion of soil	External radiation exposure	Total risks
Aroclor-1260	---	---	---
Benzo(a)pyrene	---	---	---
Aluminum	---	---	---
Arsenic	---	---	---
Manganese	---	---	---
Mercury	---	---	---
Uranium	---	---	---
Am-241	---	---	---
Ce-144	---	---	---
Co-57	---	---	---
Co-58	---	---	---
Co-60	---	---	---
Cs-134	---	---	---
Cs-137	---	2E-07	2E-07
Eu-152	---	---	---
Eu-154	---	---	---
Eu-155	---	---	---
H-3	---	---	---
I-129	---	---	---
K-40	---	---	---
Nb-95	---	---	---
Np-237	---	2E-06	2E-06
Pu-238	---	---	---
Pu-239/240	---	---	---
Pu-241	---	---	---
Pu-242	---	---	---
Ru/Rh-106	---	---	---
Sb-125	---	---	---
Sr-90	---	NTD	---
Tc-99	---	---	---
U-234	---	5E-12	5E-12
U-235	---	---	---
U-236	---	---	---
U-238	---	1E-08	1E-08
Total cancer risks by route:	0E+00	2E-06	2E-06

"---" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 17-13. Soil pathway noncarcinogenic hazard to the future onsite worker.[a,b]

COPCs	Ingestion of soil	External radiation exposure	Total HIs
Aroclor-1260	----	----	----
Benzo(a)pyrene	----	----	----
Aluminum	----	----	----
Arsenic	----	----	----
Manganese	----	----	----
Mercury	----	----	----
Uranium	----	----	----
Am-241	----	----	----
Ce-144	----	----	----
Co-57	----	----	----
Co-58	----	----	----
Co-60	----	----	----
Cs-134	----	----	----
Cs-137	----	----	----
Eu-152	----	----	----
Eu-154	----	----	----
Eu-155	----	----	----
H-3	----	----	----
I-129	----	----	----
K-40	----	----	----
Nb-95	----	----	----
Np-237	----	----	----
Pu-238	----	----	----
Pu-239/240	----	----	----
Pu-241	----	----	----
Pu-242	----	----	----
Ru/Rh-106	----	----	----
Sb-125	----	----	----
Sr-90	----	----	----
Tc-99	----	----	----
U-234	----	----	----
U-235	----	----	----
U-236	----	----	----
U-238	----	----	----
Total hazard indices by route:	0E+00	0E+00	0E+00

"----" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. All noncarcinogenic contamination at CPP-14 is buried deeper than 0.5 ft bls, so there is no calculated hazard index for workers at the site.
b. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 17-14. Soil pathway cancer risk to the future onsite resident. [a]

COPCs	Ingestion of soil	Ingestion of homegrown	External radiation exposure	Total risks
Aroclor-1260	3E-06	8E-07	—	4E-06
Benzo(a)pyrene	2E-08	2E-08	—	3E-08
Aluminum	—	—	—	—
Arsenic	—	2E-08	—	2E-08
Manganese	—	—	—	—
Mercury	—	NTD	—	—
Uranium	—	NTD	—	—
Am-241	—	4E-10	—	4E-10
Ce-144	—	—	—	—
Co-57	—	—	—	—
Co-58	—	—	—	—
Co-60	—	—	—	—
Cs-134	—	—	—	—
Cs-137	3E-09	1E-08	4E-06	4E-06
Eu-152	—	—	—	—
Eu-154	—	—	—	—
Eu-155	—	—	—	—
H-3	—	—	—	—
I-129	—	1E-10	—	1E-10
K-40	—	—	—	—
Nb-95	—	—	—	—
Np-237	3E-07	2E-08	1E-05	1E-05
Pu-238	—	—	—	—
Pu-239/240	—	3E-10	—	3E-10
Pu-241	—	5E-13	—	5E-13
Pu-242	—	2E-13	—	2E-13
Ru/Rh-106	—	—	—	—
Sb-125	—	—	—	—
Sr-90	6E-10	8E-08	NTD	8E-08
Tc-99	—	1E-07	—	1E-07
U-234	6E-09	1E-09	6E-11	7E-09
U-235	1E-11	1E-11	2E-09	2E-09
U-236	—	5E-12	—	5E-12
U-238	7E-09	1E-09	1E-07	1E-07
Total cancer risks by route:	3E-06	1E-06	1E-05	2E-05

"—" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 17-15. Soil pathway noncarcinogenic hazard to the future onsite resident. [a]

COPCs	Ingestion of soil	Ingestion of homegrown	External radiation exposure	Total HIs
Aroclor-1260	NTD	NTD	—	—
Benzo(a)pyrene	NTD	NTD	—	—
Aluminum	—	—	—	—
Arsenic	—	1E-04	—	1E-04
Manganese	—	—	—	—
Mercury	—	1E-01	—	1E-01
Uranium	—	6E-06	—	6E-06
Am-241	—	—	—	—
Ce-144	—	—	—	—
Co-57	—	—	—	—
Co-58	—	—	—	—
Co-60	—	—	—	—
Cs-134	—	—	—	—
Cs-137	—	—	—	—
Eu-152	—	—	—	—
Eu-154	—	—	—	—
Eu-155	—	—	—	—
H-3	—	—	—	—
I-129	—	—	—	—
K-40	—	—	—	—
Nb-95	—	—	—	—
Np-237	—	—	—	—
Pu-238	—	—	—	—
Pu-239/240	—	—	—	—
Pu-241	—	—	—	—
Pu-242	—	—	—	—
Ru/Rh-106	—	—	—	—
Sb-125	—	—	—	—
Sr-90	—	—	—	—
Tc-99	—	—	—	—
U-234	—	—	—	—
U-235	—	—	—	—
U-236	—	—	—	—
U-238	—	—	—	—
Total hazard indices by route:	0E+00	1E-01	0E+00	1E-01

"—" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

background comparison step, retaining chemicals detected as COPCs because there is not a corresponding background value, and retaining chemicals as COPCs for which there is no toxicity information available.

In most cases, the COPC identification process used the maximum concentration for a chemical detected in the background comparison step, regardless of its magnitude above background. The use of the maximum concentration can result in the identification of COPCs that have concentrations only slightly above background. For the site CPP-14, none of the COPCs fell into this category.

Another source of uncertainty related to the background comparison step in the chemical screening process relates to chemicals for which no background concentration exists. For example, fluoride, nitrate, and several radionuclides were not characterized as part of the Rood et al. 1995 background study. For site CPP-14, the following COPCs have no corresponding background concentration: Np-237, Sb-125, and U-235. This results in an increase in the number of COPCs considered in the remedial investigation/ Baseline Risk Assessment (RI/BRA) and a possible overestimation of risk because the observed concentrations may be within the background population.

For site CPP-14, phenanthrene was retained as a COPC for the RI/BRA. There are no toxicity values in Integrated Risk Information System (IRIS), Health Effects Assessment Summary Tables (HEAST), or EPA Region III publications for phenanthrene. Phenanthrene was detected at a maximum concentration of 0.37 mg/kg in soils. Phenanthrene is used in dyestuffs, explosives, synthesis of drugs, biochemical research, and manufacturing phenanthrenequinone. Phenanthrene is a possible carcinogen; however, sufficient data are currently not available to derive a toxicity value. Therefore, exclusion of phenanthrene possibly underestimates the risk; however, specific contribution can not be quantified.

Some concentration estimates are based on the 95% UCL for the site, or the area-weighted average 95% UCLs for sites that have been grouped. When the 95% UCL (i.e., the concentration term estimate) of a COPC is below the corresponding background value, this results in an increase in the number of COPCs in the RI/BRA and a possible overestimation of risk because the results are likely within the background range. This source of uncertainty stems from the use of maximum concentrations when identifying the COPCs for a specific sites. For site CPP-14, the following COPC concentration estimates were below background but included as COPCs in the RI/BRA: Cs-137, Sr-90, U-234, and U-238 [for the 0 to 1.22-m (0 to 4-ft) interval].

With respect to characterization, the lateral and vertical extent of contamination in the Imhoff Tanks portion of CPP-14 is based on the assumption that no leakage from the tanks has occurred. This assumption has not been verified by soil borings either adjacent to or beneath the tanks. If leakage has occurred from the tanks, the affected soil mass is currently underestimated. Additionally, the lateral extent of contamination is not precisely delineated, as some borings in the proximity to the ECA boundary contain COPCs at levels above background. The zone of contamination is assumed to extend to 9.8-m (32-ft) bgs. This is based on results from four borings. Two of these borings contain COPCs at levels above background at depths of 9.8 and 11.6 m (32 and 38 ft), while the remaining two borings show COPC levels below background at depths of 9.1 and 11.0 m (30 and 36 ft). The current assumption as to the depth of the zone of contamination may either overestimate or underestimate the true mass of affected soil. For the drain field, the precise lateral and vertical extent of contamination is unknown. The current ECA boundary is based on the extent of piping associated with the drain field, however the extent of contamination has not been confirmed with soil borings. This may lead to either an overestimation or underestimation of the true mass of affected soil.

A source of uncertainty may be associated with the contaminant inventories used for the groundwater modeling are residential intrusion exposure at each sub-area. Section 17.4.3 identifies radionuclides potentially missing from these inventories. The implication of these potential data gaps is that the source estimates could be underestimated. The potentially missing Eu-154 and Pu-241 have half-lives of 8.6 and 14.7 years, respectively, and therefore are not expected to be of concern to groundwater or surface exposure beyond the year 2095. The uncertainty is recognized in this report, but no information is available to quantify this uncertainty.

17.6 Conclusions and Recommendations

The results of the risk assessment under current land use at CPP-14 indicate that the increased cancer risk from exposure to site-related contaminants is within the EPA-recommended target range. The increased cancer risk to hypothetical future onsite workers and residents were found to be within the EPA target range. The noncarcinogenic hazard for all receptors was found to be well below the EPA hazard index goal of one. These estimates do not include the contributions associated with the air and groundwater pathways. The total increased cancer and hazard incidence to humans is reported in Section 27. The risk estimates at this site are likely to be overestimated for reasons described in Sections 7 and 17.5 of this report. Despite the slightly elevated risk estimates at this site, future response actions to mitigate adverse impacts to human health and the environment are not warranted within any of the areas of this site.

17.7 References

Golder Associates, 1991, *Report on Surface Geophysical Surveys at the Idaho Chemical Processing Plant*, Golder Associates Inc., Richland/Redmond, Washington.

WINCO, 1993, *Track 2 Summary Report WAG 3 OU 3-05 Old Sewage Treatment Plant West of CPP-664.*

Chapter 18

18. SITE CPP-34 RESULTS

Site CPP-34 consists of low-level, radioactively-contaminated soil that was buried in three trenches in the northeast corner of the ICPP (Figure 5-2). This section describes the nature and concentrations of contaminants of potential concern (COPCs) in the buried soil and evaluates the risk to human health.

18.1 Site Description

In the summer of 1983, about 9,180 m^3 (12,000 yd^3) of contaminated soil was excavated from around the WL-102 tank and stockpiled at a site to the east of building CPP-603. According to the environmental evaluation report (WINCO, 1984), the external exposure readings from the contaminated soil were generally 2 to 3 mR/hr, with maximum readings of less than 30 mR/hr. In August and September 1984, the pile of contaminated soil was removed from the location east of CPP-603 and buried in three trenches in the northeastern corner of the ICPP plant, situated between the animal (outer) and security (inner) fences (Figure 18-1). The trenches are situated parallel to the animal fences; one in an east-west direction, that abuts to one of the other two trenches that are parallel to the fence in a north-south direction (Figure 18-1). The dimensions of the trenches are 13.7-m (45-ft) wide at the top, 7.6-m (25-ft) wide at the bottom, and approximately 4.3- to 4.9-m (14- to 16-ft) deep. The length of the trenches are 126 m (413 ft), 122 m (400 ft), and 74 m (242 ft). It was reported in the Track 1 (WINCO, 1993) that at the time of disposal, the contaminated soil in the trenches was covered with approximately 0.6 m (2 ft) of clean soil.

18.2 Investigative Results

A radiological survey was conducted before moving the contaminated soil to the CPP-34 trenches. Radionuclides in the contaminated soil included Co-60, Cs-137, Eu-154, Eu-155, Sr-90, Pu-238, and Pu-239/240. Ninety-nine percent of the sample activity was due to the presence of Cs-137 and Sr-90. External exposure readings from the soil averaged 2 to 3 mR/hr at 10 cm (4 in.), with maximum readings of less than 30 mR/hr. In addition to the radionuclides detected in the soil, other radionuclides potentially associated with Tank Farm wastes include antimony, neptunium, americium, uranium, and iodine (WINCO, 1989).

Four borings (CPP-34-01 through CPP-34-04) were drilled through the trench backfill at the locations shown on Figure 18-1. The borings were drilled in January of 1990. Samples were collected continuously from the ground surface to a depth of 6.1 m (20 ft). Samples were collected with a California split spoon sampler except for the 0- to 0.6-m (0- to 2-ft) interval where grab samples were collected from the cuttings due to frozen ground. Samples collected in borings CPP-34-01, -03, and -04 were analyzed for radionuclides, inorganics, and a target list of volatile organic compounds (VOCs). Samples from boring CPP-34-02 were analyzed for radionuclides, inorganics, a full suite of VOCs and semivolatile organic compounds (SVOCs), organochlorine pesticides, polychlorinated biphenyls (PCBs), herbicides, and dioxins. The results were reported in the *Report for the Idaho Chemical Processing Plant Drilling and Sampling at Land Disposal Unit CPP-34* (Golder Associates, 1990) and are summarized on Table 18-1. Contaminants of potential concern (COPCs) identified for the site in the chemical screening process (Section 5.2) include Cs-137, Np-237, Pu-238, Sr-90, U-234, U-238, and arsenic.

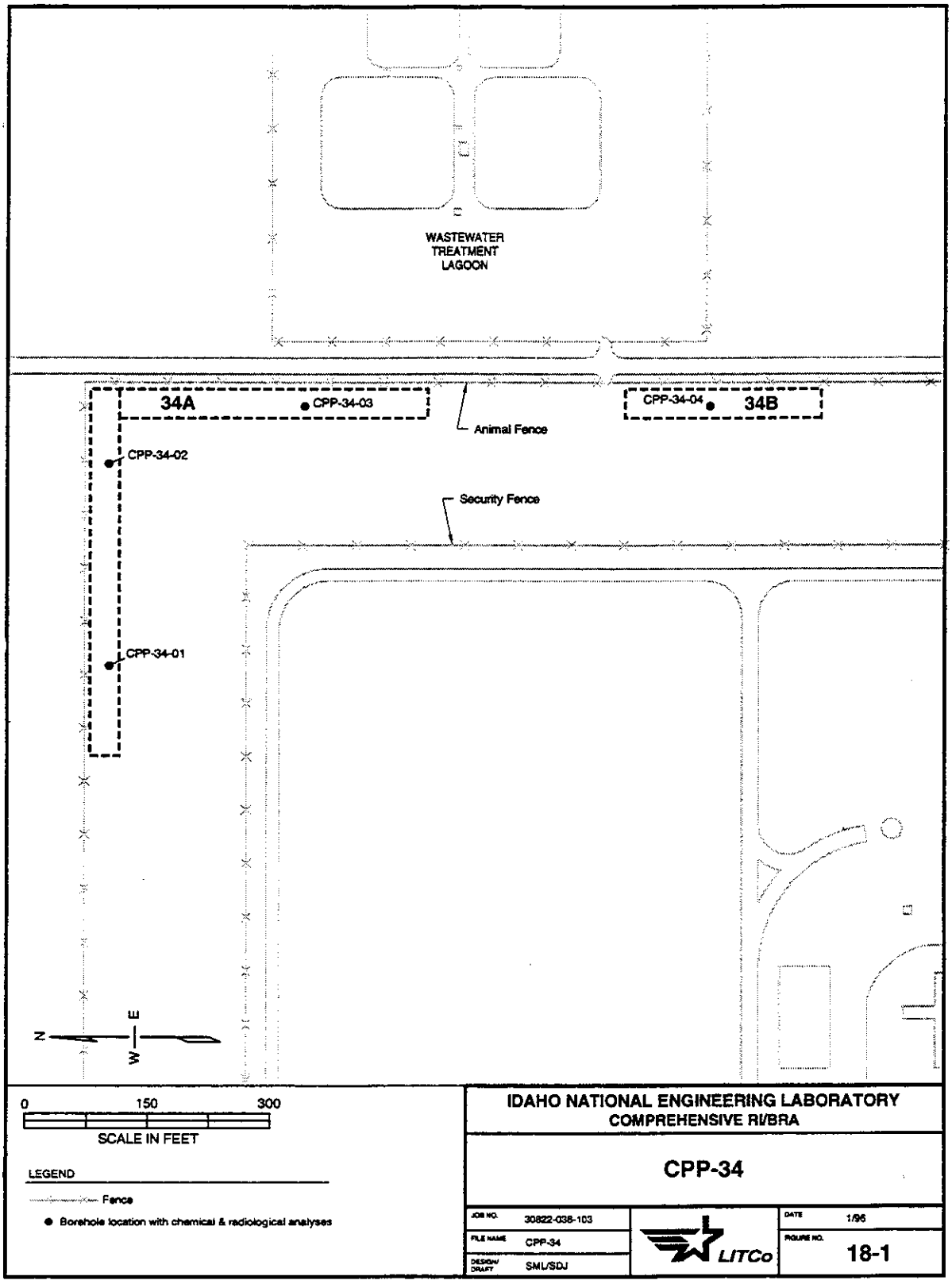


Figure 18-1. CPP-34 and borehole locations.

Table 18-1. Summary statistics for CPP-34, soil storage area in the northeast corner of the ICPP.

COPCs	Concentration (mg/kg or pCi/g) Minimum detected	Maximum detected	Arithmetic mean	Standard deviation	Number of samples	Number of detects	Frequency of detection	INEL background (mg/kg or pCi/g)	Number greater than background
Arsenic	1.5	7.1	3.96E+00	1.86E+00	20	20	100%	5.8	3
Cs-137	1.1 +/- 0.2	2000 +/- 200	3.96E+02	6.13E+02	20	16	80%	0.82	16
Np-237	0.7 +/- 0.2	0.7 +/- 0.2	7.00E-01	NA	20	1	5%	NA	NA
Pu-238	5.1 +/- 1.1	5.1 +/- 1.1	5.10E+00	NA	20	1	5%	0.0049	1
Sr-90	1.6 +/- 0.4	6000 +/- 600	8.13E+02	1.49E+03	20	19	95%	0.49	17
U-234	1.1 +/- 0.3	2.5 +/- 0.8	1.47E+00	4.40E-01	20	8	40%	1.44	2
U-238	1 +/- 0.4	2.8 +/- 0.7	1.71E+00	6.45E-01	20	9	45%	1.4	5

NA - Not applicable/available

Review of the data indicates the only inorganics detected above background concentrations in the samples were arsenic, lead, and mercury. Arsenic was detected in three of 20 samples at concentrations just above background. Lead was detected above the background concentration of 17 mg/kg (Rood et al., 1995) in two samples from depths of 1.8 to 2.4 m (6 to 8 ft) in borings CPP-34-03 and -04. The highest lead concentration (132 mg/kg) is below the 400 ppm preliminary remediation goal (PRG) for lead in soil for residential land use (EPA, 1994). Mercury was detected above background in two of 20 samples with a maximum concentration of 0.6 mg/kg.

Radionuclides detected in the samples at concentrations above background include Cs-137, Pu-238, Sr-90, U-234, and U-238. Pu-238 and Np-237 were detected in only one sample each. Pu-238 was detected in the 4.3- to 4.9-m (14- to 16-ft) sample from boring CPP-34-01. U-234 and U-238 were each detected in several samples at concentrations near or just above background. Cs-137 and Sr-90 were detected in the highest concentrations. Sr-90 was detected above background in all but one sample from all four borings with detected concentrations ranging from 2.0±0.5 to 6,000±600 pCi/g concentrations. Cs-137 was detected above background in all five samples from borings CPP-34-02 and -03, with the uppermost four samples from boring CPP-34-01 and the upper two samples from boring CPP-34-04. Detected concentrations of Cs-137 ranged from 1.1±0.2 to 2,000±200 pCi/g. The highest Cs-137 and Sr-90 concentrations were in samples collected between 1.8 to 3.7 m (6 to 12 ft) in borings CPP-34-02, -03, and -04. Relatively high Cs-137 and Sr-90 concentrations extended down to include the 4.3- to 4.9-m (14- to 16-ft) sample in boring CPP-34-01.

18.3 Nature and Extent of Contamination

Based on the investigative results, the primary COPCs at this site are Cs-137 and Sr-90. These COPCs were detected at concentrations well above background in the soil backfilled in the trenches. Highest concentrations of these radionuclides are primarily at depths between 1.8 to 3.7 m (6 to 12 ft) and extend downward to 4.9 m (16 ft) in the area of boring CPP-34-01. Concentrations of these radionuclides decrease with depth but are still above background at 5.5 to 6.1 m (18 to 20 ft) in most areas. Although the contaminated soil in the trenches was reportedly covered with 0.6 m (2 ft) of clean fill, concentrations of Cs-137 and Sr-90 are above background in surficial soil at all four boring locations. The zone of contamination assumed for this site is from 0 to 6.1 m (0 to 20 ft). The volume of contaminated soil was estimated to be 20,912 m^3 (738,500 ft^3) for the purpose of calculating a source term for the model using the reported dimensions of the trenches. An average width of the trench [10.7 m (35 ft)] was used as the width of the trench varied from 13.7 m (45 ft) to 7.6 m (25 ft).

18.4 Risk Assessment

The methodology for conducting the human health risk assessment (HHRA) for WAG 3 is detailed in Section 7. As presented, the purpose of the HHRA is to develop a quantitative description and assessment of the human health risk posed by the COPCs present at WAG 3. This section only contains the results of the HHRA for site CPP-34 with respect to the soil pathways. The results for the air and ground water pathways are detailed in Sections 27.1 and 27.2, respectively. The risk assessment at this site becomes cumulative when the contribution from the air and groundwater pathways are added to that from the soil pathway. The following sections discuss the complete exposure routes, exposure-point concentrations, and cancer risk and noncarcinogenic health hazard estimates for site CPP-34 under the three exposure scenarios evaluated.

Section 18.4.3 explains the difference in estimating sources of contamination for use in evaluating surface exposure and groundwater modeling. It also describes the use of the screened ORIGEN runs (Section 4.4) to help identify contaminants potentially missing from the soil source estimate.

18.4.1 Complete Exposure Routes

Potentially complete pathways from the source to a human receptor are described in Section 7 and illustrated on Figure 7-1. For site CPP-34, the complete exposure routes within each pathway are summarized in Table 18-2. An exposure route is considered complete if the contaminated zone (as characterized in the previous sections) occurs within the depth intervals specified for a given exposure route. All exposure routes were evaluated for site CPP-34.

18.4.2 Exposure-Point Concentrations

Specific steps in calculating exposure-point concentrations for each of the applicable scenarios are described in Section 7. The COPC soil value used was the smaller of the 95% upper confidence limit (UCL) or maximum concentration. The concentration terms for the radionuclides were adjusted to account for decay for each exposure scenario. These values were subsequently averaged over the exposure duration. The concentration terms, by depth interval, are presented in Table 18-3. Exposures from all complete exposure routes were estimated based on the exposure-point concentrations in Table 18-4. Homegrown produce concentrations are presented in Table 18-5. The values for air and ground water are presented in Sections 27.1 and 27.2, respectively.

18.4.3 Description of Source Estimates for Surface Exposure and Groundwater Modeling Use

The purpose for this subsection is two-fold. First, to compare the approach to defining the source estimate for use in both the surface exposure assessment and the groundwater model. This comparison was accomplished by comparing the soil data in Table 18-3 to the soil data used to estimate the source for use in the groundwater model, which can be found in Tables 5-39 and 5-40 of Appendix F. The benefit of these comparisons is to relate both source estimates and explain any apparent differences. Secondly, the results of the screened ORIGEN runs summarized in Section 4.4 were used to help identify any potential soil-related data gaps by comparing ORIGEN results to the field investigation soil results at this site. This comparison was based on the full inventory of contaminants in screening Table 5-11 before implementing screening steps shown therein. The results of these comparisons are described for each site in the following paragraphs. The results of this comparison for perched water and SRPA are reported at the end of Section 4.4.

The CPP-34 source estimate for groundwater use was based on almost the same soil COPC's in Table 18-3. Pu-238 was included in the groundwater source but not in the surface exposure source. Also, some of the concentrations varied slightly because the total depth interval assumption to evaluate future residential intrusion exposure is 0 to 10 feet bgs., while the soil source estimate for groundwater included the use of measurements at depths greater than 10 feet. Based on a comparison of the radionuclides that were analyzed in site soils against the potential inventory as defined by the screened ORIGEN results (Table 4-7), Am-241, Eu-154, Pu-239/240, and Pu-241, were not part of the soil sampling

Table 18-2. Complete exposure routes for CPP-34 associated exposure route depths.

Receptor	Scenario	Potentially complete exposure routes and exposure route depths used for exposure-point concentration estimates	Characterized zone of contamination	Complete exposure route?
Onsite worker	Current land use	Inhalation of VOCs [0–15 cm (0–6 in.)]	0 to 6.1 m (0 to 20 ft)	No
		Inhalation of airborne particulates [0–15 cm (0–6 in.)]		Yes
		Ingestion of surface soil [0–15 cm (0–6 in.)]		Yes
		External radiation [0–1.22 m (0–4 ft)]		Yes
Residential	Future land use	Inhalation of VOCs [0–3.05 m (0–10 ft)]	0 to 6.1 m (0 to 20 ft)	No
		Inhalation of airborne particulates [0–3.05 m (0–10 ft)]		Yes
		Ingestion of surface soil [0–3.05 m (0–10 ft)]		Yes
		Ingestion of homegrown produce [0–3.05 m (0–10 ft)]		Yes
		Ingestion of ground water		No
		Dermal contact with ground water		No
		Inhalation of VOCs from ground water		Yes
		External radiation [0–3.05 m (0–10 ft)]		
Onsite worker	Future land use	Inhalation of VOCs [0–15 cm (0–6 in.)]	0 to 6.1 m (0 to 20 ft)	No
		Inhalation of airborne particulates [0–15 cm (0–6 in.)]		Yes
		Ingestion of surface soil [0–15 cm (0–6 in.)]		Yes
		External radiation [0–1.22 m (0–4 ft)]		Yes

Table 18-3. Soil concentration terms by depth interval.

COPCs	Soil concentrations (mg/kg or pCi/g) (0 - 0.5 ft)	(0 - 4 ft)	(0 - 10 ft)
Aroclor-1260	----	----	----
Benzo(a)pyrene	----	----	----
Aluminum	----	----	----
Arsenic	5.90E+00	5.90E+00	7.10E+00
Manganese	----	----	----
Mercury	----	----	----
Uranium[a]	4.46E+00	4.46E+00	4.14E+00
Am-241	----	----	----
Ce-144	----	----	----
Co-57	----	----	----
Co-58	----	----	----
Co-60	----	----	----
Cs-134	----	----	----
Cs-137	7.00E+00	7.00E+00	2.00E+03
Eu-152	----	----	----
Eu-154	----	----	----
Eu-155	----	----	----
H-3	----	----	----
I-129	----	----	----
K-40	----	----	----
Nb-95	----	----	----
Np-237	----	----	4.08E-01
Pu-238	----	----	----
Pu-239/240	----	----	----
Pu-241	----	----	----
Pu-242	----	----	----
Ru/Rh-106	----	----	----
Sb-125	----	----	----
Sr-90	2.70E+01	2.70E+01	6.00E+03
Tc-99	----	----	----
U-234	----	----	1.30E+00
U-235	----	----	----
U-236	----	----	----
U-238	1.50E+00	1.50E+00	1.39E+00

a. mg/kg of uranium calculated from pCi/g of uranium isotopes using the equation
mg/kg = pCi/g * 2.795E-12 (mg-mole/kg-pCi-yr) * MW (g/mole) * $t_{1/2}$ (yr).

Table 18-4. Average soil exposure-point concentrations (mg/kg or pCi/g) for land use scenarios.

	Current occupational worker year 0 to year 25		Future occupational worker year 100 to year 125		Future resident year 100 to year 130
COPCs	(0 - 0.5 ft)	(0 - 4 ft)	(0 - 0.5 ft)	(0 - 4 ft)	(0 - 10 ft)
Aroclor-1260	----	----	----	----	----
Benzo(a)pyrene	----	----	----	----	----
Aluminum	----	----	----	----	----
Arsenic	5.90E+00	5.90E+00	5.90E+00	5.90E+00	7.10E+00
Manganese	----	----	----	----	----
Mercury	----	----	----	----	----
Uranium[a]	4.46E+00	4.46E+00	4.46E+00	4.46E+00	4.14E+00
Am-241	----	----	----	----	----
Ce-144	----	----	----	----	----
Co-57	----	----	----	----	----
Co-58	----	----	----	----	----
Co-60	----	----	----	----	----
Cs-134	----	----	----	----	----
Cs-137	5.33E+00	5.33E+00	5.36E-01	5.36E-01	1.45E+02
Eu-152	----	----	----	----	----
Eu-154	----	----	----	----	----
Eu-155	----	----	----	----	----
H-3	----	----	----	----	----
I-129	----	----	----	----	----
K-40	----	----	----	----	----
Nb-95	----	----	----	----	----
Np-237	----	----	----	----	4.08E-01
Pu-238	----	----	----	----	----
Pu-239/240	----	----	----	----	----
Pu-241	----	----	----	----	----
Pu-242	----	----	----	----	----
Ru/Rh-106	----	----	----	----	----
Sb-125	----	----	----	----	----
Sr-90	2.03E+01	2.03E+01	1.88E+00	1.88E+00	3.96E+02
Tc-99	----	----	----	----	----
U-234	----	----	----	----	1.30E+00
U-235	----	----	----	----	----
U-236	----	----	----	----	----
U-238	1.50E+00	1.50E+00	1.50E+00	1.50E+00	1.39E+00

a. mg/kg of uranium calculated from pCi/g of uranium isotopes using the equation
mg/kg = pCi/g * 2.795E-12 (mg-mole/kg-pCi-yr) * MW (g/mole) * $t_{1/2}$ (yr).

Table 18-5. Concentrations of COPCs in homegrown produce.

COPCs	Homegrown produce (mg/kg or pCi/g)	Kd (cm^3/g)	COPC input rate from irrigation (mg/g-d or pCi/g-d)	Leach rate constant (d^{-1})
Aroclor-1260	—	7.89E+03	0.00E+00	9.95E-07
Benzo(a)pyrene	—	1.19E+03	0.00E+00	6.57E-06
Aluminum	—	0.00E+00	0.00E+00	2.87E-02
Arsenic	1.09E-02	3.00E+00	8.71E-09	2.40E-03
Manganese	—	5.00E+01	0.00E+00	1.56E-04
Mercury	1.10E-01	1.00E+02	2.91E-08	7.83E-05
Uranium	4.30E-03	6.00E+00	7.04E-09	1.25E-03
Am-241	7.76E-06	3.40E+02	6.08E-06	2.31E-05
Ce-144	—	5.00E+02	0.00E+00	1.57E-05
Co-57	—	1.00E+01	0.00E+00	7.64E-04
Co-58	—	1.00E+01	0.00E+00	7.64E-04
Co-60	—	1.00E+01	0.00E+00	7.64E-04
Cs-134	—	5.00E+02	0.00E+00	1.57E-05
Cs-137	3.66E+00	5.00E+02	4.12E-05	1.57E-05
Eu-152	—	3.40E+02	0.00E+00	2.31E-05
Eu-154	—	3.40E+02	0.00E+00	2.31E-05
Eu-155	—	3.40E+02	0.00E+00	2.31E-05
H-3	—	0.00E+00	6.22E-04	2.87E-02
I-129	3.85E-06	0.00E+00	3.26E-05	2.87E-02
K-40	—	1.50E+01	0.00E+00	5.14E-04
Nb-95	—	0.00E+00	0.00E+00	2.87E-02
Np-237	1.75E-04	0.00E+00	8.36E-06	2.87E-02
Pu-238	—	2.20E+01	0.00E+00	3.53E-04
Pu-239/240	5.15E-06	2.20E+01	5.84E-07	3.53E-04
Pu-241	8.49E-09	2.20E+01	9.37E-08	3.53E-04
Pu-242	3.60E-09	2.20E+01	3.88E-10	3.53E-04
Ru/Rh-106	—	0.00E+00	0.00E+00	2.87E-02
Sb-125	—	5.00E+01	0.00E+00	1.56E-04
Sr-90	6.72E+01	1.20E+01	5.63E-05	6.40E-04
Tc-99	4.56E-01	0.00E+00	1.67E-04	2.87E-02
U-234	1.35E-03	6.00E+00	2.63E-06	1.25E-03
U-235	9.61E-07	6.00E+00	9.27E-08	1.25E-03
U-236	6.93E-07	6.00E+00	6.68E-08	1.25E-03
U-238	1.45E-03	6.00E+00	2.35E-06	1.25E-03

analysis performed at this site. The implication is that these radionuclides may be present and are currently not part of the soil contaminant inventory.

18.4.4 Risk Estimates. The results of this evaluation under current and future land use are presented in Sections 18.4.4.1 and 18.4.4.2. For each receptor, the results are summarized in Tables 18-6 through 18-11.

18.4.4.1 Current Land Use. As indicated in Table 18-6, total cancer risk to the current onsite worker from exposure to site-related chemicals in surface soil is estimated to be 6E-05. The risk is attributable to external radiation exposure and to ingestion of soil. Cs-137 (6E-05) is the major contributor to external radiation exposure and arsenic (1E-06) is the major contributor to the soil ingestion exposure route. Table 18-7 indicates that the total noncarcinogenic hazard index to the worker is estimated to be 6E-09. There is no hazard indices above unity for the current onsite worker.

18.4.4.2 Future Land Use. As Table 18-8 indicates, the total cancer risk to the future onsite worker from exposure to site-related chemicals in surface soil is estimated to be 8E-06. The risk is driven by external radiation exposure to Cs-137 (6E-06) and by ingestion of arsenic (1E-06) in soil. Table 18-9 indicates the total noncarcinogenic hazard index to the future onsite worker is 6E-09. There are no hazard indices above unity for the future onsite worker. As indicated in Table 18-10, the total cancer risk to the future resident from exposure to site-related chemicals in soil is estimated to be 9E-03 at CPP-34. The primary contaminants of concern (COCs) for the ingestion of soil risk are arsenic (2E-05), Cs-137 (6E-06), and Sr-90 (3E-05). Within the homegrown produce ingestion route, the major COC contributors to risk are Cs-137 (2E-05) and Sr-90 (7E-04). Cs-137 (9E-03), Np-237 (5E-06), and U-238 (2E-06) are the major contributors to risk for external radiation exposure. As presented in Table 18-11, the total noncarcinogenic hazard index for the future resident is estimated to be 1E-01 at CPP-34 . There are no hazard indices above unity for the future resident.

18.5 Uncertainties

This section describes the limitations and uncertainties specific to the site characterization of site CPP-34. Sources of uncertainty associated with site characterization include data quality, COPC identification, concentration term estimation, and assumptions regarding the lateral and vertical extent of COPC occurrence. In the risk assessment, the most significant uncertainties are due to the selection process of COPCs, the toxicity values used, and the assumptions used during the exposure assessment. The following paragraphs will discuss important sources of site-specific uncertainty in greater detail.

Sampling and analysis uncertainties are related to quality problems that may result in qualified and rejected results (Section 3.5). Qualified results are considered estimates of the concentration in the sample and, for all practical purposes, useable for their intended purpose although they could be biased high or low. Rejected results are considered unusable, thus limiting the size of the useable data set. For the site CPP-34, no data points were rejected based on the method validation as documented in the Limitations and Validation (L&V) Reports, thus making this possible source of uncertainty insignificant.

Table 18-6. Soil pathway cancer risk to the current onsite worker. [a]

COPCs	Ingestion of soil	External radiation exposure	Total risks
Aroclor-1260	----	----	----
Benzo(a)pyrene	----	----	----
Aluminum	----	----	----
Arsenic	1E-06	----	1E-06
Manganese	----	----	----
Mercury	----	----	----
Uranium	NTD	----	----
Am-241	----	----	----
Ce-144	----	----	----
Co-57	----	----	----
Co-58	----	----	----
Co-60	----	----	----
Cs-134	----	----	----
Cs-137	4E-08	6E-05	6E-05
Eu-152	----	----	----
Eu-154	----	----	----
Eu-155	----	----	----
H-3	----	----	----
I-129	----	----	----
K-40	----	----	----
Nb-95	----	----	----
Np-237	----	----	----
Pu-238	----	----	----
Pu-239/240	----	----	----
Pu-241	----	----	----
Pu-242	----	----	----
Ru/Rh-106	----	----	----
Sb-125	----	----	----
Sr-90	3E-07	NTD	3E-07
Tc-99	----	----	----
U-234	----	----	----
U-235	----	----	----
U-236	----	----	----
U-238	2E-08	4E-07	5E-07
Total cancer risks by route:	2E-06	6E-05	6E-05

"----" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 18-7. Soil pathway noncarcinogenic hazard to the current onsite worker. [a]

COPCs	Ingestion of soil	External radiation exposure	Total HIs
Aroclor-1260	----	----	----
Benzo(a)pyrene	----	----	----
Aluminum	----	----	----
Arsenic	7E-10	----	7E-10
Manganese	----	----	----
Mercury	----	----	----
Uranium	5E-09	----	5E-09
Am-241	----	----	----
Ce-144	----	----	----
Co-57	----	----	----
Co-58	----	----	----
Co-60	----	----	----
Cs-134	----	----	----
Cs-137	----	----	----
Eu-152	----	----	----
Eu-154	----	----	----
Eu-155	----	----	----
H-3	----	----	----
I-129	----	----	----
K-40	----	----	----
Nb-95	----	----	----
Np-237	----	----	----
Pu-238	----	----	----
Pu-239/240	----	----	----
Pu-241	----	----	----
Pu-242	----	----	----
Ru/Rh-106	----	----	----
Sb-125	----	----	----
Sr-90	----	----	----
Tc-99	----	----	----
U-234	----	----	----
U-235	----	----	----
U-236	----	----	----
U-238	----	----	----
Total hazard indices by route:	6E-09	0E+00	6E-09

"----" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 18-8. Soil pathway cancer risk to the future onsite worker. [a]

COPCs	Ingestion of soil	External radiation exposure	Total risks
Aroclor-1260	----	----	----
Benzo(a)pyrene	----	----	----
Aluminum	----	----	----
Arsenic	1E-06	----	1E-06
Manganese	----	----	----
Mercury	----	----	----
Uranium	NTD	----	----
Am-241	----	----	----
Ce-144	----	----	----
Co-57	----	----	----
Co-58	----	----	----
Co-60	----	----	----
Cs-134	----	----	----
Cs-137	4E-09	6E-06	6E-06
Eu-152	----	----	----
Eu-154	----	----	----
Eu-155	----	----	----
H-3	----	----	----
I-129	----	----	----
K-40	----	----	----
Nb-95	----	----	----
Np-237	----	----	----
Pu-238	----	----	----
Pu-239/240	----	----	----
Pu-241	----	----	----
Pu-242	----	----	----
Ru/Rh-106	----	----	----
Sb-125	----	----	----
Sr-90	3E-08	NTD	3E-08
Tc-99	----	----	----
U-234	----	----	----
U-235	----	----	----
U-236	----	----	----
U-238	2E-08	4E-07	5E-07
Total cancer risks by route:	1E-06	7E-06	8E-06

"----" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 18-9. Soil pathway noncarcinogenic hazard to the future onsite worker. [a]

COPCs	Ingestion of soil	External radiation exposure	Total HIs
Aroclor-1260	----	----	----
Benzo(a)pyrene	----	----	----
Aluminum	----	----	----
Arsenic	7E-10	----	7E-10
Manganese	----	----	----
Mercury	----	----	----
Uranium	5E-09	----	5E-09
Am-241	----	----	----
Ce-144	----	----	----
Co-57	----	----	----
Co-58	----	----	----
Co-60	----	----	----
Cs-134	----	----	----
Cs-137	----	----	----
Eu-152	----	----	----
Eu-154	----	----	----
Eu-155	----	----	----
H-3	----	----	----
I-129	----	----	----
K-40	----	----	----
Nb-95	----	----	----
Np-237	----	----	----
Pu-238	----	----	----
Pu-239/240	----	----	----
Pu-241	----	----	----
Pu-242	----	----	----
Ru/Rh-106	----	----	----
Sb-125	----	----	----
Sr-90	----	----	----
Tc-99	----	----	----
U-234	----	----	----
U-235	----	----	----
U-236	----	----	----
U-238	----	----	----
Total hazard indices by route:	6E-09	0E+00	6E-09

"----" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 18-10. Soil pathway cancer risk to the future onsite resident. [a]

COPCs	Ingestion of soil	Ingestion of homegrown	External radiation exposure	Total risks
Aroclor-1260	—	—	—	—
Benzo(a)pyrene	—	—	—	—
Aluminum	—	—	—	—
Arsenic	2E-05	2E-06	—	2E-05
Manganese	—	—	—	—
Mercury	—	NTD	—	—
Uranium	NTD	NTD	—	—
Am-241	—	4E-10	—	4E-10
Ce-144	—	—	—	—
Co-57	—	—	—	—
Co-58	—	—	—	—
Co-60	—	—	—	—
Cs-134	—	—	—	—
Cs-137	6E-06	2E-05	9E-03	9E-03
Eu-152	—	—	—	—
Eu-154	—	—	—	—
Eu-155	—	—	—	—
H-3	—	—	—	—
I-129	—	1E-10	—	1E-10
K-40	—	—	—	—
Nb-95	—	—	—	—
Np-237	2E-07	9E-09	5E-06	6E-06
Pu-238	—	—	—	—
Pu-239/240	—	3E-10	—	3E-10
Pu-241	—	5E-13	—	5E-13
Pu-242	—	2E-13	—	2E-13
Ru/Rh-106	—	—	—	—
Sb-125	—	—	—	—
Sr-90	3E-05	7E-04	NTD	7E-04
Tc-99	—	1E-07	—	1E-07
U-234	7E-08	1E-08	8E-10	8E-08
U-235	—	8E-12	—	8E-12
U-236	—	5E-12	—	5E-12
U-238	1E-07	2E-08	2E-06	2E-06
Total cancer risks by route:	5E-05	7E-04	9E-03	9E-03

"—" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 18-11. Soil pathway noncarcinogenic hazard to the future onsite resident. [a]

COPCs	Ingestion of soil	Ingestion of homegrown	External radiation exposure	Total HIs
Aroclor-1260	—	—	—	—
Benzo(a)pyrene	—	—	—	—
Aluminum	—	—	—	—
Arsenic	8E-09	1E-02	—	1E-02
Manganese	—	—	—	—
Mercury	—	1E-01	—	1E-01
Uranium	5E-08	4E-04	—	4E-04
Am-241	—	—	—	—
Ce-144	—	—	—	—
Co-57	—	—	—	—
Co-58	—	—	—	—
Co-60	—	—	—	—
Cs-134	—	—	—	—
Cs-137	—	—	—	—
Eu-152	—	—	—	—
Eu-154	—	—	—	—
Eu-155	—	—	—	—
H-3	—	—	—	—
I-129	—	—	—	—
K-40	—	—	—	—
Nb-95	—	—	—	—
Np-237	—	—	—	—
Pu-238	—	—	—	—
Pu-239/240	—	—	—	—
Pu-241	—	—	—	—
Pu-242	—	—	—	—
Ru/Rh-106	—	—	—	—
Sb-125	—	—	—	—
Sr-90	—	—	—	—
Tc-99	—	—	—	—
U-234	—	—	—	—
U-235	—	—	—	—
U-236	—	—	—	—
U-238	—	—	—	—
Total hazard indices by route:	5E-08	1E-01	0E+00	1E-01

"—" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Uncertainty associated with the chemical screening process (Section 5.2) results from using the maximum concentration for chemicals detected in the Environmentally Controlled Areas (ECAs) in the background comparison step, retaining chemicals detected as COPCs because there is not a corresponding background value, and retaining chemicals as COPCs for which there is no toxicity information available.

In most cases, the COPC identification process used the maximum concentration for a chemical detected in the background comparison step, regardless of its magnitude above background. The use of the maximum concentration can result in the identification of COPCs that have concentrations only slightly above background. For site CPP-34, arsenic was the only COPC that fell into this category with a maximum concentration of 7.1 mg/kg and a corresponding background value of 5.8 mg/kg. This results in an increase in the number of COPCs considered in the remedial investigation/Baseline Risk Assessment (RI/BRA) and a possible overestimation of risk because of inclusion of COPCs with concentrations that are likely within the true background population.

A source of uncertainty related to the background comparison step in the chemical screening process relates to chemicals for which no background concentration exists. For example, fluoride, nitrate, and several radionuclides were not characterized as part of the Rood et al., background study. For site CPP-34, Np-237 was the only COPC with no corresponding background concentration. This results in an increase in the number of COPCs considered in the RI/BRA and a possible overestimation of risk because the observed concentrations may be within the background population.

Some concentration estimates are based on the 95% UCL for the site, or the area-weighted average 95% UCLs for sites that have been grouped. When the 95% UCL (i.e., the concentration term estimate) of a COPC is below the corresponding background value, this results in an increase in the number of COPCs in the RI/BRA and a possible overestimation of risk because the results are likely within the background range. This source of uncertainty stems from the use of maximum concentrations when identifying the COPCs for a specific sites. For site CPP-34, U-234 and U-238 concentration estimates were below background but the radionuclides were included as COPCs in the RI/BRA. For site CPP-34, all COPCs identified had toxicity values available for use in the HHRA.

Another source of uncertainty, which is the location, area, and depth of the trenches containing contaminated soil at site CPP-34, is well documented. Therefore, it is believed that there is relatively little uncertainty in the extent of contamination at site CPP-34 and consequently relatively little uncertainty in the risk assessment to site CPP-34.

One other source of uncertainty may be associated with the contaminant inventories used for the groundwater modeling and residential intrusion exposure at each sub-area. Section 18.4.3 identifies radionulcides potentially missing from the inventories. The implication of these potential data gaps is that the source estimates could be underestimated. Based on the results of the groundwater model, the potentially missing Eu-154 and Pu -241 which have half-lives of 8.6 and 14.7 years, respectively would not be expected to be of concern because of their short half lives and long travel times to the aquifer. Am-241 is potentially missing from the source estimates but is not expected to be of concern because most of the activity has been accounted for in the tank farm and shown that the source assumptions are conservative. For discussion of uncertainty associated with Pu-239 and Pu-240, see Section 10 of Appendix F. The potential uncertainty is recognized in this report, but no information is available to quautify the uncertainty.

18.6 Conclusions and Recommendations

The results of the risk assessment under current land use at CPP-34 indicate that the increased cancer risk from exposure to site-related contaminants is above the Environmental Protection Agency (EPA)-recommended target range. The increased cancer risk to hypothetical future onsite workers is within the EPA target range and for future onsite residents it was found to be well above the EPA-recommended target range. The noncarcinogenic hazard for all receptors was found to be well below the EPA hazard index goal of one. It should be noted that these estimates do not include the contributions associated with the air and ground water pathways. The total increased cancer and hazard incidence to humans is reported in Section 27. Even though the risk estimates at this site are likely to be overestimated for reasons described in Sections 7 and 18.5 of this report, they are potentially high under future residential conditions. It is expected that some type of future response action may be appropriate to mitigate adverse impacts to human health and the environment.

18.7 References

EPA, 1994, *Soil Screening Guidance*, EPA/540/ R-94/101, PB95-963529, December.

Golder Associates, 1990, *Report for the Idaho Chemical Processing Plant Drilling and Sampling Program at Land Disposal Unit CPP-34*, Prepared for EG&G Idaho, Inc./Westinghouse Idaho Nuclear Company, Idaho Falls, Idaho under Contract No. C86-151159, Task 6.

Rood, S. M., G. A. Harris, and G. J. White, 1995, *Background Dose Equivalent Rates and Surficial Soil Metal and Radionuclide Concentrations for the Idaho National Engineering Laboratory*, INEL-94/0250, Revision 0, February.

WINCO, 1993, *Track 1 Decision Documentation Package, Site CPP-34, Soil Storage Area in the NE Corner of ICPP, Operable Unit 3-06*, February.

WINCO, 1989, *Closure Plan for CPP-34 Contaminated Soil Storage Area in the Northeast Corner of CPP*, prepared for the U.S. Department of Energy, Idaho Operations Office, Idaho Falls, Idaho.

WINCO, 1984, *Environmental Evaluation for Disposal of WL-102 Low Level Contaminated Soil*, May 17.

Chapter 19

19. SITE CPP-13 RESULTS

Site CPP-13 is located along the berm on the north side of Bin Sets 1 and 2 as shown on Figure 19-1. This section describes the nature and extent of contamination at site CPP-13 followed by the results of the human health risk assessment (HHRA).

19.1 Site Description

Site CPP-13 resulted from an air release of calcined, radioactively-contaminated waste and is located on an earthen berm covering underground storage Bin Sets 1 and 2, which contain calcined high-level radioactive waste (WINCO, 1993b) (Figure 19-1). While attempting to clear the solid storage cyclone (WC-912) of a restriction on October 26, 1976, the cyclone became overpressurized and blew contaminated granular solids into the air. The release contaminated the roof of building CPP-747 located on the top of the concrete-vaulted storage bin and the berm area to the northeast of CPP-747 and covered an area of 27.9 m^2 (300 ft^2). Elevated levels of radiation are produced by the bin sets and these levels are apparently greater than any radiation in the soil due to the past release. Surface soil from the bin set area was taken to an area of normal background and surveyed at radioactivity levels ranging between 800 and 3,000 counts per minute (cpm). Subsequent cleanup efforts were successful in decontaminating the top of building CPP-747. However, the contamination over the berm area was left in place and covered with approximately 0.15 m (6 in.) of soil.

19.2 Investigative Results

As discussed in Section 3, three borings were drilled at site CPP-13 as part of the OU 3-13 RI/FS field sampling program. The locations of borings CPP-13-1, -13-2, and -13-3 are indicated on Figure 19-1. As 0.15 m (0.5 ft) of clean soil was placed on the earthen berm after the release, surficial soil samples were collected starting at 0.15-m (0.5-ft) below ground surface (bgs).

Borings CPPs-13-2 and -13-3 were both drilled along the top of the earthen berm that covers the underground storage bin sets, and the boring logs indicate the boreholes were completed in fill material. Boring CPP-13-1 was drilled near the outer edge of the berm. At boring location CPP-13-1, surficial background radiation was measured at 300 cpm. The following samples were collected from boring CPP-13-1 and sent for analysis of radiological constituents and Contract Laboratory Program (CLP) metals: 0.15- to 0.3-m (0.5- to 1.0-ft) bgs, 0.3- to 0.8-m (1.0- to 2.5-ft) bgs, and 2.3- to 3.0-m (7.5- to 10.0-ft) bgs. All field-screening radiation levels were below background.

At boring location CPP-13-2, background radiation was measured at 300 cpm. Surficial radiation at the boring location was measured at 1,500 cpm. The following samples were collected in boring CPP-13-2, (measured radiation levels indicated in parentheses): 0.1-5 to 0.3-m (0.5- to 1.0-ft) bgs (500 cpm), and 0.8- to 1.2-m (2.5- to 4.0-ft) bgs (400 cpm). Samples were analyzed for radiological constituents, CLP metals, and zirconium.

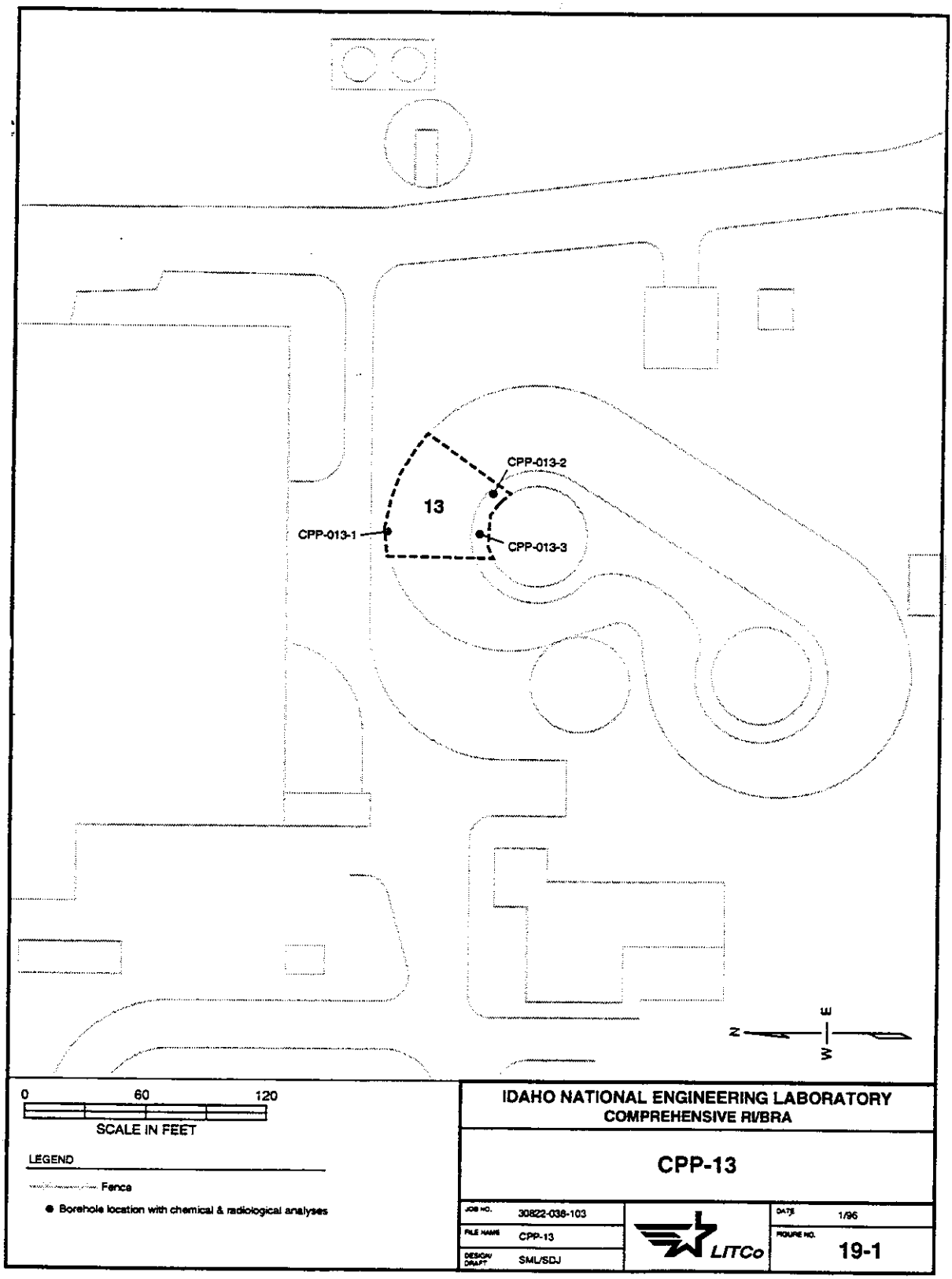


Figure 19-1. CPP-13 and borehole locations.

At sample location CPP-13-3, background radiation was measured at 50,000 cpm. The following samples were collected (measured radiation level in parentheses): 0.15 to 0.3 m (0.5 to 1.0 ft) bgs (0.8 mR) and 0.8 to 1.2 m (2.5 to 4.0 ft) bgs (25,000 cpm). Samples were analyzed for radiological constituents, CLP metals, and zirconium.

The analytical results for the contaminants of potential concern (COPCs) identified for CPP-13 are summarized in Table 19-1. A compilation of the analytical results is presented in Appendix G. *Note: Antimony, cadmium, silver, thallium, Ce-144, Co-58, Eu-155, Nb-95, Ru-103, Ru-105, and Sb-125 were analyzed for, but not detected and therefore, do not appear on Table 5-20.* Based on the chemical screening presented in Section 5.2, the following COPCs were identified for this site: arsenic, zirconium, Co-60, Sr-90, Tc-99, Cs-134, Cs-137, and Eu-154. Detections of arsenic above background were isolated. Arsenic concentrations above background ranged as high as 8.3 mg/kg relative to background of 5.8 mg/kg.

Cs-137 and Sr-90 were the most widely distributed radioactive COPCs at site CPP-13. Cs-137 activities up to 47±0.5 pCi/g were measured in surficial samples. Large Cs-137 activities of 3,710± pCi/g and 4,630± pCi/g were noted in boring CPP-13-3 in the 0.15- to 0.3-m (0.5- to 1.0-ft) and the 0.8- to 1.2-m (2.5- to 4.0-ft) sample intervals, respectively. Sr-90 activities were measured at 4,180±30 pCi/g and 2,600±30 pCi/g in the same intervals of boring CPP-13-3. Eu-154 and Tc-99 were also detected in boring CPP-13-3. Eu-154 activity increased with depth from 22±1 pCi/g in the 0.15- to 0.3-m (0.5- to 1.0-ft) interval to 31±2 pCi/g in the 0.8- to 1.2-m (2.5- to 4.0-ft) interval. Tc-99 activity decreased from 2.7±00.4 pCi/g to 1.4±0.4 pCi/g in the same intervals.

19.3 Nature and Extent of Soil Contamination

Based on the investigative results, Cs-137 and Sr-90 are considered the primary COPCs at CPP-13. Numerous other radionuclides were detected at activities above background, however, these detections were generally limited to boring CPP-13-3. Cs-137 and Sr-90 were both detected at high activity levels to a depth of 1.2 m (4.0 ft) in boring CPP-13-3. Results from a sample collected at boring CPP-13-1 indicated radionuclide activities had dropped to below background in the 2.4- to 3.0-m (8.0- to 10.0-ft) interval. Therefore, the zone of contamination at CPP-13 is assumed to extend throughout the estimated 7.6-m (25-ft) high berm to approximately 0.8 m (2.5 ft) below the base of the berm (original ground surface). The initial area of CPP-13, as shown on Figure 5-2, has been shifted to the west on Figure 19-1 based on the results of the borings. The new area of CPP-13 is 366 m^2 (3,949 ft^2).

19.4 Risk Assessment

The methodology for conducting the HHRA for WAG 3 is detailed in Section 7. As presented, the purpose of the HHRA is to develop a quantitative description and assessment of the human health risk posed by the COPCs present at WAG 3. This section only contains the results of the HHRA for site CPP-13 with respect to the soil pathways. The results for the air and groundwater pathways are detailed in Sections 27.1 and 27.2, respectively. The risk assessment at this site will become cumulative when the pathways are added to that from the soil pathway. The following sections discuss the complete exposure routes, exposure-point concentrations, and cancer risk and noncarcinogenic health hazard estimates for site CPP-13 under the three exposure scenarios evaluated. Section 19.4.3 describes the difference in estimating sources of contamination for use in evaluating surface exposure and groundwater modeling. It also describes the use of the screened ORIGEN runs (Section 4.4) to help identify contaminants potentially missing from the soul source estimate.

Table 19-1. Summary statistics for CPP-13, pressurization of the Solid Storage Cyclone northeast of CPP-13.

COPCs	Concentration (mg/kg or pCi/g) Minimum detected	Maximum detected	Arithmetic mean	Standard deviation	Number of samples	Number of detects	Frequency of detection	INEL background (mg/kg or pCi/g)	Number greater than background
Arsenic	5.2 P	8.3 P	6.16E+00	1.03E+00	8	8	100%	5.8	4
Zirconium	7.5 P	14.3 P	1.11E+01	1.95E+00	8	8	100%	NA	NA
Co-60	0.49 +/- 0.08	0.9 +/- 0.2	6.95E-01	2.90E-01	8	2	25%	NA	NA
Cs-134	0.6 +/- 0.1	0.6 +/- 0.1	6.00E-01	NA	8	1	13%	NA	NA
Cs-137	0.08 +/- 0.02	4630 +/- 50	1.21E+03	2.04E+03	8	7	88%	0.82	6
Eu-154	22 +/- 1	31 +/- 2	2.65E+01	6.36E+00	8	2	25%	NA	NA
Sr-90	4.7 +/- 0.2	4180 +/- 30	1.37E+03	1.93E+03	5	5	100%	0.49	5
Tc-99	0.9 +/- 0.4	2.7 +/- 0.4	1.67E+00	9.29E-01	4	3	75%	NA	NA

NA - Not applicable/available

19.4.1 Complete Exposure Routes

Potentially complete pathways from the source to a human receptor are described in Section 7 and illustrated on Figure 7-1. For site CPP-13, the complete exposure routes within each pathway are summarized in Table 19-2. An exposure route is considered complete if the contaminated zone (as characterized in the previous sections) occurs within the depth intervals specified for a given exposure route. All exposure routes were evaluated for site CPP-13.

19.4.2 Exposure-Point Concentrations

Specific steps in calculating exposure-point concentrations for each of the applicable scenarios are described in Section 7. The COPC soil value used was the smaller of the 95% upper confidence limit (UCL) or maximum concentration. The concentration terms for the radionuclides were adjusted to account for decay for each exposure scenario. These values were subsequently averaged over the exposure duration. The concentration terms, by depth interval, are presented in Table 19-3. Exposures from all complete exposure routes were estimated based on the exposure-point concentrations in Table 19-4. Homegrown produce concentrations are presented Table 19-5. The values for air and groundwater are presented in Sections 27.1 and 27.2, respectively.

19.4.3 Description of Source Estimates for Surface Exposure and Groundwater Modeling Use

The purpose for this subsection is two-fold. First, to compare the approach to defining the source estimate for use in both the surface exposure assessment and the groundwater model. This comparison was accomplished by comparing the soil data in Table 19-3 to the soil data used to estimate the source for use in the groundwater model, which can be found in Tables 5-39 and 5-40 of Appendix F. The benefit of these comparisons is to relate both source estimates and explain any apparent differences. Secondly, the results of the screened ORIGEN runs summarized in Section 4-4 were used to help identify any potential soil-related data gaps by comparing ORIGEN results to the field investigation soil results at this site. This comparison was based on the full inventory of contaminants in screening Table 5-20 before implementing the screening steps shown therein. The results of these comparisons are described for each site in the following paragraphs. The results of the comparison for perched water and SRPA were reported at the end of Section 4.4.

The same soil COPC's and concentrations in Table 19-3 for sites CPP-13 were used to develop the source estimate for groundwater use with the exception of mercury and zirconium. Mercury is not included in Table 19-3 because it screened out in Table 5-20. Based on a comparison of the radionuclides that were analyzed in site soils against the potential inventory as defined by the screened ORIGEN results (Table 4-7), Am-241, Pu-238, Pu-239/240, and Pu-241 were not part of the soil sampling analytical suite. The implication is that these radionuclides may be present and are currently not part of the soil contaminant inventory.

19.4.4 Risk Estimates

The results of this evaluation under current and future land use are presented in Sections 19.4.4.1 and 19.4.4.2. For each receptor, the results are summarized in Tables 19-6 through 19-11.

Table 19-2. Complete exposure routes for site CPP-13 and associated exposure route depths.

Receptor	Scenario	Potentially complete exposure routes and exposure route depths used for exposure-point concentration estimates	Characterized zone of contamination	Complete exposure route?
Onsite worker	Current land use	Inhalation of VOCs [0–15 cm (0–6 in.)]	7.6 m above surface to 0.76 m below surface (25 ft above surface to 2.5 ft below surface)	No
		Inhalation of airborne particulates [0–15 cm (0–6 in.)]		Yes
		Ingestion of surface soil [0–15 cm (0–6 in.)]		Yes
		External radiation [0–1.22 m (0–4 ft)]		Yes
Residential	Future land use	Inhalation of VOCs [0–3.05 m (0–10 ft)]	7.6 m above surface to 0.76 m below surface (25 ft above surface to 2.5 ft below surface)	No
		Inhalation of airborne particulates [0–3.05 m (0–10 ft)]		Yes
		Ingestion of surface soil [0–3.05 m (0–10 ft)]		Yes
		Ingestion of homegrown produce [0–3.05 m (0–10 ft)]		Yes
		Ingestion of groundwater		Yes
		Dermal contact with groundwater		No
		Inhalation of VOCs from groundwater		No
		External radiation [0–3.05 m (0–10 ft)]		Yes
Onsite worker	Future land use	Inhalation of VOCs [0–15 cm (0–6 in.)]	7.6 m above surface to 0.76 m below surface (25 ft above surface to 2.5 ft below surface)	No
		Inhalation of airborne particulates [0–15 cm (0–6 in.)]		Yes
		Ingestion of surface soil [0–15 cm (0–6 in.)]		Yes
		External radiation [0–1.22 m (0–4 ft)]		Yes

Table 19-3. Soil concentration terms by depth interval.

	Soil concentrations (mg/kg or pCi/g)		
COPCs[a]	(0 - 0.5 ft)	(0 - 4 ft)	(0 - 10 ft)
Aroclor-1260	---	---	---
Benzo(a)pyrene	---	---	---
Aluminum	---	---	---
Arsenic	---	7.40E+00	6.90E+00
Manganese	---	---	---
Mercury	---	---	---
Uranium	---	---	---
Am-241	---	---	---
Ce-144	---	---	---
Co-57	---	---	---
Co-58	---	---	---
Co-60	---	9.00E-01	9.00E-01
Cs-134	---	6.00E-01	6.00E-01
Cs-137	---	4.63E+03	4.63E+03
Eu-152	---	---	---
Eu-154	---	3.10E+01	3.10E+01
Eu-155	---	---	---
H-3	---	---	---
I-129	---	---	---
K-40	---	---	---
Nb-95	---	---	---
Np-237	---	---	---
Pu-238	---	---	---
Pu-239/240	---	---	---
Pu-241	---	---	---
Pu-242	---	---	---
Ru/Rh-106	---	---	---
Sb-125	---	---	---
Sr-90	---	4.18E+03	4.18E+03
Tc-99	---	2.70E+00	2.70E+00
U-234	---	---	---
U-235	---	---	---
U-236	---	---	---
U-238	---	---	---

a. Concentration terms are not calculated for zirconium, because it does not have available human toxicity data.

Table 19-4. Average soil exposure-point concentrations (mg/kg or pCi/g) for land use scenarios.

	Current occupational worker year 0 to year 25		Future occupational worker year 100 to year 125		Future resident year 100 to year 130
COPCs[a]	(0 - 0.5 ft)	(0 - 4 ft)	(0 - 0.5 ft)	(0 - 4 ft)	(0 - 10 ft)
Aroclor-1260	---	---	---	---	---
Benzo(a)pyrene	---	---	---	---	---
Aluminum	---	---	---	---	---
Arsenic	---	7.40E+00	---	7.40E+00	6.90E+00
Manganese	---	---	---	---	---
Mercury	---	---	---	---	---
Uranium	---	---	---	---	---
Am-241	---	---	---	---	---
Ce-144	---	---	---	---	---
Co-57	---	---	---	---	---
Co-58	---	---	---	---	---
Co-60	---	2.64E-01	---	5.14E-07	4.36E-07
Cs-134	---	7.13E-02	---	1.75E-16	1.46E-16
Cs-137	---	3.52E+03	---	3.54E+02	3.36E+02
Eu-152	---	---	---	---	---
Eu-154	---	1.35E+01	---	5.15E-03	4.52E-03
Eu-155	---	---	---	---	---
H-3	---	---	---	---	---
I-129	---	---	---	---	---
K-40	---	---	---	---	---
Nb-95	---	---	---	---	---
Np-237	---	---	---	---	---
Pu-238	---	---	---	---	---
Pu-239/240	---	---	---	---	---
Pu-241	---	---	---	---	---
Pu-242	---	---	---	---	---
Ru/Rh-106	---	---	---	---	---
Sb-125	---	---	---	---	---
Sr-90	---	3.15E+03	---	2.91E+02	2.76E+02
Tc-99	---	2.70E+00	---	2.70E+00	2.70E+00
U-234	---	---	---	---	---
U-235	---	---	---	---	---
U-236	---	---	---	---	---
U-238	---	---	---	---	---

a. Concentration terms are not calculated for zirconium, because it does not have available human toxicity data.

Table 19-5. Concentrations of COPCs in homegrown produce.

COPCs	Homegrown produce (mg/kg or pCi/g)	Kd (cm^3/g)	COPC input rate from irrigation (mg/g-d or pCi/g-d)	Leach rate constant (d^{-1})
Aroclor-1260	---	7.89E+03	0.00E+00	9.95E-07
Benzo(a)pyrene	---	1.19E+03	0.00E+00	6.57E-06
Aluminum	---	0.00E+00	0.00E+00	2.87E-02
Arsenic	1.06E-02	3.00E+00	8.71E-09	2.40E-03
Manganese	---	5.00E+01	0.00E+00	1.56E-04
Mercury	1.10E-01	1.00E+02	2.91E-08	7.83E-05
Uranium	7.30E-05	6.00E+00	7.04E-09	1.25E-03
Am-241	7.76E-06	3.40E+02	6.08E-06	2.31E-05
Ce-144	---	5.00E+02	0.00E+00	1.57E-05
Co-57	---	1.00E+01	0.00E+00	7.64E-04
Co-58	---	1.00E+01	0.00E+00	7.64E-04
Co-60	1.80E-04	1.00E+01	0.00E+00	7.64E-04
Cs-134	7.49E-05	5.00E+02	0.00E+00	1.57E-05
Cs-137	8.46E+00	5.00E+02	4.12E-05	1.57E-05
Eu-152	---	3.40E+02	0.00E+00	2.31E-05
Eu-154	3.59E-04	3.40E+02	0.00E+00	2.31E-05
Eu-155	---	3.40E+02	0.00E+00	2.31E-05
H-3	---	0.00E+00	6.22E-04	2.87E-02
I-129	3.85E-06	0.00E+00	3.26E-05	2.87E-02
K-40	---	1.50E+01	0.00E+00	5.14E-04
Nb-95	---	0.00E+00	0.00E+00	2.87E-02
Np-237	3.19E-05	0.00E+00	8.36E-06	2.87E-02
Pu-238	---	2.20E+01	0.00E+00	3.53E-04
Pu-239/240	5.15E-06	2.20E+01	5.84E-07	3.53E-04
Pu-241	8.49E-09	2.20E+01	9.37E-08	3.53E-04
Pu-242	3.60E-09	2.20E+01	3.88E-10	3.53E-04
Ru/Rh-106	---	0.00E+00	0.00E+00	2.87E-02
Sb-125	---	5.00E+01	0.00E+00	1.56E-04
Sr-90	4.68E+01	1.20E+01	5.63E-05	6.40E-04
Tc-99	1.13E+00	0.00E+00	1.67E-04	2.87E-02
U-234	2.73E-05	6.00E+00	2.63E-06	1.25E-03
U-235	9.61E-07	6.00E+00	9.27E-08	1.25E-03
U-236	6.93E-07	6.00E+00	6.68E-08	1.25E-03
U-238	2.44E-05	6.00E+00	2.35E-06	1.25E-03

Table 19-6. Soil pathway cancer risk to the current onsite worker. [a]

COPCs	Ingestion of soil	External radiation exposure	Total risks
Aroclor-1260	----	----	----
Benzo(a)pyrene	----	----	----
Aluminum	----	----	----
Arsenic	----	----	----
Manganese	----	----	----
Mercury	----	----	----
Uranium	----	----	----
Am-241	----	----	----
Ce-144	----	----	----
Co-57	----	----	----
Co-58	----	----	----
Co-60	----	1E-05	1E-05
Cs-134	----	2E-06	2E-06
Cs-137	----	4E-02	4E-02
Eu-152	----	----	----
Eu-154	----	4E-04	4E-04
Eu-155	----	----	----
H-3	----	----	----
I-129	----	----	----
K-40	----	----	----
Nb-95	----	----	----
Np-237	----	----	----
Pu-238	----	----	----
Pu-239/240	----	----	----
Pu-241	----	----	----
Pu-242	----	----	----
Ru/Rh-106	----	----	----
Sb-125	----	----	----
Sr-90	----	NTD	----
Tc-99	----	1E-11	1E-11
U-234	----	----	----
U-235	----	----	----
U-236	----	----	----
U-238	----	----	----
Total cancer risks by route:	0E+00	4E-02	4E-02

"----" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 19-7. Soil pathway noncarcinogenic hazard to the current onsite worker.[a,b]

COPCs	Ingestion of soil	External radiation exposure	Total HIs
Aroclor-1260	----	----	----
Benzo(a)pyrene	----	----	----
Aluminum	----	----	----
Arsenic	----	----	----
Manganese	----	----	----
Mercury	----	----	----
Uranium	----	----	----
Am-241	----	----	----
Ce-144	----	----	----
Co-57	----	----	----
Co-58	----	----	----
Co-60	----	----	----
Cs-134	----	----	----
Cs-137	----	----	----
Eu-152	----	----	----
Eu-154	----	----	----
Eu-155	----	----	----
H-3	----	----	----
I-129	----	----	----
K-40	----	----	----
Nb-95	----	----	----
Np-237	----	----	----
Pu-238	----	----	----
Pu-239/240	----	----	----
Pu-241	----	----	----
Pu-242	----	----	----
Ru/Rh-106	----	----	----
Sb-125	----	----	----
Sr-90	----	----	----
Tc-99	----	----	----
U-234	----	----	----
U-235	----	----	----
U-236	----	----	----
U-238	----	----	----
Total hazard indices by route:	0E+00	0E+00	0E+00

"----" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. All noncarcinogenic contamination at CPP-13 is buried deeper than 0.5 ft bls, so there is no calculated hazard index for workers at the site.
b. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 19-8. Soil pathway cancer risk to the future onsite worker. [a]

COPCs	Ingestion of soil	External radiation exposure	Total risks
Aroclor-1260	---	---	---
Benzo(a)pyrene	---	---	---
Aluminum	---	---	---
Arsenic	---	---	---
Manganese	---	---	---
Mercury	---	---	---
Uranium	---	---	---
Am-241	---	---	---
Ce-144	---	---	---
Co-57	---	---	---
Co-58	---	---	---
Co-60	---	3E-11	3E-11
Cs-134	---	6E-21	6E-21
Cs-137	---	4E-03	4E-03
Eu-152	---	---	---
Eu-154	---	1E-07	1E-07
Eu-155	---	---	---
H-3	---	---	---
I-129	---	---	---
K-40	---	---	---
Nb-95	---	---	---
Np-237	---	---	---
Pu-238	---	---	---
Pu-239/240	---	---	---
Pu-241	---	---	---
Pu-242	---	---	---
Ru/Rh-106	---	---	---
Sb-125	---	---	---
Sr-90	---	NTD	---
Tc-99	---	1E-11	1E-11
U-234	---	---	---
U-235	---	---	---
U-236	---	---	---
U-238	---	---	---
Total cancer risks by route:	0E+00	4E-03	4E-03

"---" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 19-9. Soil pathway noncarcinogenic hazard to the future onsite worker.[a,b]

COPCs	Ingestion of soil	External radiation exposure	Total HIs
Aroclor-1260	----	----	----
Benzo(a)pyrene	----	----	----
Aluminum	----	----	----
Arsenic	----	----	----
Manganese	----	----	----
Mercury	----	----	----
Uranium	----	----	----
Am-241	----	----	----
Ce-144	----	----	----
Co-57	----	----	----
Co-58	----	----	----
Co-60	----	----	----
Cs-134	----	----	----
Cs-137	----	----	----
Eu-152	----	----	----
Eu-154	----	----	----
Eu-155	----	----	----
H-3	----	----	----
I-129	----	----	----
K-40	----	----	----
Nb-95	----	----	----
Np-237	----	----	----
Pu-238	----	----	----
Pu-239/240	----	----	----
Pu-241	----	----	----
Pu-242	----	----	----
Ru/Rh-106	----	----	----
Sb-125	----	----	----
Sr-90	----	----	----
Tc-99	----	----	----
U-234	----	----	----
U-235	----	----	----
U-236	----	----	----
U-238	----	----	----
Total hazard indices by route:	0E+00	0E+00	0E+00

"----" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. All noncarcinogenic contamination at CPP-13 is buried deeper than 0.5 ft bls, so there is no calculated hazard index for workers at the site.
b. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 19-10. Soil pathway cancer risk to the future onsite resident. [a]

COPCs	Ingestion of soil	Ingestion of homegrown	External radiation exposure	Total risks
Aroclor-1260	—	—	—	—
Benzo(a)pyrene	—	—	—	—
Aluminum	—	—	—	—
Arsenic	2E-05	2E-06	—	2E-05
Manganese	—	—	—	—
Mercury	—	NTD	—	—
Uranium	—	NTD	—	—
Am-241	—	4E-10	—	4E-10
Ce-144	—	—	—	—
Co-57	—	—	—	—
Co-58	—	—	—	—
Co-60	1E-14	6E-10	1E-10	7E-10
Cs-134	9E-24	6E-10	2E-20	6E-10
Cs-137	1E-05	5E-05	2E-02	2E-02
Eu-152	—	—	—	—
Eu-154	5E-11	6E-10	6E-07	6E-07
Eu-155	—	—	—	—
H-3	—	—	—	—
I-129	—	1E-10	—	1E-10
K-40	—	—	—	—
Nb-95	—	—	—	—
Np-237	—	2E-09	—	2E-09
Pu-238	—	—	—	—
Pu-239/240	—	3E-10	—	3E-10
Pu-241	—	5E-13	—	5E-13
Pu-242	—	2E-13	—	2E-13
Ru/Rh-106	—	—	—	—
Sb-125	—	—	—	—
Sr-90	2E-05	5E-04	NTD	5E-04
Tc-99	5E-09	3E-07	5E-11	3E-07
U-234	—	2E-10	—	2E-10
U-235	—	8E-12	—	8E-12
U-236	—	5E-12	—	5E-12
U-238	—	3E-10	—	3E-10
Total cancer risks by route:	5E-05	5E-04	2E-02	2E-02

"—" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 19-11. Soil pathway noncarcinogenic hazard to the future onsite resident. [a]

COPCs	Ingestion of soil	Ingestion of homegrown	External radiation exposure	Total HIs
Aroclor-1260	—	—	—	—
Benzo(a)pyrene	—	—	—	—
Aluminum	—	—	—	—
Arsenic	8E-09	9E-03	—	9E-03
Manganese	—	—	—	—
Mercury	—	1E-01	—	1E-01
Uranium	—	6E-06	—	6E-06
Am-241	—	—	—	—
Ce-144	—	—	—	—
Co-57	—	—	—	—
Co-58	—	—	—	—
Co-60	—	—	—	—
Cs-134	—	—	—	—
Cs-137	—	—	—	—
Eu-152	—	—	—	—
Eu-154	—	—	—	—
Eu-155	—	—	—	—
H-3	—	—	—	—
I-129	—	—	—	—
K-40	—	—	—	—
Nb-95	—	—	—	—
Np-237	—	—	—	—
Pu-238	—	—	—	—
Pu-239/240	—	—	—	—
Pu-241	—	—	—	—
Pu-242	—	—	—	—
Ru/Rh-106	—	—	—	—
Sb-125	—	—	—	—
Sr-90	—	—	—	—
Tc-99	—	—	—	—
U-234	—	—	—	—
U-235	—	—	—	—
U-236	—	—	—	—
U-238	—	—	—	—
Total hazard indices by route:	8E-09	1E-01	0E+00	1E-01

"—" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

19.4.4.1 Current Land Use. As indicated in Table 19-6, total cancer risk to the current onsite worker from exposure to site-related chemicals in surface soil is estimated to be 4E-02. The risk is attributed to external radiation exposure, with the primary contaminants of concern (COCs) driving the risk being Co-60 (1E-05), Cs-137 (4E-02), and Eu-154 (4E-04). The total noncarcinogenic hazard index for the current worker is estimated to be 0E+00 as indicated in Table 19-7. There are no hazard indices above unity for the current onsite worker.

19.4.4.2 Future Land Use. As Table 19-8 indicates, the total cancer risk to the future onsite worker from exposure to site-related chemicals in surface soil is estimated to be 4E-03. The risk is attributed to external radiation exposure with the primary COC being Cs-137 (4E-03). Table 19-9 indicates that the total noncarcinogenic hazard index for the future onsite worker is 0E+00. There are no hazard indices above unity for the future onsite worker. As indicated in Table 19-10, the total cancer risk to the future resident from exposure to site-related chemicals in soil is estimated to be 2E-02 at CPP-13. The primary COCs for the soil ingestion exposure route are arsenic (2E-05), Cs-137 (1E-05), and Sr-90 (2E-05). Within the homegrown produce ingestion exposure route, the major contributors to risk are Cs-137 (5E-05) and Sr-90 (5E-04). The risk from Cs-137 (1E-01) is the major contributor for external radiation exposure. As presented in Table 19-11, the total noncarcinogenic hazard index for the future resident is estimated to be 1E-01 at CPP-13. There are no hazard indices above unity for the future resident.

19.5 Uncertainties

This section describes the limitations and uncertainties specific to the site characterization of site CPP-13. Sources of uncertainty associated with site characterization include data quality, COPC identification, concentration term estimation, and assumptions regarding the lateral and vertical extent of COPC occurrence. In the risk assessment, the most significant uncertainties are due to the selection process of COPCs, the toxicity values used, and the assumptions used during the exposure assessment. The following paragraphs will discuss important sources of site-specific uncertainty in greater detail.

Sampling and analysis uncertainties are related to quality problems that may result in qualified and rejected results (Section 3.5). Qualified results are considered estimates of the concentration in the sample and, for all practical purposes, useable for their intended purpose although they could be biased high or low. Rejected results are considered unusable, thus limiting the size of the useable data set. For site CPP-13, no data points were rejected based on the method validation as documented in the Limitations and Validation (L&V) Reports, thus making this possible source of uncertainty insignificant.

Uncertainty associated with the chemical screening process (Section 5.2) results from using the maximum concentration for chemicals detected in the Environmentally Controlled Areas (ECAs) in the background comparison step, retaining chemicals detected as COPCs because there is not a corresponding background value, and retaining chemicals as COPCs for which there is no toxicity information available.

In most cases, the COPC identification process used the maximum concentration for a chemical detected in the background comparison step, regardless of its magnitude above background. The use of the maximum concentration can result in the identification of COPCs that have concentrations only slightly above background. For site CPP-13, arsenic was the only COPC that fell into this category with a maximum

concentration of 8.3 mg/kg and a background value of 5.8 mg/kg. This results in an increase in the number of COPCs considered in the remedial investigation/Baseline Risk Assessment (RI/BRA) and a possible overestimation of risk because of inclusion of COPCs with concentrations that are likely within the true background population.

Another source of uncertainty related to the background comparison step in the chemical screening process relates to chemicals for which no background concentration exists. For example, fluoride, nitrate, and several radionuclides were not characterized as part of the Rood et al. (1995) background study. For site CPP-13, the following COPCs have no corresponding background concentration: Co-60, Cs-134, Eu-154, and Tc-99. This results in an increase in the number of COPCs considered in the RI/BRA and a possible overestimation of risk because the observed concentrations may be within the background population.

Some concentration estimates are based on the 95% UCL for the site. The 95% UCLs (i.e., the concentration term estimate) of a COPC is below the corresponding background value; this results in an increase in the number of COPC in the RI/BRA and a possible overestimation of risk because the results are likely within the background range. For site CPP-13, all 95% UCLs were above the corresponding background value.

For site CPP-13, zirconium was retained as a COPC for the RI/BRA. There are no toxicity values in Integrated Risk Information System (IRIS), Health Effects Assessment Summary Tables (HEAST), or EPA Region III publications for zirconium. Zirconium was detected at a maximum concentration in soil of 14.3 mg/kg. Zirconium is used in coating nuclear-fuel rods, corrosion-resistant alloys, special welding fluxes, and laboratory crucibles. The impact of not including zirconium in the RI/BRA may underestimate the risk; however, the impact is not quantifiable because of the lack of toxicity information.

With respect to the nature and extent assessment, site CPP-13 has been defined as the portion of the bermed area affected by an air release of radioactively contaminated waste. If areas surrounding the berm were also impacted, the lateral zone of contamination may be underestimated. All three samples at CPP-13 are located near the boundaries of the ECA and contained COPCs at levels above background, hence the lateral extent of contamination may be underestimated.

The zone of contamination is currently assumed to extend throughout the 7.6 m (25 ft) height of the berm. However, all samples were collected at the edges and base of the berm, hence there is no information about COPC levels within the berm. If COPC levels are below background within the berm, the true mass of affected soil may be overestimated.

A source of uncertainty may be associated with the contaminant inventories used for the groundwater modeling and residential intrusion exposure at each sub-area. Section 19.4.3 identifies radionuclides potentially missing from these inventories. The implication of these potential data gaps is that the source estimates could be underestimated. Based on the results of the groundwater model, the potentially missing Pu-241, which has a half-life of 14.7 years, would not be expected to be of concern because of its short half life and long travel time to the aquifer. Am-241 is potentially missing from the source estimates, but is not expected to be of concern because most of the activity has been accounted for in the tank farm and the source assumptions have been shown to be conservative. For a discussion of potential uncertainty associated with

Pu-238, Pu-239, and Pu-240, see Section 10 of Appendix F. The potential uncertainty is recognized in this report, but no information is available to quantify the uncertainty.

19.6 Conclusions and Recommendations

The results of the risk assessment under current land use at CPP-13 indicate that the increased cancer risk from exposure to site-related contaminants are above the Environmental Protection Agency (EPA)-recommended target range for all receptors. The noncarcinogenic hazard for all receptors was found to be well below the EPA hazard index goal of one. These estimates do not include the contributions associated with the air and groundwater pathways. The total increased cancer and hazard incidence to humans is reported in Section 27. It is likely that the risk estimates at this site are overestimated to some extent for reasons described in Sections 7 and 19.5 of this report. It should be noted that the estimates under current land use did not include the benefits associated with the implementation of a radiation protection program at the INEL that is designed to limit worker exposure to within protective levels. Given these limitations, the increased cancer incidence from site-related contamination is still expected to be severe enough that some type of future response action to mitigate adverse impacts to human health and the environment will be necessary at this site. However, it may be more appropriate to design the response action so that it is protective of future receptor populations.

19.7 References

Rood, S. M., G. A. Harris, and G. J. White, 1995, *Background Dose Equivalent Rates and Surficial Soil Metal and Radionuclide Concentrations for the Idaho National Engineering Laboratory*, INEL-94/0250, Revision 0, February.

WINCO, 1993, *Final Track 2 Summary Report for Operable Unit 3-08 (Tank Farm Area II)*, Revision 3, July.

Chapter 20

20. SITE CPP-06 RESULTS

Site CPP-06 consists of a trench near the southern border of the ICPP that was used to dispose of fuel storage basin water from building CPP-603 (Figure 20-1). This section describes the site, investigative results, the nature and extent of contamination associated with the trench, followed by the results of the human health risk assessment (HHRA).

20.1 Site Description

During the late 1950s or early 1960s, the CPP-06 trench was used to dispose of nearly 1.9M L (500,000 gal) of CPP-603 basin water that was generated during basin maintenance activities. The south basin in building CPP-603 was drained for removal of guide pins in the basin floor after the Savannah River fuel storage racks were removed. The water was piped across Willow Avenue and discharged into the trench on the south side of Willow Avenue. Personnel assigned to building CPP-603 confirmed the release of the basin water and identified the location of discharge to be the trench adjacent to Willow Avenue. Based on the volume of the water released and surface topography, the trench dimensions have been estimated at 3.0 × 76.2 m (10 × 250 ft) and the trench was abandoned in place after the disposal of basin water. The basin water sent to the trench reportedly contained up to 50 ppm chloride ion, and a former employee who worked at building CPP-603 during the release reported the basin water was surveyed before release and did not contain elevated levels of radioactivity. The area is now covered with soil backfill.

The disposal of basin water in the CPP-06 trench may have contributed to the formation of perched water beneath the southern portion of the ICPP. Perched water was first identified beneath building CPP-603 in the early 1960's and was primarily attributed to discharges to the CPP-02 French drain, but discharge of basin water to the trench may have contributed to the extent of the perched water zone. The extent of perched water beneath the ICPP is discussed in detail in Section 2.5. Contamination in perched groundwater is described in Section 4.2.

20.2 Investigative Results

The reported location of site CPP-06 was changed from outside the northeast corner of building CPP-603 to a trench area south of CPP-603 based on information gathered during the preparation of the CPP-06 Track 2 (WINCO, 1994). No soil samples have been previously collected in the CPP-06 trench area, however, personnel familiar with the release of basin water to the trench reported the water was surveyed and contained radioactivity levels near background.

One soil boring was drilled approximately midway along the length of the trench (Figure 20-1) as part of the OU 3-09 Track 2. The samples from this borehole were used to determine possible contaminants and concentrations present from the release of basin water during maintenance activities.

Samples were collected in the CPP-06 borehole from 0.0- to 0.15-m (0- to 0.5-ft) below ground surface (bgs), 0.8- to 1.2-m (2.5- to 4-ft) bgs, 1.9- to 3.0-m (9.5- to 10-ft) bgs, and at the soil/basalt interface at 9.1-m (30-ft) bgs. Radiation readings in all samples measured less than background (150–200 cpm).

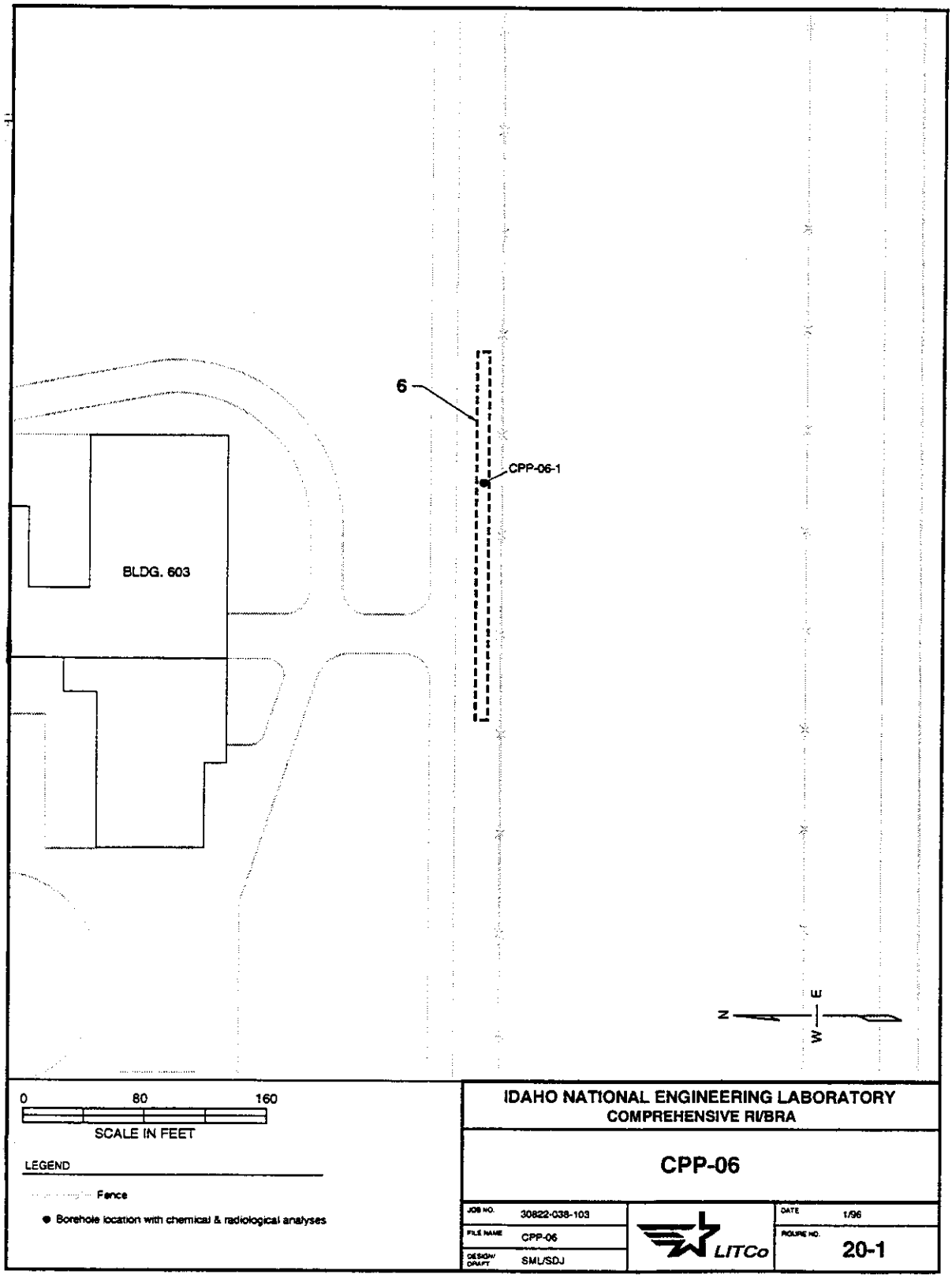


Figure 20-1. CPP-06 and borehole location.

A compilation of the analytical results for the four samples collected to characterize the release at CPP-06 is contained in Appendix G. Based on the chemical screening presented in Section 5.2, Cs-137 and Sr-90 were identified as contaminants of potential concern (COPCs) for this site. The analytical results for COPCs are summarized in Table 20-1. Results are based on samples collected from one boring, CPP-06-1. In this boring, Cs-137 activities decreased from 14.4 pCi/g in the surficial sample to 1.09 pCi/g in the 0.7- to 1.2-m (2.5- to 4.0-ft) interval, to below background in the 2.7- to 3.2-m (9.0- to 10.5-ft) interval. Sr-90 decreased from 6.98 pCi/g in the surficial sample to 1.16 pCi/g in the sample from 0.8- to 1.2-m (2.5- to 4-ft) bgs.

20.3 Nature and Extent of Contamination

Based on investigative results, the only COPCs at site CPP-06 are Sr-90 and Cs-137. Both were detected at activities above background in samples collected from 0.0 to 0.15 m (0.0 to 0.5 ft) and 0.7 to 1.2 m (2.5 to 4 ft); however, activities of both COPCs decreased with depth and were below background by 2.7 m (9 ft). The zone of contamination is assumed to extend from ground surface to 1.5-m (5.0-ft) bgs. The area of CPP-06 is estimated to be 232 m^2 (2,500 ft^2), based on the reported dimensions of the trench.

20.4 Risk Assessment

The methodology for conducting the HHRA for WAG 3 is detailed in Section 7. As presented, the purpose of the HHRA is to develop a quantitative description and assessment of the human health risk posed by the COPCs present at WAG 3. This section only contains the results of the HHRA for site CPP-06 with respect to the soil pathways. The results for the air and groundwater pathways are detailed in Sections 27.1 and 27.2, respectively. The risk assessment at this site will become cumulative when the contributions from the air and groundwater pathways are added to that from the soil pathway. The following sections discuss the complete exposure routes, exposure-point concentrations, and cancer risk and noncarcinogenic health hazard estimates for site CPP-06 under the three exposure scenarios evaluated. Section 20.4.3 explains the difference in estimating sources of contamination for use in evaluating surface exposure and groundwater modeling. It also describes the use of the screen ORIGIN results to help identify contaminants potentially missing from the soil source estimate.

20.4.1 Complete Exposure Routes

Potentially complete pathways from the source to a human receptor are described in Section 7 and illustrated on Figure 7-1. For site CPP-06, the complete exposure routes within each pathway are summarized in Table 20-2. An exposure route is considered complete if the contaminated zone (as characterized in the previous sections) occurs within the depth intervals specified for a given exposure route. All exposure routes were evaluated for site CPP-06.

20.4.2 Exposure-Point Concentrations

Specific steps in calculating exposure-point concentrations for each of the applicable scenarios were described in Section 7. The COPC soil value used was the smaller of the 95% upper confidence limit (UCL) or maximum concentration. The concentration terms for the radionuclides were adjusted to account for decay for each exposure scenario. These values were subsequently averaged over the exposure duration. The concentration terms, by depth interval, are presented in Table 20-3. Exposures from all complete exposure routes were estimated based on the exposure-point concentrations in Table 20-4. Homegrown produce

Table 20-1. Summary statistics for CPP-06, trench east of CPP-603 fuel storage basin.

COPCs	Concentration (mg/kg or pCi/g) Minimum detected	Maximum detected	Arithmetic mean	Standard deviation	Number of samples	Number of detects	Frequency of detection	INEL background (mg/kg or pCi/g)	Number greater than background
Cs-137	0.269	14.4	5.25E+00	7.93E+00	3	3	100%	0.82	2
Sr-90	1.16 J	6.98	4.07E+00	4.12E+00	2	2	100%	0.49	2

Table 20-2. Complete exposure routes for site CPP-06 and associated exposure route depths.

Receptor	Scenario	Potentially complete exposure route and exposure route depths used for exposure-point concentration estimates	Characterized zone of contamination	Complete exposure route?
Onsite worker	Current land use	Inhalation of VOCs	0 to 1.5 m	No
		[0–15 cm (0–6 in.)]	(0 to 5 ft)	Yes
		Inhalation of airborne particulates [0–15 cm (0–6 in.)]		Yes
		Ingestion of surface soil [0–15 cm (0–6 in.)]		Yes
		External radiation [0–1.22 m (0–4 ft)]		
Residential	Future land use	Inhalation of VOCs [0–3.05 m (0–10 ft)]	0 to 1.5 m	No
		Inhalation of airborne particulates [0–3.05 m (0–10 ft)]	(0 to 5 ft)	Yes
		Ingestion of surface soil [0–3.05 m (0–10 ft)]		Yes
		Ingestion of homegrown produce [0–3.05 m (0–10 ft)]		Yes
		Ingestion of groundwater		Yes
		Dermal contact with groundwater		No
		Inhalation of VOCs from groundwater		No
		External radiation [0–3.05 m (0–10 ft)]		Yes
Onsite worker	Future land use	Inhalation of VOCs [0–15 cm (0–6 in.)]	0 to 1.5 m	No
		Inhalation of airborne particulates [0–15 cm (0–6 in.)]	(0 to 5 ft)	Yes
		Ingestion of surface soil [0–15 cm (0–6 in.)]		Yes
		External radiation [0–1.22 m (0–4 ft)]		Yes

Table 20-3. Soil concentration terms by depth interval.

COPCs	Soil concentrations (mg/kg or pCi/g) (0 - 0.5 ft)	(0 - 4 ft)	(0 - 10 ft)
Aroclor-1260	---	---	---
Benzo(a)pyrene	---	---	---
Aluminum	---	---	---
Arsenic	---	---	---
Manganese	---	---	---
Mercury	---	---	---
Uranium	---	---	---
Am-241	---	---	---
Ce-144	---	---	---
Co-57	---	---	---
Co-58	---	---	---
Co-60	---	---	---
Cs-134	---	---	---
Cs-137	1.44E+01	1.44E+01	1.44E+01
Eu-152	---	---	---
Eu-154	---	---	---
Eu-155	---	---	---
H-3	---	---	---
I-129	---	---	---
K-40	---	---	---
Nb-95	---	---	---
Np-237	---	---	---
Pu-238	---	---	---
Pu-239/240	---	---	---
Pu-241	---	---	---
Pu-242	---	---	---
Ru/Rh-106	---	---	---
Sb-125	---	---	---
Sr-90	6.98E+00	6.98E+00	6.98E+00
Tc-99	---	---	---
U-234	---	---	---
U-235	---	---	---
U-236	---	---	---
U-238	---	---	---

Table 20-4. Average soil exposure-point concentrations (mg/kg or pCi/g) for land use scenarios.

	Current occupational worker year 0 to year 25		Future occupational worker year 100 to year 125		Future resident year 100 to year 130
COPCs	(0 - 0.5 ft)	(0 - 4 ft)	(0 - 0.5 ft)	(0 - 4 ft)	(0 - 10 ft)
Aroclor-1260	---	---	---	---	---
Benzo(a)pyrene	---	---	---	---	---
Aluminum	---	---	---	---	---
Arsenic	---	---	---	---	---
Manganese	---	---	---	---	---
Mercury	---	---	---	---	---
Uranium	---	---	---	---	---
Am-241	---	---	---	---	---
Ce-144	---	---	---	---	---
Co-57	---	---	---	---	---
Co-58	---	---	---	---	---
Co-60	---	---	---	---	---
Cs-134	---	---	---	---	---
Cs-137	1.10E+01	1.10E+01	1.10E+00	1.10E+00	1.05E+00
Eu-152	---	---	---	---	---
Eu-154	---	---	---	---	---
Eu-155	---	---	---	---	---
H-3	---	---	---	---	---
I-129	---	---	---	---	---
K-40	---	---	---	---	---
Nb-95	---	---	---	---	---
Np-237	---	---	---	---	---
Pu-238	---	---	---	---	---
Pu-239/240	---	---	---	---	---
Pu-241	---	---	---	---	---
Pu-242	---	---	---	---	---
Ru/Rh-106	---	---	---	---	---
Sb-125	---	---	---	---	---
Sr-90	5.26E+00	5.26E+00	4.86E-01	4.86E-01	4.61E-01
Tc-99	---	---	---	---	---
U-234	---	---	---	---	---
U-235	---	---	---	---	---
U-236	---	---	---	---	---
U-238	---	---	---	---	---

concentrations are presented in Table 20-5. The values for air and groundwater are presented in Sections 27.1 and 27.2, respectively.

20.4.3 Description of Source Estimates for Surface Exposure and Groundwater Modeling Use

The purpose for this subsection is two-fold. First, to compare the approach to defining the source estimate for use in both the surface exposure assessment and the groundwater model. This comparison was accomplished by comparing the soil data in Table 20-3 to the soil data used to estimate the source for use in the groundwater model, which can be found in Tables 5-39 and 5-40 of Appendix F. The benefit of these comparisons is to relate both source estimates and explain any apparent differences. Secondly, the results of the screened ORIGEN runs summarized in Section 4.4 were used to help identify any potential soil-related data gaps by comparing ORIGEN results to the field investigation soil results at this site. This comparison was based on the full inventory of contaminants summarized in screening Table 5-29 before implementing the screening steps shown therein. The results of these comparisons are described for each site in the following paragraphs. It should be noted that the results of the comparisons for perched water and SRPA are reported in the end of Section 4.4.

The same soil COPC's in Table 20-3 for site CPP-06 were used to develop the source estimate for groundwater use. The soil concentrations differed slightly because the soil depth assumption for evaluating residential intrusion surface exposure is based on the measurements taken between 0 to 10 feet bgs., and the groundwater source is based on all data including the measurements taken below 10 feet bgs. Based on a comparison of the radionuclides that were analyzed in site soils against the potential inventory as defined by the screened ORIGEN results (Table 4-7), Am-241 Eu-154, Pu-238, Pu-239/240 and Pu-241 were not part of the soil sampling analytical suite. The implication is that these radionuclides may be present and are currently not part of the soil contaminant inventory.

20.4.4 Risk Estimates

The results of this evaluation under current and future land use are presented in Sections 20.4.3.1 and 20.4.3.2. For each receptor, the results are summarized in Tables 20-6 through 20-11.

20.4.4.1 Current Land Use. As indicated in Table 20-6, total cancer risk to the current onsite worker from exposure to site-related chemicals in surface soil is estimated to be 1E-04. The risk is attributed to external radiation exposure with the primary contaminant of concern (COC) being Cs-137 (1E-04). Table 20-7 indicates that the total noncarcinogenic hazard index to the current worker is estimated to be 0E+00. There are no hazard indices above unity for the current onsite worker.

20.4.4.2 Future Land Use. As Table 20-8 indicates, the total cancer risk to the future onsite worker from exposure to site-related chemicals in surface soil is estimated to be 1E-05. The risk is attributed to external radiation exposure, with the primary COC being Cs-137 (1E-05). Table 20-9 indicates the total noncarcinogenic hazard index to the future onsite worker is estimated to be 0E+00. There are no hazard indices above unity for the future onsite worker. As indicated in Table 20-10, the total cancer risk to the future resident from exposure to site-related chemicals in soil is estimated to be 6E-05. The primary contributor to the risk associated with external radiation exposure is Cs-137 (6E-05). As shown on

Table 20-5. Concentrations of COPCs in homegrown produce.

COPCs	Homegrown produce (mg/kg or pCi/g)	Kd (cm^3/g)	COPC input rate from irrigation (mg/g-d or pCi/g-d)	Leach rate constant (d^{-1})
Aroclor-1260	---	7.89E+03	0.00E+00	9.95E-07
Benzo(a)pyrene	---	1.19E+03	0.00E+00	6.57E-06
Aluminum	---	0.00E+00	0.00E+00	2.87E-02
Arsenic	1.40E-04	3.00E+00	8.71E-09	2.40E-03
Manganese	---	5.00E+01	0.00E+00	1.56E-04
Mercury	1.10E-01	1.00E+02	2.91E-08	7.83E-05
Uranium	7.30E-05	6.00E+00	7.04E-09	1.25E-03
Am-241	7.76E-06	3.40E+02	6.08E-06	2.31E-05
Ce-144	---	5.00E+02	0.00E+00	1.57E-05
Co-57	---	1.00E+01	0.00E+00	7.64E-04
Co-58	---	1.00E+01	0.00E+00	7.64E-04
Co-60	---	1.00E+01	0.00E+00	7.64E-04
Cs-134	---	5.00E+02	0.00E+00	1.57E-05
Cs-137	2.71E-02	5.00E+02	4.12E-05	1.57E-05
Eu-152	---	3.40E+02	0.00E+00	2.31E-05
Eu-154	---	3.40E+02	0.00E+00	2.31E-05
Eu-155	---	3.40E+02	0.00E+00	2.31E-05
H-3	---	0.00E+00	6.22E-04	2.87E-02
I-129	3.85E-06	0.00E+00	3.26E-05	2.87E-02
K-40	---	1.50E+01	0.00E+00	5.14E-04
Nb-95	---	0.00E+00	0.00E+00	2.87E-02
Np-237	3.19E-05	0.00E+00	8.36E-06	2.87E-02
Pu-238	---	2.20E+01	0.00E+00	3.53E-04
Pu-239/240	5.15E-06	2.20E+01	5.84E-07	3.53E-04
Pu-241	8.49E-09	2.20E+01	9.37E-08	3.53E-04
Pu-242	3.60E-09	2.20E+01	3.88E-10	3.53E-04
Ru/Rh-106	---	0.00E+00	0.00E+00	2.87E-02
Sb-125	---	5.00E+01	0.00E+00	1.56E-04
Sr-90	8.51E-02	1.20E+01	5.63E-05	6.40E-04
Tc-99	4.56E-01	0.00E+00	1.67E-04	2.87E-02
U-234	2.73E-05	6.00E+00	2.63E-06	1.25E-03
U-235	9.61E-07	6.00E+00	9.27E-08	1.25E-03
U-236	6.93E-07	6.00E+00	6.68E-08	1.25E-03
U-238	2.44E-05	6.00E+00	2.35E-06	1.25E-03

Table 20-6. Soil pathway cancer risk to the current onsite worker. [a]

COPCs	Ingestion of soil	External radiation exposure	Total risks
Aroclor-1260	----	----	----
Benzo(a)pyrene	----	----	----
Aluminum	----	----	----
Arsenic	----	----	----
Manganese	----	----	----
Mercury	----	----	----
Uranium	----	----	----
Am-241	----	----	----
Ce-144	----	----	----
Co-57	----	----	----
Co-58	----	----	----
Co-60	----	----	----
Cs-134	----	----	----
Cs-137	9E-08	1E-04	1E-04
Eu-152	----	----	----
Eu-154	----	----	----
Eu-155	----	----	----
H-3	----	----	----
I-129	----	----	----
K-40	----	----	----
Nb-95	----	----	----
Np-237	----	----	----
Pu-238	----	----	----
Pu-239/240	----	----	----
Pu-241	----	----	----
Pu-242	----	----	----
Ru/Rh-106	----	----	----
Sb-125	----	----	----
Sr-90	7E-08	NTD	7E-08
Tc-99	----	----	----
U-234	----	----	----
U-235	----	----	----
U-236	----	----	----
U-238	----	----	----
Total cancer risks by route:	2E-07	1E-04	1E-04

"----" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 20-7. Soil pathway noncarcinogenic hazard to the current onsite worker.[a,b]

COPCs	Ingestion of soil	External radiation exposure	Total HIs
Aroclor-1260	----	----	----
Benzo(a)pyrene	----	----	----
Aluminum	----	----	----
Arsenic	----	----	----
Manganese	----	----	----
Mercury	----	----	----
Uranium	----	----	----
Am-241	----	----	----
Ce-144	----	----	----
Co-57	----	----	----
Co-58	----	----	----
Co-60	----	----	----
Cs-134	----	----	----
Cs-137	----	----	----
Eu-152	----	----	----
Eu-154	----	----	----
Eu-155	----	----	----
H-3	----	----	----
I-129	----	----	----
K-40	----	----	----
Nb-95	----	----	----
Np-237	----	----	----
Pu-238	----	----	----
Pu-239/240	----	----	----
Pu-241	----	----	----
Pu-242	----	----	----
Ru/Rh-106	----	----	----
Sb-125	----	----	----
Sr-90	----	----	----
Tc-99	----	----	----
U-234	----	----	----
U-235	----	----	----
U-236	----	----	----
U-238	----	----	----
Total hazard indices by route:	0E+00	0E+00	0E+00

"----" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. No noncarcinogenic contamination has been detecetd at CPP-06, so there is no calculated hazard index for workers or residents at the site.
b. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 20-8. Soil pathway cancer risk to the future onsite worker. [a]

COPCs	Ingestion of soil	External radiation exposure	Total risks
Aroclor-1260	---	---	---
Benzo(a)pyrene	---	---	---
Aluminum	---	---	---
Arsenic	---	---	---
Manganese	---	---	---
Mercury	---	---	---
Uranium	---	---	---
Am-241	---	---	---
Ce-144	---	---	---
Co-57	---	---	---
Co-58	---	---	---
Co-60	---	---	---
Cs-134	---	---	---
Cs-137	9E-09	1E-05	1E-05
Eu-152	---	---	---
Eu-154	---	---	---
Eu-155	---	---	---
H-3	---	---	---
I-129	---	---	---
K-40	---	---	---
Nb-95	---	---	---
Np-237	---	---	---
Pu-238	---	---	---
Pu-239/240	---	---	---
Pu-241	---	---	---
Pu-242	---	---	---
Ru/Rh-106	---	---	---
Sb-125	---	---	---
Sr-90	7E-09	NTD	7E-09
Tc-99	---	---	---
U-234	---	---	---
U-235	---	---	---
U-236	---	---	---
U-238	---	---	---
Total cancer risks by route:	2E-08	1E-05	1E-05

"---" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 20-9. Soil pathway noncarcinogenic hazard to the future onsite worker.[a,b]

COPCs	Ingestion of soil	External radiation exposure	Total HIs
Aroclor-1260	----	----	----
Benzo(a)pyrene	----	----	----
Aluminum	----	----	----
Arsenic	----	----	----
Manganese	----	----	----
Mercury	----	----	----
Uranium	----	----	----
Am-241	----	----	----
Ce-144	----	----	----
Co-57	----	----	----
Co-58	----	----	----
Co-60	----	----	----
Cs-134	----	----	----
Cs-137	----	----	----
Eu-152	----	----	----
Eu-154	----	----	----
Eu-155	----	----	----
H-3	----	----	----
I-129	----	----	----
K-40	----	----	----
Nb-95	----	----	----
Np-237	----	----	----
Pu-238	----	----	----
Pu-239/240	----	----	----
Pu-241	----	----	----
Pu-242	----	----	----
Ru/Rh-106	----	----	----
Sb-125	----	----	----
Sr-90	----	----	----
Tc-99	----	----	----
U-234	----	----	----
U-235	----	----	----
U-236	----	----	----
U-238	----	----	----
Total hazard indices by route:	0E+00	0E+00	0E+00

"----" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. No noncarcinogenic contamination has been detecetd at CPP-06, so there is no calculated hazard index for workers or residents at the site.
b. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 20-10. Soil pathway cancer risk to the future onsite resident. [a]

COPCs	Ingestion of soil	Ingestion of homegrown	External radiation exposure	Total risks
Aroclor-1260	—	—	—	—
Benzo(a)pyrene	—	—	—	—
Aluminum	—	—	—	—
Arsenic	—	2E-08	—	2E-08
Manganese	—	—	—	—
Mercury	—	NTD	—	—
Uranium	—	NTD	—	—
Am-241	—	4E-10	—	4E-10
Ce-144	—	—	—	—
Co-57	—	—	—	—
Co-58	—	—	—	—
Co-60	—	—	—	—
Cs-134	—	—	—	—
Cs-137	4E-08	2E-07	6E-05	6E-05
Eu-152	—	—	—	—
Eu-154	—	—	—	—
Eu-155	—	—	—	—
H-3	—	—	—	—
I-129	—	1E-10	—	1E-10
K-40	—	—	—	—
Nb-95	—	—	—	—
Np-237	—	2E-09	—	2E-09
Pu-238	—	—	—	—
Pu-239/240	—	3E-10	—	3E-10
Pu-241	—	5E-13	—	5E-13
Pu-242	—	2E-13	—	2E-13
Ru/Rh-106	—	—	—	—
Sb-125	—	—	—	—
Sr-90	3E-08	8E-07	NTD	9E-07
Tc-99	—	1E-07	—	1E-07
U-234	—	2E-10	—	2E-10
U-235	—	8E-12	—	8E-12
U-236	—	5E-12	—	5E-12
U-238	—	3E-10	—	3E-10
Total cancer risks by route:	7E-08	1E-06	6E-05	6E-05

"—" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 20-11. Soil pathway noncarcinogenic hazard to the future onsite resident. [a]

COPCs	Ingestion of soil	Ingestion of homegrown	External radiation exposure	Total HIs
Aroclor-1260	—	—	—	—
Benzo(a)pyrene	—	—	—	—
Aluminum	—	—	—	—
Arsenic	—	1E-04	—	1E-04
Manganese	—	—	—	—
Mercury	—	1E-01	—	1E-01
Uranium	—	6E-06	—	6E-06
Am-241	—	—	—	—
Ce-144	—	—	—	—
Co-57	—	—	—	—
Co-58	—	—	—	—
Co-60	—	—	—	—
Cs-134	—	—	—	—
Cs-137	—	—	—	—
Eu-152	—	—	—	—
Eu-154	—	—	—	—
Eu-155	—	—	—	—
H-3	—	—	—	—
I-129	—	—	—	—
K-40	—	—	—	—
Nb-95	—	—	—	—
Np-237	—	—	—	—
Pu-238	—	—	—	—
Pu-239/240	—	—	—	—
Pu-241	—	—	—	—
Pu-242	—	—	—	—
Ru/Rh-106	—	—	—	—
Sb-125	—	—	—	—
Sr-90	—	—	—	—
Tc-99	—	—	—	—
U-234	—	—	—	—
U-235	—	—	—	—
U-236	—	—	—	—
U-238	—	—	—	—
Total hazard indices by route:	0E+00	1E-01	0E+00	1E-01

"—" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. No noncarcinogenic contamination has been detecetd at CPP-06, so there is no calculated hazard index for workers or residents at the site.
b. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 20-11, the total noncarcinogenic hazard index to the future resident is estimated to be 1E-01. There are no hazard indices above unity for the future resident.

20.5 Uncertainties

This section describes the limitations and uncertainties specific to the site characterization of site CPP-06. Sources of uncertainty associated with site characterization include data quality, COPC identification, concentration term estimation, and assumptions regarding the lateral and vertical extent of COPC occurrence. In the risk assessment, the most significant uncertainties are due to the selection process of COPCs, the toxicity values used, and the assumptions used during the exposure assessment. The following paragraphs will discuss important sources of site-specific uncertainty in greater detail.

Sampling and analysis uncertainties are related to quality problems that may result in qualified and rejected results (Section 3.5). Qualified results are considered estimates of the concentration in the sample and, for all practical purposes, useable for their intended purpose although they could be biased high or low. Rejected results are considered unusable, thus limiting the size of the useable data set. For site CPP-06, no data points were rejected based on the method validation as documented in the Limitations and Validation (L&V) Reports, thus making this possible source of uncertainty insignificant.

Uncertainty associated with the chemical screening process (Section 5.2) results from using the maximum concentration for chemicals detected in the Environmentally Controlled Areas (ECAs) in the background comparison step, retaining chemicals detected as COPCs because there is not a corresponding background value, and retaining chemicals as COPCs for which there is no toxicity information available.

In most cases, the COPC identification process used the maximum concentration for a chemical detected in the background comparison step, regardless of its magnitude above background. The use of the maximum concentration can result in the identification of COPCs that have concentrations only slightly above background. For site CPP-06, none of the COPCs fell into this category.

A source of uncertainty related to the background comparison step in the chemical screening process relates to chemicals for which no background concentration exists. For site CPP-06, all COPCs had corresponding background concentrations. Additionally, concentration estimates for CPP-06 were based on the maximum concentration for the site. This could result in an overestimation of risk. For site CPP-06, all COPCs had toxicity information for use in the HHRA.

The precise lateral and vertical extent of contamination cannot be assessed with a single borehole at CPP-06. Therefore, source term calculations based on those results may either overestimate or underestimate true source terms, based on the true distribution of COPCs at the site. The current ECA boundary is based on the topography of the area and the volume of waste placed into the trench. Hence the true affected soil mass may be either overestimated or underestimated.

One other source of uncertainty may be associated with the contaminant inventories used for the groundwater modeling and residential intrusion exposure at this site. Section 20.4.3 identifies radionuclides potentially missing from these inventories. The implication of these potential data gaps is that the source estimates could be underestimated. Based on the results of the groundwater model, the potentially missing Eu-154 and Pu-241, which have half-lives of 8.6 and 14.7 years, respectively, would not be expected to be of concern because of their short half lives and long travel times to the aquifer. Am-241 is potentially missing

from the source estimates, but is not expected to be of concern because most of the activity has been accounted for in the tank farm, and it has been shown that the source assumptions are conservative. For a discussion of uncertainty associated with Pu-239 and Pu-240, see Section 10 of appendix F. The potential uncertainty is recognized in this report, but no information is available to qualify the uncertainty.

20.6 Conclusions and Recommendations

The results of the risk assessment under current land use at CPP-06 indicate that the increased cancer risk from exposure to site-related contaminants is within the Environmental Protection Agency (EPA)-recommended target range. The increased cancer risk to hypothetical future onsite workers and residents are both within the EPA target range. The noncarcinogenic hazard for all receptors was found to be well below the EPA hazard index goal of one. These estimates do not include the contributions associated with the air and groundwater pathways. The total increased cancer and hazard incidence to humans is reported in Section 27. It is important to note that the risk estimates at this site are likely to be overestimated for reasons described in Sections 7 and 20.5 and therefore, the actual estimates would be expected to be lower. Even after the contributions from the air and groundwater pathways are added to these values for a cumulative representation of the risk and hazard at this site, future response actions to mitigate adverse impacts from site-related contamination are not warranted.

20.7 References

WINCO, 1994, *Draft Preliminary Scoping Track 2 Summary Report For Operable Unit 3-09,* Revision 1, September.

Chapter 21

21. SITE CPP-19 RESULTS

Site CPP-19 is related to a leak in a waste transfer line to the north of building CPP-603 (Figures 5-2 and 21-1). This section describes the site, investigative results, the nature and extent of contamination related to the leak, followed by the results of the human health risk assessment (HHRA).

21.1 Site Description

During the graveyard shift on March 9, 1978, a leak was discovered in the waste transfer line from the Basin Liquid Waste Tank (SFE-106) to the Waste Evaporator Feed Tank (WL-102). The leak began at approximately 5:30 a.m. when the transfer pump was started to transfer 13,250 L (3,500 gal) of waste fluid. After the transfer was complete, the waste management operator notified the fuel storage operator that no liquid reached the storage tank (WL-102).

The line was inspected during the day shift on March 9, 1978, by filling the line with water and performing a hydrostatic test. The hydrostatic test forced water out the breach in the transfer line and up to the ground surface where it pooled. Operating procedures require transfer lines to be hydrostatically tested every 6 months, and this transfer line had a successful test on October 6, 1977. The waste transfer line was constructed of 304 stainless steel that reduced from a 3.81-cm to 3.18-cm (1-1/2- to 1-1/4-in.) diameter and ran for 530 m (0.33 mi) at a depth of approximately 1.5-m (5-ft) bgs. The major area of contamination was estimated at the time to be approximately 10 m^2 (108 ft^2) on the surface. The waste transfer line was abandoned in place after the leak was discovered.

Documentation was not available delineating the exact location of the waste transfer line leak. However, personnel from building CPP-603 familiar with the leak were interviewed to confirm the location. The personnel confirmed the area identified as site CPP-19 as the location where the line leak occurred. The locations of the Track 2 soil borings were based on this information.

21.2 Investigative Results

Soil samples were collected from the area of contamination following the line rupture date and analyzed for gamma-emitting radioisotopes. Total gamma activity was measured at approximately 2.2 μCi/g. Radionuclides detected were Ce-144, Co-60, Cs-134, Cs-137, Eu-152, Eu-154, Eu-155, Nb-95, and Sb-125. Previous sampling of the SFE-106 tank contents has also shown cadmium to be present. Surface exposure readings collected following the release in the contaminated area ranged from 50 to 3.5 R/hr. Approximately 80 m^3 (2,825 ft^3) of contaminated soil was removed from site CPP-19, with the majority of the soil being removed from the area of highest contamination [approximately 10.0 m^2 (108 ft^2)]. The remaining surface contamination was scraped off to a 0.15- to 0.23-m (6- to 8-in.) depth. Fifty-seven boxes of soil containing a total activity of 3 Ci were sent to the Radioactive Waste Management Complex (RWMC) for disposal. An Allied Chemical Corporation interoffice correspondence dated May 8, 1979, reported the entire area was then backfilled with clean soil to reduce exposure levels to less than 0.5 mR/hr.

As part of the OU 3-09 Track 2 investigation (WINCO, 1994), four borings were drilled at site CPP-19 (Figure 21-1). Boring CPP-19-2 was positioned at the approximate location of the release, while boring

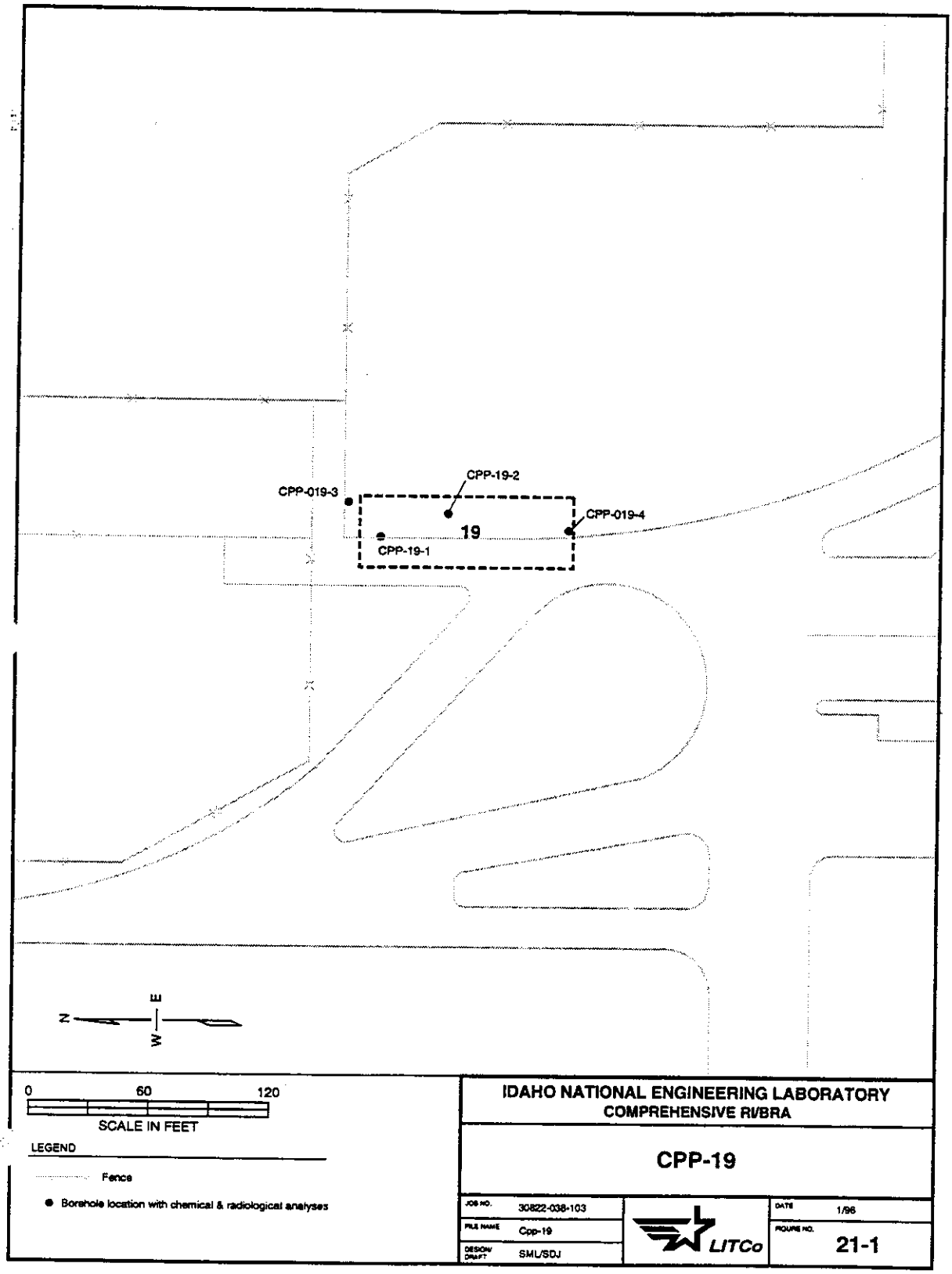


Figure 21-1. CPP-19 and borehole locations.

CPP-19-1 was located along the transfer line north of the first sample boring. Utility drawings of the building CPP-603 area showed the location of the waste transfer line.

A surface soil sample was collected from boring CPP-19-1 between 0.0 to 0.15 m (0.0 to 0.5 ft) bgs and measured 300 cpm above a 2,000 cpm background level measured at the drill rig. All additional samples collected below 0.15-m (0.5-ft) bgs were taken outside the area and compared to a background level measured in an area containing lower radiation levels. A sample was collected from 0.15- to 0.46-m (0.5- to 1.5-ft) bgs and measured 10 cpm above a 120 cpm background level. A third sample (and duplicate) was collected between 1.8- to 2.4-m (6- to 8-ft) bgs and measured 40 cpm on a Ludlum 2A portable survey instrument. Continuous split-spoon samples were taken at 1.5-m (5-ft) intervals between 3.0-m (10-ft) bgs and the soil/basalt interface located approximately 9.5 m (31 ft) bgs. The sample taken between 4.3 to 4.9 m (14 to 16 ft) bgs measured 4,600 cpm and was the highest radiation level for the 3.0 m (10 ft) to soil/basalt interface interval and the sample was sent for laboratory analyses. A sample was also collected for laboratory analyses at the soil/basalt interface.

Boring CPP-19-2 was located in the contaminated area approximately 1.5 m (5 ft) to the north of where the line rupture is believed to have occurred. A surface sample was collected between 0.0 to 0.15 m (0 to 0.5 ft) bgs and measured 200 cpm above a 100 cpm background level. A sample was then collected between 0.6 to 1.2 m (2 to 4 ft) and surveyed at 10,000 cpm above background. The third sample was collected between 1.2 to 1.8 m (4 to 6 ft) and surveyed at 80 mR/hr. Continuous split-spoon samples were taken and surveyed every 1.5-m (5-ft) between 3.0-m (10-ft) bgs and the soil/basalt interface located at approximately 9.1 m (30 ft) bgs. The sample collected between 4.0 to 4.6 m (13 to 15 ft) bgs was surveyed at 60 mR/hr and had the highest field radiation level for the samples screened between 3.0 m (10 ft) bgs and the soil/basalt interface. A soil sample was collected at the soil/basalt interface and surveyed at 1,000 cpm above a 100 cpm background. Because the radiation levels at the interface were above background, the boring was continued down to the first sedimentary interbed located 39.6-m (130-ft) bgs. The sample collected at the interbed was surveyed at background.

At location CPP-19-3, the following samples were collected and retained for radiological and inorganic analysis: 0.8 to 1.5 m (2.5 to 5.0 ft) bgs, 1.5 to 2.3 m (5.0 to 7.5 ft) bgs, 8.4 to 9.1 m (27.5- to 30.0-ft) bgs, and at the soil-basalt interface at 9.6 m (31.5 ft) bgs. Samples from all four intervals gave field-screening radiological levels of 75 cpm.

At location CPP-19-4, the following samples were collected and retained for radiological and inorganic analysis (measured radiation level in parentheses): 0.15 to 0.8 m (0.5- to 2.5-ft) bgs (100 cpm), 0.8 to 1.5 m to (2.5- to 5.0-ft) bgs (100 cpm), 2.3 to 3.0 m (7.5- to 10.0-ft) bgs (125 cpm), 6.8 to 7.6 m (22.5- to 25.0-ft) bgs (175 cpm) and at 9.6-m (31.4-ft) bgs (150 cpm).

The analytical results for the contaminants of potential concern (COPCs) associated with CPP-19 are summarized in Table 21-1. A compilation of the analytical results is provided in Appendix G. Based on the chemical screening presented in Section 5.2, the following COPCs were identified for this site: arsenic, calcium, Am-241, Co-60, Sr-90, Nb-95, Cs-134, Cs-137, Eu-152, Eu-154, Eu-155, U-235, and Pu-239. Arsenic was detected at a maximum concentration of 8.3 mg/kg relative to a background concentration of 5.8 mg/kg. Calcium was detected at a concentration of 232,000 mg/kg, which is approximately an order of magnitude greater than the background value for calcium.

Table 21-1. Summary statistics for CPP-19, CPP-603 to CPP-604 line leak.

COPCs	Concentration (mg/kg or pCi/g) Minimum detected	Maximum detected	Arithmetic mean	Standard deviation	Number of samples	Number of detects	Frequency of detection	INEL background (mg/kg or pCi/g)	Number greater than background
Arsenic	3.1 *J P	8.3 *J P	4.98E+00	1.61E+00	11	11	100%	5.8	2
Calcium	2180 P	232000 * P	3.31E+04	6.65E+04	11	11	100%	24000	2
Am-241	1.97	1.97	1.97E+00		1	1	100%	0.011	1
Co-60	0.19 +/- 0.03	21600	1.08E+04	1.53E+04	12	2	17%	NA	NA
Cs-134	0.05 +/- 0.01	0.06 +/- 0.02	5.50E-02	7.07E-03	11	2	18%	NA	NA
Cs-137	0.06 +/- 0.01	408000	3.14E+04	1.13E+05	18	13	72%	0.82	11
Eu-152	1.52	87600	2.92E+04	5.06E+04	3	3	100%	NA	NA
Eu-154	0.17 +/- 0.04	53500	1.34E+04	2.67E+04	13	4	31%	NA	NA
Eu-155	0.16 +/- 0.05	9620	2.41E+03	4.81E+03	12	4	33%	NA	NA
Nb-95	0.06 +/- 0.01	0.09 +/- 0.02	7.50E-02	1.29E-02	11	4	36%	NA	NA
Pu-239/240	141 J	141 J	1.41E+02	NA	1	1	100%	0.1	1
Sr-90	28.5	125000	2.68E+04	5.02E+04	10	8	80%	0.49	8
U-235	0.0173	2.36	8.17E-01	1.34E+00	3	3	100%	NA	NA

NA - Not applicable/available

Samples from boring CPP-19-2, drilled at the location of the release, indicated high activity levels for a number of radionuclides, particularly in the 1.2- to 1.8-m (4.0- to 6.0-ft) interval. Radionuclides detected in the interval include Am-241 at 1.97 pCi/g, Co-60 at 21,600 pCi/g, Cs-137 at 408,000 pCi/g, Eu-152 at 87,600 pCi/g, Eu-154 at 53,500 pCi/g, Eu-155 at 9,620 pCi/g, Pu-239 at 141 pCi/g, and Sr-90 at 125,000 pCi/g. In boring CPP-19-2, Sr-90 was also detected at 88,000 pCi/g in the 4.3- to 4.9-m (14.0- to 16.0-ft) interval; and Cs-137, Eu-152, Eu-154, and Sr-90 were detected at activities above 1 pCi/g at the soil/basalt interface at approximately 9.5 m (31 ft) bgs.

Cs-137 was the most widely distributed radiological contaminant in the remaining borings at site CPP-19 with activities ranging up to 11.5±0.2 pCi/g. Cs-137 was not detected above background at a depth greater than 1.2 m (4.0 ft) in borings other than CPP-19-2. Detection of radionuclides was generally limited to near-surface samples [shallower than 1.2 m (4.0 ft)] in borings other than CPP-19-2. Exceptions were detections of Sr-90 (840 pCi/g) and U-235 (0.173 pCi/g) in the 4.3- to 4.9-m (14- to 16-ft) sample from boring CPP-19-1; and low activity detections of Cs-134, Eu-155, and Nb-95 in deeper samples from boring CPP-19-4.

21.3 Nature and Extent of Soil Contamination

Based on investigative results, numerous radionuclides were identified as COPCs for site CPP-19. Cs-137, Sr-90, and isotopes of Europium are the most widespread of the COPCs and are found at the highest activity levels. These COPCs range in activity to as high as 408,000 pCi/g for Cs-137 at boring CPP-19-2, drilled at the site of the release. COPCs were detected at activity levels above background in samples collected just above the soil/basalt interface at approximately 9.2 m (31 ft) bgs. The zone of contamination is assumed to extend from the ground surface to the soil/basalt interface.

The area of site CPP-19 shown on Figure 5-2 has been expanded to the north, west, and south on Figure 21-1 based on the results of the borings. The new area of site CPP-19 is estimated to be 306 m^2 (3,300 ft^2) as shown on Figure 21-1.

21.4 Risk Assessment

The methodology for conducting the HHRA for waste area group (WAG) 3 is detailed in Section 7. As presented, the purpose of the HHRA is to develop a quantitative description and assessment of the human health risk posed by the COPCs present at WAG 3. This section only contains the results of the HHRA for site CPP-19 with respect to the soil pathways. The results for the air and groundwater pathways are detailed in Sections 27.1 and 27.2, respectively. The risk assessment for this site becomes cumulative when the contributions from the air and groundwater pathway are added to that from the soil pathway. The following sections discuss the complete exposure routes, exposure-point concentrations, and cancer risk and noncarcinogenic health hazard estimates for the site CPP-19 under the three exposure scenarios evaluated. Section 21.4.3 will explain the difference in estimating the sources of contamination for use in evaluating surface exposures and use for groundwater modeling. This section will also describes the use of the screened ORIGEN results (Section 4.4) to help identify contaminants potentially missing from the soil source estimate.

21.4.1 Complete Exposure Routes

Potentially complete pathways from the source to a human receptor are described in Section 7 and illustrated on Figure 7-1. For site CPP-19, the complete exposure routes within each pathway are summarized in Table 21-2. An exposure route is considered complete if the contaminated zone (as characterized in the previous sections) occurs within the depth intervals specified for a given exposure route. All exposure routes were evaluated for site CPP-19.

21.4.2 Exposure-Point Concentrations

Specific steps in calculating exposure-point concentrations for each of the applicable scenarios are described in Section 7. The COPC soil value used was the smaller of the 95% upper confidence limit (UCL) or maximum concentration. The concentration terms for the radionuclides were adjusted to account for decay for each exposure scenario. These values were subsequently averaged over the exposure duration. The concentration terms, by depth interval, are presented in Table 21-3. Exposures from all complete exposure routes were estimated based on the exposure-point concentrations in Table 21-4. Homegrown produce concentrations are presented in Table 21-5. The values for air and groundwater are presented in Sections 27.1 and 27.2, respectively.

21.4.3 Description of Source Estimates for Surface Exposure and Groundwater Modeling Use

The purpose for this subsection is two-fold. First, to compare the approach to defining the source estimate for use in both the surface exposure assessment and the groundwater model. This comparison was accomplished by comparing the soil data in Table 21-3 to the soil data used to estimate the source for use in the groundwater model, which can be found in Tables 5-39 and 5-40 of Appendix F. The benefit of these comparisons is to relate both source estimates and explain any apparent differences. Secondly, the results of the screened ORIGEN runs summarized in Section 4.4 were used to help identify any potential soil-related data gaps by comparing ORIGEN results to the investigation soil results at this site. This comparison was based on the full inventory of contaminants in the screening tables in Section 5 (Table 5-35) before implementing the screening steps shown therein. The results of these comparisons are described for each site in the following paragraphs. The results of the comparisons for perched water and SRPA are reported at the end of Section 4.4.

The CPP-19 source estimate for groundwater use was based on the same soil COPC's and concentrations in Table 21-3 with the exceptions of Cs-134 which is not included in the surface source . The reason for this difference is that the total depth interval assumption used to evaluate future residential intrusion exposure is 0 to 10 feet bgs., while the soil source estimate for groundwater use includes sample results deeper than 10 feet. Based on a comparison of the radionuclides that were analyzed in site soils against the potential inventory as defined by the screened ORIGEN results (Table 4-7), Pu-238, and Pu-241 were not part of the soil sampling analysis performed at this site. The implication is that these radionuclides may be present and are currently not part of the soil contaminant inventory.

Table 21-2. Complete exposure routes for site CPP-19 and associated exposure route depths.

Receptor	Scenario	Potentially complete exposure route and exposure route depths used for exposure-point concentration estimates	Characterized zone of contamination	Complete exposure route?
Onsite worker	Current land use	Inhalation of VOCs	0 to 9.5 m	No
		[0–15 cm (0–6 in.)]	[0 to 31 ft]	Yes
		Inhalation of airborne particulates [0–15 cm (0–6 in.)]		Yes
		Ingestion of surface soil [0–15 cm (0–6 in.)]		Yes
		External radiation [0–1.22 m (0–4 ft)]		
Residential	Future land use	Inhalation of VOCs [0–3.05 m (0–10 ft)]	0 to 9.5 m	No
		Inhalation of airborne particulates [0–3.05 m (0–10 ft)]	[0 to 31 ft]	Yes
		Ingestion of surface soil [0–3.05 m (0–10 ft)]		Yes
		Ingestion of homegrown produce [0–3.05 m (0–10 ft)]		Yes
		Ingestion of groundwater		Yes
		Dermal contact with groundwater		No
		Inhalation of VOCs from groundwater		No
		External radiation [0–3.05 m (0–10 ft)]		Yes
Onsite worker	Future land use	Inhalation of VOCs [0–15 cm (0–6 in.)]	0 to 9.5 m	No
		Inhalation of airborne particulates [0–15 cm (0–6 in.)]	[0 to 31 ft]	Yes
		Ingestion of surface soil [0–15 cm (0–6 in.)]		Yes
		External radiation [0–1.22 m (0–4 ft)]		Yes

Table 21-3. Soil concentration terms by depth interval.

	Soil concentrations (mg/kg or pCi/g)		
COPCs[b]	(0 - 0.5 ft)	(0 - 4 ft)	(0 - 10 ft)
Aroclor-1260	----	----	----
Benzo(a)pyrene	----	----	----
Aluminum	----	----	----
Arsenic	3.30E+00	7.50E+00	6.39E+00
Manganese	----	----	----
Mercury	----	----	----
Uranium[a]	----	----	1.09E+00
Am-241	----	----	1.97E+00
Ce-144	----	----	----
Co-57	----	----	----
Co-58	----	----	----
Co-60	1.90E-01	1.90E-01	2.16E+04
Cs-134	----	----	----
Cs-137	7.38E+01	7.38E+01	4.08E+05
Eu-152	1.52E+00	1.52E+00	8.76E+04
Eu-154	7.60E-01	7.60E-01	5.35E+04
Eu-155	----	2.40E-01	9.62E+03
H-3	----	----	----
I-129	----	----	----
K-40	----	----	----
Nb-95	----	9.00E-02	9.00E-02
Np-237	----	----	----
Pu-238	----	----	----
Pu-239/240	----	----	1.41E+02
Pu-241	----	----	----
Pu-242	----	----	----
Ru/Rh-106	----	----	----
Sb-125	----	----	----
Sr-90	4.97E+01	5.19E+01	1.25E+05
Tc-99	----	----	----
U-234	----	----	----
U-235	----	----	2.36E+00
U-236	----	----	----
U-238	----	----	----

a. mg/kg of uranium calculated from pCi/g of uranium isotopes using the equation
mg/kg = pCi/g * 2.795E-12 (mg-mole/kg-pCi-yr) * MW (g/mole) * $t_{1/2}$ (yr).

b. Concentration terms are not calculated for calcium, because it does not have available human toxicity data.

Table 21-4. Average soil exposure-point concentrations (mg/kg or pCi/g) for land use scenarios.

	Current occupational worker year 0 to year 25		Future occupational worker year 100 to year 125		Future resident year 100 to year 130
COPCs	(0 - 0.5 ft)	(0 - 4 ft)	(0 - 0.5 ft)	(0 - 4 ft)	(0 - 10 ft)
Aroclor-1260	---	---	---	---	---
Benzo(a)pyrene	---	---	---	---	---
Aluminum	---	---	---	---	---
Arsenic	3.30E+00	7.50E+00	3.30E+00	7.50E+00	6.39E+00
Manganese	---	---	---	---	---
Mercury	---	---	---	---	---
Uranium[a]	---	---	---	---	1.09E+00
Am-241	---	---	---	---	1.64E+00
Ce-144	---	---	---	---	---
Co-57	---	---	---	---	---
Co-58	---	---	---	---	---
Co-60	5.56E-02	5.56E-02	1.09E-07	1.09E-07	1.05E-02
Cs-134	---	---	---	---	---
Cs-137	5.61E+01	5.61E+01	5.65E+00	5.65E+00	2.96E+04
Eu-152	8.59E-01	8.59E-01	5.26E-03	5.26E-03	2.75E+02
Eu-154	3.32E-01	3.32E-01	1.26E-04	1.26E-04	7.80E+00
Eu-155	---	6.66E-02	---	5.70E-08	1.93E-03
H-3	---	---	---	---	---
I-129	---	---	---	---	---
K-40	---	---	---	---	---
Nb-95	---	4.99E-04	---	---	---
Np-237	---	---	---	---	---
Pu-238	---	---	---	---	---
Pu-239/240	---	---	---	---	1.41E+02
Pu-241	---	---	---	---	---
Pu-242	---	---	---	---	---
Ru/Rh-106	---	---	---	---	---
Sb-125	---	---	---	---	---
Sr-90	3.75E+01	3.91E+01	3.46E+00	3.61E+00	8.26E+03
Tc-99	---	---	---	---	---
U-234	---	---	---	---	---
U-235	---	---	---	---	2.36E+00
U-236	---	---	---	---	---
U-238	---	---	---	---	---

a. mg/kg of uranium calculated from pCi/g of uranium isotopes using the equation
mg/kg = pCi/g * 2.795E-12 (mg-mole/kg-pCi-yr) * MW (g/mole) * $t_{1/2}$ (yr).

Table 21-5. Concentrations of COPCs in homegrown produce.

COPCs	Homegrown produce (mg/kg or pCi/g)	Kd (cm^3/g)	COPC input rate from irrigation (mg/g-d or pCi/g-d)	Leach rate constant (d^{-1})
Aroclor-1260	---	7.89E+03	0.00E+00	9.95E-07
Benzo(a)pyrene	---	1.19E+03	0.00E+00	6.57E-06
Aluminum	---	0.00E+00	0.00E+00	2.87E-02
Arsenic	9.86E-03	3.00E+00	8.71E-09	2.40E-03
Manganese	---	5.00E+01	0.00E+00	1.56E-04
Mercury	1.10E-01	1.00E+02	2.91E-08	7.83E-05
Uranium	1.19E-03	6.00E+00	7.04E-09	1.25E-03
Am-241	2.51E-04	3.40E+02	6.08E-06	2.31E-05
Ce-144	---	5.00E+02	0.00E+00	1.57E-05
Co-57	---	1.00E+01	0.00E+00	7.64E-04
Co-58	---	1.00E+01	0.00E+00	7.64E-04
Co-60	4.33E+00	1.00E+01	0.00E+00	7.64E-04
Cs-134	---	5.00E+02	0.00E+00	1.57E-05
Cs-137	7.46E+02	5.00E+02	4.12E-05	1.57E-05
Eu-152	1.57E+00	3.40E+02	0.00E+00	2.31E-05
Eu-154	6.20E-01	3.40E+02	0.00E+00	2.31E-05
Eu-155	6.29E-02	3.40E+02	0.00E+00	2.31E-05
H-3	---	0.00E+00	6.22E-04	2.87E-02
I-129	3.85E-06	0.00E+00	3.26E-05	2.87E-02
K-40	---	1.50E+01	0.00E+00	5.14E-04
Nb-95	5.68E-08	0.00E+00	0.00E+00	2.87E-02
Np-237	3.19E-05	0.00E+00	8.36E-06	2.87E-02
Pu-238	---	2.20E+01	0.00E+00	3.53E-04
Pu-239/240	1.46E-01	2.20E+01	5.84E-07	3.53E-04
Pu-241	8.49E-09	2.20E+01	9.37E-08	3.53E-04
Pu-242	3.60E-09	2.20E+01	3.88E-10	3.53E-04
Ru/Rh-106	---	0.00E+00	0.00E+00	2.87E-02
Sb-125	---	5.00E+01	0.00E+00	1.56E-04
Sr-90	1.40E+03	1.20E+01	5.63E-05	6.40E-04
Tc-99	4.56E-01	0.00E+00	1.67E-04	2.87E-02
U-234	2.73E-05	6.00E+00	2.63E-06	1.25E-03
U-235	2.41E-03	6.00E+00	9.27E-08	1.25E-03
U-236	6.93E-07	6.00E+00	6.68E-08	1.25E-03
U-238	2.44E-05	6.00E+00	2.35E-06	1.25E-03

21.4.4 Risk Estimates

The results of this evaluation under current and future land use are presented in Section 21.4.4.1 and 21.4.4.2. For each receptor, the results are summarized in Tables 21-6 through 21-11.

21.4.4.1 Current Land Use. As indicated in Table 21-6, total cancer risk to the current onsite worker from exposure to site-related chemicals in surface soil is estimated to be 7E-04. The risk is attributed to external radiation exposure, with the primary COCs being Co-60 (3E-06), Cs-137 (7E-04), Eu-152 (2E-05), and Eu-154 (9E-06). Table 21-7 indicates that the total noncarcinogenic hazard index to the current worker is estimated to be 4E-10. There are no hazard indices above unity for the current onsite worker.

21.4.4.2 Future Land Use. As Table 21-8 indicates, the total cancer risk to the future onsite worker from exposure to site-related chemicals in surface soil is estimated to be 7E-05. The risk is attributed to external radiation exposure, with the primary contaminant of concern (COC) being Cs-137 (7E-05). Table 21-9 indicates the total noncarcinogenic hazard index to the future onsite worker is 4E-10. There are no hazard indices above unity for the future onsite worker. As indicated in Table 21-10, the total cancer risk to the future resident from exposure to site-related chemicals in soil is estimated to be 9E-01. Within the soil-ingestion exposure route, the greatest contribution to risk comes from arsenic (1E-05), Cs-137 (1E-03), Eu-152 (2E-06), Pu-239/240 (6E-05), and Sr-90 (6E-04). The major contributors to the ingestion of homegrown produce exposure route are Cs-137 (4E-03) and Sr-90 (1E-02). The risks from Co-60 (3E-06), Cs-137 (8E-01), Eu-152 (3E-02), Eu-154 (1E-03), and U-235 (2E-05) are the major contributors for external radiation exposure. As shown on Table 21-11, the total noncarcinogenic hazard index to the future resident is estimated to be 1E-01. There are no hazard indices above unity for the future resident.

21.5 Uncertainties

This section describes the limitations and uncertainties specific to the site characterization of site CPP-19. Sources of uncertainty associated with site characterization include data quality, COPC identification, concentration term estimation, and assumptions regarding the lateral and vertical extent of COPC occurrence. In the risk assessment, the most significant uncertainties are due to the selection process of COPCs, the toxicity values used, and the assumptions used during the exposure assessment. The following paragraphs will discuss important sources of site-specific uncertainty in greater detail.

Sampling and analysis uncertainties are related to quality problems that may result in qualified and rejected results (Section 3.5). Qualified results are considered estimates of the concentration in the sample and, for all practical purposes, useable for their intended purpose although they could be biased high or low. Rejected results are considered unusable, thus limiting the size of the useable data set. For site CPP-19, 14 data points were rejected based on the method validation as documented in the Limitations and Validation (L&V) Reports. The rejected data points consisted of six Sr-90 and eight Tc-99 results. These rejected data points affect the overall site CPP-19 data set by reducing the number of useable results to 10 for Sr-90 and 0 for Tc-99. The impact to the concentration term estimate for Sr-90 is likely insignificant because the remaining useable values are similarly distributed. However, for Tc-99, the rejected results leave the characterization of Tc-99 incomplete for CPP-19. As a result, the risk is likely to be underestimated.

Table 21-6. Soil pathway cancer risk to the current onsite worker. [a]

COPCs	Ingestion of soil	External radiation exposure	Total risks
Aroclor-1260	----	----	----
Benzo(a)pyrene	----	----	----
Aluminum	----	----	----
Arsenic	7E-07	----	7E-07
Manganese	----	----	----
Mercury	----	----	----
Uranium	----	----	----
Am-241	----	----	----
Ce-144	----	----	----
Co-57	----	----	----
Co-58	----	----	----
Co-60	3E-10	3E-06	3E-06
Cs-134	----	----	----
Cs-137	4E-07	7E-04	7E-04
Eu-152	1E-09	2E-05	2E-05
Eu-154	8E-10	9E-06	9E-06
Eu-155	----	2E-08	2E-08
H-3	----	----	----
I-129	----	----	----
K-40	----	----	----
Nb-95	----	8E-09	8E-09
Np-237	----	----	----
Pu-238	----	----	----
Pu-239/240	----	----	----
Pu-241	----	----	----
Pu-242	----	----	----
Ru/Rh-106	----	----	----
Sb-125	----	----	----
Sr-90	5E-07	NTD	5E-07
Tc-99	----	----	----
U-234	----	----	----
U-235	----	----	----
U-236	----	----	----
U-238	----	----	----
Total cancer risks by route:	2E-06	7E-04	7E-04

"----" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 21-7. Soil pathway noncarcinogenic hazard to the current onsite worker. [a]

COPCs	Ingestion of soil	External radiation exposure	Total HIs
Aroclor-1260	----	----	----
Benzo(a)pyrene	----	----	----
Aluminum	----	----	----
Arsenic	4E-10	----	4E-10
Manganese	----	----	----
Mercury	----	----	----
Uranium	----	----	----
Am-241	----	----	----
Ce-144	----	----	----
Co-57	----	----	----
Co-58	----	----	----
Co-60	----	----	----
Cs-134	----	----	----
Cs-137	----	----	----
Eu-152	----	----	----
Eu-154	----	----	----
Eu-155	----	----	----
H-3	----	----	----
I-129	----	----	----
K-40	----	----	----
Nb-95	----	----	----
Np-237	----	----	----
Pu-238	----	----	----
Pu-239/240	----	----	----
Pu-241	----	----	----
Pu-242	----	----	----
Ru/Rh-106	----	----	----
Sb-125	----	----	----
Sr-90	----	----	----
Tc-99	----	----	----
U-234	----	----	----
U-235	----	----	----
U-236	----	----	----
U-238	----	----	----
Total hazard indices by route:	4E-10	0E+00	4E-10

"----" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 21-8. Soil pathway cancer risk to the future onsite worker. [a]

COPCs	Ingestion of soil	External radiation exposure	Total risks
Aroclor-1260	----	----	----
Benzo(a)pyrene	----	----	----
Aluminum	----	----	----
Arsenic	7E-07	----	7E-07
Manganese	----	----	----
Mercury	----	----	----
Uranium	----	----	----
Am-241	----	----	----
Ce-144	----	----	----
Co-57	----	----	----
Co-58	----	----	----
Co-60	5E-16	6E-12	6E-12
Cs-134	----	----	----
Cs-137	4E-08	7E-05	7E-05
Eu-152	8E-12	1E-07	1E-07
Eu-154	3E-13	3E-09	3E-09
Eu-155	----	2E-14	2E-14
H-3	----	----	----
I-129	----	----	----
K-40	----	----	----
Nb-95	----	----	----
Np-237	----	----	----
Pu-238	----	----	----
Pu-239/240	----	----	----
Pu-241	----	----	----
Pu-242	----	----	----
Ru/Rh-106	----	----	----
Sb-125	----	----	----
Sr-90	5E-08	NTD	5E-08
Tc-99	----	----	----
U-234	----	----	----
U-235	----	----	----
U-236	----	----	----
U-238	----	----	----
Total cancer risks by route:	8E-07	7E-05	7E-05

"----" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 21-9. Soil pathway noncarcinogenic hazard to the future onsite worker. [a]

COPCs	Ingestion of soil	External radiation exposure	Total HIs
Aroclor-1260	----	----	----
Benzo(a)pyrene	----	----	----
Aluminum	----	----	----
Arsenic	4E-10	----	4E-10
Manganese	----	----	----
Mercury	----	----	----
Uranium	----	----	----
Am-241	----	----	----
Ce-144	----	----	----
Co-57	----	----	----
Co-58	----	----	----
Co-60	----	----	----
Cs-134	----	----	----
Cs-137	----	----	----
Eu-152	----	----	----
Eu-154	----	----	----
Eu-155	----	----	----
H-3	----	----	----
I-129	----	----	----
K-40	----	----	----
Nb-95	----	----	----
Np-237	----	----	----
Pu-238	----	----	----
Pu-239/240	----	----	----
Pu-241	----	----	----
Pu-242	----	----	----
Ru/Rh-106	----	----	----
Sb-125	----	----	----
Sr-90	----	----	----
Tc-99	----	----	----
U-234	----	----	----
U-235	----	----	----
U-236	----	----	----
U-238	----	----	----
Total hazard indices by route:	4E-10	0E+00	4E-10

"----" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 21-10. Soil pathway cancer risk to the future onsite resident. [a]

COPCs	Ingestion of soil	Ingestion of homegrown	External radiation exposure	Total risks
Aroclor-1260	—	—	—	—
Benzo(a)pyrene	—	—	—	—
Aluminum	—	—	—	—
Arsenic	1E-05	2E-06	—	2E-05
Manganese	—	—	—	—
Mercury	—	NTD	—	—
Uranium	NTD	NTD	—	—
Am-241	7E-07	1E-08	2E-07	9E-07
Ce-144	—	—	—	—
Co-57	—	—	—	—
Co-58	—	—	—	—
Co-60	2E-10	1E-05	3E-06	2E-05
Cs-134	—	—	—	—
Cs-137	1E-03	4E-03	8E-01	8E-01
Eu-152	2E-06	2E-06	3E-02	3E-02
Eu-154	9E-08	1E-06	1E-03	1E-03
Eu-155	4E-12	2E-08	3E-09	2E-08
H-3	—	—	—	—
I-129	—	1E-10	—	1E-10
K-40	—	—	—	—
Nb-95	—	2E-14	—	2E-14
Np-237	—	2E-09	—	2E-09
Pu-238	—	—	—	—
Pu-239/240	6E-05	8E-06	8E-08	6E-05
Pu-241	—	5E-13	—	5E-13
Pu-242	—	2E-13	—	2E-13
Ru/Rh-106	—	—	—	—
Sb-125	—	—	—	—
Sr-90	6E-04	1E-02	NTD	1E-02
Tc-99	—	1E-07	—	1E-07
U-234	—	2E-10	—	2E-10
U-235	1E-07	2E-08	2E-05	2E-05
U-236	—	5E-12	—	5E-12
U-238	—	3E-10	—	3E-10
Total cancer risks by route:	2E-03	2E-02	9E-01	9E-01

"—" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 21-11. Soil pathway noncarcinogenic hazard to the future onsite resident. [a]

COPCs	Ingestion of soil	Ingestion of homegrown	External radiation exposure	Total HIs
Aroclor-1260	—	—	—	—
Benzo(a)pyrene	—	—	—	—
Aluminum	—	—	—	—
Arsenic	7E-09	9E-03	—	9E-03
Manganese	—	—	—	—
Mercury	—	1E-01	—	1E-01
Uranium	1E-08	1E-04	—	1E-04
Am-241	—	—	—	—
Ce-144	—	—	—	—
Co-57	—	—	—	—
Co-58	—	—	—	—
Co-60	—	—	—	—
Cs-134	—	—	—	—
Cs-137	—	—	—	—
Eu-152	—	—	—	—
Eu-154	—	—	—	—
Eu-155	—	—	—	—
H-3	—	—	—	—
I-129	—	—	—	—
K-40	—	—	—	—
Nb-95	—	—	—	—
Np-237	—	—	—	—
Pu-238	—	—	—	—
Pu-239/240	—	—	—	—
Pu-241	—	—	—	—
Pu-242	—	—	—	—
Ru/Rh-106	—	—	—	—
Sb-125	—	—	—	—
Sr-90	—	—	—	—
Tc-99	—	—	—	—
U-234	—	—	—	—
U-235	—	—	—	—
U-236	—	—	—	—
U-238	—	—	—	—
Total hazard indices by route:	2E-08	1E-01	0E+00	1E-01

"—" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Uncertainty associated with the chemical screening process (Section 5.2) results from using the maximum concentration for chemicals detected in the Environmentally Controlled Areas (ECAs) in the background comparison step, retaining chemicals detected as COPCs because there is not a corresponding background value, and retaining chemicals as COPCs for which there is no toxicity information available.

In most cases, the COPC identification process used the maximum concentration for a chemical detected in the background comparison step, regardless of its magnitude above background. The use of the maximum concentration can result in the identification of COPCs that have concentrations only slightly above background. For site CPP-19, none of the COPCs fell into this category.

Another source of uncertainty related to the background comparison step in the chemical screening process relates to chemicals for which no background concentration exists. For example, fluoride, nitrate, and several radionuclides were not characterized as part of the Rood et al., background study. For site CPP-19, the following COPCs have no corresponding background concentration: Co-60, Cs-134, Eu-152, Eu-154, Eu-155, Nb-95, and U-235. This results in an increase in the number of COPCs considered in the remedial investigation/Baseline Risk Assessment (RI/BRA) and a possible overestimation of risk because the observed concentrations may be within the background population.

Some concentration estimates are based on the 95% UCL for the site, or the area-weighted average 95% UCLs for sites that have been grouped. When the 95% UCL (i.e., the concentration term estimate) of a COPC is below the corresponding background value, this results in an increase in the number of COPCs in the RI/BRA and a possible overestimation of risk because the results are likely within the background range. This source of uncertainty stems from the use of maximum concentrations when identifying the COPCs for a specific sites. For site CPP-19, none of the COPC concentration estimates were below background.

For site CPP-19, calcium was retained as a COPC for the RI/BRA because the maximum concentration observed was significantly elevated above background and likely indicates contamination. There are no toxicity values in Integrated Risk Information System (IRIS), Health Effects Assessment Summary Tables (HEAST), or EPA Region III publications for calcium and calcium is normally considered an essential nutrient. The impact of not including calcium in the BRA is assumed to be negligible because it is generally considered nontoxic; however, the levels of calcium should be evaluated during the feasibility study (FS).

With respect to the nature and extent assessment, the precise lateral extent of contamination has not been assessed at CPP-19. The ECA boundaries were expanded based on RI results, however large COPC activities were noted in results from borings adjacent to the new ECA boundaries, especially CPP-19-1. The zone of contamination is assumed to extend down to the soil/basalt interface. This may overestimate the true mass of affected soil since three of the four soil borings at CPP-19 indicated COPC levels of below background at the soil/basalt interface.

Sample results from CPP-19 for the 1.2- to 3.0-m (4- to 10-ft) interval indicate relatively low COPC levels in three of the borings, and high COPC levels in the fourth (CPP-19-2, located at the site of the spill). The source term calculation for this interval will be dominated by the large COPC results from boring CPP-19-2, and may overestimate the risk in this interval, particularly for portions of CPP-19 not adjacent to boring CPP-19-2.

A source of uncertainty may be associated with the contaminant inventories used for the groundwater modeling and residential intrusion exposure at each sub-area. Section 21.4.3 identifies radionuclides potentially missing from these inventories. The implication of these potential data gaps is that the source estimates could be underestimated. Based on the results of the groundwater model, the potentially missing Pu-238 and Pu-241 which have half lives of 87.7 and 14.4 years are not expected to be of concern because of their short half lives and long travel time through the vadoze zone and into the aquifer. The potential uncertainty is recognized but no information is available to quantify the uncertainty.

21.6 Conclusions and Recommendations

The results of the risk assessment under current land use at CPP-19 indicate that the increased cancer risk from exposure to site-related contaminants is above the EPA-recommended target range. The increased cancer risk to hypothetical future onsite workers was found to be within the recommended range and for future residents it was found to be well above the EPA target range. The noncarcinogenic hazard for all receptors was found to be well below the EPA hazard index goal of one. These estimates do not include the contributions associated with the air and groundwater pathways. The total increased cancer and hazard incidence to humans is reported in Section 27. The risk estimates at this site are likely to be overestimated for reasons described in Sections 7 and 21.5 of this report. It should be noted that the estimates under current land use did not include the benefits associated with the implementation of a radiation protection program at the INEL that is designed to limit worker exposure to within protective levels. Given these limitations, the increased cancer incidence from site-related contamination is still expected to be severe enough that some type of future response action to mitigate adverse impacts to human health and the environment will be necessary at this site. However, it may be more appropriate to design the response action so that it is protective of future receptor populations.

21.7 References

Rood, S. M., G. A. Harris, and G. J. White, 1995, *Background Dose Equivalent Rates and Surficial Soil Metal and Radionuclide Concentrations for the Idaho National Engineering Laboratory*, INEL-94/0250, Revision 0, February.

WINCO, 1994, *Draft Preliminary Scoping Track 2 Summary Report for OU 3-09,* September 7.

Chapter 22

22. SITE CPP-22 RESULTS

Site CPP-22 is the location of potential surface contamination associated with a 1958 air release that resulted from the failure of a high-efficiency particulate air (HEPA) filter. This section describes the site, investigative results, and the nature and extent of contamination associated with the release followed by the results of the human health risk assessment (HHRA).

22.1 Site Description

The release at site CPP-22 occurred during a failure of a HEPA filter associated with the Fuel Element Cutting Facility (FECF) (Figure 22-1). Acid used in the decontamination solutions apparently entered the vent line for the decontamination activities and breached the HEPA filters, enabling airborne contamination to spread over an estimated surface area of 12,200 m^2 (131,302 ft^2). Fire hoses were used to spray down the entire area to prevent the contamination from being transported by the wind.

The area has been, and continues to be, surveyed on a regular basis by radiological control personnel at the ICPP. Contamination from this airborne release has most likely been removed or covered over with soil during the period from 1958 to 1993 as a result of construction activities that have disturbed the area.

22.2 Investigative Results

As part of the OU 3-13 RI/FS field sampling program, three boreholes were drilled within site CPP-22 (Figure 22-1). The locations of boreholes CPP-22-1, CPP-22-2, and CPP-22-3 were based on a radiation survey conducted on June 16, 1995 as discussed in Section 3.3.1.7. Boreholes were sited at locations found to have the highest radiation levels above background.

At borehole location CPP-22-1, surficial radiation was measured at 200 counts per minute (cpm), with background measured at 100 cpm. Borehole CPP-22-1 was advanced to 3.0-m (10-ft) bgs. The sample collected from 0.9- to 2.1-m (3- to 7-ft) bgs was measured at 80 cpm above background, and therefore submitted for analysis. Samples from 0 to 0.15 m (0 to 0.5-ft) bgs and 0.15- to 0.9-m (0.5- to 3.0-ft) bgs were also analyzed for radiological parameters.

At borehole location CPP-22-2, surficial radiation was measured at 200 cpm, with background measured at 100 cpm. Borehole CPP-22-2 was advanced to a total depth of 3.4-m (11-ft) bgs. Soil from 0.15- to 0.8-m (0.5- to 2.5-ft) bgs measured 50 cpm above background. The remaining soil samples collected measured at background radiological levels. Samples were collected for radiological analysis from 0- to 0.15-m (0- to 0.5-ft), 0.15- to 0.8-m (0.5- to 2.5-ft), and 2.1- to 3.0-m (7- to 10-ft) bgs.

Borehole CPP-22-3 was advanced to a total depth of 3.4-m (11-ft) bgs. The surface soil radiological survey indicated 150 cpm, with local background measuring 100 cpm. All soil samples collected between surface and 3.0-m (10-ft) bgs measured less than 100 cpm and therefore the 2.4- to 3.0-m (8- to 10-ft) bgs sample was sent for analysis of radiological parameters. The 0 to 0.15 m (0 to 0.5 ft) bgs and 0.15- to 0.9-m (0.5- to 3.0-ft) bgs intervals were also sent for analysis of radiological parameters.

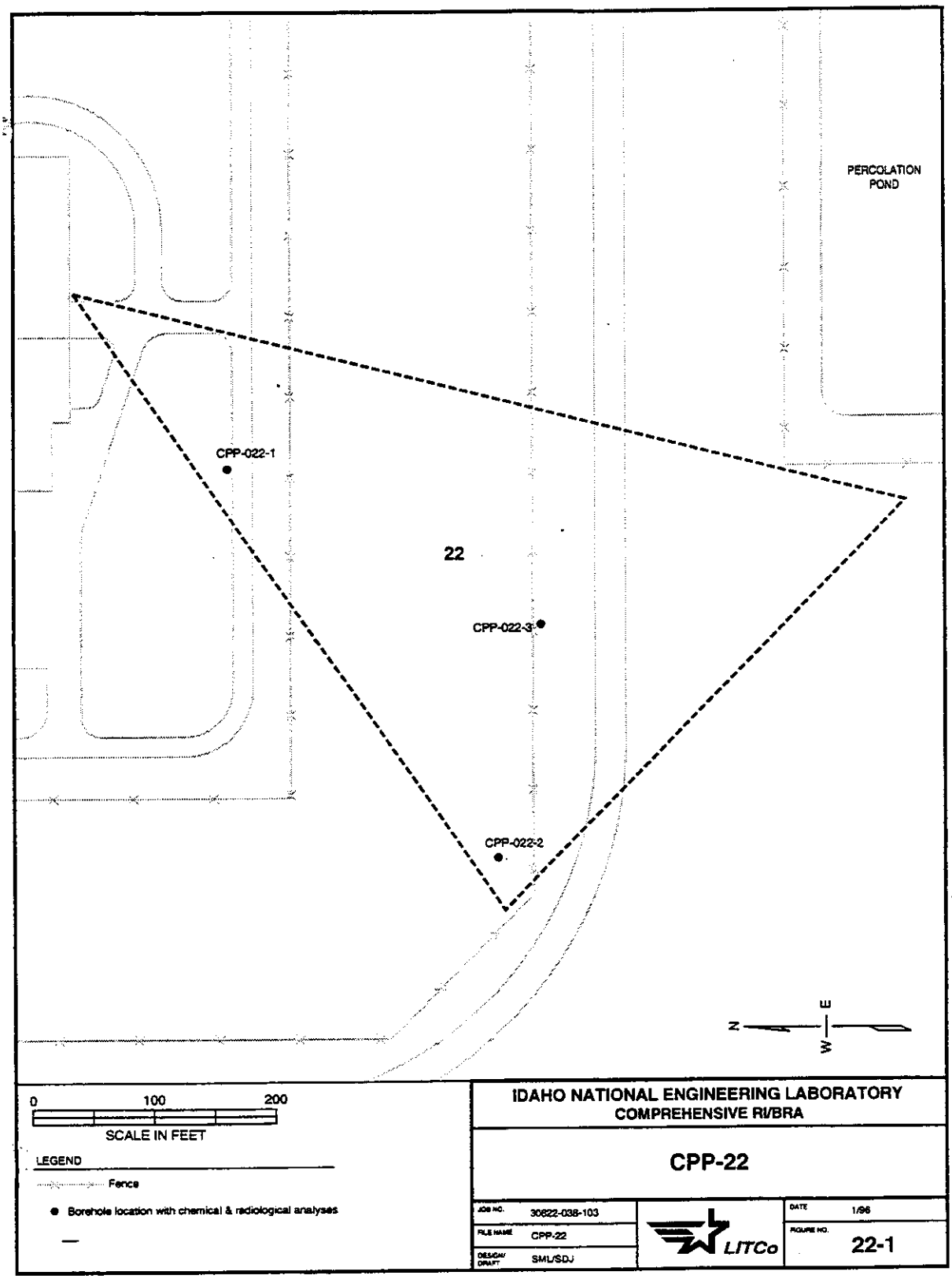


Figure 22-1. CPP-22 and borehole locations.

The analytical results for the contaminants of potential concern (COPC) are summarized in Table 22-1. A compilation of the analytical results is presented in Appendix G. Based on the chemical screening presented in Section 5.2, Sr-90, Tc-99, and Cs-137 were identified as COPCs for this site. No COPCs were detected above background activities in samples from boring CPP-22-1. Cs-137, Sr-90, and Tc-99 were detected in samples from 0- to 0.15-m (0- to 0.5-ft) bgs in borings CPP-22-2 and CPP-22-3. Cs-137 ranged from 3.7±0.1 to 14.3±0.3 pCi/g, Sr-90 ranged from 2.7±0.2 to 5.4±0.2 pCi/g, and Tc-99 ranged from 0.9±0.4 to 2.3±0.5 pCi/g in those surficial samples. Cs-137 and Sr-90 were not detected above background activity in any of the subsurface samples [below 0.0- to 0.15-m (0.0- to 0.5-ft)]. Tc-99 was detected at 3.5±0.5 pCi/g in the 0.15- to 0.8-m (0.5- to 2.5-ft) sample from boring CPP-22-3.

22.3 Nature and Extent of Contamination

Based on investigative results, Cs-137, Sr-90, and Tc-99 were the COPCs identified for site CPP-22. Samples with elevated radiological activity were collected from surface soils at borings CPP-22-2 and CPP-22-3, and in one near-surface [0.15- to 0.9-m (0.5- to 3.0-ft)] interval. The highest radionuclide activity in the samples collected was Cs-137 at 14.3±0.3 pCi/g in the 0- to 0.15-m (0- to 0.5-ft) bgs sample from boring CPP-22-2. No COPCs were detected above background in samples from boring CPP-22-1. Samples from the 2.4- to 3.0-m (8.0- to 10.0-ft) interval of boring CPP-22-3 and from the 2.1- to 3.0-m (7.0- to 10.0-ft) interval of boring CPP-22-2 also showed no COPCs above background. Consistent with an air release, contamination is evidently limited to shallow depth. The zone of contamination is assumed to extend from the ground surface down to 1.2 m (4.0 ft) bgs.

The area of site CPP-22 shown on Figure 5-2 was expanded due to results from boring CPP-22-2 that indicated above background activity levels. The revised area of site CPP-22 is 13,935 m^2 (150,000 ft^2) as shown on Figure 22-1.

22.4 Risk Assessment

The methodology for conducting the HHRA for waste area group (WAG 3) is detailed in Section 7. As presented, the purpose of the HHRA is to develop a quantitative description and assessment of the human health risk posed by the COPCs present at WAG 3. This section only contains the results of the HHRA for site CPP-22 with respect to the soil pathways. The results for the air and groundwater pathways are detailed in Sections 27.1 and 27.2, respectively. The risk assessment at this site becomes cumulative after the contributions from the air and groundwater pathways are added to that from the soil pathway. The following sections discuss the complete exposure routes, exposure-point concentrations, and cancer risk and noncarcinogenic health hazard estimates for site CPP-22 under the three exposure scenarios evaluated. Section 22.4.3 will explain the differences in estimating sources of contamination for use in evaluating surface exposure and groundwater modeling. This section will also describe the use of the screened ORIGEN results (section 4.4) to help identify contaminants potentially missing from the source estimate.

22.4.1 Complete Exposure Routes

Potentially complete pathways from the source to a human receptor are described in Section 7 and illustrated on Figure 7-1. For site CPP-22, the complete exposure routes within each pathway are summarized in Table 22-2. An exposure route is considered complete if the contaminated zone (as

Table 22-1. Summary statistics for CPP-22, particulate air release south of CPP-603.

COPCs	Concentration (mg/kg or pCi/g)			Standard deviation	Number of samples	Number of detects	Frequency of detection	INEL background (mg/kg or pCi/g)	Number greater than background
	Minimum detected	Maximum detected	Arithmetic mean						
Cs-137	3.7 +/- 0.1	14.3 +/- 0.3	9.00E+00	7.50E+00	10	2	20%	0.82	2
Sr-90	2.7 +/- 0.2	5.4 +/- 0.2	4.05E+00	1.91E+00	3	2	67%	0.49	2
Tc-99	0.9 +/- 0.4	3.5 +/- 0.5	2.23E+00	1.30E+00	3	3	100%	NA	NA

NA - Not applicable/available

Table 22-2. Complete exposure routes for site CPP-22 associated exposure route depths.

Receptor	Scenario	Potentially complete exposure route and exposure route depths used for exposure-point concentration estimates	Characterized zone of contamination	Complete exposure route?
Onsite worker	Current land use	Inhalation of VOCs	0 to 1.2 m	No
		[0–15 cm (0–6 in.)]	(0 to 4 ft)	Yes
		Inhalation of airborne particulates [0–15 cm (0–6 in.)]		Yes
		Ingestion of surface soil [0–15 cm (0–6 in.)]		Yes
		External radiation [0–1.22 m (0–4 ft)]		
Residential	Future land use	Inhalation of VOCs [0–3.05 m (0–10 ft)]	0 to 1.2 m	No
		Inhalation of airborne particulates [0–3.05 m (0–10 ft)]	(0 to 4 ft)	Yes
		Ingestion of surface soil [0–3.05 m (0–10 ft)]		Yes
		Ingestion of homegrown produce [0–3.05 m (0–10 ft)]		Yes
		Ingestion of groundwater		Yes
		Dermal contact with groundwater		No
		Inhalation of VOCs from groundwater		No
		External radiation [0–3.05 m (0–10 ft)]		Yes
Onsite worker	Future land use	Inhalation of VOCs [0–15 cm (0–6 in.)]	0 to 1.2 m	No
		Inhalation of airborne particulates [0–15 cm (0–6 in.)]	(0 to 4 ft)	Yes
		Ingestion of surface soil [0–15 cm (0–6 in.)]		Yes
		External radiation [0–1.22 m (0–4 ft)]		Yes

characterized in the previous sections) occurs within the depth intervals specified for a given exposure route. All exposure routes were evaluated for site CPP-22.

22.4.2 Exposure-Point Concentrations

Specific steps in calculating exposure-point concentrations for each of the applicable scenarios are described in Section 7. The COPC soil value used was the smaller of the 95% upper confidence limit (UCL) or maximum concentration. The concentration terms for the radionuclides were adjusted to account for decay for each exposure scenario. These values were subsequently averaged over the exposure duration. The concentration terms, by depth interval, are presented in Table 22-3. Exposures from all complete exposure routes were estimated based on the exposure-point concentrations in Table 22-4. Homegrown produce concentrations are presented in Table 22-5. The values for air and groundwater are presented in Sections 27.1 and 27.2, respectively.

22.4.3 Description of Source Estimates for Surface Exposure and Groundwater Modeling Use

The purpose for this subsection is two-fold. First, to compare the approach to defining the source estimate for use in both the surface exposure assessment and the groundwater model. This comparison was accomplished by comparing the soil data in Table 22-3 to the soil data used to estimate the source for use in the groundwater model, which can be found in Tables 5-39 and 5-40 of Appendix F. The benefit of these comparisons is to relate both source estimates and explain any apparent differences. Secondly, the results of the screened ORIGEN runs summarized in Section 4.4 were used to help identify any potential soil-related data gaps by comparing ORIGEN results to the field investigation soil results at this site. This comparison was based on the full inventory of contaminants in the screening tables in Section 5 before implementing the screening steps shown therein. The results of these comparisons are described for each site in the following paragraphs. The results of the comparison for perched water and the SRPA are reported at the end of Section 4.4.

The same soil COPC's and concentrations in Table 22-3 for sites CPP-22 were used to develop the source estimate for groundwater use. Based on a comparison of the radionuclides that were analyzed in site soils against the potential inventory as defined by the screened ORIGEN results (Table 4-7), Am-241, Pu-238, Pu-239/240, and Pu-241 were not part of the soil sampling analytical suite. The implication is that these radionuclides may be present and are currently not part of the soil contaminant inventory.

22.4.4 Risk Estimates

The results of this evaluation under current and future land use are presented in Sections 22.4.4.1 and 22.4.4.2. For each receptor, the results are summarized in Tables 22-6 through 22-11.

22.4.4.1 Current Land Use. As indicated in Table 22-6, total cancer risk to the current onsite worker from exposure to site-related chemicals in surface soil is estimated to be 1E-04. The risk is attributed to external radiation exposure, with the primary contaminant of concern (COC) being Cs-137 (1E-04). The total noncarcinogenic hazard index to the current worker is estimated to be 0E+00 as indicated on Table 22-7. There are no hazard indices above unity for the current onsite worker.

Table 22-3. Soil concentration terms by depth interval.

COPCs	Soil concentrations (mg/kg or pCi/g) (0 - 0.5 ft)	(0 - 4 ft)	(0 - 10 ft)
Aroclor-1260	---	---	---
Benzo(a)pyrene	---	---	---
Aluminum	---	---	---
Arsenic	---	---	---
Manganese	---	---	---
Mercury	---	---	---
Uranium	---	---	---
Am-241	---	---	---
Ce-144	---	---	---
Co-57	---	---	---
Co-58	---	---	---
Co-60	---	---	---
Cs-134	---	---	---
Cs-137	1.43E+01	1.43E+01	1.43E+01
Eu-152	---	---	---
Eu-154	---	---	---
Eu-155	---	---	---
H-3	---	---	---
I-129	---	---	---
K-40	---	---	---
Nb-95	---	---	---
Np-237	---	---	---
Pu-238	---	---	---
Pu-239/240	---	---	---
Pu-241	---	---	---
Pu-242	---	---	---
Ru/Rh-106	---	---	---
Sb-125	---	---	---
Sr-90	5.40E+00	5.40E+00	5.40E+00
Tc-99	2.30E+00	3.50E+00	3.50E+00
U-234	---	---	---
U-235	---	---	---
U-236	---	---	---
U-238	---	---	---

Table 22-4. Average soil exposure-point concentrations (mg/kg or pCi/g) for land use scenarios.

	Current occupational worker year 0 to year 25		Future occupational worker year 100 to year 125		Future resident year 100 to year 130
COPCs	(0 - 0.5 ft)	(0 - 4 ft)	(0 - 0.5 ft)	(0 - 4 ft)	(0 - 10 ft)
Aroclor-1260	---	---	---	---	---
Benzo(a)pyrene	---	---	---	---	---
Aluminum	---	---	---	---	---
Arsenic	---	---	---	---	---
Manganese	---	---	---	---	---
Mercury	---	---	---	---	---
Uranium	---	---	---	---	---
Am-241	---	---	---	---	---
Ce-144	---	---	---	---	---
Co-57	---	---	---	---	---
Co-58	---	---	---	---	---
Co-60	---	---	---	---	---
Cs-134	---	---	---	---	---
Cs-137	1.09E+01	1.09E+01	1.09E+00	1.09E+00	1.04E+00
Eu-152	---	---	---	---	---
Eu-154	---	---	---	---	---
Eu-155	---	---	---	---	---
H-3	---	---	---	---	---
I-129	---	---	---	---	---
K-40	---	---	---	---	---
Nb-95	---	---	---	---	---
Np-237	---	---	---	---	---
Pu-238	---	---	---	---	---
Pu-239/240	---	---	---	---	---
Pu-241	---	---	---	---	---
Pu-242	---	---	---	---	---
Ru/Rh-106	---	---	---	---	---
Sb-125	---	---	---	---	---
Sr-90	4.07E+00	4.07E+00	3.76E-01	3.76E-01	3.57E-01
Tc-99	2.30E+00	3.50E+00	2.30E+00	3.50E+00	3.50E+00
U-234	---	---	---	---	---
U-235	---	---	---	---	---
U-236	---	---	---	---	---
U-238	---	---	---	---	---

Table 22-5. Concentrations of COPCs in homegrown produce.

COPCs	Homegrown produce (mg/kg or pCi/g)	Kd (cm^3/g)	COPC input rate from irrigation (mg/g-d or pCi/g-d)	Leach rate constant (d^{-1})
Aroclor-1260	---	7.89E+03	0.00E+00	9.95E-07
Benzo(a)pyrene	---	1.19E+03	0.00E+00	6.57E-06
Aluminum	---	0.00E+00	0.00E+00	2.87E-02
Arsenic	1.40E-04	3.00E+00	8.71E-09	2.40E-03
Manganese	---	5.00E+01	0.00E+00	1.56E-04
Mercury	1.10E-01	1.00E+02	2.91E-08	7.83E-05
Uranium	7.30E-05	6.00E+00	7.04E-09	1.25E-03
Am-241	7.76E-06	3.40E+02	6.08E-06	2.31E-05
Ce-144	---	5.00E+02	0.00E+00	1.57E-05
Co-57	---	1.00E+01	0.00E+00	7.64E-04
Co-58	---	1.00E+01	0.00E+00	7.64E-04
Co-60	---	1.00E+01	0.00E+00	7.64E-04
Cs-134	---	5.00E+02	0.00E+00	1.57E-05
Cs-137	2.70E-02	5.00E+02	4.12E-05	1.57E-05
Eu-152	---	3.40E+02	0.00E+00	2.31E-05
Eu-154	---	3.40E+02	0.00E+00	2.31E-05
Eu-155	---	3.40E+02	0.00E+00	2.31E-05
H-3	---	0.00E+00	6.22E-04	2.87E-02
I-129	3.85E-06	0.00E+00	3.26E-05	2.87E-02
K-40	---	1.50E+01	0.00E+00	5.14E-04
Nb-95	---	0.00E+00	0.00E+00	2.87E-02
Np-237	3.19E-05	0.00E+00	8.36E-06	2.87E-02
Pu-238	---	2.20E+01	0.00E+00	3.53E-04
Pu-239/240	5.15E-06	2.20E+01	5.84E-07	3.53E-04
Pu-241	8.49E-09	2.20E+01	9.37E-08	3.53E-04
Pu-242	3.60E-09	2.20E+01	3.88E-10	3.53E-04
Ru/Rh-106	---	0.00E+00	0.00E+00	2.87E-02
Sb-125	---	5.00E+01	0.00E+00	1.56E-04
Sr-90	6.74E-02	1.20E+01	5.63E-05	6.40E-04
Tc-99	1.34E+00	0.00E+00	1.67E-04	2.87E-02
U-234	2.73E-05	6.00E+00	2.63E-06	1.25E-03
U-235	9.61E-07	6.00E+00	9.27E-08	1.25E-03
U-236	6.93E-07	6.00E+00	6.68E-08	1.25E-03
U-238	2.44E-05	6.00E+00	2.35E-06	1.25E-03

Table 22-6. Soil pathway cancer risk to the current onsite worker. [a]

COPCs	Ingestion of soil	External radiation exposure	Total risks
Aroclor-1260	----	----	----
Benzo(a)pyrene	----	----	----
Aluminum	----	----	----
Arsenic	----	----	----
Manganese	----	----	----
Mercury	----	----	----
Uranium	----	----	----
Am-241	----	----	----
Ce-144	----	----	----
Co-57	----	----	----
Co-58	----	----	----
Co-60	----	----	----
Cs-134	----	----	----
Cs-137	9E-08	1E-04	1E-04
Eu-152	----	----	----
Eu-154	----	----	----
Eu-155	----	----	----
H-3	----	----	----
I-129	----	----	----
K-40	----	----	----
Nb-95	----	----	----
Np-237	----	----	----
Pu-238	----	----	----
Pu-239/240	----	----	----
Pu-241	----	----	----
Pu-242	----	----	----
Ru/Rh-106	----	----	----
Sb-125	----	----	----
Sr-90	6E-08	NTD	6E-08
Tc-99	8E-10	1E-11	8E-10
U-234	----	----	----
U-235	----	----	----
U-236	----	----	----
U-238	----	----	----
Total cancer risks by route:	1E-07	1E-04	1E-04

"----" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 22-7. Soil pathway noncarcinogenic hazard to the current onsite worker.[a,b]

COPCs	Ingestion of soil	External radiation exposure	Total HIs
Aroclor-1260	—	—	—
Benzo(a)pyrene	—	—	—
Aluminum	—	—	—
Arsenic	—	—	—
Manganese	—	—	—
Mercury	—	—	—
Uranium	—	—	—
Am-241	—	—	—
Ce-144	—	—	—
Co-57	—	—	—
Co-58	—	—	—
Co-60	—	—	—
Cs-134	—	—	—
Cs-137	—	—	—
Eu-152	—	—	—
Eu-154	—	—	—
Eu-155	—	—	—
H-3	—	—	—
I-129	—	—	—
K-40	—	—	—
Nb-95	—	—	—
Np-237	—	—	—
Pu-238	—	—	—
Pu-239/240	—	—	—
Pu-241	—	—	—
Pu-242	—	—	—
Ru/Rh-106	—	—	—
Sb-125	—	—	—
Sr-90	—	—	—
Tc-99	—	—	—
U-234	—	—	—
U-235	—	—	—
U-236	—	—	—
U-238	—	—	—
Total hazard indices by route:	0E+00	0E+00	0E+00

"—" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. No noncarcinogenic contamination has been detecetd at CPP-06, so there is no calculated hazard index for workers or residents at the site.
b. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 22-8. Soil pathway cancer risk to the future onsite worker. [a]

COPCs	Ingestion of soil	External radiation exposure	Total risks
Aroclor-1260	----	----	----
Benzo(a)pyrene	----	----	----
Aluminum	----	----	----
Arsenic	----	----	----
Manganese	----	----	----
Mercury	----	----	----
Uranium	----	----	----
Am-241	----	----	----
Ce-144	----	----	----
Co-57	----	----	----
Co-58	----	----	----
Co-60	----	----	----
Cs-134	----	----	----
Cs-137	9E-09	1E-05	1E-05
Eu-152	----	----	----
Eu-154	----	----	----
Eu-155	----	----	----
H-3	----	----	----
I-129	----	----	----
K-40	----	----	----
Nb-95	----	----	----
Np-237	----	----	----
Pu-238	----	----	----
Pu-239/240	----	----	----
Pu-241	----	----	----
Pu-242	----	----	----
Ru/Rh-106	----	----	----
Sb-125	----	----	----
Sr-90	5E-09	NTD	5E-09
Tc-99	8E-10	1E-11	8E-10
U-234	----	----	----
U-235	----	----	----
U-236	----	----	----
U-238	----	----	----
Total cancer risks by route:	1E-08	1E-05	1E-05

"----" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 22-9. Soil pathway noncarcinogenic hazard to the future onsite worker.[a,b]

COPCs	Ingestion of soil	External radiation exposure	Total HIs
Aroclor-1260	----	----	----
Benzo(a)pyrene	----	----	----
Aluminum	----	----	----
Arsenic	----	----	----
Manganese	----	----	----
Mercury	----	----	----
Uranium	----	----	----
Am-241	----	----	----
Ce-144	----	----	----
Co-57	----	----	----
Co-58	----	----	----
Co-60	----	----	----
Cs-134	----	----	----
Cs-137	----	----	----
Eu-152	----	----	----
Eu-154	----	----	----
Eu-155	----	----	----
H-3	----	----	----
I-129	----	----	----
K-40	----	----	----
Nb-95	----	----	----
Np-237	----	----	----
Pu-238	----	----	----
Pu-239/240	----	----	----
Pu-241	----	----	----
Pu-242	----	----	----
Ru/Rh-106	----	----	----
Sb-125	----	----	----
Sr-90	----	----	----
Tc-99	----	----	----
U-234	----	----	----
U-235	----	----	----
U-236	----	----	----
U-238	----	----	----
Total hazard indices by route:	0E+00	0E+00	0E+00

"----" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. No noncarcinogenic contamination has been detecetd at CPP-06, so there is no calculated hazard index for workers or residents at the site.
b. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 22-10. Soil pathway cancer risk to the future onsite resident. [a]

COPCs	Ingestion of soil	Ingestion of homegrown	External radiation exposure	Total risks
Aroclor-1260	—	—	—	—
Benzo(a)pyrene	—	—	—	—
Aluminum	—	—	—	—
Arsenic	—	2E-08	—	2E-08
Manganese	—	—	—	—
Mercury	—	NTD	—	—
Uranium	—	NTD	—	—
Am-241	—	4E-10	—	4E-10
Ce-144	—	—	—	—
Co-57	—	—	—	—
Co-58	—	—	—	—
Co-60	—	—	—	—
Cs-134	—	—	—	—
Cs-137	4E-08	1E-07	6E-05	6E-05
Eu-152	—	—	—	—
Eu-154	—	—	—	—
Eu-155	—	—	—	—
H-3	—	—	—	—
I-129	—	1E-10	—	1E-10
K-40	—	—	—	—
Nb-95	—	—	—	—
Np-237	—	2E-09	—	2E-09
Pu-238	—	—	—	—
Pu-239/240	—	3E-10	—	3E-10
Pu-241	—	5E-13	—	5E-13
Pu-242	—	2E-13	—	2E-13
Ru/Rh-106	—	—	—	—
Sb-125	—	—	—	—
Sr-90	3E-08	7E-07	NTD	7E-07
Tc-99	6E-09	3E-07	6E-11	3E-07
U-234	—	2E-10	—	2E-10
U-235	—	8E-12	—	8E-12
U-236	—	5E-12	—	5E-12
U-238	—	3E-10	—	3E-10
Total cancer risks by route:	7E-08	1E-06	6E-05	6E-05

"—" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 22-11. Soil pathway noncarcinogenic hazard to the future onsite resident.[a,b]

COPCs	Ingestion of soil	Ingestion of homegrown	External radiation exposure	Total HIs
Aroclor-1260	—	—	—	—
Benzo(a)pyrene	—	—	—	—
Aluminum	—	—	—	—
Arsenic	—	1E-04	—	1E-04
Manganese	—	—	—	—
Mercury	—	1E-01	—	1E-01
Uranium	—	6E-06	—	6E-06
Am-241	—	—	—	—
Ce-144	—	—	—	—
Co-57	—	—	—	—
Co-58	—	—	—	—
Co-60	—	—	—	—
Cs-134	—	—	—	—
Cs-137	—	—	—	—
Eu-152	—	—	—	—
Eu-154	—	—	—	—
Eu-155	—	—	—	—
H-3	—	—	—	—
I-129	—	—	—	—
K-40	—	—	—	—
Nb-95	—	—	—	—
Np-237	—	—	—	—
Pu-238	—	—	—	—
Pu-239/240	—	—	—	—
Pu-241	—	—	—	—
Pu-242	—	—	—	—
Ru/Rh-106	—	—	—	—
Sb-125	—	—	—	—
Sr-90	—	—	—	—
Tc-99	—	—	—	—
U-234	—	—	—	—
U-235	—	—	—	—
U-236	—	—	—	—
U-238	—	—	—	—
Total hazard indices by route:	0E+00	1E-01	0E+00	1E-01

"—" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. No noncarcinogenic contamination has been detected at CPP-06, so there is no calculated hazard index for workers or residents at the site.
a. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

22.4.4.2 Future Land Use. As Table 22-8 indicates, the total cancer risk to the future onsite worker from exposure to site-related chemicals in surface soil is estimated to be 1E-05. The risk is attributed to external radiation exposure with the primary COC driving the risk being Cs-137 (1E-05). Table 22-9 indicates the total noncarcinogenic hazard index to the future onsite worker is estimated to be 0E+00. There are no hazard indices above unity for the future onsite worker. As indicated in Table 22-10, the total cancer risk to the future resident from exposure to site-related chemicals in soil is estimated to be 6E-05. Under this land use scenario, the excess cancer risk is driven by exposure to ionizing radiation from Cs-137 (6E-05). As shown on Table 22-11, the total noncarcinogenic hazard index to the future resident is estimated to be 1E-01. There are no hazard indices above unity for the future resident.

22.5 Uncertainties

This section describes the limitations and uncertainties specific to the site characterization of site CPP-22. Sources of uncertainty associated with site characterization include data quality, COPC identification, concentration term estimation, and assumptions regarding the lateral and vertical extent of COPC occurrence. In the risk assessment, the most significant uncertainties are due to the selection process of COPCs, the toxicity values used, and the assumptions used during the exposure assessment. The following paragraphs will discuss important sources of site-specific uncertainty in greater detail.

Sampling and analysis uncertainties are related to quality problems that may result in qualified and rejected results (Section 3.5). Qualified results are considered estimates of the concentration in the sample and, for all practical purposes, useable for their intended purpose although they could be biased high or low. Rejected results are considered unusable, thus limiting the size of the useable data set. For site CPP-22, no data points were rejected based on the validation method as documented in the Limitations and Validation (L&V) Reports, thus making this possible source of uncertainty insignificant.

Uncertainty associated with the chemical screening process (Section 5.2) results from using the maximum concentration for chemicals detected in the Environmentally Controlled Areas (ECAs) in the background comparison step, retaining chemicals detected as COPCs because there is not a corresponding background value, and retaining chemicals as COPCs for which there is no toxicity information available.

In most cases, the COPC identification process used the maximum concentration for a chemical detected in the background comparison step, regardless of its magnitude above background. The use of the maximum can result in the identification of COPCs that have concentrations only slightly above background. For site CPP-22, none of the COPCs fell into this category.

A source of uncertainty related to the background comparison step in the chemical screening process relates to chemicals for which no background concentration exists. For example, fluoride, nitrate, and several radionuclides were not characterized as part of the Rood et al. (1995) background study. For site CPP-22, only Tc-99 had no corresponding background concentration. This results in an increase in the number of COPCs considered in the remedial investigation/Baseline Risk Assessment (RI/BRA) and a possible overestimation of risk because the observed concentrations may be within the background population.

Some concentration estimates are based on the 95% UCL for the site, or the area-weighted average 95% UCLs for sites that have been grouped. When the 95% UCL (i.e., the concentration term estimate) of a

COPC is below the corresponding background value, this results in an increase in the number of COPCs in the RI/BRA and a possible overestimation of risk because the results are likely within the background range. This source of uncertainty stems from the use of maximum concentrations when identifying the COPCs for a specific sites. For site CPP-22, none of the COPC concentration estimates were below background. For site CPP-22, all COPCs had toxicity information for use in the HHRA.

With respect to the nature and extent assessment, the precise lateral extent of contamination at CPP-22 cannot be well-assessed with three boreholes. The ECA boundary has been expanded to include boring CPP-22-2, which indicated COPC results above background. The current ECA boundaries may also overestimate the lateral extent of contamination, as boring CPP-22-1 indicated all COPCs at levels below background.

One other source of uncertainty may be associated with the contaminant inventories used for the groundwater modeling and residential intrusion exposure at each sub-area. Section 22.4.3 identifies radionuclides potentially missing from these inventories. The implication of these potential data gaps is that the source estimates could be underestimated. Based on the results of the groundwater model, the potentially mission Pu-238 and Pu-241 which have half line of 87.7 and 14.4 years would not be expected to be of concern because of their long travel times to the aquifer. Am-241 is potentially missing from the source estimates but is not expected to be of concern because most of the activity has been accounted for in the tank farm and the source assumptions shown to be conservative. For a discussion of uncertainty associated with Pu-239 and Pu-240, see Section 10 of Appendix F. The potential uncertanty is recognized in this report, but no information is available to quantify the uncertainty.

22.6 Conclusions and Recommendations

The results of the risk assessment under current land use at CPP-22 indicate that the increased cancer risk from exposure to site-related contaminants is barely within the EPA recommended target range. The increased cancer risk to hypothetical future onsite workers and residents are both within the EPA target range. The noncarcinogenic hazard for all receptors was found to be well below the EPA hazard index goal of one. These estimates do not include the contributions associated with the air and groundwater pathways. The total increased cancer and hazard incidence to humans is reported in Section 27. It is important to note that the risk estimates at this site are likely to be overestimated for reasons described in Sections 7 and 22.5 and therefore, the actual estimates would be expected to be lower. Even after the contributions from the air and groundwater pathways are added to these values for a cumulative representation of the risk and hazards at this site, future response actions to mitigate adverse impacts from site-related contamination at this site are not warranted.

22.7 References

Rood, S. M., G. A. Harris, and G. J. White, 1995, *Background Dose Equivalent Rates and Surficial Soil Metal and Radionuclide Concentrations for the Idaho National Engineering Laboratory*, INEL-94/0250, Revision 0, February.

Chapter 23

23. SITE CPP-88 RESULTS

Site CPP-88 includes the radioactively-contaminated soils that have not been attributed to a release site identified in the Federal Facility Agreement/Consent Order (FFA/CO). This section describes the site, results of sampling and analysis of site CPP-88 soils, and the intended use of the CPP-88 data in the Baseline Risk Assessment (BRA).

23.1 Site Description

During construction activities at the ICPP, primarily digging and excavation, radiological contamination is occasionally discovered in the soils. Areas of contamination that are not located within other sites are included in site CPP-88. This contamination is measured by radiological control technicians (RCTs) using field instruments and is reported in Health Physics Survey Reports. These measurements are not isotope-specific (usually reported as total beta-gamma activity) and only provide a qualitative estimate of radioactivity, reported as counts per minute (cpm), or mR/hr depending on the instrument. Site CPP-88 includes only the measurements made on soils and excludes contamination associated with buildings, structures, and concrete or asphalt pads.

23.2 Investigative Results

The initial data compilation efforts for this unit involved the following activities:

- Acquisition of historical health physics (HP) records that mostly consisted of HP survey forms (Form #5601) and some excavation permits (Form #5612). These records covered the time period from December 1988 to March 1994.

- Examination of approximately 20,000 pages of these records to identify soil-related radiation measurements. This examination also identified the headings or categories that are likely to indicate soil-related records. An additional 180,000 pages of records were then searched under the headings/categories likely to contain soil-related records.

- Only the records that could be located by position (i.e., coordinates) were retained for the database. The precision with which the measurement locations could be determined was designated with a degree of confidence. Four indicators were used to convey this information:

    - Excellent—Map point located within 0.3 m (1 ft) of the measurement

    - Good—Map point located within 4.5 m (15 ft) of the measurement

    - Fair—Map point located within general area

    - Poor—Map point location is a guess, with little verification. Actual measurement location may be hundreds of meters (feet) from the location shown on the map.

From the records search, measurements indicating contamination above background that could be located using the confidence designation listed above were plotted. Whenever a range of radiation measurements were recorded in the HP survey report, the highest reading was used for plotting. In a few instances, the radiation measurements were reported in mR/hr. These values were converted in Health Physics Survey Reports from mR/hr to cpm by multiplying by 3,000. This multiplication factor is an approximate estimate used at the ICPP to convert mR/hr to cpm.

To better identify the areas of concern, the radiation measurements were screened using the following criteria:

- All data points contained within an Environmentally Controlled Area (ECA) were excluded
- For collocated data points [i.e., located within approximately 4.6 m (15 ft) of each other], the measurement from the most recent date was used and the other data excluded
- For collocated data points (i.e., located within approximately 4.6 m (15 ft) of each other), that were sampled at the same date, the highest measurement was used and the lower measurements excluded.

The radiation measurements remaining after these screening steps are plotted in the CPP-88 Track 1 (LITCO, 1995). This map uses the most recent data and presents the highest measured radiation levels recorded for a given sampling area.

As part of the OU 3-13 RI/FS field sampling program, a total of 16 boreholes were completed in order to further evaluate the distribution of radiological constituents in soils of site CPP-88. Based on evaluation of the surficial radiation measurements described previously, site CPP-88 was divided into 15 subareas (subareas and associated boreholes designated CPP-88-1 through CPP-88-15), each of relatively equal area. These 15 subareas included approximately 90% of the elevated soil radiation measurements discussed above. Each of the subareas was divided into 10- × 10-ft grids, the grids numbered, and then a sample grid selected via a random number generator. A borehole was then completed at the center of the chosen grid. An additional boring was completed in Area CPP-88-9, at a location where surface radiation surveys have routinely detected radioactivity levels above 50,000 cpm. Locations of the 16 borings are shown on Figures 3-14 through 3-18 of of Section 3 and again in Figure 23-1.

Sample location CPP-88-1-1, located south of building CPP-659, was measured at a background radiation level of approximately 100 to 120 cpm using a Ludlum 2A radiation meter. Samples were collected from the following intervals: 0.0 to 0.15 m (0.0 to 0.5 ft), 0.8 to 1.5 m (2.5 to 5.0 ft), and 2.3 to 3.0 m (7.5 to 10.0 ft). All samples indicated below background radiation levels. Samples were collected and sent for radiological analysis. In addition, the sample from 0.8 to 1.5 m (2.5 to 5.0 ft) was analyzed for Contract Laboratory Program (CLP) metals.

Sample location CPP-88-2-1, located southeast of building CPP-633, had a background radiation level of approximately 125 cpm, measured with a Ludlum 2A radiation meter. Samples were collected from the following intervals and were sent for radiological analysis: 0.0 to 0.15 m (0.0 to 0.5 ft), 0.8 to 1.5 m (2.5 to 5.0 ft), and 1.5 to 2.3 m (5.0 to 7.5 ft). All samples indicated below background radiation levels. As well, the sample from 1.5 to 2.3 m (2.5 to 5.0 ft) was analyzed for CLP metals. Samples were primarily gravels, although a 15-cm (6-in) thick sand layer was encountered at 1.8 m (6.0 ft) and directly below that a 15-cm (6-in) thick clay layer was encountered. Both layers were saturated and both were included in the 1.5- to 2.3-m (5.0- to 7.5-ft) samples for analysis.

Background soil radiation was measured at 125 cpm at sample location CPP-88-3-1 using a Ludlum 2A radiation detector. Site CPP-88-3 is located east of building CPP-630 (Figure 3-15). Samples were collected from 0.0 to 0.15 m (0.0 to 0.5 ft), 0.8 to 1.5 m (2.5 to 5.0 ft), and 2.3 to 3.0 m (7.5 to 10.0 ft) and sent for radiological analysis. In addition, the sample from 0.8 to 1.5 m (2.5 to 5.0 ft) was analyzed for CLP metals. Field-screening radiation levels for all samples were below background levels. A zone of increased moisture was encountered from approximately 2.1 to 2.4 m (7.0 to 8.0 ft).

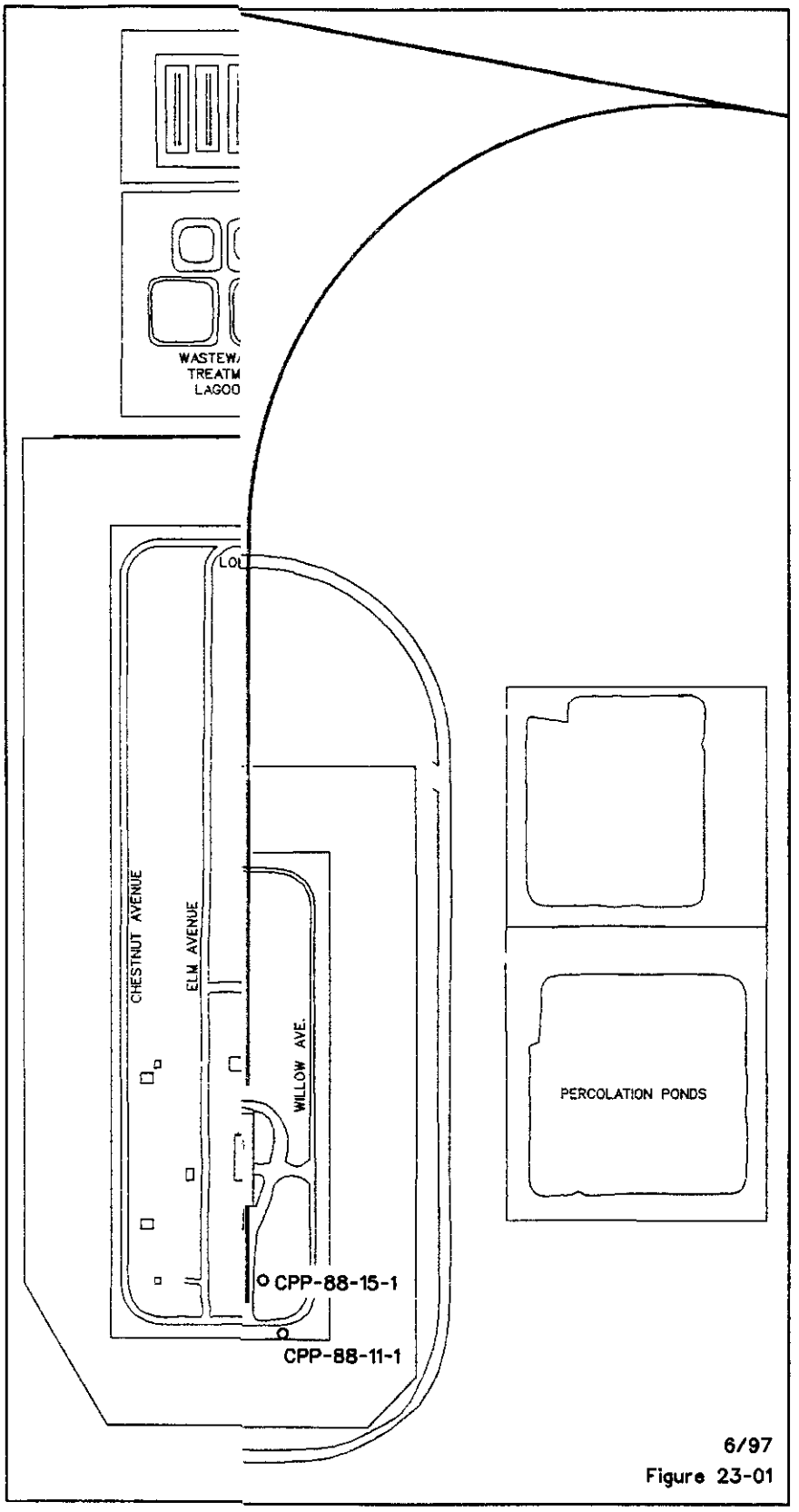


Figure 23-1. Borel

Site CPP-88-4-1, located northwest of building CPP-633, was measured at a background radiation level of approximately 200 cpm using a Ludlum 2A radiation detector. Samples were collected from 0.0 to 0.15 m (0.0 to 0.5 ft), 0.8 to 1.5 m (2.5 to 5.0 ft), and 2.3 to 3.0 m (7.5 to 10.0 ft). Field-screening radiation levels were all below background. Samples were analyzed for radiological constituents. The sample from the 0.8 to 1.5 m (2.5 to 5.0 ft) was also analyzed for CLP metals. Samples were composed of sandy gravels with some clay. The zone from approximately 2.4 to 2.7 m (8.0 to 9.0 ft) was completely saturated, and a 7.6-cm (3-in.) thick clay lens was encountered directly beneath the saturated zone.

Background soil radiation at sample location CPP-88-5-1 was measured at approximately 100 cpm. Sample location CPP-88-5-1 is located west of building CPP-633 (Figure 3-14). Samples were collected from 0.0 to 0.15 m (0.0 to 0.5 ft), 0.15 to 1.2 m (0.5 to 4.0 ft), and 2.3 to 3.0 m (7.5 to 10.0 ft) and analyzed for radionuclides. The sample from 1.2 to 2.3 m (5.0 to 7.5 ft) was also analyzed for CLP metals. All samples indicated radiation levels below background.

Sample location CPP-88-6-1 (Figure 3-15) lies east of building CPP-641. Background soil radiation at this location was measured at approximately 100 cpm using a Ludlum 2A detector. Samples were collected from 0.0 to 0.15 m (0.0 to 0.5 ft), 0.15 to 0.6 m (0.5 to 2.0 ft), and 1.2 to 1.8 m (4.0 to 6.0 ft). Field-screening radiation levels were all below background. Samples were sent for radiological analysis. Sample material was unconsolidated sands and gravels and the interval from approximately 1.4 to 1.8 m (4.5 to 6.0 ft) was saturated.

Sample location CPP-88-7-1 (Figure 3-16) lies north of building CPP-608. Background soil radiation at the sample location was measured at approximately 100 cpm using a Ludlum 2A detector. Samples were collected from 0.0 to 0.15 m (0.0 to 0.5 ft), 0.15 to 0.8 m (0.5 to 2.5 ft), and 2.3 to 3.0 m (7.5 to 10.0 ft). Samples from each interval were sent for radiological analysis. As well, the 0.15 to 0.8 m (0.5 to 2.5 ft) sample was sent for CLP metal analysis.

Sample location CPP-88-8-1 is located northwest of building CPP-617. Samples were collected from 0.0 to 0.15 m (0.0 to 0.5 ft), 0.8 to 1.2 m (2.5 to 4.0 ft), and 2.3 to 3.0 m (7.5 to 10.0 ft), and sent for radiological analyses. Field-screening radiation level measurements were all below background. The 2.3- to 3.0-m (7.5- to 10.0-ft) sample was also analyzed for CLP metals.

Site CPP-88-9-1 is located north of building CPP-603 (Figure 3-17). Surficial background radiation at this location was measured at <150 cpm using a Ludlum 2A detector. Samples were collected from 0.0 to 0.15 m (0.0 to 0.5 ft), 0.15 to 1.2 m (0.5 to 4.0 ft), and 1.2 to 3.0 m (4.0 to 10.0 ft). Field-screening radiation levels were all below background. Samples from each interval were sent for radiological analyses, as well as the sample from 0.15 to 1.2 m (0.5 to 4.0 ft), which was also analyzed for CLP metals.

Borehole CPP-88-9-2 was to be sited at a location where historic radiation measurements had indicated high radiation levels. The site area was surveyed before drilling and no significant radiation hotspots were found. Field crews noted that a fire line had been installed directly through the spot where historic measurements had indicated elevated radiation levels. Borehole CPP-88-9-2 was sited at a spot where a minor radiation increase was noted during the survey. Surficial background radiation was measured at 400 cpm using a Ludlum 2A detector. Samples were collected at the following intervals: 0.0 to 0.15 m (0.0 to 0.5 ft), 0.15 to 0.8 m (0.5 to 2.5 ft), and 2.3 to 3.0 m (7.5 to 10.0 ft). Field-screening radiation levels were all below background. Samples from each interval were analyzed for radionuclides. The sample from 0.15 to 0.8 m (0.5 to 2.5 ft) was also analyzed for CLP metals.

Site CPP-88-10-1 is located northeast of building CPP-603 as shown on Figure 3-18. Surficial background radiation was measured at approximately 200 cpm using a Ludlum 2A detector. Samples were collected from 0.0 to 0.15 m (0.0 to 0.5 ft), 0.8 to 1.2 m (2.5 to 4.0 ft), and 2.3 to 3.0 m (7.5 to 10.0 ft).

Field-screening radiation levels were all below background. Samples from each interval were analyzed for radiological constituents.

Site CPP-88-11-1 is located along the interior perimeter fence on the west side of the ICPP, near the southwest corner of the facility. Background soil radiation at the borehole site was measured at 125 cpm using a Ludlum 2A detector. Samples were collected at the following intervals: 0.0 to 0.15 m (0.0 to 0.5 ft), 0.8 to 1.2 m (2.5 to 4.0 ft), and 2.3 to 3.0 m (7.5 to 10.0 ft). Field-screening radiation levels were below background. Samples from each interval were sent for radiological analysis.

Site CPP-88-12-1 is located just west of building CPP-603. Samples were collected as detailed below. Field-screening radiation levels were all below background. Samples were collected from 0.0 to 0.15 m (0.0 to 0.5 ft), 0.15 to 0.8 m (0.5 to 2.5 ft), and 2.3 to 3.0 m (7.5 to 10.0 ft). Samples from each interval were analyzed for radionuclides.

Surficial background radiation at sample location CPP-88-13-1 was measured at 125 to 200 cpm using a Ludlum 2A detector. Sample location CPP-88-13-1 is situated east of building CPP-603. Samples were collected as follows: 0.0 to 0.15 m (0.0 to 0.5 ft), 0.15 to 0.8 m (0.5 to 2.5 ft), and 2.3 to 3.0 m (7.5 to 10.0 ft) bgs. Field-screening radiation levels were all below background. Samples from each interval were sent for radiological constituents analysis.

Sample location CPP-88-14-1 is situated approximately 58-m (190-ft) east and 18-m (60-ft) south of sample location CPP-88-13-1. Background surficial radiation of 100 to 125 cpm was measured at CPP-88-14-1 using a Ludlum 2A detector. Samples were collected from 0.0 to 0.15 m (0.0 to 0.5 ft), 0.15 to 0.8 m (0.5 to 2.0 ft), and 2.3 to 3.0 m (7.5 to 10.0 ft). Field-screening radiation levels were all below background. Samples from each interval were analyzed for radiological constituents.

Borehole CPP-88-15-1 is located near the southwest corner of the ICPP facility, just inside the interior perimeter fence. Samples were collected from the intervals indicated below. Samples were collected from 0.0 to 0.15 m (0.0 to 0.5 ft), 0.15 to 1.2 m (0.5 to 4.0 ft), and 2.1 to 3.4 m (7.0 to 10.0 ft). Samples from each interval were analyzed for radiological constituents. The sample collected from the 2.1- to 3.4-m (7.0- to 11.0-ft) interval was also analyzed for CLP metals.

The analytical results for contaminants of potential concern (COPCs) identified for site CPP-88 are summarized on Table 23-1. A complete set of results is contained in Appendix G. Based on the chemical screening presented in Section 5.2, Sr-90, Cs-137, arsenic, and thallium were identified as COPCs for CPP-88 soils.

Borings CPP-88-1-1, CPP-88-5-1, and CPP-88-2-1 are shown on Figure 3-14. Cs-137, Sr-90, and arsenic were detected above background in these borings. Cs-137 activity ranged as high as 5.9±0.1 pCi/g in surficial samples; it was also detected at activities as high as 5.7±0.1 pCi/g in samples extending as deep as 3.0-m (10.0-ft) bgs. Sr-90 activity ranged up to 3.6 pCi/g in surficial samples. Both Cs-137 and Sr-90 activities increased with depth in boring CPP-88-5-1. Arsenic detections above background were isolated.

Borings CPP-88-3-1, CPP-88-4-1, and CPP-88-6-1 are shown on Figure 3-15. Cs-137 and Sr-90 were detected commonly at activities above background. Arsenic was the only inorganic COPC detected above background, and only one occurrence of arsenic was noted (5.9 mg/kg in the 0.8- to 1.5-m (2.5- to 5.0-ft)) interval of boring CPP-88-4-1. Cs-137 activity ranged as high as 36.6±0.4 pCi/g in the 2.3- to 3.0-m (7.5- to

Table 23-1. Summary statistics for CPP-88, non-ECA radiologically contaminated soils.

COPCs	Concentration (mg/kg or pCi/g) Minimum detected	Maximum detected	Arithmetic mean	Standard deviation	Number of samples	Number of detects	Frequency of detection	INEL background (mg/kg or pCi/g)	Number greater than background
Arsenic	3.5 P	7.3 P	5.27E+00	1.09E+00	12	12	100%	5.8	3
Thallium	1 B P	1.5 B P	1.32E+00	2.36E-01	12	4	33%	0.43	3
Cs-137	0.08 +/- 0.02	36.6 +/- 0.4	4.49E+00	6.91E+00	53	34	64%	0.82	23
Sr-90	0.4 +/- 0.2	9.2 +/- .4	2.09E+00	2.32E+00	53	29	55%	0.49	17

10.0-ft) interval of CPP-88-3-1; the maximum Sr-90 activity measured was 9.2±0.4 pCi/g in the 0.8- to 1.5-m (2.5- to 5.0-ft) interval of boring CPP-88-4-1.

Borings CPP-88-7-1 and CPP-88-8-1 are shown on Figure 3-16. Cs-137 and Sr-90 were the only COPCs detected above background. Detections of Cs-137 and Sr-90 were generally at low activities and at shallow depths. Cs-137 and Sr-90 were not detected above background in samples collected deeper than 1.2 m (4.0 ft) bgs.

Borings CPP-88-9-1, -88-9-2, -88-10-1, -88-11-1, -88-12-1, and -88-15-1 are shown on Figure 3-17. Radionuclides detected above background were Cs-137 and Sr-90. Activities of Cs-137 and Sr-90 in surficial samples ranged as high as 15.2±0.3 pCi/g and 6.4±0.3 pCi/g, respectively. Near-surface samples (extending up to 0.8 m (2.5 ft) deep) showed activity levels ranging as high as 7.6±0.1 pCi/g and 7.4±0.1 pCi/g for Cs-137 and Sr-90, respectively. Only isolated detections above background of Sr-90 and Cs-137 were noted below 0.8 m (2.5 ft). These detections were of low activity (less than 1.0 pCi/g). Cs-137 and Sr-90 activities decreased with depth at each boring except CPP-88-12-1.

Sample locations CPP-88-13-1 and CPP-88-14-1 are shown on Figure 3-18. Cs-137 and Sr-90 were detected above background in samples collected above 0.6 m (2.0 ft) bgs. Cs-137 ranged as high as 12.8±0.2 pCi/g; Sr-90 as high as 1.5±0.2 pCi/g. Both of these detections were in the surficial sample at boring CPP-88-13-1. Cs-137 and Sr-90 activities decreased with depth in both boreholes.

23.3 Risk Assessment

The methodology for conducting the HHRA for WAG 3 was detailed in Section 7. As presented, the purpose of the HHRA is to develop a quantitative description and assessment of the human health risk posed by the COPCs present at WAG 3. This section contain the results of the HHRA for site CPP-88 with respect to the soil pathways. The results for the air and groundwater pathways are detailed in Sections 27.1 and 27.2. The following sections discuss the complete exposure routes, exposure-point concentrations, and cancer risk and noncarcinogenic health hazard estimates for site CPP-88.

23.2.1 Complete Exposure Routes

Potentially complete pathways from the source to a human receptor were described in Section 7 and illustrated on Figure 7-1. For site CPP-88, the complete exposure routes are summarized in Table 23.2. An exposure route is considered complete if the contaminated zone (as characterized in the previous sections) occurs within the depth intervals specified for a given exposure route.

23.3.2 Exposure-Point Concentrations

Specific steps in calculating exposure-point concentrations for each of the applicable scenarios were described in Section 7. The COPC soil value used was the smaller of the 95% UCL or maximum concentration. The concentration terms for the radionuclides were adjusted to account for decay for each exposure scenario. These values were subsequently averaged over the exposure duration. The concentration terms, by depth interval, are presented in Table 23-3. Exposure from all complete exposure routes were estimated based on the exposure-point concentrations in Table 23-4. Homegrown produce concentrations are presented in Table 23-5. The values for air and groundwater are presented in Sections 27.1 and 2.2, respectively.

Table 23-2. Complete exposure routes for site CPP-88 and associated exposure route depths.

Receptor	Scenario	Potentially complete exposure routes and exposure route depths used for exposure-point concentration estimates	Characterized zone of contamination[a]	Complete exposure route?
Onsite worker	Current land use	Inhalation of VOCs [0–15 cm (0–6 in.)]	0 to 10.1 m (0 to 33 ft)	No
		Inhalation of airborne particulates [0–15 cm (0–6 in.)]		Yes
		Ingestion of surface soil [0–15 cm (0–6 in.)]		Yes
		External radiation [0–1.22 m (0–4 ft)]		Yes
Residential	Future land use	Inhalation of VOCs [0–3.05 m (0–10 ft)]	0 to 10.1 m (0 to 33 ft)	No
		Inhalation of airborne particulates [0–3.05 m (0–10 ft)]		Yes
		Ingestion of surface soil [0–3.05 m (0–10 ft)]		Yes
		Ingestion of homegrown produce [0–3.05 m (0–10 ft)]		Yes
		Ingestion of groundwater		Yes
		Dermal contact with groundwater		No
		Inhalation of VOCs from groundwater		No
		External radiation [0–3.05 m (0–10 ft)]		Yes
Onsite worker	Future land use	Inhalation of VOCs [0–15 cm (0–6 in.)]	0 to 10.1 m (0 to 33 ft)	No
		Inhalation of airborne particulates [0–15 cm (0–6 in.)]		Yes
		Ingestion of surface soil [0–15 cm (0–6 in.)]		Yes
		External radiation [0–1.22 m (0–4 ft)]		Yes

Table 23-3. Soil concentration terms by depth interval.

COPCs	Soil concentrations (mg/kg or pCi/g) (0 - 0.5 ft)	(0 - 4 ft)	(0 - 10 ft)
Aroclor-1260	----	----	----
Benzo(a)pyrene	----	----	----
Aluminum	----	----	----
Arsenic	----	6.43E+00	5.90E+00
Manganese	----	----	----
Mercury	----	----	----
Uranium	----	----	----
Am-241	----	----	----
Ce-144	----	----	----
Co-57	----	----	----
Co-58	----	----	----
Co-60	----	----	----
Cs-134	----	----	----
Cs-137	1.41E+01	1.27E+01	1.18E+01
Eu-152	----	----	----
Eu-154	----	----	----
Eu-155	----	----	----
H-3	----	----	----
I-129	----	----	----
K-40	----	----	----
Nb-95	----	----	----
Np-237	----	----	----
Pu-238	----	----	----
Pu-239/240	----	----	----
Pu-241	----	----	----
Pu-242	----	----	----
Rh-106	----	----	----
Ru-106	----	----	----
Sb-125	----	----	----
Sr-90	3.55E+00	2.47E+00	1.57E+00
Tc-99	----	----	----
U-234	----	----	----
U-235	----	----	----
U-236	----	----	----
U-238	----	----	----

Table 23-4. Average soil exposure-point concentrations (mg/kg or pCi/g) for land use scenarios.

	Current occupational worker year 0 to year 25		Future occupational worker year 100 to year 125		Future resident year 100 to year 130
COPCs	(0 - 0.5 ft)	(0 - 4 ft)	(0 - 0.5 ft)	(0 - 4 ft)	(0 - 10 ft)
Aroclor-1260	—	—	—	—	—
Benzo(a)pyrene	—	—	—	—	—
Aluminum	—	—	—	—	—
Arsenic	—	6.43E+00	—	6.43E+00	5.90E+00
Manganese	—	—	—	—	—
Mercury	—	—	—	—	—
Uranium	—	—	—	—	—
Am-241	—	—	—	—	—
Ce-144	—	—	—	—	—
Co-57	—	—	—	—	—
Co-58	—	—	—	—	—
Co-60	—	—	—	—	—
Cs-134	—	—	—	—	—
Cs-137	1.08E+01	9.65E+00	1.08E+00	9.71E-01	8.54E-01
Eu-152	—	—	—	—	—
Eu-154	—	—	—	—	—
Eu-155	—	—	—	—	—
H-3	—	—	—	—	—
I-129	—	—	—	—	—
K-40	—	—	—	—	—
Nb-95	—	—	—	—	—
Np-237	—	—	—	—	—
Pu-238	—	—	—	—	—
Pu-239/240	—	—	—	—	—
Pu-241	—	—	—	—	—
Pu-242	—	—	—	—	—
Rh-106	—	—	—	—	—
Ru-106	—	—	—	—	—
Sb-125	—	—	—	—	—
Sr-90	2.67E+00	1.86E+00	2.47E-01	1.72E-01	1.04E-01
Tc-99	—	—	—	—	—
U-234	—	—	—	—	—
U-235	—	—	—	—	—
U-236	—	—	—	—	—
U-238	—	—	—	—	—

Table 23-5. Concentrations of COPCs in homegrown produce.

COPCs	Homegrown produce (mg/kg or pCi/g)	Kd (cm^3/g)	COPC input rate from irrigation (mg/g-d or pCi/g-d)	Leach rate constant (d^{-1})
Aroclor-1260	----	7.89E+03	0.00E+00	9.95E-07
Benzo(a)pyrene	----	1.19E+03	0.00E+00	6.57E-06
Aluminum	----	0.00E+00	0.00E+00	2.87E-02
Arsenic	9.12E-03	3.00E+00	8.71E-09	2.40E-03
Manganese	----	5.00E+01	0.00E+00	1.56E-04
Mercury	1.10E-01	1.00E+02	2.91E-08	7.83E-05
Uranium	7.30E-05	6.00E+00	7.04E-09	1.25E-03
Am-241	7.76E-06	3.40E+02	6.08E-06	2.31E-05
Ce-144	---	5.00E+02	0.00E+00	1.57E-05
Co-57	---	1.00E+01	0.00E+00	7.64E-04
Co-58	---	1.00E+01	0.00E+00	7.64E-04
Co-60	---	1.00E+01	0.00E+00	7.64E-04
Cs-134	---	5.00E+02	0.00E+00	1.57E-05
Cs-137	2.38E-03	5.00E+02	4.12E-05	1.57E-05
Eu-152	---	3.40E+02	0.00E+00	2.31E-05
Eu-154	---	3.40E+02	0.00E+00	2.31E-05
Eu-155	---	3.40E+02	0.00E+00	2.31E-05
H-3	----	0.00E+00	6.22E-04	2.87E-02
I-129	3.85E-06	0.00E+00	3.26E-05	2.87E-02
K-40	---	1.50E+01	0.00E+00	5.14E-04
Nb-95	---	0.00E+00	0.00E+00	2.87E-02
Np-237	3.19E-05	0.00E+00	8.36E-06	2.87E-02
Pu-238	---	2.20E+01	0.00E+00	3.53E-04
Pu-239/240	5.15E-06	2.20E+01	5.84E-07	3.53E-04
Pu-241	8.49E-09	2.20E+01	9.37E-08	3.53E-04
Pu-242	3.60E-09	2.20E+01	3.88E-10	3.53E-04
Ru/Rh-106	---	0.00E+00	0.00E+00	2.87E-02
Sb-125	---	5.00E+01	0.00E+00	1.56E-04
Sr-90	8.04E-03	1.20E+01	5.63E-05	6.40E-04
Tc-99	4.56E-01	0.00E+00	1.67E-04	2.87E-02
U-234	2.73E-05	6.00E+00	2.63E-06	1.25E-03
U-235	9.61E-07	6.00E+00	9.27E-08	1.25E-03
U-236	6.93E-07	6.00E+00	6.68E-08	1.25E-03
U-238	2.44E-05	6.00E+00	2.35E-06	1.25E-03

23.3.3 Risk Estimates

The results of this evaluation under current and future land use are presented in Section 23.3.3.1 and 23.3.3.2. For each receptor, the results are summarized in Tables 23-6 through 23-11.

23.3.3.1 Current Land Use. As indicated in Table 23-6, excess cancer risk to the current on-site worker from exposure to site-related chemicals in surface soil is estimated to be 1E-04. The risk is attributed to the external radiation exposure route. The primary COC for the external radiation exposure route is Cs-137. Table 23-7 indicates that the noncarcinogenic hazard index to the current worker is 0. There are no COPCs resulting in noncarcinogenic effects for the current on-site worker.

23.3.3.2 Future Land Use. As Table 23-8 indicates, the excess cancer risk to the future on-site worker from exposure to site-related chemicals in air and surface soil is estimated to be 1E-05. The risk is attributed to the external radiations exposure route. Cs-137 is the primary COC in the external radiation exposure risk. Table 23-9 indicates the noncarcinogenic hazard index to the future on-site worker is 0. There are no COPCs resulting in noncarcinogenic effects for the future on-site worker. As indicated in Table 23-10, the excess cancer risk to the future resident from exposure to site related chemicals in soil is estimated to be 7E-05. Within the ingestion of soil exposure route, the major contributor is arsenic (1E-05). Within the produce-ingestion exposure route, the major contributor to risk is Sr-90 (4E-06). The risk from Cs-137 (5E-05) is the major contributor for external radiation exposure. As shown on Table 23-11, the noncarcinogenic hazard index to the future resident is estimated to be 1E-09. There are no hazard indices above unity for the future resident.

23.4 Conclusions and Recommendations

Cs-137 and Sr-90 were the only radiological COPCs detected above background in site CPP-88 borings. The maximum Cs-137 and Sr-90 activities detected in surficial samples were 15.2±0.3 pCi/g and 6.4±0.3 pCi/g, respectively. Maximum activity levels from samples from the lowest sample interval (generally terminating at 3.0 m (10.0 ft)) were 36.6±0.4 pCi/g and 2.0±0.3 pCi/g for Cs-137 and Sr-90, respectively. Cs-137 and Sr-90 activities generally decreased with depth.

Arsenic and thallium were the inorganic COPCs detected in CPP-88 samples at concentrations above background. These detections were generally isolated and only slightly above background.

Sample results from site CPP-88 were incorporated into the air pathway analysis in the human health risk assessment (HHRA) by using the concentrations observed for the COPCs in the waste area group (WAG)-wide concentration estimates (see Section 7). In addition, CPP-88 results were assigned to non-ECA soil areas for use in calculating most group-wide concentration estimates for use in the BRA. For example, the storage yard east of the Building CPP-603 Group includes sites CPP-03, CPP-17a, and CPP-17b. For the group-wide concentration term estimate, soil areas between the sites were assigned radiological constituent concentrations based on CPP-88 results. The CPP-88 COPC concentrations were area weighted along with the concentrations of the COPCs identified in CPP-03, CPP-17a, and CPP-17b. The group-wide concentration term is then used to estimate an exposure point concentration for the group for use in the BRA. An exception to this procedure is made for the Tank Farm Group, where non-ECA soil areas will be assumed to have contaminant concentrations equal to those in the contaminated soil stockpile.

The results of the risk assessment under current land at CPP-88 indicate that the increased cancer risk from exposure to site-related contaminants is barely within the EPA recommended target range. The increased cancer risk to hypothetical future onsite workers and residents are both within the EPA target range.

Table 23-6. Cancer risk to the current on-site worker.

COPCs	Ingestion of soil	External radiation exposure	Total risks
Aroclor-1260	—	—	—
Benzo(a)pyrene	—	—	—
Aluminum	—	—	—
Arsenic	—	—	—
Manganese	—	—	—
Mercury	—	—	—
Uranium	—	—	—
Am-241	—	—	—
Ce-144	—	—	—
Co-57	—	—	—
Co-58	—	—	—
Co-60	—	—	—
Cs-134	—	—	—
Cs-137	9E-08	1E-04	1E-04
Eu-152	—	—	—
Eu-154	—	—	—
Eu-155	—	—	—
H-3	—	—	—
I-129	—	—	—
K-40	—	—	—
Nb-95	—	—	—
Np-237	—	—	—
Pu-238	—	—	—
Pu-239/240	—	—	—
Pu-241	—	—	—
Pu-242	—	—	—
Rh-106	—	—	—
Ru-106	—	—	—
Sb-125	—	—	—
Sr-90	4E-08	NTD	4E-08
Tc-99	—	—	—
U-234	—	—	—
U-235	—	—	—
U-236	—	—	—
U-238	—	—	—
			—
Total cancer risks by route:	1E-07	1E-04	1E-04

"—" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.

Table 23-7. Noncarcinogenic hazard to the current on-site worker.

COPCs	Ingestion of soil	External radiation exposure	Total HIs
Aroclor-1260	—	—	—
Benzo(a)pyrene	—	—	—
Aluminum	—	—	—
Arsenic	—	—	—
Manganese	—	—	—
Mercury	—	—	—
Uranium	—	—	—
Am-241	—	—	—
Ce-144	—	—	—
Co-57	—	—	—
Co-58	—	—	—
Co-60	—	—	—
Cs-134	—	—	—
Cs-137	—	—	—
Eu-152	—	—	—
Eu-154	—	—	—
Eu-155	—	—	—
H-3	—	—	—
I-129	—	—	—
K-40	—	—	—
Nb-95	—	—	—
Np-237	—	—	—
Pu-238	—	—	—
Pu-239/240	—	—	—
Pu-241	—	—	—
Pu-242	—	—	—
Rh-106	—	—	—
Ru-106	—	—	—
Sb-125	—	—	—
Sr-90	—	—	—
Tc-99	—	—	—
U-234	—	—	—
U-235	—	—	—
U-236	—	—	—
U-238	—	—	—
Total hazard indices by route:	0E+00	0E+00	0E+00

"—" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.

Table 23-8. Cancer risk to the future on-site worker.

COPCs	Ingestion of soil	External radiation exposure	Total risks
Aroclor-1260	—	—	—
Benzo(a)pyrene	—	—	—
Aluminum	—	—	—
Arsenic	—	—	—
Manganese	—	—	—
Mercury	—	—	—
Uranium	—	—	—
Am-241	—	—	—
Ce-144	—	—	—
Co-57	—	—	—
Co-58	—	—	—
Co-60	—	—	—
Cs-134	—	—	—
Cs-137	9E-09	1E-05	1E-05
Eu-152	—	—	—
Eu-154	—	—	—
Eu-155	—	—	—
H-3	—	—	—
I-129	—	—	—
K-40	—	—	—
Nb-95	—	—	—
Np-237	—	—	—
Pu-238	—	—	—
Pu-239/240	—	—	—
Pu-241	—	—	—
Pu-242	—	—	—
Rh-106	—	—	—
Ru-106	—	—	—
Sb-125	—	—	—
Sr-90	3E-09	NTD	3E-09
Tc-99	—	—	—
U-234	—	—	—
U-235	—	—	—
U-236	—	—	—
U-238	—	—	—
Total cancer risks by route:	1E-08	1E-05	1E-05

"—" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.

Table 23-9. Noncarcinogenic hazard to the future on-site worker.

COPCs	Ingestion of soil	External radiation exposure	Total HIs
Aroclor-1260	—	—	—
Benzo(a)pyrene	—	—	—
Aluminum	—	—	—
Arsenic	—	—	—
Manganese	—	—	—
Mercury	—	—	—
Uranium	—	—	—
Am-241	—	—	—
Ce-144	—	—	—
Co-57	—	—	—
Co-58	—	—	—
Co-60	—	—	—
Cs-134	—	—	—
Cs-137	—	—	—
Eu-152	—	—	—
Eu-154	—	—	—
Eu-155	—	—	—
H-3	—	—	—
I-129	—	—	—
K-40	—	—	—
Nb-95	—	—	—
Np-237	—	—	—
Pu-238	—	—	—
Pu-239/240	—	—	—
Pu-241	—	—	—
Pu-242	—	—	—
Rh-106	—	—	—
Ru-106	—	—	—
Sb-125	—	—	—
Sr-90	—	—	—
Tc-99	—	—	—
U-234	—	—	—
U-235	—	—	—
U-236	—	—	—
U-238	—	—	—
Total hazard indices by route:	0E+00	0E+00	0E+00

"—" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.

Table 23-10. Soil pathway cancer risk to the future on-site resident. [a]

COPCs	Ingestion of soil	Ingestion of homegrown produce	External radiation exposure	Total risks
Aroclor-1260	—	—	—	—
Benzo(a)pyrene	—	—	—	—
Aluminum	—	—	—	—
Arsenic	1E-05	2E-06	—	2E-05
Manganese	—	—	—	—
Mercury	—	NTD	—	—
Uranium	—	NTD	—	—
Am-241	—	4E-10	—	4E-10
Ce-144	—	—	—	—
Co-57	—	—	—	—
Co-58	—	—	—	—
Co-60	—	—	—	—
Cs-134	—	—	—	—
Cs-137	3E-08	1E-08	5E-05	5E-05
Eu-152	—	—	—	—
Eu-154	—	—	—	—
Eu-155	—	—	—	—
H-3	—	—	—	—
I-129	—	1E-10	—	1E-10
K-40	—	—	—	—
Nb-95	—	—	—	—
Np-237	—	2E-09	—	2E-09
Pu-238	—	—	—	—
Pu-239/240	—	3E-10	—	3E-10
Pu-241	—	5E-13	—	5E-13
Pu-242	—	2E-13	—	2E-13
Ru/Rh-106	—	—	—	—
Sb-125	—	5E-09	—	5E-09
Sr-90	7E-09	4E-06	NTD	4E-06
Tc-99	—	7E-12	—	7E-12
U-234	—	7E-12	—	7E-12
U-235	—	6E-12	—	6E-12
U-236	—	2E-10	—	2E-10
U-238	—	—	—	—
Total cancer risks by route:	1E-05	6E-06	5E-05	7E-05

"—" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 23-11. Soil pathway noncarcinogenic hazard to the future on-site resident. [a]

COPCs	Ingestion of soil	Ingestion of homegrown produce	External radiation exposure	Total HIs
Aroclor-1260	—	—	—	—
Benzo(a)pyrene	—	—	—	—
Aluminum	—	—	—	—
Arsenic	6E-09	8E-03	—	8E-03
Manganese	—	—	—	—
Mercury	—	1E-01	—	1E-01
Uranium	—	6E-06	—	6E-06
Am-241	—	—	—	—
Ce-144	—	—	—	—
Co-57	—	—	—	—
Co-58	—	—	—	—
Co-60	—	—	—	—
Cs-134	—	—	—	—
Cs-137	—	—	—	—
Eu-152	—	—	—	—
Eu-154	—	—	—	—
Eu-155	—	—	—	—
H-3	—	—	—	—
I-129	—	—	—	—
K-40	—	—	—	—
Nb-95	—	—	—	—
Np-237	—	—	—	—
Pu-238	—	—	—	—
Pu-239/240	—	—	—	—
Pu-241	—	—	—	—
Pu-242	—	—	—	—
Ru/Rh-106	—	—	—	—
Sb-125	—	—	—	—
Sr-90	—	—	—	—
Tc-99	—	—	—	—
U-234	—	—	—	—
U-235	—	—	—	—
U-236	—	—	—	—
U-238	—	—	—	—
Total hazard indices by route:	6E-09	1E-01	0E+00	1E-01

"—" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

The noncarcinogenic hazard for all receptors was found to be below the EPA hazard index goal of one. These estimates do not include the contributions associated with the air and groundwater pathways. The total increased cancer and hazard incidence to humans is reported in Section 27. It is important to note that the risk estimates at this site are likely to be overestimated for reasons described in Section 7 and 23.5 and therefore, the actual estimates would be expected to be lower. Even after the contributions from the air and groundwater pathways are added to these values for a cumulative representation of the risk and hazards at this site, future response actions to mitigate adverse impacts from site-related contamination at this site are not warranted.

23.5 Uncertainties

This section describes the limitations and uncertainties specific to the site characterization of site CPP-88. Sources of uncertainty associated with site characterization include data quality, COPC identification, concentration term estimation, and assumptions regarding the lateral and vertical extent of COPC occurrence. Data for CPP-88 were used as interstitial soil concentrations for the groups with the exception of the Tank Farm Group.

Sampling and analysis uncertainties are related to quality problems that may result in qualified and rejected results (Section 3.5). Qualified results are considered estimates of the concentration in the sample and, for all practical purposes, useable for their intended purpose although they could be biased high or low. Rejected results are considered unusable, thus limiting the size of the useable data set. For site CPP-88, six antimony data points were rejected based on the method validation as documented in the Limitations and Validation (L&V) Reports. Antimony was not retained as a COPC because the concentrations from the useable data were below the background value of 4.8 mg/kg, thus influence from this possible source of uncertainty is insignificant.

Uncertainty associated with the chemical screening process (Section 5.2) results from using the maximum concentration for chemicals detected in the ECAs in the background comparison step, retaining chemicals detected as COPCs because there is not a corresponding background value, and retaining chemicals as COPCs for which there is no toxicity information available.

In most cases, the COPC identification process used the maximum concentration for a chemical detected in the background comparison step, regardless of its magnitude above background. The use of the maximum can result in the identification of COPCs that have concentrations only slightly above background. For site CPP-90, arsenic was the only COPC that fell into this category. The maximum arsenic concentration was 7.3 mg/kg. The background value for arsenic is 5.8 mg/kg.

Another source of uncertainty related to the background comparison step in the chemical screening process relates to chemicals for which no background concentration exists. For example, fluoride, nitrate, and several radionuclides were not characterized as part of the Rood et al. (1995) background study. For site CPP-88, all COPCs had corresponding background concentrations.

Some concentration estimates are based on the 95% upper confidence limit (UCL) for the site, or the area-weighted average 95% UCLs for sites that have been grouped. When the 95% UCL (i.e., the concentration term estimate) of a COPCs is below the corresponding background value, this results in an increase in the number of COPCs in the RI/BRA and a possible overestimation of risk because the results are likely within the background range. This source of uncertainty stems from the use of maximum concentrations when identifying the COPCs for a specific sites. For site CPP-88, the arsenic concentration estimate was 5.9 mg/kg while background is 5.8 mg/kg.

For site CPP-88, thallium was retained as a COPC for the RI/BRA. There are no toxicity values in Integrated Risk Information System (IRIS), Health Effects Assessment Summary Tables (HEAST), or EPA Region III publications for thallium. Uses of thallium include thallium salts, mercury alloys, low-melting glasses, rodenticides, photoelectric applications, and electrodes in dissolved oxygen analyzers. The impact of not including thallium in the BRA may underestimate the risk; however, this impact is not quantifiable because of the lack of toxicity information.

23.6 References

LITCO, 1995, *Track 1 Decision Documentation Package, Radiologically Contaminated Soils, Operable Unit 3-13.*

Rood, S. M., G. A. Harris, and G. J. White, 1995, *Background Dose Equivalent Rates and Surficial Soil Metal and Radionuclide Concentrations for the Idaho National Engineering Laboratory*, INEL-94/0250, Revision 0, February.

Chapter 24

24. SITE CPP-90 RESULTS

CPP-90 consists of soil contaminated by leaks in service waste transfer lines between building CPP-709 and the CPP-23 injection well. This section describes the nature and extent of contamination related to the leak as well as presents the results of the human health risk assessment (HHRA) for this site.

24.1 Site Description

The leak associated with site CPP-90 is believed to have resulted in the detection of trace amounts of ruthenium (Ru-106) in the ICPP production wells in May 1959. Service waste from the process equipment waste (PEW) Evaporator System, CPP-633 (Waste Calcining Facility), floor drains, steam condensate lines, and equipment cooling jackets were routed via the service waste line through the monitoring station in building CPP-709 to the CPP-23 injection well. Service wastes were routed through CPP-709 to the injection well from 1953 to 1984 after which service wastes were routed to the percolation ponds. The waste stream with the greatest potential for contamination was condensate from the PEW system, which was a source of Sr-90, Cs-137, Ru-106, and Co-60 (LITCO, 1995).

The service waste transfer line originally consisted of a 24-in. (61-cm) concrete pipeline that ran approximately 164.6 m (540 ft) from CPP-709 to the CPP-23 injection well. Because of suspected deterioration of the line, assumed to be correlated to detections of trace amounts of ruthenium in upgradient CPP production wells, the concrete pipe was replaced in 1959–1960. The concrete pipe was replaced with salt-glazed vitrified clay pipe and the joints were sealed with a synthetic rubber polymer. In 1969, due to suspected releases of tritium from leaks in the transfer line assumed to be related to increases of tritium in the production wells, the vitrified clay pipe was abandoned in place and replaced with a stainless steel line. In 1976, a leak in the stainless steel line released approximately 70,000 L (18,500 gal) of contaminated water containing approximately 60 μCi of radioactivity. At that time the line was repaired and in 1982, approximately two-thirds of the line was replaced. During construction of building CPP-684 (remote analytical laboratory) and the 1982 upgrade of the service waste line, hotspots were detected along the pipeline. The service waste transfer line has not been used regularly since service wastes were directed to the percolation ponds in 1984. The transfer line and injection well were only used for emergency disposal purposes from 1984 to 1986 when the injection well and transfer line were permanently taken out of service. Most of the transfer lines were abandoned in place; however, the abandoned vitrified clay line was removed except for underneath building CPP-684 where it was grouted in place.

The equipment in building CPP-709 monitored radiological constituents in the service wastewaters before transfer to the CPP-23 injection well. The building was equipped with an alarm that signaled ICPP plant operators to terminate operations or divert the contaminated flows when radiological contamination was indicated by the monitoring equipment.

24.2 Investigative Results

As described in Section 3.3.1.12, three borings were drilled and sampled as part of the OU 3-13 RI/FS field investigation. Boring CPP-90-1 was drilled near the ICPP injection well, boring CPP-90-2 was drilled near building CPP-684, and boring CPP-90-3 was drilled near the CPP-709 pumphouse (Figure 24-1). The boreholes were drilled to the soil-basalt interface

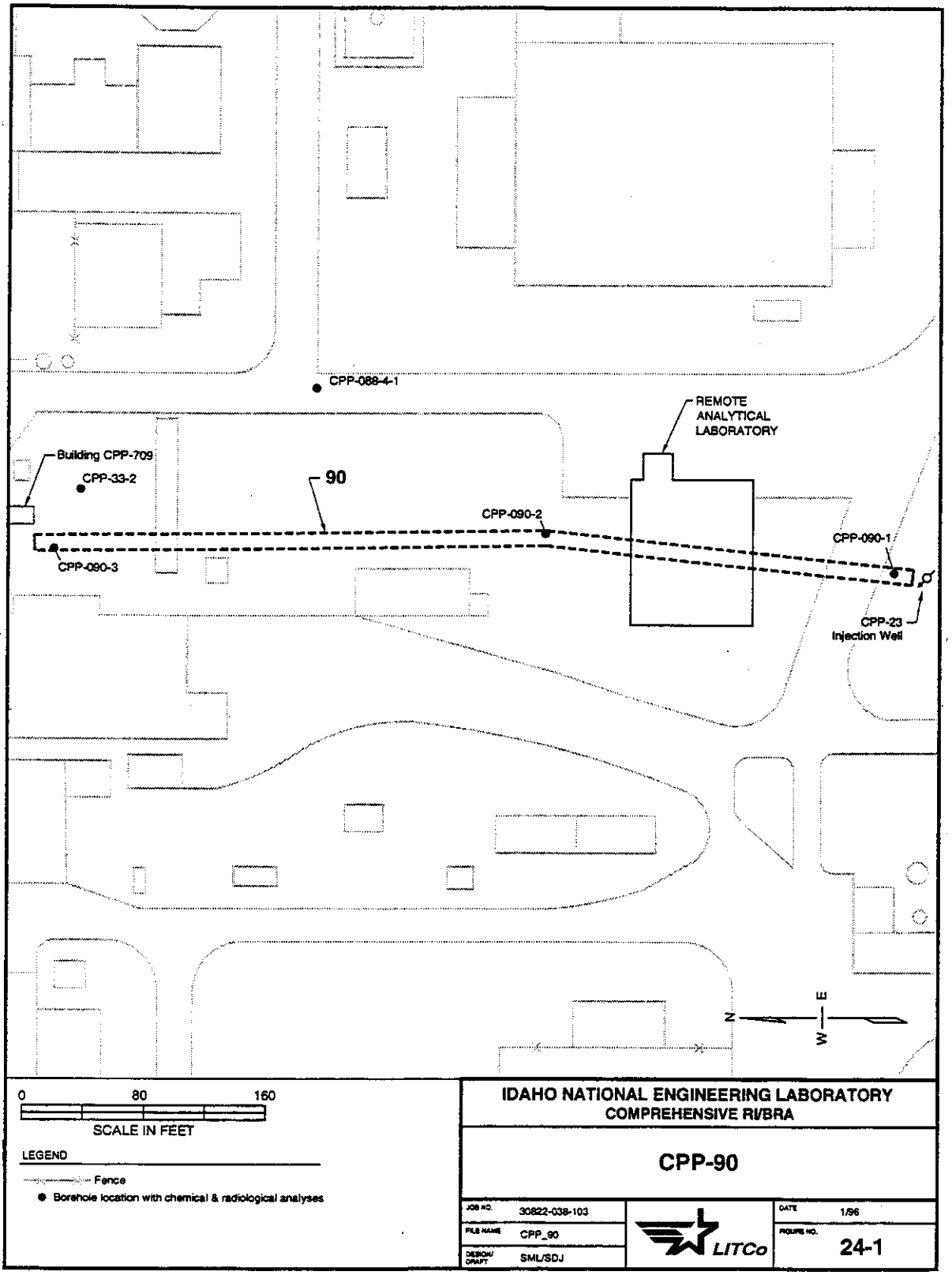


Figure 24-1. CPP-90 and borehole locations.

and five samples were collected from each borehole from within the alluvium. Samples were analyzed for Contract Laboratory Program (CLP) inorganics, volatiles organic compounds (VOCs), semivolatile organic compounds (SVOCs), gross alpha/beta radiation, and gamma spectroscopy. Samples were also analyzed for Sr-90 and Tc-99 if gross beta was greater than 30 pCi/g; and for Am-241, Np-237, and U- and Pu-isotopes if gross alpha was greater than 20 pCi/g.

The results of the analyses are summarized on Table 24-1 and a complete table of results is provided in Appendix G. It should be noted that several contaminants were completely undetected and therefore do not appear on Table 5-45. These are listed at the bottom of this table. The contaminants of potential concern (COPCs) identified at this site in the contaminant screening process were benzo(a)pyrene, phenanthrene, arsenic, thallium, Co-58, Cs-134, Cs-137, Eu-155, Nb-95, and Sr-90.

The only inorganics detected above background were antimony, arsenic, thallium, and mercury. None of these metals show trends suggestive of contamination (decrease in concentration with depth, elevated concentrations in samples with high radionuclide concentrations, etc.). Several SVOCs were detected in the samples: benzo(a)pyrene, phenanthrene, acenaphthalene, benzo(a)anthracene, benzo(a)fluoranthene, bis (2-ethylhexyl)phthalate, flouranthene, indeno (1,2,3-cd) pyrene, and pyrene. Most of these compounds were detected at very low concentrations in the 0- to 0.8-m (0- to 2.5-ft) sample in boring CPP-90-3. None of these compounds were detected above 0.4 mg/kg and all decreased in concentration with depth to below detection limits in the upper 3.0 m (10 ft).

Radionuclides that were detected in one or more samples were Co-60, Cs-134, Cs-137, Eu-155, Nb-95, and Sr-90. No U- or Pu-isotopes were detected in the samples. Maximum concentrations of Cs-137 and Sr-90 were approximately one order of magnitude above background. Cs-137 was detected above background in samples down to 3.0 m (10 ft) in borings CPP-90-1 and CPP-90-3, and down to 1.5 m (5 ft) in boring CPP-90-2. The highest Cs-137 concentrations were detected in the 0.8- to 1.5-m (2.5- to 5.0-ft) sample in all three borings. Sr-90 was only detected in three samples collected from depths greater than 6.1 m (20 ft) in borings CPP-90-1 and CPP-90-3. The highest concentration of Sr-90, 6.3±0.1 pCi/g, was detected in the 8.4- to 9.1-m (27.5- to 30.0-ft) sample from boring CPP-90-1 and the concentration decreased to 1.4±0.2 pCi/g in the sample collected just above the soil/basalt interface at a depth of 12.2- to 12.8-m (40- to 42-ft) sample. Co-58 was detected in the 14.7-m (48.1-ft) sample in boring CPP-90-2 at a concentration of 0.07 pCi/g.

24.3 Nature and Extent of Contamination

Based on the investigative results, the primary COPCs associated with this site are Cs-137 and Sr-90. These radionuclides were detected above background in borings drilled along the former pipeline that transferred service waste water to the injection well through building CPP-709. Cs-137 concentrations above background were limited to the upper 3.0 m (10 ft) in all three borings. Sr-90 was only detected above background in three soil samples collected below a depth of 3.0-m (10-ft) bgs. Several polyaromatic hydrocarbons (PAHs) were detected in the surface sample from boring CPP-90-3, but detections of these compounds do not appear to correlate with elevated Cs-137 concentrations and are not likely to be related to leaks from the transfer lines. The distribution of inorganics detected above background (i.e., mercury, arsenic, and antimony), suggests that these inorganics are not related to contamination at the site.

Table 24-1. Summary statistics for CPP-90, CPP-709 Ruthenium detection.

COPCs	Concentration (mg/kg or pCi/g) Minimum detected	Maximum detected	Arithmetic mean	Standard deviation	Number of samples	Number of detects	Frequency of detection	INEL background (mg/kg or pCi/g)	Number greater than background
Arsenic	4.3 *J P	29.5 *J P	7.05E+00	6.43E+00	15	15	100%	5.8	3
Thallium	0.77 B P	1.4 B P	1.08E+00	4.45E-01	15	2	13%	0.43	2
Benzo(a)pyrene	0.15 J	0.15 J	1.50E-01	NA	16	1	6%	NA	NA
Phenanthrene	0.053 J	0.29 J	1.71E-01	1.68E-01	16	2	13%	NA	NA
Co-58	0.07 +/- 0.02	0.07 +/- 0.02	7.00E-02	NA	16	1	6%	NA	NA
Cs-134	0.06 +/- 0.01	0.09 +/- 0.02	7.33E-02	1.53E-02	16	4	25%	NA	NA
Cs-137	0.1 +/- .01	7.5 +/- 0.1	2.07E+00	2.28E+00	16	9	56%	0.82	7
Eu-155	0.17 +/- 0.04	0.26 +/- 0.04	2.07E-01	4.73E-02	16	3	19%	NA	NA
Nb-95	0.07 +/- 0.02	0.13 +/- 0.02	9.25E-02	2.63E-02	16	4	25%	NA	NA
Sr-90	1.4 +/- 0.2	6.3 +/- 0.3	3.10E+00	2.77E+00	3	3	100%	0.49	3

NA - Not applicable/available

Based on the distribution of radionuclides in soil, the zone of contamination at this site extends from the ground surface down the soil/basalt interface at a depth of about 14.7 m (48.1 ft). Elevated Cs-137 levels are confined to the upper 3.0 m (10 ft) while Sr-90 concentrations above background are present from about 6.1 to 12.8 m (20 to 42 ft). The volume of contaminated soil was estimated for the purpose of calculating a source term for the model using a depth of 14.7 m (48.1 ft), a length of the site of 164.6 m (540 ft), and a width of 3.0 m (10 ft) along the service waste line.

24.4 Risk Assessment

The methodology for conducting the HHRA for WAG 3 was detailed in Section 7. As presented, the purpose of the HHRA is to develop a quantitative description and assessment of the human health risk posed by the COPCs present at WAG 3. This section only contains the results of the HHRA for site CPP-90 with respect to the soil pathways. The results for the air and groundwater pathways are detailed in Sections 27.1 and 27.2, respectively. The risk assessment at this site will become cumulative when the contributions from the air and groundwater pathways are added to that due to the soil pathway. The following sections discuss the complete exposure routes, exposure-point concentrations, and cancer risk and noncarcinogenic health hazard estimates for site CPP-90 under the three exposure scenarios evaluated. Section 24.4.3 will explain the difference in estimating contamination sources for use to evaluate surface exposure and groundwater modeling. This section will also describe the use of the screened ORIGEN runs (Section 4.4) to help identify contaminants potentially missing from the soil source estimate.

24.4.1 Complete Exposure Routes

Potentially complete pathways from the source to a human receptor were described in Section 7 and illustrated on Figure 7-1. For site CPP-90, the complete exposure routes within each pathway are summarized in Table 24-2. An exposure route is considered complete if the contaminated zone (as characterized in the previous sections) occurs within the depth intervals specified for a given exposure route. All exposure routes were evaluated for site CPP-90.

24.4.2 Exposure-Point Concentrations

Specific steps in calculating exposure-point concentrations for each of the applicable scenarios were described in Section 7. The COPC soil value used was the smaller of the 95% upper confidence limit (UCL) or maximum concentration. The concentration terms for the radionuclides were adjusted to account for decay for each exposure scenario. These values were subsequently averaged over the exposure duration. The concentration terms, by depth interval, are presented in Table 24-3. Exposures from all complete exposure routes were estimated based on the exposure-point concentrations in Table 24-4. Homegrown produce concentrations are presented in Table 24-5. The values for air and groundwater are presented in Sections 27.1 and 27.2, respectively.

24.4.3 Description of Source Estimates for Surface Exposure and Groundwater Modeling Use

The purpose for this subsection is two-fold. First, to compare the approach to defining the source estimate for use in both the surface exposure assessment and the groundwater model. This comparison was accomplished by comparing the soil data in Table 24-3 to the soil data used to estimate the source for use in

Table 24-2. Complete exposure routes for site CPP-90 and associated exposure route depths.

Receptor	Scenario	Potentially complete exposure route and exposure route depths used for exposure-point concentration estimates	Characterized zone of contamination	Complete exposure route?
Onsite worker	Current land use	Inhalation of VOCs [0–15 cm (0–6 in.)]	0 to 14.7 m	No
		Inhalation of airborne particulates [0–15 cm (0–6 in.)]	(0 to 48.1 ft)	Yes
		Ingestion of surface soil [0–15 cm (0–6 in.)]		Yes
		External radiation [0–1.22 m (0–4 ft)]		Yes
Residential	Future land use	Inhalation of VOCs [0–3.05 m (0–10 ft)]	0 to 14.7 m	No
		Inhalation of airborne particulates [0–3.05 m (0–10 ft)]	(0 to 48.1 ft)	Yes
		Ingestion of surface soil [0–3.05 m (0–10 ft)]		Yes
		Ingestion of homegrown produce [0–3.05 m (0–10 ft)]		Yes
		Ingestion of groundwater		Yes
		Dermal contact with groundwater		No
		Inhalation of VOCs from groundwater		No
		External radiation [0–3.05 m (0–10 ft)]		Yes
Onsite worker	Future land use	Inhalation of VOCs [0–15 cm (0–6 in.)]	0 to 14.7 m	No
		Inhalation of airborne particulates [0–15 cm (0–6 in.)]	(0 to 48.1 ft)	Yes
		Ingestion of surface soil [0-15 cm (0–6 in.)]		Yes
		External radiation [0–1.22 m (0–4 ft)]		Yes

Table 24-3. Soil concentration terms by depth interval.

COPCs	Soil concentrations (mg/kg or pCi/g) (0 - 0.5 ft)	(0 - 4 ft)	(0 - 10 ft)
Aroclor-1260	---	---	---
Benzo(a)pyrene	1.50E-01	1.50E-01	1.50E-01
Aluminum	---	---	---
Arsenic	2.95E+01	2.57E+01	1.24E+01
Manganese	---	---	---
Mercury	---	---	---
Uranium	---	---	---
Am-241	---	---	---
Ce-144	---	---	---
Co-57	---	---	---
Co-58	---	---	---
Co-60	---	---	---
Cs-134	---	9.00E-02	9.00E-02
Cs-137	3.13E+00	7.50E+00	7.50E+00
Eu-152	---	---	---
Eu-154	---	---	---
Eu-155	2.60E-01	2.60E-01	2.60E-01
H-3	---	---	---
I-129	---	---	---
K-40	---	---	---
Nb-95	8.00E-02	8.00E-02	1.30E-01
Np-237	---	---	---
Pu-238	---	---	---
Pu-239/240	---	---	---
Pu-241	---	---	---
Pu-242	---	---	---
Ru/Rh-106	---	---	---
Sb-125	---	---	---
Sr-90	---	---	---
Tc-99	---	---	---
U-234	---	---	---
U-235	---	---	---
U-236	---	---	---
U-238	---	---	---

Table 24-4. Average soil exposure-point concentrations (mg/kg or pCi/g) for land use scenarios.

	Current occupational worker year 0 to year 25		Future occupational worker year 100 to year 125		Future resident year 100 to year 130
COPCs	(0 - 0.5 ft)	(0 - 4 ft)	(0 - 0.5 ft)	(0 - 4 ft)	(0 - 10 ft)
Aroclor-1260	---	---	---	---	---
Benzo(a)pyrene	1.50E-01	1.50E-01	1.50E-01	1.50E-01	1.50E-01
Aluminum	---	---	---	---	---
Arsenic	2.95E+01	2.57E+01	2.95E+01	2.57E+01	1.24E+01
Manganese	---	---	---	---	---
Mercury	---	---	---	---	---
Uranium	---	---	---	---	---
Am-241	---	---	---	---	---
Ce-144	---	---	---	---	---
Co-57	---	---	---	---	---
Co-58	---	---	---	---	---
Co-60	---	---	---	---	---
Cs-134	---	1.07E-02	---	2.63E-17	2.19E-17
Cs-137	2.38E+00	5.71E+00	2.39E-01	5.74E-01	5.45E-01
Eu-152	---	---	---	---	---
Eu-154	---	---	---	---	---
Eu-155	7.22E-02	7.22E-02	6.17E-08	6.17E-08	5.23E-08
H-3	---	---	---	---	---
I-129	---	---	---	---	---
K-40	---	---	---	---	---
Nb-95	4.44E-04	4.44E-04	---	---	---
Np-237	---	---	---	---	---
Pu-238	---	---	---	---	---
Pu-239/240	---	---	---	---	---
Pu-241	---	---	---	---	---
Pu-242	---	---	---	---	---
Ru/Rh-106	---	---	---	---	---
Sb-125	---	---	---	---	---
Sr-90	---	---	---	---	---
Tc-99	---	---	---	---	---
U-234	---	---	---	---	---
U-235	---	---	---	---	---
U-236	---	---	---	---	---
U-238	---	---	---	---	---

Table 24-5. Concentrations of COPCs in homegrown produce.

COPCs	Homegrown produce (mg/kg or pCi/g)	Kd (cm^3/g)	COPC input rate from irrigation (mg/g-d or pCi/g-d)	Leach rate constant (d^{-1})
Aroclor-1260	---	7.89E+03	0.00E+00	9.95E-07
Benzo(a)pyrene	1.81E-03	1.19E+03	0.00E+00	6.57E-06
Aluminum	---	0.00E+00	0.00E+00	2.87E-02
Arsenic	3.92E-02	3.00E+00	8.71E-09	2.40E-03
Manganese	---	5.00E+01	0.00E+00	1.56E-04
Mercury	1.10E-01	1.00E+02	2.91E-08	7.83E-05
Uranium	7.30E-05	6.00E+00	7.04E-09	1.25E-03
Am-241	7.76E-06	3.40E+02	6.08E-06	2.31E-05
Ce-144	---	5.00E+02	0.00E+00	1.57E-05
Co-57	---	1.00E+01	0.00E+00	7.64E-04
Co-58	---	1.00E+01	0.00E+00	7.64E-04
Co-60	---	1.00E+01	0.00E+00	7.64E-04
Cs-134	1.12E-05	5.00E+02	0.00E+00	1.57E-05
Cs-137	1.45E-02	5.00E+02	4.12E-05	1.57E-05
Eu-152	---	3.40E+02	0.00E+00	2.31E-05
Eu-154	---	3.40E+02	0.00E+00	2.31E-05
Eu-155	1.70E-06	3.40E+02	0.00E+00	2.31E-05
H-3	---	0.00E+00	6.22E-04	2.87E-02
I-129	3.85E-06	0.00E+00	3.26E-05	2.87E-02
K-40	---	1.50E+01	0.00E+00	5.14E-04
Nb-95	5.05E-08	0.00E+00	0.00E+00	2.87E-02
Np-237	3.19E-05	0.00E+00	8.36E-06	2.87E-02
Pu-238	---	2.20E+01	0.00E+00	3.53E-04
Pu-239/240	5.15E-06	2.20E+01	5.84E-07	3.53E-04
Pu-241	8.49E-09	2.20E+01	9.37E-08	3.53E-04
Pu-242	3.60E-09	2.20E+01	3.88E-10	3.53E-04
Ru/Rh-106	---	0.00E+00	0.00E+00	2.87E-02
Sb-125	---	5.00E+01	0.00E+00	1.56E-04
Sr-90	6.88E-03	1.20E+01	5.63E-05	6.40E-04
Tc-99	4.56E-01	0.00E+00	1.67E-04	2.87E-02
U-234	2.73E-05	6.00E+00	2.63E-06	1.25E-03
U-235	9.61E-07	6.00E+00	9.27E-08	1.25E-03
U-236	6.93E-07	6.00E+00	6.68E-08	1.25E-03
U-238	2.44E-05	6.00E+00	2.35E-06	1.25E-03

the groundwater model, which can be found in Tables 5-39 and 5-40 of Appendix F. The benefit of these comparisons is to relate both source estimates and explain any apparent differences. Secondly, the results of the screened ORIGEN runs summarized in Section 4.4 were used to help identify any potential soil-related data gaps by comparing ORIGEN results to the field investigation soil results at this site. This comparison was based on the full inventory of contaminants in the screening table in Section 5 (Table 5-45) before implementing the screening steps shown therein. The results of these comparisons are described for each site in the following paragraphs. The results of this comparison for perched water and the SRPA are reported at the end of Section 4.4.

The CPP-90 source estimate for groundwater use was based on similar COPC's and concentrations in Table 24-3. Mercury, phenanthrene, Co-58, Sr-90, and thallium were not included in Table 24-3 because the total depth interval assumption to evaluate future residential intrusion exposure is 0 to 10 feet bgs., while the soil source estimate for groundwater use includes soil data below 10 feet bgs. Mercury is absent from this table because it screened out in Table 5-45. Based on a comparison of the radionuclides that were analyzed in site soils against the potential inventory as defined by the screened ORIGEN results (Table 4-7), Am-241, Pu-238, Pu-239/240, and Pu-241 were not part of the soil sampling analysis performed at this site. The implication is that these radionuclides may be present and are currently not part of the soil contaminant inventory.

24.4.4 Risk Estimates

The results of this evaluation under current and future land use are presented in Sections 24.4.4.1 and 24.4.4.2. For each receptor, the results are summarized in Tables 24-6 through 24-11.

24.4.4.1 Current Land Use. As indicated in Table 24-6, total cancer risk to the current onsite worker from exposure to site-related chemicals in surface soil is estimated to be 7E-05. The risk is attributed to the ingestion of soil and external radiation exposure pathways. The primary contaminant of concern (COC) for the ingestion of soil exposure route is arsenic (6E-06). The primary COC in the external radiation exposure route is Cs-137 (7E-05). Table 24-7 indicates that the total noncarcinogenic hazard index to the current worker is estimated to be 3E-09. There are no hazard indices above unity for the current onsite worker.

24.4.4.2 Future Land Use. As Table 24-8 indicates, the total cancer risk to the future onsite worker from exposure to site-related chemicals in surface soil is estimated to be 1E-05. The risk is attributed to the ingestion of soil and external radiation exposure routes. The primary COC in the ingestion of soil risk is arsenic (6E-06). The primary COC in the external radiation exposure risk is Cs-137 (7E-06). Table 24-9 indicates the total noncarcinogenic hazard index to the future onsite worker is 3E-09. There are no hazard indices above unity for the future onsite worker. As indicated in Table 24-10, the total cancer risk to the future resident from exposure to site related chemicals in soil is estimated to be 7E-05. Within the ingestion of soil exposure route, the major contributors are benzo(a)pyrene (2E-06) and arsenic (3E-05). Within the homegrown produce-ingestion exposure route, the major contributor to risk is arsenic (3E-06). The risk from Cs-137 (3E-05) is the major contributor for external radiation exposure. As shown on Table 24-11, the total noncarcinogenic hazard index to the future resident is estimated to be 1E-01. There are no hazard indices above unity for the future resident.

Table 24-6. Soil pathway cancer risk to the current onsite worker. [a]

COPCs	Ingestion of soil	External radiation exposure	Total risks
Aroclor-1260	----	----	----
Benzo(a)pyrene	2E-07	----	2E-07
Aluminum	----	----	----
Arsenic	6E-06	----	6E-06
Manganese	----	----	----
Mercury	----	----	----
Uranium	----	----	----
Am-241	----	----	----
Ce-144	----	----	----
Co-57	----	----	----
Co-58	----	----	----
Co-60	----	----	----
Cs-134	----	4E-07	4E-07
Cs-137	2E-08	7E-05	7E-05
Eu-152	----	----	----
Eu-154	----	----	----
Eu-155	3E-11	3E-08	3E-08
H-3	----	----	----
I-129	----	----	----
K-40	----	----	----
Nb-95	3E-13	7E-09	7E-09
Np-237	----	----	----
Pu-238	----	----	----
Pu-239/240	----	----	----
Pu-241	----	----	----
Pu-242	----	----	----
Ru/Rh-106	----	----	----
Sb-125	----	----	----
Sr-90	----	----	----
Tc-99	----	----	----
U-234	----	----	----
U-235	----	----	----
U-236	----	----	----
U-238	----	----	----
Total cancer risks by route:	6E-06	7E-05	7E-05

"----" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 24-7. Soil pathway noncarcinogenic hazard to the current onsite worker. [a]

COPCs	Ingestion of soil	External radiation exposure	Total HIs
Aroclor-1260	---	---	---
Benzo(a)pyrene	NTD	---	---
Aluminum	---	---	---
Arsenic	3E-09	---	3E-09
Manganese	---	---	---
Mercury	---	---	---
Uranium	---	---	---
Am-241	---	---	---
Ce-144	---	---	---
Co-57	---	---	---
Co-58	---	---	---
Co-60	---	---	---
Cs-134	---	---	---
Cs-137	---	---	---
Eu-152	---	---	---
Eu-154	---	---	---
Eu-155	---	---	---
H-3	---	---	---
I-129	---	---	---
K-40	---	---	---
Nb-95	---	---	---
Np-237	---	---	---
Pu-238	---	---	---
Pu-239/240	---	---	---
Pu-241	---	---	---
Pu-242	---	---	---
Ru/Rh-106	---	---	---
Sb-125	---	---	---
Sr-90	---	---	---
Tc-99	---	---	---
U-234	---	---	---
U-235	---	---	---
U-236	---	---	---
U-238	---	---	---
Total hazard indices by route:	3E-09	0E+00	3E-09

"---" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 24-8. Soil pathway cancer risk to the future onsite worker. [a]

COPCs	Ingestion of soil	External radiation exposure	Total risks
Aroclor-1260	---	---	---
Benzo(a)pyrene	2E-07	---	2E-07
Aluminum	---	---	---
Arsenic	6E-06	---	6E-06
Manganese	---	---	---
Mercury	---	---	---
Uranium	---	---	---
Am-241	---	---	---
Ce-144	---	---	---
Co-57	---	---	---
Co-58	---	---	---
Co-60	---	---	---
Cs-134	---	9E-22	9E-22
Cs-137	2E-09	7E-06	7E-06
Eu-152	---	---	---
Eu-154	---	---	---
Eu-155	3E-17	2E-14	2E-14
H-3	---	---	---
I-129	---	---	---
K-40	---	---	---
Nb-95	---	---	---
Np-237	---	---	---
Pu-238	---	---	---
Pu-239/240	---	---	---
Pu-241	---	---	---
Pu-242	---	---	---
Ru/Rh-106	---	---	---
Sb-125	---	---	---
Sr-90	---	---	---
Tc-99	---	---	---
U-234	---	---	---
U-235	---	---	---
U-236	---	---	---
U-238	---	---	---
Total cancer risks by route:	6E-06	7E-06	1E-05

"---" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 24-9. Soil pathway noncarcinogenic hazard to the future onsite worker. [a]

COPCs	Ingestion of soil	External radiation exposure	Total HIs
Aroclor-1260	----	----	----
Benzo(a)pyrene	NTD	----	----
Aluminum	----	----	----
Arsenic	3E-09	----	3E-09
Manganese	----	----	----
Mercury	----	----	----
Uranium	----	----	----
Am-241	----	----	----
Ce-144	----	----	----
Co-57	----	----	----
Co-58	----	----	----
Co-60	----	----	----
Cs-134	----	----	----
Cs-137	----	----	----
Eu-152	----	----	----
Eu-154	----	----	----
Eu-155	----	----	----
H-3	----	----	----
I-129	----	----	----
K-40	----	----	----
Nb-95	----	----	----
Np-237	----	----	----
Pu-238	----	----	----
Pu-239/240	----	----	----
Pu-241	----	----	----
Pu-242	----	----	----
Ru/Rh-106	----	----	----
Sb-125	----	----	----
Sr-90	----	----	----
Tc-99	----	----	----
U-234	----	----	----
U-235	----	----	----
U-236	----	----	----
U-238	----	----	----
Total hazard indices by route:	3E-09	0E+00	3E-09

"----" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 24-10. Soil pathway cancer risk to the future onsite resident. [a]

COPCs	Ingestion of soil	Ingestion of homegrown	External radiation exposure	Total risks
Aroclor-1260	—	—	—	—
Benzo(a)pyrene	2E-06	1E-06	—	3E-06
Aluminum	—	—	—	—
Arsenic	3E-05	3E-06	—	3E-05
Manganese	—	—	—	—
Mercury	—	NTD	—	—
Uranium	—	NTD	—	—
Am-241	—	4E-10	—	4E-10
Ce-144	—	—	—	—
Co-57	—	—	—	—
Co-58	—	—	—	—
Co-60	—	—	—	—
Cs-134	1E-24	9E-11	4E-21	9E-11
Cs-137	2E-08	8E-08	3E-05	3E-05
Eu-152	—	—	—	—
Eu-154	—	—	—	—
Eu-155	1E-16	5E-13	9E-14	6E-13
H-3	—	—	—	—
I-129	—	1E-10	—	1E-10
K-40	—	—	—	—
Nb-95	—	3E-14	—	3E-14
Np-237	—	2E-09	—	2E-09
Pu-238	—	—	—	—
Pu-239/240	—	3E-10	—	3E-10
Pu-241	—	5E-13	—	5E-13
Pu-242	—	2E-13	—	2E-13
Ru/Rh-106	—	—	—	—
Sb-125	—	—	—	—
Sr-90	—	7E-08	—	7E-08
Tc-99	—	1E-07	—	1E-07
U-234	—	2E-10	—	2E-10
U-235	—	8E-12	—	8E-12
U-236	—	5E-12	—	5E-12
U-238	—	3E-10	—	3E-10
Total cancer risks by route:	3E-05	5E-06	3E-05	7E-05

"—" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 24-11. Soil pathway noncarcinogenic hazard to the future onsite resident. [a]

COPCs	Ingestion of soil	Ingestion of homegrown	External radiation exposure	Total HIs
Aroclor-1260	—	—	—	—
Benzo(a)pyrene	NTD	NTD	—	—
Aluminum	—	—	—	—
Arsenic	1E-08	2E-02	—	2E-02
Manganese	—	—	—	—
Mercury	—	1E-01	—	1E-01
Uranium	—	6E-06	—	6E-06
Am-241	—	—	—	—
Ce-144	—	—	—	—
Co-57	—	—	—	—
Co-58	—	—	—	—
Co-60	—	—	—	—
Cs-134	—	—	—	—
Cs-137	—	—	—	—
Eu-152	—	—	—	—
Eu-154	—	—	—	—
Eu-155	—	—	—	—
H-3	—	—	—	—
I-129	—	—	—	—
K-40	—	—	—	—
Nb-95	—	—	—	—
Np-237	—	—	—	—
Pu-238	—	—	—	—
Pu-239/240	—	—	—	—
Pu-241	—	—	—	—
Pu-242	—	—	—	—
Ru/Rh-106	—	—	—	—
Sb-125	—	—	—	—
Sr-90	—	—	—	—
Tc-99	—	—	—	—
U-234	—	—	—	—
U-235	—	—	—	—
U-236	—	—	—	—
U-238	—	—	—	—
Total hazard indices by route:	1E-08	1E-01	0E+00	1E-01

"—" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

24.5 Uncertainties

This section describes the limitations and uncertainties specific to the site characterization of site CPP-90. Sources of uncertainty associated with site characterization include data quality, COPC identification, concentration term estimation, and assumptions regarding the lateral and vertical extent of COPC occurrence. In the risk assessment, the most significant uncertainties are due to the selection process of COPCs, the toxicity values used, and the assumptions used during the exposure assessment. The following paragraphs will discuss important sources of site-specific uncertainty in greater detail.

Sampling and analysis uncertainties are related to quality problems that may result in qualified and rejected results (Section 3.5). Qualified results are considered estimates of the concentration in the sample and, for all practical purposes, useable for their intended purpose although they could be biased high or low. Rejected results are considered unusable, thus limiting the size of the useable data set. For site CPP-90, seven Tc-99 and four Sr-90 data points were rejected based on the validation method as documented in the Limitations and Validation (L&V) Reports. These rejected results points affect the overall site CPP-90 data set by reducing the number of useable results to three for Sr-90 and zero for Tc-99. The impact to the concentration term estimate for Sr-90 is likely to be insignificant because the remaining useable values are similarly distributed. However for Tc-99, the rejected results leave the characterization of Tc-99 incomplete for site CPP-90. As a result, the risk for the site is likely to be underestimated.

Uncertainty associated with the chemical screening process (Section 5.2) results from using the maximum concentration for chemicals detected in the Environmentally Controlled Areas (ECAs) in the background comparison step, retaining chemicals detected as COPCs because there is not a corresponding background value, and retaining chemicals as COPCs for which there is no toxicity information available.

In most cases, the COPC identification process used the maximum concentration for a chemical detected in the background comparison step, regardless of its magnitude above background. The use of the maximum can result in the identification of COPCs that have concentrations only slightly above background. For site CPP-90, none of the COPCs fell into this category.

A source of uncertainty related to the background comparison step in the chemical screening process relates to chemicals for which no background concentration exists. For example, fluoride, nitrate, and several radionuclides were not characterized as part of the Rood et al., background study. For site CPP-90, Co-58, Cs-134, Eu-155, and Nb-95 had no corresponding background concentrations. This results in an increase in the number of COPCs considered in the remedial investigation/Baseline Risk Assessment (RI/BRA) and a possible overestimation of risk because the observed concentrations may be within the background population.

Some concentration estimates are based on the 95% UCL for the site, or the area-weighted average 95% UCLs for sites that have been grouped. When the 95% UCL (i.e., the concentration term estimate) of a COPC is below the corresponding background value, this results in an increase in the number of COPCs in the RI/BRA and a possible overestimation of risk because the results are likely within the background range. This source of uncertainty stems from the use of maximum concentrations when identifying the COPCs for a specific sites. For site CPP-90, none of the COPC concentration estimates were below background.

For site CPP-90, phenanthrene and thallium were retained as COPCs for the RI/BRA. There are no toxicity values in Integrated Information System (IRIS), Health Effects Assessment Summary Tables (HEAST), or EPA Region III publications for phenanthrene and thallium. Phenanthrene was detected at a maximum concentration of 0.29 mg/kg in soil at CPP-90. Phenanthrene is used in dyestuffs, explosives, synthesis of drugs, biochemical research, and manufacturing phenanthrene quinone. Phenanthrene is a possible carcinogen; however, sufficient data to derive a toxicity value are currently not available. Therefore, exclusion of phenanthrene possibly underestimates the risk; however, specific contribution can not be quantified. Uses of thallium include thallium salts, mercury alloys, low-melting glasses, rodenticides, photoelectric applications, and electrodes in dissolved oxygen analyzers. The impact of not including thallium in the BRA may overestimate or underestimate the risk; however, the impact is not quantifiable because of the lack of toxicity information.

At site CPP-90, uncertainty in the extent of contamination could result in an overestimation or underestimation of the risk at this site. The extent of contamination at this site was based on the results of three borings along the 165 m (540 ft) long waste water transfer line. The lateral extent of contamination was estimated to average 3.1 m (10 ft) in width from the ground surface down to the soil/basalt interface. In addition, the risk assessment assumed that receptors could come in contact with site contaminants over the entire length of the line. The Radiological Analysis Laboratory (RAL) is now present over a portion (14%) of the former line. This assumption may slightly overestimate the risk at this site.

One other source of uncertainty may be associated with the contaminant inventories used for the groundwater modeling and residential intrusion exposure at this site. Section 24.4.3 identifies radionuclides potentially missing from these inventories. The implication of these potential data gaps is that the source estimates could be underestimated. Based on the results of the groundwater model, the potentially missing Pu-238 and Pu-241 which have half lines of 87.7 and 14.4 years would not be expected to be of concern because of their short half lives and long travel times to the aquifer. Am-241 is potentially missing from the source estimates but is not expected to be of concern because most of the activity has been accounted for in the tank farm and shown that the source assumptions are conservative. For a discussion of uncertainty associated with Pu-239 and Pu-240, see Section 10 of Appendix F. The potential uncertainty is recognized in this report, but no information is available to quantify the uncertainty.

24.6 Conclusions and Recommendations

The results of the risk assessment under current land use at CPP-90 indicate that the increased cancer risk from exposure to site-related contaminants is within the EPA-recommended target range. The increased cancer risk to hypothetical future onsite workers and residents are both within the EPA target range. The noncarcinogenic hazard for all receptors was found to be well below the EPA hazard index goal of one. These estimates do not include the contributions associated with the air and groundwater pathways. The total increased cancer and hazard incidence to humans is reported in Section 27. It is important to note that the risk estimates at this site are likely to be overestimated for reasons described in Sections 7 and 24.5 and therefore, the actual estimates would be expected to be lower. Even after the contributions from the air and groundwater pathways are added to these values for a cumulative representation of the risk and hazard at this site, future response actions to mitigate adverse impacts from site-related contamination are not warranted.

24.7 References

LITCO, 1995, *Draft Track 1 Document OU 3-13 CPP-709 Ruthenium Detection CPP-90*, July.

Rood, S. M., G. A. Harris, and G. J. White, 1995, *Background Dose Equivalent Rates and Surficial Soil Metal and Radionuclide Concentrations for the Idaho National Engineering Laboratory*, INEL-94/0250, Revision 0, February.

Chapter 25

25. SITE CPP-92 RESULTS

CPP-92 consists of a group of soil boxes located in the southwest portion of the ICPP, northwest of building CPP-603 (Figure 25-1). This section describes the type and concentration of contaminants of potential concern (COPCs) in the boxes.

25.1 Site Description

Site CPP-92 consists of approximately 1,250 boxes of soil with low levels of radioactive contamination. The boxes measure 0.6 × 1.2 × 2.4 m (2 × 4 × 8 ft), are constructed of 1.9-cm (3/4-in.) plywood, and are lined with a polyethylene membrane. The soil in the boxes was generated during a variety of ICPP activities, including the Tank Farm upgrade, the building CPP-603 cleanup, construction of the emergency fire exit tunnel for building CPP-604/605, and the cleanup of soil at site CPP-17.

Approximately, 250 of the boxes contain soil excavated during a 1991–1992 installation of an emergency fire exit from the basement of CPP-604/605 (site CPP-89). The excavated soil was contaminated by various releases from pipeline leaks including nitric acid and condensates from the process equipment waste (PEW) Evaporator System. Six hundred boxes of soil came from site CPP-17, which is a storage area for soil, concrete, asphalt, and other debris. CPP-92 also contains 102 boxes of soil from the excavation of valve box 39 at the ICPP Tank Farm and 300 boxes of soil from the building CPP-603 area cleanup. Analysis of soil samples collected from these sites indicates that radiological contaminants, and arsenic are the COPCs at this site (see chemical screening process results in Section 5.2). However, most of the boxes contain soil that cannot be accepted for disposal at the RWMC because the radionuclide concentrations are below the RWMC acceptance criteria. Between August 17 and October 6, 1996, approximately 640 of these boxes were opened and placed in special railway cars for shipment to the Envirocare of Utah disposal facility. A total of 830 cubic yards of waste was dispositioned and the remaining boxes were left within the CPP-92 area, awaiting future disposal in an on-site or off-site facility.

25.2 Investigative Results

According to the Track 1 for site CPP-92 (LITCO, 1995) in Appendix A, contaminant concentrations from the excavation in the Tank Farm, the building 603 cleanup, and site CPP-17 are much lower than concentrations in the site CPP-89 boxed soil. Radiation surveys of the soil and debris piles (site CPP-17) performed in 1991 indicated radioactivity levels ranging from 100 to 22,000 cpm. Soil was monitored during the removal with a RO-2A meter; however, contamination was not detected. During containerization of the soil, grab samples were collected and analyzed for radiological constituents and by the Toxicity Characterization Leaching Procedure (TCLP) for metals. Site CPP-17 soil contained Cs-137 (19.4 pCi/g), Sr-90 (2.72 pCi/g), Eu-152 (2.07 pCi/g), and Eu-154 (1.88 pCi/g). The soil was not classified as a characteristic hazardous waste based on TCLP results. Soil from the excavation of valve box 39 at the Tank Farm and from the building CPP-603 area cleanup also contains low levels (<100 pCi/g) of Cs-137.

Boxed soil from the excavation for the fire exit from building 604/605 was sampled and analyzed for inorganics, VOCs, and radionuclides. The results of these samples are summarized in Table 25-1. Contaminants of potential concern (COPCs) identified from the contaminant screening in Section 5.2 are arsenic, Am-241, Cs-134, Cs-137, Co-60, Eu-152, Eu-154, I-129, Np-237, Pu-238, Pu-239/240, Sr-90, Sb-125, U-234, and U-235. Volatile organic compounds (VOCs) were not detected in the samples. The only inorganics detected above background were arsenic at 5.9 mg/kg and mercury at 10.4 mg/kg. Mercury was below the EPA Region III risk-based soil concentration of 23 mg/kg. These contaminants are consistent with the types of contaminants contained in the service wastes and condensates from the PEW Evaporator that have historically included nitric acid, mercury, plutonium, cesium, and strontium.

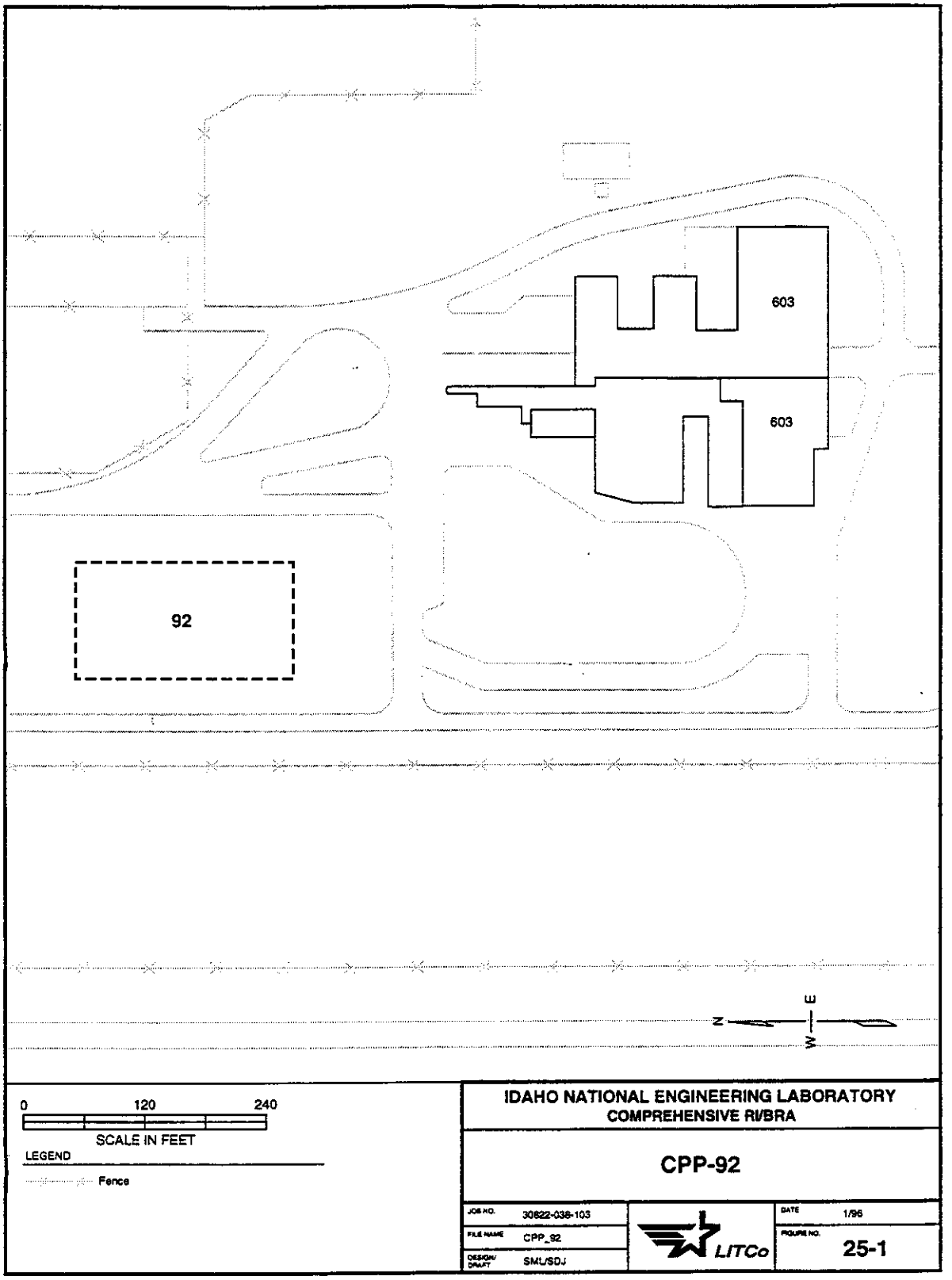


Figure 25-1. CPP-92.

Table 25-1. Summary statistics for CPP-92, soil boxes west of CPP-1617.A1.

COPCs	Concentration (mg/kg or pCi/g) Minimum detected	Maximum detected	Arithmetic mean	Standard deviation	Number of samples	Number of detects	Frequency of detection	INEL background (mg/kg or pCi/g)	Number greater than background
Am-241	0.02 +/- 0.03	23.6 +/- .4	2.67E+00	5.97E+00	18	18	100%	0.011	12
Co-60	3.9	3.9	3.90E+00	NA	1	1	100%	NA	NA
Cs-134	2.3	2.3	2.30E+00	NA	1	1	100%	NA	NA
Cs-137	0.14 +/- 0.02	7730 +/- 90	1.03E+03	2.48E+03	17	17	100%	0.82	14
I-129	3.1	3.1	3.10E+00	NA	1	1	100%	NA	NA
Np-237	0.15	0.15	1.50E-01	NA	1	1	100%	NA	NA
Pu-238	0.02 +/- 0.03	259 +/- 2	3.16E+01	8.12E+01	17	17	100%	0.0049	15
Pu-239/240	0 +/- 0.03	24.7 +/- 0.6	2.83E+00	6.75E+00	18	18	100%	0.1	4
Pu-239/240	0 +/- 0.02	24.7 +/- 0.6	2.83E+00	6.75E+00	18	18	100%	0.1	4
Sb-125	13	13	1.30E+01	NA	1	1	100%	NA	NA
Sr-90	0.3 +/- 0.1	10800 +/- 100	1.29E+03	2.71E+03	18	18	100%	0.49	17
U-234	5.1	5.1	5.10E+00	NA	1	1	100%	1.44	1
U-235	0.23	.23	2.30E-01	NA	1	1	100%	NA	NA

NA - Not applicable/available

25.3 Nature and Extent of Contamination

As summarized above, contaminants in the boxed soil include radionuclides and arsenic. The soil is contained in polyethylene-lined boxes that have not deteriorated. Therefore, it can be assumed that significant amounts of contaminated soil have not leaked from the boxes and that lateral and vertical migration from the box staging area has not occurred. Assuming that the boxes are 80% full, there is a total of approximately 1,792 m^3 (64,000 ft^3) of soil in the boxes.

25.4 Conclusions

This site will be included in the WAG 3 FS to evaluate remedial alternatives for disposition of the soil boxes and to pursue the use of this soil as part of the option evaluation for other sites. Risk estimates for this site are not included in the BRA, because the soil is confined to boxes and, as a result, is not likely to migrate or allow exposure to receptors.

25.5 Uncertainties

This section describes the limitations and uncertainties specific to the site characterization of site CPP-92. This site was not included in the risk assessment or the groundwater model because the soil is confined to boxes and is not likely to be released to allow exposure to receptors. Excluding this site from the BRA is not believed to add significant uncertainty to the risk estimates. This site will be included in the WAG 3 FS for evaluation of remedial options.

25.6 References

LITCO, 1995, *Track 1 Decision Documentation Package, CPP-92 Radiological Soil Boxes, Operable Unit 3-13.*

Chapter 26

26. SITE CPP-93 RESULTS

CPP-93 consists of nonradioactive, simulated calcine that was buried in a trench that is situated at an approximate angle of 45 degrees from the southeast corner of building CPP-633 (Figure 26-1). This section describes the nature and extent of contamination related to site CPP-93 as well as presents the results of the human health risk assessment (HHRA).

26.1 Site Description

The nonradioactive, simulated calcine associated with site CPP-93 was generated in 1961 and 1962 during testing of building CPP-633 waste calcining equipment and systems before operation with high-level radioactive waste. Historical operator log entries and photographs indicate that several tons of simulated calcine material were disposed in the trench. The trench was approximately 61 m (200 ft) in length and 2.4 m (8 ft) in width at the bottom sloping to 4.9 m (16 ft) in width at the top. The trench contained 1.1 to 1.2 m (3.5 to 4 ft) of nonradioactive calcine before being backfilled to grade with approximately 1.2 m (4 ft) of topsoil. Based on photographs and operator logs, the trench was used for simulated calcine disposal from 1964 through 1966.

Nine of the 10 test batch feed solutions (simulated calcine) contained varying amounts of aluminum nitrate, nitric acid, sodium nitrate, and boric acid. Test batch 10 was also spiked twice with an aluminum capsule containing a Na-24 tracer to test the efficiency of the offgas treatment system. Mercuric nitrate was also added with the Na-24 tracer to aid in the dissolution of the aluminum capsule. With a half-life of 15 hr, any Na-24 that did not volatilize and was processed into the test batch calcine would have decayed before eventual disposal in the trench. Chemical reactions in the calcining process should have changed the simulated calcine feed material into solid aluminum oxide (Al_2O_3), mercuric oxide (HgO), boric anhydride (B_2O_3), sodium oxide (Na_2O), and sodium nitrate ($NaNO_3$) (LITCO, 1995).

26.2 Investigative Results

As described in Section 3.3.1.14, a total of 65 boreholes were drilled between depths of 2.4- to 4.3-m (8- to 14-ft) bgs in the area southeast of the bin set area using a Geoprobe Rig. The purpose of these boreholes was to identify the location of the trench backfilled with simulated calcine.

Simulated calcine was detected in four boreholes (CPP-93-1, CPP-93-2, CPP-93-3, and CPP-93-4) in 3-to 5-cm (1- to 2-in) thick layers at depths between 1- to 1.5-m (3.5- to 5-ft) bgs. The trench reportedly contained 1.1- to 1.2-m (3.5- to 4-ft) thick layers of simulated calcine but only thin bands of simulated calcine were identified in these four boreholes. It is believed that the simulated calcine material may have been removed during construction of the bin sets. However, no documentation exists to confirm the removal of the simulated calcine.

Composite samples were collected from the thin layers of simulated calcine detected in each of the four boreholes and sent for laboratory analysis. Grab samples were also collected in these four boreholes at least 1.5 m (5 ft) below where the thin layers of simulated calcine were encountered. Samples were analyzed for mercury, aluminum, sodium, and nitrate/nitrite. As illustrated on Figure 26-1, boreholes CPP-93-1, CPP-93-2, CPP-93-3, and CPP-93-4 were located in a line along a northwest to southeast direction in the immediate vicinity of the area where the trench was thought to be located.

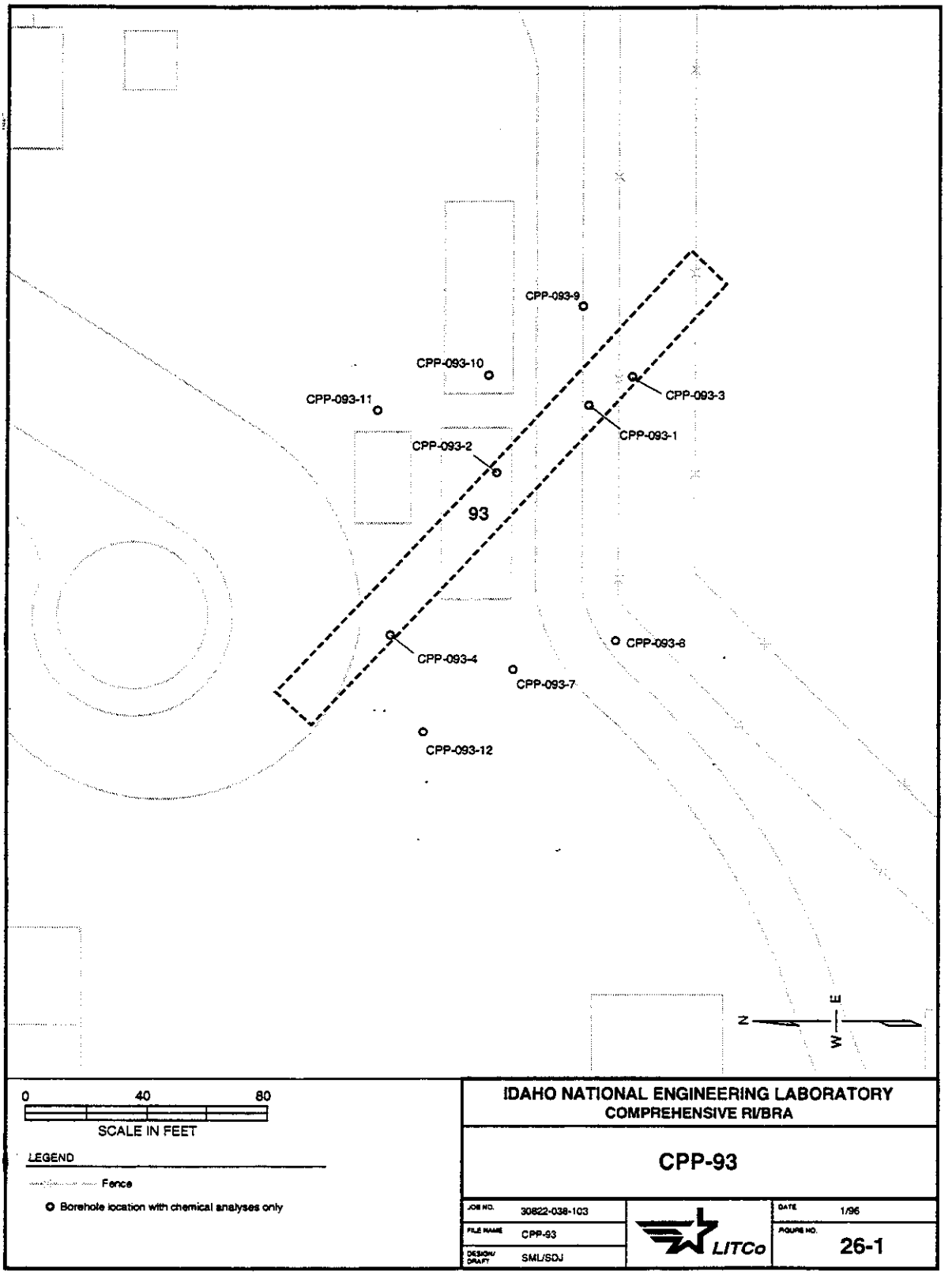


Figure 26-1. CPP-93 and borehole locations.

Results from boreholes CPP-93-1 through CPP-93-4 are summarized in Table 26-1 and a complete listing of results is provided in Appendix G. Contaminants of potential concerns (COPCs) identified from the chemical screening process (Section 5.2) are aluminum and mercury. Mercury was detected above background in all eight samples collected from these four borings. Mercury concentrations ranged from 2.8 to 140 mg/kg. Any detectable mercury is considered above background (Rood et al., 1995). Mercury concentrations decreased with depth in every borehole as did aluminum. The mercury concentrations at depth are suggestive that some downward migration of mercury has occurred from the buried calcine material. Aluminum was only detected above the background level of 16,000 mg/kg in three shallow samples. Aluminum concentrations ranged up to 120,000 mg/kg with the highest results corresponding to the highest mercury concentrations. This indicates that the elevated aluminum concentrations are also associated with the buried simulated calcine material.

Sodium and nitrate/nitrite concentrations are also generally higher in the shallow samples than in the deeper samples. These data are consistent with the identification of simulated calcine material in the shallow samples in borings CPP-93-1 through CPP-93-4.

Six additional boreholes were drilled in the area outside of the trench and collect soil samples between 2.1- to 2.4-m (7- to 8-ft) bgs. The six additional boreholes were designated as CPP-93-7, CPP-93-8, CPP-93-9, CPP-93-10, CPP-93-11, and CPP-93-12 (Figure 26-1). No simulated calcine was visible in the soil of any of the six additional samples collected. Both mercury and aluminum concentrations were significantly lower (or were not detected) than in the samples collected in the borings through the buried calcine. Aluminum was not detected above background in any of the samples while mercury was only detected in one of the samples. Sodium and nitrate/nitrite concentrations were also lower in the samples collected outside of the trench.

26.3 Nature and Extent of Contamination

The analytical results from borings CPP-93-1 through CPP-93-4 confirm the presence of thin layers of simulated calcine material in the vicinity of a trench located southeast of building CPP-603. The presence of simulated calcine material is supported by visual observations in the borings and elevated concentrations of mercury, aluminum, nitrate/nitrite, and sodium. It was expected that the borings would penetrate 1.1- to 1.2-m (3.5- to 4-ft) thick layers of simulated calcine but only 3- to 5-cm (1- to 2-in.) thick bands of simulated calcine were found. It is believed that the majority of buried simulated calcine was removed during construction of the bin sets.

Samples of the simulated calcine contain elevated concentrations of mercury, aluminum, nitrate/nitrite, and sodium. Concentrations of sodium, nitrate/nitrite, and aluminum appear to decrease with depth in the borings to background levels but mercury concentrations are still above background at the deepest samples in the borings. The full depth of mercury above background has not been defined but the analytical data suggest that mercury concentrations would continue to decrease with depth below 3.0 m (10 ft). The results of additional borings drilled outside of the area of the trench indicate that significant lateral migration of mercury and aluminum from the buried calcine has not occurred.

The contaminated zone for this site is assumed to be from 0.8 to 7.6 m (2.5 to 25 ft). A volume of contaminated soil of 2,039 m^3 (72,000 ft^3) was estimated based on the reported dimensions of the trench. A full width of 4.9 m (16 ft) down to a depth of 7.6 m (25 ft) was used to account for some lateral migration of COPCs. The orientation of the site, as shown on Figure 26-1, has been rotated slightly from that shown on Figure 5-2 to reflect the observation of buried simulated calcine material in borings CPP-93-01 through CPP-93-04.

Table 26-1. Summary statistics for CPP-93, simulated calcine trench.

COPCs	Concentration (mg/kg or pCi/g) Minimum detected	Maximum detected	Arithmetic mean	Standard deviation	Number of samples	Number of detects	Frequency of detection	INEL background (mg/kg or pCi/g)	Number greater than background
Aluminum	6110	120000	3.60E+04	4.33E+04	9	9	100%	16000	3
Mercury	2.8	140	4.03E+01	5.00E+01	9	9	100%	0.05	9

26.4 Risk Assessment

The methodology for conducting the HHRA for waste area group (WAG) 3 is detailed in Section 7. As presented, the purpose of the HHRA is to develop a quantitative description and assessment of the human health risk posed by the COPCs present at WAG 3. This section only contains the results of the HHRA for site CPP-93 with respect to the soil pathways. The results for the air and groundwater pathways are detailed in Sections 27.1 and 27.2, respectively. The risk assessment at this site will become cumulative when the contributions from the air and groundwater pathways are added to that from the soil pathway. The following sections discuss the complete exposure routes, exposure-point concentrations, and cancer risk and noncarcinogenic health hazard estimates for site CPP-93 under the three exposure scenarios evaluated.

26.4.1 Complete Exposure Routes

Potentially complete pathways from the source to a human receptor are described in Section 7 and illustrated on Figure 7-1. For site CPP-93, the complete exposure routes within each pathway are summarized in Table 26-2. An exposure route is considered complete if the contaminated zone (as characterized in the previous sections) occurs within the depth intervals specified for a given exposure route. Exposure routes that were not evaluated include: inhalation of VOCs (onsite worker—current and future land use), inhalation of airborne particles (onsite worker—current and future land use), and ingestion of surface soil (onsite worker—current and future land use). These exposure routes were not evaluated because the depth range of these exposure routes fall below the upper range of contamination at site CPP-93.

26.4.2 Exposure-Point Concentrations

Specific steps in calculating exposure-point concentrations for each of the applicable scenarios are described in Section 7. The COPC soil value used was the smaller of the 95% upper confidence limit (UCL) or maximum concentration. The concentration terms for the radionuclides were adjusted to account for decay for each exposure scenario. These values were subsequently averaged over the exposure duration. The concentration terms, by depth interval, are presented in Table 26-3. Exposures from all complete exposure routes were estimated based on the exposure-point concentrations in Table 26-4. Concentrations of COPCs in homegrown produce are presented in Table 26-5. The values for air and groundwater are presented in Sections 27.1 and 27.2, respectively.

26.4.3 Risk Estimates

The results of this evaluation under current and future land use are presented in Sections 26.4.3.1 and 26.4.3.2. For each receptor, the results are summarized in Tables 26-6 through 26-11.

26.4.3.1 Current Land Use. As indicated in Table 26-6, total cancer risk to the current onsite worker from exposure to site-related chemicals in surface soil is estimated to be 0E+00. There is no significant risk to the current worker from any of the applicable exposure routes. This is due to the COPCs at this site which include only mercury and aluminum and only have non-carcinogenic health criteria. Table 26-7 indicates that the total noncarcinogenic hazard index to the current worker is estimated to be 0E+00. There are no hazard indices above unity for the current onsite worker.

26.4.3.2 Future Land Use. As Table 26-8 indicates, the total cancer risk to the future onsite worker from exposure to site-related chemicals in surface soil is estimated to be 0E+00. There is no significant risk to the future worker from any of the applicable exposure routes. This is due to the COPCs at this site which include only mercury and aluminum and only have noncarcinogenic health criteria. Table 26-9 indicates the total noncarcinogenic hazard index to the future onsite worker was estimated to be 0E+00. There are no hazard indices above unity for the future onsite worker. As indicated in Table 26-10, the total cancer risk to the

Table 26-2. Complete exposure routes for site CPP-93 and associated exposure route depths.

Receptor	Scenario	Potentially complete exposure route and exposure route depths used for exposure-point concentration estimates	Characterized zone of contamination	Complete exposure route?
Onsite worker	Current land use	Inhalation of VOCs [0–15 cm (0–6 in.)]	0.76 to 7.6 m	No
		Inhalation of airborne particulates [0–15 cm (0–6 in.)]	(2.5 to 25 ft)	No
		Ingestion of surface soil [0–15 cm (0–6 in.)]		No
		External radiation [0–1.22 m (0–4 ft)]		Yes
Residential	Future land use	Inhalation of VOCs [0–3.05 m (0–10 ft)]	0.76 to 7.6 m	No
		Inhalation of airborne particulates [0–3.05 m (0–10 ft)]	(2.5 to 25 ft)	Yes
		Ingestion of surface soil [0–3.05 m (0–10 ft)]		Yes
		Ingestion of homegrown produce [0–3.05 m (0–10 ft)]		Yes
		Ingestion of groundwater		Yes
		Dermal contact with groundwater		No
		Inhalation of VOCs from groundwater		No
		External radiation [0–3.05 m (0–10 ft)]		Yes
Onsite worker	Future land use	Inhalation of VOCs [0–15 cm (0–6 in.)]	0.76 to 7.6 m	No
		Inhalation of airborne particulates [0–15 cm (0–6 in.)]	(2.5 to 25 ft)	No
		Ingestion of surface soil [0–15 cm (0–6 in.)]		No
		External radiation [0–1.22 m (0–4 ft)]		Yes

Table 26-3. Soil concentration terms by depth interval.

COPCs	Soil concentrations (mg/kg or pCi/g) (0 - 0.5 ft)	(0 - 4 ft)	(0 - 10 ft)
Aroclor-1260	----	----	----
Benzo(a)pyrene	----	----	----
Aluminum	----	1.20E+05	1.20E+05
Arsenic	----	----	----
Manganese	----	----	----
Mercury	----	9.84E+01	1.40E+02
Uranium	----	----	----
Am-241	----	----	----
Ce-144	----	----	----
Co-57	----	----	----
Co-58	----	----	----
Co-60	----	----	----
Cs-134	----	----	----
Cs-137	----	----	----
Eu-152	----	----	----
Eu-154	----	----	----
Eu-155	----	----	----
H-3	----	----	----
I-129	----	----	----
K-40	----	----	----
Nb-95	----	----	----
Np-237	----	----	----
Pu-238	----	----	----
Pu-239/240	----	----	----
Pu-241	----	----	----
Pu-242	----	----	----
Ru/Rh-106	----	----	----
Sb-125	----	----	----
Sr-90	----	----	----
Tc-99	----	----	----
U-234	----	----	----
U-235	----	----	----
U-236	----	----	----
U-238	----	----	----

Table 26-4. Average soil exposure-point concentrations (mg/kg or pCi/g) for land use scenarios.

	Current occupational worker year 0 to year 25		Future occupational worker year 100 to year 125		Future resident year 100 to year 130
COPCs	(0 - 0.5 ft)	(0 - 4 ft)	(0 - 0.5 ft)	(0 - 4 ft)	(0 - 10 ft)
Aroclor-1260	----	----	----	----	----
Benzo(a)pyrene	----	----	----	----	----
Aluminum	----	1.20E+05	----	1.20E+05	1.20E+05
Arsenic	----	----	----	----	----
Manganese	----	----	----	----	----
Mercury	----	9.84E+01	----	9.84E+01	1.40E+02
Uranium	----	----	----	----	----
Am-241	----	----	----	----	----
Ce-144	----	----	----	----	----
Co-57	----	----	----	----	----
Co-58	----	----	----	----	----
Co-60	----	----	----	----	----
Cs-134	----	----	----	----	----
Cs-137	----	----	----	----	----
Eu-152	----	----	----	----	----
Eu-154	----	----	----	----	----
Eu-155	----	----	----	----	----
H-3	----	----	----	----	----
I-129	----	----	----	----	----
K-40	----	----	----	----	----
Nb-95	----	----	----	----	----
Np-237	----	----	----	----	----
Pu-238	----	----	----	----	----
Pu-239/240	----	----	----	----	----
Pu-241	----	----	----	----	----
Pu-242	----	----	----	----	----
Ru/Rh-106	----	----	----	----	----
Sb-125	----	----	----	----	----
Sr-90	----	----	----	----	----
Tc-99	----	----	----	----	----
U-234	----	----	----	----	----
U-235	----	----	----	----	----
U-236	----	----	----	----	----
U-238	----	----	----	----	----

Table 26-5. Concentrations of COPCs in homegrown produce.

COPCs	Homegrown produce (mg/kg or pCi/g)	Kd (cm^3/g)	COPC input rate from irrigation (mg/g-d or pCi/g-d)	Leach rate constant (d^{-1})
Aroclor-1260	---	7.89E+03	0.00E+00	9.95E-07
Benzo(a)pyrene	---	1.19E+03	0.00E+00	6.57E-06
Aluminum	1.53E+00	0.00E+00	0.00E+00	2.87E-02
Arsenic	1.40E-04	3.00E+00	8.71E-09	2.40E-03
Manganese	---	5.00E+01	0.00E+00	1.56E-04
Mercury	8.47E+01	1.00E+02	2.91E-08	7.83E-05
Uranium	7.30E-05	6.00E+00	7.04E-09	1.25E-03
Am-241	7.76E-06	3.40E+02	6.08E-06	2.31E-05
Ce-144	---	5.00E+02	0.00E+00	1.57E-05
Co-57	---	1.00E+01	0.00E+00	7.64E-04
Co-58	---	1.00E+01	0.00E+00	7.64E-04
Co-60	---	1.00E+01	0.00E+00	7.64E-04
Cs-134	---	5.00E+02	0.00E+00	1.57E-05
Cs-137	8.22E-04	5.00E+02	4.12E-05	1.57E-05
Eu-152	---	3.40E+02	0.00E+00	2.31E-05
Eu-154	---	3.40E+02	0.00E+00	2.31E-05
Eu-155	---	3.40E+02	0.00E+00	2.31E-05
H-3	---	0.00E+00	6.22E-04	2.87E-02
I-129	3.85E-06	0.00E+00	3.26E-05	2.87E-02
K-40	---	1.50E+01	0.00E+00	5.14E-04
Nb-95	---	0.00E+00	0.00E+00	2.87E-02
Np-237	3.19E-05	0.00E+00	8.36E-06	2.87E-02
Pu-238	---	2.20E+01	0.00E+00	3.53E-04
Pu-239/240	5.15E-06	2.20E+01	5.84E-07	3.53E-04
Pu-241	8.49E-09	2.20E+01	9.37E-08	3.53E-04
Pu-242	3.60E-09	2.20E+01	3.88E-10	3.53E-04
Ru/Rh-106	---	0.00E+00	0.00E+00	2.87E-02
Sb-125	---	5.00E+01	0.00E+00	1.56E-04
Sr-90	6.88E-03	1.20E+01	5.63E-05	6.40E-04
Tc-99	4.56E-01	0.00E+00	1.67E-04	2.87E-02
U-234	2.73E-05	6.00E+00	2.63E-06	1.25E-03
U-235	9.61E-07	6.00E+00	9.27E-08	1.25E-03
U-236	6.93E-07	6.00E+00	6.68E-08	1.25E-03
U-238	2.44E-05	6.00E+00	2.35E-06	1.25E-03

Table 26-6. Soil pathway cancer risk to the current onsite worker.[a,b]

COPCs	Ingestion of soil	External radiation exposure	Total risks
Aroclor-1260	---	---	---
Benzo(a)pyrene	---	---	---
Aluminum	---	---	---
Arsenic	---	---	---
Manganese	---	---	---
Mercury	---	---	---
Uranium	---	---	---
Am-241	---	---	---
Ce-144	---	---	---
Co-57	---	---	---
Co-58	---	---	---
Co-60	---	---	---
Cs-134	---	---	---
Cs-137	---	---	---
Eu-152	---	---	---
Eu-154	---	---	---
Eu-155	---	---	---
H-3	---	---	---
I-129	---	---	---
K-40	---	---	---
Nb-95	---	---	---
Np-237	---	---	---
Pu-238	---	---	---
Pu-239/240	---	---	---
Pu-241	---	---	---
Pu-242	---	---	---
Ru/Rh-106	---	---	---
Sb-125	---	---	---
Sr-90	---	---	---
Tc-99	---	---	---
U-234	---	---	---
U-235	---	---	---
U-236	---	---	---
U-238	---	---	---
Total cancer risks by route:	0E+00	0E+00	0E+00

"---" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. All contamination at CPP-93 is buried deeper than 0.5 ft bls,
so there is no calculated risk or hazard index for workers at the site.
b. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 26-7. Soil pathway noncarcinogenic hazard to the current onsite worker.[a,b]

COPCs	Ingestion of soil	External radiation exposure	Total HIs
Aroclor-1260	----	----	----
Benzo(a)pyrene	----	----	----
Aluminum	----	----	----
Arsenic	----	----	----
Manganese	----	----	----
Mercury	----	----	----
Uranium	----	----	----
Am-241	----	----	----
Ce-144	----	----	----
Co-57	----	----	----
Co-58	----	----	----
Co-60	----	----	----
Cs-134	----	----	----
Cs-137	----	----	----
Eu-152	----	----	----
Eu-154	----	----	----
Eu-155	----	----	----
H-3	----	----	----
I-129	----	----	----
K-40	----	----	----
Nb-95	----	----	----
Np-237	----	----	----
Pu-238	----	----	----
Pu-239/240	----	----	----
Pu-241	----	----	----
Pu-242	----	----	----
Ru/Rh-106	----	----	----
Sb-125	----	----	----
Sr-90	----	----	----
Tc-99	----	----	----
U-234	----	----	----
U-235	----	----	----
U-236	----	----	----
U-238	----	----	----
Total hazard indices by route:	0E+00	0E+00	0E+00

"----" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. All contamination at CPP-93 is buried deeper than 0.5 ft bls,
so there is no calculated risk or hazard index for workers at the site.
b. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 26-8. Soil pathway cancer risk to the future onsite worker.[a,b]

COPCs	Ingestion of soil	External radiation exposure	Total risks
Aroclor-1260	----	----	----
Benzo(a)pyrene	----	----	----
Aluminum	----	----	----
Arsenic	----	----	----
Manganese	----	----	----
Mercury	----	----	----
Uranium	----	----	----
Am-241	----	----	----
Ce-144	----	----	----
Co-57	----	----	----
Co-58	----	----	----
Co-60	----	----	----
Cs-134	----	----	----
Cs-137	----	----	----
Eu-152	----	----	----
Eu-154	----	----	----
Eu-155	----	----	----
H-3	----	----	----
I-129	----	----	----
K-40	----	----	----
Nb-95	----	----	----
Np-237	----	----	----
Pu-238	----	----	----
Pu-239/240	----	----	----
Pu-241	----	----	----
Pu-242	----	----	----
Ru/Rh-106	----	----	----
Sb-125	----	----	----
Sr-90	----	----	----
Tc-99	----	----	----
U-234	----	----	----
U-235	----	----	----
U-236	----	----	----
U-238	----	----	----
Total cancer risks by route:	0E+00	0E+00	0E+00

"----" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. All contamination at CPP-93 is buried deeper than 0.5 ft bls,
so there is no calculated risk or hazard index for workers at the site.
b. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 26-9. Soil pathway noncarcinogenic hazard to the future onsite worker.[a,b]

COPCs	Ingestion of soil	External radiation exposure	Total HIs
Aroclor-1260	----	----	----
Benzo(a)pyrene	----	----	----
Aluminum	----	----	----
Arsenic	----	----	----
Manganese	----	----	----
Mercury	----	----	----
Uranium	----	----	----
Am-241	----	----	----
Ce-144	----	----	----
Co-57	----	----	----
Co-58	----	----	----
Co-60	----	----	----
Cs-134	----	----	----
Cs-137	----	----	----
Eu-152	----	----	----
Eu-154	----	----	----
Eu-155	----	----	----
H-3	----	----	----
I-129	----	----	----
K-40	----	----	----
Nb-95	----	----	----
Np-237	----	----	----
Pu-238	----	----	----
Pu-239/240	----	----	----
Pu-241	----	----	----
Pu-242	----	----	----
Ru/Rh-106	----	----	----
Sb-125	----	----	----
Sr-90	----	----	----
Tc-99	----	----	----
U-234	----	----	----
U-235	----	----	----
U-236	----	----	----
U-238	----	----	----
Total hazard indices by route:	0E+00	0E+00	0E+00

"----" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. All contamination at CPP-93 is buried deeper than 0.5 ft bls,
so there is no calculated risk or hazard index for workers at the site.
b. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 26-10. Soil pathway cancer risk to the future onsite resident. [a]

COPCs	Ingestion of soil	Ingestion of homegrown	External radiation exposure	Total risks
Aroclor-1260	—	—	—	—
Benzo(a)pyrene	—	—	—	—
Aluminum	NTD	NTD	—	—
Arsenic	—	2E-08	—	2E-08
Manganese	—	—	—	—
Mercury	NTD	NTD	—	—
Uranium	—	NTD	—	—
Am-241	—	4E-10	—	4E-10
Ce-144	—	—	—	—
Co-57	—	—	—	—
Co-58	—	—	—	—
Co-60	—	—	—	—
Cs-134	—	—	—	—
Cs-137	—	5E-09	—	5E-09
Eu-152	—	—	—	—
Eu-154	—	—	—	—
Eu-155	—	—	—	—
H-3	—	—	—	—
I-129	—	1E-10	—	1E-10
K-40	—	—	—	—
Nb-95	—	—	—	—
Np-237	—	2E-09	—	2E-09
Pu-238	—	—	—	—
Pu-239/240	—	3E-10	—	3E-10
Pu-241	—	5E-13	—	5E-13
Pu-242	—	2E-13	—	2E-13
Ru/Rh-106	—	—	—	—
Sb-125	—	—	—	—
Sr-90	—	7E-08	—	7E-08
Tc-99	—	1E-07	—	1E-07
U-234	—	2E-10	—	2E-10
U-235	—	8E-12	—	8E-12
U-236	—	5E-12	—	5E-12
U-238	—	3E-10	—	3E-10
Total cancer risks by route:	0E+00	2E-07	0E+00	2E-07

"—" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

Table 26-11. Soil pathway noncarcinogenic hazard to the future onsite resident. [a]

COPCs	Ingestion of soil	Ingestion of homegrown	External radiation exposure	Total HIs
Aroclor-1260	—	—	—	—
Benzo(a)pyrene	—	—	—	—
Aluminum	4E-01	4E-04	—	4E-01
Arsenic	—	1E-04	—	1E-04
Manganese	—	—	—	—
Mercury	2E-07	7E+01	—	7E+01
Uranium	—	6E-06	—	6E-06
Am-241	—	—	—	—
Ce-144	—	—	—	—
Co-57	—	—	—	—
Co-58	—	—	—	—
Co-60	—	—	—	—
Cs-134	—	—	—	—
Cs-137	—	—	—	—
Eu-152	—	—	—	—
Eu-154	—	—	—	—
Eu-155	—	—	—	—
H-3	—	—	—	—
I-129	—	—	—	—
K-40	—	—	—	—
Nb-95	—	—	—	—
Np-237	—	—	—	—
Pu-238	—	—	—	—
Pu-239/240	—	—	—	—
Pu-241	—	—	—	—
Pu-242	—	—	—	—
Ru/Rh-106	—	—	—	—
Sb-125	—	—	—	—
Sr-90	—	—	—	—
Tc-99	—	—	—	—
U-234	—	—	—	—
U-235	—	—	—	—
U-236	—	—	—	—
U-238	—	—	—	—
Total hazard indices by route:	4E-01	7E+01	0E+00	7E+01

"—" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.
a. See Chapter 27 for a description of the WAG 3 air and groundwater pathway risks and hazard quotients.

future resident from exposure to site-related chemicals in soil is estimated to be 2E-07. As shown on Table 26-11, the total noncarcinogenic hazard index to the future resident is estimated to be 7E+01 with ingestion of mercury through homegrown produce being the major contributor.

26.5 Uncertainties

This section describes the limitations and uncertainties specific to the site characterization of site CPP-93. Sources of uncertainty associated with site characterization include data quality, COPC identification, concentration term estimation, and assumptions regarding the lateral and vertical extent of COPC occurrence. In the risk assessment, the most significant uncertainties are due to the selection process of COPCs, the toxicity values used, and the assumptions used during the exposure assessment. The following paragraphs will discuss important sources of site-specific uncertainty in greater detail.

Sampling and analysis uncertainties are related to quality problems that may result in qualified and rejected results (Section 3.5). Qualified results are considered estimates of the concentration in the sample and, for all practical purposes, useable for their intended purpose although they could be biased high or low. Rejected results are considered unusable, thus limiting the size of the useable data set. For site CPP-93, no data points were rejected based on the method validation as documented in the Limitations and Validation (L&V) Reports, thus making this possible source of uncertainty insignificant.

Uncertainty associated with the chemical screening process (Section 5.2) results from using the maximum concentration for chemicals detected in the Environmentally Controlled Areas (ECAs) in the background comparison step, retaining chemicals detected as COPCs because there is not a corresponding background value, and retaining chemicals as COPCs for which there is no toxicity information available. Effects due to mercury exposure could not be quantified due to lack of oral health criteria. Since this element is a major COPC, the risk may be underestimated.

In most cases, the COPC identification process used the maximum concentration for a chemical detected in the background comparison step, regardless of its magnitude above background. The use of the maximum concentration can result in the identification of COPCs that have concentrations only slightly above background. For site CPP-93, none of the COPCs fell into this category.

Another source of uncertainty related to the background comparison step in the chemical screening process relates to chemicals for which no background concentration exists. For example, fluoride, nitrate, and several radionuclides were not characterized as part of the Rood et al., background study. For site CPP-93, nitrate had no corresponding background concentration. This results in an increase in the number of COPCs considered in the RI/BRA and a possible overestimation of risk because the observed concentrations may be within the background population.

Some concentration estimates are based on the 95% UCL for the site, or the area-weighted average 95% UCLs for sites that have been grouped. When the 95% UCL (i.e., the concentration term estimate) of a COPC is below the corresponding background value, this results in an increase in the number of COPC in the RI/BRA, and a possible overestimation of risk because the results are likely within the background range. This source of uncertainty stems from the use of maximum concentrations when identifying the COPCs for a specific sites. For site CPP-93, none of the COPC concentration estimates were below background. For site CPP-93, all COPCs had toxicity information for use in the HHRA.

At site CPP-93, a source of uncertainty is related to the vertical extent of mercury and aluminum concentrations above background. Aluminum and mercury concentrations in the deep samples collected at about 3.7 m (12 ft) bgs were still above background but were significantly lower than in the shallow soil samples. It was assumed that aluminum and mercury concentrations are above background to a depth of

7.6 m (25 ft). This assumption affects the estimated source mass for the vadose zone and groundwater model. The assumption is believed to be conservative and thus the contaminant mass for this site may be overestimated.

26.6 Conclusions and Recommendations

The results of the risk assessment under current land use at CPP-93 indicate that the increased cancer risk from exposure to site-related contaminants is below the EPA recommended target range. The increased cancer risk to hypothetical future onsite workers and residents are also found to be well below the EPA target range. The non-carcinogenic hazard to the current on-site worker and the future on-site worker from exposure to soil-related mercury and aluminum was found to be below the EPA recommended hazard index of one. However, the hazard index under a future residential scenario was estimated to exceed the recommended value of one. It should be noted that these estimates do not include the contributions associated with the air and groundwater pathways. The cumulative non-carcinogenic hazard incidence to humans is reported in Section 27. Even though the hazard estimates at this sites are likely to be overestimated due to reasons discussed in Sections 7 and 26.5, they are above EPA recommended criteria. It is expected that some types of remedial action is necessary at this site to protect the future resident at the year 2095 and beyond and therefore, alternatives for this site will be developed in the Feasibility Study.

26.7 References

LITCO, 1995, *Track 1 Decision Documentation Package, CPP-93 Nonradioactive Calcine Disposal Trench, Operable Unit 3-13.*

Rood, S. M., G. A. Harris, and G. J. White, 1995, *Background Dose Equivalent Rates and Surficial Soil Metal and Radionuclide Concentrations for the Idaho National Engineering Laboratory*, INEL-94/0250, Revision 0, February.

Chapter 27

27. CUMULATIVE RISK

Sections 10 through 26 of this report summarize the risk assessment results from surface exposure to site-related contaminants in soil within each retained release site. The excess cancer risk and non-carcinogenic hazard estimates do not include the contributions from exposure to contaminants in air and groundwater. These contributions were not added to the site-specific results (surface exposure) because the air and groundwater pathways were evaluated comprehensively, and therefore the exposure point concentrations within a respective scenario are the same across WAG 3 regardless of location. For a cumulative evaluation, the total excess cancer risk and hazard at each site, shown in Figure 27-1, is that portion due to site-related contaminants measured in soil and reported in Sections 10 through 26 plus the contribution associated with the air and groundwater pathways. The purpose of this section is to bring it all together in a cumulative sense. To this end, Sections 27.1 and 27.2 summarize the cancer risk and noncarcinogenic hazard estimates associated with the groundwater and air pathways. The total cumulative excess cancer risk and hazard are depicted graphically in Section 27.3 for each site and group within each exposure scenario. Note that the cumulative risk under the future land use scenario is provided for a worker and a hypothetical resident beginning in the year 2095. Finally, Section 27.4 cumulatively discusses in a qualitative sense the uncertainty associated with treating the air and groundwater pathways.

27.1 Groundwater Pathway

This section summarizes the results of the groundwater model simulations and subsequently discusses the potential health (cancer risks and noncarcinogenic hazards) impacts from exposure to simulated levels of contaminants in groundwater to a hypothetical future resident living within the ICPP proper at the year 2095 and beyond. Section 27.1.1 briefly summarizes the groundwater model results and the health impacts in terms of increased cancer incidence, and Section 27.1.2 discusses noncarcinogenic hazard.

27.1.1 Groundwater Contaminant Simulations and Exposure-Point Concentrations

Predictions of contaminant transport from the land surface to the SRPA and south to the INEEL boundary were made. All assumptions regarding parameterization of the model, calibration, identification and screening of COPCs, source estimation, and uncertainty analysis are described in detail in Appendix F of this report. Simulations were performed on arsenic, chromium, mercury, Am-241, Co-60, Cs-137, H-3, I-129, Np-237, Sr-90, Tc-99, total plutonium, and total uranium originating either at or near land surface, from historical wastewater discharges (i.e., percolation ponds), and past use of the injection well including the period when the well failed and introduced the contamination to the vadose zone rather than the SRPA. The modeling effort focused on obtaining future groundwater concentrations in the year 2095 to support the 100-year future residential risk scenario in the BRA; however, concentrations were reported as a function of time over a simulation period extending well beyond 2095 until the peak concentrations were identified. For total plutonium, a simulation time of 3804 years was necessary to ensure that the peak concentration was identified. This was the longest simulation. The interpretation of hydrogeologic conditions, contaminant source definition, and final simulation results require extensive documentation and graphics (see Section 6 and Appendix F); therefore, Table 27-1 is provided to summarize maximum and peak concentrations at various periods in time. Based on the information in this table, note that arsenic, Co-60, Cs-137, Tc-99, and Am-241 never exceed their MCL and risk-based concentration (target risk=1E-04), and thus it may not be necessary to evaluate them in the Feasibility Study. Chromium, tritium, Np-237, and total uranium exceed

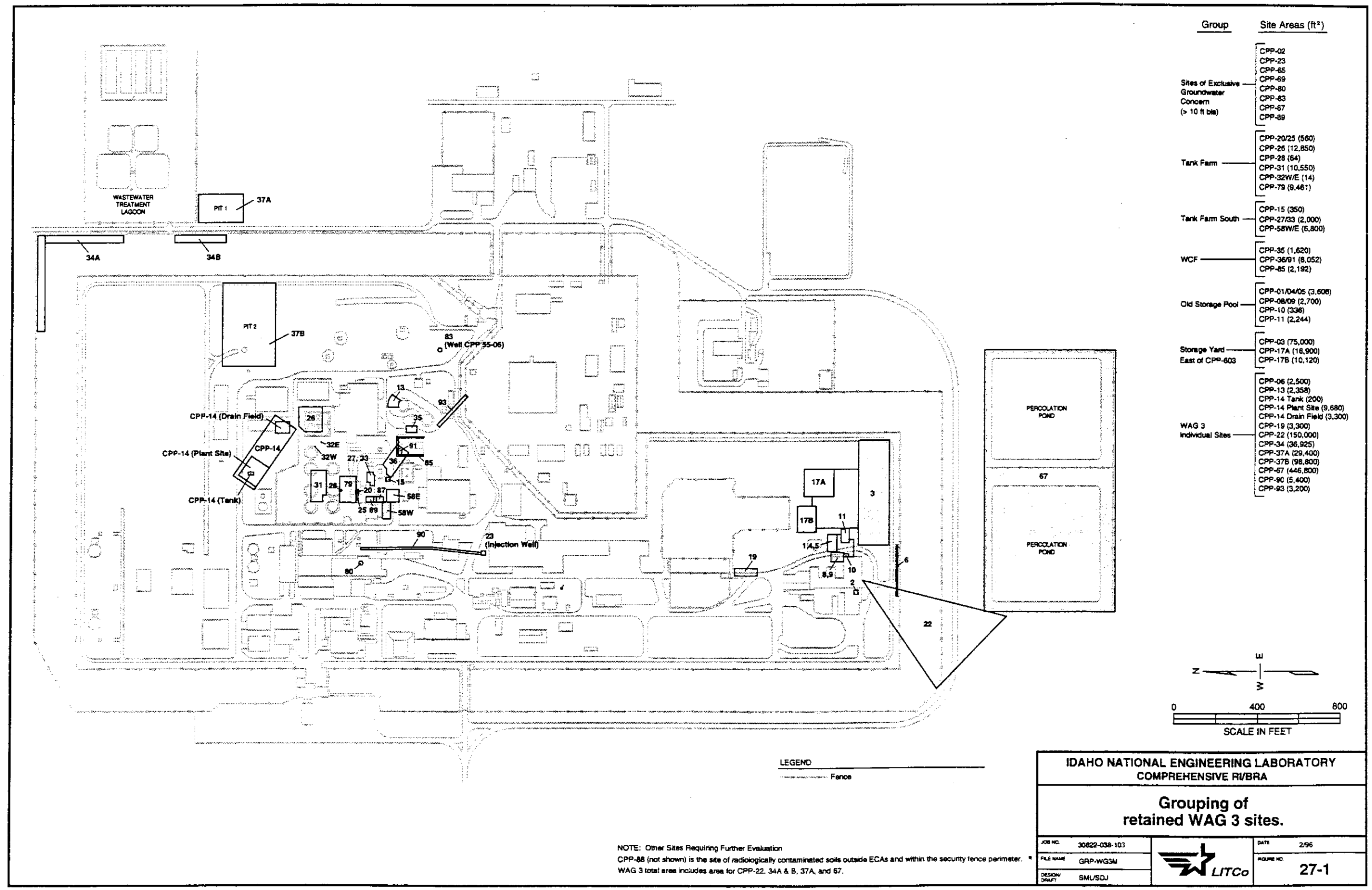


Figure 27-1. Grouping of retained WAG 3 sites.

Table 27-1. Summary of maximum and peak simulated contaminant concentrations for entire aquifer domain.[a]

COPC	K_d (cm^3/g)	MCL (mg/L or PCi/L)	1E-04 RBC	Maximum Concentration at Year 2025 (mg/L or pCi/l)	Maximum Concentration at Year 2095 (mg/L or pCi/L)	Peak Concentration After the Year 2095 (mg/L or pCi/L)	Peak Concentration Through Total Simulation Time (mg/L or pCi/L)
Arsenic	3	0.05[b]	4.5	9.4E-05	1.2E-03	1.95E-03 (2479)[e]	1.95E-03 (2479)[e]
Chromium	1.2	0.1[b]	0.18[c]	0.07	0.03	0.03 (2095)	0.9 (1971)
Mercury	100	0.002[b]	0.011[c]	0.006	0.004	0.004 (2095)	0.007 (1984)
Co-60	10	100[d]	254	0.03	0.0	0.0 (2095)	25.9 (1986)
Cs-137	500	200[d]	152	32.0	5.9	5.9 (2095)	86.2(1979)
H-3	0	20,000[d]	67,100	4,240.0	89.2	89.2 (2095)	2.6E+06 (1960)
I-129	0	1[d]	26	9.0	4.68	4.68 (2095)	97.1 (1986)
Np-237	8	<15	16	8.03	3.76	3.76 (2095)	30.5(1986)
Sr-90	12	8[d]	86	35.4	8.08	16.1 (2172)	1,200.0 (1,967)
Tc-99	0.15	900[d]	3,430	55.1	23.9	23.9 (2095)	203.0 (1,997)
Am-241	340	<15	15	0.8	0.63	0.63(2095)	0.9 (1,986)
Total Pu	22	<15	NA	0.32	0.14	36.2 (3585)	36.2 (3,585)
Total U[f]	6	0.02[b]	0.11	0.003	0.001	0.01(2468)	10.1 (1,986)

a. Entire aquifer domain is area within ICPP and that south of the facility south fence.
b. Drinking Water Regulations and Health Advisories, may 1995.
c. Values based on Hazard Quotient of 1.
d. Water concentration that will result in a dose rate of 4 mrem/yr, if contaminant is only one present, based on an ingestion of 2L/d using ICRP-2 methods.
e. Values in parentheses denotes the year when the peak occurs.
f. All concentrations for total uranium are expected in mg/L.

their MCL and/or the risk-based concentration before the year 2095 but not after 2095, and thus it may not be necessary to evaluate them further in the Feasibility Study. On the other hand, mercury, I-129, Sr-90, and total plutonium exceed their MCL and/or risk-based concentration before 2095 (except total plutonium) and also after 2095. These four contaminants are most likely to be the contaminants of concern that would require further evaluation in the Feasibility Study. For convenience, this information is summarized in Table 27-2.

From an interpretation of the graphics in Section 6.6 (Predictive Simulations) of the RI/BRA, primarily the depiction of mass flux to the aquifer from the vadose zone, and peak concentration for these four contaminants, it is possible to identify the source that led to the contaminant plume. These figures for I-129 show the mass into the aquifer peaking approximately in 1970, indicating that most of the source is due to the injection well failure. For mercury, interpretation of these figures indicate that the injection well is the main source. These figures for Sr-90 indicate that the injection well is most of the pre-2095 contribution, but that after 2095 the vadose zone contribution is more significant. Note that the discontinuity in the mass flux curve for Sr-90 correctly depicts the shutdown of plant water in the year 2095. The graphics for total plutonium indicate that the injection well is the early contributor but that later in time the contribution from the vadose zone becomes most significant.

The groundwater contribution to a cumulative evaluation in the BRA for a hypothetical future on-site resident within the ICPP proper at the year 2095 was estimated with simulated exposure point concentrations representing maximum values over the aquifer domain at 2095. The simulated concentrations for each COPC are presented in Table 27-1.

27.1.2 Risk Estimates

The increased cancer risk and noncarcinogenic hazard associated with ingestion of the contaminants in Table 27-1 by a future on-site resident at the year 2095 are summarized in Table 27-3. Since the contaminants in this medium are all inorganics, the dermal and inhalation route will not be evaluated (see Section 7.1.3.3).

Table 27-2. Summary comparison of predicted groundwater concentrations vs. regulatory levels before and after the year 2095.

Aquifer COCs Now Until 2095				Aquifer COCs After 2095	
>E-06	>E-04	>HQ=1	>MCL	>E-06	>MCL
Arsenic	H-3	Chromium	Chromium	Arsenic	Mercury
Co-60	I-129		Mercury	Cs-137	Total Plutonium
Cs-137	Np-237		H-3	I-129	Sr-90
H-3	Sr-90		I-129	Np-237	I-129
I-129			Np-237	Sr-90	
Np-237			Sr-90	Am-241	
Sr-90					
Tc-99					

Notes: Peak concentrations before and after 2095 and regulatory levels can be taken from Table 27-1. The COCs do not exceed 1E-04 risk level after 2095.

Table 27-3. Groundwater pathway exposure point concentrations, cancer risk, and noncancer hazards in the year 2095.

COPCs	Predicted Concentration in the year 2095 [a,b,c,d] (mg/L or pCi/L)	Ingestion of Groundwater Cancer Risk	Ingestion of Groundwater Hazard Quotient
Arsenic	1.25E-03	2.E-05	5.E-02
Chromium	2.21E-03	NTD	5.E-03
Mercury	4.17E-03	NTD	2.E-01
Uranium	1.01E-03	NTD	4.E-03
Am-241	8.72E-01	6.E-06	NTD
Co-60	0.00E+00	----	----
Cs-137	5.91E+00	4.E-06	NTD
H-3	8.92E+01	1.E-07	NTD
I-129	4.68E+00	2.E-05	NTD
Np-237	1.20E+00	8.E-06	NTD
Pu-238	0.00E+00	----	----
Pu-239/240	8.38E-02	6.E-07	NTD
Pu-241	1.34E-02	9.E-08	NTD
Pu-242	5.57E-05	4.E-10	NTD
Sr-90	8.08E+00	9.E-06	NTD
Tc-99	2.39E+01	7.E-07	NTD
U-234	3.78E-01	4.E-07	NTD
U-235	1.33E-02	1.E-08	NTD
U-236	9.59E-03	8.E-09	NTD
U-238	3.37E-01	4.E-07	NTD
Total	NA	7.E-05	2.E-01

"----" indicates that groundwater modeling does not predict any contamination from this COPC.
NTD indicates that toxicity data is not available.
a. The concentrations shown were taken from Table 6-6, and are predictions of the peak 2095 aquifer concentrations in the ICPP footprint area.
b. The reported Am-241 concentration includes concentration of the isotope produced through Pu-241 decay.
c. Groundwater modeling predicted a total plutonium groundwater concentration of 1.39E-01 pCi/L in the year 2095. Concentrations for individual plutonium isotopes were calculated from this total concentration using the following activity percentages: Pu-238 0%, Pu-239/240 60.32%, Pu-241 9.65%, Pu-242 0.04%.
d. Groundwater modeling predicted a total uranium groundwater concentration of 7.38E-01 pCi/L in the year 2095. Concentrations for individual uranium isotopes were calculated from this total uranium concentration using the following activity percentages: U-234 51.2%, U-235 1.8%, U-236 1.3%, U-238 45.7%.

27.2 Air Pathway

This section presents the health impacts (cancer risks and noncarcinogenic hazards) to potential receptors under current and future land use scenarios due to WAG 3 air concentrations of COPCs. The air concentrations used are based on cumulative emissions from multiple sites of concern within WAG 3 and represent an area average. The following subsections present the airborne concentration levels of particulate, VOCs, and the resulting risk estimates.

27.2.1 Exposure-Point Concentrations

Based on the methods described in Section 7 of this report, the area-weighted concentrations were calculated using the soil concentrations terms prepared for each group and site within the ICPP that are presented in Sections 10 through 26. This technique used the average from the CPP-88 data for each contaminant to include interstitial areas outside of ECAs but within the WAG 3. For the on-site worker scenarios, COPC concentrations in the 0- to 15-cm (0 to 0.5 ft) depth range were used. For the future residential scenario, COPC concentrations in soil in the 0- to 3.05-m (0 to 10 ft) depth range were used. The area-weighted air concentrations used to comprehensively evaluate potential health impacts to current and future receptors are summarized in Table 27-4.

27.2.2 Risk Estimates

The intake equations presented in Section 7 were used to calculate the scenario-specific intakes from the inhalation of fugitive dust and volatilized contaminants. These intakes and the available toxicity information were then used to estimate the increased cancer incidence and noncarcinogenic hazards. A summary of the carcinogenic impacts under each land use assumption are presented in Table 27-5, and the noncarcinogenic impacts are summarized in Table 27-6. The results indicate that the increased cancer risk from exposure to area-weighted air concentrations is less than 1E-06 under all three land use assumptions. The noncarcinogenic hazard for this pathway was found to be well below a hazard index of 1 under all three land use assumptions.

27.3 Cumulative Risk Presentation

The INEEL Cumulative Risk Assessment Guidance Protocol (LITCO, 1995) was prepared to provide general guidance for preparation of BRAs at the INEEL. One of the goals of the protocol document is to promote consistency across all WAGs and ensure that BRAs are prepared comprehensively such that their use as a decision-making tool is optimal. To this end, the protocol document deviates from previous approaches (i.e., Track 1 and 2 methods) of conducting risk evaluations on a site-by-site basis without considering interactions between sites. This condition can be avoided by incorporating features into the comprehensive BRAs that consider "cumulative" impacts, primarily those expected through the air and groundwater pathways. That is, the analysis of these two exposure pathways can be approached as a WAG-wide value rather than a site-specific value. Generally, it is appropriate to evaluate exposure to contaminants in the surface soil, by ingestion or direct contact, on a site-by-site basis because the assumption is made that each site or group will have its own receptor. There can be some exceptions such as when very high radiation fields exist adjacent to a site that has no or very low radiation fields. In this instance, it may be necessary to look at cumulative effects. This is not the case for WAG 3, sites since these are typically isolated from one another. Generally, the guidance protocol recommends that soil pathway exposures be analyzed on a release

Table 27-4. COPC exposure-point concentrations in air.

	Current on-site worker		Future on-site worker		Future on-site resident	
COPCs	Fugitive dust (mg/m^3 or pCi/m^3)	Volatiles (mg/m^3)	Fugitive dust (mg/m^3 or pCi/m^3)	Volatiles (mg/m^3)	Fugitive dust (mg/m^3 or pCi/m^3)	Volatiles (mg/m^3)
Aroclor-1260	---	---	---	---	1.9E-11	1.6E-13
Benzo(a)pyrene	1.5E-12	8.4E-16	1.5E-12	8.4E-16	1.6E-12	5.7E-16
Aluminum	---	---	---	---	7.1E-07	---
Arsenic	1.2E-09	---	1.2E-09	---	7.4E-08	---
Manganese	3.2E-09	---	3.2E-09	---	3.4E-09	---
Mercury	---	---	---	---	8.3E-10	---
Uranium	5.1E-09	---	5.1E-09	---	4.3E-09	---
Am-241	4.5E-06	---	3.9E-06	---	1.1E-05	---
Ce-144	4.6E-07	---	9.5E-46	---	1.3E-45	---
Co-57	4.4E-10	---	1.2E-50	---	1.7E-50	---
Co-58	---	---	---	---	---	---
Co-60	5.1E-06	---	1.0E-11	---	7.4E-11	---
Cs-134	1.5E-06	---	3.6E-21	---	8.5E-21	---
Cs-137	5.0E-04	---	5.0E-05	---	2.3E-03	---
Eu-152	1.3E-04	---	8.1E-07	---	2.4E-06	---
Eu-154	1.0E-04	---	3.9E-08	---	1.0E-07	---
Eu-155	1.4E-05	---	1.2E-11	---	2.2E-11	---
H-3	2.7E-07	---	9.7E-10	---	5.4E-09	---
I-129	3.1E-06	---	3.1E-06	---	1.2E-06	---
K-40	---	---	---	---	3.0E-07	---
Nb-95	4.4E-12	---	---	---	---	---
Np-237	1.3E-06	---	1.3E-06	---	1.4E-06	---
Pu-238	5.5E-06	---	2.5E-06	---	4.2E-06	---
Pu-239/240	1.7E-06	---	1.7E-06	---	3.2E-06	---
Pu-241	---	---	---	---	5.4E-07	---
Pu-242	---	---	---	---	3.8E-09	---
Ru/Rh-106	2.9E-07	---	4.6E-37	---	1.8E-37	---
Sb-125	1.7E-07	---	2.3E-18	---	1.8E-18	---
Sr-90	2.1E-04	---	1.9E-05	---	6.3E-04	---
Tc-99	6.4E-07	---	6.4E-07	---	1.6E-06	---
U-234	2.1E-06	---	2.1E-06	---	1.5E-06	---
U-235	5.6E-08	---	5.6E-08	---	5.8E-08	---
U-236	---	---	---	---	9.0E-11	---
U-238	1.7E-06	---	1.7E-06	---	1.4E-06	---

Table 27-5. Cancer risks due to COPC concentrations in air.

	Current on-site worker		Future on-site worker		Future on-site resident	
COPCs	Inhalation of fugitive dust	Inhalation of volatiles	Inhalation of fugitive dust	Inhalation of volatiles	Inhalation of fugitive dust	Inhalation of volatiles
Aroclor-1260	----	----	----	----	NTD	NTD
Benzo(a)pyrene	2E-14	1E-17	2E-14	1E-17	2E-14	8E-18
Aluminum	----	----	----	----	NTD	----
Arsenic	1E-15	----	1E-15	----	1E-13	----
Manganese	NTD	----	NTD	----	NTD	----
Mercury	----	----	----	----	NTD	----
Uranium	NTD	----	NTD	----	NTD	----
Am-241	4E-15	----	3E-15	----	1E-14	----
Ce-144	1E-18	----	2E-57	----	3E-57	----
Co-57	3E-23	----	8E-64	----	1E-63	----
Co-58	----	----	----	----	----	----
Co-60	8E-18	----	2E-23	----	1E-22	----
Cs-134	1E-18	----	2E-33	----	6E-33	----
Cs-137	2E-16	----	2E-17	----	1E-15	----
Eu-152	2E-16	----	1E-18	----	4E-18	----
Eu-154	2E-16	----	8E-20	----	2E-19	----
Eu-155	3E-18	----	3E-24	----	5E-24	----
H-3	6E-22	----	2E-24	----	1E-23	----
I-129	9E-18	----	9E-18	----	3E-18	----
K-40	----	----	----	----	5E-20	----
Nb-95	3E-25	----	----	----	----	----
Np-237	1E-15	----	1E-15	----	1E-15	----
Pu-238	3E-15	----	2E-15	----	3E-15	----
Pu-239/240	1E-15	----	1E-15	----	2E-15	----
Pu-241	----	----	----	----	5E-16	----
Pu-242	----	----	----	----	2E-18	----
Ru/Rh-106	8E-19	----	1E-48	----	5E-49	----
Sb-125	2E-20	----	3E-31	----	2E-31	----
Sr-90	3E-16	----	3E-17	----	1E-15	----
Tc-99	4E-20	----	4E-20	----	1E-19	----
U-234	7E-16	----	7E-16	----	5E-16	----
U-235	2E-17	----	2E-17	----	2E-17	----
U-236	----	----	----	----	3E-20	----
U-238	5E-16	----	5E-16	----	4E-16	----
Total cancer risks:	3E-14	1E-17	3E-14	1E-17	2E-13	8E-18

"----" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.

Table 27-6. Noncarcinogenic hazards due to COPC concentrations in air.

	Current on-site worker		Future on-site worker		Future on-site resident	
COPCs	Inhalation of fugitive dust	Inhalation of volatiles	Inhalation of fugitive dust	Inhalation of volatiles	Inhalation of fugitive dust	Inhalation of volatiles
Aroclor-1260	----	----	----	----	NTD	NTD
Benzo(a)pyrene	NTD	NTD	NTD	NTD	NTD	NTD
Aluminum	----	----	----	----	NTD	----
Arsenic	NTD	----	NTD	----	NTD	----
Manganese	4E-06	----	5E-07	----	5E-07	----
Mercury	----	----	----	----	1E-07	----
Uranium	NTD	----	NTD	----	NTD	----
Am-241	----	----	----	----	----	----
Ce-144	----	----	----	----	----	----
Co-57	----	----	----	----	----	----
Co-58	----	----	----	----	----	----
Co-60	----	----	----	----	----	----
Cs-134	----	----	----	----	----	----
Cs-137	----	----	----	----	----	----
Eu-152	----	----	----	----	----	----
Eu-154	----	----	----	----	----	----
Eu-155	----	----	----	----	----	----
H-3	----	----	----	----	----	----
I-129	----	----	----	----	----	----
K-40	----	----	----	----	----	----
Nb-95	----	----	----	----	----	----
Np-237	----	----	----	----	----	----
Pu-238	----	----	----	----	----	----
Pu-239/240	----	----	----	----	----	----
Pu-241	----	----	----	----	----	----
Pu-242	----	----	----	----	----	----
Ru/Rh-106	----	----	----	----	----	----
Sb-125	----	----	----	----	----	----
Sr-90	----	----	----	----	----	----
Tc-99	----	----	----	----	----	----
U-234	----	----	----	----	----	----
U-235	----	----	----	----	----	----
U-236	----	----	----	----	----	----
U-238	----	----	----	----	----	----
Total noncarcinogenic hazard	4E-06	0E+00	5E-07	0E+00	6E-07	0E+00

"----" indicates that the contaminant is not a COPC in the medium or at the site.
NTD indicates that toxicity data is not available.

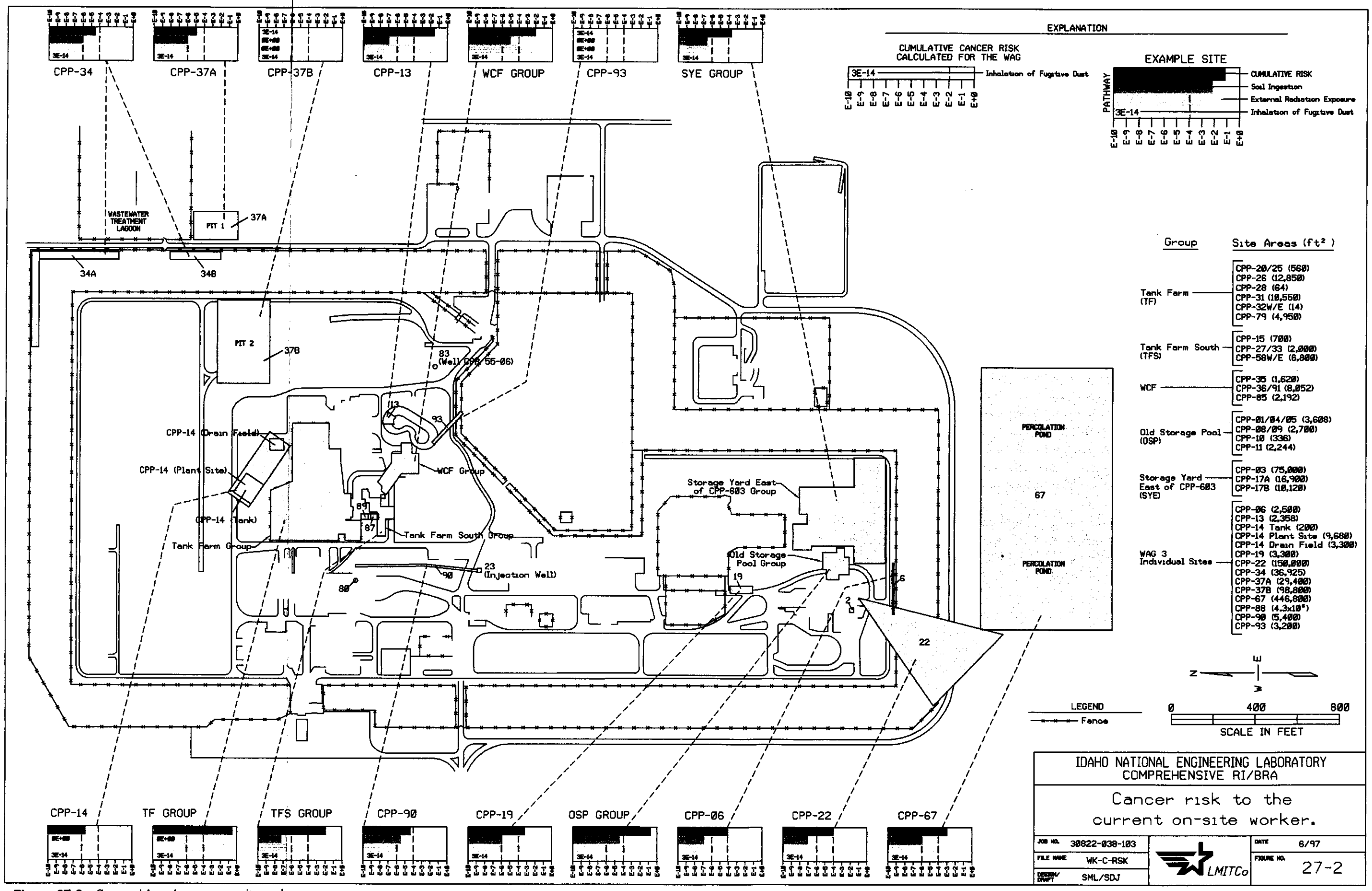
site specific, or "noncumulative," basis in the INEEL comprehensive risk assessments. In general, this BRA is "comprehensive" because it evaluates risks from all known and potential release sites within WAG 3, and it is "cumulative" because risks from multiple release sites are evaluated in the air and groundwater exposure pathways.

The objective of this section is to present the cumulative cancer risk and noncarcinogenic hazard associated with WAG 3 from all complete pathways and exposure routes. This is accomplished by summing all exposure contributions across all pathways and exposure routes for all contaminants. To this end, the contributions from the groundwater and air pathways (presented in Sections 27.1 and 27.2) will be added to that portion of the exposure from the soil pathway at each group and site within WAG 3 and presented individually in Sections 10 through 26 of this report. For convenience, the results of the cumulative evaluation are presented graphically in Figures 27-2 through 27-7.

27.4 Uncertainty Analysis

The sources of uncertainty that are cross-cutting in nature to the risk assessment process have been qualitatively discussed in Section 7, with a qualitative statement regarding the likelihood for a source to overestimate or underestimate the results. Site-specific sources of uncertainty such as those associated with site characterization are qualitatively discussed separately for each group or site in Sections 8 through 26. The uncertainty associated with simulated groundwater exposure concentrations is discussed in detail in Appendix F. Finally, this section will qualitatively discuss the air pathway uncertainty. The intent of the qualitative uncertainty analysis in Sections 7 through 27 are to help users understand the limitations of the risk assessment results during the remediation decision making process at ICPP.

The air exposure point concentrations were calculated to represent average values over WAG 3 and therefore are the same values used to evaluate inhalation exposure regardless of location within the ICPP. A large source of uncertainty from using this technique is due to overlooking the variability in airborne contamination that may exist across the ICPP between areas of higher surface soil contamination versus areas that have little if any surficial contamination. Use of this technique would tend to overestimate the results at areas of negligible surface contamination and underestimate the risks at areas of higher surface contamination. It is assumed that all of the fugitive dust within this medium contains COPCs at the area-weighted levels, and therefore this assumption would lead to an overestimation of the results. It is conservatively assumed that all the inhaled particulate matter is available for absorption in the deep portion of the human lung. Only a fraction of this matter is actually available, and thus this assumption would tend to overestimate the results.



IDAHO NATIONAL ENGINEERING LABORATORY
COMPREHENSIVE RI/BRA

Cancer risk to the current on-site worker.

JOB NO.	30822-038-103	DATE	6/97
FILE NAME	WK-C-RSK	FIGURE NO.	27-2
DESIGN/DRAFT	SML/SDJ	LMITCo	

Figure 27-2. Cancer risk to the current onsite worker.

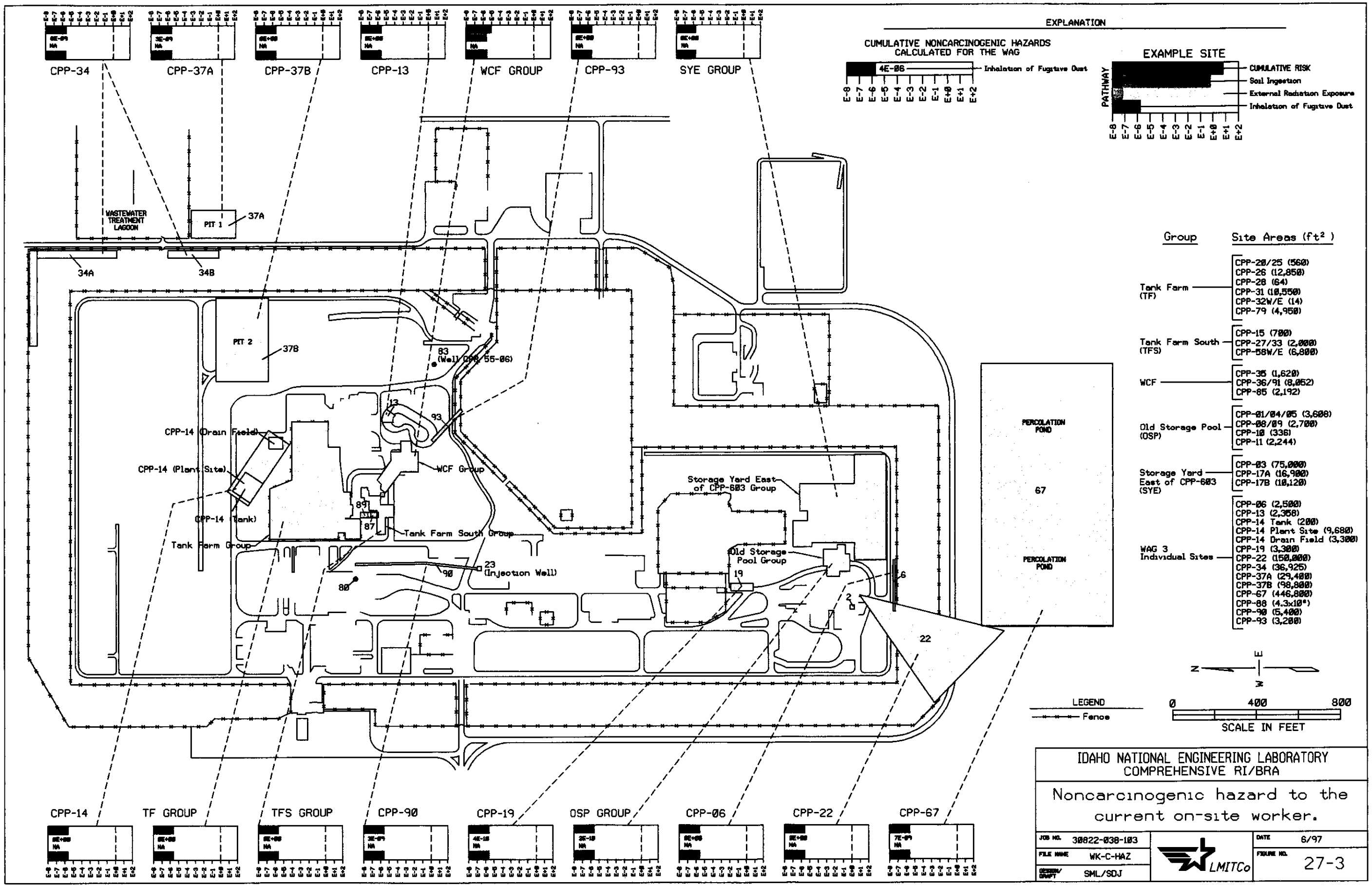


Figure 27-3. Noncarcinogenic hazard to the current onsite worker.

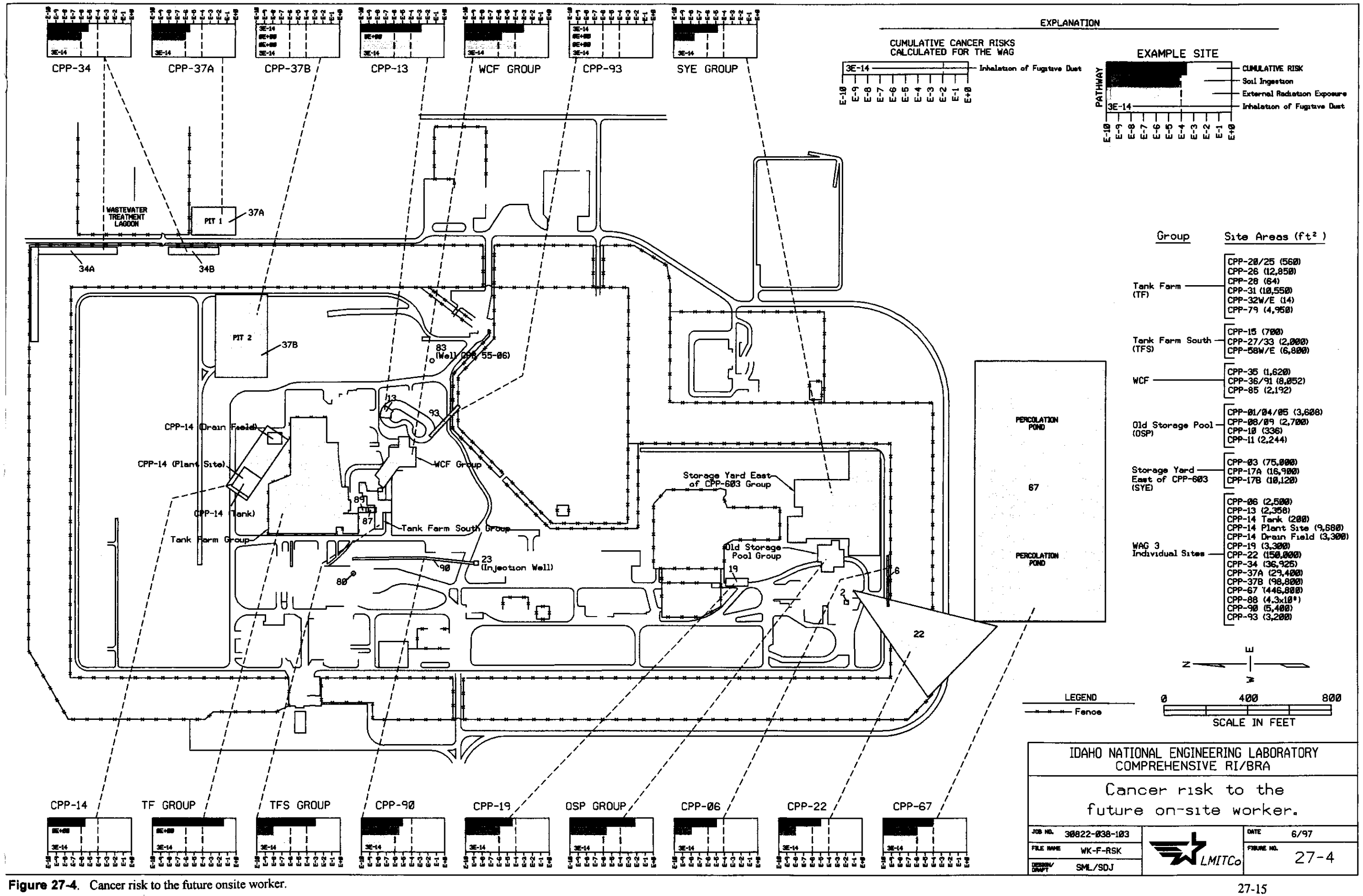


Figure 27-4. Cancer risk to the future onsite worker.

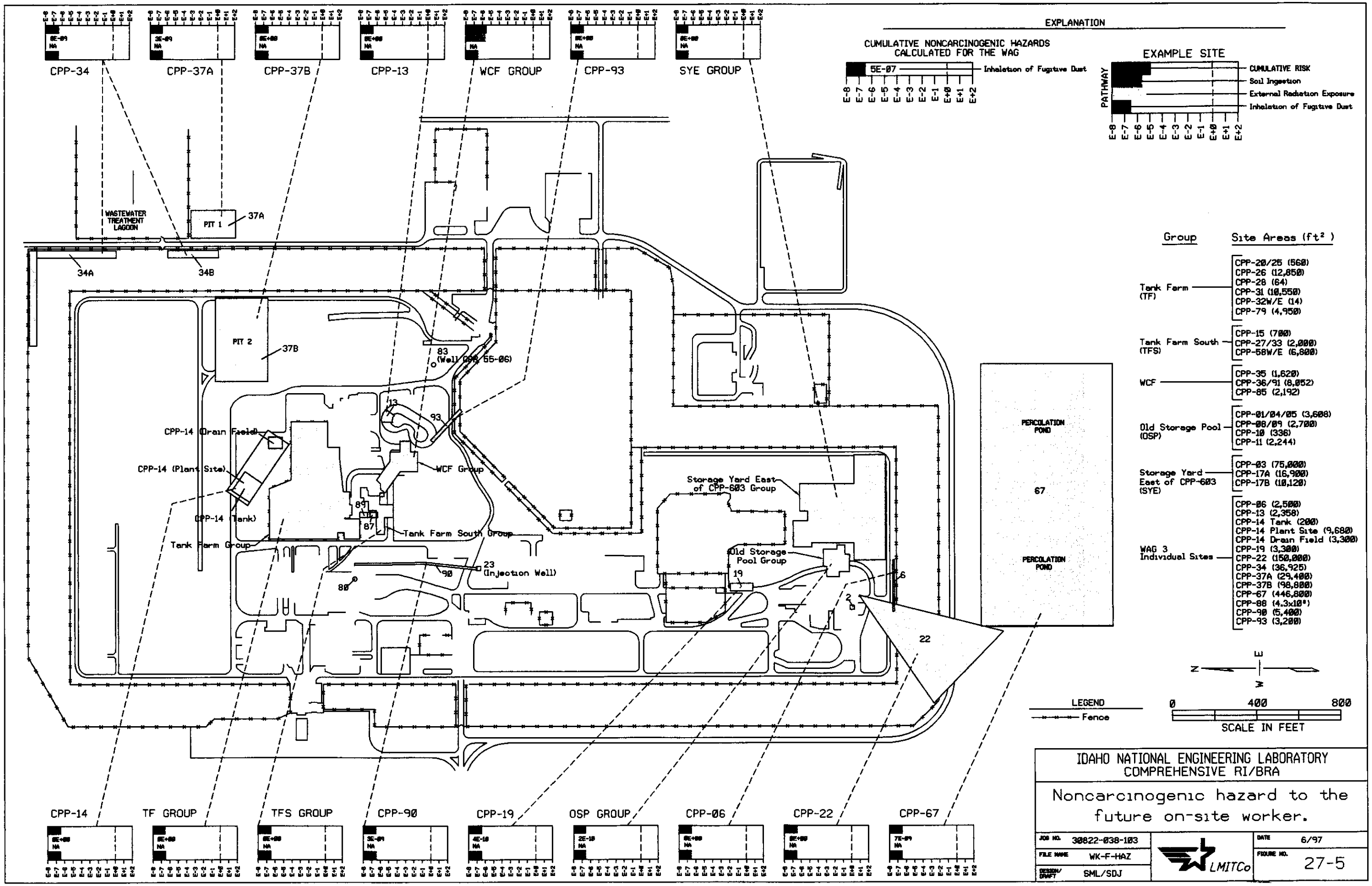


Figure 27-5. Noncarcinogenic hazard to the future onsite worker.

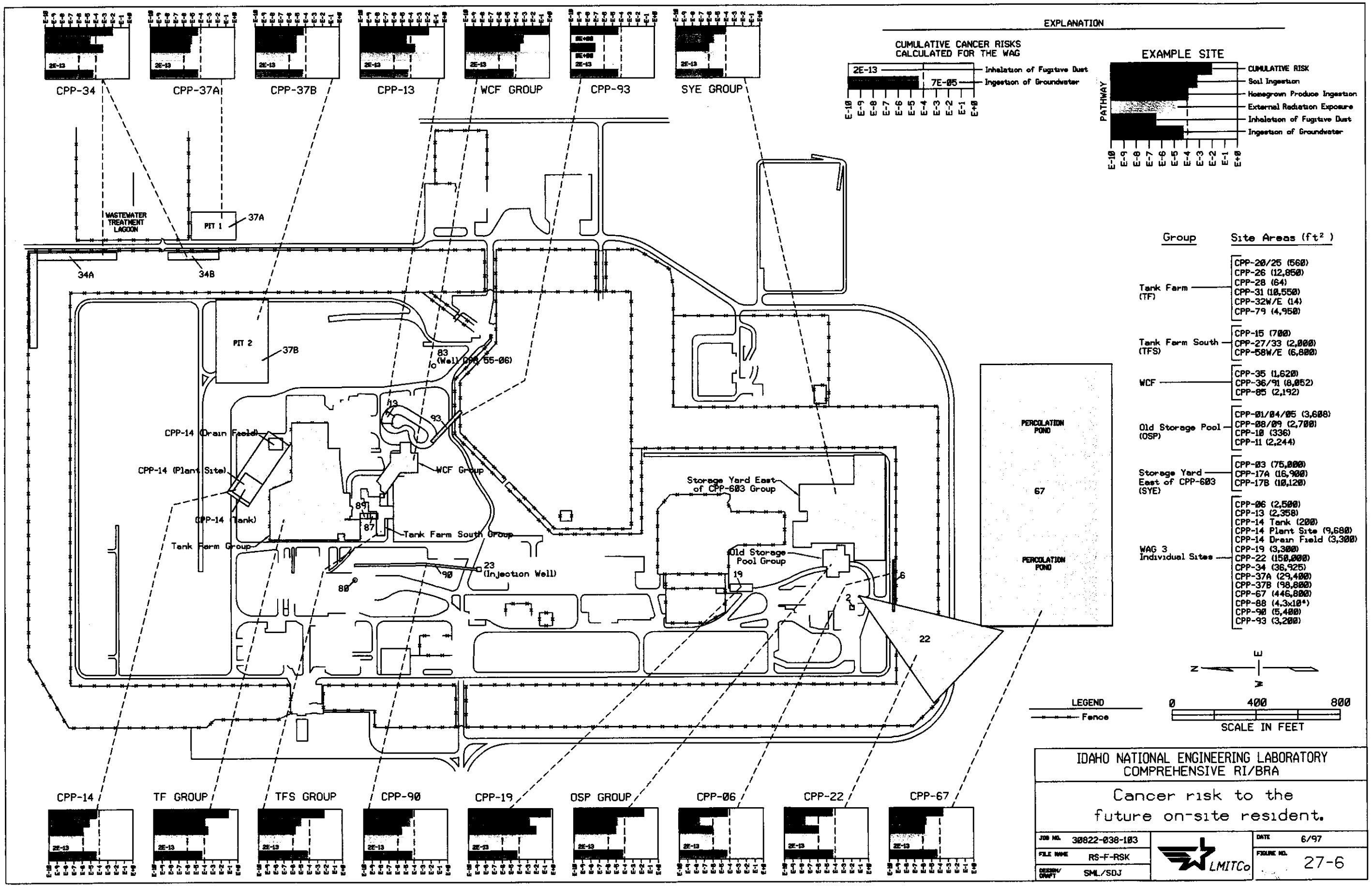


Figure 27-6. Cancer risk to the future onsite resident.

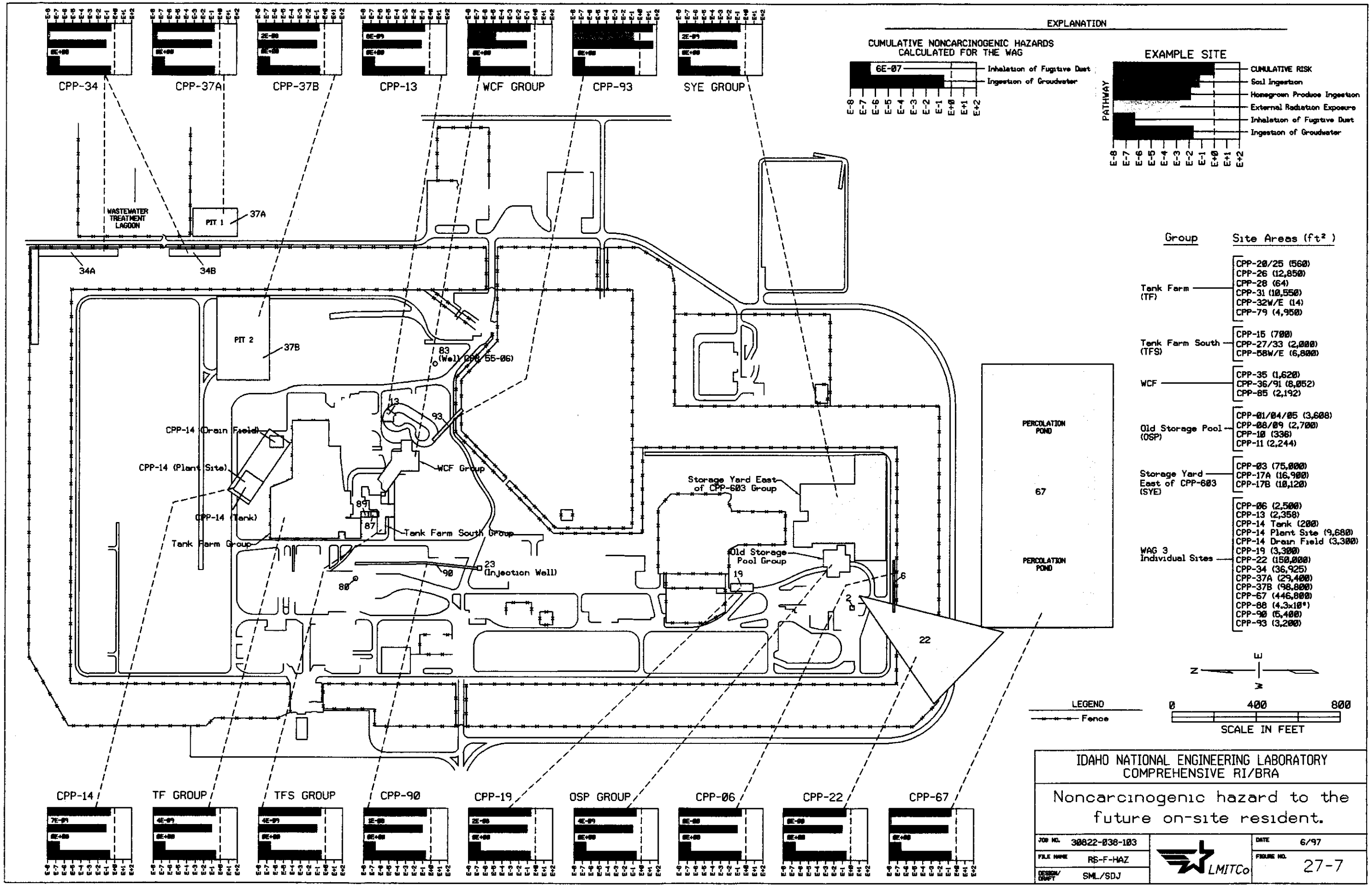


Figure 27-7. Noncarcinogenic hazard to the future onsite resident.

27.5 References

EPA, 1992a, *Supplemental Guidance to RAGS: Calculating the Concentration Term, Office of Solid Waste and Emergency Response*, Washington D.C., EPA Publication 9285.7-081, May.

Chapter 28

28. WAG 3 ECOLOGICAL RISK ASSESSMENT

This Waste Area Group (WAG)-level assessment is the second phase in the Idaho National Engineering and Environmental Laboratory (INEEL) ecological risk assessment (ERA) process (Figure 28-1) and provides a site-by-site evaluation of the potential risks to ecological resources as a result of exposure to radiological and nonradiological contaminants. The assessment was performed using the results of a previously conducted screening level ecological risk assessment (SLERA) and the same basic methodology developed in the *Guidance Manual for Conducting Screening Level Ecological Risk Assessments at the INEL* (VanHorn et al., 1995), subsequently referred to as the Guidance Manual. The SLERA was conducted to screen sites identified in the Federal Facilities Agreement/Consent Order (FFA/CO) (DOE-ID, 1991) and to identify those contaminants present at WAG 3 that have the potential to cause undesirable ecological effects. The sites and contaminants identified as a result of that assessment, in addition to those sites for which inadequate sampling information existed for inclusion in the SLERA, are analyzed here. The results of this assessment will be integrated with similar assessments for other INEEL WAGs to support the performance of the OU 10-04 baseline ERA.

28.1 Objectives

The objectives of the ERA were to:

- Determine the potential for adverse effects from contaminants on ecological receptor populations and protected wildlife species (individuals and populations), at the WAG level
- Identify sites and COPCs to be assessed in the OU 10-04 ERA
- Provide input to the data gap analysis for the OU 10-04 ERA.

This ERA was specifically designed to follow the direction provided by the *Framework for Ecological Risk Assessment* (EPA, 1992). This approach divides the ERA process into three steps: problem formulation, analysis, and risk characterization.

The goal of the problem formulation step of the ERA is to investigate the interactions between the stressor characteristics, the ecosystem potentially at risk, and the ecological effects (EPA, 1992). The problem formulation phase results in characterization of stressors (i.e., identification of the contaminants), definition of assessment and measurement endpoints, and the ecological effects that will be used to analyze risk using the conceptual site model (CSM). This step of the assessment is presented in Section 28.2, Problem Formulation.

In the analysis step, the likelihood and significance of an adverse reaction from exposure to the stressor(s) were evaluated. The behavior and fate of the contaminants of potential concern (COPCs) in the terrestrial environment was presented in a general manner since no formal fate and transport modeling was conducted for this WAG ERA. The ecological effects assessment consisted of hazard evaluation, and dose-response assessment. The hazard evaluation involved a comprehensive review of toxicity data for contaminants to identify the nature and severity of toxic properties. Dose from multiple media (surface and subsurface soil, and surface water) identified at INEEL were developed and used to assess potential risk to receptors. Because no dose-based toxicological criteria exist for ecological receptors, it was necessary to develop appropriate toxicity reference values (TRVs) for the contaminants and functional groups at INEEL.

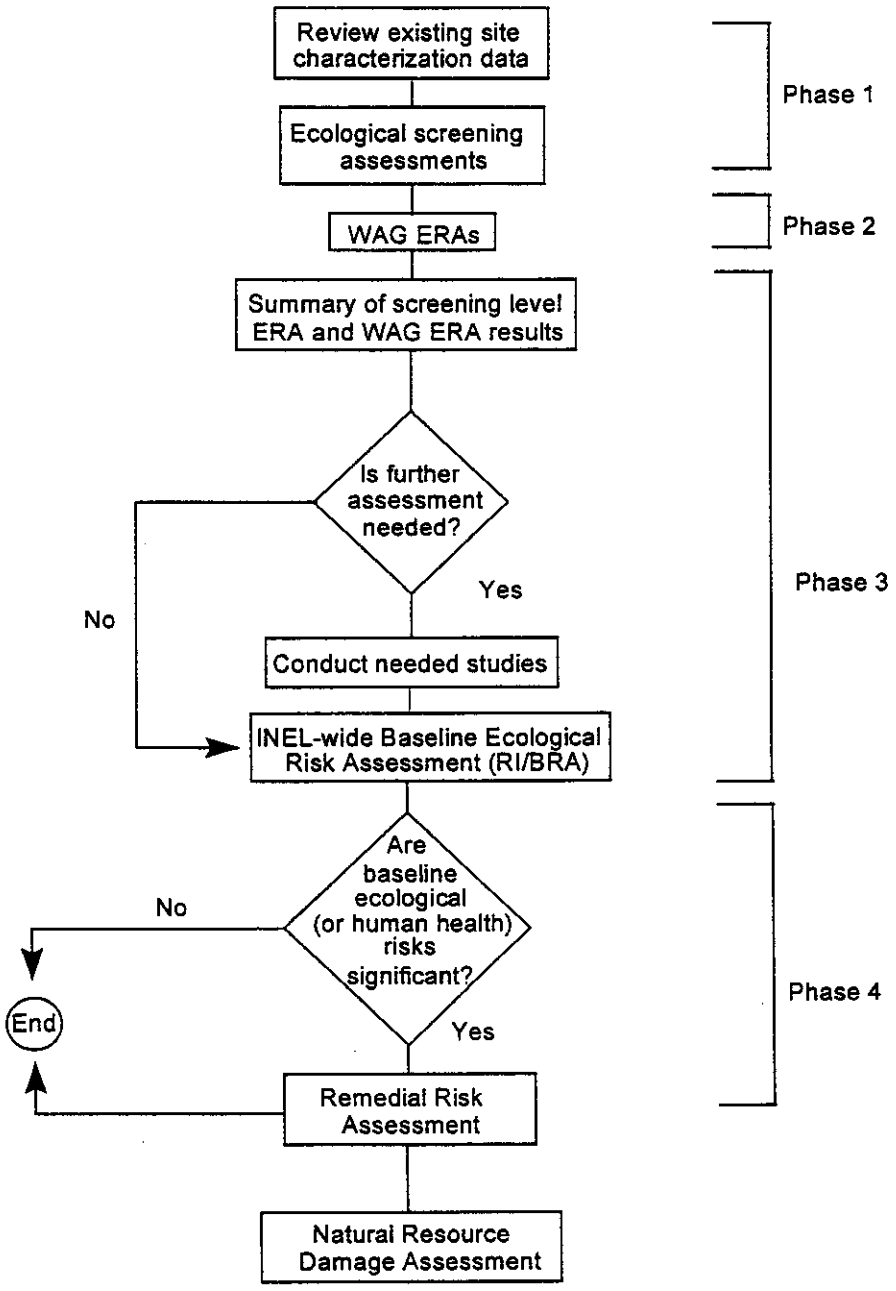


Figure 28-1. A phased approach to OU 10-04 ERA.

A quantitative analysis was used, augmented by qualitative information and professional judgment as necessary. This step of the assessment is presented in Section 28.3, Analysis.

The risk characterization step has two primary elements (EPA, 1992). The first element is the development of an indication of the likelihood of adverse effects to ecological receptors. The second element is the presentation of the assessment results in a form that serves as input to the risk management process. To determine whether there is any indication of risk due to the contaminant concentrations, exposure parameters were used to calculate dose to the key functional groups and sensitive species [threatened and/or endangered (T/E), and Category 2 (C2)]. Hazard quotients (HQS) were calculated by dividing the calculated dose by the TRV and used as an indicator of potential effects. This step of assessment is presented in Section 28.4, Risk Characterization.

The results of this WAG ERA will be integrated with assessments for other WAGs to support the Operable Unit (OU) 10-04 ERA. The strategy for using the results of the WAG 3 ERA to support the OU 10-04 ERA is discussed in Section 28.5, Transition to OU 10-04 ERA.

28.1.1 Statutory and Regulatory Basis

The widespread application of ERAs to hazardous waste site investigations under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) began recently. In December 1988, the Environmental Protection Agency (EPA) directed that "thorough and consistent" ecological assessments should be performed at all Superfund sites (EPA, 1988a). This directive was based on the language in CERCLA [as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986 and other statutes] mandating remediation of hazardous waste sites to protect the environment as well as human health. The National Contingency Plan requires that baseline risk assessments characterize the current and potential threats to human health and the environment [40 CFR Part 300.430 (d)(4)], and specifies that environmental risk evaluations "assess threats to the environment, especially sensitive habitats and critical habitats of species protected under the Endangered Species Act" [40 CFR Part 300.430(e)(2)(I)(G)].

Section 121(d)(A) of CERCLA requires that Superfund remedial actions meet Federal and State standards, requirements, criteria, or limitations that "are applicable or relevant and appropriate requirements (ARARs)." ARARs are those substantive environmental protection requirements promulgated under Federal or State laws that, while not legally applicable to the circumstances at the site or facility, address situations sufficiently similar so that their use is well suited to the particular site. ARARs applicable to the WAG 3 ERA are listed in Table 28-1. A further discussion of ARARs is included in the Guidance Manual (VanHorn et al., 1995).

Recognizing the need, DOE published *Incorporating Ecological Risk Assessment into Remedial Investigation/Feasibility Study Work Plans* (DOE, 1994). "This document provides guidance to the U.S. Department of Energy staff and contractor personnel for incorporation of ecological information into environmental remediation planning and decision making at CERCLA sites." (DOE, 1994).

Compliance with ARARs is a threshold requirement that a remedial/restoration activity must meet to be eligible for selection as a remedy. ARARs are either chemical-, action-, or location-specific, depending

Table 28-1. ARARs for the WAG 3 ERA.

Requirement	Authority	Trigger
Endangered Species Act	16 USC 1531B1543	Location specific
Threatened Fish and Wildlife	50 CFR 227.4	Location specific
Migratory Bird Conservation	16 USC 715	Location specific
Migratory Bird Treaty Act	16 USC 702	Location specific
Protection of Bald and Golden Eagles Act	16 USC 1531	Location specific
Idaho Fish and Wildlife Act	16 USC 756, 757	Location specific
Wetlands Conservation Act	16 USC 4404	Location specific

upon whether the requirement is triggered by the presence or emission of a chemical, by a particular action, or by a vulnerable or protected location. A list of the definitions of these ARARs follows.

- Contaminant-specific—Risk-based numerical values or methodologies that establish an acceptable amount of concentration of a contaminant in the ambient environment
- Action-specific—Technology or activity-based requirements for remedial/restoration actions
- Location-specific—Restrictions placed upon the concentration of hazardous substances or the conduct of activity at a given location.

Only location-specific ARARs are applicable in the WAG 3 ERA.

This WAG 3 ERA addresses issues related to all ARARs listed in Table 28-1 except the Wetlands Conservation Act. This ARAR is included since, wetland habitat has appeared on maps as part of the Fish and Wildlife National Wetlands Inventory (Hampton et al. 1995). These are generally waste ponds that are generated solely due to facility activities and preliminary surveys indicate that most do not meet formal wetland classification criteria (ACOE 1987). However, if final evaluation indicates that these do meet formal designation criteria they will be evaluated based on ARAR considerations. T/E, and/or sensitive species as protected by ARARs, are discussed in Section 28.2.4.

28.2 Problem Formulation

The goal of the problem formulation step of the ERA is to investigate the interactions between the stressor characteristics, the ecosystem potentially at risk, and the ecological effects (EPA, 1992). This process begins with a general description of the site and previous investigations, and a characterization of the ecosystem at risk. Next, the potential stressors to the ecosystem are identified, the migration pathways of the identified stressors are modeled, and the potentially affected components of the ecosystem are identified. The

ecosystem at risk and stressor characterization with exposure pathways are then assimilated into the CSM. The problem formulation step results in characterization of stressors (i.e., identification of the contaminants), definition of assessment endpoints, and the ecological effects that will be used to analyze risk using the CSM. Primary elements of the problem formulation step for the WAG 3 ERA are described in the following sections.

28.2.1 Overview of WAG 3

WAG 3 includes hazardous waste release sites at the Idaho Chemical Processing Plant (CPP). The CPP is a 200-acre facility located near the center of the INEEL between WAG 4, Central Facilities Area, and WAG 2, Test Reactor Area (TRA), as shown in Figure 1-1. The primary purpose of this facility was to recover uranium (U)-235 from expended military and test reactor fuel. The facility originally included a storage pool, housed in a separate building, to store the fuel under water until a processing campaign was under way. A process building contained dissolvers for the fuel assemblies in nitric and hydrofluoric acids (HF), and a solvent extraction system that used tributyl phosphate, hexone, and nitric acid to recover the uranium. Laboratory, water treatment, and evaporator facilities were also a part of the complex. In 1992, a decision was made by DOE to discontinue the processing of all nuclear fuels. Since then, operations at CPP have been limited to the storage of spent fuel and the calcination and storage of high-level liquid waste.

Hazardous and radioactive wastes are generated from the dissolution and processing of nuclear fuels, waste solutions produced by concentrating radioactive liquids in the process equipment waste evaporator are stored in underground stainless-steel tanks. This waste is later processed in a fluidized bed calciner at CPP to convert the liquid to a granular solid. This processing of irradiated fuels produced thousands of liters (gallons) of high-level liquid waste containing several million curies of radionuclides. These radionuclides were nearly all retained at CPP, either as liquid waste stored in underground stainless-steel tanks or as granular solids stored in underground stainless-steel bins.

WAG 3 is divided into 13 OUs consisting of potential release sites, No Action sites, and additional sites that have been subsequently identified since the initial FFA/CO site determination. Preliminary scoping Track 1 and/or 2 investigations for human health have been completed for all the release sites except the No Action sites and the newly identified sites. Sites at WAG 3, include various types of pits, a polychlorinated biphenyl (PCB) contaminated transformer yard, an injection well, numerous spills, a percolation pond, a Tank Farm, a sewage treatment plant, french drains, dry wells, and drainage ditches. Contaminants include organic compounds, radionuclides, heavy metals, corrosives, petroleum wastes, and mixed wastes. Table 28-2 briefly describes the sites within each OU and summarizes the FFA/CO level of action.

28.2.2 Sites of Concern

Sites identified in the FFA/CO (DOE-ID, 1991) were initially eliminated from consideration in the WAG 3 SLERA analysis based on whether the site is uncontaminated (no source to the environment) or because the site is unaccessible to the ecosystems of concern (no pathway to ecological receptors). All sites identified at WAG 3 were again reviewed for possible elimination from consideration in this ERA for similar reasons. Table 28-2 includes the justification for eliminating sites from consideration.

The final list of sites to be included in the ERA analysis (sites of concern) are presented in Table 28-3. This table lists the contaminants identified at each site, and provides a brief description and size of each site. Figure 28-2 illustrates the location of individual sites of potential concern with relation to the CPP facility.

Table 28-2. WAG 3 OU and site descriptions.

OU	Site Code	Site Description	Track[a]	IN[b]	Justification
None	CPP-43	Grease pit south of CPP-637	NA		No source
	CPP-52	Pickling shed east of CPP-631	NA		No source
	CPP-70	Septic tank east of CPP-655	NA		No source
	CPP-71	Seepage pits west of CPP-655	NA		No source
	CPP-72	CPP-758 cesspool east of CPP-651	NA		No source
	CPP-73	Leaching cesspool east of CPP-T-5	NA		No source
	CPP-74	Seepage pit west of CPP-626	NA		No source
	CPP-75	Septic tank west of CPP-603	NA		No source
	CPP-76	Septic tank west of CPP-659	NA		No source
	CPP-77	Seepage pit and cesspool north of CPP-662	NA		No source
3-01	CPP-49	PCB transformer yard (CPP-705)	T1	X	
	CPP-50	PCB transformer yard (CPP-731)	T1		Source and contamination removed
	CPP-51	PCB staging area west of CPP-660	T1	X	
	CPP-61	PCB spill in CPP-718 transformer yard	T1	X	
3-02	CPP-07	Contaminated soil northwest of CPP-642	T1		Source and contamination removed
	CPP-12	Contaminated paint chips and pad south of CPP-603	T1		Source and contamination removed
	CPP-18	Gas storage building CPP-668	T1		Source and contamination removed
	CPP-21	Solid waste storage bin south of CPP-668	T1		Source and contamination removed
	CPP-23	CPP injection well	T2		No pathway to ecological receptors.
	CPP-37A	CPP gravel pit #1	T2	X	
	CPP-37B	CPP gravel pit #2	T2	X	

Table 28-2. (continued).

OU	Site Code	Site Description	Track[a]	IN[b]	Justification
	CPP-41	Fire training pits between CPP-602 and CPP-603	T1		These pits were removed. The former location has been covered by buildings CPP-663/664. No pathway to ecological receptors.
	CPP-53	Paint and paint solvent area	T1		Source removed; residual concentrations below detection and/or background
	CPP-54	Drum storage area west of CPP-606	T1	X	
	CPP-55	Mercury contaminated area south of CPP-T-15	T1	X	
	CPP-57	Sulfuric acid spills east of CPP-606	T1		Contamination removed
	CPP-59	Kerosene tank overflow west of CPP-633 Zone 1	T2	X	
	CPP-59	Kerosene tank overflow west of CPP-633 Zone 2	T2	X	
	CPP-60	Paint shop at present location of CPP-645	T1		Source and contamination removed. The site is present location of building CPP-645. No pathway to ecological receptors.
	CPP-62	Mercury contaminated area near CPP-TB-4	T1		Source and contamination removed. Calcine bin #6 was erected over the location. No pathway to ecological receptors.
	CPP-63	Hexone spill by CPP-710	T1		Source removed; hexone less-than-detectable
	CPP-64	Hexone spill west of CPP-660	T1		Contamination removed
	CPP-65	CPP sewage treatment plant lagoons - sediments	T1	X	
	CPP-66	CPP CFSGP fly ash pit	T1	X	
	CPP-68	Abandoned gasoline tank CPP VES-UTI-652	T1		Source removed
3-03	CPP-67	CPP percolation ponds #1 and #2—sediments	T1	X	

Table 28-2. (continued).

OU	Site Code	Site Description	Track[a]	IN[b]	Justification
	CPP-67	CPP percolation ponds #1 and #2—perched water	T1		No pathway to ecological receptors
3-04	CPP-38	Friable transite	T1	X	Not an ecological concern
3-05	CPP-14	Area 1 (Imhoff tanks)	T2	X	
		Area 2 (plant site)	T2	X	
		Area 3 (drain field)	T2		No pathway to ecological receptors. Contamination is below 10 ft bgs.
3-06	CPP-34	Soil storage area in the northeast corner of the CPP	T1	X	
	CPP-40	Lime pit at the base of the CPP-601 berm and French drain	T1	X	
	CPP-47	Pilot plant storage area west of CPP-620	T1	X	
3-07	CPP-16	Contaminated soil from leak in line from CPP WM-181 to process equipment waste (PEW)	T2		Contaminated soil evacuated during contamination of new valve box; no source remains
	CPP-24	CPP tank farm area bucket spill	T2		Contaminated soil removed; no source remains
	CPP-26	Contaminated soil in tank farm area steam flushing—operation outside the tank farm perimeter	T2		Surface radiation survey did not detect elevated gross beta or gross gamma radiation; no source
	CPP-30	Contaminated soil in tank farm area near valve Box B-9	T2		Contaminated soil removed; no source remains
	CPP-83	Perched water	T2		No pathway to ecological receptors
3-08	CPP-13	Pressurization of the solid storage cyclone northeast of CPP-13	T2	X	
	CPP-15	Solvent burner east of CPP-605—solvents	T2		Solvent contaminated soil removed; no source remains
	CPP-29	Contaminated soil north and west of the main stack (CPP-708)	T2		Contaminated soil removed; no source remains
3-09	CPP-01	Horizontal settling basin, and vertical settling pit and soil adjacent to southwest-048 dry well and CPP-303 dry well—artifacts	T2		No pathway to the ecological receptors

Table 28-2. (continued).

OU	Site Code	Site Description	Track[a]	IN[b]	Justification
	CPP-02	French drain west of CPP-603	T2		No pathway to the ecological receptors
	CPP-06	Trench east of CPP-603 fuel storage basin	T2	X	
	CPP-19	CPP-603 to CPP-604 line leak	T2	X	
	CPP-22	Particulate air release south of CPP-603	T2	X	
	CPP-69	Abandoned liquid radioactive waste storage tank CPP VES-SFE-20	T2		No pathway to ecological receptors
	CPP-78	Contaminated soil west of CPP-693, east of dry fuel storage area	T2	X	
3-10	CPP-42	Drainage ditch west of CPP-637	T2	X	
	CPP-44	Grease pit south of CPP-608	T2	X	
	CPP-46	CPP-637 courtyard pilot plant release—inorganic contamination	T2		Contaminated soil removed; no source remains
	CPP-46	CPP-637 courtyard pilot plant release—radiological contamination	T2	X	
	CPP-56	Nitric acid contamination south of CPP-734	T2	X	
3-11	CPP-45	CPP-621 chemical storage area spills	T2		Contaminated area was remediated; no source remains
3-12	CPP-80	CPP-601 vent tunnel drain leak (VT-300)	T1		No pathway to the ecological receptors
	CPP-81	Abandoned CPP-637/CPP-601 vessel off-gas (VOG) line	T1		Source removed; no indication of a release to ecological receptors
	CPP-82	Abandoned line 1.5 in.— PLA-776 west of Beech Street	T1		Contaminated soil removed; no source remains
3-13	CPP-39	CPP HF storage tank (YDB-105) and dry well	T2	X	

Table 28-2. (continued).

OU	Site Code	Site Description	Track[a]	IN[b]	Justification
	CPP-48	French drain south of CPP-633 (Dump Tank)	T2		In 1993, the CPP-48 Dump Tank was removed and delivered to WERF for disposal. Some contamination remains at greater than 10 ft bgs. No pathway to ecological receptors.
	CPP-84	Buried gas cylinder site	T1	X	
	CPP-86	CPP-602 waste trench sump	T1		Small amounts of barium, cadmium, chromium, and mercury were found beneath concrete floor of this sump. The floor of the sump is greater than 10 ft bgs and within a building. No pathway to ecological receptors.
	CPP-87	VOG blower cell floor drain/sump and PEW evaporator feed pump cell—metals contamination	T1	X	
	CPP-87	VOG blower cell floor drain/sump and PEW evaporator feed pump cell—radiological contamination	T1		No pathway to ecological receptors
	CPP-88	Radiologically contaminated soils map	T1	X	
	CPP-89	CPP-604/605 tunnel excavation	T1		No pathway to ecological receptors
	CPP-90	CPP-709 ruthenium detection	T1	X	
	CPP-92	Soil boxes west of CPP-1617	T1		Soil boxes exhibit surface gamma radiation
	CPP-93	Simulated calcine trench	T1	X	
10-06	Windblown	Windblown area	RI	X	
—	Tank Farm Group	CPP-20, -25, -26, -28, -31, -32E/W, -79, excavated soil	—	X	
	Tank Farm South Group	CPP-15, -27, -33, -58, -88	—	X	

Table 28-2. (continued).

OU	Site Code	Site Description	Track[a]	IN[b]	Justification
	Waste Calcining Facility (WCF) Group	CPP-35, -36, -85, -88, -91	—	X	
	Old Storage Pool Group	CPP-01, -04, -05, -08, -09, -10, -11, -88	—	X	
	Storage Yard Group	CPP-03, -17a, -17b, -88	—	X	

a. CERCLA process tracks:

NA = No Action; initial investigation determined sites were uncontaminated and no source present.
T1 = Track 1; T2 = Track 2; RI = remedial investigation/feasibility study.

b. Sites marked with "X" were not screened out in WAG ERA initial site review.

Table 28-3. WAG 3 OUs and sites evaluated in the WAG ERA analysis.

OU	Site code	Sites within OU	Size (m^2)	COPCs	Contaminated medium	Comments
3-01	CPP-49	PCB Transformer Yard (CPP-705)	9.81E+1	PCBs	Surface	Residual PCB remains in soil
	CPP-51	PCB Staging Area West of CPP-660	6.04E+2	PCBs	Surface	Residual PCB remains in soil
	CPP-61	PCB Spill in CPP-718 Transformer Yard	5.81E+1	PCBs, radionuclides	Surface	Residual PCB remains in soil
3-02	CPP-37A	CPP Gravel Pit #1	2.73E+3	Radionuclides, mercury, methylene chloride	Surface, subsurface soil	
	CPP-37B	CPP Gravel Pit #2	9.18E+3	Radionuclides	Surface, subsurface soil	
	CPP-54	Drum Storage Area West of CPP-606	4.74E+1	Organics, metals	Surface, subsurface soil	Characterization results indicate concentrations were either below human risk-based concentrations or below background values.
	CPP-55	Mercury Contaminated Area South of CPP-T-15	7.66E+2	Metals	Surface	Characterization results indicate concentrations were either below human risk-based concentrations or below background values.
	CPP-59	Kerosene Tank Overflow West of CPP-633 Zone 1	NA[a]	TPH	Surface	
	CPP-59	Kerosene Tank Overflow West of CPP-633 Zone 2	1.95E+2	TPH	Surface	
	CPP-65	Sewage Treatment and Plant Lagoons	2.14E+4	Inorganics	Surface water	
	CPP-66	CPP CFSGP Fly Ash Pit	2.91E+4	Radionuclides, metals	Surface, subsurface Soil	
3-03	CPP-67	CPP Percolation Ponds #1 and #2—Sediments	4.15E+4	Radionuclides, metals, organics	Sediments, surface water	
3-05	CPP-14	Area 1 (Imhoff Tanks)	3.92E+3	Radionuclides, metals, PCBs	Subsurface soil	
		Area 2 (Plant Site)	3.05E+1	Metals, PCBs	Surface, subsurface soil	
3-06	CPP-34	Soil Storage Area in the NE Corner of the CPP	3.43E+3	Radionuclides, metals	Surface	
	CPP-40	Lime Pit at the Base of the CPP-601 Berm and French Drain	3.01E+1	Radionuclides, chromium, lead, fluoride	Surface	

Table 28-3. (continued).

OU	Site code	Sites within OU	Size (m^2)	COPCs	Contaminated medium	Comments
	CPP-47	Pilot Plant Storage Area West of CPP-620	1.86E+1	Fluoride	Surface	7.6 L (2 gal.) spill of HF in 1984
3-08	CPP-13	Pressurization of the Solid Storage Cyclone NE of CPP-13	2.19E+2	Radionuclides, metals	Surface	
3-09	CPP-06	Trench East of CPP-603 Fuel Storage Basin	2.32E+2	Radionuclides	Surface, subsurface soil	
	CPP-19	CPP-603 to CPP-604 Line Leak	3.07E+2	Radionuclides, metals	Surface, subsurface soil	
	CPP-22	Particulate Air Release South of CPP-603	1.39E+4	Radionuclides	Surface soil	No source; contaminated soil reportedly was removed
	CPP-78	Contaminated Soil West of CPP-693, East of Dry Fuel Storage Area	2.32E+0	Radionuclides	Surface, subsurface soil	
3-10	CPP-42	Drainage Ditch West of CPP-637	1.67E+2	Metals, fluoride, nitrate	Surface, subsurface soil	
	CPP-44	Grease Pit South of CPP-608	6.32E+1	Metals, organics	Surface, subsurface soil	
	CPP-46	CPP-637 Courtyard Pilot Plant Release	3.72E+1	Radionuclides	Surface, subsurface soil	
	CPP-56	Nitric Acid Contamination South of CPP-734	N/A	Nitrate	Surface, subsurface soil	
3-13	CPP-39	CPP HF Storage Tank (YDB-105) and Dry Well	4.88E+2	Metals, fluoride, organics	Surface, subsurface soil	Track 2 results indicate concentrations are below human risk-based concentrations.
	CPP-84	Buried Gas Cylinder Site	5.57E+1	Acetone, asbestos	Subsurface Soil	No known releases have occurred.
	CPP-87	VOG Blower Cell Floor Drain/Sump and PEW Evaporator Feed Pump Cell	N/A	Metals	Subsurface soil	Pathway to ecological receptors is limited. Nonradionuclide concentrations are below human risk-based concentrations.
	CPP-88	Radiologically Contaminated Soils Map	4.80E+10	Radionuclides, metals	Surface, subsurface soil	
	CPP-90	CPP-709 Ruthenium Detection	5.01E+2	Radionuclides, metals, organics	Surface, subsurface soil	
	CPP-93	Simulated Calcine Trench	2.97E+2	Metals	Surface, subsurface soil	

Table 28-3. (continued).

OU	Site code	Sites within OU	Size (m^2)	COPCs	Contaminated medium	Comments
10-06	Windblown	Windblown Area	N/A	Radionuclides	Surface soil	
—	—	Tank Farm Group	1.60E+4	Radionuclides, metals, organics	Surface, subsurface soil	
		Tank Farm South Group	2.08E+3	Radionuclides, metals, organics	Surface, subsurface soil	
		WCF Group	1.65E+3	Radionuclides, metals	Surface, subsurface soil	
		Old Storage Pool Group	1.24E+3	Radionuclides, metals	Surface, subsurface soil	
		Storage Yard Group	1.42E+4	Radionuclides, metals	Surface, subsurface soil	

N/A—not available.

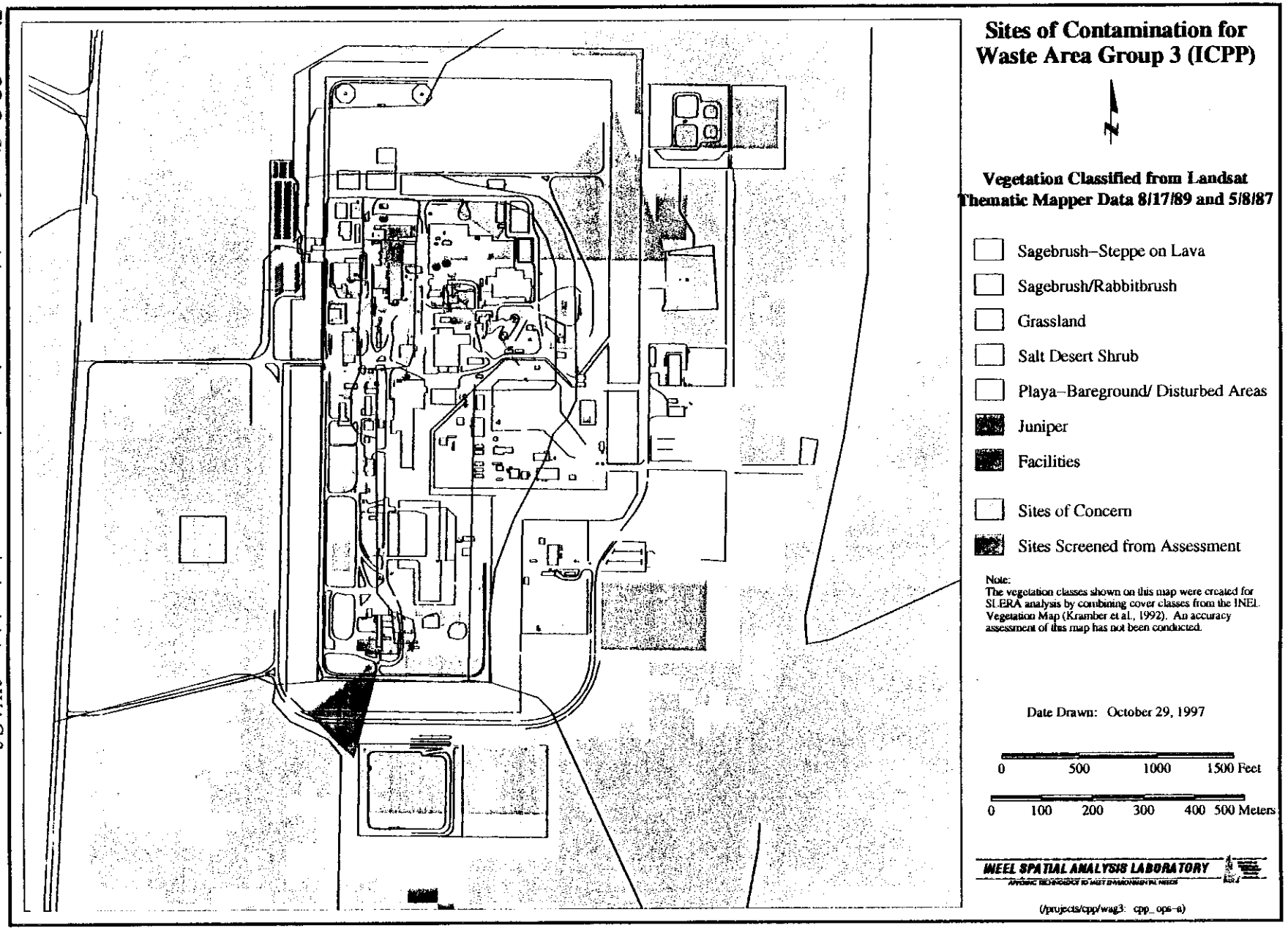


Figure 28-2. Sites of potential concern and vegetation cover types in the vicinity of WAG 3.

More complete descriptions of the sites of concern for both human and ecological health are presented as part of the human health assessment. Additionally, several sites that have been previously eliminated as a human health risk were assessed for ecological receptors. These sites were eliminated from further consideration under the human health pathway during either the Track 1 or 2 analysis. The sites typically did not pose a significant risk to human health but did indicate some contamination existed. Since the decision to include or not include sites for the human health risk assessment does not address ecological risks, these sites are retained for assessment here. The sites include: CPP-49, CPP-51, and CPP-61 of OU 3-01; CPP-54, CPP-55, CPP-59 (Zones 1 and 2), CPP-65 and CPP-66 of OU 3-02; CPP-40 (non-radionuclides) and CPP-47 of OU 3-06; CPP-26 (outside Tank Farm perimeter) of OU 3-07; CPP-42, CPP-44, and CPP-56 of OU 3-10; and CPP-39, CPP-48, CPP-84, CPP-86, and CPP-87 (metals) of OU 3-13. These sites, which were retained for assessment in the WAG ERA, are described below.

CPP-49—CPP-49 is a 105 ft^2 PCB Transformer Yard (CPP-705). A transformer oil spill with PCB contamination occurred on the cement pad. The pad has been encapsulated. Residual PCB remains in the soil at concentrations less than 1 ppm. In 1992, a Track 1 Decision Document recommending No Further Action for human health was approved for the site.

CPP-51—CPP-51 is a 6,500 ft^2 PCB staging area. Transformers leaked PCBs. The plastic sheeting on which the transformer oil leaked has been removed. Residual PCB remains in the soil at concentrations less than 0.12 ppm. In 1993, a Track 1 Decision Document recommending No Further Action for human health was approved for the site.

CPP-61—CPP-61 consists of a PCB spill in the CPP-718 transformer yard. The 625 ft^2 site contains radioactively contaminated soil as well. Residual PCB remains in the soil at concentrations less than 10 ppm. In 1993, a Track 1 Decision Document recommending No Further Action for human health was approved for the PCB spill at the site.

CPP-54—CPP-54 is a 510 ft^2 drum storage area. The area was used to store 30 to 40 drums of organic solvents and used oil on pallets. The drums have been removed. Characterization results indicate organic and metals concentrations were either below human risk-based concentrations or below background values. In 1993, a Track 1 Decision Document recommending No Further Action for human health was approved for the site.

CPP-55—CPP-55 corresponds to a 8,242 ft^2 area of soil adjacent to building CPP-T-15 where paint solvents were discarded. Characterization results indicate that organic contaminants, chromium, lead, and mercury were measured either below human risk-based concentrations or below background. In 1993, a Track 1 Decision Document recommending No Further Action for human health was approved for the site.

CPP-59, Zones 1 and 2—CPP-59 Zone 1 corresponds to the site where kerosene tank overflows resulted in spills of 200 liters. CPP-59 Zone 2 corresponds to a 2,100 ft^2 site where an estimated 60 liters of kerosene was spilled. In 1993, a Track 2 Scoping Analysis recommending No Further Action for human health was approved for the site.

CPP-65—CPP-65, the Sewage Treatment Plant Lagoons, consists of two 19,600 ft^2 aerated lagoons, two stabilization 9,170 ft^2 lagoons, four 9,580 ft^2 infiltration trenches, and six weir boxes. These facilities receive wastewater from the sewage treatment plant, which receives sanitary waste from 31 buildings at the

CPP. The lagoons are still in use. In 1994, a Track 1 decision package recommending further evaluation of this site in the RI/FS was approved.

CPP-66—CPP-66 is the site of an 7-acre ash pit currently used for disposal of ash generated by the Coal-Fired Steam Generation Facility. While a Track 1 Decision Document was approved and recommended No Further Action for human health in 1994, the decision is to be revisited in the Record of Decision with regard to solid waste regulations.

CPP-40—CPP-40 is the site of a lime pit and associated piping that were used to neutralize leaks and spills of HF from the product makeup area of CPP-601. The site is approximately 325 ft^2. The pit was filled with powdered lime to neutralize the HF. While radiological contamination at this site is considered in the human health risk evaluation for CPP, the nonradiological contamination is associated with a 1994 Track 1 approval for No Further Action for human health.

CPP-47—CPP-47 is a 200 ft^2 site located west of the southwest corner of CPP-620 and was the location where 44 Molar HF was stored for use in the CPP Pilot Plant Operation. Sometime in 1984, approximately 2 gal of HF were spilled at this site. It is assumed that the HF has reacted in the soil and this site will be assessed for fluoride. In 1992, a Track 1 recommendation of No Further Action for human health was approved.

CPP-26, Outside the Tank Farm Perimeter—CPP-26 is the site of a radioactive steam release through a faulty hose coupling during flushing of the decontamination header. This release is assumed to have contaminated 13 acres to the northeast of CPP-635. The contaminated area has been designated as "inside" and "outside" the Tank Farm perimeter. The outside site will not be considered in the human health risk assessment as a Track 2 recommendation for No Further Action for human health has been approved.

CPP-42—CPP-42 is a 1,800 ft^2 drainage ditch that is west of building CPP-637 and was originally designed to handle precipitation runoff. It is suspected that laboratory wastes may have been transported by hand from CPP-637 and released into the soil at CPP-42. Barium, fluoride, and nitrate have been observed in soil samples collected at the site. A Track 2 recommendation for No Further Action for human health has been approved.

CPP-44—CPP-44 is the site of a grease pit and concrete pad used for servicing vehicles and equipment during the construction of the CPP. The pit consists of a 12.5 by 5.2 m (41 by 17 ft) concrete pad with a 7.6 by 0.9 by 1.7 m (25 by 3 by 5.5 ft) trench in the middle, which contained a sump. The trench may have been used for disposal of petroleum products. The area has been taken out of service and covered with gravel. A number of inorganic and organic compounds have been detected in soil samples collected at the site. A Track 2 recommendation for No Further Action for human health has been approved.

CPP-56—CPP-56 is the site of a nonradioactive liquid waste release caused by a leaking transfer line between holdup tank WL-103 and the west side monitoring station (CPP-734). Approximately 5,000 liters of dilute nitric acid were released to the surrounding soil. Records indicate that the acid had been neutralized by sodium hydroxide before transfer. The site was partially excavated during the construction of building CPP-796. The Track 2 analysis considered nitrate a potential contaminant at this site. However, no sampling data for nitrate were available. A Track recommendation for No Further Action human health has been approved.

CPP-39—CPP-39 is a 5,250 ft^2 site that consists of a HF storage tank containment vault and a 38 m (125 ft) tile line connected to a dry well. CPP-39 is located in the northwest portion of the CPP at the intersection of Birch and Pine Avenues. HF was transferred from the tank to CPP-601 before the dissolution process. Only off-specification solution was returned to the containment vault for neutralization. The tile line was removed in 1993. No radioactive constituents were associated with this process. A number of inorganic and organic compounds have been detected in soil samples collected at the site. A Track 2 Preliminary Scoping Package has been submitted recommending this site for No Further Action for human health.

CPP-84—CPP-84 is the 600 ft^2 site that consists of 40 to 100 construction gas cylinders buried in a trench northwest of the CPP near the Big Lost River. The number and contents of the cylinders are not known but are expected to be construction gases such as acetylene, nitrogen, oxygen, helium, argon, carbon dioxide, and compressed air. The only possible contaminants of concern (COCs) were determined to be acetone and asbestos (fillers in acetylene cylinders). A Track 1 document recommending this site for No Further Action for human health has been submitted.

CPP-87, Metals Contamination—The PEW evaporator system vents to the CPP VOG system. A new piping system, the process waste liquid collection system, was installed in 1990. At that time, soil samples were collected under the Blower Cell. Metals concentrations in the soil were used to estimate (human) risk for this site. The system is operational and collects hazardous wastes from several buildings, including CPP-604. In CPP-604, wastes are collected from various floor drains, including the floor drain in the VOG blower cell. Based on the Track 1 assessment, contamination, if any, is not present above (human) risk-based levels. Radiological contamination at this site is considered separately.

28.2.3 Ecosystem Characterization

The INEEL is located in a cool desert ecosystem characterized by shrub-steppe vegetative communities. The flora and fauna are typical of the northern Great Basin and Columbia Plateau region. The surface of the INEEL is relatively flat, with several prominent volcanic buttes and numerous basalt flows that provide important habitat for small and large mammals, reptiles, and some raptors. The shrub-steppe communities are dominated by sagebrush and provide habitat for sagebrush community species, such as sage grouse, pronghorn, and sage sparrows (*Amphispiza belli*). Rabbitbrush (*Chrysothamnus* spp.), grasses and forbs, salt desert shrubs, and exotic/weed species comprise other communities. Juniper woodlands occur near the buttes and in the northwest portion of the INEEL; these woodlands provide important habitat for raptors and large mammals. Limited riparian communities exist along intermittently flowing waters of the Big Lost River and Birch Creek drainages.

WAG 3, which is comprised of hazardous waste release sites at the CPP, has a total land area of approximately 200 acres. WAG 3 is located in the south-central portion of the INEEL (refer to Figure 1-1). The CPP is an industrial facility with most land surfaces covered by disturbed, bare ground or facilities and pavement. Natural areas are limited to those areas outside the perimeter of WAG 3. Areas outside the WAG 3 fenced boundary include sagebrush/rabbitbrush shrub-steppe, sagebrush-steppe on lava, and grasslands (refer to Figure 28-2).

28.2.4 Biotic Components

Sagebrush-steppe habitat on the INEEL supports a number of species including sage grouse, pronghorn, elk (*Cervus elaphus*), and waterfowl (all important game species); grasslands provide habitat for species such as the western meadowlark (*Sturnella neglecta*) and mule deer (also a game species). Rock outcroppings support species such as bats, woodrats (*Neotoma cinerea*), and sensitive species such as the pygmy rabbit (*Brachylagus idahoensis*). WAG 3 is comprised of about 85 percent bare ground and about 13 percent facilities. However, buildings, lawns and ornamental vegetation, and wastewater treatment ponds at WAG 3 are utilized by a number of species such as waterfowl, raptors, rabbits, and bats. No areas of critical habitat as defined in the Code of Federal Regulations (40 CFR Part 300) are known to exist within the WAG 3 facility or the surrounding area.

The flora and fauna that exist in the areas surrounding WAG 3 are representative of those found across the INEEL and are described in the following subsections. Flora was determined using a vegetation map constructed for the INEEL using Landsat imagery and field measurements from vegetation plots (EG&G Idaho, 1993). Fauna was characterized using a 1986 vertebrate survey performed on the INEEL (Reynolds et al., 1986) and data collected subsequent to that survey. While the flora and fauna present on WAG 3 and in the surrounding areas have not been verified with a comprehensive field survey, information presented here is supported by previous field surveys and observations previously described in Appendix K.

28.2.4.1 Flora. The 15 INEEL vegetation cover classes defined using Landsat imagery data (Kramber et al., 1992) have been combined into eight cover classes for the WAG-wide ERAs (VanHorn et al., 1995), and are carried over into this ERA. The vegetation mapped in the vicinity of WAG 3 is shown in Figure 28-2. Six vegetation cover classes are represented, including sagebrush-steppe on lava, sagebrush/rabbitbrush, grassland, salt desert shrub, playa-bareground/disturbed, and juniper. The species composition for each of these classes is summarized on Table 28-4. Sagebrush-steppe on lava and sagebrush/rabbitbrush are the two predominant vegetation types comprising the vegetation surrounding WAG 3. The dominant vegetation species within these two communities is Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*). Grasslands present in the area are comprised primarily of wheat grasses (*Agropyron* spp. and *Elymus* spp.). The onsite areas within WAG 3 are not vegetated, with the exception of landscaped and lawn areas. However, several wetland plant species have been identified in the percolation ponds to the south of the CPP facility (Hampton et al., 1995). These species are supported by intermittent standing water from facility drainage.

28.2.4.2 Fauna. A comprehensive list of fauna potentially present within WAG 3 and the surrounding area is presented in Appendix I. The list incorporates the concept of functional grouping as described in Appendix E of the Guidance Manual (VanHorn et al., 1995). The functional grouping approach is designed to group similar species to aid in analyzing the effects of stressors on INEEL ecosystem components. The primary purpose for functional grouping is to apply existing data from one or more species within the group to assess the risk to the group as a whole. Functional groups are used to perform a limited evaluation of exposures for all potential receptors and provide a mechanism for focusing subsequent analyses on receptors that best characterize potential contaminant effects.

Species characteristics including trophic level, breeding, and feeding locations were used to construct functional groups for INEEL species. Individual groups were assigned a unique identifier consisting of a one- or two-letter code to indicate taxon (A = amphibians, AV = birds, M = mammals, R = reptiles, I = insects),

Table 28-4. Vegetation cover class summary for areas in and surrounding WAG 3.

WAG ERA Vegetation Cover Class	INEEL Vegetation Cover Classes	Dominant Species
Grasslands	Steppe Basin Wildrye Grassland	*Leymus cinereus* *Descurainia sophia* *Sisymbrium altissimum* *Elymus lanceolatus* *Artemisia tridentata* ssp. *wyomingensis* *Elymus elymoides* *Chrysothamnus viscidiflorus*
Sagebrush/Rabbitbrush	Sagebrush-steppe off lava Sagebrush-winterfat Sagebrush-rabbitbrush	*Artemisia tridentata* ssp. *wyomingensis* *Chrysothamnus viscidiflorus* *Bromus tectorum* *Sisymbrium altissimum* *Achnatherum hymenoides*
Salt desert shrubs	Salt desert shrub	*Atriplex nuttallii* *Atriplex canescens* *Atriplex confertifolia* *Kraschennikovia lanata*
Sagebrush-steppe on lava	Sagebrush-steppe on lava	*Artemisia tridentata* ssp. *wyomingensis* *Achnatherum hymenoides* *Chrysothamnus viscidiflorus*
Playa-bareground/ disturbed areas	Playa-bareground/gravel borrow pits, old fields, disturbed areas, seedings	*Kochia scoparia* *Salsola kali* *Artemisia tridentata* ssp. *wyomingensis* *Chrysothamnus viscidiflorus*

and a three-digit code derived from the combination of trophic category and feeding habitats. For example, AV122 represents the group of seed-eating (herbivorous) bird species whose feeding habitat is the terrestrial surface and/or understory. The trophic categories (first digit in three-digit code) are as follows: 1 = herbivore, 2 = insectivore, 3 = carnivore, 4 = omnivore, and 5 = detrivore. The feeding habitat codes (second and third digits in three-digit code) are derived as follows:

1.0 Air
2.0 Terrestrial
    2.1 Vegetation canopy
    2.2 Surface/understory
    2.3 Subsurface
    2.4 Vertical habitat (man-made structures, cliffs, etc.)
3.0 Terrestrial/Aquatic Interface
    3.1 Vegetation canopy
    3.2 Surface/understory
    3.3 Subsurface
    3.4 Vertical habitat
4.0 Aquatic
    4.1 Surface water
    4.2 Water column
    4.3 Bottom

The functional grouping methodology is described in detail in Appendix E of the Guidance Manual (VanHorn et al., 1995). Species potentially present in WAG 3 and the surrounding area were placed into 23 avian functional groups and 9 mammalian functional groups as shown in Appendix I.

The list of species potentially present in the vicinity of WAG 3 was developed by updating 1986 data on the relative abundance, habitat use, and seasonal presence of fish, amphibians, reptiles, birds, and mammals recorded on the INEEL (Reynolds et al., 1986) and communicating with INEEL researchers and personnel conducting ecological studies since 1986. With the exception of T/E and sensitive species, fauna that are not supported by the existing habitat or that are rare or uncommon or otherwise unlikely to be found in the WAG 3 area were not included in the literature search for species-specific exposure parameters. Those species are listed in Appendix I.

A subset of INEEL functional groups (Appendix I) was selected for assessment in this WAG ERA. These groups represent species most common to the INEEL and are used as conservative indicators of effects for other similar groups.

Both reptilian functional groups are represented by species inhabiting the assessment area. No surface hydrology exists that support fish, however, the boreal chorus frog (*Pseudacris triseriata)* and aquatic invertebrates are supported by the CPP percolation ponds, when water is present. These man-made ponds receive permitted facility effluent and hold water only on an intermittent basis. The ponds are fenced to prohibit their use as source of drinking water for large mammals. A study of INEEL ponds (Cieminski, 1993) indicates the CPP sewage treatment and percolation ponds are used primarily by waterfowl. Small mammal use was shown to be minimal, however, bats were frequently recorded at CPP sewage disposal ponds and less often at the percolation ponds (Cieminski, 1993). Invertebrate populations were found to be

higher in CPP sewage treatment ponds than in the percolation ponds (Cieminski, 1993; Cieminski and Flake, 1995).

With the exception of wildlife use of CPP ponds, no studies addressing wildlife use of CPP facilities have been conducted. A habitat survey for T/E and species of special concern was conducted outside the facility fences and is discussed in Section 28.2.4.3. Species potentially present on the WAG are limited to those species adapted to disturbed industrial areas, such as small mammals (e.g., mice, rabbits, ground squirrels) and birds (e.g., sparrows, finches) that utilize the bare ground and landscaped areas that are present onsite.

Although some population studies have been conducted for cyclic rabbit and rodent populations, several game species (e.g., pronghorn, sagegrouse), and raptors, no recent comprehensive studies have been conducted to assess either WAG-specific or OU 10-04 wildlife population status and/or trends with respect to contaminant effects. Discussion of potential needs for population level data in the interpretation of analysis results for this WAG ERA is included in Section 28.4.4.

Wildlife species present at WAG 3 and the surrounding areas include birds, mammals, and reptiles that are associated with facilities, sagebrush-steppe, rock outcroppings, deciduous trees and shrubs, grasslands, and water (e.g., facility ponds and drainage areas). The varying behaviors of these species include but are not limited to grazing and browsing on vegetation, burrowing and flying, and preying on insects and small mammals. The complexity of these behaviors is significant when considering fate and transport of contaminants and the possibility of exposure to contaminants. Subsurface contamination can become surface contamination when translocated by burrowing animals, or can be introduced into the food web when plants uptake contamination and are then ingested by an herbivore. If prey, such as a small mammal, becomes contaminated by ingesting contaminated soil or vegetation, and is then captured by a predator, such as a ferruginous hawk, the contamination can be taken offsite when the hawk returns to its nest to feed nestlings. Scenarios for potential exposure of fauna to WAG 3 contaminants are discussed in Section 28.5.

The flora and fauna present within the WAG 3 vicinity are combined into a simplified food web model as presented in Figure 28-3. Variability in environmental conditions, such as population sizes or seasons, is not considered in this model, and a constant environment is assumed. Because both aquatic (i.e., percolation and sewage treatment ponds) and terrestrial habitats are present in the area, the model incorporates both terrestrial and aquatic species. Present at the site are decomposers, producers (vegetation), primary consumers or herbivores (e.g., rodents), secondary consumers or carnivores (e.g., snakes), and tertiary or top carnivores (e.g., raptors). These relationships were incorporated to identify direct and indirect exposure to contaminants for the CSM as discussed in Section 28.2. This model depicts the possible transport of WAG 3 contaminants through the food web.

28.2.4.3 Threatened, Endangered and Sensitive Species. A list of threatened and endangered (T/E) and sensitive species was compiled from the U.S. Fish and Wildlife Service (USFWS) (letter dated July 16, 1997), the Idaho Department of Fish and Game Conservation Data Center threatened, endangered, and sensitive species for the State of Idaho (CDC, 1994); and RESL documentation for the INEEL (Reynolds 1994; Reynolds et al. 1986). At the time the WAG 3 SLERA was conducted, Oxytheca (Oxytheca dendroidea) was listed as a sensitive plant species with the U.S. Bureau of Land Management (BLM) and the Idaho Native Plant Society (INPS)/Idaho Fish and Game Conservation Data Center. This species has since been determined to occur in greater abundance than originally believed and has been dropped from the INPS and BLM lists (CDC, 1994).

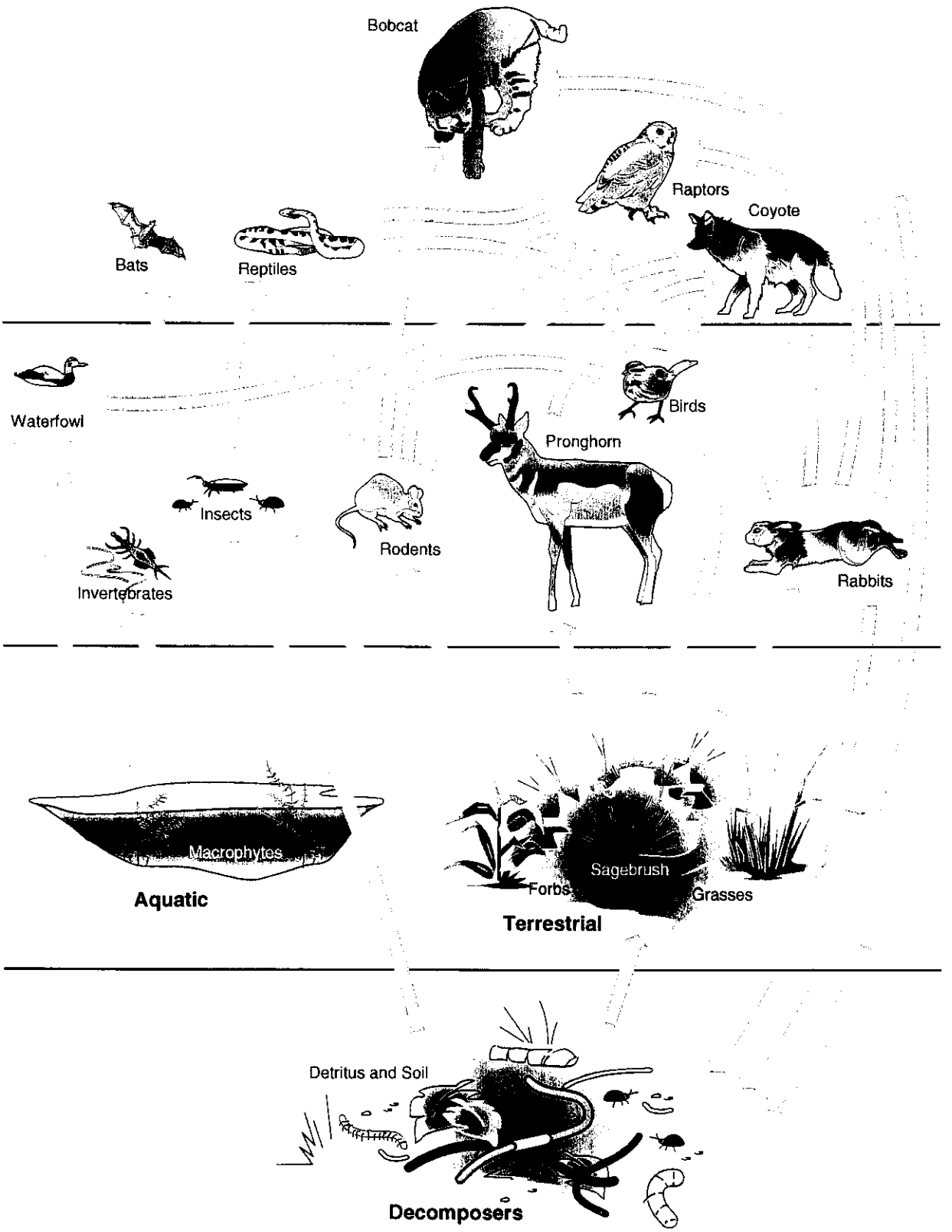


Figure 28-3. Food web for fauna at WAG 3.

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T/E or sensitive species that could exist in the vicinity of WAG 3 are listed in Table 28-6. Avian species include six terrestrial species: the ferruginous hawk (*Buteo regalis*), the peregrine falcon (*Falco peregrinus*), the northern goshawk (*Accipiter gentilis*), the loggerhead shrike (*Lanius ludovicianus*), the burrowing owl (*Athene cunicularia*), and the bald eagle (*Haliaeetus leucocephalus*), and three aquatic species: the white-faced ibis (*Plegadis chihi*), the black tern (*Childonias niger*), and the trumpeter swan (*Cygnus buccinator*). T/E or sensitive species that potentially exist in the vicinity of WAG 3 are the pygmy rabbit (*Brachylagus idahoensis*), Townsend's western big-eared bat (*Plecotus townsendii*), the long-eared myotis (*Myotis evotis*), and the small-footed myotis (*Myotis subulatus*), and the sagebrush lizard (*Sceloporus graciosus*). No critical habitat is known to exist in the WAG 3 area.

With the exception of facility ponds (Cieminski, 1993; Cieminski and Flake, 1995), no formal surveys for presence and use of WAG 3 facilities by T/E and species of special concern have been conducted. A geographical information system (GIS) analysis was also conducted to determine the presence of known T/E or sensitive raptor nesting sites within the vicinity of WAG 3.

Breeding bird surveys (BBS) have been conducted by the Environmental Science and Research Foundation in habitats surrounding WAG 3 on the INEEL from 1985 through the present. The BBS survey route around WAG 3 is 8 km long with 25 stops. Stops were 0.32 km apart. The habitat along the route is described by the BBS surveyors (Belthoff et al. Submitted) as big sagebrush (*Artemisia tridentata*), thick-spiked wheatgrass (*Elymus lanceolatus*), and needle-and-thread grass (*Hesperostipa comata*). Results of the BBSs for the period 1985–1991 were reported by Beltoff et al. (Submitted). These data, and those from subsequent years through 1996, were used to provide an assessment of whether nine species of special concern have inhabited the area surrounding WAG 3 provide a basis for an inference about their continued use of the area. The birds of interest were the trumpeter swan, black tern, loggerhead shrike, long-billed curlew, bald eagle, peregrine falcon, ferruginous hawk, northern goshawk, and burrowing owl.

In 1996, field surveys were conducted in the areas surrounding WAG 3 facilities to assess the presence and use of those areas by T/E species or other species of special concern (i.e. species formerly designated as C2). The survey findings have been documented in draft reports that include survey protocols (ERSF 1996a) and results for WAG 3 (ERSF 1996b). Specific information collected and reported for each T/E or species of special concern includes:

- Date and conditions under which the surveys were conducted;
- Area encompassed by the surveys (GPS mapping where practical);
- GPS locations for observed habitat, sign, and species sighted (where practicable);
- Habitat description, the proximity to WAG or site, and an estimate of whether contaminated sites or areas are within the home range of members of the species in question;
- Species presence, abundance, current site use, past site use (historical sightings or surveys), and anticipated site use (professional judgment); and
- An estimated site or area population (where possible).

Table 28-6. Threatened and endangered species, special species of concern, and sensitive species that may be found on the INEEL. Species in **bold** are those T/E and Category 2 (C2)[b] species included for the WAG 3 ERA.

Common names	Scientific name	Federal status[b,c]	State status[c]	BLM status[c]	USFS[f] status[c]	INPS status[c]
Plants						
Lemhi milkvetch	*Astragalus aquilonius*	—	—	S	S	S
Painted milkvetch[e]	*Astragalus ceramicus var. apus*	3c	—	—	—	R
Plains milkvetch	*Astragalus gilviflorus*	NL	—	S	S	1
Winged-seed evening primrose	*Camissonia pterosperma*	NL	—	—	—	S
Nipple cactus[e]	*Coryphantha missouriensis*	NL	—	—	—	R
Spreading gilia	*Ipomopsis (Gilia) polycladon*	NL	—	S	—	2
King's bladderpod	*Lesquerella kingii var. cobrensis*	—	—	—	—	M
Tree-like oxytheca[e]	*Oxytheca dendroidea*	NL	—	R	—	R
Inconspicuous phacelia[d]	*Phacelia inconspicua*	C2	SSC	S	S	
Puzzling halimolobos	*Halimolobos perplexa var. perplexa*	—	—	—	S	M
Ute's ladies tresses[d]	*Spiranthes diluvialis*	LT	—	—	—	—
Birds						
Peregrine falcon	***Falco peregrinus***	**LE**	**E**	—	—	
Merlin	*Falco columbarius*	NL	—	S	—	
Gyrfalcon	*Falco rusticolus*	NL	SSC	S	—	
Bald eagle	***Haliaeetus leucocephalus***	**LT**	**T**	—	—	
Ferruginous hawk	***Buteo regalis***	**C2**	**SSC**	**S**	—	
Black tern	***Chlidonias niger***	**C2**	—	—	—	
Northern pygmy owl[d]	*Glaucidium gnoma*	—	SSC	—	—	
Burrowing owl	***Athene cunicularia***	**C2**	—	**S**	—	
Common loon	*Gavia immer*	—	SSC	—	—	
American white pelican	*Pelicanus erythrorhynchos*	—	SSC	—	—	
Great egret	*Casmerodius albus*	—	SSC	—	—	
White-faced ibis	***Plegadis chihi***	**C2**	—	—	—	
Long-billed curlew	*Numenius americanus*	3c	—	S	—	
Loggerhead shrike	***Lanius ludovicianus***	**C2**	**NL**	**S**	—	
Northern goshawk	***Accipiter gentilis***	**C2**	**S**	—	**S**	
Swainson's hawk	*Buteo swainsoni*	—	—	S	—	
Trumpeter swan	***Cygnus buccinator***	**C2**	**SSC**	**S**	**S**	
Sharptailed grouse	*Tympanuchus phasianellus*	C2	—	S	S	
Boreal owl	*Aegolius funereus*	—	SSC	S	S	
Flammulated owl	*Otus flammeolus*	—	SSC	—	S	

Table 28-6. (continued).

Common names	Scientific name	Federal status[b,c]	State status[c]	BLM status[c]	USFS[f] status[c]	INPS status[c]
Mammals						
Gray wolf	*Canis lupus*	LE/XN	E	—	—	
Pygmy rabbit	***Brachylagus (Sylvilagus) idahoensis***	**C2**	**SSC**	**S**	—	
Townsend's western big-eared bat	***Plecotus townsendii***	**C2**	**SSC**	**S**	**S**	
Merriam's shrew	*Sorex merriami*	—	S	—	—	
Long-eared myotis	***Myotis evotis***	**C2**	—	—	—	
Small-footed myotis	***Myotis subulatus***	**C2**	—	—	—	
Western pipistrelle[d]	*Pipistrellus hesperus*	NL	SSC	—	—	
Fringed myotis[d]	*Myotis thysanodes*	—	SSC	—	—	
California myotis[d]	*Myotis californicus*	—	SSC	—	—	
Reptiles and Amphibians						
Northern sagebrush lizard	***Sceloporus graciosus***	**C2**	—	—	—	
Ringneck snake[d]	*Diadophis punctatus*	C2	SSC	S	—	
Night snake[e]	*Hypsiglena torquata*	—	—	R	—	
Insects						
Idaho pointheaded grasshopper[d]	*Acrolophitus punchellus*	C2	SSC	—	—	
Fish						
Shorthead sculpin[d]	*Cottus confusus*	—	SSC	—	—	

a. This list was compiled from the U.S. Fish and Wildlife Service (USFWS) (letter dated July 16, 1997) the Idaho Department of Fish and Game Conservation Data Center threatened, endangered, and sensitive species for the State of Idaho (CDC 1994), and RESL documentation for the INEEL (Reynolds 1994; Reynolds et al. 1986).

b. The USFWS no longer maintains a candidate (C2)species listing but addresses former listed species as "species of concern" (USFWS April 30, 1996). The C2 designation is retained here to maintain consistency between the SLERA and WAG ERA assessments.

c. Status Codes: S = sensitive; 2 = State Priority 2; 3c = no longer considered for listing; M = State monitor species; NL = not listed; 1 = State Priority 1; LE = listed endangered; E = endangered; SSC = species of special concern; and C2 = Category 2 (defined in CDC 1994). BLM = Bureau of Land Management; INPS = Idaho Native Plant Society; XN=Experimental, non-essential, R = removed from sensitive list (non-agency code added here for clarification).

d. No documented sightings at the INEEL; however, the ranges of these species overlap the INEEL and are included as possibilities to be considered for field surveys.

e. Recent updates resulting from Idaho State Sensitive Species meetings (BLM, USFWS, INPS, USFS) - (INPS 1995;1996)

f. United States Forest Service (USFS) Region 4.

Surveys for some species were also supported by GIS analyses using recently developed habitat models.

On July 31, 1997 a field survey was conducted for individual sites of concern within CPP facilities that have been or are currently being evaluated as part the WAG 3 ERA (see Table 28-7). An on-site inspection was conducted and each site of contamination was evaluated for habitat qualities and potential to support INEEL T/E species or other species of special concern. The attributes evaluated include:

- Size
- Substrate (gravel, asphalt, lawn, etc.)
- Natural or manmade features that may attract wildlife (e.g. water, lights)
- Proximity to areas or sites of facility activity
- Presence and availability of food or prey
- Available nesting, roosting or loafing habitat
- Signs of wildlife use
- Prior history, known wildlife sightings or use

Each attribute was subjectively rated for its positive contribution to overall habitat suitability . An overall site rating of high, medium, low, or none was assigned based on the number of positive habitat features and probability that the species of concern may or does utilize the site. Although T/E and sensitive species were of primary consideration, potential use by big game species and unique populations (spadefoot toad and Merriam's shrew) was also assessed.

Results of the survey and ratings for the WAG 3 sites of concern are summarized on Table 28-7 and are discussed for each species of concern in the paragraphs below. Sites for which no positive habitat attributes were observed are unlikely to contribute to wildlife exposures and have been eliminated as sources of risk to T/E and other species of special concern. Sites rated overall as "low" are those having one or two positive attributes and therefore potential for incidental use by wildlife. These sites may generally be discounted as contributing significantly to chronic wildlife contaminant exposures.

These surveys were conducted to allow evaluation of WAG sites of concern in an ecological context. The duration and rigor of these surveys were not adequate to verify presence or frequency of occurrence. The rankings for sites presented here are subjective, based on professional opinion supported by limited observation.

Bald Eagle—The bald eagle is federally listed as threatened and has been observed in small numbers on the INEEL (Craig 1979; Hanson 1994). Wintering populations also congregate in areas adjacent to the INEEL northern boundaries and may be particularly concentrated during years in which black-tailed jackrabbit populations are high. There is, therefore, some potential for bald eagles to prey on jackrabbits associated with WAG 3 sites of contamination or on prey species associated with the Big Lost River just north of the facility. No positive habitat features to support the bald eagle were found at WAG 3 sites of

Table 28-7. WAG 3 site survey results.

Page 1	B. Tern	T. Swan	W.f. Ibis	B. Owl	F. Hawk	P. Falcon	L. Shrike	B. Eagle	Bats	M. Shrew	P. Rabbit	S. b. Lizard	S. toad	Big game	Comments
Date: 7/31/97															
WAG 3 Site #															
CPP-06															Gravel substrate
CPP 13															Gravel berm, remedial action completed, see residuals - swallows in area
CPP-14															Gravel substrate, former sewage lagoon - remedial action complete, no vegetation - see residuals
CPP-19															Gravel and asphalt substrate, higher levels below surface, no vegetation - see residuals subsurface soil
CPP-22				L	L	L	L					M		L	Air release to areas south outside fence, sagebrush and weeds, gravel substrate inside fences
CPP-34					L	L	L		L					L	Weed cover, gravel substrate, adjacent power poles/lighting, adjacent to sewage disposal ponds
CPP-37A					L	L	L								Outside fence, weedy annuals
CPP-37B									L						Ditch with significant, periodic water, weedy annuals
CPP-39															Gravel and asphalt substrate, remedial action - see residual levels (HF acid tank)
CPP-40															Gravel berm, remedial action completed - see residuals
CPP-42															Shallow ditch, gravel substrate, sparse weeds (Russian thistle), intermittent water
CPP-44															Gravel substrate
CPP-46															Gravel substrate
CPP-48															Gravel substrate, remedial action completed, sparse weeds (Russian thistle)
CPP-54															Gravel substrate, sparse weeds (Kochia)
CPP-55															Gravel substrate, sparse weeds (Russian thistle)
CPP-56															Gravel substrate, removal action in progress, adjacent buildings/structures
CPP-59 (2)															Gravel berms, sparse weeds (Kochia and Russian thistle)
CPP-61															Gravel substrate
CPP-65									H					H	Sewage lagoons, permanent water, lights, observed wildlife use
CPP-66															Gravel and asphalt substrates
CPP-78															Tiny area, gravel substrate and asphalt, no vegetation
CPP-84															Beneath exsisting building
CPP-86															Belowground, remediation in progress
CPP-87															Gravel substrate, adjacent roosting structures
CPP-88															Large general areas of contaminated soil inside fences
CPP-90															Gravel substrate, remedial action complete, adjacent roosting, little potential for exposures
CPP-93															Gravel berm
Perc ponds, tank farm and 10-06 sites assessed seperately															

concern listed on Table 7-6. Consequently, there is little likelihood that exposures to bald eagles will occur as a result of frequenting sites located inside facility fences.

Burrowing Owl—A burrowing owl habitat survey was conducted at WAG 3 on August 20, 1996 (ERSF 1996). Habitat out to 200 m from the WAG 3 perimeter was included in the survey. No optimal habitat for burrowing owl reproduction was located within 200 m of the WAG 3 perimeter. During habitat surveys, no signs (droppings, pellets, etc., at potential nest burrows) were observed, nor were any burrowing owls observed on the survey areas. Four nesting habitat types were described in the survey protocol. In the 200-m perimeter surrounding CPP, none of the habitat was Type 1 (optimal nesting habitat), 16% of the habitat was Type 2 (moderate nesting habitat), 23% of the habitat was Type 3 (low use nesting habitat), and 61% of the habitat was Type 4 (unsuitable nesting habitat). However, the BBSs previously revealed burrowing owls on the CPP (WAG 3) route and at least one sighting was within or very near 600m from the WAG 3 perimeter. Since burrowing owls are known to return to sites used in previous years, the areas surrounding WAG 3 are likely to be used by this species in the future. Only one site, CPP-22, demonstrated any positive habitat features for this species. Because the air release associated with CPP-22 extends to areas of vegetation outside the facility fences, this area has somewhat higher potential for use by raptors. However, the overall rating for this site is still considered "low". There is little likelihood that exposures to burrowing owls will occur as a result of frequenting sites located inside facility fences.

Loggerhead Shrike—Loggerhead shrikes have not been observed during the BBSs conducted around WAG 3 between 1985 and 1996 (ERSF 1996). However, loggerhead shrikes have both nested and hunted within areas of human occupation and have been observed inside contaminated areas at other WAGs. Only three WAG 3 sites (CPP-22, CPP-34 and CPP-37A) demonstrate any positive habitat features to support this species. Sites CPP-34 and CPP-37A support weedy vegetation and marginal cover for prey, as well as adjacent perching structures. There is some possibility that these sites will be used by loggerhead shrikes. The air release associated with CPP-22 extends to areas of vegetation outside the facility fences, increasing the potential for use by loggerhead shrikes. Some exposure to loggerhead shrikes may occur as a result of hunting at sites located inside facility fences.

Ferruginous Hawk, Peregrine Falcon, Northern Goshawk—Recent studies indicate a range of 11–15 nesting pairs of ferruginous hawks on the INEEL; one of these nests was within 6 km of WAG 3. Several previously occupied ferruginous nests were checked by L. D. Flake in summer of 1996 and occupancy rates remained high. Wakeley (1978) observed hunting activity out to 5–6 km from ferruginous nest sites in Utah. Thus, ferruginous hawks within this distance of WAG 3 may be hunting near the WAG. BBS survey data indicate that ferruginous hawks have demonstrated a tendency to use the WAG 3 area over a period of several years. There is no reason not to expect continued use. Habitat features were found for CPP-34 and CPP-37A were of low quality, and these sites provide only limited potential for hunting. Because the extent associated with an air release (CPP-22) includes areas of vegetation outside the facility fences, this area has somewhat higher potential for use by raptors. However, ferruginous hawks tend to avoid areas frequented by humans. For this reason, it is unlikely that ferruginous hawks will nest or hunt at active sites closely associated with facilities. In addition, sightings for the peregrine falcon and northern goshawk on the INEEL have totaled fewer than seven and most have occurred in the southernmost areas of INEEL. Use of WAG 3 sites is possible but not likely and there is little likelihood that exposures to raptors will occur as a result of frequenting sites located inside facility fences.

Pygmy Rabbit—Based on a GIS analysis of vegetal, slope, and geological characteristics, areas surrounding WAG 3 demonstrate the appropriate habitat features necessary support pygmy rabbits (Gabler,

1997), particularly the area southeast of the facility. The selection criteria was developed based on characteristics of known pygmy rabbit sites on the INEEL (Gabler, 1997). A field survey of areas within 250 m of the fences surrounding various buildings were systematically searched, however, no sign or suitable habitat was observed (ERSF 1996). No positive habitat features were found for any CPP sites of concern. Consequently, there is a low probability that pygmy rabbits will be exposed as a result of frequenting sites located inside facility fences.

Sagebrush Lizard—Sagebrush lizards are known to inhabit grassland areas, and were observed near the WAG 3 area in similar habitat in 1994. One sagebrush lizard was observed (ERSF 1996) during a brief survey for sagebrush lizards conducted around the WAG 3 perimeter in 1996. The surveyed habitat consisted primarily of sagebrush-rabbitbrush and mixed grassland communities. Only 1 site within the WAG 3 facility demonstrates positive habitat features to support sagebrush lizards. The air release associated with CPP-22 extends to areas of vegetation outside the facility fences, increasing the potential for use by sagebrush lizards. Because WAG 3 sites, in general, lack adequate vegetative cover, there is low potential for sagebrush lizards to be exposed as a result of frequenting areas inside facility fences.

Townsend's Western Big-Eared Bat, Long-Eared Myotis and Small-Footed Myotis—Little historical data are available for bat use of habitat at the INEEL. However, bats have been observed hunting over native sagebrush communities and evidence indicates that they are drawn to ponds and lighting in search of drinking water and insect prey. Four bats were detected at WAG 3 during acoustical surveys conducted in 1996 (ERSF 1997), including 2 small-footed myotis. Two sites, CPP-34 and CPP-37B demonstrate marginal habitat qualities including periodic water, sparse vegetation and lighting that could attract bats. Overall, these sites are unlikely to receive use. The use of the sewage disposal ponds (CPP-65) by bats has been confirmed in previous surveys (Keller et al. 1993; Cieminski 1993). Continued use of this site by bats is considered highly likely and poses potential for exposure through contaminated insect prey and drinking water.

Black Tern, Trumpeter Swan, and White-Faced Ibis—The black tern, trumpeter swan, and white-faced ibis are associated exclusively with water sources and have also been recorded fewer than seven times sitewide. Only one sighting of a sensitive species (common loon) has was recorded at the CPP percolation ponds during a three- year study by Cieminski (1993). The standing water at WAG 3 industrial and sewage disposal ponds (CPP-65) poses potential for exposure to contaminants associated with pond activities. However, these facilities are most frequently used by more common species. The occurrence of these three species at sites inside facility fences would be incidental; therefore, their potential for chronic exposure to site-related contamination is low.

Potential risks associated with contaminant exposures for T/E and C2 species are of interest for both individuals and populations. Therefore, those species most likely to contact WAG 3 sites and contaminants have been evaluated for individual exposures. Other species, considered incidental (see Appendix F, Table F-2), and considered unlikely to receive chronic doses through frequenting WAG 3 and surrounding areas, are represented through evaluation of the functional group with which they are associated. T/E and C2 species that were individually evaluated for exposure to contaminants at WAG 3 are listed in boldface text in Table 7-5. These include the bald eagle, burrowing owl, loggerhead shrike, peregrine falcon, ferruginous hawk, Townsend's western big-eared bat, long-eared myotis, small-footed myotis, pygmy rabbit, and sagebrush lizard which were evaluated for direct and indirect exposure to soil contaminants.

28.2.5 Abiotic Components

28.2.5.1 Soils. The CPP facility is located on the alluvial plain of the Big Lost River. The topography surrounding the facility is relatively flat. The soils surrounding the facilities are comprised primarily of Typic-Camborthids-Typic Calciorthids (TCC), Typic Torrifluvents (TTF) and Malm-Bondfarm-Matheson complex (432) soils.

Both TCC and TTF soils are alluvium, which are deposited by the Big Lost River. TTF soils are somewhat newer than TCC soils and are found in closer proximity to the river. The TCC soils are loams or silty loams over gravelly or sandy loams, and the surface is frequently hardened due to alkaline conditions. The TTF soils are also loams or sandy loams over gravelly subsoils. However, the gravels associated with TTF soils are finer and more frequently found on the surface than those of TCC soils. Both soil types are often dry and generally alkaline and saline, impermeable, erodible and have little organic accumulation in the upper layer (Olson et al. 1995). Spring thaws and intense rainstorms may lead to significant soil erosion in these soil types.

The Malm-Bondfarm-Matheson (432) consists of moderately deep, well drained, sandy-loam soils on basalt plains. A calcic horizon is present at approximately 30cm (12 in.). Permeability of these soils is moderately rapid, and the erosion hazards for these soils are slight to moderate (Olson et al. 1995).

28.2.5.2 Surface Water. The main channel of the Big Lost River passes within 100m of the northwest corner of CPP facility fences along its route to the Sinks [approximately 18 km (11 mi) to the north]. Surface water discharges from CPP facilities to the Big Lost River are controlled and managed as part of the INEEL stormwater management plan under the National Pollution Discharge Elimination System. The main requirements of NPDES permit are to prevent contaminants from coming into contact with stormwater and prevent contaminated stormwater from entering the Big Lost drainage system or groundwater. As part of this permit, surface waters from CPP are currently managed under a facility specific stormwater pollution prevention plan and contaminant transport to ecological receptors through this pathway is unlikely (EGG 1994; DOE 1993). Perched water and groundwater are present; however, for this assessment, it is assumed that no pathways to surface ecological receptors exist for these sites.

28.2.6 Stressor Identification and Characterization

DOE Guidance (DOE 1993) defines a stressor as "any physical, chemical, or biological entity that can induce adverse response." CERCLA is primarily concerned with the effects of chemical stressors. At WAG 3, chemical stressors include a variety of radionuclides, organics, and metals identified at multiple sites.

Human Health Concentration Data—At the WAG level, data from the human health risk assessment are solely available for the ERA. The sites and contaminants for which human health concentration data were available are identified in Table 28-11. The human health concentration data were broken into 0 to 0.5 ft, 0 to 4 ft, and 0 to 10 ft average concentrations. For the WAG ERA, the 0 to 15 cm (0 to 0.5 ft) concentrations were used to characterize surficial soil concentrations. The subsurface concentrations, considered to be 15 cm to 3 m (0.5 to 10 ft), are based on the 15 cm to 3 m (0 to 10 ft) concentrations. When only 0 to 3 m (0 to 10 ft) concentrations were available for a site, these concentrations were also used to characterize 0 to 15 cm (0 to 0.5 ft) concentrations. Exposure-point concentrations were determined in the human health risk assessment for the sites identified in Table 28-11. The 95% upper

confidence level (UCL) of the arithmetic mean was used to estimate exposure-point concentrations. Maximum concentrations were used when the 95% UCL exceeded the maximum value or when the 95% UCL could not be calculated because data from only three or less samples were available. Section 7.1.3, Derivation of the Exposure-Point Concentrations contains more information on the summarization and calculation of the final data concentrations.

28.2.7 Initial Screening of Contaminants

It is the intent of this section to provide the final screening of contaminants against both background concentrations and ecologically based screening levels (EBSLs). The background concentrations come from Rood et al (1995). All EBSLs were calculated specifically for use at the INEEL using the methodology presented in the Guidance Manual (VanHorn et al. 1995). The development of EBSLs will be included in the OU-10-04 work plan. EBSLs used in the screening process are identified on Tables 28-8 through 28-10.

Table 28-3 identifies the sites and the contaminants at those sites to be evaluated in this assessment. Tables 28-8 through 28-10 compare site concentrations to the EBSL and background values for radionuclides, organics, and inorganics, respectively. The concentrations are maximum site concentrations unless otherwise noted. However, for sites that are not considered in the human health risk assessment, the concentrations generally came from Track 1 and Track 2 Decision Documents; in these cases, it is assumed that maximum concentrations were used in the Documents, though this is not always the case. Blank cells in the tables indicate that the contaminant was not observed at the site. A concentration in bold font means that contaminant and site combination must be included in the WAG ERA.

The stepwise decision process for inclusion of a contaminant in the WAG ERA was:

1. If the site concentration of the contaminant (usually the maximum) does not exceed the 95/95% upper tolerance limit (UTL) for background concentrations, then the contaminant will not be considered in the ERA for that site.

2. If the site concentration of the contaminant does not exceed the EBSL concentration, then the contaminant will not be considered in the WAG ERA for that site.

3. Otherwise, the contaminant is included in the WAG ERA for the site.

The results of this decision process are shown in Table 28-11. Sites for which all contaminants have been screened out will not be considered in the WAG ERA.

28.2.8 Pathways of Contaminant Migration and Exposure

28.2.8.1 Surface Soil. Contaminated surface soil represents the major source of possible contaminant exposure for WAG 3 ecological components. Surface soil, as defined for use in the INEEL WAG ERAs, includes the uppermost 15 cm (0.5 ft). Many of the WAG 3 sites of concern represent sources of surface soil contamination resulting from past contamination.

Table 28-8. Results of radionuclide screening.

	pCi/g	Am-241	Ce-144	Co-57	Co-60	Cs-134	Cs-137	Eu-152	Eu-154	Eu-155
	Min EBSL[a]	3.55E+02	2.27E+04	2.45E+04	1.18E+03	1.95E+03	4.95E+03	2.18E+03	2.48E+03	3.25E+04
OU	Background	1.10E-02	NA	NA	NA	NA	8.20E-01	NA	NA	NA
3-01	CPP-61, Rad						2.51E+00			
3-02	CPP-37A	9.90E-01					2.31E+00			
	CPP-37B	1.95E+00					4.20E+00			
3-03	CPP-67, Sediment[b]	7.80E+00	1.50E+00		2.35E+00	3.50E+00	9.36E+01			
3-05	CPP-14[c]						1.27E+01			
3-06	CPP-34						2.00E+03			
	CPP-40, Rad						1.34E+00			
3-08	CPP-13				9.00E-01	6.00E-01	4.63E+03		3.10E+01	
3-09	CPP-06						1.44E+01			
	CPP-19	1.97E+00			**2.16E+04**		**4.08E+05**	**8.76E+04**	**5.35E+04**	9.62E+03
	CPP-22						1.43E+01			
	CPP-78						3.80E-01			
3-10	CPP-46, Rad					7.00E-02	1.76E+00			
3-13	CPP-88						3.66E+01			
	CPP-90					9.00E-02	7.50E+00			2.60E-01
	CPP-93									
	Windblown	3.00E-02					1.84E+01			
Tank Farm		**1.66E+04**	1.44E+01		**2.27E+04**	**7.55E+04**	**1.02E+08**		**5.65E+05**	
Tank Farm South		2.91E+00					**4.34E+04**		4.23E+00	
WCF		**7.63E+02**				8.69E+02	**8.64E+03**		**5.04E+03**	
Old storage pool			2.39E+03	1.02E+00	**2.39E+03**	1.45E+03	**2.65E+04**	**3.50E+04**	**3.50E+04**	7.60E+03
Storage yard				5.43E-01			6.34E+01	2.13E+00	1.88E+00	

Sites not included in the human health risk assessment.

3-01	CPP-49
	CPP-51
	CPP-61, PCB
3-02	CPP-54
	CPP-55
	CPP-59, Zone 1
	CPP-59, Zone 2
	CPP-66*
3-04	CPP-38
3-06	CPP-40, nonrad
	CPP-47
3-07	CPP-26, outside
3-10	CPP-42
	CPP-44
	CPP-56
3-13	CPP-39
	CPP-84
	CPP-87 (metals)

Table 28-8. (continued).

	pCi/g	H-3	I-129	K-40	Nb-95	Np-237	Pu-238	Pu-239	Pu-241	Pu-242
	Min EBSL[a]	3.43E+05	4.76E+04	3.53E+03	3.56E+03	3.88E+02	3.55E+02	3.79E+02	3.73E+05	3.99E+02
OU	Background	NA	NA	2.40E+01	NA	NA	4.90E-03	1.00E-01	NA	NA
3-01	CPP-61, Rad									
3-02	CPP-37A					1.07E+00	1.20E-01			
	CPP-37B					5.60E-01	5.00E-01			
3-03	CPP-67, Sediment[b]	6.10E-01	3.70E+00			1.63E+00	1.30E+01	2.07E+00		
3-05	CPP-14[c]					3.50E+00				
3-06	CPP-34					7.00E-01				
	CPP-40, Rad									
3-08	CPP-13									
3-09	CPP-06									
	CPP-19				9.00E-02			1.41E+02		
	CPP-22									
	CPP-78									
3-10	CPP-46, Rad									
3-13	CPP-88									
	CPP-90				1.30E-01					
	CPP-93									
	Windblown			2.78E+01			3.70E-01	7.00E-02		
Tank Farm		2.49E+04		2.29E+01		1.63E+00	3.58E+00	**1.26E+04**	**1.05E+06**	3.20E+01
Tank Farm South							1.41E+00	3.40E-01		
WCF				2.06E+01			1.32E+01	7.25E-01		
Old storage pool						5.00E-02		9.19E+00		
Storage yard										
Sites not included in the human health risk assessment.										
3-01	CPP-49									
	CPP-51									
	CPP-61, PCB									
3-02	CPP-54									
	CPP-55									
	CPP-59, Zone 1									
	CPP-59, Zone 2									
	CPP-66*			2.80E+00						
3-04	CPP-38									
3-06	CPP-40, nonrad									
	CPP-47									
3-07	CPP-26, outside									
3-10	CPP-42									
	CPP-44									
	CPP-56									
3-13	CPP-39									
	CPP-84									
	CPP-87 (metals)									

Table 28-8. (continued).

	pCi/g	Rh-106	Ru-106	Sb-125	Sr-90	Tc-99	Th-232	U-233	U-234	U-235
	Min EBSL[a]	1.33E+03	1.94E+05	6.02E+03	3.34E+03	4.87E+02	NA	4.05E+02	4.09E+02	4.51E+02
OU	Background	NA	NA	NA	4.90E-01	NA	1.60E+00	NA	1.44E+00	NA
3-01	CPP-61, Rad				3.00E+00	1.90E+00				
3-02	CPP-37A				6.90E-01					
	CPP-37B				2.95E+00					5.00E-02
3-03	CPP-67 Sediment[b]	4.92E+00	5.97E+00	1.89E+00	1.63E+01				2.75E+00	7.00E-02
3-05	CPP-14[c]				3.52E+00					
3-06	CPP-34				**6.00E+03**				1.60E+00	
	CPP-40, Rad									
3-08	CPP-13				**4.18E+03**	2.70E+00				
3-09	CPP-06				6.98E+00					
	CPP-19				**1.25E+05**					2.36E+00
	CPP-22				5.40E+00	3.50E+00				
	CPP-78				7.00E-01	8.00E-01				
3-10	CPP-46, Rad				9.00E-01	1.50E+00				
3-13	CPP-88				9.20E+00					
	CPP-90									
	CPP-93									
	Windblown				5.72E+00			1.09E+00	1.18E+00	5.00E-02
Tank Farm			5.41E+01		**5.68E+07**	2.20E+00			2.12E+01	**9.00E+03**
Tank Farm South					4.17E+02					6.79E-02
WCF					**1.40E+05**					7.16E-02
Old storage pool					1.67E+03				1.20E+00	3.02E-01
Storage yard					4.39E+01					
Sites not included in the human health risk assessment.										
3-01	CPP-49									
	CPP-51									
	CPP-61, PCB									
3-02	CPP-54									
	CPP-55									
	CPP-59, Zone 1									
	CPP-59, Zone 2									
	CPP-66*						1.50E+00			7.50E-02
3-04	CPP-38									
3-06	CPP-40, nonrad									
	CPP-47									
3-07	CPP-26, outside									
3-10	CPP-42									
	CPP-44									
	CPP-56									
3-13	CPP-39									
	CPP-84									
	CPP-87 (metals)									

Table 28-8. (continued).

	pCi/g	U-236	U-238	Y-90
	Min EBSL[a]	4.34E+02	4.64E+02	1.74E+03
OU	Background	NA	1.40E+00	NA
3-01	CPP-61, Rad			
3-02	CPP-37A			
	CPP-37B			
3-03	CPP-67 Sediment[b]		2.60E+00	1.20E+00
3-05	CPP-14[c]		3.90E-01	
3-06	CPP-34		1.50E+00	
	CPP-40, Rad			
3-08	CPP-13			
3-09	CPP-06			
	CPP-19			
	CPP-22			
	CPP-78			
3-10	CPP-46, Rad			
3-13	CPP-88			
	CPP-90			
	CPP-93			
	Windblown		1.17E+00	
Tank Farm		7.55E-01	1.39E+00	
Tank Farm South				
WCF				
Old storage pool			1.00E+00	
Storage yard				
Sites not included in the human health risk assessment.				
3-01	CPP-49			
	CPP-51			
	CPP-61, PCB			
3-02	CPP-54			
	CPP-55			
	CPP-59, Zone 1			
	CPP-59, Zone 2			
	CPP-66*		1.60E+00	
3-04	CPP-38			
3-06	CPP-40, nonrad			
	CPP-47			
3-07	CPP-26, outside			
3-10	CPP-42			
	CPP-44			
	CPP-56			
3-13	CPP-39			
	CPP-84			
	CPP-87 (metals)			

a. Includes minimum EBSL for either external or internal exposure.

b. CPP-67 sediments were screened as soils.

c. CPP-14 was assessed by maximum concentration at both area 1 and 2.

*CPP-66 concentrations are geometric mean concentrations of the fly ash

Table 28-9. Results of organics screening.

OU	Mg/kg Min EBSL	Acetone 2.87E-01	Anthracene 1.39E+02	Benzo(a)-anthracene 3.10E+00	Benzo(a)-pyrene 3.34E-02	Benzo(b) fluoranthene 6.67E-02	Benzo(g,h,i) perylene 6.67E-02[a]	Benzo(k) fluoranthene 6.67E-02[a]
3-01	CPP-61, Rad							
3-02	CPP-37A							
	CPP-37B							
3-03	CPP-67, Sediment[d]		2.40E-01	6.20E-01	**3.50E-01**	**4.40E-01**		
3-05	CPP-14							
	Area 1	2.1E-01	3.8E-01		**3.2E-01**		**2.7E-01**	
	Area 2							
3-06	CPP-34							
	CPP-40, Rad							
3-08	CPP-13							
3-09	CPP-06							
	CPP-19							
	CPP-22							
	CPP-78							
3-10	CPP-46, Rad							
3-13	CPP-88							
	CPP-90			1.85E-01	**1.85E-01**	**1.85E-01**		
	CPP-93							
	Windblown							
Tank Farm								
Tank Farm South								
WCF								
Old storage pool								
Storage yard								
<u>Sites not included in the human health risk assessment.</u>								
3-01	CPP-49							
	CPP-51							
	CPP-61, PCB							
3-02	CPP-54							
	CPP-55							
	CPP-59, Zone 1							
	CPP-59, Zone 2							
	CPP-66							
3-04	CPP-38							
3-06	CPP-40, nonrad							
	CPP-47							
3-07	CPP-26, outside							
3-10	CPP-42							
	CPP-44							
	CPP-56							
3-13	CPP-39		1.80E-01	8.60E-01	**5.00E-01**	**1.10E+00**	**2.70E-01**	**9.70E-01**
	CPP-84	**2.80E+03**						
	CPP-87 (metals)							

Table 28-9. (continued).

OU	Mg/kg Min EBSL	Butylbenzyl-phthalate 1.47E+01	4-chloro-aniline 5.35E-01	Chrysene 2.33E-01	Decanal NA	Di(2-ethyl-hex-yl)phthalate 2.63E+00	Di-n-butyl-phthalate 1.54E+01	Diethyl phthalate 7.64E+00	Fluoranthene 1.74E+01
3-01	CPP-61, rad								
3-02	CPP-37A								
	CPP-37B								
3-03	CPP-67, Sediment[a]			**6.00E-01**		2.50E-01			1.50E+00
3-05	CPP-14								
	Area 1		**1.10E+00**	**3.8E-01**			9.00E-02		7.20E-1
	Area 2								
3-06	CPP-34								
	CPP-40, rad								
3-08	CPP-13								
3-09	CPP-06								
	CPP-19								
	CPP-22								
	CPP-78								
3-10	CPP-46, rad								
3-13	CPP-88								
	CPP-90					1.85E-01			
	CPP-93								
	Windblown								
Tank Farm									
Tank Farm South									
WCF									
Old storage pool									
Storage yard									
Sites not included in the human health risk assessment.									
3-01	CPP-49								
	CPP-51								
	CPP-61, PCB								
3-02	CPP-54	4.20E-01				**4.00E+00**	2.00E+00	1.30E+00	
	CPP-55								
	CPP-59, Zone 1								
	CPP-59, Zone 2								
	CPP-66								
3-04	CPP-38								
3-06	CPP-40, nonrad								
	CPP-47								
3-07	CPP-26, outside								
3-10	CPP-42								
	CPP-44				**9.00E-03**				
	CPP-56								
3-13	CPP-39			**1.60E+00**		**1.40E+01**			2.30E+00
	CPP-84								
	CPP-87 (metals)								

Table 28-9. (continued).

OU	Mg/kg Min EBSL	Indeno (1,2,3- cd)pyrene 6.67E-02[a]	Methylene chloride 4.27E-01	4-methyl-4-hydroxy-2-pentanone[b] NA	4-methyl-phenol 4.92E+00	Naphthalene 7.37E+00	Nitrate 3.20E+01	PCBs 1.43E-02
3-01	CPP-61, rad							
3-02	CPP-37A		1.40E-01					
	CPP-37B							
3-03	CPP-67, Sediment[d]		1.10E-02					
3-05	CPP-14							
	Area 1		1.2E-01		7.60E-01	1.30E+00		**6.0E+00**
	Area 2		1.2E-01					**7.4E-01**
3-06	CPP-34							
	CPP-40, rad							
3-08	CPP-13							
3-09	CPP-06							
	CPP-19							
	CPP-22							
	CPP-78							
3-10	CPP-46, rad							
3-13	CPP-88							
	CPP-90	**1.85E-01**	1.70E-02					
	CPP-93							
	Windblown							
Tank Farm							2.75E+00	
Tank Farm South								
WCF								
Old storage pool								
Storage yard								
Sites not included in the human health risk assessment.								
3-01	CPP-49							**1.00E+0**
	CPP-51							**1.20E-01**
	CPP-61, PCB							**1.00E+01**
3-02	CPP-54		1.00E-03					
	CPP-55							
	CPP-59, Zone 1							
	CPP-59, Zone 2							
	CPP-66							
3-04	CPP-38							
3-06	CPP-40, nonrad							
	CPP-47							
3-07	CPP-26, outside							
3-10	CPP-42						2.21E+00	
	CPP-44			**9.50E+00**				
	CPP-56							
3-13	CPP-39	**4.80E-01**						
	CPP-84							
	CPP-87 (metals)							

Table 28-9. (continued).

OU	Mg/kg Min EBSL	Phenanthrene 1.39E+02	Pyrene 2.08E+01	Toluene 3.03E+01	1,1,1-Tri-chloroethane 4.08E+02	TPH NA[c]	Trichloro-ethylene 1.74E+01	Xylene 2.86E-01
3-01	CPP-61, rad							
3-02	CPP-37A							
	CPP-37B							
3-03	CPP-67, Sediment[d]	8.10E-01	9.30E-01					
3-05	CPP-14	8.70E-02						
	Area 1							
	Area 2							
3-06	CPP-34							
	CPP-40, rad							
3-08	CPP-13							
3-09	CPP-06							
	CPP-19							
	CPP-22							
	CPP-78							
3-10	CPP-46, rad							
3-13	CPP-88							
	CPP-90		4.00E-01					
	CPP-93							
	Windblown							
Tank Farm				2.00E-03				
Tank Farm South							4.60E-03	
WCF								
Old storage pool								
Storage yard								
Sites not included in the human health risk assessment.								
3-01	CPP-49							
	CPP-51							
	CPP-61, PCB							
3-02	CPP-54							4.00E-03
	CPP-55							
	CPP-59, Zone 1					**2.8E+01**		
	CPP-59, Zone 2					**6.3E+02**		1.10E-03
	CPP-66							
3-04	CPP-38							
3-06	CPP-40, nonrad							
	CPP-47							
3-07	CPP-26, outside							
3-10	CPP-42							
	CPP-44				5.00E-03			
	CPP-56							
3-13	CPP-39	1.10E+00	1.30E+00					
	CPP-84							
	CPP-87 (metals)							

a. Use benzo(b)fluoranthene values. This PAH is shown to be more toxic and is therefore bounding (ATSDR 1990b).

b. Laboratory contamination (byproduct of acetone), eliminated from assessment.

c. NA—not available.

d. CPP-67 sediments were screened as soil.

Table 28-10. Results of inorganic screening assessment.

	Mg/kg	Aluminum	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium	Chromi
	Min EBSL	4.27E+00	7.67E-01	9.01E-01	1.08E-01	7.34E-01	1.28E+00	2.63E-03	3.25E+
OU	Background	1.60E+04	4.80E+00	5.80E+00	3.00E+02	1.8E+00	NA	2.20E+00	3.30E+01
3-01	CPP-61, rad								
3-02	CPP-37A								
	CPP-37B								
3-03	CPP-67, Sediment[a]	4.57E+03			1.90E+02	3.20E-01		1.84E+00	**3.31E+01**
3-05	CPP-14								
	Area 1	8.99E+03		4.6E+00	1.75E+02				**5.12E+01**
	Area 2	4.27E+03			9.52E+01			6.6E-01	1.83E+01
3-06	CPP-34			**7.10E+00**					
	CPP-40, rad								
3-08	CPP-13			**8.30E+00**					
3-09	CPP-06								
	CPP-19			**6.30E+00**					
	CPP-22								
	CPP-78								
3-10	CPP-46, rad								
3-13	CPP-88			**7.10E+00**					
	CPP-90		**9.50E+00**	**2.95E+01**					
	CPP-93	**1.20E+05**							
	Windblown								
Tank Farm				4.79E+00					
Tank Farm South				**5.90E+00**				**3.42E+00**	1.68E+01
WCF				**6.30E+00**				1.80E+00	2.18E+01
Old storage pool				**5.90E+00**	1.12E+02				
Storage yard				**5.90E+00**					

Sites not included in the human health risk assessment.

3-01	CPP-49								
	CPP-51								
	CPP-61, PCB								
3-02	CPP-54			**8.80E+00**					
	CPP-55			**1.34E+01**				1.40E+00	**6.50E+01**
	CPP-59, Zone 1								
	CPP-59, Zone 2								
	CPP-66[b]		**<7.5**	2.00E+00	1.30E+02	1.10E+00	**3.10E+02**	5.90E-01	3.10E+01
3-04	CPP-38								
3-06	CPP-40, nonrad								**7.20E+01**
	CPP-47								
3-07	CPP-26, outside								
3-10	CPP-42				**1.10E+03**				
	CPP-44							**8.40E+00**	**1.54E+03**
	CPP-56								
3-13	CPP-39				**1.10E+03**				
	CPP-84								
	CPP-87 (metals)			<0.065	1.36E+01			1.10E-01	2.70E-01

Table 28-10. (continued).

	Mg/kg	Chromium-VI	Cobalt	Copper	Cyanide	Fluoride	Lead	Manganese	Mercury	Molybdenum	Nickel
	Min EBSL	1.67E-01	4.67E-01	2.17E+00	2.15E-02	3.11E+00	7.17E-02	1.44E+01	6.13E-03	5.57E+00	2.77E+00
OU	Background	NA	1.10E+01	2.20E+01	NA	NA	1.70E+01	4.90E+02	5.00E-02	NA	3.50E+01
3-01	CPP-61, Rad										
3-02	CPP-37A								**9.60E-01**		
	CPP-37B										
3-03	CPP-67, Sediment*		4.5E+00	**2.44E+01**	**2.10E-01**		1.06E+01	1.60E+02	**3.62E+01**		1.55E+01
3-05	CPP-14										
	Area 1						**3.56E+01**	2.48E+02	1.2E+00		2.4E+01
	Area 2			1.03E+01			1.03E+01	1.62E+02			1.46E+01
3-06	CPP-34								**6.00E-01**		
	CPP-40, rad										
3-08	CPP-13								**5.95E-01**		
3-09	CPP-06										
	CPP-19										
	CPP-22										
	CPP-78										
3-10	CPP-46, rad										
3-13	CPP-88								**1.00E+00**		**1.63E+02**
	CPP-90								**1.00E+00**		
	CPP-93								**1.40E+02**		
	Windblown										
Tank Farm						1.95E+00			**2.30E-01**		
Tank Farm South									**1.51E+00**		**5.51E+01**
WCF								2.26E+02	**7.20E+00**		**5.51E+01**
Old storage pool								2.23E+02	**5.52E-01**		**5.51E+01**
Storage yard									**5.52E-01**		**5.51E+01**
Sites not included in the human health risk assessment.											
3-01	CPP-49										
	CPP-51										
	CPP-61, PCB										
3-02	CPP-54								2.90E-01		
	CPP-55	**6.50E+01**					**3.20E+01**		**5.20E+00**		**6.50E+01**
	CPP-59, Zone 1										
	CPP-59, Zone 2										
	CPP-66*		<1.0	2.00E+01		**1.65E+02**	1.50E+01	3.90E+01	3.70E-02	2.10E+00	8.20E+00
3-04	CPP-38										
3-06	CPP-40, nonrad					**1.10E+01**	**6.00E+01**				
	CPP-47					**2.48E+02**					
3-07	CPP-26, outside										
3-10	CPP-42					6.04E-01					
	CPP-44	**1.54E+01**					**2.81E+02**		**5.00E+00**		**3.44E+02**
	CPP-56										
3-13	CPP-39					**9.29E+02**			**1.70E-01**		
	CPP-84										
	CPP-87 (metals)						<0.065		<5E-4		

Table 28-10. (continued).

	Mg/kg	Selenium	Silver	Sodium	Strontium	Sulfide	Thallium	Tin	Vanadium	Zinc
	Min EBSL	8.34E-02	1.39E+00	1.10E+02	1.06E+02	NA	1.17E-01	3.84E+00	2.55E-01	6.37E+0
OU	Background	2.20E-01	LTD	320	NA	NA	4.30E-01	NA	4.50E+01	1.50E+02
3-01	CPP-61, rad									
3-02	CPP-37A									
	CPP-37B									
3-03	CPP-67, Sediment[a]	**3.70E-01**	**1.03E+01**	1.71E+02		**3.57E+01**	2.10E-01		1.73E+01	4.17E+01
3-05	CPP-14									
	Area 1		**1.22E+01**						3.1E+01	1.35E+02
	Area 2								1.51E+01	3.75E+01
3-06	CPP-34									
	CPP-40, rad									
3-08	CPP-13									
3-09	CPP-06									
	CPP-19									
	CPP-22									
	CPP-78									
3-10	CPP-46, rad									
3-13	CPP-88									
	CPP-90									
	CPP-93									
	Windblown									
Tank Farm										
Tank Farm South										
WCF										
Old storage pool										
Storage yard										
Sites not included in the human health risk assessment.										
3-01	CPP-49									
	CPP-51									
	CPP-61, PCB									
3-02	CPP-54									
	CPP-55	**6.40E-01**	**3.00E+00**							
	CPP-59, Zone 1									
	CPP-59, Zone 2									
	CPP-66*	**1.60E+00**	**<1.5**		**6.90E+02**			<1.5	2.00E+01	2.60E+01
3-04	CPP-38									
3-06	CPP-40, nonrad									
	CPP-47									
3-07	CPP-26, outside									
3-10	CPP-42									
	CPP-44									
	CPP-56									
3-13	CPP-39		**1.87E+01**							
	CPP-84									
	CPP-87 (metals)	<0.095	<0.006							

a. CPP-67 sediments screened as soils.

*CPP-66 concentrations are geometric means of the fly ash concentration

Table 28-11. Site and COPC retention decision table for WAG 3 ecorisk.

OU	Site	Human Health Data Available	Retain for Further Assessment[a]	Eliminate as Concern[a]	COPCs
3-01	CPP-61, rad	Yes		R	
3-02	CPP-37A	Yes	C	R	Mercury
	CPP-37B	Yes		C & R	
	CPP-65	Yes		C&R	Screened using liquid effluent concentrations in Table 28-16.
3-03	CPP-67, sediment	Yes/no[b]	C & R[b]		
3-05	CPP-14				
	Area 1	Yes	C	R	PCBs, organics, lead, mercury, silver, chromium III
	Area 2		C	R	PCBs
3-06	CPP-34	Yes	C & R		Arsenic, mercury, strontium (Sr)-90
	CPP-40, rad	Yes		R	
3-08	CPP-13	Yes	C & R		Arsenic, Cs-137, Sr-90 (internal only)
3-09	CPP-06	Yes		C & R	
	CPP-19	Yes	C & R		Arsenic, cobalt (Co)-60, Cs-137, europium (Eu)-152, Eu-154, Sr-90
	CPP-22	Yes		C & R	
	CPP-78	Yes		C & R	
3-10	CPP-46, rad	Yes		R	
3-13	CPP-88	Yes	C	R	Arsenic, mercury, nickel
	CPP-90	Yes	C	R	Antimony, arsenic, mercury, organics
	CPP-93	Yes	C		Aluminum, mercury
	Windblown	Yes		C & R	
Tank farm		Yes	C & R		Fluoride, mercury, americium (Am)-241, Co-60, Cs-134, Cs-137, Eu-154, plutonium (Pu)-239, Pu-241, Sr-90, U-235
Tank farm south		Yes	C & R		Arsenic, cadmium, mercury, nickel, Cs-137
WCF		Yes	C & R		Arsenic, mercury, nickel, Am-241, Cs-134, Cs-137, Eu-154, Sr-90
Old storage pool		Yes	C & R		Arsenic, mercury, nickel, Co-60, Cs-134, Cs-137, Eu-152, Eu-154, Sr-90

Table 28-11. (continued).

OU	Site	Human Health Data Available	Retain for Further Assessment[a]	Eliminate as Concern[a]	COPCs
Storage yard		Yes	C	R	Arsenic, mercury, nickel
Sites not included in the human health risk assessment					
3-01	CPP-49	No	C		PCBs
	CPP-51	No	C		PCBs
	CPP-61, PCB	No	C		PCBs
3-02	CPP-54	No	C		Arsenic, organics
	CPP-55	No	C		Arsenic, Cr-III, Cr-VI, lead, mercury, nickel, selenium, silver
	CPP-59, Zone 1	No		C[c]	TPH
	CPP-59, Zone 2	No		C[c]	TPH
	CPP-66	No	C	R	Antimony, boron, fluoride, molybdenum, selenium, strontium, tin[d]
3-04	CPP-38	No		C[e]	
3-06	CPP-40, non-rad	No	C		Fluoride, lead
	CPP-47	No	C		Fluoride
3-07	CPP-26, outside	No		C & R[f]	
3-10	CPP-42	No	C	R	Barium, fluoride
	CPP-44	No	C	R	Cadmium, chromium, Cr-VI, lead, mercury, nickel, organics
	CPP-56	No		C[g]	

Table 28-11. (continued).

OU	Site	Human Health Data Available	Retain for Further Assessment[a]	Eliminate as Concern[a]	COPCs
3-13	CPP-39	No	C	R	Organics, barium, fluoride, mercury, silver
	CPP-84	No	C		Acetone
	CPP-87, metals	No		C	

a. R—radionuclides; C—nonradiological chemicals.

b. The radionuclides, at the percolation ponds, CPP-67, will be evaluated as potentially ingested (in water) by wildlife. The human health data has sediment concentrations; surface water concentrations are not available.

c. Xylenes were all less-than-detectable; however petroleum hydrocarbons were detected at 28 mg/kg.

d. Antimony and tin will not be carried over into the WAG-level ecological risk analysis, as they were less-than-detectable. The detection limit for antimony in fly ash (7.5 mg/kg) was greater than the EBSL in soil (1.34 mg/kg) and the upper tolerance limit on background antimony soil concentrations (4.8 mg/kg). The detection limit for tin in fly ash (1.5 mg/kg) was greater than the EBSL in soil (0.47 mg/kg). Background values for tin were not available.

e. Asbestos in building walls. Potential asbestos in surrounding soil, but no soil concentration data. The site is to be considered under the asbestos abatement program (outside of the FFA/CO).

f. No elevated gross beta-gamma activity was detected during a surface radiation survey.

g. Nitrate is the only potential contaminant identified in the Track 2 Draft Final Scoping Summary Report for WAG 3 OU 10, Site CPP-56. However, no concentration data for nitrate at the site was available. The EBSL value for nitrate is 4.68 mg/kg. It is assumed that concentrations of nitrates at this site would be <EBSL.

The ecological pathways/exposure model for WAG 3 contaminated surface soil is shown in Figure 28-4. This model depicts the following mechanisms for surface soil contamination transport:

- Wind and water erosion
- Leaching and infiltration
- Plant uptake
- Burrowing animal translocation.

Transportation of contaminated soils through these mechanisms may result in contamination of various other media or secondary sources, including the following onsite and offsite sources:

- Surface water
- Surface soil
- Subsurface soil
- Vegetation.

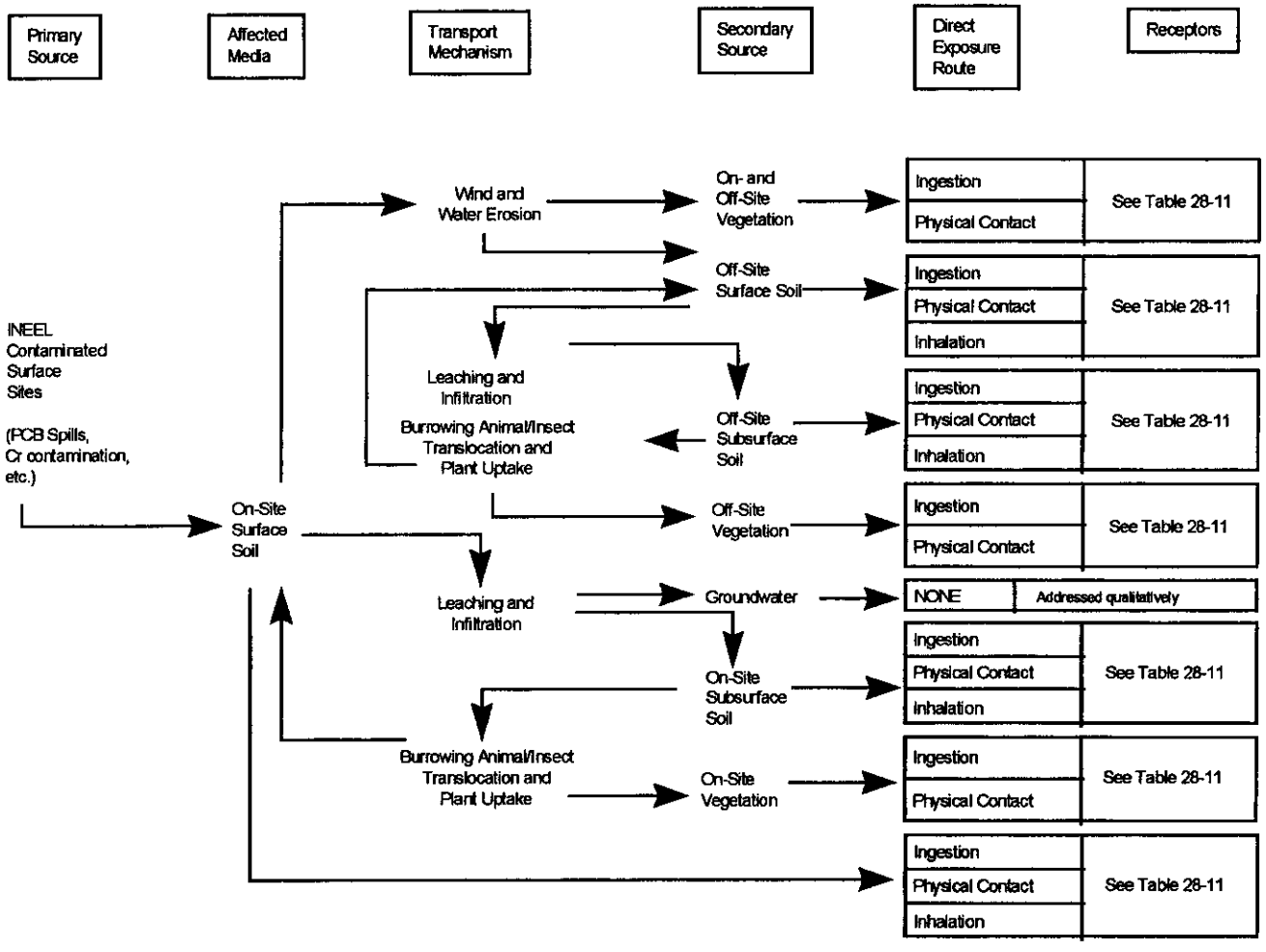

Figure 28-4. Ecological pathways/exposure model for WAG 3 surface contamination.

Receptors having potential for direct exposure to WAG 3 surface soils are presented in Table 28-12. Ecological receptors can be exposed to contaminated media directly through ingestion of contaminated soil or water, and indirectly by consuming vegetation or prey that have bioaccumulated contaminants in their tissue.

28.2.8.2 Subsurface Soil. The ecological pathways/exposure model for WAG 3 contaminated subsurface soils is presented in Figure 28-5. Many of the WAG 3 sites of concern are contaminated subsurface soil sites resulting from buried contaminated soil or sediments, leaking underground storage tanks, and past surface spills followed by leaching. For the WAG ERA analysis, subsurface soils are defined at depths of 15 cm to 3 m (0.5 to 10 ft). Contaminants in subsurface soil can be transported to ecological receptors by plant uptake and translocation by burrowing animals. Contamination depths greater than 3 m (10 ft) below surface are considered inaccessible to ecological receptors, since this is generally below the root zone of plants and burrowing depth of ground-dwelling animals.

Once contaminated soil is brought close to the surface, transport and exposure scenarios for ecological receptors are the same as for surface soil. For subsurface contamination, inhalation and direct contact (by burrowing animals) are likely more important exposure routes than for surface contamination.

Receptors having potential for direct exposure to WAG 3 subsurface soil contamination are presented on Table 28-12. These receptors include animals dwelling belowground and deep rooting plants. Because subsurface soil contamination may be translocated to the surface by burrowing and plant uptake, other terrestrial species also have some potential for exposure through this pathway.

28.2.8.3 Surface Water. The ecological pathways/exposure model for WAG 3 contaminated surface water is presented in Figure 28-6. Ecological receptors having a potential for direct exposure to surface water pathways are identified on Table 28-12. There are two sources of standing water at the CPP facility: the Percolation Ponds #1 and #2 (Site CPP-67) and the Sewage Treatment Plant Lagoons (CPP-65).

The Sewage Treatment Plant Lagoons consist of two aerated lagoons, two stabilization lagoons, four infiltration trenches, and six weir boxes. They receive wastewater from the Sewage Treatment Plant, which receives sanitary waste from 31 buildings at the CPP. While the lagoons are still in use, they will be evaluated as perched water sources as discussed in Chapter 5. Additionally, surface water ingestion by animals at CPP-65 is a pathway considered in the ERA.

The Percolation Ponds consist of two unlined percolation ponds. The ponds received service wastewater consisting primarily of cooling water and condensed steam generated by various CPP operations. These ponds have achieved RCRA clean-closure equivalency for metals. However, radiological contamination may still exist. Water ingestion from radiological contaminants at CPP-67 is considered in the ERA.

The main channel of the Big Lost River passes within 12 m of the northwest corner of CPP facility fences along its route to the Sinks [approximately 18 km (11 mi) to the north]. Surface water discharges from CPP facilities to the Big Lost River are controlled and managed as part of the INEEL stormwater management plan under the National Pollution Discharge Elimination System (NPDES). The main requirements of the NPDES permit are to prevent contaminants from coming into contact with stormwater and prevent contaminated stormwater from entering the Big Lost drainage system or groundwater. As part of this permit, surface waters from CPP are currently managed under a facility-specific stormwater pollution

Table 28-12. Summary of WAG 3 direct exposure pathways and associated INEEL functional groups.

	Exposure Media and Routes																
	Surface Soils			Subsurface Soils			Vegetation		Surface Water		Sediments			Prey			
RECEPTOR	Ing[a]	P[b]	Inh[c]	Ing	P	Inh	Ing	P	Ing	P	Ing	P	Inh	Invertebrates	Mammals	Birds	
Amphibians (A232)									x		x			a/t			
Avian herbivores (AV122)	x						x										
Avian herbivores (AV143)—Trumpeter swan							x		x		x						
Avian insectivores (AV210A)									x		x			a/t			
Avian insectivores (AV210)—Black tern									x		x			a			
Avian insectivores (AV222)	x	x												t			
Avian insectivores (AV232)									x		x			a			
Avian insectivores (AV233)—White-faced ibis									x		x			a			
Avian carnivores (AV310)—	x								x						x	x	
Northern goshawk	x														x	x	
Peregrine falcon	x														x		
Avian carnivores (AV322)—									x						x		
Bald eagle															x		
Ferruginous hawk															x		
Loggerhead shrike															x	x	
Avian carnivores (AV322A)— Burrowing owl	x			x										t	x		
Avian omnivores (AV422)							x							t	x	x	
Avian omnivores (AV442)							x							a			
Mammalian herbivores (M122)	x						x		x								
Mammalian herbivores (M122A)	x			x			x										
Pygmy rabbit	x			x			x										

Table 28-12. (continued).

RECEPTOR	Exposure Media and Routes															
	Surface Soils			Subsurface Soils			Vegetation		Surface Water		Sediments			Prey		
	Ing[a]	P[b]	Inh[c]	Ing	P	Inh	Ing	P	Ing	P	Ing	P	Inh	Invertebrates	Mammals	Birds
Mammalian insectivores (M210A)	x								x					t		
Townsend's western big-eared bat	x								x					t		
Small-footed myotis	x								x					t		
Long-eared myotis									x					t		
Mammalian insectivores (M222)—Merriam's shrew	x								x		x			t/a		
Mammalian carnivore (M322)	x								x						x	
Mammalian omnivores (M422)	x			x			x							t		
Reptilian insectivores (R222)—Sagebrush lizard														t		
Reptilian carnivores (R322)															x	
Plants																

Highlighted = aquatic groups/species.

Ing—ingestion.

P—Physical contact.

Inh—inhalation.

a—aquatic.

t—terrestrial.

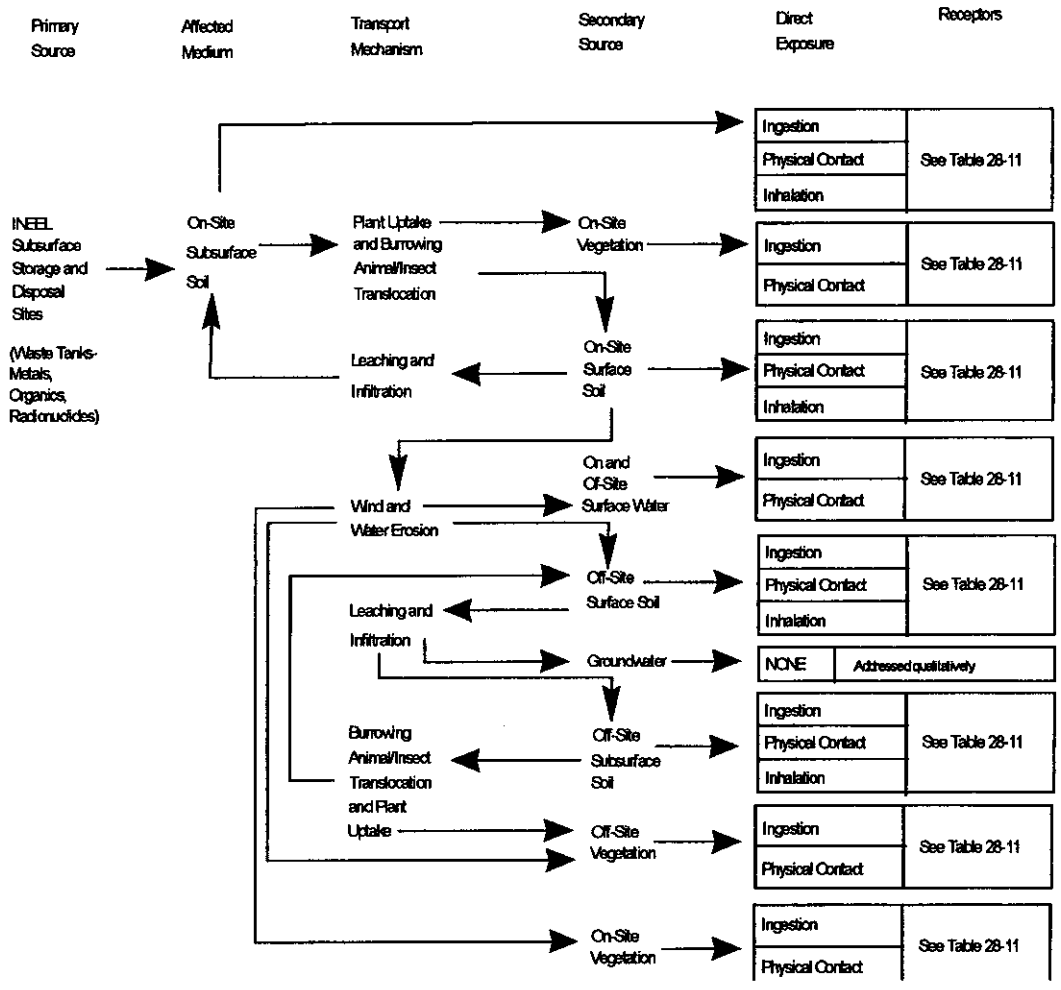

Figure 28-5. Ecological pathways/exposure model for WAG 3 subsurface storage and disposal sites.

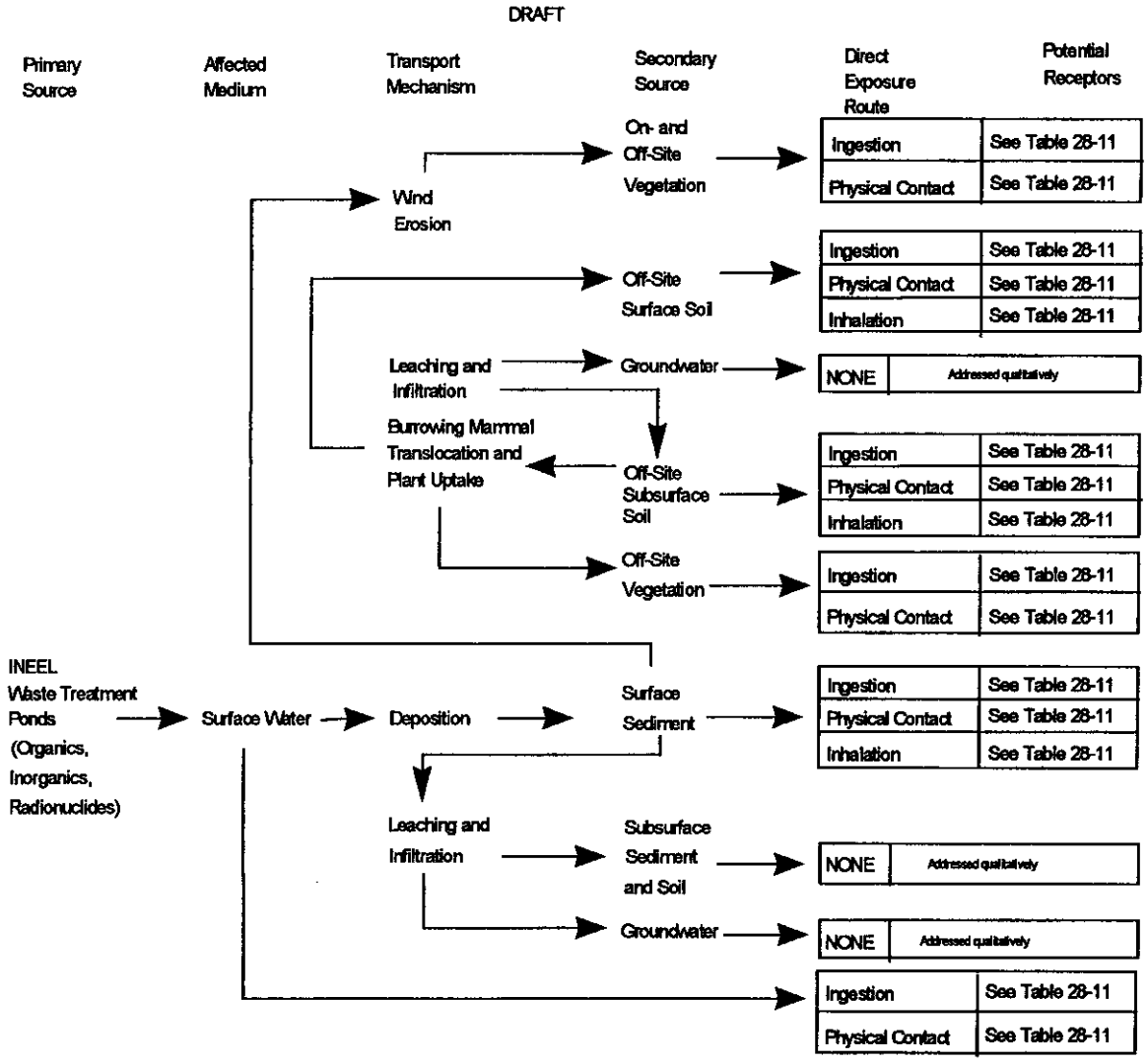

Figure 28-6. Ecological pathways/exposure model for WAG 3 surface water contamination.

prevention plan, and contaminant transport to ecological receptors through this pathway is unlikely (Walker, 1994; DOE, 1993). Perched water and groundwater are present; however, for this assessment, it is assumed that no pathways to surface ecological receptors exist for these sites.

28.2.9 Conceptual Site Model

The pathways/exposure models for surface soil, subsurface soil, and surface water were integrated to produce the WAG 3 CSM shown in Figure 28-7. This model reflects both direct (previous sections) and indirect (i.e., predation) receptor exposure pathways for WAG 3 COPCs.

28.2.10 Development of Assessment Endpoints

This section addresses the development of assessment endpoints. Assessment endpoints are "formal expressions of the actual environmental values that are to be protected" (Suter, 1989). Assessment endpoints developed for this WAG ERA are presented on Table 28-13. The endpoints were developed around the protection of INEEL biota represented by functional groups and individual T/E and sensitive species known to exist at WAG 3 and identified as having potential for exposure to COPCs. Each T/E and sensitive species with the potential for exposure is addressed individually in the risk analysis, whereas potential effects to other receptors of concern are dealt with at the functional group level. Assessment endpoints defined for the WAG 3 ERA reflect OU 10-04 hazard/policy goals discussed in the Guidance Manual (VanHorn et al., 1995) and incorporate the suggested criteria for developing assessment endpoints, including ecological relevance and policy goals (EPA, 1992; Suter, 1993).

These assessment endpoints are the focus for WAG ERA risk characterization and link the measurement endpoints to the WAG ERA goals. The primary objective of this WAG ERA is to identify COPCs and levels of those contaminants that represent potential risk to WAG 3 ecological components. Consequently, toxic effects to ecological components as a result of exposure to COPCs were considered a primary concern for WAG 3 biota. Although adverse effects due to physical stressors are also of concern in evaluating potential risks to INEEL ecological components, these effects are not addressed by the WAG ERA. This was used to establish the potential for contaminants to contribute to ecological risk to WAG 3 individuals and populations. The HQ is used to indicate whether or not a potential for adverse effects exists. The use of the HQ as an indicator of effects is discussed in detail in Section 28.4.1.

28.2.11 Measurement Endpoint Selection

This section describes the selection of measurement endpoints for the WAG ERA. Measurement endpoints are measurable responses of ecological receptors to contaminants that can be related to ERA assessment endpoints. For this ERA, WAG 3 ecological components (flora and fauna) were not measured or surveyed directly. Rather, published references were used as the primary sources of ecological and toxicological data from which measurement endpoints were derived. Values extracted from these references were used to calculate dose for all ecological receptors and to develop TRVs for contaminants.

Table 28-14 summarizes the WAG 3 ERA assessment endpoints. Quantified critical exposure levels (QCELs) and adjustment factors (AFs) were constructed from the literature to develop appropriate TRVs for receptors associated with WAG 3 contaminant pathways. Criteria for development of these TRVs are discussed in Section 28.4.1. In general, the criteria incorporate the requirements for appropriate endpoints, including relevance to an assessment endpoint, applicability to the route of exposure, use of existing data, and consideration of scale (VanHorn et al., 1995).

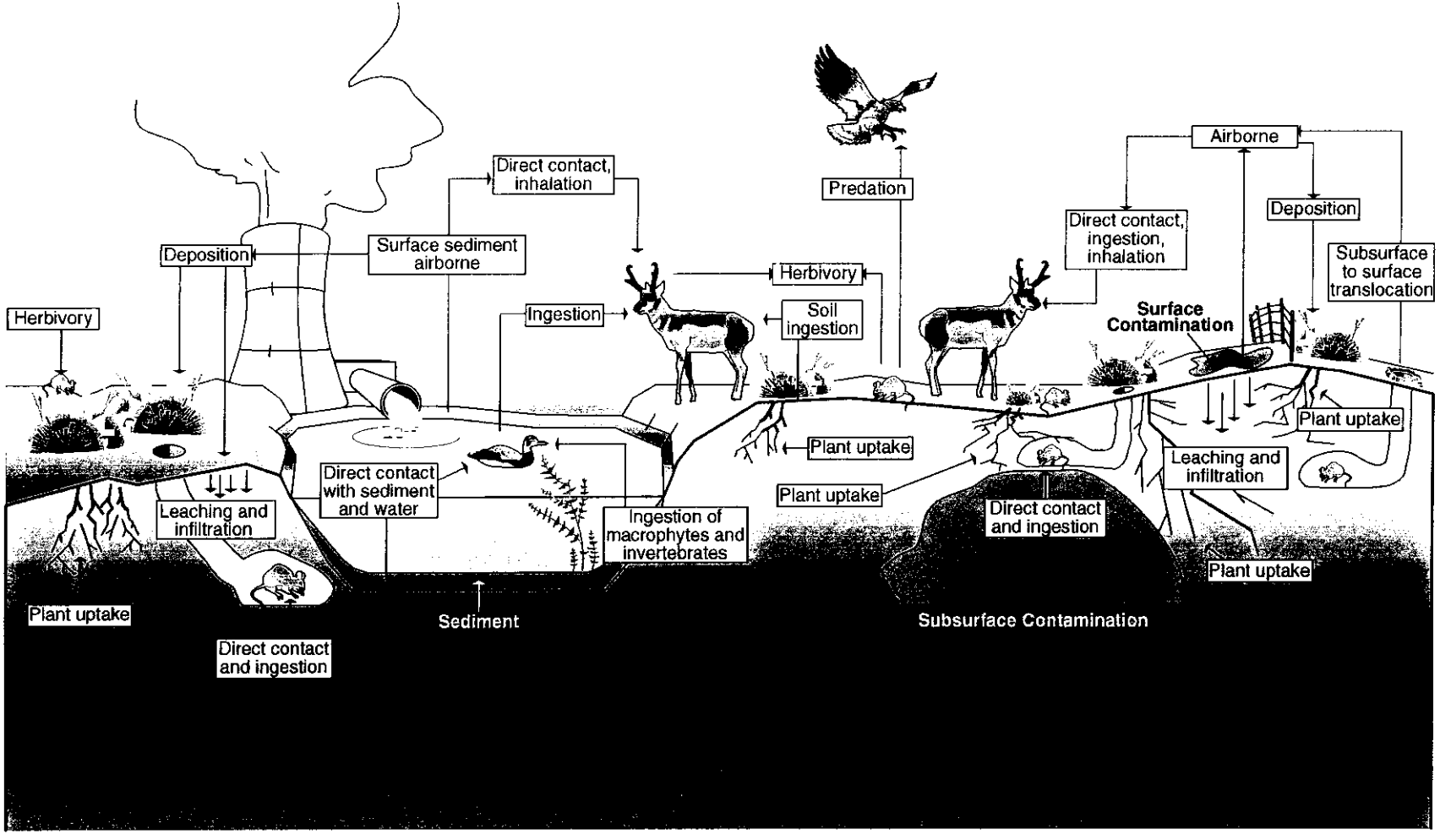

Figure 28-7. WAG 3 ecological conceptual site model.

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Table 28-13. Summary of assessment endpoints for WAG 3 ERA.

Management Goal	WAG Assessment Endpoint	Indicator of Risk[a]
Maintain INEEL T/E individuals and populations by limiting exposure to organic, inorganic, and radionuclide contamination.	No indication of possible effects (risk) to T/E individuals and populations as a result of contaminant exposure: peregrine falcon, northern goshawk, bald eagle, burrowing owl, ferruginous hawk, loggerhead shrike, white-faced ibis, black tern, pygmy rabbit, Townsend's western big-eared bat, long-eared myotis, small-footed myotis, sagebrush lizard, and trumpeter swan individuals and populations (Functional Groups AV310, AV322, AV322A, AV233, AV210, R222, M123 and M210A).	HQ ≥ target value
Maintain INEEL T/E individuals and populations by limiting exposure to physical stressors.	Not addressed by WAG ERA.	N/A
Maintain abundance and diversity of INEEL native biota by limiting exposure to organic, inorganic, and radionuclide contamination.	No indication of possible effects (risk) to WAG native vegetation communities as a result of contaminant exposure.	HQ ≥ target value
	No indication of possible effects (risk) to WAG wildlife populations as a result of contaminant exposure (represented by functional groups identified in the site conceptual model: waterfowl, small mammals, large mammals, song birds, raptors, top predators, invertebrates).	HQ ≥ target value
Maintain abundance and diversity of INEEL native biota by limiting exposure to physical stressors.	Not addressed by WAG ERA.	N/A

Source: Suter 1993

a. Based on original guidance provided by EPA (1994), this column might have been called the "measurement endpoint." Subsequent guidance from EPA (1996) now discusses measures/indicators of effects.

b. HQ=hazard quotient. The target value is 1 for nonradionuclide contaminants and 0.1 for radionuclide contaminants. The HQ approach does not consider variability and uncertainty in either exposure or toxicity estimates, and therefore does not represent a statistical probability of occurrence of adverse ecological effects. HQS provide essentially a "yes or no" determination of risk and are therefore well-suited for screening-level assessments (EPA 1988b). A limitation of the quotient method is that is does not predict the degree of risk or magnitude of effects associated with specified levels of contamination (EPA 1988b).

Table 28-14. Summary of WAG 3 ERA endpoints.

WAG 3 Assessment Endpoint	Ecological component	Functional Group (other groups represented)	Measurement Species (TRV test species)
Indication of risk to T/E individuals and populations as a result of contaminant exposure.	Pygmy rabbit	M122A (M123)	Rate, mouse/meadow vole (M122A), deer mouse
	Peregrine falcon, northern goshawk	AV310	Chicken, goshawk (AV310), American Kestrel/red-tailed hawk (AV322)
	Ferruginous hawk, loggerhead shrike, bald eagle, burrowing owl	AV322, AV322A	Chicken, goshawk (AV310), American kestrel/red-tailed hawk (AV322)
	Black tern, white-faced ibis, trumpeter swan	AV210, AV233, AV143	Mallard (AV143)
	Townsend's western big-eared bat, long-eared myotis, small-footed myotis	M210A (M210)	None located
	Sagebrush lizard	R222	None located
Indication of possible effects to WAG 3 native vegetation communities as a result of contaminant exposure.	Vegetation	Sagebrush, bunchgrass	Bush beans, crop plants
Indication of possible effects to WAG 3 wildlife populations as a result of contaminant exposure (represented by functional groups identified in the site conceptual mode: waterfowl, small mammal, large mammals, song birds, raptors, top predators, invertebrates)	Small mammals	M422, M122A (M222, M123)	Rat, mouse/meadow vole (M122A), deer mouse (M422)
	Mammalian carnivore/omnivores	M422A, M322	Rat, mouse, dog, cat, mink/fox
	Mammalian herbivores	M122 (M121)	Rat, mouse, mule deer/pronghorn (M122)
	Mammalian insectivore	M210A, M222 (M210)	None located.
	Avian carnivores	AV322, AV310	Goshawk (AV310), American kestrel/red-tailed hawk (AV322)
	Avian herbivores	AV122 (AV121)	Chicken, pheasant, quail, passerines/sharp-tailed and ruffed grouse
	Avian insectivores	AV210A, AV222, AV232 (AV210, AV221)	Chicken, pheasant, quail, passerines/American robin (AV222), cliff swallow (AV210A)
	Reptiles	R222, R322	Western racer/None located
	Invertebrates*	Phytophagous, saprophagous, entomophagous	Unidentified

Published values for species dietary habits, home ranges, site use, ED, soil ingestion, food digestion, and body weights for the representative species listed in Table 28-14. The exposure-point concentrations of contaminants in each media were used to calculate dose for each affected receptor.

The measurement endpoints are the modeled dose as compared to the TRVs for each contaminant for each receptor functional group. The modeled dose was divided by the TRV to produce an HQ for each contaminant and receptor of concern. The HQ is ultimately used to measure whether the assessment endpoints have been attained, that is, survival and reproductive success are ensured for the receptor groups being assessed (HQS are less than target value for all receptors for each contaminant).

28.3 Analysis

The risk analysis step of the WAG 3 ERA involves assessing exposure to contaminants (characterization of exposure) and potential effects of exposure (characterization of effects). These activities are conducted interactively to ensure that the methods used to assess exposure and effects are compatible. Assessing exposure and effects is based on the ecological endpoints and conceptual models derived during the problem formulation presentation.

A primary step in analyzing risk is to determine the potential for site-related contaminants to increase the incidence of adverse effects in exposed populations.. The objective of this activity is to estimate the magnitude, frequency, duration, and route of exposure to site-related contaminants by ecological receptors. Accomplishing this task involves completing the following steps:

1. Discuss the factors which influence contaminant fate and transport.

2. Estimate dose for all functional groups and contaminants.

28.3.1 Contaminant Fate and Transport

No formal transport and fate modeling was conducted for this WAG ERA. Environmental fate properties are important because they provide information on the environmental behavior of contaminant compounds throughout various environmental media. WAG 3 surface and subsurface soil contaminants, identified by the SLERA and subsequent sampling include the following:

- 4-chloroaniline
- 4-methyl-4-hydroxyl
- 2-pentanone
- acetone
- aluminum
- antimony
- arsenic
- benzo(a)pyrene
- benzo(b)fluoranthene
- benzo(k)fluoranthene
- boron
- cadmium
- chromium III
- chromium VI
- chrysene
- decanal
- di(2-ethylhexyl)phthalate
- fluoride
- indeno(1,2,3-cd)pyrene
- lead
- mercury
- nickel
- polychlorinated biphenyls
- selenium
- silver
- strontium
- Am-241
- Co-60
- Cs-134
- Cs-137
- Eu-152
- Eu-154
- Pu-239
- Pu-241
- Sr-90
- U-235

- TPH
- xylene
- barium
- copper
- cyanide

Many of the inorganic contaminants are metals. Soils represent the most concentrated source of metals in the terrestrial environment. The health risks posed by trace metals in soils are not determined solely by their quantity. A number of contaminant, environmental, and biological conditions and processes influence the accessibility and availability of metals to organisms, and hence their toxicological significance. First, speciation is a major determinant of the fate, bioavailability, absorption, and toxicologic characteristics of metal compounds. Second, the distribution coefficient between soil and water (K_d) depends upon both the properties of the metal and the composition of the soil. This coefficient also governs the bioavailability of a metal to organisms contacting the soil, with weakly bound metals highly bioavailable and more strongly bound metals less bioavailable. Other influential factors include: (1) the characteristics of the interface (e.g., lung, skin, intestine), (2) the reactivity of the metal with the interface, and (3) the concurrent presence of other metals or other substances that may stimulate or inhibit metal uptake. Factors that influence the fate and transport (and thereby bioavailability) of the WAG 3 COPCs are presented in Sections 28.3.4 through 28.3.6, along with discussions of the ecotoxicological effects for these contaminants.

28.3.2 Determining Exposure

Potential exposures for functional group, T/E, and sensitive species were determined based on site-specific life history and feeding habits when possible. Quantification of group and individual exposures incorporated species-specific numerical exposure factors including body weight, ingestion rate, and fraction of diet composed of vegetation or prey, and soil consumed from the affected area. Parameters used to model contaminant intakes by the functional groups are presented in Table 28-15. These values were derived from a combination of parameters that produced the most conservative overall exposure for the group. The functional group parameters in Table 28-15 represent the most conservative combination of percent prey, percent vegetation, percent soil, ED, ingestion rate, body weight, and home ranges from species within the functional group.

Each receptor's diet was assumed to be composed of percentages of two food types (i.e., percentages of either prey or vegetation) to simplify exposure calculations. For example, herbivorous animals are assumed to consume solely vegetation taken from the WAG 3 area (i.e., 100% of the vegetation consumed by herbivores comes from WAG 3). While this is a simplistic and conservative assumption, breaking down the diet of individual species within a functional group in more detail, while warranted, is beyond the scope of a WAG ERA. Most terrestrial receptors incidentally or directly ingest soil, and the percent of soil ingested from that affected area was also estimated. Insectivores are not determined because of the complexity of contaminant intake from insects to insectivores, and the data are currently inadequate to support the insect prey methodology in the assessment. Therefore, the method used for estimating contaminant concentrations in insect prey poses large uncertainty.

Exposure estimates were corrected for the WAG 3 site areas by the use of SUFs. The SUF is the WAG 3 site area (ha) divided by the species' home range (ha) to a maximum of 1. The SUF is the proportion of the site area to the home range and is not allowed to be greater than 1 (the animal can use no more than 100% of the site area). Home ranges for the functional groups at WAG 3 are summarized in Table 28-15. A

Table 28-15. WAG 3 species parameters.

Functional Groups	PP[a]	PV[b]	PS[c]	ED[d]	IR (kg/day)[e]	BW (kg)[f]	HR (Ha)[g]	WI (L/day)[h]
Amphibian (A232)	9.41E-01	0.0000	5.90E-02	1.00E+00	6.49E-05	8.00E-03	1.24E-01	0.00E+00
Avian herbivores (AV122)	0.0000	9.07E-01	9.30E-02	1.00E+00	1.46E-03	3.50E-03	5.18E+00	1.33E-03
Avian herbivores- aquatic (AV143)	0.0000	9.18E-01	8.20E-02	6.50E-01	2.92E-02	3.47E-01	aquatic	2.90E-02
Avian insectivores (AV210)	9.70E-01	0.0000	2.00E-02	6.50E-01	2.90E-03	1.00E-02	8.38E+00	2.70E-03
Avian insectivores (AV210A)	9.70E-01	0.0000	3.00E-02	6.50E-01	3.89E-03	1.46E-02	2.39E+00	3.48E-03
Avian insectivores (AV222)	9.07E-01	0.0000	9.30E-02	1.00E+00	3.07E-03	1.09E-02	3.80E-01	2.86E-03
Avian carnivores (AV310)	9.80E-01	0.0000	2.00E-02	1.00E+00	1.02E-02	1.47E-01	1.01E+03	1.63E-02
Avian carnivores (AV322)	9.80E-01	0.0000	2.00E-02	1.00E+00	7.44E-03	4.25E-02	9.00E+00	7.11E-03
Avian omnivores (AV422)	6.27E-01	2.08E-01	9.30E-02	1.00E+00	1.13E-02	8.02E-02	1.10E+01	1.09E-02
Avian omnivores- aquatic (AV442)	6.20E-01	2.70E-01	1.10E-01	1.00E+00	4.41E-02	6.54E-01	aquatic	4.44E-02
Mammalian herbivores (M122)	0.0000	9.37E-01	6.30E-02	1.00E+00	3.30E-03	1.10E-02	2.30E+01	1.71E-03
Mammalian herbivores (M122A)	0.0000	9.23E-01	7.70E-02	1.00E+00	4.27E-03	1.57E-03	3.00E-01	2.35E-03
Mammalian insectivores (M210)	9.80E-01	0.0000	2.00E-02	5.00E-01	1.43E-03	9.03E-03	2.39E+00	1.43E-03
Mammalian insectivores (M210A)	9.80E-01	0.0000	2.00E-02	2.50E-01	1.43E-03	4.65E-03	2.39E+00	7.88E-04
Mammalian insectivores (M222)	9.76E-01	0.0000	2.40E-02	1.00E+00	1.66E-03	6.00E-03	1.24E-01	9.91E-04
Mammalian carnivore (M322)	9.23E-01	0.0000	7.70E-02	1.00E+00	1.66E-01	1.78E+00	1.30E+01	2.09E-02

Table 28-15. (continued).

Functional Groups	PP[a]	PV[b]	PS[c]	ED[d]	IR (kg/day)[e]	BW (kg)[f]	HR (Ha)[g]	WI (L/day)[h]
Mammalian omnivores (M422)	8.04E-01	1.00E-01	9.40E-02	1.00E+00	3.06E-03	1.70E-02	7.20E-03	2.53E-03
Reptilian insectivores (R222)	9.76E-01	0.0000	2.40E-02	1.00E+00	5.60E-05	6.60E-02	1.17E-01	0.0000
Reptilian carnivores (R322)	9.52E-01	0.0000	4.80E-02	1.00E+00	6.80E-03	1.50E-02	3.00E+00	0.0000
Plants	0.0000	0.0000	1.00E+00	1.00E+00	—	—	—	—
Northern goshawk (*Accipiter gentilis*)	9.80E-01	0.0000	2.00E-02	1.00E-01	1.61E-02	1.39E+01	2.18E+02	1.57E-02
Ferruginous hawk (*Buteo regalis*)	9.80E-01	0.0000	2.00E-02	1.00E-00	7.44E-03	4.25E+02	9.00E+00	7.11E-03
Burrowing owl (*Athene cunicularia*)	9.70E-01	0.0000	3.00E-02	2.50E-01	1.73E-02	1.55E-01	1.00E+01	1.69E-02
Pygmy rabbit (*Brachylagus idahoensis*)	0.0000	9.23E-01	7.70E-02	1.00E+00	4.27E-03	1.57E-02	3.00E-01	2.35E-03
Townsend's western big-eared bat (*Plecotus townsendii*)	9.80E-01	0.0000	2.00E-02	2.50E+01	1.43E-03	4.65E-03	2.39E-00	7.88E-04
Long-eared myotis (*Myotis evotis*)								
Small-footed myotis (*Myotis subulatus*)	9.80E-01	0.0000	2.00E-02	2.50E+01	1.43E-03	4.65E-03	2.39E-00	7.88E-04

Table 28-15. (continued).

Functional Groups	PP[a]	PV[b]	PS[c]	ED[d]	IR (kg/day)[e]	BW (kg)[f]	HR (Ha)[g]	WI (L/day)[h]
Sagebrush lizard (*Sceloporus graciosus*)	9.76E-01	0.0000	2.40E-02	1.00E+00	5.65E-05	6.61E-03	61.17E-01	0.0000

a. PP = percentage of diet represented by prey ingested (unitless). Herbivores = 0% prey, total PV = PV-PS; carnivores = 0% vegetation, total PP - PS): and omnivores =(1.00-PS)/2 for PP and PV.

b. PV = percentage of diet represented by vegetation ingested (unitless).

c. PS = percentage of diet represented by soil ingested (unitless). Soil ingestion from Beyer et al. (1994) and Arthur and Gates (1988) - (pronghorn, jackrabbit).

d. ED = exposure duration (fraction of year spent in the affected area) (unitless). Conventions: Residents - 0.05-1.00 (birds and migratory and transient mammals) 1.00 (small mammals); breeding - 0.05-0.65 (birds and migratory and transient mammals); summer visitors - 0.05-0.25; winter visitors - 0.05-0.25.

e. IR = ingestion rate [derived using allometric equations based on body weight (Nagy, 1987)] (kg/day).

f. BW = receptor-specific body weight (kg). Mammalian body weight primarily from Burt and Gotssenheider (1976) and EPA Exposure Factors Handbook (1993a) for some species. Avian body weight from Dunning (1993).

g. Home ranges from Hoover and Wills (1987). >Unknown = defaulted to an SUF of 1.0 (i.e., assumes 100% site use).

h. WI = water ingestion rates derived using allometric equation (Nagy, 1987).

SUF of less than 1 indicates that the home range is larger than the area affected, and it is likely that these functional groups or T/E species consume prey, vegetation, and soil from unaffected areas.

ED is based on the migratory pattern of the receptors. This is determined using the status and abundance data compiled for site species (VanHorn et al., 1995). Five status/abundance categories are represented: resident, breeding, summer visitor, migratory, and winter visitor. For year-round residents, ED is assumed to be 1 (i.e., receptors potentially spend up to 100% of the year on the assessment area). For species breeding onsite, the ED is assumed to be 0.65, (i.e., receptors potentially spend up to 65% of the year on the assessment area). For migratory summer and winter visitors, the ED is assumed to be 0.25 (i.e., receptors potentially spend up to 25% of the year on the assessment area). The most conservative ED duration is chosen from the functional group members to represent the functional group ED.

Food intake rates (g dry weight/day) for passerine birds, nonpasserine birds, rodents, herbivores, all other mammals, and insectivorous reptiles can be estimated using the following allometric equations (Nagy, 1987). The equation for insectivorous reptiles can be conservatively assumed to be applicable to the carnivorous reptiles (R322). Because of the fact that different allometric equations may apply to different species within a group, the equations representative of all mammals and avians were used to calculate the ingestion rate for the functional groups.

$$\textit{Food intake rate} = 0.398\ BW^{0.850}\ \textit{(passerines)} \quad (28\text{-}1)$$

$$\textit{Food intake rate} = 1.110\ BW^{0.445}\ \textit{(desert bird)} \quad (28\text{-}2)$$

$$\textit{Food intake rate} = 0.648\ BW^{0.651}\ \textit{(nonpasserines)} \quad (28\text{-}3)$$

$$\textit{Food intake rate} = 0.583\ BW^{0.585}\ \textit{(rodents)} \quad (28\text{-}4)$$

$$\textit{Food intake rate} = 0.577\ BW^{0.727}\ \textit{(herbivores)} \quad (28\text{-}5)$$

$$\textit{Food intake rate} = 0.015\ BW^{0.874}\ \textit{(desert mammals)} \quad (28\text{-}6)$$

$$\textit{Food intake rate} = 0.013\ BW^{0.773}\ \textit{(insectivorous reptiles)} \quad (28\text{-}7)$$

where

BW = body weight in grams.

An equation for ingestion rates for carnivorous reptiles was compiled from Diller and Johnson (1988).

$$\textit{Food intake rate} = BW^{1.5}/100\ \textit{days per year (carnivorous reptiles)} \quad (28\text{-}8)$$

Exposure of each functional group was calculated using best available estimates for species-specific exposure parameters. Each of the receptors was evaluated individually. Potential exposures for these species was determined based on the species' life history and feeding habits. Quantification of exposures used species-specific numerical exposure factors including body weight, ingestion rate, fraction of diet composed of vegetation or prey, and soil consumed from the affected area. Species parameters used to model intakes by the functional groups are presented in Table 28-15. These values are derived from the various key species in

the functional groups. The parameters in Table 28-15 are the maximum percent prey, percent vegetation, percent soil, and ED and the maximum ingestion-rate-to-body-weight ratio and home range for each functional group because these values were the most conservative. Percent soil ingestion rate values come from the *Wildlife Exposure Factors Handbook* (EPA, 1993a) and Beyer et al., (1994) and site specific-data where available.

28.3.2.1 Exposure to Nonradiological Contaminants. The exposure equation used to calculate average daily soil intake is used to calculate the dose to functional groups and T/E species. For example, dose (intake) in mg/kg body weight-day can be estimated using the following equation, as adapted from EPA's *Wildlife Exposure Factors Handbook* (EPA, 1993a):

$$EE_{tot} = \frac{[(PP \times CP) + (PV \times CV) + (PS \times CS)] \times IR \times ED \times SUF}{BW} \quad (28\text{-}9)$$

where

EE_{tot} = estimated exposure from all complete exposure pathways (mg/kg body weight-day)

PP = percentage of diet represented by prey ingested (unitless)

CP = concentration of contaminant in prey item ingested (mg/kg)

PV = percentage of diet represented by vegetation ingested (unitless)

CV = concentration of contaminant in vegetation ingested (mg/kg)

PS = percentage of diet represented by soil ingested (unitless)

CS = concentration of contaminant in soil ingested (mg/kg)

IR = ingestion rate (kg/day), food intake rate (g/day) divided by 1,000 g/kg

ED = exposure duration (fraction of year spent in the affected area) (unitless)

BW = receptor-specific body weight (kg)

SUF = site usage factor (site area divided by home range; cannot exceed 1) (unitless).

The concentration of contaminant in prey can be estimated using the equation (VanHorn et al, 1995):

$$CP = CW \times BAF \quad (28\text{-}10)$$

where

CP = concentration in prey item ingested (mg/kg)

CS = concentration of contaminant in soil (mg/kg)

BAF = contaminant-specific bioaccumulation factor (unitless).

The concentration of contaminant in vegetation can be estimated using the equation (VanHorn et al. 1995):

$$CV = CS \times PUF \tag{28-11}$$

where

CV = concentration of contaminant in vegetation (mg/kg)

CS = concentration of contaminant in soil (mg/kg)

PUF = contaminant-specific plant uptake factor (unitless).

Finally, burrowing and nonburrowing animals are potentially exposed to different soil concentrations. In order to account for this, nonburrowing animals are expected to only ingest surface soils; however, their prey are still considered to be potentially exposed to subsurface conditions.

Combining Equations 28-10 through 28-11 gives the following total dose to nonradiological contaminants in mg/kg body weight-day:

for nonburrowers, and

$$EE_{tot} = [(PP \times BAF + PV \times PUF + PS) \times CS_g \times IR + WI \times CW] \left(\frac{ED \times SUF}{BW} \right) \tag{28-12}$$

for burrowers

$$EE_{tot} = \{[(PP \times BAF + PV \times PUF) \times CS_g + CS_s \times PS] \times IR + WI \times CW\} \times \left(\frac{ED \times SUF}{BW} \right) \tag{28-13}$$

where

WI = water ingestion rate (L/d)

CS_s = surface soil concentration (mg/kg)

CS_g = the greater of the surface and subsurface soil concentrations (mg/kg)

CW = concentration of contaminant in water (mg/L).

The water ingestion is found from the following equations (EPA, 1993a):

$$WI = 0.059\, BW^{0.67} \text{ (for birds)} \tag{28-14}$$

$$WI = 0.099\ BW^{0.90}\ (\textit{for mammals}) \quad (28\text{-}15)$$

Due to the complexity of water ingestion by reptiles, no general reptilian water ingestion equation is available. It is assumed here that desert reptiles, such as those found at the INEEL, get their water solely from prey.

Water concentrations of contaminants at CPP-65 came from two sources. The primary source for water concentrations at the Sewage Treatment Plant was from the INEEL's Liquid Effluent Monitoring Program. The Liquid Effluent Monitoring Program recently began taking monthly samples from effluent stream CPP-773B (effluent from the Sewage Treatment Plant). Liquid Effluent Monitoring Program data was available for the period September 1995 to February 1996. The other source of water concentrations is the Track 1 document (WINCO, 1994a). These data are based upon 1988-1990 radionuclide sampling data and 1992 lagoon water sampling data. The Sewage Treatment Plant does not provide habitat for fish; therefore, the water concentrations were evaluated from a wildlife drinking water perspective only.

Water concentrations of contaminants at CPP-67 came from a variety of documents and databases. The primary source for water concentrations at the Percolation Ponds was from the INEEL's Liquid Effluent Monitoring Program. The Liquid Effluent Monitoring Program recently began taking approximately quarterly samples from CPP-797A (Percolation Ponds). Liquid Effluent Monitoring Program data were available for the period September 1995 to February 1996. Sediment concentrations were also used to derive water concentrations. That is, when a contaminant was observed in the sediments, but not in the effluent data, the sediment concentrations were used to derive a water concentration. All radionuclide concentrations are from the human health risk assessment. The organic and inorganic sediment concentrations are from the Track 1 document (WINCO, 1994b). The Percolation Ponds are used on an alternating schedule, and therefore, one is dry when the other is in use.

The observed effluent concentrations are compared against available toxicological benchmarks for wildlife exposure through drinking water (Opresko et al., 1995), as shown in Table 28-16 for CPP-65 and Table 28-17 for CPP-67. If the effluent concentration exceeds the benchmark value, that contaminant will be considered in the water ingestion pathway.

Some of the potential contaminants identified in the effluent monitoring samples are not considered in this ecological risk assessment. These include the essential elements Ca, K, Mg, and Na. These elements do not have toxicological benchmarks for wildlife. These elements and are essential for animal growth and survival, and are therefore readily metabolized and generally non-toxic.

When a contaminant is present in the sediments but is not present in the effluent monitoring results, a surface water concentration was calculated by assuming that the partitioning of the contaminant in the sediment and water reaches equilibrium. In this case, the equation used to calculate nonradionuclide concentrations in surface water from concentrations in sediment is:

$$CW = \frac{1{,}000 mL/L \times Cs \times \rho \times 1\ kg/1{,}000\ g}{K_d \rho + \theta} \quad (28\text{-}16)$$

Table 28-16. Screening of liquid effluent concentrations at the Sewage Treatment Plant, CPP-65.

COPC	Liquid Effluent Concentration (mg/L)[a]	Toxicological Benchmark (mg/L or pCi/L)[b]	Water Concentration of Concern(mg/L)[c]
As	1.0E-03	1.6E-01	—
Ba	8.4E-02	1.56E+01	—
Cd	5.0E-03	2.3E-02	—
Cl	9.5E+01	2.3E+05[e]	—
Cr	6.0E-03	9.36E+00	—
Cu	1.7E-02	4.7E+01	—
Pb	2.8E-03	1.01E+01	—
Hg	1.0E-04	9.1E-02	—
Mo	1.7E-02	3.3E-01	—
Ni	1.5E-02	1.14E+02	—
Se	2.0E-03	9.6E-02	—
Ag	1.0E-03	NA	1.0E-03[d]
Zn	2.7E-02	3.04E+02	—
Nitrate	1.21E+01	1.9E+03	—
Total phosphorous	2.9E+00	NA	2.9E+00[e]
Plutonium-239/240	1.9E-03[f]	NA	—
Strontium-90	3.6E-01[f]	NA	—

a. Effluent concentrations are mean concentrations, except Cl, nitrate, and total phosphorous are maximum observed concentrations. Units are mg/L, except for radionuclides, which are pCi/L.

b. These are toxicological benchmarks for wildlife exposure through drinking water from Opresko et al., (1995) unless otherwise noted. The lowest applicable NOAEL-based benchmark was selected from the Opresko et al. (1995) database for conservative screening purposes. NA = not available.

c. Based on EPA Region IV Water Management Division, Water Quality Standards Unit's Screening List (Suter II and Tsao, 1966). This contaminate was eliminated form the assessment based on this criteria.

d. Silver toxicity is related to water hardness. At water hardnesses of 50, 100 and 200 $mg \cdot L^{-1}$ as $CaCo_3$, the U.S. EPA (1980) recommended that the concentration of total recoverable silver not exceed 1.2, 4.1 and 13 $\mu g \cdot L^{-1}$, respectively, at any time. The water hardness at INEEL has a maximum of 500 mg/L. Therefore toxicity would be lower. Also the concentration in the effluent is within the range seen as background nationally. Kopp (1969) found silver in 6.6% of 1,577 surface waters sampled with a mean detected concentration of 2.6 µg/L (range: 0.1– 38 µg/L). For 1970–1979, according to U.S. surface water sampling data from EPA's STORET database, the annual mean levels ranged from 1 µg/L to 9 µg/L and annual maximum concentrations were 94 µg/L to 790 µg/L (Scow et al. 1981). Based on this rationale the silver at the concentration in the effluent was eliminated as a concern.

e. Phosphorous is an essential component of the animal body and eliminated as a concern at this level. Excess phosphorous is excreted in the urine (NAS, 1980). This contaminant will be eliminated as a concern based on this rationale.

f. Radionuclide levels acceptable as drinking water for human receptors should be acceptable for ecological receptors as well. These contaminants will be eliminated based on this criteria.

where

Cs = concentration of the nonradionuclide in sediment (mg/kg)

ρ = soil bulk density (g/cm^3)—assumed to be 1.5 g/cm^3

θ = volumetric moisture content (m^3/m^3)—assumed to be 0.32 m^3/m^3

K_d = partition coefficient between soil and water ([mg/g soil]/[mg/cm^3 water])

The K_d values shown in Table 28-17 are based on a compilation of observed K_d values reported in a variety of references (Baes and Sharp, 1983; Coughtrey et al., 1985; Del Debbio and Thomas, 1989; Hawkins and Short, 1965; Looney et al., 1987; Schmalz, 1972; and Sheppard and Thibault, 1990). Specifically, the median K_d value reported from those references is used in Tables 28-17 and Table 28-20 for radionuclides.

When no K_d value is available, the recommended Track 2 values were used (DOE-ID, 1993). When even these were not available, a conservative value of zero was used.

The following functional groups and T/E species are considered burrowers: AV210A, M122A, M210A, M222, M322, M422, M422A, R222, R322, burrowing owl, pygmy rabbit, Townsend's western big-eared bat, and the sagebrush lizard.

Contaminant-specific PUFs and BAFs for nonradionuclides contaminants are presented in Table 28-18. PUFs for all metals are taken from Baes et al. (1984). The PUF and BAFs for organics are estimated using the Travis and Arms (1988) equation of 1.588-0.578 log K_{ow} and -7.735 + 1.033 log K_{ow}, respectively. Log partitioning coefficients (K_{ow}s) were taken from Montgomery and Welkom (1990).

28.3.2.2 Dose for Radiological Contaminants. The following sections describe the estimation of dose for radiological contaminants. Both internal and external radiation dose development are described separately.

Internal Radiation Dose—Internal radiation dose estimates are calculated by assuming that the steady-state whole body concentration is equivalent to the steady-state concentration of radionuclides in reproductive organs using the equation:

Table 28-17. Screening of nonradionuclide liquid effluent concentrations at CPP-67, Percolation Ponds.

COPC	Liquid Effluent Concentration (mg/L)[a]	Sediment Concentration (mg/kg)	K_d (cm^3/g)[c]	Calculated Water Concentration (mg/L)	Toxicological Benchmark (mg/L)[b]	Results of Screening[d]
Al	ND (4E-02)	—	—	—	2.45E+00	E
As	ND (1.5E-03)	—	—	—	1.6E-01	E
Ba	1.04E-01	—	—	—	1.56E+01	E
Be	—	5.00E-01	250	3.3E-03	1.88E+00	E
Cd	ND (1E-03)	—	—	—	2.3E-02	E
Cl	2.98E+02	—	—	2.98E+02	NA	NB

Table 28-17. (continued).

COPC	Liquid Effluent Concentration (mg/L)[a]	Sediment Concentration (mg/kg)	K_d (cm^3/g)[c]	Calculated Water Concentration (mg/L)	Toxicological Benchmark (mg/L)[b]	Results of Screening[d]
Cr	6.30E-02	—	—	—	9.36E+00	E
Co	—	4.60E+00	55	8.33E-02	NA	NB
Cu	6.30E-03	—	—	—	4.7E+01	E
Fe	5.70E-02	—	—	—	NA	NB
Pb	ND (1.5E-02)	—	—	—	1.01E+01	E
Mn	1.60E-03	—	—	—	2.51E+02	E
Hg	ND (2.5E-04)	—	—	—	9.1E-02	E
Ni	4.50E-03	—	—	—	1.14E+02	E
Se	ND (1E-03)	—	—	—	9.6E-02	E
Ag	ND (2E-03)	—	—	—	NA	NB
Tl	—	2.10E-01	3,300	6.36E-05	2.1E-02	E
V	—	1.88E+01	1,000	1.88E-02	5.4E-01	E
Zn	—	4.58E+01	18	2.51E+00	3.04E+02	E
Cyanide	—	1.20E-01	0.0000	5.63E-01	1.8E+02	E
Fluoride	ND (5.4E-01)	—	—	—	7.48E+01	E
Nitrate	5.58E+00	—	—	—	1.9E+03	E
Nitrite	ND (8E-0)	—	—	—	NA	NB
Phosphate	5.22E+00	—	—	—	NA	NB
Sulfate	5.15E+01	—	—	—	NA	NB
Sulfide	—	1.57E+01	0.0000	7.34E+01	NA	NB
Anthracene	—	2.40E-01	0.0000	1.13E+00	NA	NB
Benzo(a)anthracene	—	6.20E-01	0.0000	2.91E+00	NA	NB
Benzo(a)pyrene	—	3.50E-01	0.0000	1.64E+00	1.27E+00	X
Benzo(b)fluoranthene	—	4.40E-01	0.0000	2.06E+00	NA	NB
Bis(2-ethylhexyl)phthalate	—	2.50E-01	18.0000	1.37E-02	1.0E+01	E
Chrysene	—	6.00E-01	0.0000	2.81E+00	NA	NB
Fluoranthene	—	1.50E+00	0.0000	7.03E+00	NA	NB
Methylene chloride	—	1.10E-02	0.0000	5.16E-02	1.67E+01	E
Phenanthrene	—	8.10E-01	0.0000	3.80E+00	NA	NB
Pyrene	—	9.30E-01	100	8.08E-00	NA	NB

a. Effluent concentrations are maximum observed concentrations. ND = not detected; detection limit is in parentheses.

b. These are toxicological benchmarks for wildlife exposure through drinking water from Opresko et al. (1995). The lowest applicable NOAEL-based benchmark was selected from the Opresko et al. (1995) database for conservative screening purposes. Concentrations are given if the observed or calculated water concentration exceeds the toxicological benchmark. The resulting final concentrations are used as the water concentrations in the internal ingestion route of exposure. NA = Not available.

c. The K_d values are based on a compilation of available K_d values in the literature, except for Be and V, which are from the Track 2 guidance manual. When no K_d value is available, it is conservatively assumed to be zero.

d. E=Eliminate, NB=no benchmark, X=exceeds benchmark.

Table 28-18. PUFs and BAFs for WAG 3 nonradionuclide contaminants (unitless).

	PUF[a]	BAF[b] for Insectivores	BAF for Predators	BAF for Omnivores
Inorganics[c]				
Aluminum	4.0E-03	1.0E+00	4.0E-03	1.0E+00
Antimony	2.0E-02	9.0E-01	6.0E-03	9.0E-01
Arsenic	4.0E-02	1.0E+00	4.0E-02	1.0E+00
Barium	1.5E-02	1.0E+00	1.5E-02	1.0E+00
Boron	4.0E+00	1.0E+00	8.0E-04	1.0E+00
Cadmium	5.5E-01	1.1E+00	1.9E+00	1.9E+00
Chromium III	7.5E-03	6.0E-02	2.0E-01	2.0E-01
Chromium VI	7.5E-03	6.0E-02	2.0E-01	2.0E-01
Fluoride	1.0E+00	1.0E+00	1.0E+00	1.0E+00
Lead	4.5E-02	3.0E-01	6.0E-01	6.0E-01
Mercury	9.0E-01	4.0E-01	7.0E-01	7.0E-01
Nickel	6.0E-02	1.0E+00	6.0E-03	1.0E+00
Selenium	2.5E-02	1.0E+00	2.5E-02	1.0E+00
Silver	4.0E-01	1.0E+00	4.0E-01	1.0E+00
Strontium[d]	7.5E-02	1.5E+00	1.5E+00	1.5E+00
Organics[e]				
Acetone	5.3E+01	5.5E-07	5.5E-07	5.5E-07
Aroclor 1254	1.3E-02	4.0E-04	4.0E-04	4.0E-04
Benzo(a)pyrene	1.2E-02	4.1E-04	4.1E-04	4.1E-04
Benzo(b)fluoranthene	1.2E-02	4.1E-04	4.1E-04	4.1E-04
Benzo(g,h,i)pyrene	6.7E-03	6.5E-04	6.5E-04	6.5E-04
Benzo(k)fluoranthene	1.2E-02	4.1E-04	4.1E-04	4.1E-04
4-Chloraniline	3.4E+00	4.9E-06	4.9E-06	4.9E-06

Table 28-18. (continued).

	PUF[a]	BAF[b] for Insectivores	BAF for Predators	BAF for Omnivores
Chrysene	2.2E-02	2.5E-04	2.5E-04	2.5E-04
Di-2-ethylhexylphthalate	1.0E+00	1.0E+00	1.0E+00	1.0E+00
Indeno(1,2,3-cd)pyrene	6.8E-03	6.5E-04	6.5E-04	6.5E-04
Naphthalene	1.6E-01	5.3E-05	5.3E-05	5.3E-05
Phenanthrene	1.0E-01	7.6E-05	7.6E-05	7.6E-05

a. PUF = plant uptake factor.

b. Bioaccumulation factor

c. Values and or literature (Appendix K) for inorganics come from Baes et al. (1984).

d. Site-specific data (VanHorn et al., 1995).

e. Values for organics come from allometric equations presented in Travis and Arms (1988).

$$Dose = \frac{TC \times ED \times SUF \times AE \times 3{,}200\ dis/day\text{-}pCi}{6.24 \times 10^9\ MeV/g\ tissue\text{-}Gy} \qquad (28\text{-}17)$$

where

Dose = radiation dose estimate (Gy/day)

TC = tissue radionuclide concentration (pCi/g)

ED = exposure duration (fraction of year spent in affected area) (unitless)

AE = average absorbed energy (MeV/dis).

Since tissue levels of radionuclides are derived by multiplying the concentration of radionuclide in soil by a radionuclide-specific concentration factor (CF) for all terrestrial animals or terrestrial plants, the above equation can be rewritten as:

$$Dose = \frac{CS \times CF \times ED \times SUF \times AE \times 3{,}200\ dis/day\text{-}pCi}{6.24 \times 10^9\ MeV/g\ tissue\text{-}Gy} \qquad (28\text{-}18)$$

where

Dose = internal radiation dose estimate (Gy/day)

CS = concentration of contaminant in soil ingested (pCi/g soil)

CF = concentration factor [unitless; determined by (pCi/g tissue)/(pCi/g soil)]

ED = exposure duration (unitless)

AE = average absorbed energy (MeV/dis).

For alpha-emitting radionuclides, the dose is multiplied by 20 to account for the increased quality of alpha radiation.

As mentioned in Section 28.2.9, water ingestion of radionuclides may occur at Percolation Ponds #1 and #2 (CPP-67). To get the water ingestion of contaminants, a simple differential equation was used.

$$\frac{dTC}{dt} = I - \lambda_1(TC) - \lambda_2(TC) - L \qquad (28\text{-}19)$$

where

TC = tissue concentration (pCi/g tissue)

I = intake [(pCi/L) (L/g tissue-day)]

λ_1 = radiological decay constant (1/day)

λ_2 = biological loss constant (1/day)

L = other loss (e.g., through urination) [(pCi/L) (L/g tissue-day)].

Conservatively assuming L = 0 and solving for TC at equilibrium (i.e., dTC/dt = 0) gives

$$TC = \frac{I}{\lambda_1 + \lambda_2} \qquad (28\text{-}20)$$

The daily ingestion rate of the radionuclide from water, I, is calculated as

$$I = \frac{CW \times WI}{BW \times 1{,}000\ g/kg} \qquad (28\text{-}21)$$

where

CW = concentration of the radionuclide in water (pCi/L)

WI = water ingestion rate (L/d)

BW = body weight (kg).

So the tissue concentration due to water ingestion is

$$TC = \frac{CW \times WI}{BW \times (\lambda_1 + \lambda_2) \times 1{,}000\ g/kg} \qquad (28\text{-}22)$$

Because water concentrations are not available, these concentrations had to be derived from the available sediment concentrations at CPP-67. The equation used to calculate water concentrations (pCi/L) from the sediment concentration is

$$CW = \frac{1{,}000\ mL/L \times Cs \times \rho}{K_d \rho + \theta} \qquad (28\text{-}23)$$

where

Cs = concentration of the radionuclide in sediment (pCi/g)

ρ = soil bulk density (g/cm^3)—assumed to be 1.5 g/cm^3

K_d = partition coefficient between soil and water [(pCi/g soil) / (pCi/cm^3 water)]

θ = volumetric moisture content (m^3/m^3)—assumed to be 0.32 m^3/m^3.

The K_d, λ_1, λ_2, CPP-67 sediment concentrations (C_S) and calculated water concentrations (CW) are shown in Table 28-19. The biological loss constants, λ_2, are based on data from Schultz and Whicker (1982), as discussed below. The radiological decay constants are derived directly from the radionuclide half-life data as

$$\lambda_1 = \frac{ln2}{t_{1/2}} \qquad (28\text{-}24)$$

where $t_{1/2}$ is the half-life (d) from Friedlander et al. (1981).

The biological loss constants are calculated from the observed retention times of radionuclides as documented in Schultz and Whicker (1982). The retention times represent the amount of time the radionuclide will remain in the body tissues. Schultz and Whicker (1982) give qualitative estimates of these times. If the retention time is high (on the order of years), a "biological half-life" of 5 years was assigned to the radionuclide. If the retention time was moderate (months), a biological half-life of 1 year was assigned to

Table 28-19. Calculation of water and sediment radionuclide concentrations at CPP-67, Percolation Ponds #1 and #2.[a]

Radionuclide	K_d	λ_1	Biological Half-life	λ_2	CS	CW
Am-241	8.1E+2	4.39E-06	5 yr[b]	3.80E-04	1.67E+0	2.06E+0
Ce-144	1.1E+3	2.44E-03	5 yr	3.80E-04	1.50E+0	1.36E+0
Co-60	5.5E+1	3.60E-04	30 d	2.31E-02	1.74E+0	3.15E+1
Cs-134	1.1E+3	9.22E-04	1 yr[c]	1.90E-03	3.50E+0	3.33E+0
Cs-137	1.1E+3	6.31E-05	1 yr	1.90E-03	9.36E+1	8.91E+1
H-3	1.0E-3	1.54E-04	30 d	2.31E-02	2.19E-1	1.02E+3
I-129	1.0E+0	1.19E-10	1 yr[c]	1.90E-03	1.43E+0	1.18E+3
Np-237	2.5E+1	8.87E-10	5 yr[b]	3.80E-04	1.34E+0	5.31E+1
Pu-238	1.5E+3	2.16E-05	5 yr	3.80E-04	1.20E+1	8.03E+0
Pu-239	1.5E+3	7.78E-08	5 yr	3.80E-04	8.89E-1	5.93E-1
Rh-106	0.0E+0[d]	2.01E+03	5 yr[b]	3.80E-04	4.92E+0	2.30E+4
Ru-106	2.2E+2	1.89E-03	30 d	2.31E-02	2.74E+0	1.24E+1
Sb-125	2.0E+3	7.03E-04	5 yr[b]	3.80E-04	1.21E+0	6.00E-1
Sr-90	2.4E+1	6.66E-05	5 yr	3.80E-04	9.97E+0	4.12E+2
U-234	4.0E+1	7.75E-09	1 yr[c]	1.90E-03	1.60E+0	3.97E+1
U-235	4.0E+1	2.70E-12	1 yr[c]	1.90E-03	3.55E-2	8.83E-1
U-238	4.0E+1	4.25E-13	1 yr	1.90E-03	1.39E+0	3.45E+1
Y-90	7.2E+2	2.60E-01	5 yr[c]	3.80E-04	1.20E+0	1.67E+0

a. Symbol definitions and units are given in the text.

b. No biological retention data was available; a conservative value of 5 years is assumed.

c. For Cs-134, I-129, Pu-238, U-234, U-235, and Y-90, the biological half-life values of Cs-137, I-131, Pu-239, U-238, U-238, and Y-91 are used, respectively.

d. No K_d data were available for Rh-106, so a conservative value is used instead.

the radionuclide. If the retention time was low (days), a biological half-life of 30 days was assigned to the radionuclide. The biological loss constants, λ_2, are then calculated as

$$\lambda_2 = \frac{ln2}{t_{biol/2}} \tag{28-25}$$

where $t_{biol/2}$ is the biological half-life (d).

As with the nonradiological dose equation, burrowing and nonburrowing animals are handled slightly differently to account for exposure to different soil concentrations. The total internal radiation dose rate (Gy/day) for burrowing animals is given by

$$Dose_{internal} = \left(CS_g \times CF + \frac{CW \times WI}{BW \times (\lambda_1 + \lambda_2) \times 1{,}000} \right) \times SUF \times ED \times AE \times \frac{3{,}200}{6.24 \times 10^9} \tag{28-26}$$

and for nonburrowers is

$$Dose_{internal} = \left(CS_s \times CF + \frac{CW \times WI}{BW \times (\lambda_1 + \lambda_2) \times 1{,}000} \right) \times SUF \times ED \times AE \times \frac{3{,}200}{6.24 \times 10^9}$$

The average absorbed energy, AE, is calculated by first determining the average decay energy per disintegration, $\bar{E}$, with units of MeV/dis. Only radiations with an intensity of 1% or greater are considered, and Auger and conversion electrons are not considered. The $\bar{E}$ are calculated using the following equation (Kocher, 1981):

$$\bar{E} = \sum Y_i E_i \tag{28-27}$$

where

Y_i = yield or intensity

E_i = energy of radiation, for β = average energy (MeV/dis).

The average decay energy per disintegration is calculated separately for α/β and γ decay, producing respectively $\bar{E}_{\alpha/\beta}$ and $\bar{E}_\gamma$. The average absorbed energy, *AE*, is then the sum of the two products calculated by multiplying the average decay energies by a factor accounting for the fraction absorbed and a factor accounting for the quality of the radiation.

$$AE = (FA_{\alpha/\beta} \times QR_{\alpha/\beta} \times \bar{E}_{\alpha/\beta}) + (FA_\gamma \times QR_\gamma \times \bar{E}_\gamma) \tag{28-28}$$

where

FA = fraction of energy absorbed (unitless)

QR = quality of radiation (unitless).

CFs for radionuclides are presented in Table 28-20. Animal CFs were obtained from the literature and site-specific data. The CF for Sr-90 (used for mammalian herbivores) was calculated by dividing the deer mouse carcass concentration (Arthur et al., 1987) by the soil concentration (Arthur and Markham, 1983). A second value for the CF for Sr-90 for mammalian herbivores was derived by dividing the pronghorn carcass concentration by the soil concentration (Markham et al., 1980). The most conservative of these two values was used. If CF values were not available in the literature, then the CF was assumed to be 1.

External Radiation Dose—External dose is derived using formulas outlined in Shleien (1992). Dose rate to tissue in an infinite medium uniformly contaminated by a gamma emitter is calculated as

$$\dot{D} = \frac{2.12 \times \overline{E} \times C \times ED \times SUF}{\rho} \qquad (28\text{-}29)$$

where

$\dot{D}$ = external dose rate to tissue (rads/hr)

$\overline{E}$ = average gamma decay energy per disintegration (MeV/dis)

C = concentration of contaminant (ρCi/cm^3)

ρ = density of the medium (g/cm^3), generally soil.

Since soil concentrations are given in pCi/g, they need to be converted to μCi/g by dividing by 10^6. Finally, the dose in Equation (28-28) is converted to Gy/day using the conversion factor 0.24. The resulting equation for burrowing animals is:

$$Dose_{external} = (0.24 \times 2.12 \times \overline{E} \times CS_g \times ED \times SUF)/(1.68 \times 10^6) \qquad (28\text{-}30)$$

and for nonburrowing animals is

$$Dose_{external} = (0.24 \times 2.12 \times \overline{E} \times CS_s \times ED \times SUF)/(2 \times 1.68 \times 10^6). \qquad (2\text{-}31)$$

This equation conservatively estimates the dose to burrowing terrestrial functional groups. This equation also conservatively reflects that these functional groups spend 100% of their time with external exposure. For the nonburrowing functional groups, it is conservatively assumed that they are exposed to 50% (hemisphere) of radiation.

Table 28-20. WAG 3 radiological CFs (unitless).

Parameter	Am-241	Co-60	Cs-134	Cs-137	Eu-152	Eu-154	Pu-239/241	Sr-90
Avian herbivores (AV122)	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.54E+00
Avian herbivores (AV143)	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.54E+00
Avian insectivores (AV212)	1.00E+00	5.00E-01	5.00E-01	5.00E-01	1.00E+00	1.00E+00	1.00E+00	1.54E+00
Avian insectivores (AV222)	1.00E+00	5.00E-01	5.00E-01	5.00E-01	1.00E+00	1.00E+00	1.00E+00	1.54E+00
Avian carnivores (AV310)	1.00E+00	1.00E+00	2.00E+00	2.00E+00	1.00E+00	1.00E+00	1.00E-01	1.10E+00
Northern goshawk	1.00E+00	1.00E+00	2.00E+00	2.00E+00	1.00E+00	1.00E+00	1.00E-01	1.10E+00
Avian carnivores (AV322)	1.00E+00	1.00E+00	2.00E+00	2.00E+00	1.00E+00	1.00E+00	1.00E-01	1.10E+00
Ferruginous hawk	1.00E+00	1.00E+00	2.00E+00	2.00E+00	1.00E+00	1.00E+00	1.00E-01	1.10E+00
Avian omnivores (AV422)	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.54E+00
Avian omnivores (AV442)	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.54E+00
Mammalian herbivores (M122)	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.54E+00
Mammalian herbivores (M122A)	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.54E+00
Pygmy rabbit	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.54E+00
Mammalian insectivores (M210)	1.00E+00	5.00E-01	5.00E-01	5.00E-01	1.00E+00	1.00E+00	1.00E+00	1.54E+00
Mammalian insectivores (M210A)	1.00E+00	5.00E-01	5.00E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.54E+00
Townsend's western big-eared bat & small-footed myotis	1.00E+00	1.00E+00	2.00E+00	2.00E+00	1.00E+00	1.00E+00	1.00E+00	1.54E+00
Mammalian insectivores (M222)	1.00E+00	1.00E+00	5.00E-01	5.00E-01	1.00E+00	1.00E+00	1.00E+00	1.54E+00
Mammalian carnivores (M322)	1.00E+00	1.00E+00	2.00E+00	2.00E+00	1.00E+00	1.00E+00	1.00E-01	1.54E+00
Mammalian omnivores (M422)	1.00E+00	1.00E+00	5.00E-01	5.00E-01	1.00E+00	1.00E+00	1.00E+00	1.07E+00
Mammalian omnivores (M422A)	1.00E+00	1.00E+00	5.00E-01	5.00E-01	1.00E+00	1.00E+00	1.00E+00	1.07E+00
Reptilian insectivores (R222)	1.00E+00	5.00E-01	5.00E-01	5.00E0-1	1.00E+00	1.00E+00	1.00E+00	1.54E+00
Reptilian carnivores (R322)	1.00E+00	1.00E+00	2.00E+00	2.00E+00	1.00E+00	1.00E+00	1.00E-01	1.54E+00

28.3.2.3 Uncertainty Associated with Functional Groups. The selection of receptor parameters used is designed to ensure that each of the members of the functional groups is conservatively represented. Since all members of a functional group are considered similar, it is reasonable to assume that all members of a group will be equally exposed to site-related contaminants. Quantification of dose for each functional group is expected to provide sufficient data to assess the general condition of the ecosystem and to be adequately protective of the majority of species potentially inhabiting WAG 3. In addition, sensitive species are included on the list of receptors for which dose is calculated. Hence, uncertainty associated with the selection of receptor parameters is expected to minimally influence dose estimates.

28.3.2.4 Uncertainty Associated with the Ingestion Rate. Estimation for terrestrial receptors intake (ingestion) estimates used for the terrestrial receptors are based upon data in the scientific literature, when available. Food ingestion rates are calculated by use of allometric equations reported in Nagy (1987). Uncertainties associated with the use of allometric equations could result in either an over- or underestimation of the true dose rate, since not all of these values are known exactly.

28.3.2.5 Uncertainty Associated with the Receptor Site Usage. The calculation of dose incorporated the probability that the receptors may use or inhabit each site. The SUF is defined as the affected area (ha) divided by the home range (ha) of the receptor. If a given receptor's home range is larger than the affected area, then it is reasonable to assume that the receptor may not spend 100% of its life within the site area. Incorporation of the SUF adjusts the dose to account for the estimated time the receptor spends on the site. The less time spent on the site, the lower the dose. However, most home ranges are estimated from available literature values and allometric equations. Home range and usage of areas also vary from season to season as well as year to year (depending on the species of interest), and are difficult to measure. This uncertainty could result in either an over- or underestimation of the true dose rates.

28.3.2.6 Uncertainty Associated with the PUFs and BAFs. Using PUFs to estimate plant concentrations has the advantages that it is easy to use and requires minimum data inputs (i.e., the measured or estimated concentration of metal in soil and a PUF taken from the literature). A PUF of 0.01 indicates that the plant concentration should be 1/100th of the total concentration in soil. For this WAG ERA, PUFs for metals are taken from Baes et al. (1984). Although preference is given to studies that reported the steady-state concentration of metals in plants at edible maturity, various soil properties are not considered and data for numerous plant species (both animal feeds and those consumed by humans) are combined. However, since root uptake of metals is a complex process that depends on various soil properties (e.g., pH, CEC, and organic matter content) as well as the metal and type of plant involved, the use of generic or crop-specific PUFs taken from the literature may not accurately estimate the concentration of metals in plants for all environmental conditions and species that may occur on WAG 3. The PUF for organics is estimated using the geometric mean regression equation developed by Travis and Arms (1988) and using log K_{ow} values. The reliability of estimated PUFs is directly related to the reliability of the K_{ow} values used for the organics. Since K_{ow} values can vary greatly, use of the Travis and Arms (1988) equation to estimate a PUF for organics may over- or underestimate the true dose for organics.

There is a great deal of uncertainty associated with the bioaccumulation factors (BAFs) used to calculate dose. Very few BAFs are available in the scientific literature, since they must be both contaminant- and receptor-specific. In the absence of specific BAFs, a value of 1 was assumed. This assumption could over- or underestimate the true dose from the contaminant, and the magnitude of error cannot be quantified. Travis and Arms (1988) and Baes et al. (1984) report BAFs for contaminants to beef and milk; all of these are less than 1 for the contaminants at WAG 3. If the terrestrial receptors of concern accumulate metals and PCBs in a similar way and to a comparable degree as beef and dairy cattle, the use of a BAF of 1 for all

contaminants and receptors would overestimate the dose. On the other hand, if the terrestrial receptors of concern for WAG 3 accumulate metals and PCBs to a much larger degree than beef and dairy cattle, the assumption of BAFs equal to 1 could underestimate the true dose from the COPCs.

28.3.2.7 Uncertainty Associated with Soil Ingestion. The exposure assessment incorporates percentage of soil ingested by each representative of the functional groups. Although food ingestion rates have the greatest effect on intake estimates, soil ingestion rates could also influence intake rates and, therefore, dose estimates. The EPA *Wildlife Exposure Factors Handbook* (EPA 1993a), Beyer et al. (1994) and Arthur and Gates (1988) were used to assign soil ingestion parameters to four of the 12 functional groups and individual species. Estimating the percent soil ingested may over- or underestimate the dose since the effect of the estimated values on the overall dose outcome is dependent on the concentration of contaminant in the media of concern.

28.3.2.8 Uncertainty Associated with the Radiological Equation. Equation (28-14) was taken from an International Atomic Energy Agency (IAEA) report titled *Effects of Ionizing Radiation on Plants and Animals at Levels Implied by Current Radiation Protection Standards* (IAEA 1992). This equation was for the estimation of dose rates to plants. For the estimation of dose rates to animals, the IAEA recommends multiplying the internal Cs-137 dose rates to animals by a factor of 10 to account for bioconcentration mechanisms (e.g., carnivory, or consumption of certain plants) for species not incorporated into the human food-chain calculation. This may under- or overestimate the dose from those particular radionuclides.

28.3.3 Ecological Effects Assessment

Ecological effects assessment consists of three elements:

- Selecting QCEs
- Developing AFs
- Developing TRVs.

Sections 28.3.3.1 through 28.3.3.4 below contain a general description of the procedures of ecological effects assessment and discussions of the each of the three elements.

28.3.3.1 General Procedures. A TRV is defined as a dose for a receptor (including sensitive subgroups such as taxa under regulatory protection) that is likely to be without appreciable risk of deleterious effects from chronic exposure. Application of toxicity data derived from surrogate species introduces uncertainty into the risk assessment. The magnitude of this uncertainty depends largely upon (1) the degree of taxonomic difference between the key and test species, (2) the conditions under which the toxicity data are obtained, and (3) the endpoint of interest [e.g., chronic lowest-observed-adverse-effect-level (LOAEL) or no-observed-adverse-effect-level (NOAEL)] and the endpoint measured (e.g., death). Uncertainties associated with extrapolation of toxicity information from literature to site conditions can therefore be offset by applying AFs to the endpoint values identified in the literature.

The approach for TRV derivation used in this WAG ERA was developed by Ludwig et al. (1993) for use at the Rocky Mountain Arsenal Superfund site in Commerce City, CO, and is generally based on the EPA reference dose approach as modified by Lewis et al. (1990). It is predicated on the development and application of AFs, which are intended to explicitly account for variations and uncertainties in the data and

necessary extrapolations from it. The types of variation and extrapolation uncertainties explicitly quantified are:

- Variation in sensitivity among the members of a receptor population
- Uncertainty in extrapolating data from one taxon to another
- Uncertainty in using various effect levels to estimate no-effect levels in receptors
- The inability of any single study to adequately address all possible adverse outcomes in a wild receptor population.

The approach of Ludwig et al. (1993) offers several distinct advantages. By carefully identifying the specific types of adjustments needed in the extrapolation, this method permits maximum resolution of what each adjustment is intended to achieve. It emphasizes consensual, data-quality-based development of values for specific AFs rather than defaulting to arbitrary factors. It clearly discriminates between "best estimates" of the values of individual factors and adjustment for overall uncertainty, including the uncertainty associated with the AFs themselves.

The TRV values used for antimony, arsenic, cadmium, chromium, copper, lead, mercury, nickel, silver, and toluene for plants were taken directly from Suter et al. (1993) and no AF values were assigned. The values presented in that paper are toxicological benchmarks for screening potential COCs for effects on terrestrial plants in soil. These values are for those contaminants potentially associated with DOE sites and were, therefore, appropriately used in the calculations for the INEEL.

TRV derivation for radionuclides did not include the use of AFs. Instead, effects of chronic irradiation were adequately discussed in the IAEA report (IAEA, 1992) in which it was concluded that irradiation at chronic dose rates of 1 and 10 mGy/d or less does not appear likely to cause observable changes in terrestrial animal and plant populations, respectively. These values were, therefore, used conservatively as the TRVs for animals and plants and no AFs were applied in the derivation.

28.3.3.2 Selecting Quantified Critical Exposures. TRV development is initiated by reviewing the available toxicological literature and relevant databases for each contaminant and functional group members to identify quantified critical exposures (QCEs) from the best available study. Studies considering nonlethal endpoints and reporting NOAELs are selected, if available; those reflecting reproductive competence are most preferred as such endpoints are considered to best reflect the population-level impacts of greatest concern in ERA. The following criteria are used to select QCEs:

- Experimental taxa should be as similar as possible to receptors at INEEL site(s), both physiologically and ecologically. With respect to body size, feeding, and behavioral habits, anatomy, and physiology, the surrogate species should be matched as closely as possible to the receptors.

- Test exposure route and medium should be similar to that expected for receptors in the field. For most of the receptors at INEEL, exposure media are limited to soil and dietary items (both animal and vegetable). Liquid intake is largely in the form of metabolic water. Dietary laboratory studies are therefore the most appropriate models for extrapolation. Gavage and drinking water studies will be considered if necessary, but reduce confidence in the applicability of the study.

- Long-term (preferably lifetime) exposures should be used, as they are closest to exposure patterns occurring in the field.

- Experimental endpoints should represent ecologically significant effects at the population level. In general, loss of a few individuals of a species is unlikely to significantly diminish the viability of the population or disrupt the community or ecosystem of which it is a part. As a result, the fundamental unit for ERA is generally the population rather than the individual, with the exception of T/E and sensitive species (EPA, 1992). In general, the most appropriate endpoints for ERA are reproduction, neurological function, and growth and development. For species under regulatory protection, TRVs are based on the most sensitive nonlethal endpoints referring specifically to individuals.

- Doses within the NOAEL-LOAEL bracket should be identified. If these data are not available, the following dose levels (in decreasing order of preference) may be used: chronic-nonlethal-adverse-effect-level > no-effect-level > frank-effect-level (including lethality). The definition of adversity requires considerable analysis of the potential ecological significance of the effects reported. For example, elevated liver weight or enzyme induction could represent an adaptive response rather than toxic injury.

- Studies should be of high quality, defined as complete in design, with adequate numbers of subjects and dose levels, lifetime duration, explicit analysis of experimental uncertainty, clear results, and well-justified conclusions.

If a single study cannot be selected (e.g., where only acute exposure, lethal endpoint studies are available), then an average of several studies of similar quality using the same or closely similar species may be used. In averaging, extreme outliers (defined as greater than two standard deviations away from the mean) are excluded. Where similar endpoints are observed in more than one study of similar quality, the lowest QCE should be used.

Information on the toxicological effects on mammalian receptors of the following contaminants was not located. Therefore, these contaminations could not be evaluated for potential risk.

Decanal	4-Methyl-4-hydroxy-2pentanone	4-Methyl-phenol

Information on the toxicological effects on avian receptors of the following contaminants was not located. Therefore these contaminations could not be evaluated for potential risk.

Acetone	Antimony	Barium
Benzo(a)pyrene	Benzo(b)fluoranthene	Benzo(g,h,i)perylene
Benzo(k)fluoranthene	Beryllium	Boron
4-Chloraniline	Chromium VI	Chrysene
Decanal	Di-2-ethylhexylphthalate	Indeno(1,2,3-cd)pyrene
4-Methyl-4hydroxy-2-pentanone	4-Methyl-phenol	Naphthalene
Phenanthrene	Silver	Strontium
Xylene		

28.3.3.3 Developing AFs. Six AFs for extrapolation from experimental studies to field exposures at INEEL are defined for

- I = intrataxon variability
- R = intertaxon variability
- Q_1 = risk assessor's certainty that the COPC actually causes the critical effect in the receptor, and that it is an ecologically significant effect
- Q_2 = extrapolation from short- to long-term EDs
- Q_3 = extrapolation across endpoint types to estimate an NOAEL
- U = any residual uncertainty in the data evaluation process and estimation of other AFs based on data quality, study design, and known but otherwise unaccounted for extrapolation issues
- M = correction of differences in metal bioavailability between QCE studies where soluble salts are administered via drinking water and INEEL exposure conditions (i.e., metal species are encountered in soil and dietary items).

Values for these AFs are set based on the quality of the selected study in particular, and of the database in general. Other potentially influential factors include the ecological circumstances of the receptor, regulatory criteria and standards, background contaminants levels, and protection status. To prevent needless overestimation of risk, the maximal AF product (all AFs multiplied together) is scaled to the overall extrapolation error observed in experimental studies designed specifically to determine the uncertainty in such extrapolations. Barnthouse et al. (1990) quantified the range of maximal uncertainty necessary to permit extrapolation of various kinds of toxicity data for various taxa of finfish at the population level. The types of toxicity data used included studies involving particular species of interest and other species, for acute, partial life-cycle, and full life-cycle exposures. The range of maximal uncertainty varied with the type of data used, and ranged from approximately 200 to 400 (Barnthouse et al., 1990). It is assumed that the degree of variability observed among fish taxa is similar to that occurring among other vertebrate taxa.

Based on a systematic review of all available information (Ludwig et al., 1993), a simple, relative scale is developed consisting of "low," "medium," and "high" rankings for each AF, with adjustments made of the basis of specific inherent uncertainty or variability in the particular extrapolations. The quantitative valuation of this scale is designed to be constrained by an upper bound in the range of 200 to 400, and use the most plausible values for each AF.

Specific values for these AFs and a brief description of criteria for their use are presented in Table 28-21. Values for all AFs except Q_1 and M are set at 1 ("low"), 2 ("medium"), and 3 ("high"), with lower values generally representing greater confidence that the QCEs correspond well with "safe" doses for receptors. The factor Q_1, which expresses the degree of certainty that the experimental effect will not occur in the field or is not of ecological significance, runs on a positive scale equivalent where 0.1 represents high certainty that the effect either does not occur in the receptor or is ecologically irrelevant, 0.5 represents moderate certainty that the effect does not occur or is irrelevant, and 1 represents reasonable certainty that the effect will occur in the receptor species and is ecologically significant. The medium of exposure factor M is set at 1 if the medium of exposure in the QCE study is similar to field exposure media at this site (i.e., primarily food and soil ingestion). However, because a number of toxicological studies for metals used soluble salts in drinking water as a means of exposure, and both the contaminant species and exposure matrix tend to maximize metal absorption (e.g., Steele et al., 1990; Griffin and Turck, 1991; Witmer et al., 1991), M is set at 0.5 to conservatively represent the significantly lower bioavailability of the metal species associated with soils and dietary items in the natural environment. Thus, the maximum product of the seven AFs is 243. This AF maximum represents the extent to which valid extrapolation of the data can be applied across

Table 28-21. AF values and criteria for their use in developing TRVs for INEEL.

Adjustment factor	Qualitative ranking	Value	Criteria
I	Low	1	Variability is low
	Medium	2	Variability is moderate or average
	High	3	Variability is high, or information on variability is inadequate
R	Low	1	Test organism and functional group, T/E, C2 are in same taxonomic order and trophic category
	Medium	2	Test organism and functional group, T/E, C2 are in same trophic category but different taxa
	High	3	Test organism and functional group, T/E, C2 are in different trophic categories
Q_1	Low	0.1	Experimental endpoint is highly unlikely to occur in the field
	Medium	0.5	Experimental endpoint is moderately unlikely to occur in the field
	High	1	Experimental endpoint is likely to occur in the field
Q_2	Low	1	Study was of chronic duration
	Medium	2	Study was of subchronic duration
	High	3	Study was of acute duration
Q_3	Low	1	NOAEL
	Medium	2	LOAEL
	High	3	Adverse effect level or frank effect level
U	Low	1	High quality studies
	Medium	2	Studies of reasonable quality
	High	3	Studies with flawed design or incomplete information
M	—	0.5	Soluble metal salt administered in drinking water
	—	1	Exposure medium comparable to those at INEEL

experimental protocols or among taxa. More detailed information on the definition and valuation of these factors is available in Ludwig et al. (1993).

28.3.3.4 Developing TRVs. The third element in ecological effects assessment is the derivation of TRVs. TRVs were derived for each functional group by selecting the experimental study with the most appropriate QCE for that chemical and assigning numeric values for all AFs to account for uncertainties associated with extrapolation across species and exposure conditions.

The algorithm used for deriving a TRV is

$$TRV = \frac{QCE}{AF} \tag{28-32}$$

where

QCE = quantified critical exposure

AF = $[I] \times [R] \times [Q_1] \times [Q_2] \times [Q_3] \times [U] \times [M]$.

Information used to derive TRVs for nonradioactive inorganic and organic contaminants is summarized in this section. The development of TRVs for each contaminant/functional group combination is presented in Appendix J for mammalian and avian receptors. Table J-1 summarizes the TRVs for mammalian functional groups. A summary of the TRVs for avian functional groups is contained in Table J-2. Shading in Tables J-1 and J-2 corresponds to the TRVs chosen for each functional group. When the test organism and the receptor were in the same taxonomic order and trophic category (R = 1), the corresponding TRV was chosen, as shown in heavier shading. If the test organism and receptor are in the same trophic level and different taxa, R = 2 was used. Otherwise, the minimum TRV (R = 3) for each COPC was chosen for all mammalian or avian receptors. Little information was found describing the effects of COPCs on reptilian, invertebrate, or terrestrial plant receptors. When available, that information is summarized in Sections 28.3.4 and 28.3.5. Development of TRVs for radionuclides is described in Section 28.3.6.

28.3.4 Development of TRVS for Inorganic Contaminants of Potential Concern

This section contains summaries of the information used in determining the TRVs for the inorganic contaminants for which toxicological studies were located. A discussion of the fate and transport properties of the contaminants is also included. The inorganic contaminants include

- Aluminum
- Antimony
- Arsenic
- Boron
- Cadmium
- Chromium
- Lead
- Mercury
- Molybdenum
- Nickel
- Selenium
- Silver
- Strontium

The development of TRVs from the studies identified for each COPC is contained in Appendix J.

Aluminum nitrate nonahydrate [Al(NO3)3•9H2O] (CAS 7784-27-2) (See also Nitrate). Aluminum (Al) compounds are generally not toxic except in cases of high experimental doses or prolonged inhalation

(Venugopal and Luckey, 1978). The lack of toxic effects is partly attributable to the poor absorption of aluminum by the gut and lungs. Most large oral doses of aluminum are excreted if the kidneys are intact. In mammals, the mechanism of aluminum toxicity appears to be the impairment of phosphorous metabolism. The neurotoxicity of aluminum is due to its binding with nervous tissue, which can cause massive neurofibrillary degeneration. Chronic administration of aluminum (as aluminum chloride) caused impaired growth in second and third generation animals without affecting litter size. The normal concentration of aluminum in the mammalian brain is 1 to 2 kg/g. Rats are the least sensitive species to aluminum toxicosis, while cats and rabbits are the most sensitive species.

A TDLo of 1,620 mg/kg-day was available for rats (omnivores) exposed orally to aluminum nitrate nonahydrate (Teratology, 1988). In an additional study, a NOAEL of 6.0 mg/kg-day was established when 3- to 4- week old rats fed 6 to 10 mg/kg aluminum hydroxide exhibited significantly retarded growth (Thurston et al., 1972). The Thurston et al. (1972) study was used to develop a TRV for omnivores.

NOAELs of 1, 900, and 1,200 mg/kg-day were reported for rabbits (Nekipelov, 1966), sheep (Thompson et al., 1959), and cattle (Valdivia et al., 1978) exposed to Al(NO3)2, AlSO4, and AlCl2, respectively. A TRV was developed for herbivores and carnivores using the Nekipelow (1966) data.

For avian receptors, a NOAEL of 3,500 mg/kg-day (Miller and Kifer, 1970) and a NOAEL of 324 mg/kg-day (Cakir et al., 1978) were available for chickens and turkeys, both of which belong to the order galliformes and are omnivores. The study identifying a subchronic NOAEL for 1-day old turkeys exposed to Al(SO4)•18H2O (Cakir et al., 1978) was selected for TRV development because it was the most conservative of the values and a sensitive life stage was examined.

No data on the toxicological effects of aluminum nitrate nonahydrate on reptiles were available.

Antimony (CAS 7440-36-0). Antimony (Sb) is a multivalent element and can exist in the +5, +3, or -3 oxidation states. Antimony may accumulate with heavy elements in carbonaceous shales or become sorbed on clays and hydrous oxides. Antimony may be volatilized when stibine (SbH3) or its methylated derivatives are formed during the reduction of antimony in soils. Antimony has an affinity for clay and other mineral surfaces. Less than 10% of the antimony in sediments from both contaminated and uncontaminated sediments was bound to easily oxidizable organic matter (Callahan et al., 1979). Since antimony has an anionic character in aqueous solution, it probably has little affinity for complexation with humic and fulvic acids.

Antimony causes a number of toxic effects in animals, including suppression of weight gain, shortened life span, and damage to liver, heart, thyroid, and kidneys. Trivalent compounds (e.g., antimony trioxide, antimony trisulfide) are about 10 times more toxic than pentavalent forms. The gastrointestinal absorption of trivalent antimony is about 15 36% (Weitz and Ober, 1965; VanBruwaene et al., 1981; Gerber et al., 1982). The acute toxicity of antimony trioxide is low, with an oral LD50 in rats of greater than 20 g/kg (Smyth and Carpenter, 1948).

In chronic studies, 5 mg/L potassium antimony tartrate (approximately 0.35 mg/kg-day) in drinking water is associated with slightly decreased life spans in rats (Schroeder et al., 1968) and female mice (Schroeder et al., 1968 and Kanisawa and Schroeder, 1969). Endpoints examined in these chronic (lifetime) studies included growth and body weight, median life span, longevity, tumor incidence, and histopathology. Other ecologically relevant endpoints (e.g., reproduction) were not examined, and only one dose was

administered. Although rats appeared to be more sensitive than mice in these studies, the effects reported are of questionable ecological significance.

The recommended screening benchmark concentration for phytotoxicity in soil for antimony of 5 mg/kg was used as the TRV for terrestrial plants (Suter et al., 1993).

No information on the toxicological effects of antimony on avian, reptile or invertebrate receptors was located.

Arsenic (CAS No. 7440-38-2). Arsenic (As) is a metalloid element that is widespread in all environmental media, making up about 0.0005% of the earth's crust. Arsenic is commonly present in living organisms and is constantly being oxidized, reduced, or metabolized. Many arsenic compounds are readily soluble in soil, making them available for plant uptake or for reduction by organisms or chemical interactions. Biological uptake of arsenic results in measurable quantities of reduced or methylated arsenic forms. Arsenic occurs naturally in all environmental media. Arsenic has four valence states: -3, 0, +3, and +5. Arsines and methylarsines, which are characteristic of compounds in the -3 state, are unstable in air. Most arsenicals degrade to yield arsenate, although arsenate may form under anaerobic conditions. Biotransformation of these compounds may occur and yield volatile arsenicals. The dominant form of arsenic present in aerobic soils is As^{+5}, while As^{+3} is the primary species in anaerobic soils. Inorganic arsenic is more mobile than organic arsenicals and thus is more likely to leach into surface or groundwaters. Trivalent species are generally more toxic, more soluble, and more mobile than pentavalent forms. Soil microbes can metabolize arsenic to volatile arsine forms. The half-life of arsenic in soil is estimated to be 6.5 years for arsenic trioxide to 16 years for lead arsenate. Soils with high organic matter content, low pH, low phosphate, and low mineral content readily sorb arsenates. In air, most arsenic particulates contain inorganic arsenic compounds, particularly As^{+3} compounds (Eisler 1988a).

At relatively low levels, arsenic stimulates growth and development in several plant species (Eisler, 1988a). The bioavailability of arsenic depends on several factors including pH, soil texture, fertility level, and plant species. Inorganic arsenate is readily taken up by plants via the phosphate carrier mechanism. Therefore, plants tend to have a poor ability to distinguish arsenate from phosphate. In general, arsenic is most available to plants grown in coarse soils having little colloidal material and a low ion-exchange capacity. Conversely, fine soils high in clay, organic matter, iron, calcium, and phosphate tend to retard the bioavailability of arsenic to plants (NRCC, 1978). The accumulation of arsenic in plants tends to be directly correlated with the amount of arsenic in the dissolved fraction versus total arsenic concentrations (NRCC, 1978).

The potential toxicity of arsenic to any organism is dependent on its chemical form. Inorganic arsenicals are generally more toxic than organic arsenicals, and trivalent forms are more toxic than pentavalent forms. Toxicity is related to aqueous solubility, and the order of toxicity (from greatest to least) is arsines > inorganic arsenites > organic trivalent compounds > inorganic arsenates > organic pentavalent compounds > arsonium compounds > elemental arsenic (Eisler, 1988a).

Chemical properties contributing to arsenic's toxicity include its ability to bind to protein sulfhydryl groups and to substitute for phosphorus in some biochemical reactions. These chemical properties may also be responsible for arsenic's apparent essentially in several mammalian species (e.g., Frost, 1983; Uthus, 1992). In fact, arsenical feed additives are used to promote growth in a number of agricultural species (Eisler, 1988a). Recent studies have suggested that arsenic has a physiological role in the formation of

various metabolites of methionine metabolism (Uthus, 1992). The arsenic requirement for growing chicks and rats is approximately 25 mg/kg diet (Uthus, 1992). Species differences in the pharmacokinetic disposition of arsenic have significant effects on their sensitivity to its toxic effects. In addition, animals exposed to sublethal levels of arsenic can develop tolerance to subsequent exposures (Eisler 1988a).

A subacute study using domestic sheep was documented (Eisler 1988a) in which an NOEL endpoint using 2.3 mg/kg-day was reported. An LOAEL of 1.5 mg/kg-day was reported in a chronic study using sodium arsenate in rats (Byron et al. 1967). The data did not show a good dose-response curve in the low-dose range. This study was used in the development of TRVs for rats.

The National Academy of Sciences reported a LD_{50} of 39 mg/kg-day using sodium arsenite in mallards.

The recommended screening benchmark concentration for phytotoxicity in soil for arsenic of 10 mg/kg was used as the TRV for terrestrial plants (Suter et al. 1993).

Boron (CAS 7440-42-8). Boron (Bo) is a poison by ingestion and a moderate fire hazard in the form of dust when exposed to air or by chemical reaction. It is an explosion hazard in the form of dust which ignites on contact with air. The routes of entry are inhalation of dust, fumes, and aerosols and ingestion. Boron compounds may produce irritation of the nasal mucous membranes, the respiratory tract, and eyes. Acute poisoning in man from boric acid or borax is usually the result of application of dressings, powders, or ointment to large areas of burned or abraded skin, or accidental ingestion (Sittig, 1981).

Studies reported in ATSDR (1991) and Weir and Fisher (1972) were used to develop TRVs for boron. Male and female rats were given boron in feed during a 2 year, 3 generation study during which a NOAEL of 17.5 mg/kg-day was established. A subchronic (38-week) study in which dogs were fed boron established a NOAEL of 8.75 mg/kg-day.

No data was located on the toxicological effects of boron on avian, reptilian, or invertebrate receptors was located.

Cadmium (CAS 7440-43-9). Cadmium (Cd) is found naturally in the environment due to chemical weathering of rocks. It is generally found in soil as the free cadmium compounds (ATSDR, 1993). It is insoluble in water, although its chloride and sulfate salts are relatively soluble in water. The availability of cadmium in soils depend upon soil pH, cation exchange capacity, chemical speciation, and many other factors. Adsorption and desorption process tend to influence the concentration of cadmium in natural waters. Adsorption and desorption occur rapidly in soil. Cadmium tends to remain in the upper portion of the soil profile. Its bioavailability depends on adsorption/desorption rates, pH, and speciation. Cadmium uptake by plants is influenced by the concentration of calcium, sulfides, and sulfites present in the soil. Calcium and cadmium are considered to have the same uptake site; thus, levels of calcium present in soil could limit the amount of cadmium taken up by plants. Cadmium availability to plants is affected by redox potential and pH. Humus-bound and sorbed cadmium contribute to the plant available pool. Availability may be reduced by higher organic matter content and higher cation exchange capacity (Eisler, 1985a).

There is no evidence that cadmium is biologically essential (Eisler, 1985a). Cadmium is not reduced or methylated by microorganisms (ATSDR, 1993). Birds and mammals are comparatively resistant to cadmium toxicity as compared to aquatic species. Sublethal effects of cadmium include growth retardation, anemia, and testicular damage (Hammons et al., 1978) as cited in Eisler (1985a). Cadmium readily reacts with

sulfhydral groups and may inhibit enzymatic reactions (Eisler, 1985a). Bioaccumulation of cadmium has been reported in aquatic systems, however, only lower trophic levels are reported to exhibit biomagnification (Eisler, 1985a). Accumulation of cadmium in avian species has been reported in liver and kidneys.

TRVs were developed using a multigeneration rat reproduction study by Wills et al. (1981) in which a LOAEL of 5 mg/kg-day was established.

Chickens exposed to cadmium in the diet had reduced growth rates in a study by Pritzl et al. (1974). This study was used to derive a TRV for avian receptors. Behavioral changes were observed in young American black ducks when parents were fed 4 ppm cadmium for 4 months before egg-laying (Heinz and Haseltine, 1983 as cited in Eisler, 1985a).

For invertebrates, a study on the toxicity of cadmium nitrate to the isopod (*Porcellio scaber*) was used to develop a TRV. The study reports a critical concentration of 100 g/g cadmium in food on a dry weight basis for reproduction (Hopkin and Hames, 1994).

The recommended screening level toxicological benchmark for phytotoxicity in soil of 2 mg/kg for cadmium was used as the TRV (Suter et al., 1993).

No information on the toxicological effects of cadmium on reptilian or invertebrate receptors was located.

Chromium (CAS No. 7440-47-31). Chromium (Cr) is a multivalent element and can exist in the +2, +3, and +6 oxidation states. The latter two, chromium (III) and chromium (VI), are the most stable in the environment. In soils and sediments, chromium is influenced by oxidation and reduction reactions and can be adsorbed on the mineral and organic exchange complex or exist as a coating in iron and manganese hydrous oxide particles. Moreover, chromium may remain in solution in the pore water phase, or may become chelated by an organic liquid or precipitated (Adriano 1986; Callahan et al. 1979). The sorption of chromium (VI) by hydrous metals oxides and other soil mineral components decreases as pH levels increase. The presence of other anions (e.g., sulfate and phosphate) significantly affects the extent of adsorption by competing for adsorption sites. Formation of ion pairs, such as dissolved calcium chromate, may also reduce the extent of adsorption. In contrast to chromium (VI), the sorption of chromium (III) increases as pH units increase. In general, it appears from laboratory studies that chromium (III) is adsorbed more strongly than chromium (VI). Organic material may also be an important adsorbent in sediments and soils. Slight enrichment of chromium occurs in the humic fraction. Typically, in normal, well-drained soils, the great majority of chromium is in the form of chromium (III).

Chromium(III) is an essential nutrient (required for insulin function) in mammals. However, it is interchangeable in the environment with the more toxic species chromium(VI), depending primarily on the redox potential and pH of soil (Bartlett, 1991). Chromium (VI) is generally more toxic than chromium (III). Although most chromium (VI) is reduced to chromium (III) in the acidic environment of the stomach (Donaldson and Barreras, 1966), chromium (VI) compounds are absorbed significantly more efficiently from the gastrointestinal tract (2 to 10% of administered dose) than chromium (III) compounds (Outridge and Scheuhammer, 1993). Once absorbed, chromium (VI) is quickly reduced to the trivalent form. The damaging effects of chromium (VI) are caused by its greater membrane permeability, which allows it to cross biological membranes and oxidize cellular components not normally accessible to chromium (VI). As a

result, the differences in systemic toxicity are primarily attributable to differential solubilities and absorption rates of the two valence states (Franchini and Mutti, 1988).

The mobility of chromium (VI) and the limited supply of extracellular reductants causes chromium (VI) to be distributed more widely in the body than chromium (III). The intracellular reduction of chromium (VI) to chromium (III) generates unstable intermediate chromium (V) and chromium (IV) ions, active oxygen species (hydroxyl and superoxide radicals, single oxygen), and thiyl and organic radicals that are responsible for the cytotoxicity, mutagenicity, and carcinogenicity of the hexavalent form (reviewed by Manzo et al. 1992; Cohen et al. 1993; O'Flaherty 1993; Outridge and Scheuhammer 1993).

Chromium exhibits a pattern of biominification rather than biomagnification in ecological food webs. Because the speciation of chromium (VI) taken up by plants is poorly understood, it is assumed to be the primary form of exposure to herbivores. However, chromium (VI) is immediately converted to chromium (III) in animal tissues. Therefore, carnivorous receptors will be primarily exposed to the less toxic trivalent form. Development of TRVs based on chromium (VI) for receptors higher in the food chain is thus highly conservative, and will tend to overestimate chromium-related risk to these receptors.

Plants play an important role in the biogeochemistry of chromium, containing approximately three orders of magnitude higher concentrations of this element than animal tissues (Outridge and Scheuhammer, 1993). Chromium(III) accumulates in the roots of plants but has low mobility for transport to stems and leaves (Wallace et al., 1977 and Carey, 1982). Within roots, it may form a variety of complexes with organic materials (Outridge and Scheuhammer, 1993). In plants as in animals, chromium(VI) is more toxic than chromium(III). Decreased yield was observed in bush beans (Wallace et al., 1977) and 10 species of crop plants (Fiussello and Novo, 1977) grown in culture media containing chromium(VI) salts. A TRV was derived from the work of Wallace et al. (1977).

Rosomer et al. (1961) (cited in Eisler, 1986a) reported a subchronic NOAEL of 49 mg/kg-day in the diet for chickens. These data are used to develop a TRV for avian functional groups.

Pregnant female mice receiving 250 mg/L potassium dichromate in drinking water throughout gestation showed no clinical signs of toxicity, but produced significantly fewer viable offspring (Trivedi et al., 1989). In the dog, 6 mg/L in drinking water (approximately 0.3 mg/kg-day) was a chronic NOAEL [Steven et al., 1976 (cited in Eisler, 1986a)]. A similar level was without observable effects in a study by Anwar et al. (1961) (cited by Outridge and Scheuhammer, 1993). Rats exposed to high concentrations of chromium oxide in their diets for more than 2 years showed no decreased body weight, food consumption, or life span, or histological abnormalities in major organs (Ivankovic and Preussmann, 1975). A NOAEL of 1500 mg/kg-day was used to develop a TRV from this study. Based on these results, TRVs were derived for mammalian functional groups.

No information on the toxicological effects of chromium on reptile or invertebrate receptors was located.

Lead (CAS No. 7439-92-1). Lead (Pb) is a ubiquitous trace constituent in rocks, soils, plants, water, and air, with an average concentration of 16 mg/kg in the earth's crust (Eisler, 1988b). Lead has four stable isotopes: Pb-204 (1.5%), Pb-206 (23.6%), Pb-207 (22.6%), and Pb-208 (52.3%). Lead occurs in four valence states: elemental (Pb°), monovalent (Pb^{+}), divalent (Pb^{+2}), and tetravalent (Pb^{+4}). In nature, lead occurs mainly as Pb^{+2} and is oxidized to Pb^{+4}. Metallic lead is relatively insoluble in hard waters. Some lead

salts are somewhat soluble in water. Of the organoleads, tetraethyllead and tetramethyllead are the most stable and are highly soluble in many organic solvents but are fairly insoluble in water. Both undergo photochemical degradation in the atmosphere to elemental lead and free organic radicals. Organolead compounds are primarily anthropogenically-produced (Eisler, 1988b).

Lead is neither essential nor beneficial to living organisms. Lead affects the kidney, blood, bone, and central nervous system. Effects of lead on the nervous system is both functional and structural. Lead toxicity varies widely with the form and dose of administered lead. In general, organolead compounds are more toxic than inorganic lead. In nature, lead occurs mainly as divalent, Pb^{2+}. Ingestion of lead shot by regulatory waterfowl is a significant cause of mortality in these species.

Hatchlings of chickens, quail, and pheasants are relatively tolerant to moderate lead exposure (Eisler, 1988b). There was no effect on hatchling growth of these species at dietary levels of 500 mg/kg or on survival to 2,000 mg/kg lead (Hoffman et al., 1985 as cited in Eisler 1988). For avian herbivores, a TRV was estimated using a study of mallards (Dieter and Finley, 1978). Altricial species are generally more sensitive to lead than precocial species (Eisler, 1988b) of avian insectivores. An oral study using European starlings (Osborn et al., 1983) was used to generate a TRV for trimethyllead chloride. Because organic lead compounds are generally more toxic than inorganic lead, the HQs generated using this TRV should be interpreted with caution. American kestrel (*Falco sparverius*) exposed to 50 mg/kg/day metallic lead in diets did not exhibit effects on survival or reproductive success (Colle et al., 1980). Using these studies, TRVs were developed for avian functional groups.

Studies using rats administered lead in drinking water (Kimmel et al., 1980), of lead toxicity in calves (Zmudzki et al., 1983), and using dogs (Demayo et al., 1982) were used to develop TRVs for mammalian receptors.

A study on the toxicity of lead nitrate to the isopod (*Porcellio scaber*) reports a critical concentration of 2,000 g/g lead in food on a dry weight basis for reproduction (Hopkin and Hames, 1994).

The recommended screening benchmark concentration for phytotoxicity in soil for lead of 50 mg/kg was used as the TRV for terrestrial plants (Suter et al., 1993).

No information on the toxicological effects of lead on reptiles or invertebrate receptors was located.

Mercury (CAS No. 7439-96-5). Mercury (Hg) exists in the environment in three oxidation states: the element itself, +1 (mercurous) state, and +2 (mercuric) state. The factors that affect which species dominates in an environment are the redox potential and the pH of the system. Particle-bound mercury can be converted to insoluble mercury sulfide, which can be bioconverted into more soluble or volatile forms that may reenter the atmosphere or be taken up by biota and bioaccumulated in the terrestrial food chain. Mercury forms many stable organic complexes that generally are more soluble in organic matter than in water. Inorganic and organic particles strongly sorb mercury. Mercury can be transformed in the environment by biotic and abiotic oxidation and reduction, bioconversion of organic and inorganic forms, and photolysis. Mercury can be strongly concentrated by living organisms (Callahan et al., 1979). The chemistry of mercury in the environment is complex, not only because of its various oxidation states but also because of biotic and abiotic methylation and demethylation processes, complexation with organic and inorganic ligands, and the differential solubility and volatility of various forms. As speciation is a major determinant of the fate, bioavailability, absorption, and toxicological characteristics of mercury compounds, lack of knowledge of the

state of the mercury in INEEL soils is a large source of uncertainty in both exposure assessment and TRV development.

Although the generally more toxic organic forms of mercury are unlikely to persist in the environment, they (in particular, methylmercury) may be formed in biotic tissues and are known to biomagnify through ecosystems, particularly aquatic systems (reviewed by Wren 1986; Scheuhammer 1987). Thus, to ensure that mercury TRVs for the WAG ERA are protective of receptors at all levels of ecological organization, TRVs are developed from studies investigating the toxic effects of organic mercurials. It is noted that this measure is highly conservative and will tend to overestimate risks for receptors lower in the food web because the majority of mercury in soil and plants (i.e., the majority of exposure to plants and soil-dwelling and herbivorous animals) is expected to be inorganic.

Because of its chemical stability and lipophilicity, methylmercury readily penetrates the blood-brain barrier. The central nervous system is thus a major target organ in both mammals and birds. However, reproductive effects have been reported at even lower doses. Methylmercury can be converted to inorganic mercury both in tissues and by microflora in the gut. The homolytic cleavage of the mercury-carbon bond leads to generation of reactive intermediates, e.g., methyl and metal radicals, which cause cellular damage (reviewed by Wren, 1986; Scheuhammer, 1987; Manzo et al., 1992).

The effects of mercury on avian receptors were evaluated as follows. A chronic study of American black ducks was used to develop a TRV for avian herbivores. Significantly decreased reproduction, elevated tissue levels, and brain lesions resulted from 3 mg/kg-day of methylmercury exposure in the diet. For avian carnivores, TRVs were developed from a study on goshawks. Three goshawks were fed a diet of chickens that had eaten wheat dressed with an organomercurial fungicide (Borg et al., 1970). Their tissues contained 10 to 40 ppm of mercury, mostly as methylmercury. The hawks died after 30 to 47 days; their total mercury intake was about 20 mg/bird.

Two studies examined the effects of subchronic methylmercury exposure on the reproductive competence of male and female rats (Khera and Tabacova, 1973 and Khera, 1973). The NOAEL identified for both sexes was 0.25 mg/kg/day. Much less information is available regarding methylmercury toxicity to herbivores. In a study of acute methylmercury toxicity in mule deer (*Odocoileus hemionus hemionus*) 17.88 mg/kg was said to be the LD_{50} (Eisler 1987a). A number of studies have examined the effects of chronic methylmercury ingestion on carnivorous mammals, particularly cats (e.g., Albanus et al. 1972; Charbonneau et al. 1976; Eaton et al., 1980) and mink (e.g., Aulerich et al., 1974; Wobeser et al., 1976; Wren et al., 1987). The chronic toxicity of cats study by was considered superior to other available studies because of its long duration (2 years), use of relatively large group sizes, detailed examination of endpoints, identification of both no-effect and effect levels, and administration of mercury via both contaminated fish and addition to diet (Charbonneau et al., 1976).

TRV of 0.3 mg/kg was assigned for mercury for terrestrial plants based on the toxicological benchmark (Suter et al., 1993).

No information on the toxicological effects of mercury on reptiles or invertebrates was located.

Molybdenum (CAS 7439-98-7). Molybdenum (Mo) exposure can occur through inhalation of dust or fumes, ingestion, or eye and skin contact for soluble compounds. It is considered to be an essential trace element in many species, including man. Animal studies indicate that insoluble molybdenum compounds are

of a low order of toxicity. Freshly generated molybdenum fumes, however, are considerably more toxic. Inhalation of high concentrations of molybdenum trioxide dust is very irritating to animals and has caused weight loss, diarrhea, loss of muscular coordination, and a high mortality rate. Molybdenum trioxide dust is more toxic than the fumes. Large oral doses of ammonium molybdate in rabbits caused some fetal deformities. Excessive intake of molybdenum may produce signs of a copper deficiency (Sittig, 1981).

The results of three studies (TOXNET 1994) on the toxicological effects of molybdenum on rats and guinea pigs described LOAELs of 2, 7.5, and 40 mg/kg-day. The most conservative of these was used to develop a TRV for mammalian receptors.

Information on the toxicological effects of molybdenum on avian and reptilian function groups was not located.

Nickel (CAS No. 7440-02-0). Nickel (Ni) is a naturally occurring metal that is found in the earth's crust (ATSDR, 1988). Nickel is continuously transferred between, air, water, and soil via various natural processes including weathering, runoff, erosion, and leaching. Nickel is very persistent in both soil and water. The average residence time of nickel in soil is estimated to be 2,400 to 3,500 years. Although nickel is persistent in soil, it can leach into groundwater. The sorption of nickel to soils correlates with pH, total iron, and organic matter content. Organic complexing agents in soil tend to restrict the movement of nickel by forming organs-nickel compounds. Nickel is fairly mobile in soils a low pH and CEC (ATSDR, 1988a). However, nickel ferrite appears to be the most probable nickel species to precipitate in soil. Nickel can exist in water in various soluble and insoluble forms depending on the physiochemical properties of the water. The mobility of nickel in aqueous media is affected by complexation, precipitation and dissolution, oxidation and reduction, and adsorption and desorption.

Small amounts of nickel can be essential for normal growth and reproduction (ATSDR, 1988). Oral exposure to high concentrations of nickel has been reported to adversely affect the hematological system and reproduction.

Toxicity studies of chicks by (Weber and Reid, 1968) and of mallards (Eastin and O'Shea, 1981) were used to develop TRVs for avian herbivores.

Mammalian TRVs were developed from three experiments. Rats fed 5 mg/kg/day nickel sulfate in a 2-year dietary study did not produce hepatic changes or altered body weights (Ambrose et al., 1976). This NOAEL was supported by a rat subchronic drinking water study conducted by American Biogenics Corp. (ABC, 1986) and a rat reproductive study by Research Triangle Institute (RTI, 1987). Using the 2-year study (Ambrose et al., 1976), a TRV for small mammals was developed. For mammalian herbivores, a subchronic study of cows that did not exhibit reduced food intake or growth rate when fed 250 mg/kg/d nickel carbonate (O'Dell et al., 1979 as cited in NAS 1980) was used to develop a TRV. A dietary study exposing dogs to 1,000 ppm nickel did not result in adverse effects (Ambrose et al., 1976) and was used to develop a TRV for mammalian carnivores.

The recommended screening benchmark concentration for phytotoxicity in soil for nickel of 25 mg/kg was used as the TRV for terrestrial plants (Suter et al., 1993).

No information on the toxicological effects of nickel in reptile or invertebrate receptors was located.

Selenium (CAS No. 7782-49-2). Selenium (Se) is a critical nutrient and a key component of several enzymes (Eisler, 1985b). It is often found in high concentrations in areas where soils have been derived from Cretaceous rocks (Eisler, 1985b). Selenium is stable in four valence states: -2, 0, +4, and +6. The positive anions are present in oxyanions and organo-selenium compounds. The inorganic forms dominate the physical chemistry of selenium in solution. Inorganic selenium is extremely insoluble and will sorb strongly to soil. Selenium can be adsorbed by iron and manganese hydroxides, organic matter, and iron sulfides. Selenium can become mobile in soil/water systems under alkaline conditions. Under low pH conditions, more insoluble elemental selenium tends to be present (Callahan et al., 1979).

Selenium can accumulate to high concentrations in certain species of plants (e.g., *Aster*, *Astragalus*) (Eisler, 1985b). Livestock species ingesting these plants have been reported to exhibit toxic symptoms such as abnormal movements, labored breathing, dilated pupils, bloating, diarrhea, and rapid pulse. No effective treatment is known for counteracting the toxic effects of high levels of ingested selenium. Prolonged exposure to more moderate levels of selenium result in skin lesions involving alopecia, hoof necrosis and loss, emaciation and increased serum transaminases, and alkaline phosphatase in animals (TOXNET, 1994). Selenium has been reported to cause growth retardation, decreased fertility, embryotoxicity, fetotoxicity, and teratogenic effects in animals (TOXNET, 1994). Birds appear to be particularly susceptible to selenium, particularly in the area of reproductive success. Malformations in chickens and waterfowl have been widely reported (EPA, 1993b).

Selenium deficiency is often a greater threat to health than selenium poisoning (Eisler, 1985b). Selenium deficiency has been documented in a variety of species including fish, quail, ducks, poultry, rats, dogs, domestic grazing animals, antelope, monkeys, and humans (Eisler, 1985b). Selenium can also reduce the toxicity of other heavy metals such as thallium, arsenic, and copper (Wilber, 1980).

Studies by Ort and Latshaw (1978), Heinz et al. (1987), and Smith et al. (1988) evaluating the effects of sodium selenite in chickens, mallards, and black-crowned night herons were used to derive TRVs for avian receptors.

In a study by Rosenfeld and Beath (1954), selenium administered as potassium selenate to sires and pregnant rats through five breeding cycles did not affect reproduction, the number of young reared, or on the reproduction of two successive generations of dams and sires in groups receiving 1.5 ppm selenium. A NOAEL of 0.075 mg/kg-day was established to develop a TRV. Selenium doses of as low as 3.2 mg/kg body weight have resulted in death in sheep (Eisler, 1985b). A mammalian TRV was developed using these data.

No information on the toxicity of selenium in reptile or invertebrate receptors was located.

The recommended screening benchmark concentration for phytotoxicity in soil for selenium of 1 mg/kg was used as the TRV for terrestrial plants (Suter et al., 1993).

Silver (CAS No. 7440-22-4). Silver (Ag) is a transitional metal with one stable cationic state, Ag^+. Chemical speciation, sorption, and bioaccumulation are important factors affecting the fate and transport of silver. Oxidation-reduction potential and soil pH primarily determine the fate of silver in soils. In the absence of organic matter, silver tends to be removed from soils. The precious metal silver is relatively rare in the earth's crust and does not occur regularly in animal tissues. As a result, the toxicity of silver has been little studied. Approximately 10% of ingested silver is absorbed; as much as 18% may be retained.

Silver-protein complexes accumulate in the liver, and biliary excretion (complexed with glutathione) is the major route of elimination. In most tissues, silver is deposited as large granules. With rare exceptions, these deposits are not associated with adverse effects. The LD_{50} of silver in rats is relatively high at 24 mg/kg (reviewed by Rungby, 1990).

Silver causes a conditioned deficiency of selenium in rats, decreasing tissue levels of selenium, and the selenoprotein glutathione peroxidase (Ganther, 1980). Silver ions complex strongly to sulfhydryl groups and cause peroxidation of hepatocellular membrane lipids (Rungby et al., 1987 and Shinogi and Maeizumi, 1993). Because of its affinity for sulfhydryls, the degree of binding to cellular macromolecules and toxicity of silver is mitigated by induction of the divalent metal-binding protein metallothionein (Shinogi and Maeizumi, 1993). Exposure of fetal and adult rats to silver results in deposition in the central nervous system (Rungby and Danscher, 1983a, 1983b). Pyramidal cells in the developing hippocampus appears to be a sensitive target, exhibiting reduced cellular volume in both pre- and postnatally exposed rats (Rungby et al., 1987 and Rungby 1990). The mammalian TRVs for silver are based on the subchronic study by Rungby and Danscher (1984) in which mice exposed to approximately 18 mg/kg/day were observed to be "hypoactive." Although silver deposits occurred in certain motor centers of the brain, no association between the concentration of deposits and the extent of hypoactivity was found.

No information on the toxicological effects of silver in avian, reptile, amphibian, invertebrate or plant receptors was located.

Strontium (CAS No. 7440-24-6). Strontium (Sr) is an alkaline earth element and is, therefore, chemically similar to calcium and barium. Strontium follows calcium through food chains from environment to organism, but some degree of discrimination exists against strontium (Kirchman et al., 1993). Both strontium and calcium are retained in vertebrate organisms primarily in bone. Strontium is moderately toxic by ingestion and inhalation. The stable form has low toxicity. Strontium compounds are chemically and biologically similar to calcium. The oxides and hydroxides are moderately caustic materials (Sax and Lewis, 1987). Ingested strontium is distributed in the body in three compartments: plasma extracellular fluid; soft tissue and superficial zone of bone tissue; and bone itself (El Solh and Rousselet, 1981). The toxic effect of excessive strontium intakes is inhibition of calcification of epiphyseal cartilage and deformities of long bones at high doses. strontium causes adverse effects on bone by substituting for calcium during bone calcification or by displacing calcium from existing calcified matrix (Skoryna 1981 and Kshirsagar, 1985).

Storey (1961) fed young and adult female rate (3/group) diets with adequate calcium, phosphorous, and vitamin D for 20 days. The dietary levels of strontium (as strontium carbonate) given to both adult and young rats correspond to 190, 380, 750, 1,000, 1,500, and 3,000 mg/kg-day for young rats and 95, 190, 375, 750, and 1,500 mg/kg-day for adult rats. Rats were examined for changes in bone mineralization and defects in cartilage. Young rats were found to be affected more severely at lower dietary strontium levels than were adult rats. For young rats, the dietary level of 190 mg/kg-day was an NOAEL and 350 mg/kg-day was an LOAEL. In adults, the first obvious bone change occurred at the 750 mg/kg-day dietary strontium level. For adult rats, the dietary level of 375 mg/kg-day was an NOAEL and 750 mg/kg-day was an LOAEL.

Marie et al. (1986) administered stable strontium to weanling male Spraque-Dawley rats. Rats were divided into groups (8/group) receiving 0, 316, 425, 525, and 633 mg/kg-day. Rats in the 633 mg/kg-day dose group showed signs of increased mineralization lag time; excessive osteoid thickness associated with a decline in the rate of calcification, which resulted in slow growth rate; and defective long bone growth. This study identified an NOAEL of 525 mg/kg and an LOAEL of 633 mg/kg-day.

Skoryna (1981) investigated the oral toxicity of stable strontium in male adult RVH hooded rats. The rats were administered experimental doses of strontium chloride corresponding to 70, 147, and 263 mg/kg-day strontium. The control and experimental groups received adequate amounts of calcium and magnesium in their drinking water. Except for bone, no organ predilection for strontium was observed. A chronic NOAEL of 263 mg/kg-day was identified from this study.

No information on the toxicological effects of strontium in avian, reptile, amphibian, invertebrate or plant receptors was located.

28.3.5 Development of TRVs for Organic Contaminants of Potential Concern

The following section summarizes the information used in determining the TRVs for organic contaminants for which toxicological studies were located. These contaminants are:

- Acetone
- Benzo(a)pyrene
- Benzo(b)fluoranthene
- Chrysene
- Polychlorinated Biphenols

The development of TRVs for the studies identified for each COPC is contained in Appendix J.

Acetone (CAS-67-64-1). Acetone is expected to be mobile in soil/groundwater systems. Only a small amount of acetone released into the environment is expected to sorb to soil. The majority is expected to migrate freely through the soil-water phase and migrate freely via diffusion and infiltration with little or no retardation. Acetone is infinitely soluble in water as evidenced by its very low K_{oc} and K_{ow} values. Since acetone is not strongly sorbed to soils, some volatilization may also occur. Acetone is also highly susceptible to microbial degradation (ADL, 1987). Acetone is moderately toxic by various routes. It is a skin and eye irritant and is narcotic in high concentrations (Sax and Lewis, 1987).

Acetone was administered via gavage for 90 days to group of albino rats (30 of each sex per group) at treatment levels of 0, 100, 500, or 2,500 mg/kg-day (EPA, 1986). Body weights, clinical chemistry, hematology, histopathologic parameters, food consumption, and organ weights were measured. No effects were observed at the 100 mg/kg-day dose. Histopathologic studies showed that rats in the 2,500 mg/kg-day group had a marked increase in tubular degeneration of the kidneys and hyaline droplet accumulation with increasing dose.

No information on the toxicological effects of acetone on reptile, invertebrate, or avian receptors or on terrestrial plants was located.

Benzo(a)pyrene (CAS 50-32-8) (See PAHs). Benzo(a)pyrene (BaP) is a polyaromatic hydrocarbon (PAH). PAHs constitute a class of materials of which BaP is one of the most common and also the most hazardous. Mammalian TRVs were developed from a long-term study (Brune et al., 1981) in which BaP was administered orally by gavage to male and female rats with a cancer endpoint. No toxicological information on the effect of BaP on avian, reptile, or plant receptors was located.

Benzo(b)fluoranthene (CAS 205-99-2) (See PAHs). Benzo(b)fluoranthene [B(b)F] is one of the PAH compounds. Because it is formed when gasoline, garbage, or any animal or plant material burns, it is usually found in smoke and soot. This chemical combines with dust particles in the air and is carried into water and soil and onto crops. B(b)F is found in the coal tar pitch that industry uses to join electrical parts

together. It is also found in creosote, a chemical used to preserve wood. The toxicity study for benzo(a)pyrene (above) was used to determine TRVs for benzo(b)fluoranthene. No information on the toxicological effects of B(b)F on reptile, invertebrate, or avian receptors or on terrestrial plants was located.

Chrysene (CAS 218-01-9) (See PAHs). Chrysene is one of the PAH compounds. Like B(b)F, it is usually found in smoke and soot. Chrysene is absorbed by the oral route of exposure and may also occur following dermal exposure. No information was found in the available literature concerning effects of chrysene following oral exposure. Mammalian TRVs were developed from a chronic study (Hecht et al., 1974 and ATSDR, 1990c) in which 20 female mice were dermally exposed to chrysene. A LOAEL of 1.2 mg/kg-day was reported from this study. No information on the toxicological effects of chrysene on avian, reptilian, invertebrate, or terrestrial plant receptors was located.

PCBs (CAS 1336-36-3). PCBs comprise a physicochemically and toxicologically diverse group of 209 compounds whose widespread use and chemical stability have made them ubiquitous in the environment. The chemical properties of commercial PCB mixtures depend on their degree of chlorination. PCB congeners with five to seven chlorine atoms per molecule are the most abundant in environmental matrices and the most bioaccumulative, while those that are more highly chlorinated are more tightly bound to particles and hence less bioavailable (reviewed by McFarland and Clarke, 1989; Borlakoglu and Haegele, 1991; Safe, 1992). The fate of PCBs in the environment is affected by biodegradation and photolysis. Non-destructive processes that affect the distribution and transport of PCBs biphenyls are adsorption, volatilization, and bioaccumulation. PCBs tend to have high octanol-water partitioning coefficients, low water solubilities, and sorb strongly to soil organic matter. The tendency of PCBs to adsorb to soil and hence their environmental persistence increases with the degree of chlorination as well as with the organic content of the soil. PCBs with a high degree of chlorination degrade very slowly in the environment. Significant leaching of PCBs from soil is not likely. Volatilization and transport as an aerosol followed by fallout with dust or rain is the probable cause of the widespread distribution of PCBs (Callahan et al., 1979). Biota are another environmental compartment into which these compounds may be partitioned.

Because of their generally low acute toxicity, effects on environmental receptors are more likely to be sublethal and chronic than acute. Toxicity and risk assessment of PCB mixtures is complicated by the fact that the 209 congeners differ markedly in both the severity and the nature of their biological effects. The toxic potency of individual congeners is dependent upon their structure. While the approximate isostereomers of 2,3,7,8-tetrachlorodibenzo-p-dioxin i.e., coplanar molecules with chlorine atoms in the lateral (but not ortho) ring positions are the most toxic (and carcinogenic in some species), many others manifest very low acute or chronic toxicity.

The most toxic congeners are also the most potent inducers of mixed-function oxidases as well as some Phase II enzyme activities (reviewed by Safe, 1992). These enzymes metabolize not only the inducing PCBs but also a variety of endogenous molecules, such as steroid hormones, that are necessary for normal physiological function. As a result, PCBs may exert adverse effects on development and reproduction in various vertebrate species, including birds (e.g., Koval et al., 1987). In addition, there is considerable difference in the sensitivity of various species to these compounds. Particularly sensitive species include some birds, guinea pigs, and mink (McConnell, 1985).

Dahlgren and Linder (1971) and Dahlgren et al. (1972) examined the effects of Aroclor-1254 exposure in pheasants. Although no NOAEL was identified in this work, its focus on a wild species and dosing of both sexes makes it attractive for TRV development. Nine to 10 mg/kg-day Aroclor-1254 reduced sperm concentrations in American kestrels, *(Falco sparverius)* (Bird et al., 1983). Avian TRVs were derived from these studies.

Linder et al. (1974) identified NOAELs for Aroclor-1254 in a two-generation reproductive study in rats. Many studies have focused on the toxicity of various PCBs to mink. Hornshaw et al. (1983) developed a NOAEL of 0.25 mg/kg-day for mink. Mammalian TRVs were derived from these studies.

For terrestrial plants, the recommended toxicological benchmark identified for PCB exposure was used as the TRV (Suter et al., 1993).

No information on the toxicological effects of PCBs on reptile or invertebrate receptors was located.

PAHs. PAHs are a group of chemicals that are formed during the incomplete burning of coal, oil and gas, garbage, or other organic substances. PAHs can be manmade or occur naturally. Some of the PAHs are used in medicines and others are used to make dyes, plastics, and pesticides. PAHs are found throughout the environment in the air, water, and soil. Most PAHs do not occur alone in the environment, rather they are found as mixtures of two or more PAHs. They can occur in the air attached to dust particles or in soil or sediment as solids. They can also be found in substances such as crude oil, coal tar pitch, creosote, and road and roofing tar. Most PAHs do not dissolve easily in water, but some PAHs readily evaporate into the air. Higher molecular weight PAHs tend to have lower solubilities in water. PAHs generally do not burn easily and they will last in the environment for months to years (ATSDR, 1990). PAHs tend to sorb strongly to soil and organic matter and can be very persistent in soils. The dominant mechanism of PAH removal from soil is microbial degradation. Benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perlyene, benzo(k)fluoranthene, chrysene, and indeno(1,2,3-cd)pyrene are PAHs.

PAHs accumulate from soil into roots, which will translocate them into other vegetation parts (Eisler, 1987). In general, unsubstituted PAHs do not tend to accumulate in mammalian adipose tissues despite their high lipid solubility (Eisler, 1987). This is probably a result of the fact that PAHs are rapidly and extensively metabolized. Numerous PAHs are distinct in their ability to produce tumors in most animal species tested. Acute and chronic exposure to various carcinogenic PAHs has resulted in destruction of the hematopoietic and lymphoid tissues, ovotoxicity, respiratory epithelia, and other documented effects (Eisler, 1987). For the most part, tissue damage occurs at dose levels expected to cause cancer, so the threat of malignancy is the predominant health effect of concern. Target organs affected by PAHs are diverse, probably due to their widespread distribution in the body and to selective attack by PAHs on proliferating cells. Laboratory studies with mice show that many PAHs affect the animal's immune system.

28.3.6 Development of TRVs for Radionuclides

For exposure to radiological contaminants, injury is caused by absorption of energy into living tissue and from the decay of radionuclides. As in the case of chemical toxicants, the dose of radiation absorbed by any individual organism is a function of its anatomy, physiology, ecology, and behavior. Studies on the effects of radionuclides have shown that the rate of chronic exposure is more important than the total dose in assessing radiotoxicity (IAEA, 1992). The TRV values for all radionuclides and all animal functional groups was 1 mGy/day, which is the chronic dose below which there does not appear to be changes observed in terrestrial animal populations (IAEA, 1992). For terrestrial plants, the equivalent dose was 10 mGy/day, and this value was applied as the TRV for terrestrial plants for all radionuclides. Other available information on the effects of radionuclides on various functional groups is described below.

A chronic NOEL of 6 mGy/day was established for passerine birds based on no effect on breeding success of swallows and wrens exposed to 0.7 6 mGy/day (IAEA, 1992). The more conservative TRV of 1 mGy/day for avian groups was identified as described above in the IAEA (1992) report.

Redback vole populations (*Clethrionomys gapperi*) were unaffected at dose rates of 15 mGy/hour (IAEA, 1992). Chronic exposure of pigs and donkeys to 1 mGy/day was found to be an NOEL (Garner and

Barber, 1966, as cited in IAEA, 1992). Chronic exposure of 4 mGy/day produced measurable declines in the number, motility, and viability of sperm in the dog, while exposure rates of <1.2 mGy/day failed to produce sperm count changes in dogs (IAEA, 1992). The more conservative TRV for mammalian groups is 1 mGy/day, which was identified for all animal functional groups (IAEA, 1992).

No significant differences in sex ratios, age distributions, or life spans were observed between lizards exposed to 20 mGy/day for 5 years and control iguanid lizards (IAEA, 1992). Conflicting results occurred when females of two other lizard species occupying the same enclosures became sterile, where reproduction was blocked after 1 or 2 years, and the populations later drifted towards extinction. IAEA (1992) suggests that the ovaries of the two affected species (which live longer and mature slower than the iguanid lizards) would accumulate a greater total dose before sexual maturation. As identified above, the more conservative TRV for all animal functional groups is 1 mGy/day from the IAEA (1992) report.

The IAEA (1992) concluded that invertebrates appear to be more affected by indirect than direct effects. The direct effects of radiation on terrestrial invertebrates, insects in specific, are most likely limited by responses in fertility rather than mortality.

Doses of less than 10 mGy/day were assumed to represent an NOEL for plant species (IAEA, 1992). A more conservative TRV for all terrestrial plants is 10 mGy/day from the IAEA (1992) report.

Americium (Am-241). Am-241 is produced by the beta-emission disintegration of Pu-241 (Poet and Martell, 1972 and Faure, 1991). Americium has the potential to exist in two oxidation states, Am(III) and Am(IV), in natural systems. Am(III), however, is the more stable form. The Eh-pH diagram for the Am-C-O-H system (Brookins, 1988) presents two main fields of stability for americium species at pH values typically found in natural systems. For acidic pH values of 6 or less, the Am(III) cation is stable. For pH values above 6, the carbonate solid (crystalline form), $Am_2(CO_3)_{3(c)}$, and the solid americium dioxide (crystalline form), $AmO_{2(c)}$, are stable (Brookins, 1988). Americium is known to be strongly adsorbed to clays and carbonate solids such as calcite. Data for equilibrium partitioning of americium to calcite is on the order of 105 or greater (Faure, 1991). The positive three charge on the trivalent americium ion indicates that it is strongly partitioned by adsorption or ion exchange such as to solids (silts, clays, and iron oxyhydroxides) that exhibit high negative surface charges. Because the subsurface sediments and soils at INEL have a high percentage of these solids (the INEL northern portion is covered by lake and eolian deposits, mostly composed of unconsolidated clay, silt, and sand), americium solubility and mobility in the vadose zone soils, in groundwater, and dissolved in surface water at INEL should be very low. Oxides and hydroxides of Am(III) are relatively insoluble. Americium does have the potential; however, to be transported as an adsorbed particle via eolian transport or overland flow to surface water if it is present at the soil-atmosphere interface.

Cesium (Cs-134 and Cs-137). These two cesium isotopes are fission products produced in nuclear reactors. Cesium is an alkali metal with properties similar to potassium and rubidium. The distribution of Cs-137 in the stratosphere and the pattern of its terrestrial deposition are similar to those for Sr-90. Cs-134 has a 2.06 year half-life and Cs-137 has a 30.2-year half-life. Cesium is tightly bound to soil with a strong retention to clay soils. As late as 18 years after the cessation of nuclear weapons testing in 1963, Cs-137 was still confined to the upper 24 cm of silty clay and exhibited a half-value depth (that depth at which the concentration is 50% of the surface contamination) of about 6 cm in undisturbed soil (Eisenbud, 1987). Thus, the main portal of entry of cesium to the food chain during periods of active fallout was foliar absorption. There has been evidence of a high bioconcentration in some plant and animal species. An example is the Cheronobyl fallout in Sweden, which reached sixfold higher concentrations in certain animals. (IAEA, 1992). Cesium is a congener of potassium. However, the cesium/potassium ratio is not as constant in biological systems as is the strontium/calcium ratio. Cesium metabolism resembles that of potassium. It

too is distributed uniformly throughout the body. The uptake of cesium from soil has been shown to be inversely proportional to the potassium content of soils in which there is a potassium deficiency.

Cobalt (Co-60). Co-57 and Co-60 are produced in nuclear explosions and in reactors. Co-57 has a 271 day half-life and Co-60 has a 5.27 year half-life. Cobalt has a tendency to form soluble complexes with dissolved organic matter.

Europium (Eu-152, Eu-154, and Eu-155). The half-lives for these three europium isotopes are 13.6, 8.80, and 4.96 years, respectively. All three europium isotopes may behave similarly to cesium.

Plutonium (Pu-239 and Pu-240). Plutonium is a transuranic radioactive (actinide series) element produced by fission reaction in nuclear reactors, by the explosion of nuclear fission devices, and by natural radioactive processes. There are 15 isotopes of plutonium, with half-lives ranging from minutes to thousands of years. The principal isotope of plutonium, Pu-239, has a half-life of 24,390 years and a specific activity of 6.13×10^{10} pCi/g. Four other abundant isotopes are Pu-238, Pu-240, Pu-241, and Pu-242. Pu-238 has a half-life of 86.4 years, Pu-240 has a half-life of 6,580 years, Pu-241 has a half-life of 13.2 years, and Pu-242 has a half-life of 376,000 years (EPA, 1990). Pu-240 decays by beta emission to produce Am-241 (Hardy, 1974). Although Pu-239 and Pu-240 are the most abundant of the nuclides, they cannot be distinguished by alpha spectrometry. Thus, these two nuclides are usually reported together as "plutonium." Small amounts of Pu-239 are produced naturally in uranium minerals, such as pitchblende and carnotite, by neutron capture of U-238 followed by beta-decay of the resulting U-239 and neptunium (Np)-239 (Faure, 1991). Many different chemical species of plutonium often co-exist. Plutonium has four oxidation or states, ranging from III to VI, and forms stable compounds with all the nonmetallic elements except the rare gases. Pu(III) is the dominant species in acidic environments, whereas Pu(IV) is the dominant species under alkaline or oxidizing conditions. In aqueous solutions, Pu(III) is oxidized into Pu(IV). The compounds PuF^4, $Pu(IO^3)^4$, $Pu(OH)^4$ and plutonium oxalate are insoluble in water. The chlorides, nitrates, perchlorates, and sulfates are soluble in water (EPA 1990). Pu(IV) ions complex readily with organic and inorganic compounds. The stability of complexes decreases in the order Pu(IV) > Pu(III) > Pu(VI) > Pu(V). It is, therefore, probable that most if not all plutonium in environmental and biological systems is in the Pu(IV) state. Plutonium ions in solution rapidly hydrolyze and form polymers. Hydrolysis of Pu(IV) can result in the formation of relatively insoluble polymers, a process which is only slowly reversible (EPA, 1990). Under alkaline and oxidizing conditions, a soluble (aqueous) form of plutonium, $Pu(OH)_{5-(aq)}$ is potentially stable, by the hydrolysis of solid $Pu(OH)_{4(c)}$ (crystalline form) (Brookins, 1988). However, thermodynamic calculations indicate that the conversion of plutonium hydroxide to plutonium dioxide is mildly exothermic, indicating that with sufficient time freshly precipitated $Pu(OH)_{4(c)}$ will convert to $PuO_{2(c)}$. Conversion of the hydroxide to the oxide would reduce the potential to release the plutonium-hydroxide anion to solution and thus lower its potential mobility. The relatively low seasonal recharge rates at the INEEL favor the formation of (crystalline form) $PuO_{2(c)}$. In general, plutonium species have a strong affinity for the solid phase as indicated by their high K_d (soil/water distribution coefficient) values. Mean distribution coefficients range from 550 mL/g in sandy soils (>70% sand-sized particles) to 5,100 mL/g in clay soil (>35% clay-sized particles). A value of 5,100 mL/g indicates that plutonium is strongly adsorbed to clay particles, and also is expected to undergo strong cation exchange reactions due to its strong positive charge. A lack of plutonium in surface water or groundwater is expected based on plutonium behavior documented in the literature. Because plutonium tends to bind tightly in soil, there is little plant uptake. Concentrations in plants generally range from 0.001 to 0.00001% of the amount in soil (EPA, 1990).

Strontium (Sr-90). Strontium is an alkaline earth element and is, therefore, chemically similar to calcium and barium. Strontium follows calcium through food chains from environment to organism, but some degree of discrimination exists against strontium (Kirchman et al., 1993). Both strontium and calcium are retained in vertebrate organisms primarily in bone. Sr-90 is a radionuclide formed during nuclear fission. It has a radioactive half-life of 29.1 years and decays by beta emission. Its daughter radionuclide, Y-90 also is

radioactive. Y-90 has a half-life of 64 hours and decays by beta emission to the stable isotope zirconium (Zr)-90 (Shleien, 1992). Since Sr-90 is produced in the fuel of nuclear reactors, some Sr-90 in the environment at the INEEL may be from the reactors operated there or from waste transported onto the site. WHO (1983) reports that small amounts of Sr-90 produced in reactor fuel may reach the coolant through defects in the fuel cladding. In coolant purification or following coolant leakage, Sr-90 may reach the gaseous and/or liquid effluent streams and, in controlled amounts, be released to the environment. In terrestrial ecosystems, 60 to 80% of Sr-90 from fallout is retained in the upper 5 cm of undisturbed soil (Horne, 1978). The rate of movement of Sr-90 in soil typically is slow and depends on soil type; low cation exchange capacity, rapid water movement, and high electrolyte concentrations increase migration rates (WHO, 1983).

Plants acquire Sr-90 by root uptake and direct deposition onto foliage. Adsorption into the leaves is relatively slow and superficial material is readily lost. Uptake from soil normally is the primary mode of Sr-90 entry into plants. The amount of exchangeable calcium in soil is a key factor in determining the extent of Sr-90 uptake by plants; uptake is greatest from soils of low calcium content. Sr-90 in plants can be transferred to herbivorous animals and subsequently to higher trophic level (WHO, 1983 and Kirchman et al., 1993). Sr-90 in the environment at the INEL most likely is from both atmospheric fallout and release from onsite activities. Sr-90 in the environment is transferred to animal and human diets primarily through terrestrial pathways, and is retained in vertebrate organisms primarily in bone, but also is retained in muscle tissue and various internal organs (Kirchman et al., 1993).

Uranium (U-233 and U-235). Uranium is found in all rocks and soils. Acid igneous rocks (high silica content) contain a concentration of the order of 3 ppm, about 100 times greater than ultra-basic igneous rocks but considerably less than the phosphate rocks of Florida and southeastern Idaho and neighboring areas. The phosphate rocks in these areas contain as much as 120 ppm. The high uranium content of phosphate rocks is reflected in high uranium concentrations in commercial phosphate fertilizers. The uranium normally found in nature consists of four isotopes: U-230, U-234, U-235, and U-238. U-238 is present in the amount of 99.28%, has a half-life of 4.5×10^9 years and a specific activity of 3.3×10^5 pCi/g, and is usually in equilibrium with U-234 (0.0058%). U-235, the parent isotope of the actinium series, is present in the amount of 0.71%, and has a half-life of 7.04×10^8 years and a specific activity of 1.54×10^4 pCi/g. U-238 has a short half-life of 20.8 days. Although not typically occurring naturally in soil U-236 has a half-life of 2.34×10^7. Uranium exists in nature in two oxidation states, U(IV) and U(VI) (Hem, 1985). The Eh-pH diagram of the U-C-O-H system shows that tetravalent uranium is relatively insoluble in soil-water systems, existing primarily as the solid species $UO_{2(c)}$ across the entire spectrum of pH values, and reducing Eh values. When oxidized to the hexavalent form, uranium is highly mobile under all pH conditions, except for a limited area around pH 5 to pH 6.5 where the uranium carbonate is stable, precipitating as $UO_2CO_{3(c)}$. At values greater than 6, the uranyl carbonate complex $UO_2(CO_3)_2^{-2}{}_{(aq)}$ becomes stable thereby increasing the solubility of uranium. At highly alkaline values, the highly soluble complex $UO_2(CO_2)_2^{-4}{}_{(aq)}$ is stable. Because uranium occurs in soils and fertilizers, the element is present in food and human tissues.

28.3.7 Identifying Uncertainty Associated with TRVs

The following paragraphs identify the uncertainty associated with the TRVs.

Although QCEs should be derived from the best available literature and all the uncertainties that could be reasonably accounted for are included in the AFs used to calculate TRVs, it is unlikely that any single scheme could suffice to extrapolate available toxicity data for all chemicals among all species. Thus, the remaining uncertainty in these criteria may be even greater than that associated with exposure estimation.

Some of the extrapolations required in TRV development are listed in Table 28-22. TRVs are themselves dependent not only on extrapolation procedures but also on sampling adequacy and analytic

Table 28-22. Extrapolations required for developing TRVs.[a]

Extrapolation	Example
Between taxonomic groups	From laboratory mouse to field mouse
Between responses to stressor	From mortality in dogs to a no-observed-effect-level in bobcats
Between laboratory and field conditions	From cage to steppe
Between individual animals to population	From decreased growth rate in captive individuals to effects on a wild population
Between short- and long-term exposure conditions	From acute or subchronic toxicity tests to lifetime exposure
Between laboratory and natural exposure media	Percent uptake of chemical mixed with laboratory diet vs. adsorbed to soil
Between spatial scales	Evaluation of the impact of exposure to a contaminated field on predators whose foraging range is 50 times as large

a. Adapted from EPA (1992).

accuracy, and the completeness and accuracy of response measurements in variable populations of test organisms. Combining results from different species, gathered under different experimental conditions, and extrapolation of results in test organisms to populations of resident species introduce additional, potentially significant sources of error. These errors are:

- While classical human toxicology relies on extrapolation of toxicity data from a handful of mammalian species to one species, an ecotoxicological evaluation must rely on extrapolation from a few test species to a larger number of receptor species spanning variable (and often large) ranges in terms of phylogeny, anatomy, physiology, and life histories. Further, the spatial and temporal heterogeneity of exposure and conditions in natural systems can cause large variations in the doses and responses observed.

- Organisms in the environment are rarely (if ever) exposed to pure compounds alone, but rather to complex mixtures of chemicals whose effects in combination are unknown.

- Chemicals may be volatilized and transformed to more or less toxic products sequestered in the environment.

Our lack of knowledge of environmental variables and limited ability to replicate them in the laboratory or control them in the field results in a high level of uncertainty in our predictions of the effects of stressors on any given ecosystem component from laboratory toxicity tests.

28.4 Risk Characterization

Risk characterization is the final step of the WAG ERA process. The risk evaluation determines whether there is any indication of risk due to the contaminant concentrations and exposure parameter-calculated dose for INEEL functional groups, T/E, and sensitive species and discusses the uncertainty inherent in the assessment.

For a WAG ERA, the evaluation step has two components starting with a description of the estimation of risk. A summary of the risk evaluation follows the risk estimation. These two components are described in the following sections.

28.4.1 Risk Estimation

This section discusses the estimation of risk. Exposure parameters used to calculate dose to functional groups, T/E, and sensitive species are outlined in Section 28.2. HQs are calculated using the following equation:

$$HQ = \frac{Dose}{TRV}$$

where

HQ = hazard quotient (unitless)

$Dose$ = dose from all media (mg/kg-day or Gy/day)

TRV = TRV (mg/kg-day or Gy/day).

HQs are derived for all contaminants, functional groups, T/E, and sensitive species identified in WAG 2 for each site of concern. The results of the dose calculations are presented in Appendix L. The HQs from the results of the risk analysis are presented in Appendix L. If information was not available to derive a TRV, then an HQ could not be developed for that particular contaminant and functional group or sensitive species combination. These are indicated in the Appendix L tables and Table 28-23 presents a summary of these results.

An HQ greater than the target value indicates that exposure to a given contaminant (at the concentrations and for the duration and frequencies of exposure estimated in the exposure assessment) may cause adverse health effects in exposed populations. However, the level of concern associated with exposure may not increase linearly as HQ values exceed the target value. This means that the HQ values can not be used to represent a probability or a percentage, since an HQ of 10 does not necessarily indicate that adverse effects are 10 times more likely to occur than an HQ of 1. It is only possible to infer that the greater the HQ the greater the concern about potential adverse effects to ecological receptors.

Soil concentration data calculated in the human health risk assessment were used to assess each site. The use of human health concentration data (i.e., 95% UCL) is assumed to be representative of the range of concentrations to which ecological receptors using a site at WAG 3 are likely to be exposed. If the dose from the contaminant does not exceed its TRV (i.e., are less than 1 for nonradiological contaminants and 0.1 for radiological contaminants), adverse effects from exposure to that contaminant by ecological receptors are not expected, and no further evaluation of that contaminant is required. Hence, the HQ is an indicator of potential risk.

28.4.2 Uncertainty Association with Hazard Quotients

For the WAG ERA, a HQ is used as an indicator of risk and as a trigger for further evaluation of the site. HQs are ratios of the calculated dose for a receptor from COPCs to the TRV. These ratios provide a quantitative index of risk to defined functional groups or individual receptors under assumed exposure conditions. The ratio, or hazard quotient method is commonly used in both human health and ecological risk assessments. It is used in the WAG ERA to eliminate contaminants and sites as a risk to the ecosystem at a WAG level, including sites and contaminants that should be subsequently assessed.

In general, the significance of exceeding a target HQ (Table 28-13) value depends on the perceived "value" (ecological, social, or political) of the receptor, the nature of the endpoint measured, and the degree of uncertainty associated with the process as a whole. Therefore, the decision to take no further action, consider corrective action, or perform additional assessment should be approached on a site-, chemical-, and species-specific basis. Because the unit of concern in ecological risk assessment is usually the population as opposed to the individual (EPA, 1992), exceeding conservative screening criteria does not necessarily mean that significant adverse effects are likely.

An HQ less than the target value (traditionally 1.0 for non-radionuclide contaminants) implies a "low likelihood" of adverse effects from that contaminant. The HQ target value is 1 for nonradionuclides and 0.1 for radionuclides. Nonradiological and radiological contaminants are treated separately, since these two classes of contaminants cause different effects in exposed receptors. Effects from the nonradioactive metals are expected to cause systemic toxicity, while the effects to reproductive processes are typically associated with exposure to ionizing radiation. A separate approach in which the target HQ is set to 1/n, where n is the number of nonradiological or radiological contaminants of concern, could also be used, while the HQ for could be set at 0.1 (1/10) for the radiological contaminants. This approach would be too conservative for nonradiological contaminants since it assumes cumulative (simultaneous) exposure to all nonradionuclides and that all contaminants within a given group behave synergistically in a given receptor. Given that all receptors within a functional group may not be simultaneously exposed to all contaminants, and that a synergistic effect may not be seen, this approach may be more stringent than necessary to protect all ecological receptors from nonradiological effects. Therefore, the HQ is set to 1 for all nonradiological contaminants. This method may underestimate the risk in that is does not account for cumulative exposure to multiple contaminants by a give receptor. Or this approach may be more realistic given the amount of conservatism already built into the determination of exposure. The HQ target value for radionuclides will be set at 0.1, however. Radionuclides have a greater potential for cumulative dose and the development of TRVs was less conservative than for the nonradiological contaminants.

At this level in the ERA approach at the INEEL, both exposure and toxicity assumptions are generally "worst-case," and represent the upper bound of potential risks to ecological receptors. The HQ approach does not consider variability and uncertainty in either exposure or toxicity estimates, and therefore does not represent a statistical probability of occurrence of adverse ecological effects. Hazard quotients provide essentially a "yes or no" determination of risk and are therefore well-suited for screening-level assessments (EPA, 1988b). A limitation of the quotient method is that it does not predict the degree of risk or magnitude of effects associated with specified levels of contamination (EPA, 1988b). However, "modified quotient methods" are available that attempt to address this issue. Barnthouse et al. (1986) uses a method in which the conclusions are expressed as "no concern," "possible concern," and "high concern," depending on the ratio of the contaminant concentration to the reference. However, this is not useful in all cases due to specific contaminant characteristics.

Table 28-23. Summary of WAG 3 ERA HQ assessment. HQs reported in order of magnitude.

	Nonradionuclide		Radionuclide internal		Radionuclide external	
Site	Contaminant	HQ	Contaminant	HQ	Contaminant	HQ
CPP-13	arsenic mercury	<10	Sr-90	<10	Initially screened[a]	
CPP-14			Initially screened[a]		Initially screened[a]	
Imhoff	chromium III	<100				
Tanks	lead	<10				
Area 1	mercury	<10				
	silver	<10				
Plant	PCBs	None exceed target value				
Site						
Area 2						
CPP-19	arsenic	<10	Cs-137	<100	None exceeded target value	
			Eu-152	>10 and <100		
			Eu-154	<100		
			Sr-90	<100		
			Co-60	<10		
CPP-34	arsenic	< 10	Sr-90	<10	None exceeded target value	
	mercury	<100				
CPP-37A	mercury	<100	Initially screened[a]		Initially screened[a]	
CPP-39	barium	< 1,000	Initially screened[a]		Initially screened[a]	
	fluoride	< 10				
	mercury	<10				
	silver	<10				
	di-2-ethylhexlphthalate	<10				

Table 28-23. (continued).

	Nonradionuclide		Radionuclide internal		Radionuclide external	
Site	Contaminant	HQ	Contaminant	HQ	Contaminant	HQ
CPP-40	fluoride chromium III lead	<100 <100[a] <10	Initially screened[a]		Initially screened[a]	
CPP-42	barium	<1,000	None		None	
CPP-44	chromium III lead mercury chromium VI nickel cadmium decanal	<100[b] <100 <100 <100[b] <10 <100 No toxicity data	None		None	
CPP-47	fluoride	None exceeded target value	None		None	
CPP-49	PCBs	None exceeded target value	None		None	

Table 28-23. (continued).

	Nonradionuclide		Radionuclide internal		Radionuclide external	
Site	Contaminant	HQ	Contaminant	HQ	Contaminant	HQ
CPP-51	PCBs	None exceeded target value	None		None	
CPP-54	arsenic organics	None exceed target value	None		None	
CPP-55	mercury	>100 and <1,000	None		None	
	arsenic	<10				
	chromium-VI	<100				
	lead	<100				
	nickel	<10				
	selenium	<10				
	chromium-III	<100[b]				
	silver	< 10				
CPP-59, Zones 1, 2	TPH	Not assessed				
CPP-61	PCBs	None exceeded target value	Initially screened[a]		Initially screened[a]	
CPP-66	boron	< 1,000	Initially screened[a]		Initially screened[a]	
	fluoride	<100				
	selenium	<100				
	strontium	<10				
CPP-67 sediment	See sediment assessment sections					

Table 28-23. (continued).

Site	Nonradionuclide Contaminant	HQ	Radionuclide internal Contaminant	HQ	Radionuclide external Contaminant	HQ
CPP-67 effluent	chlorine cobalt iron silver phosphate sulfate organics[c]					
CPP-84	acetone	>1,000[d]	None		None	
CPP-88	mercury nickel arsenic	<100 <100 < 10	Initially screened[a]		Initially screened[a]	
CPP-90	arsenic mercury antimony	<10 <100 >1 and <10	Initially screened[a]		Initially screened[a]	
CPP-93	aluminum mercury	>1,000 >1,000	None		None	
Old Storage Pool	arsenic mercury nickel	<10 <10 <10	Cs-137 Eu-152 Eu-154 Co-60 Sr-90	<1 <10 <10 <1 <1	Cs-137 Eu-152 Eu-154 Co-60	<10 <10 <10 <1
Storage Yard	arsenic mercury nickel	<10 <10 <10	Initially screened[a]		Initially screened[a]	

Table 28-23. (continued).

	Nonradionuclide		Radionuclide internal		Radionuclide external	
Site	Contaminant	HQ	Contaminant	HQ	Contaminant	HQ
Tank Farm	mercury	<10	Cs-137	<1,000	Cs-137	<1,000
			Sr-90	<1,000	Eu-154	<1
			Am-241	<100		
			U-235	<100		
			Pu-239	<10		
			Eu-154	<1		
Tank Farm South	mercury	<100	Cs-137	<0.1	Cs-137	<0.1
	cadmium	<10				
	arsenic	<10				
	nickel	<10				
WCF	mercury	>10 and <100	Sr-90	<100	Cs-134	<1
	arsenic	>1 and <10	Am-241	<100	Cs-137	<1
	nickel	>1 and <10	Cs-134	<1		
			Cs-137	<1		
			Eu-154	<1		

a. Initially screened using EBSLs in Table 28-8.

b. High HQ for plants only. All functional groups and C2 species had HQ less than one.

c. Chlorine, cobalt, iron, silver, phosphate, sulfate, anthracene, benzo(a)pyrene, benzo(a)onthracene, benzo(b)fluororathene, chrysene, fluoranthene, methylene chloride, nitrite, phenanthene and pyrene may also be of potential concern in the liquid effluent at CPP-67.

d. Estimated concentration, no release has known to occur. Acetone will biodegrade in this environment. See text discussion.

A summary of the WAG ERA results is provided in Table 28-23. This table shows the order of magnitude for the largest observed HQ across all functional groups within the site up to an order of 1,000. The actual range of the HQs across functional groups within a site may vary by at least three orders of magnitude. The raw HQ results are shown in Appendix L.

28.4.3 Evaluation of Hazard Quotient Assessment

This section describes the results of the HQ assessment associated with exposure of the functional groups, T/E, and species sensitive to contaminants at WAG 3 sites.

Of the CPP sites assessed in the HQ step of the WAG 3 ERA, five of them (CPP-14—Area 2, CPP-47, CPP-49, CPP-51, CPP-54, and CPP-61) were eliminated. Of the remaining sites, all have HQs greater than 1.0 for nonradiological contamination and eight have radiological contamination resulting in HQs greater than 0.1. Based on the WAG ERA assumptions and methodology, arsenic and mercury soil contamination at WAG 3 were identified as the most common nonradiological contaminants with HQs greater than 1.0; Sr-90 and Cs-137 were the most common radionuclides with HQs greater than 0.1.

CPP-13, pressurization of the solid storage cyclone northeast of CPP-13, has HQs greater than 1.0 from exposure to mercury. HQs greater than 0.1 were calculated from internal ingestion of Sr-90.

CPP-14 Area 1, decommissioned sewage treatment plant Imhoff tanks, had HQs greater than 1.0 for chromium III, lead, mercury, and silver. However, most of this samples were taken at 9 ft depth and will have a more limited exposure than modeled.

CPP-19, a contaminated zone due to a pipe leak of radioactively contaminated liquids, has HQs greater than target values from arsenic and internal exposure to radionuclides. The source-term concentration for arsenic, 5.95 mg/kg, and the maximum-observed concentration, 6.3 mg/kg, slightly exceeded the average background concentration and UTL values of 4.46 and 5.8 mg/kg, respectively. The radionuclide concentrations having HQs exceeding target values from internal exposure include Co-60, Cs-137, Eu-152, Eu-154, and Sr-90.

CPP-34, three trenches used to store radioactively-contaminated soil, has HQs greater than target values from metals and internal exposure to radionuclides. The metals of concern are arsenic and mercury. Both the source term concentration and maximum observed concentration of arsenic were 7.1 mg/kg, as compared to a background average concentration and UTL of 4.46 and 5.8 mg/kg, respectively. Internal exposure to Sr-90 is a concern as indicated by the results.

CPP-37A, CPP Gravel Pit #1, has HQ's greater than 1.0 from exposure to mercury at the site.

CPP-39, a hydrofluoric acid storage tank containment vault and a tile line connected to a dry well, has HQs greater than 1.0 from exposure to metals and organic compounds. Exposure to barium and fluoride has the greatest HQ's. Mercury, silver and to a lesser extent di-(2)-ethylhexylphthalate also have HQs over target values.

CPP-40, the lime pit at CPP-601, has HQs greater than 1.0 from exposure to lead and (to a lesser extent) fluoride. Chromium III concentrations also exceed target values for plants.

CPP-42, a drainage ditch west of CPP-637, has HQs greater than 1.0 from exposure to barium.

CPP-44, a grease pit south of CPP-608, has HQs greater than 1.0 from exposure to metals. The largest HQs result from exposures to lead and mercury. Other metal contaminants of concern include cadmium,

chromium-III (solely to plants), chromium-VI, and nickel. Additionally, there were no toxicity data for decanal, which was observed at 0.009 mg/kg.

CPP-55, an area contaminated with paint solvents, has HQs greater than 1.0 from exposure to metals contamination. The greatest HQs are due to mercury contamination. Arsenic, chromium-VI, lead, nickel, selenium, and (to a lesser extent) silver are potential concerns at CPP-55. Plants at this site also have HQs greater than 1.0 from chromium III concentrations.

CPP-59 (Zones 1 and 2), the kerosene spills were not assessed for TPH.

CPP-66, a pit where fly ash is disposed, has HQs greater than one for a number of inorganic contaminants. Boron has the greatest HQs for the site, with fluoride, molybdenum, selenium, and strontium also of concern. These risk calculations used the fly-ash concentrations rather than soil concentration data, since they were the only concentrations available. It is not known whether the soil around and below the fly ash is contaminated. Due to the poor sorptive qualities of the substrata below the ash pit and the low concentrations of constituents in the source material, it is unlikely that higher concentrations have accumulated in the subsurface.

CPP-67, the percolation ponds, were assessed in Section 28.3.2.1 from internal exposure to the alpha emitters Am-241, Np-237, Pu-238, Pu-239, U-234, and U-238 to the fauna. Additionally, there are a number of nonradioactive contaminants of concern at this site including mercury, benzo(b)fluoranthene, benzo(a)pyrene, cyanide, selenium, cobalt, copper, and silver. A major source of this risk is from water ingestion.

CPP-84, a burial site, has buried gas cylinders, of concern. It is not clear that any acetone (used as a filler) has leaked from the buried cylinders. Chemical biodegradation studies indicated that the biodegradation of acetone in sediments and soils will be significant (ATSDR 1992) and CPP-84 should not remain a site of concern based on this rationale.

CPP-88, general contaminated soils across the site, has HQs greater than 1.0 calculated from exposure to inorganics. The contaminants of concern are arsenic, mercury, and nickel. Arsenic concentrations ranged from 3.5 to 7.1 mg/kg and 5.9 mg/kg was used as the soil concentration. The background average and UTL concentrations for arsenic are 4.46 and 5.8 mg/kg, respectively.

CPP-90, ruthenium detection at CPP-709, has HQs greater than 1.0 from exposure to arsenic and mercury. Antimony concentrations were large enough to be of concern.

CPP-93, the simulated waste calcine trench, has HQs significantly greater than 1.0 from both aluminum and mercury exposure. From the toxicity standpoint, both the aluminum and mercury toxicity values are based on organic compounds containing these chemicals. It is not clear for aluminum that the flora and fauna would be exposed to such organic compounds, since the simulated calcine material is inorganic (see Section 26.1).

The Old Storage Pool group of sites has HQs for both metals and radionuclide that exceeded target values. For the inorganics, arsenic, mercury, and nickel are of concern. The source term and maximum concentrations for arsenic were 3.0 and 5.9 mg/kg, respectively, which are close to the background average and UTL values of 4.46 and 5.8 mg/kg. The radionuclides Cs-137, Eu-152, and Eu-154 were in concentrations large enough to indicate concern for both internal and external exposures, and Co-60 concentrations caused a slight potential risk from internal and external exposures. Additionally, Sr-90 was present in concentrations large enough to indicate a concern from internal exposure.

The Storage Yard group has HQs greater than 1.0 from exposure to metals contamination. The metals of concern are arsenic, mercury, and nickel concentrations are of concern. The source term and maximum concentrations for arsenic were 2.0 and 5.9 mg/kg, respectively, which are close to the background average and UTL values of 4.46 and 5.8 mg/kg.

At the Tank Farm group, metals and radionuclides have HQs significantly greater than the target values. Mercury concentrations are of potential concern at this site. Cs-137 and Sr-90 caused the highest HQs from internal exposure, while Am-241 and U-235 caused lesser HQs from internal exposure. Eu-154 and Pu-239 have evaluated HQs for the internal exposure pathway. For external exposure, Cs-137 concentrations show evaluated HQ, while Eu-154 concentrations show only some concern.

The Tank Farm South group has HQs greater than the target value for metals and from internal and external exposure to Cs-137. The metals of concern are arsenic, cadmium, mercury, and nickel. The source term and maximum concentrations for arsenic were 3.9 and 5.9 mg/kg, respectively, which are close to the background average, and UTL values of 4.46 and 5.8 mg/kg.

The Waste Calcining Facility (WCF) group has HQs greater than the target values due to exposure from metals and radionuclides. The metals of concern are arsenic, mercury, and nickel. The source term and maximum concentrations for arsenic were 5.5 and 6.3 mg/kg, respectively, which are close to the background average and UTL values of 4.46 and 5.8 mg/kg. Sr-90 and Am-241 concentrations caused a potentially significant risk from internal exposure, while Cs-134, Cs-137, and Eu-154 concentrations are a concern from internal exposure. Additionally, Cs-134 and Cs-137 concentrations are large enough to target concern from external exposure.

28.4.4 Discussion of Uncertainty

The WAG ERA, by definition, is a conservative approach to assess the potential for risk to ecological receptors from WAG 3 contaminant sources. The WAG ERA incorporates levels of uncertainty that could either overestimate or underestimate the actual risk to these receptors. To compensate for potential uncertainties, the WAG ERA incorporates various factors that are designed to be conservative rather than result in a conclusion of no indication of risk when actual risk may exist. Regardless, uncertainties exist that could affect the estimation of true risk associated with WAG 3. These are summarized in Table 28-24.

Principal sources of uncertainty lie within the development of an exposure assessment and toxicity assessment. Uncertainties inherent in the exposure assessment are associated with estimation of receptor ingestion rates, selection of acceptable HQs, estimation of site usage, and estimation of PUFs and BAFs. Additional uncertainties are associated with the depiction of site characteristics, the determination of the nature and extent of contamination, and the derivation of TRVs. All of these uncertainties will likely influence risk estimates.

At this level of assessment, HQs greater than 1.0 tend to be from nonradionuclide contamination. This is explained in part by the methods used to determine toxicity values. For radionuclides, the TRVs are based on effects to populations, while for nonradionuclides, the TRVs are based on effects to individuals. As such, the nonradionuclide toxicity data is in this sense more conservative than the radionuclide toxicity data.

In relation to extrapolations between individuals and populations, it is difficult to accurately predict ecological effects of toxic substances because of the complexity of the ecosystem. Most toxicity information comes from laboratory studies of single contaminant impacts on single species. Hence, there is a great deal of uncertainty in extrapolating controlled laboratory results to complex field situations and from one species to

Table 28-24. Sources and effects of uncertainties in the ecological risk assessment.

Uncertainty Factor	Effect of Uncertainty (Level of Magnitude)	Comment
Estimation of ingestion rates (soil and food)	May overestimate or underestimate risk (moderate)	Few intake (ingestion estimates used for terrestrial receptors are based on data in the scientific literature (preferably site-specific) when available. Food ingestion rates are calculated by using allometric equations available in the literature (Nagy 1987). Soil ingestion values are generally taken from Beyer et al. (1987).
Estimation of bioaccumulation and plant uptake factors	May overestimate or underestimate risk and the magnitude of error cannot be quantified (high).	Few bioaccumulation factors (BAFs) or plant uptake factors (PUFs) are available in the literature because they must be both contaminant- and receptor-specific. In the absence of more specific information, PUFs and BAFs for metals and elements are obtained from Baes et al. (1984), and for organics from Travis and Arms (1988).
Use of human health exposure concentrations	May overestimate (high) risk	Exposure concentrations were derived from data obtained as a product of biased sampling of WAG 3 sites. Samples were generally obtained from areas where contamination was believed to greatest.
Estimation of toxicity reference values	May overestimate (high) or underestimate (moderate) risk	To compensate for potential uncertainties in the exposure assessment, various adjustment factors are incorporated to extrapolate toxicity from the test organism to other species.
Use of functional grouping	May overestimate (high)	Functional groups were designed as an assessment tool that would ensure that the ERA would address all species potentially present at the facility. A hypothetical species is developed using input values to the exposure assessment that represents the greatest exposure of the combined functional group members.
Site use factor	May overestimate or underestimate (moderate) risk	Site use factor is a percentage of the site of concern compared to home range. This is extrapolated from literature values and allometric equations, may vary from season to season and year to year depending on environmental conditions. Highly uncertain.

another. Single contaminant studies cannot predict the interactions of multiple contaminants with each other and with the ecosystem. Additionally, interactions of organisms with the ecosystem are complex and not easily predicted.

Arsenic and mercury are the most common nonradiological ecological risk drivers at WAG 3. These metals show "potential risk" even at background concentrations. Hence, any indication of concentrations above background for these two metals will result in a potential risk. The background values used to screen against are from Rood et al. (1995). These background values can be used to eliminate potential contaminants that are clearly at background levels. As discussed in Rood et al. (1995), because of spatial variation in background concentrations due in part to differences in soil types, exceeding the background limits does not necessarily mean that the site is contaminated. As such, there is reason to suspect that some of the sites determined to have potential risks from arsenic and mercury may actually be background risks. Furthermore, the presence of arsenic at WAG 3 is likely to be unrelated to site activities since there are no known CPP processes that included arsenic.

A number of data gaps were identified in the course of the ecorisk analysis that will be addressed in the OU 10-04 ERA effort. Few data are available for the invertebrate populations at the INEEL. Invertebrates are important links in dietary exposure for wildlife. There is sufficient ecological and toxicological data to adequately characterize the contaminant effects in the invertebrate component of the ecosystem. Such uncertainty will propagate into some of the other endpoint compartments, in particular those representing mammalian, avian, and reptilian insectivores. At the OU 10-04 level this data gap will be addressed to the extent possible.

There are a number of T/E or sensitive species that could occur at WAG 3. In some cases, they are known to exist in close proximity to WAG 3 sites. The lack of information concerning the presence or absence of T/E and/or sensitive species in the vicinity of INEEL facilities and at the INEEL in general has been previously identified as an acceptable data gap.

Ecotoxicological data is recognized as one of the major uncertainties in ERA. As with human health risk assessments, the TRVs are updated as new information is available for use in INEEL ERAs. This is an ongoing effort that will continue throughout the ERA process at the INEEL. Several contaminants (e.g., arsenic) appear to be an ecological risk at soil concentrations that are typical of background concentrations for these metals at similar sites. However, they fail the background screen at the INEEL. To permit a more accurate assessment, these contaminants will be reviewed during the 10-04 ERA. At this time a greater discussion on issues of background and these contaminants will be included.

Many of these uncertainties will be difficult to reduce without obtaining extensive site-specific information. As part of the 10-04 ERA effort, site-specific ecological sampling has been proposed to provide information concerning movement of contaminants through the ecosystem. This sampling will be directed at eliminating some of the uncertainty that is present in the WAG ERA. Currently, an assessment of the uncertainty of using functional groups is being performed, and it has been proposed that a combination of functional groups and individual species be used for the 10-04 ERA. This should allow a better understanding of the results of the risk assessment.

28.4.5 Subsequent Screening and Evaluation of Nonradionuclide Contamination

Twenty sites remain after the WAG ERA HQ screening step. Of the sites remaining, all have nonradiological contamination and eight have radiological contamination with HQs greater than the target value. This includes CPP-13, 14 (Imhoff tanks, Area 1), 19, 34, 37A, 39, 40, 42, 44, 55, 66, 67, 88, 90, 93, Old Storage Pool Group, Storage Yard Group, Tank Farm Group, Tank Farm South Group, and WCF Group. Nonradionuclide contamination at these sites is screened and evaluated in more detail in this section.

Additional screens and discussion are appropriate at this stage of the WAG ERA process to use a weight-of-evidence approach for the further elimination of sites and contaminants for consideration in the FS process. This type of evaluation will eliminate unnecessary and undesirable remediations for ecological receptors based on the following rationale.

- Contaminant Concentrations—For the ERA, data values calculated for the BRA for the human health risk assessment were used when available. For those concentrations determined in the human health risk assessment (for the sites identified in Table 28-11) the 95% upper confidence level (UCL) of the arithmetic mean was used to estimate exposure-point concentrations whenever possible. Many sites that had previously been evaluated for human health in Track 1 or 2 efforts did not have these calculations performed and for this step of the ERA the maximum value reported in these documents was used.

- Modeling Conservatism—The exposure scenario used for ecological receptors assumes that the fences are down and the site has a viable habitat that is completely accessible to receptors. However, many of the sites of concern are currently within the fenced area that defines the CPP industrial complex. Both the fence and the activities associated with this currently active facility should limit the exposure of receptors to much less than that modeled in the ERA. Additionally, (with some exceptions, particularly sites with water sources) most of these sites are being gravel unsuitable habitat at the present time and would not provide any special attraction to ecological receptors.

- Parameter Conservatism—It is accepted in the risk assessment process that many of the input parameters are developed to be conservatively protective of the receptors. Particularly, based on limited knowledge and the uncertainty of extrapolating to multiple species, TRVs development is very conservative. This is particularly true for native metals, which can vary greatly regionally.

Based on this rationale, an additional screening was determined appropriate for the WAG 3 sites as agreed upon in an October 20, 1997 conference call between DOE-ID, EPA, and IDHW. This screening was composed of the following steps.

1. It was decided to eliminate contaminants as a concern if the exposure point concentration exceeds 10X the background value. For those contaminants that have no site-specific background the mean for the western states presented in Shacklette and Boerngen (1984) or other sources was considered acceptable.

2. For those sites that initially used the maximum values, if possible, the 95% UCLs were calculated (see Table 28-25) for each contaminant that was not eliminated in the HQ evaluation of the ERA. This value was also eliminated if the 95% UCL exceeds the 10X background.

Table 28-25 presents the results of this analysis. This screening resulted in eliminating CPP-37A, 39, 40, 42, 88, and 90 as sites of concern. An additional qualitative evaluation of sites was performed and subsequently suggests the elimination of CPP-14 (Imhoff Tanks-Area 1) and CPP-55 as sites of concern to ecological receptors.

Table 28-25. Results of additional site/contaminant evaluation and screening.

Site	COC	Maximum Concentration	95% UCL	10X Background	Elimination Rationale
CPP-13	Arsenic	8.30E+00		5.80E+01	Below 10X background
	Mercury	5.95E-01	4.70E-01	5.00E-01	95% UCL below 10X background
CPP-14					
Area 1	Chromium III	5.12E-01		5.80E+01	Below 10X background
	Lead	3.56E+01		1.70E+02	Below 10X background
Area 2	Mercury	1.20E+00		5.00E-01 3.7E+01	Sample was taken at approximately 9 ft bgs
	Silver	1.22E+01			Below 10X background
CPP-19	Arsenic	6.30E+00		5.80E+001	Below 10X background
CPP-34	Arsenic	7.10E+00		5.80E+01	Below 10X background
	Mercury	6.00E-01	2.80E-01	5.00E-01	95% UCL below 10X background
CPP-37A	Mercury	9.60E-01	4.40E-01	5.00E-01	95% UCL below 10X background
CPP-39	Barium	1.10E+03		3.00E+03	Below 10X Background
	Di-2-ethylhexylphthalate	1.40E+01			Contaminant below 15 ft
	Fluoride	9.29E+02		2.80E+03[a]	Below 10X background
	Mercury	1.70E-01		5.00E-01	Below 10X background
	Silver	1.87E+01		3.7E+01	Below 10X background
CPP-40	Chromium III	7.20E+01		3.30E+02	Below 10X background
	Fluoride	1.10E+01		2.80E+03[a]	Below 10X background
	Lead	6.00E+01		1.70E+02	Below 10X background
CPP-42	Barium	1.10E+03		3.00E+03	Below 10X background
CPP-44	Cadmium	8.40E+00		2.20E+01	Below 10 X background
	Chromium III	1.54E+03		3.30E+02	Retain
	Chromium VI	1.54E+01		NA	Retain
	Decanol	9.00E-03		NA	Retain
	Lead	2.81E+02		1.70E+02	Retain
	Mercury	5.00E+00		5.00E-01	Retain
	Nickel	3.44E+02		3.50E+02	Below 10X background
CPP-55	Arsenic	1.34E+01		5.80E+01	Below 10X background
	Chromium III	6.50E+01		3.30E+02	Below 10X background
	Chromium VI	6.50E+01	8.70E+00	NA	Not expected to exist as
	Lead	3.20E+01		1.70E+02	Chromium VI in the environment
	Mercury	5.20E+00	6.10E-01	5.00E-01	Below 10X background
	Nickel	6.50E+01		3.50E+02	Retain
	Selenium	6.40E-01		2.20E+00	Below 10X background
	Silver	300E+00		3.7E+01	Below 10X background
					Below 10X background
CPP-66	Boron	3.10E+02		2.30E+02	Retain
	Fluoride	1.65E+02		2.80E+03[a]	Below 10X background
	Selenium	1.60E+00		2.20E+00	Below 10X background
	Strontium	6.90E+02		2.00E+03[a]	Below 10X background
CPP-88	Arsenic	7.10E+00		5.80E+01	Below 10X background
	Mercury	1.00E+00	3.00E-01	5.00E-01	95% UCL below 10X background
	Nickel	1.63E+02		3.50E+02	Below 10X background
CPP-90	Antimony	9.50E+00		4.80E+01	Below 10X background
	Arsenic	2.95E+01		5.80E+01	Below 10X background
	Mercury	1.00E+00	4.50E-01	5.00E-01	95% UCL below 10X background

Table 28-25. (continued).

Site	COC	Maximum Concentration	95% UCL	10X Background	Elimination Rationale
CPP-93	Aluminum	1.20E+05		1.60E+05	Below 10X background
	Mercury	1.40E+02	6.80E+01	5.00E-01	Retain
Old Storage	Arsenic	5.90E+00		5.80E+01	Below 10X background
	Mercury	5.52E-01	2.20E-01	5.00E-01	95% UCL below 10X background
	Nickel	5.51E+01		3.50E+02	Below 10X background
Storage Yard	Arsenic	5.90E+00		5.80E+01	Below 10X background
	Mercury	5.52E-01	3.30E-01	5.00E-01	95% UCL below 10X background
	Nickel	5.51E+01		3.50E+02	Below 10X background
Tank Farm	Mercury	2.30E-01		5.00E-01	Below 10X background
Tank Farm	Arsenic	5.90E+00		5.80E+01	Below 10X background
	Cadmium	3.42E+00		2.20E+01	Below 10X background
	Mercury	1.51E+00	2.60E-01	5.00E-01	95% UCL below 10X background
	Nickel	5.51E+01		3.50E+02	Below 10X background
WCF	Arsenic	7.30E+00		5.80E+01	Below 10X background
	Mercury	7.50E+00	1.50E+00	5.00E-01	Retain
	Nickel	2.80E+02		3.50E+02	Below 10X background

a. Background from Shacklette and Boerngen (1984).

A discussion summarizing this evaluation for each of these sites is presented below.

CPP-13, pressurization of the solid storage cyclone northeast of CPP-13, has HQs greater than 1.0 for arsenic and mercury. Using the ten times the background screen as shown in Table 28-25 eliminates arsenic as a concern. Mercury was eliminated as a concern when screened using the calculated UCL of 0.47 compared to the 10 times background criteria.

CPP-14 Area 1, the decommissioned sewage treatment plant Imhoff tanks (Area 1), have HQs greater than 1.0 from exposure to metals (chromium III, lead, mercury, and silver).

Using the ten times the background screen as shown in Table 28-25 eliminates chromium III, lead and silver as a concern. Subsequent review of the sampling of this area indicates that the two soil samples taken at the Imhoff tanks were taken at depths greater than 9.0 ft bgs. Therefore, since the modeling performed in the ERA assumes that the contamination is evenly distributed throughout the subsurface soil area, the exposure will not be as high as what has been modeled. It is recommended that based on this reduced exposure (due to the depth of the contamination) that this area should be eliminated from the FS evaluation.

CPP-19, a contaminated zone due to a pipe leak of radioactively contaminated liquids, has HQs greater than 1.0 for arsenic. This contaminate concentration is below 10X background and can be eliminated as a concern.

CPP-34, comprised of three trenches used to store radioactively-contaminated soil, has HQs greater than 1.0 for arsenic and mercury. Using the ten times the background screen as shown in Table 28-25 eliminates arsenic as a concern. Mercury was eliminated as a concern when screened using the calculated UCL of 0.28 compared to the 10X background criteria.

CPP-37A, CPP Gravel Pit #1, has HQ greater than 1.0 for mercury. Subsequent screening using a calculated UCL of 0.44 eliminated this contaminate when compared to the 10 times background criteria. Based on this subsequent screen against the agreed upon criteria this site will not be evaluated in the FS (Table 28-25).

CPP-39, a hydrofluoric acid storage tank containment vault and a tile line connected to a dry well, has HQs greater than 1.0 for exposure to barium, fluoride, mercury, silver, and di-2-ethylhexylphthalate. After review, it was determined that the detection of di-2-ethylhexylphthalate occurred at a depth of 15 feet, eliminating this contaminant since there is no pathway to ecological receptors. All three of the native metals are eliminated when compared to 10X background (either Rood et al., (1995) or regional). Based on this subsequent screen against the agreed upon criteria this site will not be evaluated in the FS (Table 28-25).

CPP-40, the lime pit at CPP-601, has HQs greater than 1.0 from exposure to chromium III, fluoride, and lead. All three of the native metals are eliminated when compared to 10X background (either Rood et al., 1995 or regional. Based on this subsequent screen against the agreed upon criteria this site will not be evaluated in the FS (Table 28-25).

CPP-42, a drainage ditch west of CPP-637, has HQs greater than 1.0 from exposure to barium. This native metal is eliminated as a COPC when compared to 10X background (either Rood et al., 1995 or regional). Based on this subsequent screen against the agreed upon criteria this site will not be evaluated in the FS (Table 28-25).

CPP-44, a grease pit south of CPP-608, has HQs greater than 1.0 from exposure to cadmium, chromium III, chromium VI, lead, mercury, nickel, and decanal. Cadmium and nickel are native metals that are eliminated as COPCs when compared to 10X background (either Rood et al., 1995 or regional). However, based on the combined potential risk from chromium, lead, and mercury this site will be retained in the FS for evaluation (Table 28-25).

CPP-55, an area contaminated with paint solvents, has HQs greater than 1.0 from exposure to metals (arsenic, chromium III, chromium VI, lead, mercury, nickel, selenium, and silver). Arsenic, chromium III, lead, and nickel are native metals that are eliminated as COPCs when compared to 10X background (either, Rood et al., 1995 or regional). Chromium is not expected to persist in the environment in the chromium VI form (Bartlett and Kimble, 1976; Rai et al., 1989). Mercury remains a concern after this initial screening. However 11 locations (3 samples each) were taken at this site. Of these 33 samples 13 were undetects or B flags. The highest concentration was 5.2 mg/kg, the next highest was 0.62, then 0.27 and the rest were 0.12 mg/kg. It is highly probable that the one sample having the high hit was a small hotspot that would not contribute that greatly to average exposure.

CPP-66, a pit where fly ash is disposed, has HQs greater than 1.0 from exposure to boron, fluoride, selenium, and strontium. The native metals with the exception of boron, are eliminated as COPCs when compared to 10X background (either Rood et al., 1995 or regional). However, the observed range of boron in the western United States is <10 to 300 and based on the rationale that exposure will be limited at this site it should not be recommended for remedial action. However, this site will be further evaluated in the FS (Table 28-25).

CPP-88, general contaminated soils across the CPP, has HQs greater than 1.0 from exposure to arsenic, mercury, and nickel. Arsenic and nickel concentrations are both 10X below background and can be eliminated as a concern based on this criteria. The calculated 95% UCL concentration for mercury (UCL=0.31 mg/kg) is below 10X background and is eliminated as a concern. Based on this rationale CPP-88 is eliminated as a site of concern and will not be further discussed in the FS (see Table 28-25).

CPP-90, ruthenium detection at CPP-709, has HQs greater than 1.0 from exposure to arsenic, mercury, and antimony. Arsenic and antimony concentrations are both 10X below background and can be eliminated as a concern based on this criteria. The calculated 95% UCL concentration for mercury (UCL = 0.45) is below the 10X background. Based on this rationale CPP-90 is eliminated as a site of concern and will not be further discussed in the FS (see Table 28-25).

CPP-93, the simulated waste calcine trench, has HQs greater than 1.0 from exposure to aluminum and mercury. The aluminum concentration is 10X below background and can be eliminated as a concern based on this criteria. However, this site should be retained in the FS for evaluation of the mercury concentration.

Old Storage Pool, is a group of sites that has HQs greater than 1.0 from exposure to arsenic, mercury, and nickel. Arsenic and nickel concentrations are both 10X below background and can be eliminated as a concern based on this criteria. The calculated 95% UCL concentration for mercury (UCL = 0.22) is below the 10X background. Based on this rationale the metals at the Old Storage Pool are eliminated as a concern at this site. However, this site will be further evaluated in the FS based on radionuclide contamination (see Table 28-26).

Storage Yard, is a group of sites that has HQs greater than 1.0 from exposure to arsenic, mercury, and nickel. Arsenic and nickel concentrations are both 10X below background and can be eliminated as a concern based on this criteria. The calculated 95% UCL concentration for mercury (UCL = 0.33) is below the 10X background. Based on this rationale the metals at the Storage Yard are eliminated as a concern at this site. Based on this rationale the Storage Yard is eliminated as a site of concern and will not be further discussed in the FS (see Table 28-25).

Tank Farm, is a group of sites that has HQs greater than 1.0 from exposure to mercury. The calculated 95% UCL concentration for mercury (UCL = 0.12) is below the 10X background. Based on this rationale mercury at the Tank Farm is eliminated as a concern at this site. However, this site will be further evaluated in the FS based on radionuclide contamination (see Table 28-26).

Tank Farm South, is a group of sites that has HQs greater than 1.0 from exposure to arsenic, cadmium, mercury, and nickel. Arsenic, cadmium, and nickel concentrations are both 10X below background and can be eliminated as a concern based on this criteria. The calculated 95% UCL concentration for mercury (UCL = 0.26) is below the 10X background. Based on this rationale the metals at the Tank Farm South are eliminated as a concern at this site. However, this site will be further evaluated in the FS based on radionuclide contamination (see Table 28-26).

WCF is a group of sites that has HQs greater than 1.0 from exposure to arsenic, mercury, and nickel. Arsenic and nickel concentrations are both 10X below background and can be eliminated as a concern based on this criteria. However, this site will be further evaluated in the FS based on radionuclide and mercury contamination (see Table 28-26).

28.4.6 WAG ERA Inputs to the FS Process

For use in the FS process the initial results were further screened and evaluated as discussed Section 28.4.5. This allows the elimination, based on risk management decisions, of sites and contaminates that would possibly result in unnecessary remediation actions. The following Table 28-26 summarizes the results of this screening and evaluation and presents the sites and contaminates to be evaluated in the FS.

Table 28-26. Sites and contaminants of concern for consideration in the FS.

Site	Non-radionuclide	Radionuclide	Comments
CPP-13	Mercury	Sr-90	
CPP-14 Imhoff Tanks (Area 1)	Mercury		Solely an ecological concern. This site is recommended to be eliminated since the contamination is at 9 ft bgs.
CPP-19		Cs-137, Eu-152, Eu-154, Sr-90, Co-60	
CPP-34		Sr-90	
CPP-44	Chromium III Chromium VI Lead Mercury		Solely an ecological concern.
CPP-55	Chromium-VI		Solely an ecological concern. This site may be eliminated based on discussion in Section 28.4.5.
CPP-66	Boron		
CPP-67	Metals and organics	Am-241, Np-237, Pu-238/239, U-234, and U-238	This site will be remediated based on the human health evaluation, an assessment beyond the screening level was not deemed necessary.
CPP-93	Mercury	None	
Old Storage Pool		Cs-137, Eu-152, Eu-154, Co-60, and Sr-90	
Tank Farm		Am-241, Cs-137, Eu-154, Pu-239, Sr-90, and -235	
Tank Farm South		Cs-137	
WCF	Mercury	Am-241, Cs-134, Cs-137	

28.5 Transition to Sitewide ERA

This WAG ERA represents the second phase of the three-phased approach to ERA proposed in Figure 28-1. The approach applies an iterative, "tiered" process in which preliminary assessments, based on conservative assumptions, support progressively more refined assessments (Maughn, 1993; Opresko et al., 1995; Levin et al., 1989).

The first phase is the SLERA, which is a "preassessment" performed at the WAG level. The SLERA is performed to reduce the number of sites and contaminants to be addressed in subsequent assessments. The SLERA is used only as a preassessment tool to (1) better define the extent and nature of individual WAG sites of contamination and identify sites at which no COPCs are found, (2) reduce the number of COPCs to be addressed in the WAG transition ERA by eliminating those that clearly pose a low likelihood for risk, (3) identify sites for which further data are needed, and (4) identify other data gaps. SLERAs also serve to support problem formulation and drive media and pathways to be evaluated for WAG transition ERA assessments. Since the risk assessment tasks based on the FFA/CO are ongoing and/or additional sites may be identified, the SLERA will also be used to screen new sampling data and/or additional sites. The SLERA plays no role in setting remedial action levels. Details of SLERA methodology can be found in VanHorn et al. (1995).

In phase two, the WAG ERA incorporates the SLERA results and assesses potential risks to ecological receptors using an approach that parallels the human health risk assessment methodology for addressing risk to ecological receptors at the WAG level. The WAG ERA applies aspects of the methodologies developed for the SLERA and will incorporate the results of the SLERA. The WAG transition ERA, however, also duplicates the approach developed for the cumulative human health risk assessments (Burns, 1994) by providing a site-by-site assessment of those contaminants that were not eliminated in the SLERA.

The WAG ERA represents the assessment of the No Action alternative for remediation at the WAG level. The WAG transition ERA results will (1) provide a list of COPCs to be addressed in the OU 10-04 ERA and (2) identify OU 10-04 level data gaps that must be filled before performing the OU 10-04 ERA. The results of the WAG transition ERA may also support risk assessments to evaluate WAG remedial actions or additional assessments if necessary. The COPCs are identified in Table 28-23, and the data gaps are discussed below.

The third phase of the ERA process is the OU 10-04 ERA, which is performed to integrate WAG transition ERAs to evaluate risk to OU 10-04 ecological resources. This assessment will be conducted to evaluate effects resulting from past contamination, and their potential for adversely impacting INEEL-wide ecological resources including residual impacts from completed interim or remedial actions.

The OU 10-04 ERA will integrate the results of the transition ERAs for all INEEL WAGs to determine whether contamination at the WAGs contributes to potential risk to populations and communities on an ecosystem-wide basis (over the entire INEEL). The OU 10-04 ERA is contrasted with the previous phases of the process in Table 28-27.

Table 28-27. Comparison of WAG ERA assessment components for screening and Site-wide phases of INEEL ERA.

Component of Assessment	SLERA (Phase 1)	WAG ERA (Phase 2)	Site-wide Baseline ERA (Phase 3)
Stressor and Receptor Identification (contaminants and sites of potential concern)	Tracks 1 and 2, all FFA/CO sites and contaminants	Screening level ERA COPC and site retention lists	WAG transition ERA COPC and site retention lists
Spatial scale	WAG assessment area	Sites within the WAG assessment area	OU 10-04 or WAG level for individual sites
Temporal scale	Current	Current, future (buried waste)	Current, future (buried waste)
Contaminant concentration in media of interest	Average concentration across the WAG—human health sampling	Average concentration for each site—human health sampling and modeling for buried waste	To be determined.
Exposure assessment	EBSL soil and water	Dose across media	Dose across media
Risk characterization	screening level quotient—unranked	HQ—ranked	HQ—ranked and qualitative discussion
Cumulative risk	Multiple sites combined across the WAG—avg. conc	Multiple contaminants—individual sites—avg. conc.	Multiple contaminants across multiple WAGs
Assessment endpoints	WAG functional groups and individual T/E species semiquantitative	WAG functional groups and individual T/E species—quantitative and qualitative	EPA assessment endpoint criteria (to be determined)—quantitative, semiquantitative and qualitative
Measurement endpoints	Exposure model parameters	Exposure model parameters	To be determined—Ecological components based on assessment endpoints and COPCs from WAG transition ERAs
Status	Drafts for WAGs 1, 3, 7, and 9, WAG 2 complete; WAG 8 in progress; WAGs 4, 5, 6, and 10 to be scheduled	Draft methodology for WAG 7 and WAG 2 in progress	Planning stages

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Chapter 29

29. SUMMARY AND CONCLUSIONS

The purpose of this final section is three-fold. First, the objectives of this Remedial Investigation and how they were met is discussed in Section 29.1. Second, the findings from implementing the risk assessment framework described in Section 7 for each Group and site are summarized in Section 29.2. The conclusions and recommendations for the groups and sites of most concern is summarized in Section 29.3, with a discussion of risk management decisions that may be necessary for each location.

29.1 RI Objectives

The objectives of the RI/BRA were as follows:

- Fill data gaps identified in the OU 3-13 Work Plan
- Determine the nature and extent of contamination associated with all retained release sites identified at WAG 3
- Evaluate the groundwater transport potential of chemicals measured within the WAG 3 contaminant system
- Determine the current and future cumulative and comprehensive cancer risk and hazard posed by WAG 3 contaminants of concern to human health and the environment.

The first two objectives were satisfied by implementing a sampling and analysis program for the field investigations conducted during the summer of 1995. The features of this program with the minor deviations that occurred are described in Section 3. This section also describes the attainment of the data quality objectives enumerated in LITCO (1995). The third objective was met with the use of the three-dimensional computer code, TETRAD. The approach and assumptions necessary to apply this model to the WAG 3 contaminant system are described in detail in Section 6 and Appendix F of this report. The last objective was met by conducting a comprehensive BRA according to the framework described in Sections 7 and 27.3 (cumulative risk assessment).

29.2 Baseline Risk Assessment Summary

The results of the HHRA and the WAG ERA, which together are usually referred to as a BRA, are summarized separately in Sections 29.2.1 and 29.2.2, respectively. The underlying assumption in both evaluations is that the results have been made possible through the use of scenario evaluation which consists of defining hypothetical situations about how exposures occur and to whom. The results of these evaluations help quantify the potential for adverse impacts to human health and the environment caused by hazardous substance releases from a site in the absence of any action to control or mitigate these releases.

29.2.1 Human Health Risk Assessment Summary

The results of the HHRA are depicted in Figures 27.2 through 27.7 of Section 27.3. These figures provide a convenient means of quickly identifying those sites most likely to adversely affect human health.

The figures also clearly depict which exposure routes within a pathway are responsible for driving the health concerns at a particular release site or group. With the exception of site CPP-93 (Simulated Calcine Trench), the results summarized in these figures indicate that the potential noncarcinogenic effects from exposure to site and group surface-related contaminants are negligible when compared against the NCP hazard index goal of one. On the other hand, the potential of increased cancer risk from exposure to surface-related contaminants has been estimated to be unacceptably high at several groups and sites under both current and future land use assumptions. The following identifies those groups and sites of greatest concern. These were identified by comparing the group and site results against the NCP criteria for acceptable levels of increased cancer incidence. According to these criteria, an increased cancer incidence greater than 1 in 10,000 (i.e., 1E-04) is unacceptable whereas an increased incidence less than 1 in 1,000,000 (1E-06) is acceptable. Generally, the NCP criteria consider an increased cancer incidence between 1E-04 and 1E-06 as acceptable. The sites within the group of Sites of Negligible Soil Contamination were evaluated semiquantitatively and found not to exceed the NCP criteria, and thus are not discussed further. The sites within the group of Exclusive Groundwater Concern have no surface exposure routes associated with them but will be carried forward to the FS for further evaluation as a source of recharge and/or groundwater contamination.

Under current land use, the risk of increased cancer incidence within the five remaining groups were found to be above 1E-04 except for the Storage Yard East Group, where the increased cancer estimate is only slightly above 1E-04. The risk estimates for the sites within this group were calculated separately and indicate that only sites CPP-03 and -17A exceed 1E-4. Potential cancer risk estimates at release sites CPP-13, -19, and -67 were found to be above the NCP recommended value of 1E-04. The estimates for sites CPP-14, -90, -06, -22, -34, -93, -37A, and -37B are below 1E-04 and therefore acceptable under this land use assumption.

Under future occupational land use, the risk of increased cancer incidence within four groups and site CPP-13 was found to be well above 1E-04. The Storage Yard East is the only Group where the estimated increased incidence of cancer is below 1E-04, both as a group evaluation and on a site-by-site basis. The risk estimate at CPP-67 is nearly 1E-04. The estimates for sites CPP-14, -19, -90, -93, -06, -22, -34, -37A, and 37B were found to be less than 1E-04 and therefore acceptable under this land use assumption.

Under future residential land use, the risk of increased cancer incidence within four groups were found to be above 1E-04. The estimate at the Storage Yard East Group is only slightly above 1E-04. The sites within this group were re-evaluated individually and found that only site CPP-03 exceeds 1E-04. Potential increased cancer incidence at release sites CPP-13, -19, -67, and -34 were found to be above the NCP recommended value of 1E-04. The estimates for sites CPP-14, -90, -06, -22, -37A, and -37B were found to be less than 1E-04 and therefore acceptable. Under a future residential scenario, due to high levels of mercury in the soil, the noncarcinogenic hazard at site CPP-93 was found to exceed the EPA recommended value of 1.

By in large, the potential increased cancer risk to current and future on-site workers and future residents at sites that were within or exceeded the EPA recommended target range are driven by direct exposure to ionizing radiation. The dose from this exposure route is due almost exclusively to elevated levels of Cs-137 in surficial site soils. Other significant exposure routes adversely affecting this receptor population are ingestion of site soils and ingestion of homegrown produce.

29.2.2 WAG-wide Ecological Risk Assessment

The WAG 3 ERA presented in Section 28 represents the second phase of the three-phased approach to ERA proposed in Figure 28-1. This approach applies an iterative, "tiered" process in which preliminary assessments, based on conservative assumptions, support progressively more refined assessments (Maughn, 1993; Opresko et al., 1994; Levin et al., 1989). The results are primarily designed to provide a list of COPCs to be addressed in the OU-10-04 ERA, and identify OU 10-04 level data gaps that must be filled before performing the OU 10-04 ERA. The results of the WAG 3 ERA may also support the WAG remedial action decision making or additional assessments with some understanding of the assumptions and uncertainties inherent in the WAG ERA process as discussed in Section 28.4.4.

All potential release sites identified in the FFA/CO and 11 new sites added after 1991, were evaluated using the general approach as discussed in VanHorn et al. (1995) and following guidelines proposed by EPA (EPA 1994, 1996). The first step in the process determined that 37 release sites either have a source of contamination and/or a pathway to ecological receptors. The next step was to compare contaminant concentrations to EBSLs and background. This resulted in eliminating all but 27 release sites, 19 for a sole concern based on non-radionuclide concentrations.

The final step of the WAG ERA process calculates a dose from exposure to contaminants using intake models that assume that the area is totally accessible to ecological receptors. This evaluation results in a range of hazard quotients (HQs) calculated for functional groups. This step resulted in all but 21 sites and groups being eliminated as a concern. One site (CPP-84) was also eliminated since no known release of acetone has occurred at this site and since acetone would not tend to remain in the environment.

In summary, the WAG ERA resulted in identifying 20 sites and groups that have potential ecological concerns. Of the twenty sites having HQs greater than the target value, all have nonradiological contamination and seven have radiological contamination. This includes CPP 13, 14 (Imhoff tanks, Area 1), 19, 34, 37A, 39, 40, 42, 44, 55, 66, 67, 88, 90, 93, Old Storage Pool Group, Storage Yard Group, Tank Farm Group, Tank Farm South Group, and WCF Group.

As discussed in Section 28, HQs are only used as an indicator of risk and should not be interpreted as a final indication of actual adverse effects to ecological receptors. Therefore, additional screenings and discussion are appropriate at this stage of the WAG ERA process to use a weight of evidence approach for the further elimination of sites and contaminants for consideration in the FS process. This type of evaluation will eliminate unnecessary and remediations based on potential risk to ecological receptors.

Based on the rationale presented in Section 28.4.3 an additional screening for metals was determined appropriate for the WAG 3 sites as agreed upon in an October 20, 1997 conference call between DOE-ID, EPA, and IDHW. This screening was composed of two steps.

1. Contaminants were eliminated as a concern if the maximum concentration was less than 10X the background value

2. Contaminants were eliminated as a concern if the 95% UCLs was less than the 10X background.

This additional screening resulted in eliminating all but 13 sites as a concern in the FS. The sites include CPP-13, 14 (Imhoff Tanks-Area 1), 19, 34, 44, 55, 66, 67, 93, Old Storage Pool Group, Tank Farm Group, Tank Farm South Group, and WCF. Concentrations of radionuclides at CPP-13, 19, 34, 67, Old Storage Pool Group, Tank Farm Group, Tank Farm South Group and WCF are of concern for ecological receptors. The most common radionuclides of concern include Am-241, Cs-137, and Sr-90 with the highest HQs occurring (>1,000) at the Tank Farm Group. CPP-13, CPP-14-Imhoff Tanks (Area 1), 44, 93, and WCF concentrations of mercury that are of concern to ecological receptors. As is shown in Table 28.26, CPP-14, the Imhoff Tanks is solely a concern due from exposure to mercury. It is recommended that this site be removed as a concern in the FS to ecological receptors since the mercury contamination is at depths greater than 9 ft. CPP-44 has soil containing chromium, lead, and mercury contamination. CPP-67 has sediment that contains multiple non-radionuclide contaminants as well as radionuclides. CPP-55 may have chromium VI as a concern to ecological receptors, however, based on research it is extremely unlikely the chromium has remained in the VI form in this environment (Citation), and based on the sampling results, mercury may not be an issue at this site (see the discussion in Section 28.4.3).

29.3 Conclusions and Risk Management Decisions

The conclusions supported by the OU 3-13 RI/BRA are based on the results of the contaminant nature and extent evaluations, the site and contaminant screening evaluations, and the human health risk assessment described separately for each group and individual release site in Sections 8 through 26 of this report. The results of an Ecological Risk Assessment (Section 28) summarized in Section 29.2.2 identify 13 sites that require further evaluation in the Feasibility Study. Ten of these sites were identified as posing a concern to human receptors as well. Sites CPP-14, -44, and -55 were identified as posing solely a potential problem to ecological receptors.

Based on the results of the HHRA, summarized graphically in Section 27, and given the exposure assumptions necessary to develop these results, it is evident that there are a number of groups and sites that pose a significant potential impact to human health regardless of land use scenario. However, further evaluation will only be recommended at those groups and sites where under a future residential land use assumption the potential increased cancer incidence is above the NCP value of 1E-04 or the noncarcinogenic effects exceed a hazard index of 1. The groups and sites that meet this condition include the WCF Group, Tank Farm Group, Tank Farm South Group, Old Storage Pool Group, CPP-03, -13, -19, -34, -67, and -93. The estimated potential cancer risk at some of these areas was found to be one to three orders of magnitude greater than 1E-04. Therefore, an appropriate recommendation is for response actions to be further evaluated in the OU 3-13 Feasibility Study for these groups and sites. The group of sites of exclusive groundwater concern do not contribute to surface exposure but were evaluated in the groundwater model as a source of contamination and/or recharge to the SRPA and will also be carried through the Feasibility Study. Site CPP-92 was not evaluated quantitatively in the BRA but was recommended for further evaluation of soil disposal options in the 3-13 Feasibility Study. For convenience, a summary of the risk assessment results along with the recommendation for each group and site are presented in Table 29-1.

Table 29-1. Summary of RI/BRA conclusions and recommendations for groups and sites of concern.

Group /Site	Contaminants Identified	Risk Assessment Results[a]	Conclusions and Recommendations
Sites of Exclusive Groundwater Concern (CPP-02,-23, -65, -69, -80, -83, -87, -89)	CPP-02: Radionuclides	CPP-02: Unknown potential for groundwater contamination, site included in the groundwater model.	These sites were evaluated in the RI/BRA to the extent that they are a source of recharge and/or contamination to the SRPA and will be evaluated further in the OU 3-13 Feasibility Study.
	CPP-23: Radionuclides	CPP-23: Significant potential source of groundwater contamination, site included in the groundwater model.	
	CPP-65: Low levels of radionuclides and inorganics	CPP-65: Significant source of water, insignificant source of groundwater contamination, site included in the groundwater model.	
	CPP-69: Radionuclides and metals	CPP-69: No identified source, site not included in the groundwater model.	
	CPP-80: Radionuclides	CPP-80: Unknown potential for groundwater contamination, site included in the groundwater model.	
	CPP-83: Radionuclides and metals	CPP-83: Significant potential source of groundwater contamination, site included in the groundwater model.	
	CPP-87: Radionuclides	CPP-87: No identified route for contamination transport to the aquifer, site not included in the groundwater model.	
	CPP-89: Radionuclides and metals	CPP-89: Unknown potential for groundwater contamination, site included in the groundwater model.	
Tank Farm (CPP-20/25, -26, -28, -31, -32W/E, -79)	Radionuclides at all sites	**Current occupational:** surface risk >1E-04 due to external radiation exposure (Cs-137) **Future occupational:** surface risk >1E-04 due to external radiation exposure (Cs-137) **Future residential:** surface risk >1E-04 due to external radiation exposure (Cs-137)	The potential increased cancer risk is unacceptable regardless of land use assumptions. Alternatives protective of future residents should be evaluated during the OU 3-13 Feasibility Study for this group.
Tank Farm South (CPP-15, -27/33, -58W/E)	Radionuclides at all sites	**Current occupational:** surface risk >1E-04 due to external radiation exposure (Cs-137) **Future occupational:** surface risk >1E-04 due to external radiation exposure (Cs-137) **Future residential:** surface risk >1E-04 due to external radiation exposure (Cs-137) and ingestion of homegrown produce (Cs-137)	The potential increased cancer risk is unacceptable regardless of land use assumptions. Remedial alternatives protective of future residents should be evaluated during the OU 3-13 Feasibility Study for this group.

Table 29-1. (continued).

Group /Site	Contaminants Identified	Risk Assessment Results*	Conclusions and Recommendations
Waste Calcine Facility (CPP-35, -36/91, -85)	CPP-35: Radionuclides CPP-36/91: Radionuclides CPP-85: No release identified	**Current occupational:** surface risk > 1E-04 due to external radiation exposure (Cs-137) **Future occupational:** surface risk > 1E-04 due to external radiation exposure (Cs-137) **Future residential:** surface risk > 1E-04 due to soil ingestion (Am-241, Cs- 137, Sr-90), homegrown produce ingestion (Cs-137 and Sr-90), and external radiation exposure (Cs-137)	The potential increased cancer risk is unacceptable regardless of land use assumptions. Remedial alternatives protective of future residents should be evaluated during the OU 3-13 Feasibility Study for this group.
Old Storage Pool (CPP-01/04/05, -08/09, -10, -11)	Radionuclides for all sites	**Current occupational:** surface risk > 1E-04 due to external radiation exposure (Co-60, Cs-134, Cs-137, Eu-152, Eu-154) **Future occupational:** surface risk > 1E-04 due to external radiation exposure (Cs-137, Eu-152) **Future residential:** surface risk > 1E-04 due to external radiation exposure (Cs-137, Eu-152, Eu-154)	The potential increased cancer risk is unacceptable regardless of land use assumptions. Remedial alternatives protective of future residents should be evaluated during the OU 3-13 Feasibility Study for this group.
Storage Yard East of CPP-603 (CPP-03, -17A, -17B)	Radionuclides for the 3 sites	**Current occupational:** surface risk >1E-04 due to external radiation exposure (Cs-137) **Future occupational:** 1E-04> surface risk > 1E-06 due to radiation exposure (Cs-137) **Future residential:** surface risk > 1E-04 due to external radiation exposure (Cs-137)	The potential increased cancer risk is slightly greater than 1E-04 under current occupational and future residential assumptions. Only site CPP-03 should be evaluated further in the OU 3-13 Feasibility Study.
CPP-37A/B	Radionuclides and arsenic	**Current occupational:** 1E-04 > surface risk > 1E-06 due to external radiation exposure (Cs-137) **Future occupational:** 1E-04 > surface risk > 1E-06 from external radiation exposure (Cs-137, Np-237) **Future residential:** 1E-04 > surface risk > 1E-06 due to soil ingestion (arsenic) and external radiation exposure (Cs-137, Np-237)	The potential increased cancer incidence at this release site is less than 1E-04 under all land use assumptions; therefore, further evaluation in the OU 3-13 Feasibility Study is not warranted.

Table 29-1. (continued).

Group /Site	Contaminants Identified	Risk Assessment Results[a]	Conclusions and Recommendations
CPP-67	Radionuclides	**Current occupational:** surface risk >1E-04 due to external radiation exposure (Cs-137) **Future occupational:** 1E-04> surface risk > 1E-06 due to external radiation exposure (Cs-137, Np-237) **Future residential:** surface risk >1E-04 due to external radiation exposure (Cs-137)	The potential increased cancer risk is unacceptable under future residential land use assumptions. Remedial alternatives protective of future residents should be evaluated during the OU 3-13 Feasibility Study for this site.
CPP-14	Radionuclides	**Current occupational:** 1E-04>surface risk > 1E-06 due to external radiation exposure (Cs-137, Np-237) **Future occupational:** 1E-04> surface risk > 1E-06 due to external radiation exposure (Cs-137, Np-237) **Future residential:** 1E-04> surface risk > 1E-06 due to external radiation exposure (Cs-137, Np-237)	The potential increased cancer incidence at this release site is less than 1E-04 under all land use assumptions; therefore, further evaluation in the OU 3-13 Feasibility Study is not warranted.
CPP-34	Radionuclides	**Current occupational:** 1E-04> surface risk > 1E-06 external radiation exposure (Cs-137) **Future occupational:** 1E-04> surface risk > 1E-06 due to external radiation exposure (Cs-137) **Future residential:** surface risk > 1E-04 due to homegrown produce ingestion (Sr-90) and external radiation exposure (Cs-137)	The potential increased cancer risk is unacceptable under future residential land use assumptions. Remedial alternatives protective of future residents should be evaluated during the OU 3-13 Feasibility Study for this site.
CPP-13	Radionuclides	**Current occupational:** surface risk >1E-04 due to external radiation exposure (Cs-137, Eu-154) **Future occupational:** surface risk > 1E-04 due to external radiation exposure (Cs-137) **Future residential:** surface risk >1E-04 due to homegrown produce ingestion (Sr-90) and external radiation exposure (Cs-137)	The potential increased cancer risk is unacceptable under all land use assumptions evaluated. Remedial alternatives protective of future residents should be evaluated during the OU 3-13 Feasibility Study for this site.

Table 29-1. (continued).

Group /Site	Contaminants Identified	Risk Assessment Results[a]	Conclusions and Recommendations
CPP-06	Radionuclides	**Current occupational:** surface risk >1E-04 due to external radiation exposure (Cs-137) **Future occupational:** 1E-04 > surface risk > 1E-06 due to external radiation exposure (Cs-137) **Future residential:** 1E-04 > surface risk > 1E-06 due to external radiation exposure (Cs-137)	The potential increased cancer incidence at this release site is greater than 1E-04 under current land use but less than 1E-04 under future occupational and residential land use assumptions; therefore, further evaluation of this site in the FS is not warranted.
CPP-19	Radionuclides	**Current occupational:** surface risk >1E-04 due to external radiation exposure (Cs-137) **Future occupational:** 1E-04 > surface risk > 1E-06 due to external radiation exposure (Cs-137) **Future residential:** surface risk > 1E-04 due to soil ingestion (Cs-137, Sr-90), homegrown produce ingestion (Cs-137, Sr-90) and external radiation exposure (Cs-137, Eu-152, Eu-154)	The potential increased cancer incidence at this release site is greater than 1E-04 under current and future residential land use assumptions but less than 1E-04 under future occupational land use. Remedial alternatives protective of future residents should be evaluated during the OU 3-13 Feasibility Study for this site.
CPP-22	Radionuclides	**Current occupational:** surface risk >1E-04 due to external radiation exposure (Cs-137) **Future occupational:** 1E-04 > surface risk > 1E-06 due to external radiation exposure (Cs-137) **Future residential:** 1E-04 > surface risk > 1E-06 due to external radiation exposure (Cs-137)	The potential increased cancer incidence at this release site is greater than 1E-04 under current land use but less than 1E-04 under future occupational and residential land use assumptions; therefore, further evaluation of this site in the OU 3-13 Feasibility Study is not warranted.
CPP-90	Radionuclides	**Current occupational:** 1E-04> surface risk > 1E-06 due to radiation exposure (Cs-137) **Future occupational:** 1E-04> surface risk > 1E-06 due to radiation exposure (Cs-137) **Future residential:** 1E-04> surface risk > 1E-06 due to external radiation exposure (Cs-137)	The potential increased cancer incidence at this release site is less than 1E-04 under all land use assumptions; therefore, further evaluation of this site in the OU3-13 Feasibility Study is not warranted.

Table 29-1. (continued).

Group /Site	Contaminants Identified	Risk Assessment Results[a]	Conclusions and Recommendations
CPP-88	Radionuclides	**Current occupational:** 1E-04> surface risk > 1E-06 due to radiation exposure (Cs-137) **Future occupational:** 1E-04> surface risk > 1E-06 due to radiation exposure (Cs-137) **Future residential:** 1E-04> surface risk > 1E-06 due to external radiation exposure (Cs-137)	The potential increased cancer incidence at this release site is less than 1E-04 under all land use assumptions; therefore, further evaluation of this site in the OU3-13 Feasibility Study is not warranted.
CPP-92	Radionuclides	The waste boxes that contain radioactive soil were not evaluated quantitatively in the RI/BRA Report.	The disposition of these boxes will be deferred to the OU 3-13 Feasibility Study.
CPP-93	Mercury	**Current occupational:** surface risk < 1E-06 **Future occupational:** surface risk < 1E-06 **Future residential:** non-carcinogenic hazard > 1 due to ingestion of home grown produce	The noncarcinogenic hazard under future residential assumptions is > 1; therefore, further evaluation of this site in the OU 3-13 FS is warranted.

a. The risk assessment results in this table do not include the air and groundwater contribution. The contaminant in parenthesis is the risk driver for the predominant exposure route.

29.4 Unresolved Issues

There are a number of unresolved issues identified during LMITCO internal review of the RI/BRA Report. The purpose of presenting these issues here is to facilitate discussions among EPA, State of Idaho, DOE, and contractor personnel, which if necessary, will lead to joint resolution of these issues and revisions and incorporation of them in the final version of the RI/FS Report. The following paragraphs each briefly describe an unresolved issue.

The results of past field investigations measured several plutonium isotopes in soils, primarily in the ICPP tank farm area, but not in the perched water or the SRPA above the detection limit. The results of the groundwater model, based on a K_d of 22 and 0 cm^3/g for sedimentary interbeds and vadose zone basalt, respectively, predict plutonium to exceed the MCL of 15 pCi/L beginning in the year 2850 and reach a peak concentration of 36.2 pCi/L in the year 3585. Plutonium is a COC being evaluated further in the 3-13 Feasibility Study. Three significant issues associated with the plutonium model predictions are unresolved. Most important, the base case plutonium K_d of 22 is suspected of being too small (other INEEL projects are using values greater than 1000 for interbed material). The results of sensitivity runs with values of 220 and 0 for interbed material and vadose zone basalt show the peak concentration below the MCL. These sensitivity results show that a factor of ten increase in the K_d can make the difference whether plutonium is a COC, and therefore, has significant implications to the scope of the Feasibility Study. Most of the plutonium released to the environment can be found within the tank farm area. The source estimates used int he groundwater model are based on limited release history and process knowledge. Soil and groundwater characterization data in this area are very limited to help verify the accuracy of both the source estimates and the simulation results. Therefore, the second plutonium issue is the high uncertainty associated with the source estimates. The third issue is that the model predictions are reported as total plutonium rather than as separate simulations for each isotope (i.e., Pu-238, -239, -240, and -241). This approach was taken because the plutonium isotopes are transported together, and there are no field data to define the isotope distribution in the source area, perched water, or SRPA. The flow and transport model predicts total plutonium mass concentrations which are converted into activity concentrations, assuming the plutonium isotopic distribution is decay corrected to the year 2095. Given the long travel time to the SRPA, even with an interbed K_d of 22 cm^3g, the Pu-241 and Pu-238 will decay away by the time the peak concentration occurs in the year 3585. Only Pu-239 and -240 will remain. Because Pu-239 has a long decay half-life and contributes the vast majority of the mass, the total plutonium by the year 3585 can be assumed to be all Pu-239.

Evaluation of expected contaminants, that is, identifying contaminants that could be present but have not been analyzed for, may be necessary. Measures to respond to this concern have been taken and are already included in this document. The approach is described in Section 4.4 of this report and has been implemented in Sections 10 through 26.

In comparison to other WAGs, the ICPP has an extensive network of monitoring wells. The well construction details and the results of the monitoring campaigns have been crucial to the parameterization and subsequent calibration of the groundwater model. This process has led to an increased understanding of the flow and transport system. As a result, possible data gaps have emerged. For instance, proper temporal data to evaluate trends over time has not been possible for some contaminants (i.e., Np-237, Tc-99) because of insufficient monitoring data over time. Another concern is the sufficiency of perched or SRPA wells in the right locations to properly monitor plumes and check the accuracy of model predications in the future.

Filling these potential data gaps would help address another unresolved issue about the screening process used in Appendix F to arrive at the 13 COPCs to be modeled. The concern is that there may not be monitoring wells in the proper locations and a sufficient history of field measurements to conclude that contaminants are not in the perched water or the SRPA at risk-based concentration levels. In particular, some of the nonradionuclides may have been screened out prematurely based on low concentrations in the field data. Another concern with the screening process is that metals with travel times greater than 1000 years were not evaluated further. This screening step eliminated arsenic and chromium as a COPC. The issue is that given enough time, these contaminants will reach the SPA. If radionuclides are modeled for 1000 years or more to ensure that the peak concentration is captured, then mercury and chromium should not be screened out until they are evaluated over the same simulation period.

The source estimate in the groundwater model for the injection well did not include Tc-99. The concern is that this contaminant is part of the injection well contaminant inventory and was not modeled. The model predictions based on the quantity of Tc-99 that resides in the soil show the concentration exceeding a 1E-06 risk-based value up to the year 2050. The implication is that adding an estimate for the injection well contribution could increase the predicted values such that its contribution when viewed in a cumulative sense with the other COPCs would be more significant. Because of the underestimated source for Tc-99 and the relatively limited monitoring results, the full extent of this contaminant plume is not well defined. This could be a concern for WAG 7 if the plume extends south to the RWMC. The implication is that without monitoring wells between CFA and the RWMC, it will not be possible to accurately attribute measurements of Tc-99 in RWMC wells to the CPP plume or a source within WAG 7.

Surface flooding scenarios of the ICPP caused by the Big Lost River have not been evaluated in the RI/FS because of delays in obtaining updated USGS flood plain maps. Speculative modeling may be necessary in lieu of flooding maps.