UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, CA 94105

JAN 30 2002

Dennis A. Rea, Colonel, USAF
Vice Commander, 56 FW
13970 W. Lightning Street
Luke AFB, Arizona 85309-1149

Re: First Five Year Review, Luke Air Force Base, Arizona, January 18, 2002

Dear Colonel Rea:

The U.S. Environmental Protection Agency (EPA) Region 9 has received the First Five Year Review, Luke Air Force Base (AFB), Arizona, dated January 18, 2002. We have reviewed the aforementioned document and the Air Force's responses to our comments on the draft final version dated November 29, 2001. Based on this review, EPA agrees with the findings, conclusions, and recommendations provided in the Report, and concurs with the Air Force that the remedies at Luke AFB remain protective of human health and the environment and exposure pathways that could result in unacceptable risks are being controlled through implementation of institutional controls and monitoring.

We understand the Declaration of Environmental Use Restriction (DEUR) for Potential Source of Contamination (PSC) DP-23 has been filed with Arizona Department of Environmental Quality (ADEQ) (filed in November 2001). The DEUR for PSC ST-18 will also be filed to ensure long-term protectiveness. The groundwater monitoring wells at PSC SS-42 will be sampled annually until the ROD requirement of 5 annual sampling events is completed, after which these wells can be sampled at five year intervals. Continued groundwater monitoring will be conducted for PSCs RW-02, FT-07, ST-18, SD-20 and SS-42 as part of future five-year reviews.

If there are any questions, please contact Xuan-Mai Tran, Remedial Project Manager, at (415) 972-3002.

Sincerely,

Jane Diamond
Acting Director Superfund Division

cc: Lou Minkler, ADEQ
Belle Matthews, Luke AFB
Jeff Rothrock, Luke AFB
Daniel Salzler (CAB Co-Chair)
Ed Cayous, EPA-HQ
Ronald McRobbie, Air Force Regional Environmental Office

ARCADIS

Final First Five-Year Review

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Our Ref.:
AZO00891.0001

Date:
January 18, 2002

List of Acronyms and Abbreviations

ADEQ	Arizona Department of Environmental Quality
ADWR	Arizona Department of Water Resources
AMSL	Above Mean Sea Level
AWQS	Aquifer Water Quality Standard
BEP	Bis (2-Ethyl Hexyl) Phthalate
BGS	Below Ground Surface
BGP	Base General Plan
BNA	Base/Neutral and Acid Extractable Organic Compound
BTEX	Bezene, Toluene, Ethylbinzene, Total Xylene
BX	Base Exchange
CERCLA	Comprehensive Environmental Response Compensation and Liability Act
CFR	Federal Code of Regulations
COC	Constituents of Concern
COEC	Constituents of Ecological Concern
COPC	Constituents of Potential Concern
DBCP	1,2-dibromo-3-chlorpropane
DCA	1,2-dichloroethane
DCP	Dichloropropane
DOD	Department of Defense
DPDO	Defense Property Disposal Office
DRO	Diesel – Range Organics
DEUR	Declaration of Environmental Use Restriction
ECC	Environmental Chemical Corporation
EI	Ecological Inventory
ELCR	Excess Lifetime Cancer Risk
EPA	Environmental Protection Agency
FCOR	Final Close Out Report
FCOR	Final Closeout Report
FFA	Federal Facilities Agreement
FS	Feasibility Study
GWNT	Groundwater Not Threatened
GPL	Groundwater Protection Level
HDPE	High Density Polyethylene
HI	Hazard Index
HQ	Hazard Index
HRS	Hazard Ranking System
ICE	Internal Combustion Engine
ICP	Institutional Control Plan
IEUBK	Integrated Exposure Uptake Biokinetic
IRP	Installation Restoration Program
LCU	Lower Conglomerate Unit
LTM	Long Term Monitoring

LUST	Leaking Underground Storage Tank
MCL	Maximum Contaminate Level
MFU	Middle Fine Unit
NCP	National Contingency Plan
NPL	National Properties List
OSWER	Office of Solid Waste and Emergency Response
OU	Operable Unit
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polycholrinated Biphenyls Chromium
PCE	Tetracholoethane
PPE	Personal Protective Equipment
PRG	Preliminary Remediation Goal
PSC	Potential Source of Contamination
QA/QC	Quality Control and Assurance
OU	Operable Unit
RCRA	Resource Conservation and Recovery Act
RCVA	Resource Conservation Recovery Act
RFA	Facility Assessment
RFI	Facility Investigation
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
SARA	Super fund Amendments and Reauthorization Act
SRL	Soil Remediation Level
SVE	Soil Vapor Extraction
TCE	Trichloroethene
TPH	Total Petroleum Hydrocarbons
TPH	Total Petroleum Hydrocarbons
TRPH	Total Recoverable Petroleum Hydrocarbons
TRPH	Total Recoverable Petroleum Hydrocarbons
UAU	Upper Alluvial Unit
USACE	United States Army Corps of Engineers
USAF	United States Air Force
USEPA	United States Environmental Protection Agency
UST	Underground Storage Tank
UTL	Upper Threshold Limit
VEMUR	Voluntary Environmental Mitigation Use Restriction
VES	Vapor Extraction System
VOC	Volatile Organic Compound
WSRV	West Salt River Valley
WWTP	Waste Water Treatment Plant

Tables

Figures

Appendices

Executive Summary

In 1990, the United States Environmental Protection Agency (USEPA) placed Luke Air Force Base (Luke AFB) on the National Priorities List (NPL) pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA also known as Superfund) of 1980, as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986. Luke AFB (the site) was added to the NPL as a result of past hazardous material handling and disposal practices.

This five-year review was conducted pursuant to the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) Section 121(c), 42 U.S.C. § 9621(c), the National Contingency Plan (NCP) (40 CFR § 300.430 (f)(4)(ii)), Office of Solid Waste and Emergency Response (OSWER) Directive 9355.7-03B-P Final. This report summarizes the remedial actions and data collected since the beginning of the project in August 1990 through November 2001 and provides an evaluation of the effectiveness of the remedial actions relative to remedial objectives and to verify that remedial actions remain protective of human health and the environment.

Luke AFB, which is an advanced fighter pilot training institution, covers approximately 4,000 acres west of the Phoenix metropolitan area in Glendale, Arizona. Aircraft maintenance and light industrial operations in support of training missions have been in existence at Luke AFB since its inception in 1941. The results of these activities generated potentially hazardous wastes such as petroleum residues, cleaning solvents, and other related wastes.

Subsequent to the listing of Luke AFB, remedial investigation/feasibility studies were performed to determine the nature and extent of contamination. A total of 33 potential sources of contamination (PSCs) were initially identified for investigation purposes. To aid in the management of the investigations, the PSCs were divided into two operable units, OU-1 and OU-2. OU-2, the first to be investigated, included the investigation of soils at eight sites at which only petroleum-related wastes were disposed. OU-2 PSCs include the following:

• PSC OT-04	Old Perimeter Road POL Waste Site
• PSC DP-05	POL Waste Disposal Trench
• PSC FT-06	South Fire Training Area
• PSC FT-07W	Western Portion of the North Fire Training Area
• PSC ST-18	Facility 993
• PSC DP-22	POL Trench at Northeast Runway
• PSC DP-23	Old Surface Impoundment West of Facility 999
• PSC SD-40	Taxiway Discharge Area

OU-1 included the investigation of the soils at 25 PSCs and the Base-wide investigation of air, surface water, and groundwater resources. OU-1 PSCs include the following:

- Old Incinerator Site (PSC OT-01).
- Wastewater Treatment Annex Landfill (PSC RW-02).
- Outboard Runway Landfill (PSC LF-03).
- Eastern Portion of North Fire Training Area (PSC FT-07E).
- F-15 Burial Site (PSC OT-08).
- Canberra Burial Site (PSC OT-09).
- Concrete Rubble Burial Site (PSC OT-10).
- Former Outside Transformer Storage (PSC SS-11).
- Old Explosive Ordnance Division (EOD) Burial Site (PSC OT-12).
- Drainage Ditch Disposal Area (PSC DP-13).
- Old Salvage Yard Burial Site (PSC LF-14).
- Facility 328 Spill Site (PSC SS-15).
- Facility 321 Underground Storage Tank (UST) (PSC SS-16).
- Former Defense Property Disposal Office (DPDO) Yard (PSC SS-17).
- Base Exchange (BX) Leaking USTs (PSC ST-19).
- Oil/Water Separator Canal and Earth Fissures (PSC SD-20).
- Sewage Treatment Plant Effluent Canal (PSC SD-21).
- Base Ammunition Storage Area (PSC DP-24).
- Northwest Landfill (PSC LF-25).
- Hush House Canal (PSC SD-26).
- Northeast Landfill (PSC LF-37).
- Southwest Oil/Water Separator at the Auto Hobby Shop (SD-38).
- Waste Discharge at the Old Lockheed Site (SD-39).
- Skeet Range (OT-41).
- Bulk Fuels Storage (SS-42).

A more detailed description and background information for OU-1 and OU-2 PSCs is in Appendix A. It is important to note that PSCs 27 through 36 do not exist because there was a break in the numbering between PSC SD-26 and PSC LF-37.

In addition to the investigation of identified PSCs, a RCRA facility assessment (RFA) and RCRA facility investigation (RFI) were conducted to determine if any of the current operational facilities at Luke AFB should be included as PSCs in the CERCLA program. Remedial alternatives were identified, and remedial actions were designed and implemented as part of clean up activities.

As part of the OU-1 Feasibility Study (FS), a risk-based assessment was performed regarding acceptability of PSCs for residential land use given current conditions. Residential land use implies that a site can be developed and used for any purpose, including residential development. If a PSC was deemed unsuitable for residential land use, remedial alternatives were developed for that site.

Remedial alternatives were also developed for any site that could potentially impact underlying groundwater resources in the future.

Potentially exposed populations considered in the risk assessment included the following:

- Base workers
- Excavation workers
- Military personnel
- Child visitors for sites which extend off the base property
- Base residents

The risk assessment considered both average and reasonable maximum exposure conditions to characterize current and future risks.

Risk from residential exposure to combined surface and subsurface soil were calculated using both the USEPA Region IX PRGs and the ADEQ SRLs. Based on the results of the evaluation, all of the PSC areas evaluated were determined to be suitable for unrestricted, or residential land use with the exception of the following PSCs:

- RW-02
- LF-03
- FT-07 E
- DP-13
- LF-14
- ST-18
- LF-25
- DP-23 N
- SD-38

In addition to evaluating potential human exposure at Luke AFB, an ecological risk assessment was also performed.

This five-year review report provides a historical and five-year review process summary for OU-1 and OU-2 PSCs for which remedies were selected. These PSCs include the following:

- RW-02
- LF-03
- FT-07 E
- DP-13
- LF-14

- ST-18
- DP-23
- LF-25
- SD-38
- SS-42

The historical review and evaluation process also includes PSCs for which it was determined no action was required. These PSCs include the following:

- OT-01
- OT-04
- DP-05
- FT-06
- FT-07 W
- OT-08
- OT-09
- OT-10
- SS-15
- SS-16
- SS-19
- DP-22
- SD-21
- DP-24
- SD-26
- LF-37
- SD-39
- SD-40
- OT-41

The five-year review process primarily consisted of a site inspection, interviews and a review of relevant documents and data. Jeff Rothrock of Luke AFB led the five-year review for the site. The following team members assisted in the review:

- Jeff Rothrock, Luke AFB
- Jon Sherrill, ARCADIS G&M, Inc.
- Kent Lang, ARCADIS G&M, Inc.
- Stephanie Armijo, ARCADIS G&M, Inc.
- Monique Ostemann, USACE
- Greg Mellema, USACE

- Dan Stralka, USEPA
- Nancy Lou Minkler, ADEQ

The five-year review process includes the following primary elements:

- Remedy selection and implementation is reviewed and summarized for each OU-1 and OU-2 PSC for which a remedy was selected.

- Changes in standards were evaluated with respect to the continued effectiveness of the remedies that were implemented based on cancer risks and non-cancer hazards for applicable constituents of concern (COCs) for base worker or excavation worker scenarios.

- Groundwater monitoring results are compared to groundwater standards established for the project.

- Representatives of Luke AFB, USEPA, US Army Corps. of Engineers, ADEQ and ARCADIS G&M performed a site inspection of each PSC for which a remedy was selected on May 22, 2001.

- The results of interviews with individuals knowledgeable about the project.

OU-1 PSCs for which remedies were selected based on the results of risk assessment include the following:

- RW-02
- LF-03
- FT-07 E
- DP-13
- LF-14
- LF-25
- SD-38
- SS-42

For OU-1 PSCs, PRGs were not established. Alternatively, PSC specific cancer risks and non-cancer hazards were calculated using 1996 USEPA Region IX PRG guidance to develop a site-specific industrial scenario. To evaluate changes in standards as part of this five-year review, cancer risk and non-cancer hazards were recalculated using 2000 USEPA Region IX industrial PRGs and post remediation exposure point concentrations for base worker and excavation worker scenarios as applicable. ADEQ SRLs were also reviewed since they were used to determine risk under a residential land use scenario.

Changes in standards are evaluated with respect to the continued effectiveness of the remedies that were implemented based on a non-cancer HI less than or equal to 1.0 or an ELCR greater than the risk range of $1x10^{-6}$ to $1x10^{-4}$.

OU-2 PSCs for which remedies were selected based on the results of risk assessment include the following:

- ST-18
- DP-23

For OU-2 PSCs, 1991 USEPA Region IX PRGs were originally used to establish performance standards. To evaluate changes in standards as part of this five-year review, cancer risks and non-cancer hazards were recalculated for each COC using 2000 USEPA Region IX industrial PRGs and post remediation exposure point concentrations for base worker and excavation worker scenarios as applicable. The analysis of standard changes also included a review of 1996 USEPA industrial PRGs. ADEQ SRLs were also reviewed since they were used to evaluate residential use standards. Changes in standards are evaluated with respect to the continued effectiveness of the remedies that were implemented based on a non-cancer HI less than or equal to 1.0 or an ELCR greater than the risk range of $1x10^{-6}$ to $1x10^{-4}$.

The comparison indicates that PSCs for which changes in standards were evaluated are still within the acceptable risk range. It was concluded that selected remedies are protective of human health and the environment and exposure pathways that could result in unacceptable risks are being controlled with the following exceptions:

- The northern portion of PSC DP-23 is within the acceptable risk range for industrial or non-residential land use, but outside the risk range for residential land use.

- The remedy at PSC ST-18 Facility 993 currently protects human health and the environment because the cap prevents exposure in the short term. However, in order for the remedy to be protective in the long term, a (Declaration of Environmental Use Restriction) DEUR is needed at the site to ensure long-term protectiveness.

A DEUR for PSC ST-18 and the northern portion of DP-23 has been filed with the ADEQ to resolve these issues.

A comparison of exposure point concentrations in groundwater (maximum concentrations for the period of record) and USEPA Region IX 2000 PRGs for tap water and ADEQ aquifer water quality standards were evaluated for the following PSCs:

- RW-02
- DP-05
- FT-06
- FT-07
- ST-18
- SD-20
- SD-21
- SD-38
- SS-42

The comparison indicates that exposure to groundwater results in risk that are within the acceptable risk range for these PSCs. A review of groundwater data for the period of record indicates that groundwater at Luke AFB is not impacted as there are no constituents in groundwater that currently exceed applicable water quality standards. All potential sources of constituents have been controlled or eliminated through the institution of pollution prevention measures or remedial activities

The following individuals were solicited for interviews by questionnaire as part of this five-year review:

- Belle Matthews, Luke AFB Project Manager
- Sean Hogan, EPA Project Manager
- Nancy Lou Minkler, ADEQ Project Manager
- Dan Salzler, Citizens Advisory Board (CAB) Community Co-Chairperson
- Joyce Clark, CAB member
- Martin Jeffries, CAB member

In addition to solicitation of interviews by questionnaire, the following individuals were interviewed in person as part of the five-year review site inspection:

- Chris Christoffer, Luke AFB Environmental Analyst
- Sergeant Anthony Michels, Luke AFB Infrastructure Superintendent

Chris Christoffer and Sergeant Michels were interviewed relative to procedures that ensure compliance with the Base General Plan (BGP) and Institutional Control Plan (ICP). As part of these interviews, the BGP was reviewed and it was verified that the ICP had been implemented. Also verified were approval and record keeping procedures for digging permits relative to environmental constraints at Luke AFB.

Luke AFB Five-Year Review Signature Cover Preliminary Information

Site name: Luke Air Force Base		EPA ID: AZ0570024133
Region: 09	State: Arizona	City/County: Luke AFB/Maricopa
LTRA* (highlight)		Construction completion date: December 17, 1999
Fund/PRP Lead: Luke AFB		NPL status: Final
Lead agency: USEPA Region IX		
Who conducted the review (EPA Region, state, Federal agencies or contractor): USEPA Region IX, ADEQ, USACE, ARCADIS G&M, Inc.		
Dates review conducted: From: April 2001 through December 2001		Date(s) of site visit: May 22, 2001
Whether first or successive review: First		
Circle: Regional Discretion		Due date: January 21, 2002
Trigger for this review: Final close-out process (2000-2001) and time that has lapsed since finalization of the OU-2 Record of Decision (ROD) in January 1994.		
Recycling, reuse, redevelopment site (highlight): N/A		

Issues: Northern portion of PSC DP-23 not remediated to residential soil standards and requires deed restriction. PSC ST-18 requires deed restriction to prevent future removal of cap and excavation of soil. Continued of monitoring at specific PSC to confirm protectiveness of remedies.

Recommendations: Declaration of Environmental Use Restrictions (DEURs) for PSC ST-18 and DP-23 have been filed with ADEQ (filed in 2001). Continued monitoring of groundwater will be conducted for PSCs RW-02, FT-07, ST-18, SD-20 and SS-42 as part of future five-year reviews.

Protectiveness Statement(s): The remedies at Luke AFB are protective of human health and the environment and exposure pathways that could result in unacceptable risks are being controlled through implementation of remediation, institutional controls and monitoring.

Other Comments: None

Signature of Luke AFB Environmental Protection Committee Chairman

18 Jan 02

DENNIS A. REA, Colonel, USAF
Vice Commander, 56 FW

Date

1.0 Introduction

In 1990, the United States Environmental Protection Agency (USEPA) placed Luke Air Force Base (Luke AFB) on the National Priorities List (NPL) pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA also known as Superfund) of 1980, as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986. Luke AFB (the site) was added to the NPL as a result of past hazardous material handling and disposal practices. The location of the site is shown in Figure 1-1. On behalf of the United States Air Force, ARCADIS G&M, Inc. (ARCADIS G&M) has prepared this final first five-year review of remedial actions at Luke AFB, Arizona.

This five-year review was conducted pursuant to the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) Section 121(c), 42 U.S.C. § 9621(c), the National Contingency Plan (NCP) (40 CFR § 300.430 (f)(4)(ii)), Office of Solid Waste and Emergency Response (OSWER) Directive 9355.7-03B-P Final.

1.1 Background

The following sections provide a general overview of site conditions, and project history. This information is intended to give the reader of the final first five-year review report for Luke AFB adequate background information with which to evaluate current conditions at the site.

1.1.1 Physical Characteristics

Luke AFB, which is an advanced fighter pilot training institution, covers approximately 4,000 acres west of the Phoenix metropolitan area in Glendale, Arizona. Aircraft maintenance and light industrial operations in support of training missions have been in existence at Luke AFB since its inception in 1941. Luke AFB lies in the Salt River Valley (SRV), which lies within the Basin and Range physiographic province. Elevations at Luke AFB range from 1,250-feet above mean sea level (amsl) at the northwest corner to 995-feet amsl at the southeast corner. The climate at Luke AFB is characterized as a desert climate. Rainfall at Luke AFB averages about 7.7 inches per year.

1.1.2 Land and Resource Use

The eastern portion of Luke AFB currently consists of a variety of light industrial facilities, office buildings occupied by administrative and community services, base barracks, and outdoor recreation centers. The central and western portions of Luke AFB include the runways, open spaces, and aircraft operations, training and maintenance facilities. Base residential housing and commercial areas are located east of the fenced areas of the main portions Luke AFB. Aircraft maintenance and light industrial operations in support of training missions have been in existence at Luke AFB since its inception in 1941. The results of these activities generated potentially hazardous wastes such as petroleum residues, cleaning solvents, and other related wastes.

1.1.3 Project History

Subsequent to the listing of Luke AFB on the NPL, remedial investigation/feasibility studies were performed to determine the nature and extent of contamination. Remedial alternatives were identified, and remedial actions were designed and implemented as part of clean up activities. A record of the remedial actions implemented and how cleanup was accomplished at Luke AFB are summarized in the Remedial Action Report. The following is a background summary relative to the Superfund project at Luke AFB:

- Prior to 1976 and the Resource Recovery and Conservation Act (RCRA), potentially hazardous wastes, such as petroleum residues, cleaning solvents, and other related materials, were disposed on Base through fire department training exercises, road oiling for dust suppression, and in shallow trenches.

- In 1981, the Department of Defense (DOD) initiated the IRP to investigate and remediate past hazardous materials handling and disposal practices at all military institutions.

- Before the passage of SARA, the USEPA did not supervise the IRP program at Luke AFB. Subsequent to the passage of SARA, the USEPA was required to establish and maintain a docket of potentially contaminated federal facilities, perform Hazard Ranking System (HRS) scoring on these facilities, and list those facilities exceeding the HRS threshold score on the NPL.

- The USEPA audited Luke AFB in 1987, and scored the institution using the HRS.

- Because the Luke AFB HRS score of 37.93 exceeded the threshold value of 28.5, the USEPA added Luke AFB to the NPL in August 1990.

- On September 27, 1990, the USEPA, Arizona Department of Environmental Quality (ADEQ), Arizona Department of Water Resources (ADWR), and the United States Air Force (USAF) signed a FFA to establish the procedural framework for conducting the required environmental investigations at Luke AFB.

- Environmental investigations at Luke AFB were implemented in accordance with regulations established in the NCP at Title 4, part 300 of the Federal Code of Regulations (CFR).

Based on the results of the Installation Restoration Program (IRP) and other information compiled during the initial planning stages, the Federal Facilities Agreement (FFA) identified 33 potential sources of contamination (PSCs). To aid in the management of the investigations, the FFA parties divided the PSCs into two operable units (OU). OU-1 included the investigation of the soils at 25 PSCs and the Base-wide investigation of air, surface water, and groundwater resources. OU-2 included the investigation of soils at eight sites at which only petroleum-related wastes were disposed. The FFA created this special grouping to put the eight OU-2 sites on a “fast-track;” the idea being that sites with common wastes would allow for a timely investigation and cleanup. The eight OU-2 PSCs are listed below. The location of PSCs in OU-2 is in Figure 1-2.

•	PSC OT-04	Old Perimeter Road POL Waste Site
•	PSC DP-05	POL Waste Disposal Trench
•	PSC FT-06	South Fire Training Area
•	PSC FT-07W	Western Portion of the North Fire Training Area
•	PSC ST-18	Facility 993
•	PSC DP-22	POL Trench at Northeast Runway
•	PSC DP-23	Old Surface Impoundment West of Facility 999
•	PSC SD-40	Taxiway Discharge Area

OU-1 was the last of two operable units to be addressed at Luke AFB and was defined to govern the investigation and potential remediation of air, surface water, and groundwater resources Base-wide. In addition, the soils at 25 PSCs believed to have been impacted primarily by non-petroleum related wastes were included in OU-1. The 25 PSCs included in OU-1 are listed below. The location of PSCs in OU-1 is in Figure 1-3.

- Old Incinerator Site (PSC OT-01).
- Wastewater Treatment Annex Landfill (PSC RW-02).
- Outboard Runway Landfill (PSC LF-03).
- Eastern Portion of North Fire Training Area (PSC FT-07E).
- F-15 Burial Site (PSC OT-08).
- Canberra Burial Site (PSC OT-09).
- Concrete Rubble Burial Site (PSC OT-10).
- Former Outside Transformer Storage (PSC SS-11).
- Old Explosive Ordnance Division (EOD) Burial Site (PSC OT-12).
- Drainage Ditch Disposal Area (PSC DP-13).
- Old Salvage Yard Burial Site (PSC LF-14).
- Facility 328 Spill Site (PSC SS-15).
- Facility 321 Underground Storage Tank (UST) (PSC SS-16).
- Former Defense Property Disposal Office (DPDO) Yard (PSC SS-17).
- Base Exchange (BX) Leaking USTs (PSC ST-19).
- Oil/Water Separator Canal and Earth Fissures (PSC SD-20).
- Sewage Treatment Plant Effluent Canal (PSC SD-21).
- Base Ammunition Storage Area (PSC DP-24).
- Northwest Landfill (PSC LF-25).
- Hush House Canal (PSC SD-26).
- Northeast Landfill (PSC LF-37).
- Southwest Oil/Water Separator at the Auto Hobby Shop (SD-38).
- Waste Discharge at the Old Lockheed Site (SD-39).
- Skeet Range (OT-41).
- Bulk Fuels Storage (SS-42).

A more detailed description and background information for OU-1 and OU-2 PSCs is in Appendix A. It is important to note that PSCs 27 through 36 do not exist because there was a break in the numbering between PSC SD-26 and PSC LF-37.

1.2 Purpose

This report summarizes the remedial actions and data collected since the beginning of the project in August 1990 through November 2001 and provides an evaluation of the effectiveness of the remedial actions relative to remedial objectives and to verify that remedial actions remain protective of human health and the environment. The need for this five-year review was identified during preparation of the Final Close Out Report (FCOR)[1] as part of the delisting process. This review is required because hazardous substances, pollutants, or contaminants remain in the subsurface at concentrations that are above levels that allow unrestricted land use. As the delisting process progressed, it was determined that the five-year review would be required because of the amount of time that has lapsed since finalization of the OU-2 Record of Decision (ROD) in January 1994.

This five-year review report is intended to be a concise summary of the work that was conducted at OU-1 and OU-2 to meet the statutory requirements of the Superfund process at Luke AFB. Numerous references are provided as part of this report however, not all support documents may be referenced. Rather, the most relevant documents are referenced in support of the objectives of the five-year review.

2.0 Site Chronology

2.1 Operable Unit 2

This section of the five-year review report provides a summary of the chronology of events for the implementation of the remedial alternatives for OU-2 at Luke AFB. The chronology of events for PSCs ST-18 and DP-23 are summarized in Tables 2-1 and 2-2, respectively.

Table 2-1. Chronology of Events for the Construction of the Concrete Cap at PSC ST-18

Date	Event
October 19, 1983	RCRA closure of facility 993 begins.
April 19, 1988	Final inspection of concrete cap construction.
September 27, 1990	Signing of the FFA transferring jurisdiction of ST-18 to CERCLA.

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[1] ARCADIS Geraghty & Miller. 2001. Final Close-Out Report, Luke Air Force Base, Arizona. April 5, 2001.

Date	Event
January 28, 1994	Signing of the OU-2 ROD.
Annually	Cap inspection and maintenance at PSC ST-18.
Five year review	Groundwater monitoring.

Table 2-2 Chronology of Events for the Ex-situ Bioremediation (Soil Composting) at PSC DP-23

Date	Event
January 28, 1994	Signing of the OU-2 ROD.
April 11, 1995	Conduct preliminary soil sampling to further characterize the site.
May, 1994	Submittal and agency approval of the remedial design Report.
July 7, 1995	Excavation of contaminated soil and mixing in treatment cell.
October, 1995	Interim sampling to check status of bioremediation.
April 3, 1997	Addition of optimized soil amendment mix and continued soil composting.
June 5, 1997	Final sampling and begin construction demobilization.
August 1, 1997	Site restoration; re-grading and hydro seeding.
August 6, 1997	Conduct final site inspection.
August 27, 1997	Submit final closure report.

2.2 Operable Unit 1

This section of the five-year review report provides a summary of the chronology of events for the implementation of the remedial alternatives for OU-1 at Luke AFB. The chronology of events for the eight OU-1 sites are summarized in Table 2-3. The chronology for the SVE at PSC SS-42 is summarized in Table 2-4.

Table 2-3 Chronology of Events for the OU-1 Remedial Action

Date	Event
September 7, 1999	Final signatures on the OU-1 ROD.
December 16, 1999	Remedial design workplan for PSC LF-25 submitted.
December 17, 1999	Conducted metal shot recovery at PSC LF-25.
December 21, 1999	Radiological monitoring points installed at PSC RW-02.
December 29,1999	Perimeter fencing installed around containment structure at PSC RW-02.
January 5, 2000	Revisions to base general plan implemented and policy letter established to implement required institutional controls.
January 12, 2000	Radiological LTM plan for PSC RW-02 submitted.
June 15, 2000	VEMURs filed for PSCs RW-02, LF-03, FT-07E, DP-13, LF-14, LF-25, and SD-38 to restrict residential development of the sites.
November 13, 2000	Institutional Control Plan (ICP) developed and submitted.
Annually	Radiological monitoring at RW-02.

Table 2-4 Chronology of Events for the SVE at PSC SS-42

Date	Event
May 1995	Wells installed for bioventing treatability study.
August 6, 1996	Initiation of SVE using Internal Combustion Engine (ICE).
June 1997	Soil Boring CB-1 advanced to determine effectiveness of ICE.
November 2, 1998	Shut down of SVE system.
January 7, 1999	Second boring advanced to determine effectiveness of SVE.
September 7, 1999	OU-1 ROD signed requiring five-year groundwater monitoring.
May 12, 2000	Groundwater LTM plan for PSC SS-42 submitted.
May 16, 2000	First groundwater sampling event of five-year monitoring completed.

Date	Event
May 22, 2000	Soil vapor extraction and confirmation sampling summary report submitted.
Annually	Groundwater monitoring.

3.0 RI/FS Results and ROD Findings

The section of the report summarizes RI/FS results as recorded in the RODs for OU-1[2] and OU-2[3]. The purpose of this section of the five year review report is to identify what COCs were evaluated as part of the RIs, which COCs exceeded standards established for the project, and what remedies were selected to address impacts for applicable PSCs.

3.1 OU-2 RI/FS Results

OU-2 included the investigation of soils at eight PSCs at which only petroleum-related wastes were believed to have been disposed. The location of the OU-2 PSCs are in Figure 1-2. The OU-2 RI/FS was conducted in accordance with USEPA guidance[4] and approved work plans[5,6,7,8,9]. The OU-2 field activities were limited to soil evaluations.

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[2] Geraghty & Miller, 1999. Final Record of Decision, Operable Unit 1. Luke Air Force Base, Arizona. January 1999.

[3] Geraghty & Miller, 1994. Final Record of Decision, Operable Unit 2. Luke Air Force Base, Arizona. January 1994.

[4] USEPA, 1988. Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, Interim Final: Office of Solid Waste and Emergency Response, OSWER Directive 9355.3-01.

[5] Geraghty & Miller, 1991. Luke Air Force Base, Arizona, Final Base-Wide Remedial Investigations/Feasibility Study Work Plan, August 1991.

[6] Geraghty & Miller, 1991. Luke Air Force Base, Arizona, Final Base-Wide Sampling and Analysis Plan, August 1991.

[7] Geraghty & Miller, 1991. Luke Air Force Base, Arizona, Final OU-2 Remedial Investigations/Feasibility Field Sampling and Analysis Plan, November 1991.

[8] Geraghty & Miller, 1992. Final Addenda for the Remedial Investigation/Feasibility Study Planning Documents, May 1992.

[9] U.S. Army Corps of Engineers, 1991. Scope of Services, Operable Unit #2, Remedial Investigation/Feasibility Study (RI/FS), Luke Air Force Base, Arizona, August 9, 1991.

OU-2 RI results are detailed in the OU-2 RI report[10]. Part of the FS, USEPA guidance[11] was used to calculate Preliminary Remediation Goals (PRGs) for OU-2 soils. OU-2 FS results are detailed in the OU-2 FS report[12] . OU-2 RI/FS results are summarized in Table 3-1.

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[10] Geraghty & Miller, 1992. Final Remedial Investigation Report, Operable Unit 2, Luke Air Force Base, Arizona, October 20, 1992.

[11] USEPA, 1991. Human Health Evaluation Manual Part B: Development of Risk-Based Preliminary Remediation Goals. Office of Emergency and Remedial Response, Washington, DC.

[12] Geraghty & Miller, 1993. Final Feasibility Study Report, Operable Unit 2, Luke Air Force Base, Arizona, May 12, 1993.

Table 3-1 Summary of RI/FS Results for OU-2

PSC	**Description**	**COCs evaluated**	**COCs in excess of Industrial PRGs**	**Selected Remedial Alternative**
OT-04	Old perimeter road POL waste site	Bis (2-ethylhexyl) phthalate, butylbenzylphthalate, TRPH, copper, lead	Less than PRGs	No action
DP-05	POL Waste Disposal Trench	Ethylbenzene, xylenes, bis (2-ethylhexyl) phthalate, 2-methylnaphthalene, naphthalene, TRPH, copper, lead	Less than PRGs	No action
FT-06	South fire training area	2-butanone (MEK), ethylbenzene, 2-hexanone (MBK), 1,1,2,2-tetrachlorethane, tetrachloroethene, toluene, trichloroethene, xylenes, acenaphthene, anthracene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, benzo(a)pyrene, bis(2-ethylhexyl) phthalate, butylbenzylphthalate, chrysenedibenzo(a,h)anthracene, dibenzofuran, di-n-butylphthalate, fluoranthene, fluorene, indeno(1,2,3-c,d)pyrene, 2-methylnaphthalene, 4-Methylphenol, Naphthalene, Pentachlorophenol, Phenanthrene, Phenol, Pyrene, TRPH, Metals, Copper, Lead	Trichloroethene, Benzo(a)anthracene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(a)pyrene, Indeno(1,2,3-cd)pyrene, Dibenzo(a,h)anthracene	Below the risk range
FT-07 W	Western portion of the north fire training area	benzo(b)fluoranthene, benzo(g,h,i)perylene, bis(2-ethylhexyl)phthalate, chrysene, fluoranthene, 2-methylnaphthalene, naphthalene pyrene, TRPH, copper, lead	Less than PRGs	No action

PSC	**Description**	**COCs evaluated**	**COCs in excess of Industrial PRGs**	**Selected Remedial Alternative**
ST-18	Facility 993	benzene, 1,1 dichloroethene, ethylbenzene, 1,1,2,2-tetrachlorethane, tetrachloroethene, toluene, trichloroethene, xylenes, benzo(a)anthracene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(a)pyrene, benzyl alcohol, bis(2-ethylhexyl)phthalate, chrysene, fluoranthene, indeno(1,2,3-cd)pyrene, 2-methylnaphthalene, naphthalene, phenanthrene, pyrene, TRPH, copper, lead	Benzene, 1,1,2,2-Tetrachlorethane, Benzo(a)pyrene	Maintain concrete cap, groundwater monitoring during each five-year review
DP-22	POL trench at northeast runway	acetone, TRPH, copper, lead	Less than PRGs	No action
DP-23	Old surface impoundment west of facility 999	ethylbenzene, toluene, anthracene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, benzo(a)pyrene, bis(2-ethylhexyl)phthalate, chrysene, dibenzo(a,h)anthracene, fluoranthene, indeno(1,2,3-cd)pyrene, phenanthrene, pyrene, TRPH, copper, lead	Benzo(a)anthracene Benzo(k)fluoranthene Benzo(a)pyrene Dibenz(a,h)anthracene Indeno(1,2,3-cd)pyrene	Ex-situ biological treatment
SD-40	Taxiway discharge area	acetone, benzene, ethylbenzene, toluene, xylenes, 2-methylnaphthalene, naphthalene, TRPH, copper, lead	Less than PRGs	No action

3.2 OU-1 RI/FS Results

OU-1 included the investigation of soils at 25 PSCs and the Base-wide investigation of air, surface water, and groundwater resources. In addition to the investigation of identified PSCs, a RCRA facility assessment (RFA) and RCRA facility investigation (RFI) were conducted to determine if any of the current operational facilities at Luke AFB should be included as PSCs in the CERCLA program. The results of the RCRA investigation are in Appendix A of the OU-1 report[13]. The location of PSCs in OU-1 are in Figure 3-2.

Prior to the beginning of the OU-1 RI field activities, the FFA parties determined that “no further remedial investigations” were needed at eight OU-1 PSCs, as follows:

- PSCs OT-01, OT-08, and OT-09 were classified as “no further action” sites because data obtained during an extensive review of Base records showed that hazardous materials or wastes were never handled or disposed at these sites.
- PSC DP-24 was removed from the Superfund process because it had mistakenly been included on the list of potentially contaminated sites.
- PSCs SS-15, SS-16, and ST-19 were removed from the Superfund process and placed under the jurisdiction of the ADEQ Underground Storage Tank (UST) section.
- PSC OT-10 was removed from the list of sites requiring field investigations because that site lies completely within the boundaries of PSC DP-13 and the landfill contents of both sites were presumed similar.

Because of its complexity, the OU-1 RI field investigation was divided into three phases, phase I conducted from October 1991 through March 1992, phase II activities conducted from June 1992 through April 1994 and phase III activities conducted in August and September 1996. Phase III activities were required to collect additional data for risk assessment purposes due to Phase I and Phase II laboratory data quality issues. However, the information reported as part of this five-year review is based on a consolidation of the most defensible data collected in conjunction with the overall Superfund process in terms of quality control and assurance (QA/QC) protocol.

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[13] Geraghty & Miller, 1997 Final Remedial Investigation Report OU-1, Luke Air Force Base, Arizona. Volumes 1 and 2. October 1997.

The OU-1 RI/FS was conducted in accordance with USEPA guidance[2] and approved work plans[3,14,15,16,17]. OU-1 RI investigation results are detailed in the OU-1 RI report[13].

As part of the OU-1 FS, a risk-based assessment was performed regarding acceptability of PSCs for residential land use given current conditions. Residential land use implies that a site can be developed and used for any purpose, including residential development. If a PSC was deemed unsuitable for residential land use, remedial alternatives were developed for that site. Remedial alternatives were also developed for any site that could potentially impact underlying groundwater resources in the future. The OU-1 FS results are detailed in the OU-1 FS report[18]. OU-1 RI/FS results are summarized in Table 3-2.

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[14] Geraghty & Miller, 1993c. OU-1 Phase II Remedial Investigation/Feasibility Study Field Sampling and Analysis Plan, Luke Air Force Base, Arizona.

[15] Geraghty & Miller, 1994. Bioventing Treatability Study Sampling and Analysis Plan for PSC SS-42. Luke Air Force Base, Arizona.

[16] Geraghty & Miller, 1995. Final Sampling and Analysis Plan Environmental Evaluation in Support of the Ecological Risk Assessment, Luke Air Force Base, Arizona.

[17] Geraghty & Miller, 1995. Final Sampling and Analysis for the Additional Sampling Investigations in Support of the Luke AFB CERCLA investigation, Luke AFB, Arizona.

[18] Geraghty & Miller, 1998. Final OU-1 Feasibility Study Report, Luke Air Force Base, Arizona. March 1998.

Table 3-2 Summary of OU-1 RI/FS Results

PSC	Description	COCs Evaluated	COCs Outside Risk-Based Range	Selected Remedial Alternative
OT-01	Old incinerator site	An extensive data review of base records indicated that hazardous materials and wastes were never handled or disposed at this location.	RI not required	No action
RW-02	Wastewater treatment annex landfill	2-methylnaphthalene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, bis(2-ethylhexyl)phthalate, chrysene, di-n-butyl phthalate, di-n-octyl phthalate, fluoranthene, indeno(1,2,3-cd)pyrene, phenanthrene, pyrene, TRPH, arsenic, barium, beryllium, cadmium, chromium, copper, lead, mercury, nickel, silver, uranium, zinc, gross alpha, gross beta, radium-226, radium-228	Radionuclides are currently be monitored, however the COCs were below risk standards	Institutional controls, radiological monitoring and fencing
LF-03	Outboard runway landfill	TRPH, arsenic, barium, beryllium, cadmium, chromium, copper, lead, nickel, silver, zinc	COCs below risk standard	Institutional controls
FT-07E	Eastern portion of north fire training area	acetone, ethylbenzene, toluene, xylenes, TRPH, arsenic, barium chromium, copper, lead, nickel, zinc	TRPH are below non-residential ADEQ SRLs	Institutional controls
OT-08	F-15 burial site	An extensive data review of base records indicated that hazardous materials and wastes were never handled or disposed at this location.	RI not required	No action
OT-09	Canberra burial site	An extensive data review of base records indicated that hazardous materials and wastes were never handled or disposed at this location.	RI not required	No action

PSC	Description	COCs Evaluated	COCs Outside Risk-Based Range	Selected Remedial Alternative
OT-10	Concrete rubble burial site	This site lies completely within the boundaries of DP-13.	RI not required	No action
SS-11	Former outside transformer storage	PCBs	Risk below risk range	No action
OT-12	Old explosive ordnance division (EOD) burial site	Acenaphthylene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, carbazole, chrysene, dibenz(a,h)anthracene, fluoranthene, indeno(1,2,3-c,d)pyrene, pentachlorophenol, phenanthrene, pyrene, TRPH, arsenic, barium, beryllium, cadmium, chromium, copper, lead, nickel, zinc, cyanide	Risk below risk range, with the exception of Benzo(a)pyrene	No action
DP-13	Drainage ditch disposal area	acenaphthene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, bis(2-ethylhexyl)phthalate, carbazole, chrysene, dibenz(a,h)anthracene, dibenzofuran, fluoranthene, fluorine, indeno(1,2,3-cd)pyrene, phenanthrene, pyrene, TRPH, antimony, arsenic, barium, beryllium, cadmium, chromium, copper, lead, mercury, nickel, zinc, cyanide	Chromium Lead Benzo(a)pyrene	Institutional controls
LF-14	Old salvage yard burial site	Xylenes, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, butyl benzyl phthalate, chrysene, fluoranthene, indeno(1,2,3-cd)pyrene, phenanthrene, pyrene, PCBs, TRPH, arsenic, barium, beryllium, cadmium, chromium, copper, lead, nickel, silver, zinc, cyanide,	Polychlorinated Biphenyls (PCB)	Institutional controls

PSC	Description	COCs Evaluated	COCs Outside Risk-Based Range	Selected Remedial Alternative
SS-15	Facility 328 spill site	This site were removed from the superfund process and placed under the ADEQ UST jurisdiction.	RI not required	ADEQ jurisdiction
SS-16	Facility 321 underground storage tank (UST).	This site were removed from the superfund process and placed under the ADEQ UST jurisdiction.	RI not required	ADEQ jurisdiction
SS-17	Former defense property disposal office (DPDO) yard.	chrysene, di-n-octyl phthalate, fluoranthene, pyrene, PCBs, TRPH, arsenic, barium, beryllium, cadmium, chromium, copper, lead, nickel, silver, zinc	Risk below risk range	No action
ST-19	Base exchange (BX) leaking USTs.	This site were removed from the superfund process and placed under the ADEQ UST jurisdiction.	RI not required	ADEQ UST jurisdiction
SD-20	Oil/water separator canal and earth fissures.	Toluene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, bis(2-ethylhexyl)phthalate, chrysene, di-n-octylphthalate, fluoranthene, indeno(1,2,3-c,d)pyrene, phenanthrene, pyrene, TRPH, antimony, arsenic, barium, beryllium, cadmium, chromium, copper, lead, nickel, zinc	Risk below risk range, with the exception of Benzo(a)pyrene	No action
SD-21	Sewage treatment plant effluent canal	Anthracene, benzo(a)anthracene, benzo(b)fuoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, benzo(a)pyrene, chrysene, dibenzo(a,h)anthracene, fluoranthene, indeno (l,2,3-c,d)pyrene, phenanthrene, pyrene, TRPH, arsenic, barium, beryllium, cadmium, chromium, copper, lead, nickel, silver, zinc	Risk below risk range, with the exception of Benzo(a)pyrene	No action
DP-24	Base ammunition storage area	Removed from the Superfund process because this site was mistakenly included on the list of potentially contaminated sites.	RI not required	No action

PSC	Description	COCs Evaluated	COCs Outside Risk-Based Range	Selected Remedial Alternative
LF-25	Northwest landfill	Xylenes, benzo(a)anthracene, benzo(a)prene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, fluoranthene, pyrene, TRPH, antimony, arsenic, barium, beryllium, cadmium, chromium, copper, lead, nickel, silver, zinc, cyanide	Lead and antimony were above risk range	Lead shot recovery Institutional controls
SD-26	Hush house canal	ethylbenzene, toluene, xylenes, 2-methylnaphthalene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, bis(2-ethylhexyl)phthalate, chrysene, di-n-butylphthalate, fluoranthene, indeno(1,2,3-cd)pyrene, naphthalene, phenanthrene, pyrene, TRPH, arsenic, barium, beryllium, cadmium, chromium, copper, lead, nickel, silver, zinc	Risk below risk range	No action
LF-37	Northeast landfill	benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, bis(2-ethylhexyl)phthalate, butylbenzylpthalate, chrysene, fluoranthene, pyrene, TRPH, arsenic, barium, beryllium, cadmium, chromium [b] copper, lead, nickel, silver, zinc	Risk below risk range, with the exception of Benzo(a)pyrene	No action
SD-38	Southwest oil/water separator at the auto hobby shop	TRPH, antimony, arsenic, barium, beryllium, cadmium, chromium, copper, lead, nickel, zinc	TRPHs were below non-residential ADEQ SRLs	Institutional controls
SD-39	Waste discharge at the old Lockheed site	diethyl phthalate, TRPH, arsenic, barium, cadmium, chromium, copper, lead, nickel, zinc	Risk below risk range	No action
OT-41	Skeet range	Lead	Risk below risk range	No Action

PSC	Description	COCs Evaluated	COCs Outside Risk-Based Range	Selected Remedial Alternative
SS-42	Bulk fuels storage	Benzo(a)anthracene, benzo(b)fluoranthene, bis(2-ethylhexyl)phthalate, chrysene, di-n-butylphalate, fluoranthene, pyrene, TPH, lead	Benzene, Toluene, Total Xylenes, TPH	Soil vapor extraction (SVE) and five-year groundwater monitoring

3.3 OU-2 ROD Summary

The description of the remedy in the OU-2 ROD is summarized in Table 3-3.

Table 3-3 Description of the Remedy for OU-2

PSC	Selected Remedy	Implemented Remedial Components
ST-18	Capping, Surface Controls, and Groundwater Monitoring.	Concrete CAP installed in 1987, Annual Inspection and maintenance of a concrete cap and groundwater monitoring during each 5-year review
DP-23	Excavation, ex-situ biological treatment, confirmation sampling, and on-site disposal of impacted soils from the canal portion.	Design and implementation of excavation and on-site ex-situ biological treatment of soils impacted by PAHs above industrial PRGs.

3.4 OU-1 ROD Summary

The description of the remedy in the OU-1 ROD is summarized in Table 3-4.

Table 3-4 Description of the Remedy for OU-1

PSC	Selected Remedy	Implemented Remedial Components
RW-02	Institutional Controls, Radiological Monitoring, and Fencing	• Voluntary Environmental Mitigation Use Restriction (VEMUR) executed and recorded to restrict land use to non-residential purposes. • Base General Plan (BGP) modified to place constraints on future residential development of the site. • Geophysical monitoring program to ensure safety of potential receptors and warning mechanism in case subsurface conditions change. • Perimeter fencing. • Institutional Control Plan (ICP) to maintain and document required institutional controls.
LF-03	Institutional Controls	• A VEMUR to restrict land use to non-residential. • The BGP modified to place constraints on future residential development. • An ICP to document required institutional controls.
FT-07E	Institutional Controls	• A VEMUR to restrict land use to non-residential. • The BGP modified to place constraints on future residential development. • An ICP to document required institutional controls.

PSC	Selected Remedy	Implemented Remedial Components
DP-13	Institutional Controls	• A VEMUR to restrict land use to non-residential. • The BGP modified to place constraints on future residential development. • Work practices requiring the use of Personal Protective Equipment (PPE) while excavating the site. • An ICP to document required institutional controls.
LF-14	Institutional Controls	• A VEMUR to restrict land use to non-residential. • The BGP modified to place constraints on future residential development. • An ICP to document required institutional controls.
LF-25	Institutional controls/ex-situ physical treatment/metal recovery	• The area of impacted soils containing COCs in excess of evaluated criteria to be further delineated. • Surficial soils with COCs in excess of Arizona soil remediation standards to be excavated and disposed. • Remediation of metal shot via mechanical sifting and gravimetric separation. • Recovered metal shot recycled or disposed. • Soil material returned to excavated areas. • A VEMUR to restrict land use to non-residential. • The BGP modified to place constraints on future residential development. • Work practices requiring the use of PPE while excavating the site. • An ICP to document required institutional controls.
SD-38	Institutional Controls	• A VEMUR to restrict land use to non-residential. • The BGP modified to place constraints on future residential development. • An ICP to document required institutional
SS-42	Soil Vapor Extraction and Groundwater Monitoring	• Install SVE System. • Monitor soil and groundwater to confirm effectiveness of remedy.

4.0 Summary of Base-wide Risk Assessment

This section of the report provides a summary of the approach used in the development of the Base-wide risk assessment[19]. The risk assessment evaluated current and potential future risks to human health and the environment from exposure to the constituents of potential concern (COPCs) in soil, sediment, groundwater, surface water, and ambient air at each of the PSCs. The following summarizes the results of

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[19] Geraghty & Miller, 1997. Final Remedial Investigation Report OU-1, Appendix B – Baseline Base Wide Risk Assessment, Luke Air Force Base, Arizona. Volumes 1 and 2. October 1, 1997.

the risk assessment. Luke AFB is an active military facility, and is expected to remain active in the foreseeable future. Therefore, the most likely type of exposure is for industrial workers rather than residents. Exposure to soil and sediments included the ingestion, dermal contact, and inhalation of fugitive dusts and/or vapors. Risks from exposure to soils and sediments were evaluated using either surficial, base worker scenario (0 to 2 feet bgs) or combined surface and subsurface, excavation worker (0 to 16 feet bgs) data. Exposure to groundwater was evaluated through the ingestion and dermal contact pathways. Potential groundwater exposure was evaluated using production well sampling data as well as data collected from groundwater monitoring wells.

Potentially exposed populations considered in the risk assessment included the following:

- Base workers
- Excavation workers
- Military personnel
- Child visitors for sites which extend off the base property
- Base residents.

The risk assessment considered both average and reasonable maximum exposure conditions to characterize current and future risks. During the five-year review, exposure point concentrations (EPC) were taken from the 95 percent upper confidence limit (one-tailed) on the mean, assuming a normal distribution. For PSCs with post-remediation data, the EPC was taken from the maximum concentration from the appropriate soil horizon or medium.

The USEPA established risk-based guidance goals as an aid in determining which sites would be acceptable for use in an industrial setting in the absence of remediation. Sites at which a non-cancer hazard index (HI) greater than or equal to 1.0 or an excess lifetime cancer risk (ELCR) greater than the risk of $1x10^{-6}$ to $1x10^{-4}$, as determined by risk assessment, generally would require remediation and would therefore be recommended for inclusion in the FS.

Arsenic and beryllium were found to be constituents that potentially contributed most significantly to the estimates of risk in the assessment. The results of the risk assessment were reevaluated to determine the impact background had on the level of risk at the various PSCs. When background was considered in the evaluation, it was found that most of the naturally occurring inorganic constituents (e.g., arsenic, beryllium) were present at background levels. Remediation to concentrations below background is not typically required by USEPA. Therefore, based on this reevaluation of the risk assessment results, only two PSCs, LF-25 and SS-42, were found to pose a risk above the target risk range.

To determine whether the PSC areas at Luke AFB are suitable for future residential land use, risks from exposure to soil by a hypothetical future resident were evaluated. Because Luke AFB is an active military facility, and is expected to remain active in the foreseeable future, calculating risks for residential exposure to soils at each of the PSCs is highly conservative; it is unlikely that the active portions of Luke AFB will be used for residential purposes in the future. The ADEQ proposed soil remediation levels (SRLs)[20] and the USEPA Region IX PRGs were used in the residential exposure evaluation.

Risks from residential exposure to combined surface and subsurface soil were calculated using both the USEPA Region IX PRGs and the ADEQ SRLs. Based on the results of the evaluation, all of the PSC areas evaluated were determined to be suitable for unrestricted, or residential land use with the exception of the following PSCs:

- RW-02
- LF-03
- FT-07 E
- DP-13
- LF-14
- ST-18
- LF-25
- DP-23 N
- SD-38

In addition to evaluating potential human exposure at Luke AFB, an ecological risk assessment was also performed. Prior to completing the ecological risk assessment, a Base-wide ecological inventory (EI) was conducted to collect data on:

- Biotic communities present on the base.
- Evidence of biological stress.
- Pathways of potential exposure to impacted media.

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[20] ADEQ, 1996. A.A.C. Title 18, Chapter 7, Article 2, Appendix A. Soil Remediation levels.

- The presence of species of special concern.

Luke AFB is in the lower Colorado River Valley of the Sonoran Desert. However, little vegetation characteristics of this area were identified during the EI. Instead, flora was dominated by vegetation characteristic of urban, disturbed areas at similar elevations in the Sonoran Desert. This is consistent with current and past land use at the Base.

No species of special concern were observed during the EI. Animal species observed at the Base during the EI are more tolerant of urban and disturbed conditions. Because vegetative growth at the Base is sparse due to physical activities associated with normal operations, the diversity and abundance of animals observed were less than that typical in more native conditions.

Potential risks to ecological receptors were assessed quantitatively by using the round-tailed ground squirrel, desert cottontail, western whiptail lizard and side-blotched lizard as indicator species. The desert cottontail was used to represent herbivorous primary consumers; the round-tailed ground squirrel to represent herbivorous/insectivorous primary consumers; and the western whiptail lizard and side-blotched lizard to represent insectivorous secondary consumers. HQs were calculated for the indicator species by comparing an estimated intake of site-related constituents of ecological concern (COECs) with a toxicity reference value derived for the specific indicator species and for the specific COEC. Hazard quotients (HQs) were determined for the ingestion of food sources and for the incidental ingestion of soil where appropriate for the indicator species. The HQs were then added to obtain a HI for each PSC.

Based on previous investigations at Luke AFB and coordination with USEPA representatives, the following PSCs were determined to be representative of site conditions and were selected for study in the ecological risk assessment:

- LF-25
- FT-07
- Combined portions of SS-17 and LF-14
- SD-20

This selection was based on a combination of observations of ecosystems at the PSCs, detected COEC concentrations, and potential risks to higher trophic level organisms.

COECs evaluated in the ecological risk assessment included the following:

- PAHs
- TPH
- PCBs
- Antimony
- Cadmium
- Lead

Data used to assess potential adverse effects to ecological receptors included chemical analysis of soil, plant tissue, and insect tissue. Based on the results of the ecological assessment, it is unlikely that site-related COEC concentrations would pose a risk to ecological receptors at Luke AFB.

5.0 Groundwater Summary

This section of the five-year review report provides information on the hydrogeology of Luke AFB and surrounding region. Also provided is information on the status of monitor wells and a summary of groundwater monitoring results for PSCs.

5.1 Groundwater Hydrology

5.1.1 Aquifer Units

The occurrence and movement of groundwater at Luke AFB is affected by hydraulic characteristics of the aquifer units, and the magnitude and distribution of groundwater recharge and discharge for agriculture and other uses. Aquifer units include the upper alluvial unit (UAU), middle fine unit (MFU) and lower conglomerate unit (LCU). Withdrawals in excess of recharge have created declines in water levels in the Luke AFB area of 300-feet[21]. Structural changes associated with the Luke Salt Body significantly affect local groundwater conditions south and east of the Luke AFB.

Interpolation of data from the regional study of Brown and Pool [22] indicates that the UAU has been completely dewatered in the Luke AFB area, except for localized

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[21] US Geological Survey, 1994. Hydrogeological Characterization and Land Subsidence Investigation for Luke Air Force Base, Arizona.

[22] US Geological Survey, 1998. Water Resources Investigation Report 88-4202, 1989, Hydrogeology of the Western Part of the Salt River Valley, Maricopa County, Arizona (Brown, JamesG. Pool, D.R.)

areas along the Agua Fria River, near the Luke AFB Waste Water Treatment Plant (WWTP). Partial dewatering of the MFU has also occurred in the Luke AFB area. The upper most aquifer is now the MFU.

5.1.2 Regional Recharge

Groundwater recharge in the WSRV is affected by natural as well as artificial sources. Groundwater is naturally recharged by infiltration through the beds of river channels during stormwater events or releases from upstream impoundments. Water levels in Monitoring Well MW-101, situated near the Aqua Fria River, rose approximately 25-feet between December 28, 1992, and March 14, 1993, in response to upstream releases from Lake Pleasant Reservoir [23].

Artificial sources of groundwater recharge include infiltration of excess irrigation water applied to fields and seepage losses from irrigation ditches and canals. Infiltration of treated effluent from the Luke AFB WWTP may also provide recharge in the immediate area of the releases to the Aqua Fria River floodplain. Potential recharge due to other activities at the Luke AFB is discussed in greater detail in the Vadose Zone leaching model presented in the Base-wide risk assessment.

5.1.3 Regional Discharge

Groundwater discharge from the regional aquifer in the Luke AFB area occurs primarily from cultural uses. Owing to the depth to the water table, there is no natural discharge due to evapotranspiration or discharge to surface water bodies. Discharge of groundwater occurs principally from pumpage from numerous wells, primarily for irrigation with the remainder for municipal, military, and light industrial consumption.

The amount of groundwater discharge for municipal usage is anticipated to increase dramatically in response to the growing population of the area (Water Resources Associates, 1994). As the population increases in the area it is anticipated that groundwater discharged for agricultural uses will decrease (Water Resources Associates, 1994). Comparison of the increased withdrawals for municipal uses and decreased withdrawals for irrigation uses shows that the demand for groundwater in the area will remain generally the same into the foreseeable future. However, the

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[23] Geraghty & Miller, Inc. 1993d. OU-1, Phase II, Remedial Investigations/Feasibility Study Planning Documents for PSC SS-42, Luke Air Force Base, Arizona.

transition from irrigation uses to municipal uses will put greater importance on water quality.

5.1.4 Historical Trends in Regional Groundwater Levels

Groundwater levels declined more than 300 feet in the vicinity of Luke AFB over a 40+ year period from 1923 to the late 1970s, primarily because of significant overdraft in response to pumpage for irrigation requirements. The greatest declines occurred west, north, and south of Luke AFB. A large cone of depression has existed southwest of the Luke AFB prior to 1964. The regional groundwater flow direction is to the south-southwest modified by the cone of depression.

Water levels from selected wells for which data were adequate were plotted to show groundwater declines over time at a given location. Analysis of these hydrographs suggests that water levels have declined substantially over most of the study area through at least 1980. After 1980, many of the hydrographs show a leveling off of the decline trend, or a groundwater rise of up to 40 to 60 feet. Groundwater table altitudes in the study area have continued to rise due to reduction in pumpage and increased recharge related to above average precipitation over the early 1980s in the Phoenix area. The availability of Colorado River water via the Central Arizona Project (CAP) canal (especially for agricultural irrigation) has greatly lessened the demands placed on groundwater in the Phoenix area, and has resulted in the groundwater table rising throughout much of the area.

Water level data for the period 1991 to 1995, documents a continued rise in the groundwater table throughout the study area. Altitudes had increased up to 20 feet, in large part due to above average precipitation for 1992 and 1993. Overall, the historical groundwater altitude data for the study area shows a consistent pattern of water level decline over time despite the limitations in the data previously described.

5.1.5 Groundwater Occurrence, Apparent Gradient, and Estimated Flow Directions in the Luke AFB Area

Water Level Measurements

The water level measurement program was established for the Luke AFB RI and included monthly water level measurements and continuous water level measurements. Monthly water level data were collected to evaluate seasonal water level responses from regional stresses on the groundwater system. Continuous water level measurement were collected at selected monitoring wells using pressure transducers and data loggers. Continuous water level data were collected to evaluate local water responses from regional as well as local pumping stresses due to both off base and on-Base production well pumping[24]. Because several different production wells are in use, the data loggers and transducers were periodically moved to collect data from all parts of the Base.

The monthly water level program included measurements of all monitoring wells and selected off Base wells. The program began in October 1990, and extended through December 1995.

Continuous water level recorders were installed periodically in Monitoring Wells MW-3, MW-5, MW-102, MW-103, MW-104, MW-106 through MW-111, MW-112S, MW-112D, MW-113, MW-117, MW-118, MW-119, MW-121, MW-123 and Inactive Production Well IP-PW-12. Nearby on Base production wells, which potentially affected water levels, include Production Wells PW-4, PW-7, PW-9, PW-10, PW-11, PW-12, PW-13, and PW-14.

Well Perforated Intervals and Measured Water Levels.

All of the monitoring wells at the main part of Luke AFB are screened entirely within the MFU. Interpolation of data from the regional study indicates that all monitor well locations near the Luke AFB WWTP (MW-101, MW-115, MW-116, and MW-124) are screened in the UAU. Monitoring Well MW-101 is primarily screened in the UAU with the lower portion of the screen extending into the MFU. Monitoring Wells MW-115, MW-116, and MW-124 are screened in the lower portions of the UAU. All of the monitoring wells at the main Base, except for Monitoring Wells MW-102, MW-103, and MW-112D are screened in upper parts of the saturated thickness of the MFU.

The Luke AFB production wells are screened typically in the LCU with some wells also screened in the MFU. Seven of the 15 off Base wells included in the monthly water level network are exclusively perforated within the MFU, and five other off Base wells are perforated within both the MFU and LCU. Six of the off Base wells may have casing collapses below the current indicated depth of the well, which may suggest that these wells may be open to the formations below the indicated depth of

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[24] Geraghty & Miller, Inc., 1992. First Quarter 1992 Quarterly Well Measurement Report, Hydrogeological Survey, Luke Air Force Base, Arizona.

perforations. Limited hydraulic connection may exist in the well bore with deeper portions of the formation at the location of the casing collapse.

Limitations in the Construction of Water Level Altitude Contour Plots

Water level altitude contour plots are typically used to infer groundwater flow directions. Evidence from water levels measured at site-specific PSC wells at Luke AFB suggest that semi-independent groundwater zones have developed at the local scale as the result of long-term water level declines in response to regional groundwater withdrawals in excess of recharge. Water level measurements also suggest that head differences between zones have created vertical gradients within and between these zones. The development of these semi-independent groundwater zones makes it imperative that water level measurements used in the construction of water level altitude contours be from wells with perforated intervals which extend and penetrate into similar lithologic portions of these zones or when compatible data is not available, that the data be used with an understanding of its comparability and hence the accuracy of the resulting plot. One approach is to use contour intervals that are large enough to limit the effect of small vertical head gradients within these zones.

Evidence which supports the existence of semi-independent groundwater zones at Luke AFB includes anomalous water levels within similar areas, limited or non-response of water levels in wells near pumping wells, and limited or non-response of water levels in wells to seasonal water-level changes experienced by other nearby wells. Anomalous water levels occur at PSC SD-20 where water levels are as much as 50-feet lower than at PSCs immediately to the northwest. These anomalous water levels are suspected to be attributed to the geologic structure associated with the Luke Salt Body.

Non-responsive water levels in wells near a pumping well occur at PSC FT-07 where pumpage from production well PW-12 (approximately 1,000 gallons per minute) does not cause any direct water level response in nearby monitoring wells. The lack of response of the water levels is suspected to be attributed to an aquitard which most likely occurs between the largest penetrating perforated interval of the monitoring wells at the PSC (453 feet bgs at MW-109) and the top of the perforated interval of the production well (600 feet bgs at PW-12). This aquitard limits the vertical hydraulic connection between the perforated intervals of these wells.

Water level changes at PSC FT-07 also experience the smallest amplitude of seasonal change of any of the monitoring wells at Luke AFB. Seasonal water level amplitudes in the monitoring wells at PSC FT-07 average approximately five feet. Seasonal water level amplitudes in monitoring wells at other Luke AFB PSCs range from approximately five feet at PSCs FT-06/ST-18 to 23 feet at PSC SD-20. The limited response of water levels in these wells to regional changes in water levels is likely caused by the aquitard, which is suspected to exist at this location.

Evidence which supports the existence of vertical head gradients within groundwater zones include water level differences between nearby wells with slight to significant differences in saturated extent and penetration of perforated intervals. This is evident at PSC FT-07 and SD-20. Monitoring wells MW-110 (saturated perforated interval from approximately 362 to 398 feet bgs [screened interval from approximately 362 to 398 feet bgs]) and MW-123 (saturated perforated interval from approximately 340 to 395 feet bgs [total screened interval from 295 to 395 feet bgs]) at PSC FT-07 located within 30 feet of each other have consistent differences in water levels of approximately three feet. Measurements at monitoring wells MW-112S (saturated perforated from approximately 290 to 342 feet bgs [screened interval from 780 to 722 feet above mean sea level]) and MW-112D (saturated perforated interval from 381 to 428 feet bgs [screened interval from 682 to 632 feet above mean sea level]) at PSC SD-20 have indicated differences in water levels of 0.5 to 8.5 feet (Figure 4-48).

The hydraulic effects associated with the development of the semi-independent groundwater zones at Luke AFB requires special precautions in the construction of site-specific PSC water level altitude contour plots. Water level data used to construct water level contours needs to be relatively comparable in that data should be from wells, which measure similar lithologic portions of the water zones. However, most PSCs have limited number of wells, which measure similar lithologic portions of the water zones. Water-level altitude contour plots for the site specific PSCs have therefore been constructed with the use of site-specific and regional water level measurements, and a contour interval of ten feet to limit the impact of the effects. Regardless of these precautions, groundwater flow directions inferred from these contour plots should still be viewed with a degree of scrutiny, and should only be used as the direction of a general groundwater flow at the time of water level measurement.

Contour intervals at site specific PSCs at Luke AFB were constructed using a regional ten feet contour interval. Because of the inherent effects on measured water levels from the vertical component of flow, the regional contours provide the best representation of the lateral groundwater flow direction a two dimensional contour plot can achieve.

Impact of Luke Salt Body on Groundwater Flow

The Luke Salt Body has impacted groundwater movement in the study area. Groundwater flow in the vicinity of the salt mass has been affected in several ways. Doming of the Luke Salt Body has deformed the overlying and peripheral sediments through high angle faulting and folding, as mentioned previously in Section 4.6.5. Furthermore, permeability and anisotropy of the basin fill sediments in the study area have been altered by depositional changes from proximal coarse-grained to distal fine-grained sediments peripheral to the Luke Salt Body, and compaction of the fine-grained sediments overlying the Luke Salt Body. In conjunction with the structural complexities, the result has been to create a complex groundwater flow regime in the vicinity of the Luke Salt Body. The effect on groundwater movement and aquifer properties along the southern portions of the Base is not fully understood.

Regionally, the localization of fine-grained sediments and the additional compaction over the Luke Salt Body have resulted in reduced transmissivities east and south of Luke AFB within the basin fill units [25,26]. This reduction has impacted regional groundwater movement into the pumping areas west of Luke AFB, with higher water levels to the east of the Base (near WWTP) and lower water levels in wells in the western part of Luke AFB. Although the groundwater flow across the site is generally southwest, near monitoring wells MW-112 and MW-113, the groundwater flow is northwest because of the Luke Salt Body.

5.2 PSC Groundwater Summary

The status of groundwater monitoring wells at Luke AFB is summarized in Table 5-1. The location and status of groundwater monitoring wells is in Figure 5-1. Groundwater sampling results are summarized in Table 5-2 and Figure 5-2. In addition, a table that provides groundwater monitoring results including sampling dates and concentrations of COCs for all wells for the period of record is in Appendix B. In general, a review of the data in Appendix B indicate that groundwater at Luke AFB is not impacted as there

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[25] Stulik, R.S. and F.R. Twenter, 1964. Geology and Groundwater of the Luke Area, Maricopa County, Arizona. USGS Water Supply Paper #1799P.

[26] Eaton, G.P., D.L. Peterson, and D.L. Schumann, 1972. Geophysical, Geohydrological, and Geochemical Reconnaissance of the Luke Salt Body in Central Arizona, USGS Professional Paper #753.

are no constituents in groundwater that currently exceed applicable water quality standards and it appears all potential sources of constituents have been controlled or eliminated through the institution of pollution prevention measures or remedial activities. However, there have been some occurrences of COCs above detection limits during the period of record. Therefore, some monitoring will be conducted as part of future five-year reviews to verify that remedies are protective of groundwater. MW-124 (RW-02), MW-118 and MW-123 (FT-07),), MW-112S, MW-112D and MW-113 (SD-20) and MW-121 and MW-125 (SS-42) will be monitored for VOCs as part of future five-year reviews. MW-114 and MW-122 (ST-18) will be monitored annually for VOCs and the results evaluated as part of the next five-year review.

The following sections provide a more detailed description of groundwater conditions associated with specific PSCs.

Table 5-1 Status of Groundwater Monitoring Wells

Well ID	Site ID	Site Location	Status	Comments
MW-1	ST-18	Facility 993	Abandoned	Unknown location
MW-2	ST-18	Facility 993	Abandoned	COC concentrations did not warrant additional monitoring.
MW-3	ST-18	Facility 993		Possible RCRA point of compliance
MW-4	ST-18	Facility 993	Abandoned	COC concentrations did not warrant additional monitoring.
MW-5	ST-18	Facility 993		Possible RCRA point of compliance
MW-101	**SD-21**	**Aqua Fria River**	**ACTIVE**	**Needed for Compliance Sampling**
MW-102	SD-20	Head of O/W Separator Canal	Abandoned	COC concentrations did not warrant additional monitoring.
MW-103	SD-20	Near Ammo. Storage	Abandoned	COC concentrations did not warrant additional monitoring.
MW-104	DP-05	Eastern edge of Site	Abandoned	COC concentrations did not warrant additional monitoring.
MW-105	DP-05	Southern edge of Site	Abandoned	COC concentrations did not warrant additional monitoring.
MW-106	DP-05	Western edge of Site	Abandoned	COC concentrations did not warrant additional monitoring.
MW-107	FT-06	Near Bldg. 1031	Abandoned	COC concentrations did not warrant additional monitoring.
MW-108	FT-06	North of DP-23	Active	

Well ID	**Site ID**	**Site Location**	**Status**	**Comments**
MW-109	FT-07	Western edge of Site	Active	
MW-110	FT-07	Central portion of Site	Abandoned	COC concentrations did not warrant additional monitoring.
MW-111	FT-07	North of perimeter road.	Abandoned	COC concentrations did not warrant additional monitoring.
MW-112S	SD-20	Earth Fissures area	Active	
MW-112D	SD-20	Earth Fissures area	Active	
MW-113	SD-20	Earth Fissures area	Active	
MW-114	ST-18	Point of release at ST-18		Possible RCRA point of compliance
MW-115	RW-02	Church parking lot	Abandoned	COC concentrations did not warrant additional monitoring.
MW-116	RW-02	Tanner property		To be Abandoned
MW-117	SD-38	South of Auto Hobby Shop	Active	
MW-118	FT-07	Between FTPs	Active	
MW-119	**SS-42**	**Near central portion of site.**	**DETERIORATED**	**To be Abandoned**
MW-120	**SS-42**	**CE yard**	**DETERIORATED**	**To be Abandoned**
MW-121	**SS-42**	**Point of release at SS-42**	**ACTIVE**	**Needed for Sampling per OU-1 ROD**
MW-122	ST-18	Downgradient of ST-18		Possible RCRA point of compliance

Well ID	Site ID	Site Location	Status	Comments
MW-123	FT-07	Downgradient of FTPs	Active	
MW-124	RW-02	DRMO yard	Active	
MW-125	**SS-42**	**Downgradient of SS-42**	**ACTIVE - Replaced**	**Needed for Sampling per OU-1 ROD**

Table 5-2 Groundwater Sampling Summary

Operable Unit	PSC	COCs in Soil (based on post remediation when available)	COCs Detected in Groundwater	Source of Detected Constituents	Attributable to PSC
OU-1	RW-02	Benzo(a)pyrene, arsenic, beryllium, cadmium, copper	bis(2-ethylhexyl)phthalate (BEP), arsenic, barium, chromium, copper, nickel, lead, zinc	BEP - Laboratory contaminant chromium, copper, nickel and lead were found within the range of naturally occurring concentrations.	No constituents attributable to PSC
OU-2	DP-05	ethylbenzene, xylenes, bis(2-ethylhexyl)phthalate, 2-methylnaphthalene, naphthalene, TRPH, copper, lead	Acetone, toluene, BEP barium, lead, silver, arsenic, barium, chromium, copper, lead, zinc	Acetone and toluene were detected in one well during one sampling event and not detected again. BEP is a common laboratory contaminant. Barium and lead were found within the range of naturally occurring concentrations.	No constituents attributable to PSC
OU-1	FT-07	arsenic, TRPH	Chloroform, 1,2-dichloropropane (DCP), 1,2-dichloroethane (DCA), toluene, BEP barium, chromium, copper, lead, zinc	Chloroform, DCP, DCA, and BEP were found to laboratory contaminants. Toluene source unknown but detected in only one well. Barium, chromium, copper, zinc and lead were found within the range of naturally occurring concentrations.	No constituents attributable to PSC

Operable Unit	PSC	COCs in Soil (based on post remediation when available)	COCs Detected in Groundwater	Source of Detected Constituents	Attributable to PSC
OU-2	ST-18	benzene, 1,1 dichloroethene, ethylbenzene, 1,1,2,2-tetrachlorethane, tetrachloroethene, toluene, trichloroethene, xylenes, benzo(a)anthracene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(a)pyrene, benzyl alcohol, bis(2-ethylhexyl)phthalate, chrysene, fluoranthene, indeno(1,2,3-c,d)pyrene, 2-methylnaphthalene, naphthalene, phenanthrene, pyrene, TRPHs, copper, lead	Toluene BEP, DBCP, 2-butanone, arsenic, barium, chromium, copper, lead, nickel, selenium, zinc and TCE.	Toluene was detected in one well during one sampling event and not detected again. BEP is a common laboratory contaminant and DBCP is an agricultural contaminant. Arsenic, barium, chromium, copper, nickel, selenium, zinc and lead were found within the range of naturally occurring concentrations.	Potentially attributable to PSC (monitoring continuing).
OU-1	SD-20	toluene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, bis(2-ethylhexyl)phthalate, chrysene, di-n-octylphthalate, fluoranthene, indeno(1,2,3-c,d)pyrene, phenanthrene, pyrene, TRPH, antimony, arsenic, barium, beryllium, cadmium, chromium, Copper, lead, nickel, zinc	TCE, PCE, DCA, DCP, BEP, acetone, bromodichloromethane, bromoform, chloroform, methylene chloride, arsenic, barium, boron, chromium, copper, lead, nickel, selenium, and zinc	TCE and DCA source unknown but not detected in wells at source area. DCP detected one time. BEP is a common laboratory contaminant. Arsenic, barium, boron, chromium, copper, nickel, selenium, zinc and lead were found within the range of naturally occurring concentrations.	It is possible that TCE originating from points on-base that discharged to the oil water separator canal may have migrated to the groundwater. The fissures at the end of the canal may have provided a pathway for these constituents to reach groundwater.

Operable Unit	PSC	COCs in Soil (based on post remediation when available)	COCs Detected in Groundwater	Source of Detected Constituents	Attributable to PSC
OU-1	SD-21	anthracene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, benzo(a)pyrene, chrysene, dibenzo(a,h)anthracene, fluoranthene, indeno(1,2,3-c,d)pyrene, phenanthrene, pyrene, TRPH, arsenic, barium, beryllium, cadmium, chromium, copper, lead, nickel, silver, zinc	Acetone, carbon disulfide, and BEP arsenic, barium, boron, copper, lead, and zinc	Acetone, carbon disulfide and BEP were found to be laboratory contaminant. Arsenic, barium, boron, copper, zinc and lead were found within the range of naturally occurring concentrations.	No constituents attributable to PSC
OU-1	SD-38	arsenic, beryllium	Barium, copper, lead, and zinc	Barium, copper, zinc and lead were found within the range of naturally occurring concentrations.	No constituents attributable to PSC
OU-1	SS-42	Benzene, ethylbenzene, toluene, xylene	PCE, DCP, TRPH, TPH, BTEX, arsenic, barium, boron, chromium, copper, lead, nickel, selenium, and zinc. (non-detect for past two years).	DCP is a common laboratory contaminant. TRPH, TPH, and BTEX have been detected inconsistently at the site. The latest sampling results did not contain hydrocarbons. Arsenic, barium, boron, chromium, copper, nickel, selenium, zinc and lead were found within the range of naturally occurring concentrations.	TPH and BTEX were attributable to PSC. Remediation system has been effective in reducing constituents to residual concentrations that will not impact groundwater. Five year monitoring implemented.

5.2.1 PSC RW-02

PSC RW-02 is located approximately 2 miles east of Luke AFB at the WWTP. Three monitoring wells, MW-115, MW-116, and MW-124, were installed at this site. Monitoring wells MW-115 and MW-116 were installed in 1992, and monitoring well MW-124 was installed in 1994. The screened interval has not been submerged during any of the sampling events. Monitoring well MW-115 was abandoned in February 1996. Monitoring wells MW-116 and MW-124 are still located on the site. Based on 1995 water level measurements, groundwater flow is towards the west.

Concentrations of naturally occurring constituents were compared with site-specific background concentrations as well as with regional background (within Maricopa County). These two comparisons were performed to ensure that the background was well characterized. Arsenic, chromium, copper, nickel, and lead were detected within the range of naturally occurring concentrations. BEP was detected in three samples during the May 1994 sampling event, however, the results were qualified as non-detect because BEP was also detected in the method blank. All VOC and BNA analyses of groundwater samples collected prior to August 1995, were analyzed by ATI Phoenix laboratory and do not satisfy data validation requirements for quantitative data. However, eight validated samples collected from August 1995 to 1998 were non-detect.

The most recent sampling event at the site was in May 1998. A sample was collected from monitoring well MW-124. No analytes were detected above laboratory detection limits. Samples have not been collected from monitoring well MW-116 since June 1996 and from MW-115 since February 1996. MW-115 is abandoned. No analytes were detected above laboratory detection limits during these sampling events. MW-124 will be monitored as part of the next five-year review period.

5.2.2 PSC DP-05

PSC DP-05 is located on the southwestern portion of Luke AFB, near Taxiway I. Three monitoring wells, MW-104, MW-105, and MW-106, were installed at this site in 1986. The screened intervals on these wells have been submerged since or right after installation. Based on 1995 water level measurements, groundwater flow is towards the southwest.

Barium and lead were detected within the range of naturally occurring concentrations, as defined by the site-specific and countywide background determinations, described above. Toluene and acetone were detected in one sample from monitoring well MW-104 and BEP was detected in one sample from monitoring well MW-106 during the third quarter 1992 sampling event. These contaminants were not reported at detectable concentrations in any other sampling events. All VOC and BNA analyses of groundwater samples collected prior to August 1995, were analyzed by ATI Phoenix laboratory and do not satisfy data validation requirements for quantitative data. However, validated samples for five sample events conducted from October 1995 to May 1998 were non-detect.

The most recent sampling event at the site was in May 1998, when a sample was collected from monitoring well MW-105. No analytes were detected above laboratory detection limits. Samples have not been collected from monitoring wells MW-104 and MW-106 since June 1996. No analytes were detected above laboratory detection limits during this sampling event. All three wells have been abandoned.

5.2.3 PSC FT-06

PSC FT-06 is located on the southern portion of Luke AFB. Two monitoring wells, MW-107 and MW-108, were installed at this site in 1986. The screened intervals on these wells have been submerged since installation. Both wells are still located on the site. Based on 1995 water level measurements, groundwater flow is towards the west-southwest.

Chromium, selenium, and lead were detected within the range of naturally occurring concentrations, as defined by the site-specific and countywide background determinations, described above. DBCP, an agricultural contaminant, was detected in samples collected during the fourth quarter 1992 sampling event in concentrations, below the 2000 PRGs, ranging from 0.02 mg/L through 0.05 mg/L. The 2000 PRGs for DBCP are 0.45 mg/L for residential land use and 4.0 mg/L for industrial land use. This was the only sampling event in which DBCP was analyzed. These detections have been attributed to agricultural fields located up-gradient of the site. The most recent sampling events at the site were conducted in 1996. Samples were collected from monitoring wells MW-107 and MW-108. No analytes were detected above laboratory detection limits. MW-107 has been abandoned. MW-108 is scheduled to be abandoned.

5.2.4 PSC FT-07

PSC FT-07 is located on the northern portion of Luke AFB. Five monitoring wells, MW-109, MW-110, MW-111, MW-118, and MW-123, were installed at this site. Monitoring wells MW-109, MW-110, and MW-111 were installed in 1986, monitoring well MW-118 was installed in 1993, and monitoring well MW-123 was installed in 1994. The screened intervals in monitoring wells MW-109, MW-110, and MW-111 have been submerged since installation. Monitoring wells MW-110 and MW-111 were abandoned in 1996. Monitoring wells MW-109, MW-118, and MW-123 are still located on the site. Based on 1995 water level measurements, groundwater flow is towards the southwest.

Barium, chromium, copper, zinc, and lead were detected within the range of naturally occurring concentrations, as defined by the site-specific and countywide background determinations, described above. Chloroform was detected consistently in monitoring wells MW-110 and MW-123 through the first quarter of 1995. It was again detected in monitoring well MW-123 in 1997 and 1998. The concentrations were well below the MCL and AWQS. Toluene was detected in monitoring well MW-110 during the fourth quarter 1993 and first quarter 1993 sampling events. Toluene was not reported at detectable concentrations in any other sampling events. DCA and DBCP were detected in samples collected during the third quarter of 1992. These analytes were not reported at detectable concentrations in any other sampling events. BEP was detected in the duplicate sample collected from monitoring well MW-110 and the primary sample from MW-111 during the June 1993 sampling event. The presence of BEP appears to be anomalous because the primary/duplicate pair did not contain BEP. All VOC and BNA analyses of groundwater samples collected prior to August 1995, were analyzed by ATI Phoenix laboratory and do not satisfy data validation requirements for quantitative data. However, samples from 14 sampling events conducted from August 1995 through May 1999 were non-detect for all but three events. DBCP, an agricultural contaminant, was detected in samples collected during the fourth quarter 1992 sampling event. This was the only sampling event in which DBCP was analyzed. These detections have been attributed to agricultural fields located up-gradient of the site. Samples from three sample events conducted from October 1995 through June 1996 were non-detect.

The most recent sampling event at the site was in May 1999. A sample was collected from monitoring well MW-123. No analytes were detected above laboratory detection limits. Methylene chloride was detected during the November 1998 sampling event but was qualified because it was also detected in the blank. Monitoring well MW-118 was sampled in May 1998. No analytes were detected above laboratory detection limits. Samples have not been collected from monitoring wells MW-109, MW-110, and MW-111 since 1996. No analytes were detected above laboratory detection limits during this sampling event. MW-118 and MW-123 will be monitored as part of the next five-year review period.

5.2.5 PSC ST-18

PSC ST-18 is located on the southern portion of Luke AFB. Six monitoring wells, MW-2, MW-3, MW-4, MW-5, MW-114, and MW-122, were installed at this site. Monitoring wells MW-2 and MW-3 were installed in 1985. Monitoring wells MW-4 and MW-5 were installed in 1987. Monitoring well MW-114 was installed in 1991, and monitoring well MW-122 was installed in 1994. The screened intervals in monitoring wells MW-2, MW-3, MW-4, and MW-5 have been submerged since or just after installation. The screened intervals in MW-114 and MW-122 have not been submerged. Monitoring well MW-2 was abandoned in October 1993. Monitoring well MW-4 was abandoned in October 1994. Monitoring wells MW-3, MW-5, MW-114, and MW-122 are still located on the site. Based on 1995 water level measurements, groundwater flow is towards the west-southwest.

Arsenic, barium, chromium, copper, nickel, selenium, zinc, and lead were detected within the range of naturally occurring concentrations, as defined by the site-specific and countywide background determinations, described above. BEP was detected in monitoring well MW-114 during the first quarter of 1992, and the second quarter of 1993. BEP was not reported at detectable concentrations in any other sampling events. All VOC and BNA analyses of groundwater samples collected prior to August 1995, were analyzed by ATI Phoenix laboratory and do not satisfy data validation requirements for quantitative data. However, samples collected from 13 sample events conducted from August 1995 to October 2001 were non-detect for all but two events. DBCP, an agricultural contaminant, was detected in a sample collected from monitoring well MW-3 during the fourth quarter 1992 sampling event. This was the only sampling event in which DBCP was analyzed. This detection has been attributed to agricultural fields located up-gradient of the site.

The most recent sampling event at the site was in October 2001. Samples were collected from monitoring wells MW-114 and MW-122. No analytes were detected above laboratory detection limits in MW-122. Trichloroethene, 1,1-dichloroethene and tetrachloroethene were above detection limits but well below applicable water quality standards in MW-114 Methylene chloride was detected in monitoring wells MW-114 and MW-122 during the November 1998 sampling event but was qualified as estimated because it was also detected in the blank. 2-Butanone was also detected in monitoring well MW-114 during this sampling event and was qualified as estimated. MW-114 and MW-122 will be monitored on an annual basis for the next five-year period to evaluate VOC trends, although, no trends are anticipated given the overall monitoring results for the period of record. Samples have not been collected from monitoring wells MW-3 and MW-5 since June 1996. No analytes were detected above laboratory detection limits during this sampling event.

5.2.6 PSC SD-20

PSC SD-20 is located on the southern portion of Luke AFB. Five monitoring wells, MW-102, MW-103, MW-112S, MW-112D, and MW-113, were installed at this site. Monitoring wells MW-102 and MW-103 were installed prior to 1991. Monitoring wells MW-112S, MW-112D, and MW-113 were installed in 1991. The screened intervals in monitoring wells MW-103 and MW-112D have been submerged the majority of the time since installation. The screened intervals in monitoring wells MW-102, MW-112S and MW-113 have not been submerged the majority of the time since installation. Based on 1995 water level measurements, groundwater flow is towards the northwest.

Arsenic, barium, boron, chromium, copper, nickel, selenium, zinc, and lead were detected within the range of naturally occurring concentrations, as defined by the site-specific and countywide background determinations, described above. BEP was detected in two samples during the fourth quarter of 1991. BEP was not reported at detectable concentrations in any other sampling events. TCE and DCA were detected in monitoring well MW-113 consistently through the first quarter of 1995. TCE, DCA, PCE, and methylene chloride were detected in monitoring well MW-113 in November 1998. TCE was consistently detected in monitoring well MW-112S through the fourth quarter of 1993. TCE, DCA, PCE, acetone, and methylene chloride were detected in monitoring well MW-112S in November 1998. Since groundwater flow is towards the northwest, the source of these analytes may be attributable to an off-site source rather than the oil/water separator located northeast of the wells. The presence of fissures in this area further complicates the behavior of groundwater. Alternatively, it is possible TCE and other constituents that originated from points on-base that discharged to the oil water separator canal may have migrated to the groundwater. The fissures at the end of the canal may have provided a pathway for these constituents to reach groundwater. The institution of pollution prevention control measures at Luke AFB has eliminated any future potential sources of constituents in this regard. All VOC and BNA groundwater samples collected prior to August 1995 were analyzed by ATI Phoenix laboratory and did not satisfy data validation requirements for quantitative data. However, samples from 16 sampling events conducted from August 1995 to May 1999 were non-detect for all but six events.

The most recent sampling event at the site was in May 1999. Samples were collected from monitoring wells MW-112S and MW-113. Bromodichloromethane and chloroform were detected in monitoring well MW-113. No other analytes were detected above laboratory detection limits. Monitoring well MW-112D was last sampled in May 1998. No analytes were detected above laboratory detection limits during this sampling event. Samples have not been collected from monitoring wells MW-102 and MW-103 since June 1996. No analytes were detected above laboratory detection limits during this sampling event. MW-102 and MW-103 have been abandoned. MW-112S, MW-112D and MW-113 will be monitored as part of the next five-year review period.

5.2.7 PSC SD-21

PSC SD-21 is located approximately two miles from Luke AFB south of the WWTP. One monitoring well, MW-101, was installed at this site in 1986. The screened interval has been submerged since installation. Monitoring well MW-101 is still located on the site. Based on 1995 water level measurements, groundwater flow is towards the west.

Arsenic, barium, boron, copper, zinc, and lead were detected within the range of naturally occurring concentrations, as defined by the site-specific and countywide background determinations, described above. BEP, acetone, and carbon disulfide was detected in one sample during the second quarter of 1994. These analytes were not reported at detectable concentrations in any other sampling events. All VOC and BNA analyses of groundwater samples collected prior to August 1995 were analyzed by ATI Phoenix laboratory and do not satisfy data validation requirements for quantitative data. However, samples from two sampling events conducted from August 1995 to June 1996 were non-detect.

The most recent sampling event at the site was in June 1996. No analytes were detected above laboratory detection limits during this sampling event.

5.2.8 PSC SD-38

PSC SD-38 is located on the eastern portion of Luke AFB. One monitoring well, MW-117, was installed at this site. The screened interval has not been submerged during any of the sampling events. Based on 1995 water level measurements, groundwater flow is towards the southwest.

Barium, copper, zinc, and lead were detected within the range of naturally occurring concentrations, as defined by the site-specific and countywide background determinations, described above. The most recent sampling event at the site was in June 1996. No analytes were detected above laboratory detection limits during this sampling event.

5.2.9 PSC SS-42

PSC SS-42 is located in the northeastern portion of Luke AFB. Four monitoring wells, MW-119, MW-120, MW-121, and MW-125, were installed at this site. Monitoring wells MW-119, MW-120, and MW-121 were installed in 1993. Monitoring well MW-125 was installed in 1995. The screened interval has not been submerged during any of the sampling events. Based on 1995 water level measurements, groundwater flow is towards the southwest.

Arsenic, barium, boron, chromium, copper, nickel, selenium, zinc, and lead were detected within the range of naturally occurring concentrations, as defined by the site-specific and countywide background determinations, described above. DCP, a common component of insecticides, was detected in several samples collected from monitoring wells MW-119, MW-120, and MW-121 between November 1993 and February 1995. DCP was again detected in 1997 and 1998 in all four monitoring wells on the site. This data was qualified as estimated. TPH was detected at the site beginning in the first quarter of 1995. BTEX was detected in monitoring well MW-121 in 1997 and 1998. Methylene chloride and PCE were detected in monitoring well MW-121 in 1998. Toluene and methylene chloride were detected in monitoring well MW-120 in November 1998. This data was qualified as estimated. Methylene chloride was detected in monitoring well MW-125 in November 1998. These data were qualified as estimated. All VOC and BNA analyses of groundwater samples collected prior to August 1995 were analyzed by ATI Phoenix laboratory and do not satisfy data validation requirements for quantitative data. However, samples from 19 sampling events conducted from August 1995 to November 2001 were non-detect for all but five events.

The most recent sampling events at the site were in August and November 2001. Samples were collected from monitoring well MW-121 and a replacement to well MW-125 designated, as MW-125R MW-125 had to be replaced because the casing had collapsed. The well that collapsed had steel casing. The deterioration of the steel casing is attributed to the reactivity of the steel with the underlying geologic materials. No analytes were detected above laboratory detection limits. Monitoring well MW-119 was last sampled in July 1997. DCP was detected above laboratory detection limits during this sampling event. Monitoring well MW-120 was last sampled in November 1998. DRO, DCP, methylene chloride, and toluene were detected above laboratory detection limits during this sampling event. MW-119 and MW-120 have collapsed due to corrosion and are scheduled to be abandoned. MW-121 and MW-125 are still active and will be monitored as part of the next five-year review.

6.0 Investigative Site History

This section of the five-year review report provides a historical and five year review process summary for OU-1 and OU-2 PSCs for which remedies were selected. The five-year review process primarily consisted of a site inspection, interviews and a review of relevant documents and data. The five-year review for the site was led by Jeff Rothrock of Luke AFB. The following team members assisted in the review:

- Jon Sherrill, ARCADIS G&M, Inc.
- Kent Lang, ARCADIS G&M, Inc.
- Stephanie Armijo, ARCADIS G&M, Inc.
- Nichole Cherry, ARCADIS G&M, Inc.
- Monique Ostemann, USACE
- Greg Mellema, USACE
- Dan Stralka, USEPA
- Nancy Lou Minkler, ADEQ

6.1 Five Year Review Process Summary

The five-year review process includes the following primary elements:

- Remedy selection and implementation is reviewed and summarized for each OU-1 and OU-2 PSC for which a remedy was selected.
- Changes in standards were evaluated with respect to the continued effectiveness of the remedies that were implemented based on cancer risks and

non-cancer hazards for applicable COCs for Base worker or excavation worker scenarios.

- Groundwater monitoring results are compared to groundwater standards established for the project.
- Representatives of Luke AFB, USEPA, US Army Corps. of Engineers, ADEQ and ARCADIS G&M performed a site inspection of each PSC for which a remedy was selected on May 22, 2001.
- The results of interviews with individuals knowledgeable about the project.

6.2 Review of OU-1 PSCs

OU-1 PSCs for which there was no action taken (refer to discussion in Section 1.1.3 and information in Table 3-2) include the following:

- OT-01
- OT-08
- OT-09
- OT-10
- SS-15
- SS-16
- SS-19
- SD-21
- DP-24
- SD-26
- LF-37
- SD-39
- OT-41

A comparison of the EPC for a given COC in the combined surface and subsurface soil, with USEPA Region IX industrial PRGS (1996 and 2000) and ADEQ residential and non-residential SRLs is in Appendix C. EPCs were taken from the 95 percent upper confidence limit (one-tailed) on the mean assuming a normal distribution unless indicated otherwise.

OU-1 PSCs for which remedies were selected based on the results of risk assessment include the following:

- RW-02
- LF-03

- FT-07
- DP-13
- LF-14
- LF-25
- SD-38
- SS-42

For OU-1 PSCs, PRGs were not established. Alternatively, PSC specific cancer risks and non-cancer hazards were calculated using 1996 USEPA Region IX PRG guidance to develop a site-specific industrial scenario. To evaluate changes in standards as part of this five-year review, cancer risk and non-cancer hazards were recalculated using 2000 USEPA Region IX industrial PRGs and post remediation exposure point concentrations for base worker and excavation worker scenarios as applicable (USEPA Region IX PRGS for 1996 and 2000 are in Appendix D). EPCs were taken from the 95 percent upper confidence limit (one-tailed) on the mean assuming a normal distribution, or from the maximum concentration for PSCs with post-remediation data in surface soils for the base worker and in all soils collected to a depth of 16 feet bgs for excavation workers. ADEQ SRLs were also reviewed since they were used to determine risk under a residential land use scenario.

Changes in standards are evaluated with respect to the continued effectiveness of the remedies that were implemented based on a non-cancer HI less than or equal to 1.0 or an ELCR greater than the risk range of $1x10^{-6}$ to $1x10^{-4}$.

6.2.1 PSC RW-02 Wastewater Treatment Annex

Remedial Actions

Remedy Selection

As stated in the OU-1 ROD[27], the remedy selected for PSC RW-02 consisted of institutional controls listed as follows:

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[27] ARCADIS Geraghty & Miller, Inc., 1999. Final Record of Decision, Operable Unit 1, Luke AFB, Arizona, January 20, 1999.

- Land use restrictions consisting of a VEMUR and constraints within the Base General Plan to limit future development and residential use at the site.
- Geophysical monitoring conducted annually for 30 years to ensure safety of potential receptors and to provide a warning mechanism in case of a change in subsurface conditions.
- Perimeter fencing installed around the low-level waste containment structure to provide a physical barrier.

Remedy Implementation

The establishment of PSC RW-02 was part of overall remediation of an associated landfill and bank stabilization for the Agua Fria River. The implementation of the remedy for PSC RW-02 is summarized as follows:

- A VEMUR was placed on the radiological waste portion of the site on June 15, 2000, to restrict residential development on the site.
- The BGP was revised on January 5, 2000, to place restraints on the residential development of the site.
- An ICP[28] was prepared and implemented as part of the BGP to facilitate training and education of all personnel involved with the implementation and enforcement of the required institutional controls.
- The ICP details the objectives and rationales for establishing institutional controls and described the procedures that were implemented to ensure the required institutional controls are enforced.
- The ICP includes provisions for annual reviews and updates of the BGP, thus ensuring regular checks and balances are in place into the foreseeable future.
- Four monitoring points were installed to a depth of 20 feet in December 1999. According to the monitoring plan[29], radiological logging will be conducted on an annual basis at the three monitoring points for a period of 30 years. The third annual radiological monitoring event was conducted on August 8, 2001.

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[28] ARCADIS Geraghty & Miller, Inc., 2000. Institutional Control Plan, Luke Air Force Base, Arizona, December 15, 2000.

[29] ARCADIS Geraghty & Miller, Inc., 2000. Long Term Radiological Monitoring Plan. November 14, 2000.

> The background levels for soil in the area were measured at 11,558 through 19,618 counts per minute (cpm). The radiological levels for all four measuring points were between 10,310 and 20,434 cpm. These results are similar to background levels, indicating that the soil surrounding the buried radiological waste has not been impacted and the radiological waste containment structure remains protective.

System Operation and Maintenance

No operation and maintenance was required for the remedy selected. The cost of the remediation at PSC RW-02 to date has been $23,560. The annual monitoring is expected to cost $2,000.

Progress Since the Last Five-year Review

This is the first five-year review conducted for the site.

Five-year Review Process

Five-year Review Findings

Site Inspection

No change in land use had occurred since implementation of the remedy for the site. Stabilization work conducted on the Aqua Fria River as part of remediation of a former landfill at the site was also inspected and discussed. Photographs of PSC RW-02 taken during the site inspection are in Appendix E.

Changes to Standards

A comparison of exposure point concentrations (taken to be the maximum detected concentration within the soil profile considered) in surface soils and USEPA Region IX PRGs for a base worker and soils to a depth of 16 feet bgs and USEPA Region IX PRGs for an excavation worker are in Tables 6-1 and 6-2, respectively. The comparison indicates that exposure to constituents detected at PSC RW-02 is still within the acceptable risk range.

Changes in Exposure Pathways, Toxicity and Other Contaminant Characteristics

There were no changes in exposure pathways, toxicity, or other contaminant characteristics, with the exception of beryllium. Beryllium was reclassified by USEPA for risk assessments as non-carcinogenic based on the types of exposure. This difference can be seen in a comparison of the 1996 PRGs and the 2000 PRGs.

Data Evaluation

TRPH was detected to a depth of ten feet in the test pit with the highest concentration at 4,100 mg/kg. TRPH was detected in all eight-soil borings advance in 1993. Radiochemical results indicated that concentrations were consistent with natural soils. Additional soil borings were advance in 1996. BNAs were detected to a depth of 16 feet. The risk assessment conducted for the site concluded that the most conservative ELCR and HI were 2×10^{-7} and 0.6, respectively[30]. Based on the results of the risk assessment, COPCs identified at PSC RW-02 were not present in concentrations high enough to cause adverse health effects under industrial or residential land use. However, the decision to use institutional controls was based on the presence of the low-level radioactive waste containment structure limits potential future land usage.

Assessment

Is the remedy functioning as intended by decision documents?

The objective of the institutional controls was to prevent exposure to radioactive material and to prevent residential development at the site. The institutional controls have functioned as intended.

Are the assumptions used at the time of the remedy selection still valid?

The assumptions used in performing the risk assessment at the site are still valid.

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[30] Geraghty & Miller, 1997. Final Remedial Investigation Report OU-1, Appendix B – Baseline Base wide Risk Assessment, Luke Air Force Base, Arizona. Volumes 1 and 2. October 1, 1997.

Table 6-1

REASONABLE MAXIMUM SOIL EXPOSURE POINT CONCENTRATIONS IN SOIL AND USEPA REGION IX PRGS FOR SURFACE SOIL (BASE WORKER)

PSC RW-02

Luke Air Force Base, Arizona

Constituent	Exposure Point Concentration (mg/kg)	USEPA Region IX Industrial PRG (mg/kg) 1996	USEPA Region IX Industrial PRG (mg/kg) 2000	*Risk or Hazard	ADEQ SRL (mg/kg) Residential	ADEQ SRL (mg/kg) Non-Residential
Cancer Effects				ELCR		
BNAs						
Benzo(a)pyrene	0.10	0.26	0.29	3.4E-07	0.61	2.6
Metals						
Arsenic	5.3	2.4	2.7	2.0E-06	10	10
Total Site Risk or Hazard				***2E-06***		
Non-Cancer Effects				HQ		
BNAs						
Benzo(a)pyrene [a]	0.10	800	190	5.3E-04	0.61	2.6
TRPHs [b]	330	NA	NA	NA	4,100	18,000
Metals						
Arsenic	5.3	2.4	2.7	2.0E+00	10	10
Hazard Index				***2***		

All Units in milligrams per kilogram (mg/kg).

ADEQ SRL	Arizona Department of Environmental Quality 2000 Soil Remediation Level.
BNAs	Base-neutral and extractable acids.
ELCR	Excess lifetime cancer risk.
HQ	Hazard quotient.
NA	Not available.
PRG	Preliminary Remediation Goal.
TRPHs	Total recoverable petroleum hydrocarbons.
USEPA	U.S. Environmental Protection Agency.

[a] The PRG is based on naphthalene non-carcinogenic effects.
[b] n-Hexane was used as a surrogate in the risk assessment for toxicity. A PRG for TRPHs is not provided.
*Risk and Hazards are based upon 2000 Industrial PRGs

Surface soil samples were taken from a depth of 0 to 2 feet below ground surface.
Subsurface soil samples were taken from a depth of 2 to 16 feet below ground surface.
Exposure point concentrations were taken from the 95 percent upper confidence limit (one-tailed) on the mean, assuming a normal distribution.

Arsenic background levels in the State of Arizona regularly exceed the PRGs. Arsenic is present at this site within background levels, and when taken out of the equation the ELCR and hazard index are within acceptable risk ranges.

Table 6-2

REASONABLE MAXIMUM EXPOSURE POINT CONCENTRATIONS IN SOIL AND USEPA REGION IX PRGS FOR SURFACE AND SUBSURFACE (EXCAVATION WORKER)
PSC RW-02
Luke Air Force Base, Arizona

Constituent	Exposure Point Concentration (mg/kg)	USEPA Region IX Industrial PRG (mg/kg)		*Risk or Hazard	ADEQ SRL (mg/kg)	
		1996	2000		Residential	Non-Residential
Cancer Effects				ELCR		
BNAs						
Benzo(a)pyrene	0.10	0.26	0.29	3.4E-07	0.61	2.6
Metals						
Arsenic	6.0	2.4	2.7	2.2E-06	10	10
Beryllium	0.27	1.1	2,200	1.2E-10	1.4	11
Cadmium [a]	5.0	850	3,000	1.7E-09	38	850
Total Site Risk				***3E-06***		
Non-Cancer Effects				HQ		
BNAs						
Benzo(a)pyrene [b]	0.10	800	190	5.3E-04	0.61	2.6
TRPHs [c]	530	NA	NA	NA	4,100	18,000
Metals						
Arsenic	6.0	NA	440	1.4E-02	10	10
Beryllium	0.27	NA	3,700	7.3E-05	1.4	11
Cadmium	5.0	850	810	6.2E-03	38	850
Copper	370	63,000	76,000	4.9E-03	2,800	63,000
Hazard Index				***0.03***		

All Units in milligrams per kilogram (mg/kg).

ADEQ SRL	Arizona Department of Environmental Quality 2000 Soil Remediation Level.
BNAs	Base-neutral and extractable acids.
ELCR	Excess lifetime cancer risk.
HQ	Hazard quotient.
NA	Not available.
PRG	Preliminary Remediation Goal.
TRPHs	Total recoverable petroleum hydrocarbons.
USEPA	U.S. Environmental Protection Agency.

[a] PRG is based on non-carcinogenic effects.
[b] The PRG is based on naphthalene non-carcinogenic effects.
[c] n-Hexane was used as a surrogate in the risk assessment for toxicity. A PRG for TRPHs is not provided.
*Risk and Hazards are based upon 2000 Industrial PRGs

Surface soil samples were taken from a depth of 0 to 2 feet below ground surface.
Subsurface soil samples were taken from a depth of 2 to 16 feet below ground surface.
Exposure point concentrations were taken from the 95 percent upper confidence limit (one-tailed) on the mean, assuming a normal distribution.
Arsenic background levels in the State of Arizona regularly exceed the PRGs. Arsenic is present at this site within background levels, and when taken out of the equation the ELCR and hazard index are within acceptable risk ranges.

Has any other information come up that could question the protectiveness of the remedy?

No additional information has come to light that could call into question the protectiveness of the remedy.

Issues

No issues were discovered during this five-year review.

Recommendations and Follow-up Activities

MW-124 will be monitored as part of future five-year reviews. No other recommendations or follow-up activities are suggested at this time.

Protectiveness Statement

The remedy at PSC RW-02 is protective of human health and the environment and exposure pathways that could result in unacceptable risks are being controlled.

6.2.2 PSC LF-03 Outboard Runway Landfill

Remedial Actions

Remedy Selection

As stated in the OU-2 ROD, the remedial action selected for PSC LF-03 consisted of institutional controls list as follows:

- Land use restrictions consisting of a VEMUR and constraints within the Base General Plan to limit future development and residential use at the site.

Remedy Implementation

The implementation of the remedy for PSC LF-03 is summarized as follows:

- A VEMUR was placed on the site on June 15, 2000, to restrict residential development on the site.

- The BGP was revised on January 5, 2000, to place restraints on the residential development of the site.
- The ICP was incorporated as part of the BGP to facilitate training and education of all personnel involved with the implementation and enforcement of the required institutional controls.
- The ICP details the objectives and rationales for establishing institutional controls and describes the procedures that were implemented to ensure the required institutional controls are enforced.
- The ICP includes provisions for annual reviews and updates of the BGP, thus ensuring regular checks and balances are in place into the foreseeable future.

System Operation and Maintenance

No operation and maintenance was required for the remediation selected. The cost of the institutional controls implemented at PSC LF-03 was $347.

Progress Since the Last Five-year Review

This is the first five-year review conducted for the site.

Five-year Review Process

Five-year Review Findings

Site Inspection

No changes in land use since implementation of the remedy for the site were observed during the inspection. Photographs of PSC LF-03 taken during the site inspection are in Appendix E.

Changes to Standards

A comparison of exposure point concentrations in surface soils and USEPA Region IX PRGs for a base worker and surface and sub-surface soils and USEPA Region IX PRGs for an excavation worker are in Tables 6-3 and 6-4, respectively. The comparison indicates PSC LF-03 is still with in the acceptable risk range.

Table 6-3

REASONABLE MAXIMUM EXPOSURE POINT CONCENTRATIONS IN SOIL AND USEPA REGION IX PRGS FOR SURFACE SOIL (BASE WORKER)

PSC LF-03

Luke Air Force Base, Arizona

Constituent	Exposure Point Concentration (mg/kg)	USEPA Region IX Industrial PRG (mg/kg)		*Risk or Hazard	ADEQ SRL (mg/kg)	
		1996	2000		Residential	Non-Residential
Cancer Effects				ELCR		
Metals						
Arsenic	4.8	2.4	2.7	1.8E-06	10	10
Beryllium	0.7	1.1	2,200	3.2E-10	1.4	11
Total Site Risk				***1.8E-06***		
Non-Cancer Effects				HQ		
Metals						
Arsenic	4.8	NA	440	1.1E-02	10	10
Beryllium	0.7	NA	3,700	1.9E-04	1.4	11
Hazard Index				***0.01***		

All Units in milligrams per kilogram (mg/kg).

ADEQ SRL	Arizona Department of Environmental Quality 2000 Soil Remediation Level.
BNAs	Base-neutral and extractable acids.
ELCR	Excess lifetime cancer risk.
HQ	Hazard quotient.
PRG	Preliminary Remediation Goal.
USEPA	U.S. Environmental Protection Agency.

*Risk and Hazards are based upon 2000 Industrial PRGs

Surface soil samples were taken from a depth of 0 to 2 feet below ground surface.
Subsurface soil samples were taken from a depth of 2 to 16 feet below ground surface.
Exposure point concentrations were taken from the 95 percent upper confidence limit (one-tailed) on the mean, assuming a normal distribution.

Arsenic background levels in the State of Arizona regularly exceed the PRGs. Arsenic is present at this site within background levels, and when taken out of the equation the ELCR and hazard index are within acceptable risk ranges.

Table 6-4

REASONABLE MAXIMUM EXPOSURE POINT CONCENTRATIONS IN SOIL AND USEPA REGION IX PRGS FOR SURFACE AND SUBSURFACE SOIL (EXCAVATION WORKER)
PSC LF-03
Luke Air Force Base, Arizona

Constituent	Exposure Point Concentration (mg/kg)	USEPA Region IX Industrial PRG (mg/kg)		*Risk or Hazard	ADEQ SRL (mg/kg)	
		1996	2000		Residential	Non-Residential
Cancer Effects				ELCR		
Metals						
Arsenic	6.9	2.4	2.7	2.6E-06	10	10
Beryllium	0.42	1.1	2,200	1.9E-10	1.4	11
Chromium [a]	140	450	450	3.1E-07	2,100	4,500
Total Site Risk				***2.9E-06***		
Non-Cancer Effects				HQ		
Metals						
Arsenic	6.9	NA	440	1.6E-02	10	10
Beryllium	0.42	NA	3,700	1.1E-04	1.4	11
Chromium [b]	140	NA	6,100	2.3E-02	2,100	4,500
Copper	1,100	63,000	76,000	1.4E-02	2,800	63,000
Hazard Index				***0.1***		

All Units in milligrams per kilogram (mg/kg).

ADEQ SRL	Arizona Department of Environmental Quality 2000 Soil Remediation Level.
BNAs	Base-neutral and extractable acids.
ELCR	Excess lifetime cancer risk.
HQ	Hazard quotient.
PRG	Preliminary Remediation Goal.
USEPA	U.S. Environmental Protection Agency.

[a] The chromium PRG is based on total chromium carcinogenic effects and a 1:6 ratio of chromium IV to chromium III.
[b] The chromium PRG is based on chromium VI non-carcinogenic effects.
*Risk and Hazards are based upon 2000 Industrial PRGs

Surface soil samples were taken from a depth of 0 to 2 feet below ground surface.
Subsurface soil samples were taken from a depth of 2 to 16 feet below ground surface.
Exposure point concentrations were taken from the 95 percent upper confidence limit (one-tailed) on the mean, assuming a normal distribution.

Arsenic background levels in the State of Arizona regularly exceed the PRGs. Arsenic is present at this site within background levels, and when taken out of the equation the ELCR and hazard index are within acceptable risk ranges.

Changes in Exposure Pathways, Toxicity and Other Contaminant Characteristics

There were no changes in exposure pathways, toxicity, or other contaminant characteristics.

Data Evaluation

The determination to use institutional controls was based on the ELCR for chromium concentrations at the site of 5×10^{-6}, above the allowable residential risk of 1×10^{-6}. The elevated ELCR for chromium was caused by two samples with high chromium concentrations collected at test pit TP-5. The risk assessment used the conservative assumption that all of the chromium was in the hexavalent state.

Assessment

Is the remedy functioning as intended by decision documents?

The objective of the institutional controls was to prevent residential development at the site. The institutional controls have functioned as intended.

Are the assumptions used at the time of the remedy selection still valid?

The assumptions used in performing the risk assessment at the site are still valid.

Has any other information come up that could question the protectiveness of the remedy?

No additional information has come to light that could call into question the protectiveness of the remedy.

Issues

No issues were discovered during this five-year review.

Recommendations and Follow-up Activities

There are no further recommendations or follow-up activities suggested at this time.

Protectiveness Statement

The remedy at PSC LF-03 is protective of human health and the environment and exposure pathways that could result in unacceptable risks are being controlled.

6.2.3 PSC FT-07E Eastern Portion of North Fire Training Area

Remedial Actions

Remedy Selection

A SVE system was installed in 1992 at a cost of $395,000 and was done independent of the OU-I ROD. The system was operational from April 1992 through December 1992 and approximately 14,000 pounds of contaminants were removed. During the RI, an investigation was conducted to determine the effectiveness of the removal. The conclusions of the investigation were that the SVE effectively removed contaminants greater than 16 feet bgs. However, high levels of contaminants still remained in the shallow soils. As stated in the OU-1 ROD, and based on the risk assessment for the shallow soils, the remedial action selected for PSC FT-07E consisted of institutional controls. Institutional controls at PSC FT-07E consisted of the following:

- Land use restrictions consisting of a VEMUR and constraints within the Base General Plan to limit future development and residential use at the site.

Remedy Implementation

The implementation of the remedy for PSC FT-07E is summarized as follows:

- A VEMUR was placed on the site on June 15, 2000, to restrict residential development on the site.
- The BGP was revised on January 5, 2000, to place restraints on the residential development of the site.
- The ICP was incorporated as part of the BGP to facilitate training and education of all personnel involved with the implementation and enforcement of the required institutional controls.

- The ICP details the objectives and rationales for establishing institutional controls and describes the procedures that were implemented to ensure the required institutional controls are enforced.
- The ICP includes provisions for annual reviews and updates of the BGP, thus ensuring regular checks and balances are in place into the foreseeable future.

System Operation and Maintenance

No operation and maintenance was required for the remediation selected. The cost of the institutional controls implemented at PSC FT-07E was $347.

Progress Since the Last Five-year Review

This is the first five-year review conducted for the site.

Five-year Review Process

Five-year Review Findings

Site Inspection

There were no changes in land use at the site since implementation of the remedy was observed. Photographs of PSC FT-07E taken as part of the site inspection are in Appendix E.

Changes to Standards

A comparison of exposure point concentrations in surface soils and USEPA Region IX PRGs for a base worker and surface and sub-surface soils and USEPA Region IX PRGs for an excavation worker are in Tables 6-5 and 6-6, respectively. The comparison indicates that PSC FT-07E is still within the acceptable risk range.

Changes in Exposure Pathways, Toxicity and Other Contaminant Characteristics

There were no changes in exposure pathways, toxicity, or other contaminant characteristics.

Table 6-5

REASONABLE MAXIMUM EXPOSURE POINT CONCENTRATIONS IN SOIL AND USEPA REGION IX PRGS FOR SURFACE AND SUBSURFACE SOIL (EXCAVATION WORKER)
PSC FT-07
Luke Air Force Base, Arizona

Constituent	Exposure Point Concentration (mg/kg)	USEPA Region IX Industrial PRG (mg/kg) 1996	USEPA Region IX Industrial PRG (mg/kg) 2000	*Risk or Hazard	ADEQ SRL (mg/kg) Residential	ADEQ SRL (mg/kg) Non-Residential
Cancer Effects				ELCR		
Metal Arsenic	5.2	2.4	2.7	1.9E-06	10	10
Total Site Risk				***1.9E-06***		
Non-Cancer Effects				HQ		
TRPH [a]	7,500	NA	NA	NA	4,100	18,000
Metal Arsenic	5.2	NA	440	1.2E-02	10	10
Hazard Index				***0.01***		

All Units in milligrams per kilogram (mg/kg).

ADEQ SRL	Arizona Department of Environmental Quality 2000 Soil Remediation Level.
ELCR	Excess lifetime cancer risk.
H	Hazard quotient.
NA	Not applicable.
PRG	Preliminary Remediation Goal.
R	Excess lifetime cancer risk.
TRPH	Total recoverable petroleum hydrocarbons.
USEPA	U.S. Environmental Protection Agency.
VOCs	Volatile organic compounds.

[a] n-Hexane was used as a surrogate in the risk assessment for toxicity. A PRG for TRPHs is not provided.
*Risk and Hazards are based upon 2000 Industrial PRGs

Surface soil samples were taken from a depth of 0 to 2 feet below ground surface.
Subsurface soil samples were taken from a depth of 2 to 16 feet below ground surface.
Exposure point concentrations were taken from the 95 percent upper confidence limit (one-tailed) on the mean, assuming a normal distribution.

Arsenic background levels in the State of Arizona regularly exceed the PRGs. Arsenic is present at this site within background levels, and when taken out of the equation the ELCR and hazard index are within acceptable risk ranges.

Table 6-6

REASONABLE MAXIMUM EXPOSURE POINT CONCENTRATIONS IN SOIL AND USEPA REGION IX PRGS FOR SURFACE SOIL (BASE WORKER)
PSC FT-07
Luke Air Force Base, Arizona

Constituent	Exposure Point Concentration (mg/kg)	USEPA Region IX Industrial PRG (mg/kg)		*Risk or Hazard	ADEQ SRL (mg/kg)	
		1996	2000		Residential	Non-Residential
Cancer Effects				ELCR		
Metal						
Arsenic	7.9	2.4	2.7	2.9E-06	10	10
Total Site Risk				***2.9E-06***		
Non-Cancer Effects				HQ		
TRPH [a]	1,600	NA	NA	NA	4,100	18,000
Metal						
Arsenic	7.9	NA	440	1.8E-02	10	10
Hazard Index				***0.02***		

All Units in milligrams per kilogram (mg/kg).

ADEQ SRL	Arizona Department of Environmental 2000 Quality Soil Remediation Level.
ELCR	Excess lifetime cancer risk.
H	Hazard quotient.
NA	Not applicable.
PRG	Preliminary Remediation Goal.
R	Excess lifetime cancer risk.
TRPH	Total recoverable petroleum hydrocarbons.
USEPA	U.S. Environmental Protection Agency.
VOCs	Volatile organic compounds.

[a] n-Hexane was used as a surrogate in the risk assessment for toxicity. A PRG for TRPHs is not provided.
*Risk and Hazards are based upon 2000 Industrial PRGs

Surface soil samples were taken from a depth of 0 to 2 feet below ground surface.
Subsurface soil samples were taken from a depth of 2 to 16 feet below ground surface.
Exposure point concentrations were taken from the 95 percent upper confidence limit (one-tailed) on the mean, assuming a normal distribution.

Arsenic background levels in the State of Arizona regularly exceed the PRGs. Arsenic is present at this site within background levels, and when taken out of the equation the ELCR and hazard index are within acceptable risk ranges.

Data Evaluation

The determination to have no remedial action at the site was based on the results of soil sampling conducted as part of the RI. Soil samples collected in 1991 had concentrations of TRPH ranging up to 3,800 mg/kg. Lead was detected above the background UTL. The highest concentration was 172 mg/kg. The risk assessment conducted for the site concluded that the most conservative ELCR and HI were 4×10^{-8} and 0.0002, respectively. The vadose zone transport model also indicated that the COCs would not migrate to and impact groundwater. Due to TPH concentrations, residential land use is was restricted through a VEMUR.

Assessment

Is the remedy functioning as intended by decision documents?

The remedial action is functioning as intended.

Are the assumptions used at the time of the remedy selection still valid?

The assumptions used in performing the risk assessment at the site are still valid.

Has any other information come up that could question the protectiveness of the remedy?

No additional information has come to light that could call into question the protectiveness of the remedy.

Issues

No issues were discovered during this five-year review.

Recommendations and Follow-up Activities

MW-118 and MW-123 will be monitored as part of future five-year reviews. No other recommendations or follow-up activities are suggested at this time.

Protectiveness Statement

The remedy at PSC FT-07E is protective of human health and the environment and exposure pathways that could result in unacceptable risks are being controlled.

6.2.4 DP-13 Drainage Ditch Disposal Area

Remedial Actions

Remedy Selection

As stated in the ROD for OU-1, institutional controls were the selected remedy for PSC DP-13. Institutional controls implemented at PSC DP-13 consisted of the following:

- A VEMUR to restrict land use to non-residential.
- The BGP modified to place constraints on future residential development.
- Work practices requiring the use of Personal Protective Equipment (PPE) while excavating the site.
- An ICP to document required institutional controls.

Remedy Implementation

The implementation of the remedy for PSC DP-13 is summarized as follows:

- A VEMUR was implemented at site on June 15, 2000, to restrict residential development. The BGP was revised on January 5, 2000, to restrict residential development and to require the use of PPE by workers in the event soils are excavated at the site.
- An Institutional Control Plan was implemented on December 15, 2000, which was designed to facilitate training and education of all personnel involved with the implementation and enforcement of the required institutional controls.
- The ICP included provisions for annual reviews and updates of the BGP, thus ensuring regular checks and balances are in place into the foreseeable future.

System Operation and Maintenance

No operation and maintenance was required for the selected remedy. The cost of the institutional controls implemented at PSC DP-13 was $347.

Progress Since the Last Five-year Review

This is the first five-year review conducted for the site.

Five-year Review Process

Five-year Review Findings

Site Inspection

During the inspection, the feasibility of removing landfill materials at some future date was raised as an issue. There were no other comments. No changes in land use had occurred since implementation of the remedy for the site. Photographs of PSC DP-13 taken as part of the inspection are in Appendix E.

Changes to Standards

A comparison of exposure point concentrations in surface soils and USEPA Region IX PRGs for a base worker and surface and sub-surface soils and USEPA Region IX PRGs for an excavation worker are in Tables 6-7 and 6-8, respectively. The comparison indicates that PSC DP-13 is still within the acceptable risk range.

Changes in Exposure Pathways, Toxicity and Other Contaminant Characteristics

There were no changes in exposure pathways, toxicity, or other contaminant characteristics.

Data Evaluation

The determination to use institutional controls was based on the ELCR at the site of 3×10^{-5}, which is greater than the allowable residential risk of 1×10^{-6}, and the HI of 2, which is greater than the allowable residential risk of 1. The risk assessment assumed that all of the chromium was in the hexavalent state. Mean blood lead levels for sensitive populations that included children up to seven years old, were calculated using the IEUBK model. The predicted blood lead level for exposure to subsurface soils at PSC DP-13 were 21.4 µg/dL, which exceeds the concern limit of 10 µg/dL.

Table 6-7

REASONABLE MAXIMUM EXPOSURE POINT CONCENTRATIONS IN SOIL AND USEPA REGION IX PRGS FOR SURFACE SOIL (BASE WORKER)
PSC DP-13
Luke Air Force Base, Arizona

Constituent	Exposure Point Concentration (mg/kg)	USEPA Region IX Industrial PRG (mg/kg) 1996	USEPA Region IX Industrial PRG (mg/kg) 2000	*Risk or Hazard	ADEQ SRL (mg/kg) Residential	ADEQ SRL (mg/kg) Non-Residential
Cancer Effects				ELCR		
Metals						
Arsenic	6.3	2.4	2.7	2.3E-06	10	10
Beryllium	0.47	1.1	2,200	2.1E-10	1.4	11
Total Site Risk				***2.3E-06***		
Non-Cancer Effects				HQ		
TRPHs [a]	530	NA	NA	NA	4,100	18,000
Metals						
Arsenic	6.3	NA	440	1.4E-02	10	10
Beryllium	0.47	NA	3,700	1.3E-04	1.4	11
Hazard Index				***0.01***		

All Units in milligrams per kilogram (mg/kg).

ADEQ SRL	Arizona Department of Environmental Quality 2000 Soil Remediation Level.
BNAs	Base-neutral and extractable acids.
ELCR	Excess lifetime cancer risk.
HQ	Hazard quotient.
PRG	Preliminary Remediation Goal.
USEPA	U.S. Environmental Protection Agency.

[a] n-Hexane was used as a surrogate in the risk assessment for toxicity. A PRG for TRPHs is not provided.
*Risk and Hazards are based upon 2000 Industrial PRGs

Surface soil samples were taken from a depth of 0 to 2 feet below ground surface.
Subsurface soil samples were taken from a depth of 2 to 16 feet below ground surface.
Exposure point concentrations were taken from the 95 percent upper confidence limit (one-tailed) on the mean, assuming a normal distribution.

Arsenic background levels in the State of Arizona regularly exceed the PRGs. Arsenic is present at this site within background levels, and when taken out of the equation the ELCR and hazard index are within acceptable risk ranges.

Table 6-8

REASONABLE MAXIMUM EXPOSURE POINT CONCENTRATIONS IN SOIL AND USEPA REGION IX PRGS FOR SURFACE AND SUBSURFACE SOIL (EXCAVATION WORKER)
PSC DP-13
Luke Air Force Base, Arizona

Constituent	Exposure Point Concentration (mg/kg)	USEPA Region IX Industrial PRG (mg/kg)		*Risk or Hazard	ADEQ SRL (mg/kg)	
		1996	2000		Residential	Non-Residential
Cancer Effects				ELCR		
BNAs						
Benzo(a)anthracene	0.33	2.6	2.9	1.1E-07	6.1	26
Benzo(b)fluoranthene	0.36	2.6	2.9	1.2E-07	6.1	26
Benzo(a)pyrene	0.32	0.26	0.29	1.1E-06	0.61	2.6
Dibenzo(a,h)anthracene	0.11	0.26	0.29	3.8E-07	0.61	2.6
Metals						
Arsenic	5.1	2.4	2.7	1.9E-06	10	10
Beryllium	0.39	1.1	2,200	1.8E-10	1.4	11
Chromium [a]	820	450	450	1.8E-06	2,100	4,500
Total Site Risk				***5.4E-06***		
Non-Cancer Effects				HQ		
BNAs						
Benzo(a)anthracene [b]	0.33	800	190	1.7E-03	6.1	26
Benzo(b)fluoranthene [b]	0.36	800	190	1.9E-03	6.1	26
Benzo(a)pyrene [b]	0.32	800	190	1.7E-03	0.61	2.6
Dibenzo(a,h)anthracene [b]	0.11	800	190	5.8E-04	0.61	2.6
TRPH [c]	790	NA	NA	NA	4,100	18,000
Metals						
Arsenic	5.1	NA	440	1.2E-02	10	10
Beryllium	0.39	NA	3,700	1.1E-04	1.4	11
Chromium [d]	820	NA	6,100	1.3E-01	2,100	4,500
Copper	250	63,000	76,000	3.3E-03	2,800	63,000
Hazard Index				***0.16***		

All Units in milligrams per kilogram (mg/kg).

ADEQ SRL	Arizona Department of Environmental Quality 2000 Soil Remediation Level.
BNAs	Base-neutral and extractable acids.
ELCR	Excess lifetime cancer risk.
HQ	Hazard quotient.
PRG	Preliminary Remediation Goal.
USEPA	U.S. Environmental Protection Agency.

[a] The chromium PRG is based on total chromium carcinogenic effects and a 1:6 ratio of chromium IV to chromium III.
[b] The PRG is based on naphthalene non-carcinogenic effects.
[c] n-Hexane was used as a surrogate in the risk assessment for toxicity. A PRG for TRPHs is not provided.
[d] The chromium PRG is based on chromium VI non-carcinogenic effects.
*Risk and Hazards are based upon 2000 Industrial PRGs

Surface soil samples were taken from a depth of 0 to 2 feet below ground surface.
Subsurface soil samples were taken from a depth of 2 to 16 feet below ground surface.
Exposure point concentrations were taken from the 95 percent upper confidence limit (one-tailed) on the mean, assuming a normal distribution.

Arsenic background levels in the State of Arizona regularly exceed the PRGs. Arsenic is present at this site within background levels, and when taken out of the equation the ELCR and hazard index are within acceptable risk ranges.

The elevated ELCR and HI values for chromium and blood level values predicted by the IEUBK model were the result of one sample with elevated chromium concentrations (15,900 mg/kg) and lead concentrations (36,000 mg/kg) collected from test pit TP-12. The elevated concentrations of chromium were attributed to a paint pail and dried paint observed in this test pit. The paint pail and dried paint was removed from the test pit.

Assessment

Is the remedy functioning as intended by decision documents?

The objective of the institutional controls was to prevent residential development at the site. The institutional controls have functioned as intended.

Are the assumptions used at the time of the remedy selection still valid?

The assumptions used in performing the risk assessment at the site are still valid.

Has any other information come up that could question the protectiveness of the remedy?

No additional information has come to light that could call into question the protectiveness of the remedy.

Issues

No issues were discovered during this five-year review.

Recommendations and Follow-up Activities

There are no further recommendations or follow-up activities suggested at this time.

Protectiveness Statement

The remedy at PSC DP-13 is protective of human health and the environment and exposure pathways that could result in unacceptable risks are being controlled.

6.2.5 PSC LF-14 Old Salvage Yard Burial Site

Remedial Actions

Remedy Selection

As stated in the OU-1 ROD, the remedy selected for PSC LF-14 consisted of institutional controls. Institutional controls implemented at PSC LF-14 consisted of the following:

- A VEMUR to restrict land use to non-residential.
- The BGP modified to place constraints on future residential development.
- Work practices requiring the use of Personal Protective Equipment (PPE) while excavating the site.
- An ICP to document required institutional controls.

Remedy Implementation

The implementation of the remedy for PSC LF-14 is summarized as follows:

- A VEMUR was placed on the site on June 15, 2000, to restrict residential development on the site.
- The BGP was revised on January 5, 2000, to place restraints on the residential development of the site and to require the use of PPE while excavating soils at the site.
- An ICP was developed and implemented at the site on December 15, 2000, as part of the BGP to facilitate training and education of all personnel involved with the implementation and enforcement of the required institutional controls.
- The ICP details the objectives and rationales for establishing institutional controls and describes the procedures that were implemented to ensure the required institutional controls are enforced.
- The ICP includes provisions for annual reviews and updates of the BGP, thus ensuring regular checks and balances are in place into the foreseeable future.

System Operation and Maintenance

No operation and maintenance was required for the remediation selected. The cost of the institutional controls implemented at PSC LF-14 was $347.

Progress Since the Last Five-year Review

This is the first five-year review conducted for the site.

Five-year Review Process

Five-year Review findings

Site Inspection

There were no changes in land use since implementation of the remedy observed during the site inspection. Photographs of PSC LF-14 taken as part of the site inspection are in Appendix E.

Changes in Standards

A comparison of exposure point concentrations in surface soils and USEPA Region IX PRGs for a base worker, and surface and sub-surface soils and USEPA Region IX PRGs for an excavation worker are in Tables 6-9 and 6-10, respectively. The comparison indicates that PSC LF-14 is still within the acceptable risk range.

Changes in Exposure Pathways, Toxicity and Other Contaminant Characteristics

There were no changes in exposure pathways, toxicity, or other contaminant characteristics.

Table 6-9

REASONABLE MAXIMUM EXPOSURE POINT CONCENTRATIONS IN SOIL AND USEPA REGION IX PRGS FOR SURFACE SOIL (BASE WORKER)
PSC LF-14
Luke Air Force Base, Arizona

Constituent	Exposure Point Concentration (mg/kg)	USEPA Region IX Industrial PRG (mg/kg)		*Risk or Hazard	ADEQ SRL (mg/kg)	
		1996	2000		Residential	Non-Residential
Cancer Effects				ELCR		
BNAs						
Benzo(a)pyrene	0.15	0.26	0.29	5.2E-07	0.61	2.6
PCBs	3.6	0.34	1.0	3.6E-06	2.5	13
Metals						
Arsenic	5.8	2.4	2.7	2.1E-06	10	10
Beryllium	0.62	1.1	2,200	2.8E-10	1.4	11
Chromium [a]	100	450	450	2.2E-07	2,100	4,500
Total Site Risk				***6.5E-06***		
Non-Cancer Effects				HQ		
BNAs						
Benzo(a)pyrene [b]	0.150	800	190	7.9E-04	0.61	2.6
PCBs [c]	3.6	NA	14.0	2.6E-01	2.5	13
TRPHs [d]	1100	NA	NA	NA	4,100	18,000
Metals						
Arsenic	5.8	NA	440	1.3E-02	10	10
Beryllium	0.62	NA	3,700	1.7E-04	1.4	11
Chromium [e]	100	NA	6,100	1.6E-02	2,100	4,500
Hazard Index				***0.3***		

All Units in milligrams per kilogram (mg/kg).

ADEQ SRL	Arizona Department of Environmental Quality 2000 Soil Remediation Level.
BNAs	Base-neutral and extractable acids.
ELCR	Excess lifetime cancer risk.
HQ	Hazard quotient.
NA	Not applicable.
PRG	Preliminary Remediation Goal.
USEPA	U.S. Environmental Protection Agency.

[a] The chromium PRG is based on total chromium carcinogenic effects and a 1:6 ratio of chromium IV to chromium III.
[b] The PRG is based on naphthalene non-carcinogenic effects.
[c] The PRG is based on the Aroclor 1254 non-carcinogenic effects.
[d] n-Hexane was used as a surrogate in the risk assessment for toxicity. A PRG for TRPHs is not provided.
[e] The chromium PRG is based on chromium VI non-carcinogenic effects.
*Risk and Hazards are based upon 2000 Industrial PRGs

Surface soil samples were taken from a depth of 0 to 2 feet below ground surface.
Subsurface soil samples were taken from a depth of 2 to 16 feet below ground surface.
Exposure point concentrations were taken from the 95 percent upper confidence limit (one-tailed) on the mean, assuming a normal distribution.

Arsenic background levels in the State of Arizona regularly exceed the PRGs. Arsenic is present at this site within background levels, and when taken out of the equation the ELCR and hazard index are within acceptable risk ranges.

Table 6-10

REASONABLE MAXIMUM EXPOSURE POINT CONCENTRATIONS IN SOIL AND USEPA REGION IX PRGS FOR SURFACE AND SUBSURFACE SOIL (EXCAVATION WORKER)
PSC LF-14
Luke Air Force Base, Arizona

Constituent	Exposure Point Concentration (mg/kg)	USEPA Region IX Industrial PRG (mg/kg)		*Risk or Hazard	ADEQ SRL (mg/kg)	
		1996	2000		Residential	Non-Residential
Cancer Effects				ELCR		
BNAs						
Benzo(a)pyrene	0.16	0.26	0.29	5.5E-07	0.61	2.6
PCBs	5.2	0.34	1.0	5.2E-06	2.5	13
Metals						
Arsenic	5.4	2.4	2.7	2.0E-06	10	10
Beryllium	0.53	1.1	2,200	2.4E-10	1.4	11
Chromium [a]	59	450	450	1.3E-07	2,100	4,500
Total Site Risk				***7.9E-06***		
Non-Cancer Effects				HQ		
BNAs						
Benzo(a)pyrene [b]	0.16	800	190	8.4E-04	0.61	2.6
PCBs [c]	5.2	NA	14.0	3.7E-01	2.5	13
TRPHs [d]	570	NA	NA	NA	4,100	18,000
Metals						
Arsenic	5.4	NA	440	1.2E-02	10	10
Beryllium	0.53	NA	3,700	1.4E-04	1.4	11
Chromium [e]	59	NA	6,100	9.7E-03	2,100	4,500
Hazard Index				***0.4***		

All Units in milligrams per kilogram (mg/kg).

ADEQ SRL	Arizona Department of Environmental Quality 2000 Soil Remediation Level.
BNAs	Base-neutral and extractable acids.
ELCR	Excess lifetime cancer risk.
HQ	Hazard quotient.
NA	Not applicable.
PRG	Preliminary Remediation Goal.
USEPA	U.S. Environmental Protection Agency.

[a] The chromium PRG is based on total chromium carcinogenic effects and a 1:6 ratio of chromium IV to chromium III.
[b] The PRG is based on naphthalene non-carcinogenic effects.
[c] The PRG is based on the Aroclor 1254 non-carcinogenic effects.
[d] n-Hexane was used as a surrogate in the risk assessment for toxicity. A PRG for TRPHs is not provided.
[e] The chromium PRG is based on chromium VI non-carcinogenic effects.
*Risk and Hazards are based upon 2000 Industrial PRGs

Surface soil samples were taken from a depth of 0 to 2 feet below ground surface.
Subsurface soil samples were taken from a depth of 2 to 16 feet below ground surface.
Exposure point concentrations were taken from the 95 percent upper confidence limit (one-tailed) on the mean, assuming a normal distribution.

Arsenic background levels in the State of Arizona regularly exceed the PRGs. Arsenic is present at this site within background levels, and when taken out of the equation the ELCR and hazard index are within acceptable risk ranges.

Data Evaluation

The determination to use institutional controls was based on the ELCR at the site of 3 x 10^{-5}, above the allowable residential risk of 1 x 10^{-6}. The elevated ELCR was caused by two samples with high chromium concentrations. The risk assessment used the conservative assumption that all of the chromium was in the hexavalent state. Additionally high concentrations of PCBs elevated the ELCR. The highest concentration of PCBs was found at 20 feet bgs. Because exposure to soils beneath 16 feet bgs is not likely concentration of PCBs detected below 16 feet were not used in calculating the ELCR.

Assessment

Is the remedy functioning as intended by decision documents?

The objective of the institutional controls was to prevent residential development at the site. The institutional controls have functioned as intended.

Are the assumptions used at the time of the remedy selection still valid?

The assumptions used in performing the risk assessment at the site are still valid.

Has any other information come up that could question the protectiveness of the remedy?

No additional information has come to light that could call into question the protectiveness of the remedy.

Issues

No issues were discovered during this five-year review.

Recommendations and Follow-up Activities

No follow-up activities are suggested at this time.

Protectiveness Statement

The remedy at PSC LF-14 is protective of human health and the environment and exposure pathways that could result in unacceptable risks are being controlled.

6.2.6 PSC LF-25 Northwest Landfill

Remedial Actions

Remedy Selection

As stated in the OU-1 ROD, the remedy selected for PSC LF-25 consisted of the following:

- Ex-situ physical treatment/metals recovery
- Institutional controls

Remedy Implementation

Implementation of ex-situ physical treatment/metals recovery at PSC LF-25 is summarized as follows:

- Shot recovery activities, conducted from December 16-19, 1999[31], included removal of surficial soil from an area approximately 375 feet by 375.
- The soil was fed into a metal recovery processor, which sorted out the metal shot and returned that soil to the ground.
- Approximately 2,800 pounds of shot was recovered.
- Confirmation sampling was conducted to ensure that site remediation was effective.
- The analytical results showed that all soil samples were below the residential SRLs of 31 mg/kg for antimony and 400 mg/kg for lead.

Implementation of institutional controls at PSC LF-25 is summarized as follows:

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[31] ARCADIS Geraghty & Miller, Inc., 2000. Shot Recovery Summary Report for PSC LF-25, June 1, 2000.

- A VEMUR was placed on the site on June 15, 2000, to restrict residential development on the site.
- The BGP was revised on January 5, 2000, to place restraints on the residential development of the site and to require the use of PPE while excavating soils at the site.
- An ICP was developed and implemented at the site on December 15, 2000, as part of the BGP to facilitate training and education of all personnel involved with the implementation and enforcement of the required institutional controls.
- The ICP details the objectives and rationales for establishing institutional controls and describes the procedures that were implemented to ensure the required institutional controls are enforced.
- The ICP includes provisions for annual reviews and updates of the BGP, thus ensuring regular checks and balances are in place into the foreseeable future.

System Operation and Maintenance

No operation and maintenance was required for the remediation selected. The cost of the institutional controls implemented at PSC LF-25 was $347. The cost of the ex-situ physical treatment/metals recovery was $42,985.

Progress Since the Last five-year Review

This is the first five-year review conducted for the site.

Five-year Review Process

Five-year Review Findings

Site Inspection

There were no changes in land use since implementation of the remedy observed during the site inspection. Photographs of PSC LF-25 taken as part of the site inspection are in Appendix E.

Changes to Standards

A comparison of exposure point concentrations in surface and subsurface soils and USEPA Region IX PRGs for Base and excavation worker is in Table 6-11. The comparison indicates that PSC LF-25 is still within the acceptable risk range.

Table 6-11

POST REMEDIATION CONCENTRATIONS IN SOIL AND USEPA REGION IX PRGS FOR SURFACE AND SUBSURFACE SOIL (BASE AND EXCAVATION WORKER)

PSC LF-25

Luke Air Force Base, Arizona

Constituent	Post Remediation Concentration (mg/kg)	USEPA Region IX Industrial PRG (mg/kg) 1996	USEPA Region IX Industrial PRG (mg/kg) 2000	*Risk or Hazard	ADEQ SRL (mg/kg) Residential	ADEQ SRL (mg/kg) Non-Residential
Cancer Effects				ELCR		
Metals						
Antimony	10	NC	NC	NC	NA	NA
Lead	240	400	750	3.2E-07	400	2,000
Total Site Risk or Hazard				***3E-07***		
Non-Cancer Effects				HQ		
Metals						
Antimony	10	NA	820	1.2E-02	NA	NA
Lead [a]	240	400	750	0.32	400	2,000
Hazard Index				***0.3***		

All Units in milligrams per kilogram (mg/kg).

ADEQ SRL	Arizona Department of Environmental Quality 2000 Soil Remediation Level.
BNAs	Base-neutral and extractable acids.
ELCR	Excess lifetime cancer risk.
HQ	Hazard quotient.
NA	Not Applicable
NC	Non Carcinogenic
PRG	Preliminary Remediation Goal.
USEPA	U.S. Environmental Protection Agency.

[a] The PRG for lead is based on acceptable levels of lead in the blood stream rather than a traditional toxicity approach. The hazard quotient presented under non-cancer effects is actually just the ratio of the PRG to the soil concentration.

*Risk and Hazards are based upon 2000 Industrial PRGs

Results were taken from post remediation conformational soil sampling constituent concentrations. Post remediation results were obtained from the Results and Conclusions section of the Remedial Action Report for PSC LF-25 by ARCADIS Geraghty & Miller dated June 1, 2000.

Surface soil samples were taken from a depth of 0 to 2 feet below ground surface.

Subsurface soil samples were taken from a depth of 2 to 16 feet below ground surface.

Changes in Exposure Pathways, Toxicity and Other Contaminant Characteristics

There were no changes in exposure pathways, toxicity, or other contaminant characteristics.

Data Evaluation

The determination to implement institutional controls was based on failed site-specific industrial risk standards that was a result of one sample with high antimony concentrations. This sample contained a piece of metal shot, resulting in the high concentration of antimony. The metal shot came from the nearby skeet range. Removal of the metal shot from the site was conducted in December 1999 and subsequent soil sampling indicated that soil levels were below residential SRLs[31]. Since no carcinogens were identified as COCs, an ELCR was not calculated for the site.

Mean blood lead levels for sensitive populations, children up to seven years old, were calculated using the IEUBK model. The predicted blood lead level for exposure to subsurface soils at LF-25 was 14.5 µg/dL. This is above the limit of 10 µg/dL. The high concentration of lead in one sample (10,100 mg/kg) elevated the predicted blood lead level. This sample contained a piece of metal shot, resulting in the high concentration of lead. The metal shot came from the nearby skeet range. Removal of the metal shot from the site was conducted in December 1999, and subsequent soil sampling indicated that soil levels were below residential SRLs. Even though antimony and lead concentrations are below residential SRLs, institutional controls (VEMUR) are still required because the site is still utilized as an active skeet range and there is still a potential source of these metals.

Assessment

Is the remedy functioning as intended by decision documents?

The objective of the institutional controls was to prevent residential development at the site. The institutional controls have functioned as intended. Removal of the metal shot from the site was conducted in December 1999, and subsequent soil sampling indicated that soil levels were below residential SRLs[31].

Are the assumptions used at the time of the remedy selection still valid?

The assumptions used in performing the risk assessment at the site are still valid.

Has any other information come up that could question the protectiveness of the remedy?

No additional information has come to light that could call into question the protectiveness of the remedy.

Issues

No issues were discovered during this five-year review.

Recommendations and Follow-up Activities

No follow-up activities are suggested at this time.

Protectiveness Statement

The remedy at PSC LF-25 is protective of human health and the environment and exposure pathways that could result in unacceptable risks are being controlled.

6.2.7 PSC SD-38 Southwest Oil/Water Separator at the Auto Hobby Shop

Remedial Actions

Remedy Selection

As stated in the OU-1 ROD, the remedy selected for PSC SD-38 consisted of institutional controls. Institutional controls implemented at PSC SD-38 consisted of the following:

- A VEMUR to restrict land use to non-residential.
- The BGP modified to place constraints on future residential development.
- Work practices requiring the use of PPE while excavating the site.
- An ICP to document required institutional controls.

Remedy Implementation

The implementation of the remedy for PSC SD-38 is summarized as follows:

- A VEMUR was placed on the site on June 15, 2000, to restrict residential development on the site.
- The BGP was revised on January 5, 2000, to place restraints on the residential development of the site and to require the use of PPE while excavating soils at the site.
- An ICP was developed and implemented at the site on December 15, 2000, as part of the BGP to facilitate training and education of all personnel involved with the implementation and enforcement of the required institutional controls.
- The ICP details the objectives and rationales for establishing institutional controls and describes the procedures that were implemented to ensure the required institutional controls are enforced.
- The ICP includes provisions for annual reviews and updates of the BGP, thus ensuring regular checks and balances are in place into the foreseeable future.

System Operation and Maintenance

No operation and maintenance was required for the remediation selected. The cost of the institutional controls implemented at PSC SD-38 was $347.

Progress Since the Last Five-year Review

This is the first five-year review conducted for the site.

Five-year Review Process

Five-year Review Findings

Site Inspection

There were no changes in land use since implementation of the remedy observed during the site inspection. Photographs of PSC SD-38 taken as part of the site inspection are in Appendix E.

Changes to Standards

A comparison of exposure point concentrations in surface and subsurface soils and USEPA Region IX PRGs for an excavation worker is in Table 6-12. The comparison indicates PSC SD-38 is still within the acceptable risk range.

Table 6-12

REASONABLE MAXIMUM EXPOSURE POINT CONCENTRATIONS IN SOIL AND USEPA REGION IX PRGS FOR SURFACE AND SUBSURFACE SOIL (EXCAVATION WORKER)
PSC SD-38
Luke Air Force Base, Arizona

Constituent	Exposure Point Concentration (mg/kg)	USEPA Region IX Industrial PRG (mg/kg)		*Risk or Hazard	ADEQ SRL (mg/kg)	
		1996	2000		Residential	Non-Residential
Cancer Effects				ELCR		
Metals						
Arsenic	7.8	2.4	2.7	2.9E-06	10	10
Beryllium	0.37	1.1	2,200	1.7E-10	1.4	11
Total Site Risk				***3E-06***		
Non-Cancer Effects				HQ		
TRPHs [a]	16,000	NA	NA	NA	4,100	18,000
Metals						
Arsenic	7.8	NA	440	1.8E-02	10	10
Beryllium	0.37	NA	3,700	1.0E-04	1.4	11
Hazard Index				***0.02***		

All Units in milligrams per kilogram (mg/kg).

ADEQ SRL	Arizona Department of Environmental Quality 2000 Soil Remediation Level.
BNAs	Base-neutral and extractable acids.
ELCR	Excess lifetime cancer risk.
HQ	Hazard quotient.
NA	Not available.
PRG	Preliminary Remediation Goal.
TRPHs	Total recoverable petroleum hydrocarbons.
USEPA	U.S. Environmental Protection Agency.

[a] n-Hexane was used as a surrogate in the risk assessment for toxicity. A PRG for TRPHs is not provided.
*Risk and Hazards are based upon 2000 Industrial PRGs

Surface soil samples were taken from a depth of 0 to 2 feet below ground surface.
Subsurface soil samples were taken from a depth of 2 to 16 feet below ground surface.
Exposure point concentrations were taken from the 95 percent upper confidence limit (one-tailed) on the mean, assuming a normal distribution.
Arsenic background levels in the State of Arizona regularly exceed the PRGs. Arsenic is present at this site within background levels, and when taken out of the equation the ELCR and hazard index are within acceptable risk ranges.

Changes in Exposure Pathways, Toxicity and Other Contaminant Characteristics

There were no changes in exposure pathways, toxicity, or other contaminant characteristics.

Data Evaluation

The determination to use institutional controls was based on the HI, which was above the allowable residential risk of 1.0. The elevated HI was caused by several samples with high TRPH concentrations.

Assessment

Is the remedy functioning as intended by decision documents?

The objective of the institutional controls was to prevent residential development at the site. The institutional controls have functioned as intended.

Are the assumptions used at the time of the remedy selection still valid?

The assumptions used in performing the risk assessment at the site are still valid.

Has any other information come up that could question the protectiveness of the remedy?

No additional information has come to light that could call into question the protectiveness of the remedy.

Issues

No issues were discovered during this five-year review.

Recommendations and Follow-up Activities

No recommendations or follow-up activities are suggested at this time.

Protectiveness Statement

The remedy at PSC SD-38 is protective of human health and the environment and exposure pathways that could result in unacceptable risks are being controlled.

6.2.8 PSC SS-42 Bulk Fuels Storage

Remedial Actions

Remedy Selection

As stated in the OU-1 ROD, the remedy selected for PSC SS-42 consisted of the following:

- Soil vapor extraction
- Groundwater monitoring

Remedy Implementation

Implementation of the remedial action selected for PSC SS-42 is summarized as follows:

- In August 1996, the Base initiated a SVE removal action at PSC SS-42.
- A highly modified ICE was used to draw contaminated vapors from the ground and to treat the off-gas prior to discharge.
- The SVE removal action continued through November 1998.
- In June 1997, an initial confirmation boring was advanced to a depth of 181 feet bgs near the former UST location.
- The analytical results indicated that BTEX and TPH had been decreased in the subsurface. However, the results also indicated that BTEX was detected at depths below 150 bgs at concentrations higher than they had been originally detected.
- A second confirmation boring, located approximately eight feet northwest of monitoring well MW-121, was advanced to a depth of 310 feet bgs.
- TPH and benzene were detected above their respective residential SRLs. Benzene was also detected above the industrial SRLs. Toluene, ethylbenzene,

and total xylenes were detected in several samples but below their respective SRLs[32].

- Analytical data indicates that SVE operation has removed approximately 399,514 pounds of TPH (approximately 66,584 gallons of hydrocarbons) and reduced BTEX concentrations by 87%.
- Although benzene was detected above the AWQS during the November 1998 groundwater sampling event, the May 1999, May 2000 and August 2001 samples did not contain benzene above laboratory detection limits.
- Groundwater monitoring has continued at the site[32].

System Operation and Maintenance

Operation and maintenance was performed monthly during operation of the SVE. This included sampling, field measurements, readings from the system, and engine service. Also, any problems with the system between monthly visits were addressed as needed. The cost of the operation and maintenance was $65,910. There was no cost for remediation because the internal combustion engine (ICE) was provided to Luke AFB without charge by AFCEE.

Progress Since the Last Five-year Review

This is the first five-year review conducted for the site.

Five-year Review Findings

Site Inspection

There were no changes in land use since implementation of the remedy observed during the site inspection. Photographs of PSC SS-42 taken as part of the site inspection are in Appendix E.

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[32] ARCADIS Geraghty & Miller, Inc. 2000. Soil Vapor Extraction and Confirmation Sampling Summary Report, PSC SS-42, May 22, 2000.

Changes to Standards

A comparison of exposure point concentrations in surface and subsurface soils and USEPA Region IX PRGs for an excavation worker is in Table 6-13. The comparison indicates that PSC SS-42 is still within the acceptable risk range.

Changes in Exposure Pathways, Toxicity and Other Contaminant Characteristics

There were no changes in exposure pathways, toxicity, or other contaminant characteristics.

Data Evaluation

Based on the laboratory analysis of soil samples collected from confirmation soil boring number 2 (CB-2), detected TPH concentrations in the soil directly beneath the former Leaking Under Storage Tank (LUST) range from 250 to 7,400 mg/kg. With the exception of the 7,400 mg/kg concentration, all other detected TPH values are below the residential SRL of 4,100 mg/kg. The TPH concentration of 7,400 mg/kg is above the residential SRL but below the non-residential SRL of 14,000 mg/kg. Detected benzene concentrations ranged from 0.23 to 150 mg/kg. The benzene concentrations detected at 140 feet bgs (150 mg/kg) and 150 feet bgs (2.5 mg/kg) were above both the residential SRL (0.62 mg/kg) and non-residential SRL (1.4 mg/kg), respectively. Detected toluene concentrations were below both the residential SRL (790 mg/kg) and the non-residential SRL (2,700 mg/kg), respectively. Detected ethylbenzene concentrations were below both the residential SRL (1,500 mg/kg) and the non-residential SRL (2,700 mg/kg), respectively. Detected total xylenes concentrations were below both the residential (2,800mg/kg) and non-residential SRL (2,800mg/kg). Analytical data indicates that SVE operation has removed approximately 399, 514 pounds of TPH (approximately 66,584 gallons of hydrocarbons) and reduced BTEX concentrations by 87 percent. Although benzene was detected above AWQSs during the November 1998 groundwater-sampling event, the May 1999, May 2000 and August 2001 samples did not contain benzene above laboratory detection limits. Groundwater monitoring has continued at the site[32].

Table 6-13

POST REMEDIATION CONCENTRATIONS IN SOIL AND USEPA REGION IX PRGS FOR SURFACE AND SUBSURFACE SOIL (EXCAVATION WORKER)
PSC SS-42
Luke Air Force Base, Arizona

	Post Remediation Concentration (mg/kg)	USEPA Region IX Industrial PRG (mg/kg)		*Risk or Hazard	ADEQ SRL (mg/kg)	
Constituent		1996	2000		Residential	Non-Residential
Cancer Effects				ELCR		
VOCs						
Benzene	ND	1.4	1.5	NA	0.62	1.4
Ethylbenzene [a]	ND	NC	NC	NA	1,500	2,700
Toluene [a]	ND	NC	NC	NA	790	2,700
(total) Xylenes [a]	ND	NC	NC	NA	2,800	2,800
Total Site Risk				***NA***		
Non-Cancer Effects				HQ		
TPH [b]	ND	NA	NA	NA	4,100	18,000
VOCs						
Benzene	ND	NA	24	NA	0.62	1.4
Ethylbenzene [a]	ND	230	230	NA	1,500	2,700
Toluene [a]	ND	880	520	NA	790	2,700
(total) Xylenes [a]	ND	320	210	NA	2,800	2,800
Hazard Index				***NA***		

All Units in milligrams per kilogram (mg/kg).

ADEQ SRL	Arizona Department of Environmental Quality 2000 Soil Remediation Level.
BNAs	Base-neutral and extractable acids.
ELCR	Excess lifetime cancer risk.
HQ	Hazard quotient.
PRG	Preliminary Remediation Goal.
USEPA	U.S. Environmental Protection Agency.

ND - Non Detect
NA - Not Applicable
[a] The PRG is based on soil saturation.
[b] n-Hexane was used as a surrogate in the risk assessment for toxicity. A PRG for TRPHs is not provided.

*Risk and Hazards are based upon 2000 Industrial PRGs
Exposure point concentrations are based upon second confirmation sampling analytical results from 1999 of the Soil Vapor Extraction and Confirmation Sampling Summary Report by ARCADIS Geraghty & Miller dated May 22, 2000.

Surface soil samples were taken from a depth of 0 to 2 feet below ground surface.
Subsurface soil samples were taken from a depth of 2 to 16 feet below ground surface.

Groundwater Protection Level (GPL) Modeling

As detailed in the ROD, vadose zone fate-and-transport modeling was previously conducted at the site during the OU-1 remedial investigation[13]. Results of this modeling indicate that petroleum related compounds (i.e. TPH and BTEX) could eventually leach to the groundwater. However, the vadose zone modeling results conducted as part of the OU-1 remedial investigation did not predict whether these petroleum related compounds could cause a violation of the AWQS at a point of compliance. As a result, groundwater protection levels (GPLs) had not been previously established for the site. GPLs could not be calculated for TPH because there are no numeric water quality standards established for TPH. GPLs can only be calculated for individual constituents with AWQSs. Of the petroleum-related constituents with established AWQSs detected at the site, BTEX compounds posed the greatest potential risk to human health. For these reasons, GPLs calculated for BTEX are considered representative values established for the protection of groundwater from the petroleum release at the site.

As a consequence of the limited depth of incorporation range presented in the ADEQ “Alternative GPL” tables, a site-specific model had to be used to determine GPLs for the site. The ADEQ screening model was selected for use in this evaluation. Several model runs were conducted using varying depths of incorporation and varying depths to groundwater. These additional runs were conducted so that GPLs could be established for a variety of potential site conditions in the event confirmation sampling at the site yields a different depth of incorporation and depth to groundwater than indicated by previously collected site characterization data. The results of the additional modeling runs are summarized below:

- GPLs calculated for benzene ranged from 8,685 mg/kg (180.45 ft depth of incorporation and 295.28 ft depth to groundwater) to 400,600 mg/kg (180.45 ft depth of incorporation and 328.10 ft depth to groundwater).
- GPLs calculated for the ethylbenzene ranged from 679 mg/kg (180.45 ft depth of incorporation and 229.66 ft depth to groundwater) to GWNT at variable depths.
- GPLs calculated for toluene ranged from 35,310 mg/kg (180.45 ft depth of incorporation and 229.66 ft depth to groundwater) to GWNT at variable depths.
- GPLs calculated for xylenes ranged from 23,580 mg/kg (180.45 ft depth of incorporation and 229.66 ft depth to groundwater) to GWNT at variable depths.

Concentrations of BTEX remaining in the soils are protective of groundwater. Analytical results and the GPL model also indicate that remediation has decreased hydrocarbon concentrations to this protective point and further remediation is not needed. However, because constituents of concern were detected at a depth of 140 feet bgs, it was prudent to conduct groundwater monitoring.

Assessment

Is the remedy functioning as intended by decision documents?

The objective of the remedial action was to clean up impacted soil and prevent migration to groundwater. Analytical data indicates that SVE operation has removed approximately 399,514 pounds of TPH (approximately 66,584 gallons of hydrocarbons) and reduced BTEX concentrations by 87 percent. TPH and BTEX were not detected above laboratory detection limits during the most recent groundwater results.

Are the assumptions used at the time of the remedy selection still valid?

The assumptions made at the time of the remedy selection are still valid.

Has any other information come up that could question the protectiveness of the remedy?

No additional information has come to light that could call into question the protectiveness of the remedy.

Issues

No issues were discovered as part of this five-year review.

Recommendations and Follow-up Activities

MW-121 and MW-125R will be monitored as part of future five-year reviews. No other recommendations or follow-up activities are suggested at this time.

Protectiveness Statement

The remedy at PSC SS-42 is protective of human health and the environment and exposure pathways that could result in unacceptable risks are being controlled.

6.3 Review Process for OU-2 PSCs

OU-2 PSCs for which there was no action taken (refer to discussion in Section 1.1.3 and information in Table 3-1) include the following:

- OT-04
- DP-05
- FT-06
- FT-07W
- DP-22
- SD-40

A comparison of the EPC for a given COC in the combined surface and subsurface soil, with USEPA Region IX industrial PRGS (1996 and 2000) and ADEQ residential and non-residential SRLs is in Appendix C. EPCs were taken from the 95 percent upper confidence limit (one-tailed) on the mean assuming a normal distribution.

OU-2 PSCs for which remedies were selected based on the results of risk assessment include the following:

- ST-18
- DP-23

For OU-2 PSCs, 1991 USEPA Region IX PRGs were originally used to establish performance standards. To evaluate changes in standards as part of this five-year review, cancer risks and non-cancer hazards were recalculated for each COC using 2000 USEPA Region IX industrial PRGs and post remediation exposure point concentrations for Base worker and excavation worker scenarios as applicable. The analysis of standard changes also included a review of 1996 USEPA industrial PRGs. ADEQ SRLs were also reviewed since they were used to evaluate residential use standards. USEPA Region IX PRGs for 1991, 1996 and 2000 are in Appendix D. Changes in standards are evaluated with respect to the continued effectiveness of the remedies that were implemented based on a non-cancer HI greater than or equal to 1.0 or an ELCR greater than the risk of $1x10^{-6}$ to $1x10^{-4}$.

6.3.1 PSC ST-18 Facility 993

Remedial Actions

Remedy Selection

As stated in the OU-2 ROD, the remedy selected for PSC ST-18 consisted of the following:

- Inspection and maintenance of concrete cap
- Institutional controls
- Monitoring of groundwater every five years

Remedy Implementation

The implementation of the remedy for PSC ST-18 is summarized as follows:

- The site was capped with nine inches of concrete, underlain by six inches of base course and a 30-mil HDPE liner as part of the RCRA closure requirement in 1987.
- The integrity of the cap has been maintained through annual inspections of the concrete and joints and repairs as needed in accordance with the Air Force design guidance for airfield pavement maintenance and recommendations contained in the annual inspection report. Annual inspection reports are maintained at the Environmental Flight office of Luke AFB. A visual inspection was conducted in August 2000 and the need for some repairs was identified. Recommended repairs were performed in August 2001. The annual inspection report dated October 2001 documents the successful completion of repairs.
- According to the ROD, a deed restriction would be placed on the site as part of the surface controls to prevent removal of the cap and excavation of the soil. A DEUR has been filed with the ADEQ for this site.
- The other surface control at the site is the Base perimeter fence monitored 24-hours a day which prevents public access and exposure.

- Groundwater at the site has been monitored semiannually since 1991. A review of the site data was conducted in 2000 and it was concluded that groundwater monitoring was not necessary at the site[33].
- The FCOR states that groundwater monitoring will be conducted at the site as part of each five-year review. Well MW-114 was monitored in October 2001 as part of the five-year review process. No constituent s exceeded standards in the sample from MW-114.

System Operation and Maintenance

Operation and maintenance has included annual inspections of the cap. The integrity of the cap has been maintained through annual inspections of the concrete and joints and repairs have been conducted as needed in accordance with the Air Force design guidance for airfield pavement and maintenance and recommendations contained in the annual inspection reports. The cost of the cap in 1987 was $122,300. The annual cap inspection is $2,500. To date, the costs of repairs to the cap have been $12,118. An additional $3,880 in repairs is scheduled for 2001.

Progress Since the Last Five-year Review

This is the first five-year review conducted for the site.

Five-year Review Process

Five-year Review Findings

Site Inspection

Comments made during the site inspection of PSC ST-18 are noted under recommendations and follow-up activities below. No changes in land use were observed since implementation of the remedy. Photographs of PSC ST-18 taken as part of the site inspection are in Appendix E.

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[33] Geraghty & Miller, Inc., 2000. RCRA Facility Investigation Summary Report Facility #993 (PSC ST-18), Luke Air Force Base, Arizona, December 19, 2000.

Changes to Standards

A comparison of exposure point concentrations in surface and subsurface soils and USEPA Region IX PRGs for an excavation worker is in Table 6-14. The comparison indicates that PSC ST-18 is still within the acceptable risk range.

Changes in Exposure Pathways, Toxicity and Other Contaminant Characteristics

There were no changes in exposure pathways, toxicity, or other contaminant characteristics.

Table 6-14

POST REMEDIATION CONCENTRATIONS IN SOIL AND USEPA REGION IX PRGS FOR SURFACE AND SUBSURFACE SOIL (EXCAVATION WORKER)
PSC ST-18
Luke Air Force Base, Arizona

Constituent	Post Remediation Concentration (mg/kg)	USEPA Region IX Industrial PRG (mg/kg)		*Risk or Hazard	ADEQ SRL (mg/kg)	
		1996	2000		Residential	Non-Residential
Cancer Effects				ELCR		
VOCs						
Ethylbenzene	0.15	NC	NC	NA	1,500	2,700
Xylenes	1.3	NC	NC	NA	2,800	2,800
BNAs						
Benzo(a)anthracene	0.43	2.6	2.9	1.5E-07	6.1	26
Benzo(b)fluoranthene	0.77	2.6	2.9	2.7E-07	6.1	26
Benzo(a)pyrene	0.43	0.26	0.29	1.5E-06	0.61	2.6
Benzyl alcohol	0.42	100,000	100,000	4.2E-12	20,000	200,000
Bis(2-Ethylhexyl)phthalate	0.075	140	180	4.2E-10	320	1,400
Chrysene	0.92	7.2	62	1.5E-08	610	2,600
Indeno (1,2,3-cd)pyrene	0.34	0.61	0.62	5.5E-07	6.1	26
Total Site Risk				***2E-06***		
Non-Cancer Effects				HQ		
VOCs						
Ethylbenzene	0.15	230	230	6.5E-04	1,500	2,700
Xylenes	1.3	320	210	6.2E-03	2,800	2,800
BNAs						
Benzo(a)anthracene [b]	0.43	800	190	2.3E-03	6.1	26
Benzo(b)fluoranthene [b]	0.77	800	190	4.1E-03	6.1	26
Benzo(g,h,i)perylene [a]	0.56	100	54,000	1.0E-05	NA	NA
Benzo(a)pyrene [b]	0.43	800	190	2.3E-03	0.61	2.6
Benzyl alcohol	0.42	100,000	100,000	4.2E-06	20,000	200,000
Bis(2-ethylhexyl)phthalate [c]	0.075	140	180	NA	320	1,400
Chrysene [c]	0.92	7.2	62	NA	610	2,600
Fluoranthene	0.49	27,000	30,000	1.6E-05	2,600	27,000
2-Methylnaphthalene [d]	0.35	800	190	0.00	NE	NE
Phenanthrene [a]	0.18	100	54,000	3.3E-06	NA	NA
Pyrene	0.56	100	54,000	1.0E-05	2,000	20,000
TRPHs	ND	NA	NA	NA	4,100	18,000
Hazard Index				***0.02***		

All Units in milligrams per kilogram (mg/kg).

ADEQ SRL	Arizona Department of Environmental Quality 2000 Soil Remediation Level.
BNAs	Base-neutral and extractable acids.
ELCR	Excess lifetime cancer risk.
HQ	Hazard quotient.
NA	Not Applicable
ND	Non-detect
PRG	Preliminary Remediation Goal.
TRPHs	Total recoverable petroleum hydrocarbons.
USEPA	U.S. Environmental Protection Agency

[a] Pyrene is used as a surrogate.
[b] The PRG is based on naphthalene non-carcinogenic effects.
The hazard quotient presented under non-cancer effects is actually just the ratio of the PRG to the soil concentration.
[c] The PRG is based on carcinogenic effects so a non-cancer hazard quotient is not calculated.
[d] Napthalene is used as a furrogate for comparison to the Region IX PRG.

*Risk and Hazards are based upon 2000 Industrial PRGs

Surface soil samples were taken from a depth of 0 to 2 feet below ground surface.
Subsurface soil samples were taken from a depth of 2 to 10 feet below ground surface.
Post remediaiton concentrations were taken from the maximum concentration of the constituent within a medium from a depth of 0 through 10 feet from Figures 2 and 4 of the RCRA Facility Investigation Summary Report Facility #993 (PSC ST-18) by Geraghty & Miller, Inc., date December 19, 2000.

Data Evaluation

Soil samples collected in 1992 had concentrations of TRPH ranging up to 17,000 mg/kg. BTEX, 1,1-DCA, 1,1,2,2-tetrachloroethane, TCE, and PCE were also detected. Lead was detected above the background UTLs. The highest concentration of lead was 32 mg/kg. The risk assessment conducted for the site concluded that the most conservative ELCR and HI were 3 x 10^{-6} and 0.1, respectively. The purpose of the institutional controls at the site are to ensure the integrity of the concrete cap.

Assessment

Is the remedy functioning as intended by decision documents?

The objective of the remedial action was to prevent exposure to the contaminated soil. By maintaining the integrity of the cap, implementing surface controls, and continuing groundwater monitoring, the remedy is functioning as intended.

Are the assumptions used at the time of the remedy selection still valid?

The assumptions made at the time of the remedy selection are still valid.

Has any other information come up that could question the protectiveness of the remedy?

No additional information has come to light that could call into question the protectiveness of the remedy.

Issues

According to the ROD, a deed restriction should be placed on the site as part of the institutional controls to prevent removal of the cap and excavation of the soil. A Declaration of Environmental Use Restriction (DEUR) for PSC ST-18 has been filed with the ADEQ.

Recommendations and Follow-up Activities

The following are the recommendations or follow-up activities suggested at this time:

- According to the ROD, a deed restriction needs to be placed on the site as part of the institutional controls. A DEUR has been filed with the ADEQ to restrict residential land use in the future.
- As part of the inspection, it was noted the concrete cap is in good condition and is well maintained by Luke AFB and that maintenance of cracks in the concrete is less critical given the presence of the geomembrane layer. The cap will continue to be inspected annually.
- MW-114 and MW-122 will be monitored annually for VOCs and the results evaluated as part of the next five-year review.

Protectiveness Statement

The remedy at PSC ST-18 Facility 993 currently protects human health and the environment because the cap prevents exposure in the short term. However, in order for the remedy to be protective in the long term, a DEUR will be placed at the site to ensure long-term protectiveness. In addition, MW-114 and WM-122 will be monitored for VOCs and evaluated as part of the next five-year review.

6.3.2 PSC DP-23 Old Surface Impoundment West of Facility 993

Remedial Actions

Remedy Selection

In accordance with the OU-2 ROD, the selected remedy for the southern portion of PSC DP-23 consisted of the following:

- Excavation
- Ex-situ biological treatment
- On-site disposal
- Monitoring

The selected remedy for the northern portion of PSC DP-23 was no action.

<u>Remedy Implementation</u>

Southern Portion of PSC DP-23

The implementation of the remedy for the southern portion of PSC DP-23 is summarized as follows:

- In 1995, a preliminary soil survey was conducted by Environmental Chemical Corporation (ECC) to determine the exact extent of the impacted soil[34].
- Based on the results of the preliminary survey, the USACE requested a more detailed site characterization.
- Additional samples were collected and ECC used the results to determine the area for excavation.
- ECC constructed berms to contain impacted soil and divert surface runoff away from the excavation areas.
- An on-site containment cell was constructed and lined with a 40 mil HDPE liner and topped with approximately six inches of native soil to protect the liner.
- ECC excavated 625 cubic yards of soil, which was transferred to the containment cell.
- The soil was mixed with alfalfa, manure, wood chips and green waste according to ratios established by Woods End Research Laboratory during computer optimization studies to form a compost.
- Composite samples were collected to determine the baseline levels of benzo(a)pyrene.
- The soil was tilled and watered and monitored daily for temperature, oxygen, and moisture content.
- Interim sampling was conducted after the compost had been processed for 60 days from the same locations as the baseline samples with a final sampling event was conducted after 120 days.
- The interim sample results indicated one quarter of the soil remained above PRGs.
- The soil was composted for an additional 60 days.

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[34] Environmental Chemical Corporation, 1997. Closure Report, Site DP-23, Soil Composting at Luke Air Force Base, Arizona, August 27, 1997.

- Samples collected after the additional 60 days of composting indicated benzo(a)pyrene concentrations were below PRGs.
- Upon completion of the remediation, the site was restored to its original condition and the liner was disposed at a local landfill.
- The PAH concentrations were compared to analytical detection limits and not PRGs. This was done because the evaluation of risk determined that the risk associated with the higher concentrations was acceptable based on the potential for exposure of a base worker or construction worker to PAH at DP-23 south.
- The site was closed based on completion of remediation

Northern Portion of PSC DP-23

While the extent of impacted soil was being determined for the southern portion of the site it became apparent that the contamination extended northward. The implementation of the remedy for the northern portion of PSC DP-23 is summarized as follows:

- In 1996, Dames & Moore performed a risk-based assessment for the northern portion of PSC DP-23 based on two rounds of soil sampling conducted to characterize soil impacts at the site[35] and the results of samples collected by ECC in 1995. The extent of contamination to the north was never fully determined due to the tarmac at the northern most reaches of the site. Due to mission impact, no samples were collected from under the tarmac.
- Dames & Moore used the 1996 EPA Region IX PRG tables for soil to calculate the potential risk. Dames & Moore concluded that over the entire extent of the site, the predicted risk associated with exposure to carcinogens from PAHs in the surface soil was 1×10^{-5} and that predicted risks associated with exposure to subsurface soils ranged from 6×10^{-6} to 2×10^{-5}.
- These risks calculated by Dames & Moore were within the acceptable range of 1×10^{-6} to 1×10^{-4} for industrial sites according to EPA and ADEQ standards.
- Although Dames & Moore did not recommend soil remediation, they did recommend a VEMUR be implemented on the site.
- In 2001, a DEUR was filed with the ADEQ.

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[35] Dames & Moore, 1998. Final Site DP-23 Phase II Remedial Design Report, Luke Air Force Base, Arizona, April 1998.

System Operation and Maintenance

No operation and maintenance was required for the remedy selected. Remedial costs for the southern portion of PSC DP-23 were $735,805. The cost of the risk-based assessment for the northern portion of PSC DP-23 was $149,159.

Progress Since the Last Five-year Review

This is the first five-year review conducted for the site.

Five-year Review Findings

Site Inspection

There were no comments during the site inspection of PSC DP-23. No changes in land use were observed since implementation of the remedy. Photographs of PSC DP-23 taken as part of the site inspection are in Appendix E.

Changes to Standards

Southern Portion of PSC DP-23

A comparison of exposure point concentrations in sub-surface soils utilizing post-remediation data and USEPA Region IX PRGs is in Tables 6-15. The comparison indicates the southern portion of PSC DP-23 is within the acceptable risk range.

Northern Portion of PSC DP-23

A comparison of exposure point concentrations in surface soils and USEPA Region IX PRG's for a base worker and surface and sub-surface soils and USEPA Region IX PRG's for an excavation worker are in Tables 6-16 and 6-17, respectively. The comparison indicates the northern portion of PSC DP-23 is within the acceptable risk range for industrial land use and outside the acceptable risk range for residential land use. A DEUR for this portion of the site has been filed with the ADEQ to provide long-term protectiveness.

Changes in Exposure Pathways, Toxicity and Other Contaminant Characteristics

There were no changes in exposure pathways, toxicity, or other contaminant characteristics.

Data Evaluation

Southern Portion of PSC DP-23

The impacted soil at the site was remediated. Post-remediation soil samples collected from the walls and floors of the excavation indicate the site has been remediated to residential standards.

Table 6-15

POST REMEDIATION CONCENTRATIONS IN SOIL AND USEPA REGION IX PRGS FOR SURFACE SOIL (BASE WORKER)
PSC DP-23 (NORTHERN PORTION)
Luke Air Force Base, Arizona

Constituent	Post Remediation Concentration (mg/kg)	USEPA Region IX Industrial PRG (mg/kg)		*Risk or Hazard	ADEQ SRL (mg/kg)	
		1996	2000		Residential	Non-Residential
Cancer Effects				ELCR		
BNAs						
Benzo(a)anthracene	35.0	2.6	2.9	1.2E-05	6.1	26
Benzo(a)pyrene	35.0	0.26	0.29	1.2E-04	0.61	2.6
Benzo(b)fluoranthene	57.0	2.6	2.9	2.0E-05	6.1	26
Benzo(k)fluoranthene	18.0	26	29	6.2E-07	61	260
Chrysene	28.0	7.2	62	4.5E-07	610	2,600
Dibenzo(a,h)anthracene	2.5	0.26	0.29	8.6E-06	0.61	26
Indeno(1,2,3-cd)pyrene	31.0	0.61	0.62	5.0E-05	6.1	26
Total Site Risk				***2.1E-04***		
Non-Cancer Effects				HQ		
BNAs						
Acenaphthene	1.1	110	38,000	2.9E-05	3,900	41,000
Acenaphthylene	<5	NA	NA	NA	NA	NA
Anthracene	3.50	5.7	100,000	3.5E-05	20,000	200,000
Benzo(g,h,i)perylene [a]	33.00	100	54,000	6.1E-04	NA	NA
Fluoranthene	33	27,000	30,000	1.1E-03	2,600	27,000
Fluorene	5	90	33,000	1.5E-04	2,600	27,000
Napthalene	7.6	240	190	4.0E-02	2,600	27,000
Phenanthrene [a]	14	100	54,000	2.6E-04	NA	NA
Pyrene	40	100	54,000	7.4E-04	2,000	20,000
Hazard Index				***0.04***		

All Units in milligrams per kilogram (mg/kg).

ADEQ SRL	Arizona Department of Environmental Quality 2000 Soil Remediation Level.
BNAs	Base-neutral and extractable acids.
ELCR	Excess lifetime cancer risk.
HQ	Hazard quotient.
NA	Not available.
NC	Not carcinogenic.
PRG	Preliminary Remediation Goal.
USEPA	U.S. Environmental Protection Agency.

[a] Pyrene is used as a surrogate.
*Risk and Hazard are based upon 2000 Industrial PRGs

Surface soil samples were taken from a depth of 0 to 3 feet below ground surface.
Subsurface soil samples were taken from a depth of 3 to 10 feet below ground surface.

The cancer effect concentrations were based on the maximum exposure concentrations in the surface soil. These concentrations came from one sample, which contained the highest concentrations of BNAs, and exceed the risk value of 1.0E-04. The remaining sample concentrations for BNAs do not exceed the risk value of 1.0E-04.
Post remediation information was obtained from the Final Site DP-23 Phase II Remedial Design Report by Dames & Moore, dated April 10, 1998.

Table 6-16

POST REMEDIATION CONCENTRATIONS IN SOIL AND USEPA REGION IX PRGS FOR SURFACE AND SUBSURFACE SOIL (BASE AND EXCAVATION WORKER)
PSC DP-23 (SOUTHERN PORTION)
Luke Air Force Base, Arizona

Constituent	Post Remediation Concentration (mg/kg)	USEPA Region IX Industrial PRG (mg/kg)		*Risk or Hazard	ADEQ SRL (mg/kg)	
		1996	2000		Residential	Non-Residential
Cancer Effects				ELCR		
BNAs						
Benzo(a)pyrene	0.508	0.26	0.29	1.8E-06	0.61	2.6
Benzo(b)fluoranthene	ND	2.6	2.9	NA	6.1	26
Indeno(1,2,3)pyrene	ND	0.61	0.62	NA	6.1	26
Total Site Risk				***1.8E-06***		
Non-Cancer Effects				HQ		
BNAs						
Benzo(a)pyrene	0.508	0.26	0.29	NA	0.61	2.6
Benzo(b)fluoranthene	ND	2.6	2.9	NA	6.1	26
Indeno(1,2,3)pyrene	ND	0.61	0.62	NA	6.1	26
Hazard Index				***NA***		

All Units in milligrams per kilogram (mg/kg).

ADEQ SRL	Arizona Department of Environmental Quality 2000 Soil Remediation Level.
BNAs	Base-neutral and extractable acids.
ELCR	Excess lifetime cancer risk.
HQ	Hazard quotient.
NA	Not available.
NC	Not carcinogenic.
ND	Non-detect.
PRG	Preliminary Remediation Goal.
USEPA	U.S. Environmental Protection Agency.

[a] Pyrene is used as a surrogate.
*Risk and Hazard are based upon 2000 Industrial PRGs

Soil samples were taken from depths of 0 to 2 feet, 4 to 6 feet, and 8 to 10 feet below ground surface.
Post remediation concentration data was obtained from the Closure Report, Site DP-23, Soil Composting, by Environmental Chemical Corporation, dated August 27, 1997.

Table 6-17

POST REMEDIATION CONCENTRATIONS IN SOIL AND USEPA REGION IX PRGS FOR SURFACE AND SUBSURFACE SOIL (EXCAVATION WORKER)
PSC DP-23 (NORTHERN PORTION)
Luke Air Force Base, Arizona

Constituent	Post Remediation Concentration (mg/kg)	USEPA Region IX Industrial PRG (mg/kg) 1996	USEPA Region IX Industrial PRG (mg/kg) 2000	*Risk or Hazard	ADEQ SRL (mg/kg) Residential	ADEQ SRL (mg/kg) Non-Residential
Cancer Effects				ELCR		
BNAs						
Benzo(a)anthracene	8.11	2.6	2.9	2.8E-06	6.1	26
Benzo(a)pyrene	8.03	0.26	0.29	2.8E-05	0.61	2.6
Benzo(b)fluoranthene	13.8	2.6	2.9	4.8E-06	6.1	26
Benzo(k)fluoranthene	5.1	26	29	1.8E-07	61	260
Chrysene	6.8	7.2	62	1.1E-07	610	2,600
Dibenz(a,h)anthracene	8.0	0.26	0.29	2.8E-05	0.61	26
Indeno(1,2,3-cd)pyrene	7.3	0.61	0.62	1.2E-05	6.1	26
Total Site Risk				***7.5E-05***		
Non-Cancer Effects				HQ		
BNAs						
Acenaphthene	1.6	110	38,000	4.2E-05	3,900	41,000
Acenaphthylene	<1.6	NA	NA	NA	NA	NA
Anthracene	9.8	5.7	100,000	9.8E-05	20,000	200,000
Benzo(g,h,i)perylene [a]	145	100	54,000	2.7E-03	NA	NA
Fluoranthene	110	27,000	30,000	3.7E-03	2,600	27,000
Fluorene	1.5	90	33,000	4.5E-05	2,600	27,000
Napthalene	17.9	240	190	9.4E-02	2,600	27,000
Phenanthrene [a]	44.2	100	54,000	8.2E-04	NA	NA
Pyrene	147	100	54,000	2.7E-03	2,000	20,000
Hazard Index				***0.1***		

All Units in milligrams per kilogram (mg/kg).

ADEQ SRL	Arizona Department of Environmental Quality 2000 Soil Remediation Level.
BNAs	Base-neutral and extractable acids.
ELCR	Excess lifetime cancer risk.
HQ	Hazard quotient.
NA	Not available.
NC	Not carcinogenic.
PRG	Preliminary Remediation Goal.
USEPA	U.S. Environmental Protection Agency.

[a] Pyrene is used as a surrogate.
*Risk and Hazard are based upon 2000 Industrial PRGs

Surface soil samples were taken from a depth of 0 to 3 feet below ground surface.
Subsurface soil samples were taken from a depth of 3 to 10 feet below ground surface.
Post remediation information was obtained from the Final Site DP-23 Phase II Remedial Design Report by Dames & Moore, dated April 10, 1998.
The northern portion of DP-23 is capped and affected soils are inaccessible to base and construction workers, therefore there is no exposure to the impacted soils.

Northern Portion of PSC DP-23

No remedial action was performed on this site. A risk-based assessment was conducted by Dames & Moore[36] and concluded that the potential risk from exposure to the carcinogenic PAHs was between 1 x 10^{-6} and 1 x 10^{-4}. The potential risk meets the acceptable ranges for industrial sites but does not meet the acceptable limit for residential sites. Therefore, a DEUR should be implemented on the site. The risk-based assessment used 1996 PRGs, which are more stringent than the 2000 PRGs.

Assessment

Is the remedy functioning as intended by decision documents?

The objective of the remedial action established in the OU-2 ROD was to clean up impacted soil in the southern portion of PSC DP-23. Since the soil was successfully remediated to residential standards, the remedy is considered protective.

Are the assumptions used at the time of the remedy selection still valid?

The assumptions made at the time of the remedy selection are still valid.

Has any other information come up that could question the protectiveness of the remedy?

No additional information has come to light that could call into question the protectiveness of the remedy.

Issues

The northern portion of PSC DP-23 requires a DEUR to provide long-term protectiveness.

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[36] Dames & Moore, 1998. Final DP-23 Phase II Remedial Desgn Report, Luke Air Force Base, Arizona.

Recommendations and Follow-up Activity

The following are the recommendations or follow-up activities suggested at this time:

- A DEUR needs to be finalized for the northern portion of PSC DP-23 since the site was not remediated to residential standards.

Protectiveness Statement

The remedy for the southern portion of PSC DP-23 is protective of human health and the environment. To ensure conditions for the northern portion of PSC DP-23 are protective of human health and the environment in the long-term, a DEUR has been filed with the ADEQ.

6.4 Groundwater Review

A comparison of exposure point concentrations in groundwater (maximum concentrations for the period of record) and USEPA Region IX 2000 PRGs for tap water and ADEQ aquifer water quality standards are in Tables 6-18 through 6-26, respectively, for the following PSCs:

- RW-02
- DP-05
- FT-06
- FT-07
- ST-18
- SD-20
- SD-21
- SD-38
- SS-42

The comparison indicates groundwater is within the acceptable risk range for applicable PSCs.

Table 6-18

MAXIMUM EXPOSURE POINT CONCENTRATIONS IN GROUNDWATER AND USEPA REGION IX PRGS FOR PSC RW-02 (MW-115; MW-116; MW-124) Luke Air Force Base, Arizona

Constituent	Exposure Point Concentration (mg/L)	USEPA Region IX Tap Water PRG (mg/L) 2000	*Risk or Hazard	ADEQ 2000 Aquifer Water Qualtiy Standards (mg/L)
Cancer Effects			ELCR	
Inorganics				
Arsenic	0.017	0.000045	3.8E-04	0.05
Barium	0.071	NC	NC	2
Chromium	0.058	NC	NC	0.1
Copper	0.276	NC	NC	NA
Lead	0.018	NC	NC	0.05
Nickel	0.042	NC	NC	NA
Zinc	0.86	NC	NC	NA
Total Site Risk			***4E-04***	
Non-Cancer Effects			HQ	
Inorganics				
Arsenic	0.017	0.011	1.5E+00	0.05
Barium	0.071	2.6	2.7E-02	2
Chromium [a]	0.058	0.11	5.3E-01	0.1
Copper	0.276	1.4	2.0E-01	NA
Lead	0.018	NA	-	0.05
Nickel [b]	0.042	0.73	5.8E-02	NA
Zinc	0.86	11	7.8E-02	NA
Hazard Index			***2***	

ADEQ	Arizona Department of Environmental Quality.
ELCR	Excess lifetime cancer risk.
HQ	Hazard quotient.
NA	Not available.
NC	Non-Carcinogenic.
PRG	Preliminary Remediation Goal.
USEPA	U.S. Environmental Protection Agency.

[a] PRG is based on chromium VI non-carcinogenic effects.
[b] The PRG is based on nickel (soluble salts).
*Risk and Hazards are based upon 2000 Tap Water PRGs
MW-115 was abandoned on 2/7/95
MW-116 is to be abandoned.
MW-124 is to be abandoned.
(The metals in this table are based upon the maximum range of detects in the Occurrence of Constituents Detected in Groundwater Samples at PSC RW-02 table in the Basewide Risk Assessment. The analysis of the latest sampling event conducted on May 12, 1998, indicated the constituents analyzed were at non-detect levels.)

Arsenic background levels in the State of Arizona regularly exceed the PRG's. Arsenic is present at this site within background levels, and when taken out of the equation the ELCR and hazard index are within acceptable risk ranges.

Table 6-19

MAXIMUM EXPOSURE POINT CONCENTRATIONS IN GROUNDWATER AND USEPA REGION IX PRGS FOR PSC DP-05 (MW-104; MW-105; MW-106) Luke Air Force Base, Arizona

Constituent	Exposure Point Concentration (mg/L)	USEPA Region IX Tap Water PRG (mg/L) 2000	*Risk or Hazard	ADEQ 2000 Aquifier Water Qualtiy Standards (mg/L)
Cancer Effects			ELCR	
Inorganics				
Arsenic	0.014	0.000045	3.1E-04	0.05
Barium	0.27	NC	NC	2
Chromium	0.034	NC	NC	0.1
Copper	0.04	NC	NC	NA
Lead	0.017	NC	NC	0.05
Zinc	1.2	NC	NC	NA
Total Site Risk			***3E-04***	
Non-Cancer Effects			HQ	
Inorganics				
Arsenic	0.014	0.011	1.3E+00	0.05
Barium	0.27	2.6	1.0E-01	2
Chromium [a]	0.034	0.11	3.1E-01	0.1
Copper	0.04	1.4	2.9E-02	NA
Lead	0.017	NA	NA	0.05
Zinc	1.2	11	1.1E-01	NA
Hazard Index			***2***	

ADEQ	Arizona Department of Environmental Quality.
ELCR	Excess lifetime cancer risk.
HQ	Hazard quotient.
NA	Not available.
NC	Non-Carcinogenic.
PRG	Preliminary Remediation Goal.
USEPA	U.S. Environmental Protection Agency.

[a] PRG is based on chromium VI non-carcinogenic effects.
*Risk and Hazards are based upon 2000 Tap Water PRGs
MW-104 was abandoned.
MW-105 was abandoned.
MW-106 was abandoned.
(The metals in this table are based upon the maximum range of detects in the Occurrence of Constituents Detected in Groundwater Samples at PSC DP-05 table in the Basewide Risk Assessment. The analysis of the latest sampling event conducted on May 12, 1998, indicated the constituents analyzed were at non-detect levels.)

Arsenic background levels in the State of Arizona regularly exceed the PRG’s. Arsenic is present at this site within background levels, and when taken out of the equation the ELCR and hazard index are within acceptable risk ranges.

Table 6-20

MAXIMUM EXPOSURE POINT CONCENTRATIONS IN GROUNDWATER AND USEPA REGION IX PRGS FOR PSC FT-06 (MW-107; MW-108) Luke Air Force Base, Arizona

Constituent	Exposure Point Concentration (mg/L)	USEPA Region IX Tap Water PRG (mg/L) 2000	*Risk or Hazard	ADEQ 2000 Aquifier Water Qualtiy Standards (mg/L)
Cancer Effects			ELCR	
Inorganics				
Arsenic	0.016	0.000045	3.6E-04	0.05
Barium	0.214	NC	NC	2
Chromium	0.054	NC	NC	0.1
Copper	0.019	NC	NC	NA
Lead	0.01	NC	NC	0.05
Nickel	0.022	NC	NC	NA
Selenium	0.011	NC	NC	0.05
Zinc	2.05	NC	NC	NA
Total Site Risk			***4E-04***	
Non-Cancer Effects			HQ	
Inorganics				
Arsenic	0.016	0.011	1.5E+00	0.05
Barium	0.214	2.6	8.2E-02	2
Chromium [a]	0.054	0.11	4.9E-01	0.1
Copper	0.019	1.4	1.4E-02	NA
Lead	0.01	NA	-	0.05
Nickel [b]	0.022	0.73	3.0E-02	NA
Selenium	0.011	0.18	6.1E-02	0.05
Zinc	2.05	11	1.9E-01	NA
Hazard Index			***2***	

ADEQ	Arizona Department of Environmental Quality.
ELCR	Excess lifetime cancer risk.
HQ	Hazard quotient.
NA	Not available.
NC	Non-Carcinogenic.
PRG	Preliminary Remediation Goal.
USEPA	U.S. Environmental Protection Agency.

[a] The PRG is based on chromium VI non-carcinogenic effects.
[b] The PRG is based on nickel (soluble salts).
*Risk and Hazards are based upon 2000 Tap Water PRGs
MW-107 is abandond.
MW-108 is to be abandoned.
(The metals in this table are based upon the maximum range of detects in the Occurrence of Constituents Detected in Groundwater Samples at PSC FT-06 table in the Basewide Risk Assessment. The analysis of the latest sampling event conducted on June 6, 1996, indicated the constituents analyzed were at non-detect levels.)

Arsenic background levels in the State of Arizona regularly exceed the PRG’s. Arsenic is present at this site within background levels, and when taken out of the equation the ELCR and hazard index are within acceptable risk ranges.

Table 6-21

MAXIMUM EXPOSURE POINT CONCENTRATIONS IN GROUNDWATER AND USEPA REGION IX PRGS FOR PSC FT-07 (MW-109; MW-110; MW-111; MW-118; MW-123) Luke Air Force Base, Arizona

Constituent	Exposure Point Concentration (mg/L)	USEPA Region IX Tap Water PRG (mg/L) 2000	*Risk or Hazard	ADEQ 2000 Aquifier Water Qualtiy Standards (mg/L)
Cancer Effects			ELCR	
Inorganics				
Barium	0.32	NC	NC	2
Chromium	0.024	NC	NC	0.1
Copper	0.032	NC	NC	NA
Lead	0.008	NC	NC	0.05
Zinc	1.07	NC	NC	NA
Total Site Risk			***NC***	
Non-Cancer Effects			HQ	
Inorganics				
Barium	0.32	2.6	1.2E-01	2
Chromium [b]	0.024	0.11	2.2E-01	0.1
Copper	0.032	1.4	2.3E-02	NA
Lead	0.008	NA	-	0.05
Zinc	1.07	11	9.7E-02	NA
Hazard Index			***0.5***	

ADEQ	Arizona Department of Environmental Quality.
ELCR	Excess lifetime cancer risk.
HQ	Hazard quotient.
NA	Not available.
NC	Non-Carcinogenic.
PRG	Preliminary Remediation Goal.
USEPA	U.S. Environmental Protection Agency.

[a] Compund was detected but reported value is estimated.
[b] The PRG is based on chromium VI non-carcinogenic effects.
*Risk and Hazards are based upon 2000 Tap Water PRGs
MW-109 is to be abandoned.
MW-110 was abandoned 2/7/95.
MW-111 was abandoned 11/21/96.
MW-118 is to be abandoned.
MW-123 is to be abandoned.
(The metals in this table are based upon the maximum range of detects in the Occurrence of Constituents Detected in Groundwater Samples at PSC FT-07 table in the Basewide Risk Assessment. The analysis of the latest sampling event conducted on May 19, 1999, indicated the constituents analyzed were at non-detect levels.)

Table 6-22

MAXIMUM EXPOSURE POINT CONCENTRATIONS IN GROUNDWATER AND USEPA REGION IX PRGS FOR PSC ST-18 (MW-2; MW-3; MW-4; MW-5; MW-114; MW-122) Luke Air Force Base, Arizona

Constituent	Exposure Point Concentration (mg/L)	USEPA Region IX Tap Water PRG (mg/L)	*Risk or Hazard	ADEQ 2000 Aquifier Water Quality Standards (mg/L)
		2000		
Cancer Effects			ELCR	
VOCs				
cis-1,2-Dichloroethene	0.00094	NC	NC	0.07
Trichloroethene	0.002	0.0016	1.3E-06	0.005
Tetrachloroethene	0.00095	0.0011	8.6E-07	0.005
Inorganics				
Arsenic	0.019	0.000045	4.2E-04	0.05
Barium	0.26	NC	NC	2
Chromium	0.12	NC	NC	0.1
Copper	0.13	NC	NC	NA
Lead	0.026	NC	NC	0.05
Nickel	0.051	NC	NC	NA
Selenium	0.006	NC	NC	0.05
Zinc	8.7	NC	NC	NA
Total Site Risk			***4E-04***	
Non-Cancer Effects			HQ	
VOCs				
cis-1,2-Dichloroethene	0.00094	61	1.5E-05	0.07
Trichloroethene	0.002	0.0016	1.3E+00	0.005
Tetrachloroethene	0.00095	0.0011	8.6E-01	0.005
Inorganics				
Arsenic	0.019	0.011	1.7E+00	0.05
Barium	0.26	2.6	1.0E-01	2
Chromium [c]	0.12	0.11	1.1E+00	0.1
Copper	0.13	1.4	9.3E-02	NA
Lead	0.026	NA	-	0.05
Nickel [d]	0.051	0.73	7.0E-02	NA
Selenium	0.006	0.18	3.3E-02	0.05
Zinc	8.7	11	7.9E-01	NA
Hazard Index			***6***	

ADEQ	Arizona Department of Environmental Quality.
ELCR	Excess lifetime cancer risk.
HQ	Hazard quotient.
NA	Not available.
NC	Non-Carcinogenic.
PRG	Preliminary Remediation Goal.
USEPA	U.S. Environmental Protection Agency.

[a] Compound was detected but reported value is estimated.
[b] The PRG is based on bromodichloromethane carcinogenic effects, a non-carcinogenic value is not available.
[c] The PRG is based on chromium VI non-carcinogenic effects.
[d] The PRG is based on nickel (soluble salts).
*Risk and Hazards are based upon 2000 Tap Water PRGs
MW-2 was abandoned 10/1993.
MW-3 is active.
MW-4 was abandoned 10/4/94.
MW-5 is active.
MW-114 is active.
MW-122 is active.
(The metals in this table are based upon the maximum range of detects in the Occurrence of Constituents Detected in Groundwater Samples at PSC ST-18 table in the Basewide Risk Assessment and the analysis of the latest sampling event conducted on October 25, 2001.

Arsenic background levels in the State of Arizona regularly exceed the PRG’s. Arsenic is present at this site within background levels.

Table 6-23

MAXIMUM EXPOSURE POINT CONCENTRATIONS IN GROUNDWATER AND USEPA REGION IX PRGS FOR PSC SD-20 (MW-102; MW-103; MW-112D; MW-112S; MW-113) Luke Air Force Base, Arizona

Constituent	Exposure Point Concentration (mg/L)	USEPA Region IX Tap Water PRG (mg/L) 2000	*Risk or Hazard	ADEQ 2000 Aquifer Water Quality Standards (mg/L)
Cancer Effects			ELCR	
VOCs				
Bromodichloromethane	0.006	0.00018	3.3E-05	NA
**Chloroform	0.005	0.00016	3.1E-05	0.1
Inorganics				
Arsenic	0.026	0.000045	5.8E-04	0.05
Barium	0.47	NC	NC	2
Boron	0.23	NC	NC	NA
Chromium	0.11	NC	NC	0.1
Copper	0.17	NC	NC	NA
Lead	0.048	NC	NC	0.05
Nickel	0.071	NC	NC	NA
Zinc	1.66	NC	NC	NA
Total Site Risk			***6E-04***	
Non-Cancer Effects			HQ	
VOCs				
Bromodichloromethane	0.006	0.12	5.0E-02	NA
**Chloroform	0.005	0.00063	7.9E+00	0.1
Inorganics				
Arsenic	0.026	0.011	2.4E+00	0.05
Barium	0.47	2.6	1.8E-01	2
Boron	0.23	3.3	7.0E-02	NA
Chromium [b]	0.11	0.11	1.0E+00	0.1
Copper	0.17	1.4	1.2E-01	NA
Lead	0.048	NA	NA	0.05
Nickel [c]	0.071	0.73	9.7E-02	NA
Zinc	1.66	11	1.5E-01	NA
Hazard Index			***12***	

ADEQ	Arizona Department of Environmental Quality.
ELCR	Excess lifetime cancer risk.
HQ	Hazard quotient.
NA	Not available.
NC	Non-Carcinogenic.
PRG	Preliminary Remediation Goal.
USEPA	U.S. Environmental Protection Agency.

[a] Compound was detected but reported value is estimated.
[b] The PRG is based on chromium VI non-carcinogenic effects.
[c] The PRG is based on nickel (soluble salts).
*Risk and Hazards are based upon 2000 Tap Water PRGs
MW-102 was abandoned.
MW-103 was abandoned.
MW-112D is to be abandoned.
MW-112S is to be abandoned.
MW-113 is to be abandoned.
(The metals in this table are based upon the maximum range of detects in the Occurrence of Constituents Detected in Groundwater Samples at PSC SD-20 table in the Basewide Risk Assessment and the analysis of the latest sampling event conducted on May 19, 1999.)

**Chloroform is a known common laboratory contaminate. Chloroform was found in only one sampling event, May 19, 1999 in MW-113, from 1991 through 1999 from five different monitoring wells.
Arsenic background levels in the State of Arizona regularly exceed the PRG's. Arsenic is present at this site within background levels.

Table 6-24

MAXIMUM EXPOSURE POINT CONCENTRATIONS IN GROUNDWATER AND USEPA REGION IX PRGS FOR PSC SD-21 (MW-101) Luke Air Force Base, Arizona

Constituent	Exposure Point Concentration (mg/L)	USEPA Region IX Tap Water PRG (mg/L) 2000	*Risk or Hazard	ADEQ 2000 Aquifer Water Quality Standards (mg/L)
Cancer Effects			ELCR	
Inorganics				
Arsenic	0.011	0.000045	2.4E-04	0.05
Barium	0.117	NC	NC	2
Boron	0.25	NC	NC	NA
Copper	0.092	NC	NC	NA
Lead	0.007	NC	NC	0.05
Zinc	0.5	NC	NC	NA
Total Site Risk			***2E-04***	
Non-Cancer Effects			HQ	
Inorganics				
Arsenic	0.011	0.011	1.0E+00	0.05
Barium	0.117	2.6	4.5E-02	2
Boron	0.25	3.3	7.6E-02	NA
Copper	0.092	1.4	6.6E-02	NA
Lead	0.007	NA	-	0.05
Zinc	0.5	11	4.5E-02	NA
Hazard Index			***1***	

ADEQ	Arizona Department of Environmental Quality.
ELCR	Excess lifetime cancer risk.
HQ	Hazard quotient.
NA	Not available.
NC	Non-Carcinogenic.
PRG	Preliminary Remediation Goal.
USEPA	U.S. Environmental Protection Agency.

*Risk and Hazards are based upon 2000 Tap Water PRGs
MW-101 is active.
(The metals in this table are based upon the maximum range of detects in the Occurrence of Constituents Detected in Groundwater Samples at PSC SD-21 table in the Basewide Risk Assessment. The analysis of the latest sampling event conducted on June 4, 1996, indicated the constituents analyzed were at non-detect levels.)

Arsenic background levels in the State of Arizona regularly exceed the PRG’s. Arsenic is present at this site within background levels, and when taken out of the equation the ELCR and hazard index are within acceptable risk ranges.

Table 6-25

MAXIMUM EXPOSURE POINT CONCENTRATIONS IN GROUNDWATER AND USEPA REGION IX PRGS FOR PSC SD-38 (MW-117) Luke Air Force Base, Arizona

Constituent	Exposure Point Concentration (mg/L)	USEPA Region IX Tap Water PRG (mg/L) 2000	*Risk or Hazard	ADEQ 2000 Aquifer Water Quality Standards (mg/L)
Cancer Effects			ELCR	
Inorganics				
Barium	0.146	NC	NC	2
Copper	0.012	NC	NC	NA
Lead	0.003	NC	NC	0.05
Zinc	0.378	NC	NC	NA
Total Site Risk			***NC***	
Non-Cancer Effects			HQ	
Inorganics				
Barium	0.146	2.6	5.6E-02	2
Copper	0.012	1.4	8.6E-03	NA
Lead	0.003	NA	-	0.05
Zinc	0.378	11	3.4E-02	NA
Hazard Index			***0.1***	

All Units in milligrams per Liter (mg/L).

ADEQ	Arizona Department of Environmental Quality.
ELCR	Excess lifetime cancer risk.
HQ	Hazard quotient.
NA	Not available.
NC	Non-Carcinogenic.
PRG	Preliminary Remediation Goal.
USEPA	U.S. Environmental Protection Agency.

*Risk and Hazards are based upon 2000 Tap Water PRGs
MW-117 is to be abandoned.
(The metals in this table are based upon the maximum range of detects in the Occurrence of Constituents Detected in Groundwater Samples at PSC SD-38 table in the Basewide Risk Assessment. The analysis of the latest sampling event conducted on May 29, 1996, indicated the constituents analyzed were at non-detect levels.)

Table 6-26

MAXIMUM EXPOSURE POINT CONCENTRATIONS IN GROUNDWATER AND USEPA REGION IX PRGS FOR PSC SS-42 (MW-119; MW-120; MW-121; MW-125) Luke Air Force Base, Arizona

Constituent	Exposure Point Concentration (mg/L)	USEPA Region IX Tap Water PRG (mg/L) 2000	*Risk or Hazard	ADEQ 2000 Aquifer Water Quality Standards (mg/L)
Cancer Effects			ELCR	
Inorganics				
Arsenic	0.007	0.000045	1.6E-04	0.05
Barium	0.139	NC	NC	2
Chromium	3.84	NC	NC	0.1
Copper	0.036	NC	NC	NA
Nickel	0.254	NC	NC	NA
Selenium	0.008	NC	NC	0.05
Zinc	3.09	NC	NC	NA
Total Site Risk			***2E-04***	
Non-Cancer Effects			HQ	
Inorganics				
Arsenic	0.007	0.011	6.4E-01	0.05
Barium	0.139	2.6	5.3E-02	2
Chromium [b]	3.84	0.11	3.5E+01	0.1
Copper	0.036	1.4	2.6E-02	NA
Nickel [c]	0.254	0.73	3.5E-01	NA
Selenium	0.008	0.18	4.4E-02	0.05
Zinc	3.09	11	2.8E-01	NA
Hazard Index			***36***	

All Units in milligrams per Liter (mg/L).

ADEQ	Arizona Department of Environmental Quality.
ELCR	Excess lifetime cancer risk.
HQ	Hazard quotient.
NA	Not available.
NC	Non-Carcinogenic.
PRG	Preliminary Remediation Goal.
TPH	Total Petroleum Hydrocarbons
USEPA	U.S. Environmental Protection Agency.

[a] Compound was detected but reported value is estimated.
[b] The PRG is based on chromium VI non-carcinogenic effects.
[c] The PRG is based on nickel (soluble salts).
*Risk and Hazards are based upon 2000 Tap Water PRGs
MW-119 deteriorated.
MW-120 deteriorated.
MW-121 is active.
MW-125 deteriorated.
(The metals in this table are based upon the maximum range of detects in the Occurrence of Constituents Detected in Groundwater Samples at PSC SS-42 table in the Basewide Risk Assessment. The analysis of the latest sampling event conducted on May 16, 2000, indicated the constituents analyzed were at non-detect levels.)

Arsenic background levels in the State of Arizona regularly exceed the PRG's. Arsenic is present at this site within background levels.

6.5 Interviews

The following individuals were solicited for interviews by questionnaire as part of this five-year review:

- Belle Matthews, Luke AFB Project Manager
- Sean Hogan, EPA Project Manager
- Nancy Lou Minkler, ADEQ Project Manager
- Dan Salzler, Citizens Advisory Board (CAB) Community Co-Chairperson
- Joyce Clark, CAB member
- Martin Jeffries, CAB member

The only individuals who responded to the questionnaire were Belle Matthews, Nancy Lou Minkler and Martin Jeffries. Interview results for these individuals are in Appendix F.

In addition to solicitation of interviews by questionnaire, the following individuals were interviewed in person as part of the May 22, 2001 site inspection:

- Chris Christoffer, Luke AFB Environmental Analyst
- Sergeant Anthony Michels, Luke AFB Infrastructure Superintendent

Chris Christoffer and Sergeant Michels were interviewed relative to procedures that ensure compliance with the BGP and ICP. As part of these interviews, the BGP was reviewed and it was verified that the ICP had been implemented. Also verified were approval and record keeping procedures for digging permits relative to environmental constraints at Luke AFB.

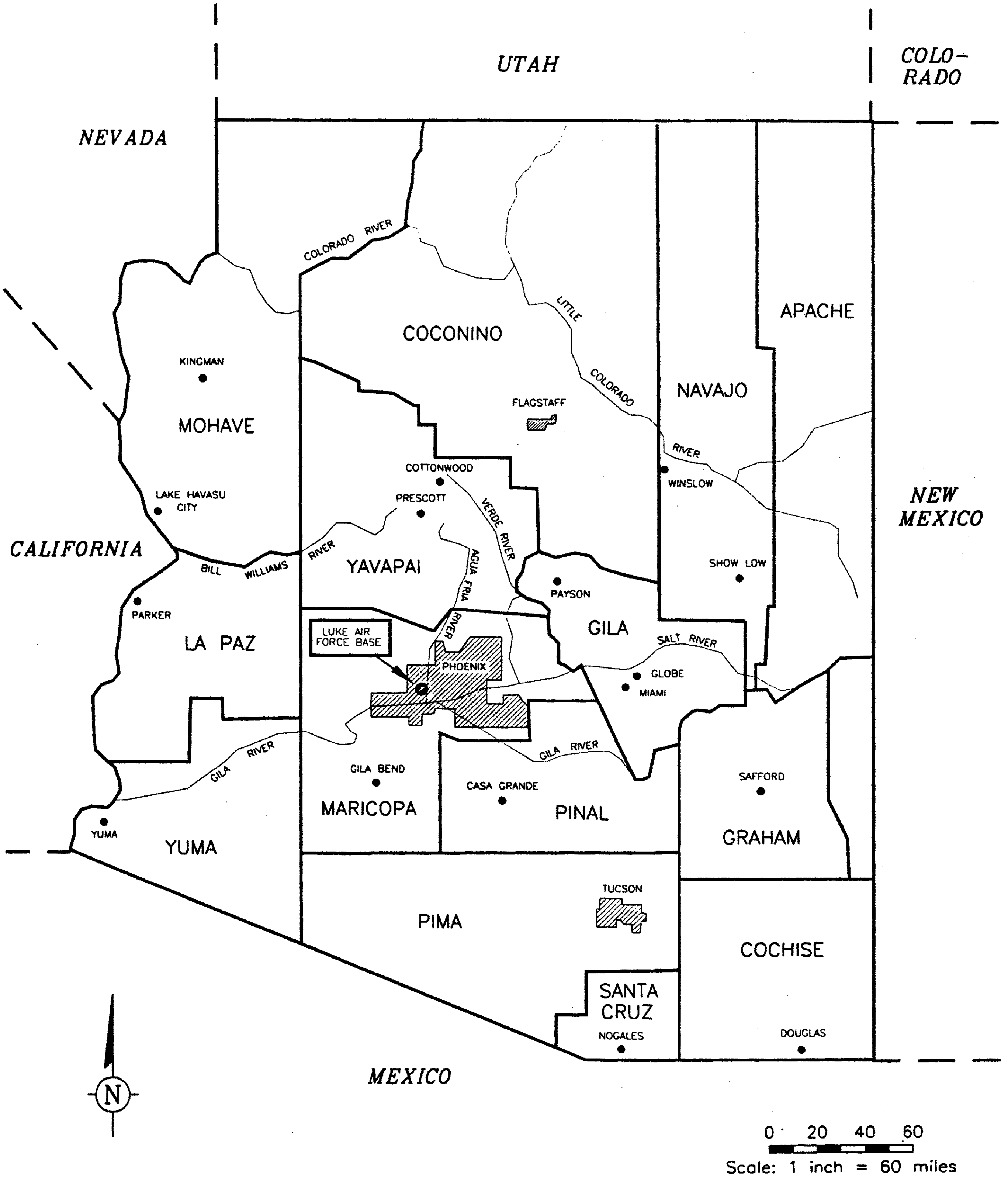


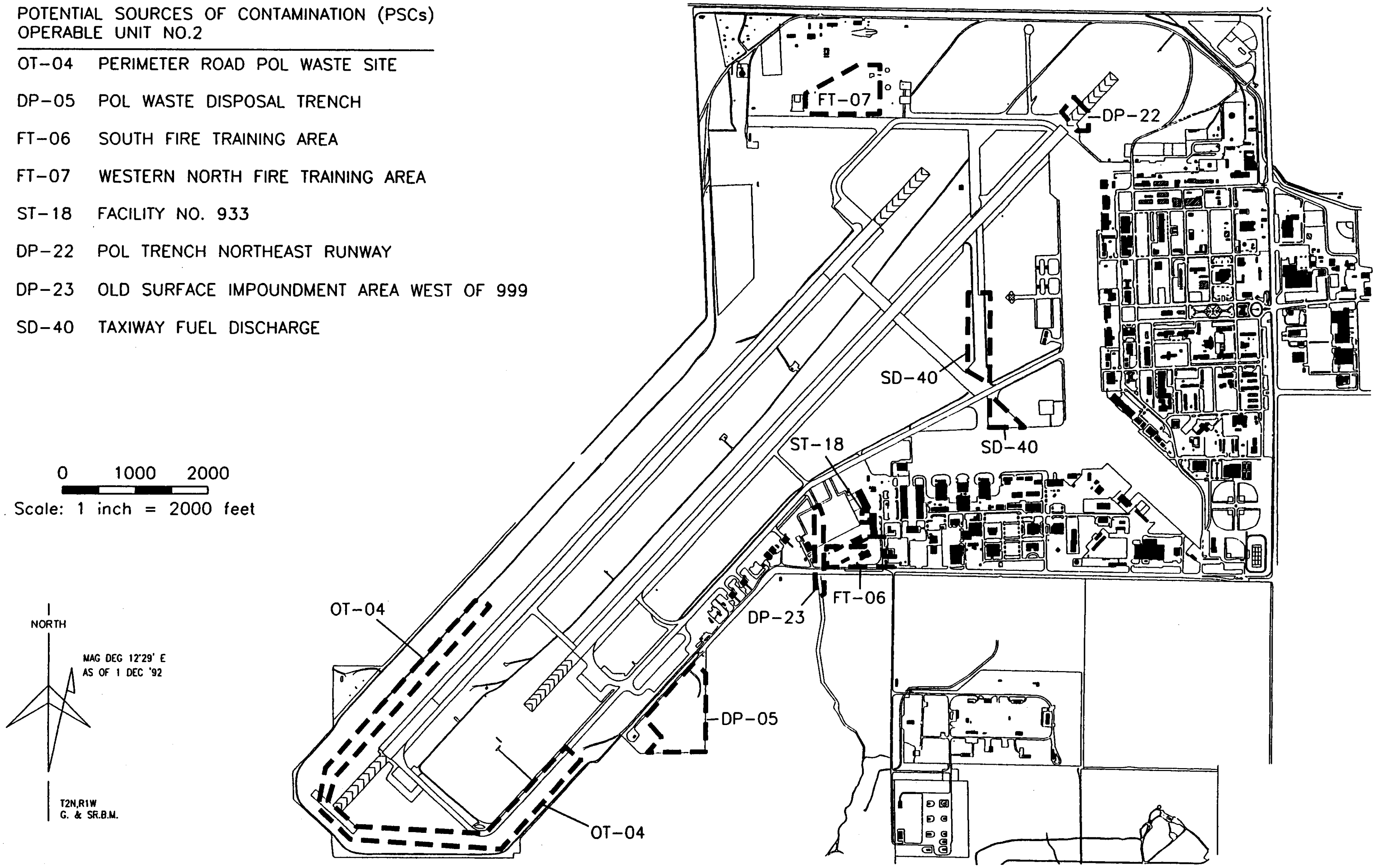
FIGURE 1-1

LOCATION OF LUKE AIR FORCE BASE, ARIZONA

OPERABLE UNIT NO.1, RECORD OF DECISION
LUKE AIR FORCE BASE, ARIZONA

POTENTIAL SOURCES OF CONTAMINATION (PSCs)
OPERABLE UNIT NO.2

OT-04	PERIMETER ROAD POL WASTE SITE
DP-05	POL WASTE DISPOSAL TRENCH
FT-06	SOUTH FIRE TRAINING AREA
FT-07	WESTERN NORTH FIRE TRAINING AREA
ST-18	FACILITY NO. 933
DP-22	POL TRENCH NORTHEAST RUNWAY
DP-23	OLD SURFACE IMPOUNDMENT AREA WEST OF 999
SD-40	TAXIWAY FUEL DISCHARGE



FIGURE

1-2

LOCATION OF OU-2 PSCs

LUKE AIR FORCE BASE, ARIZONA

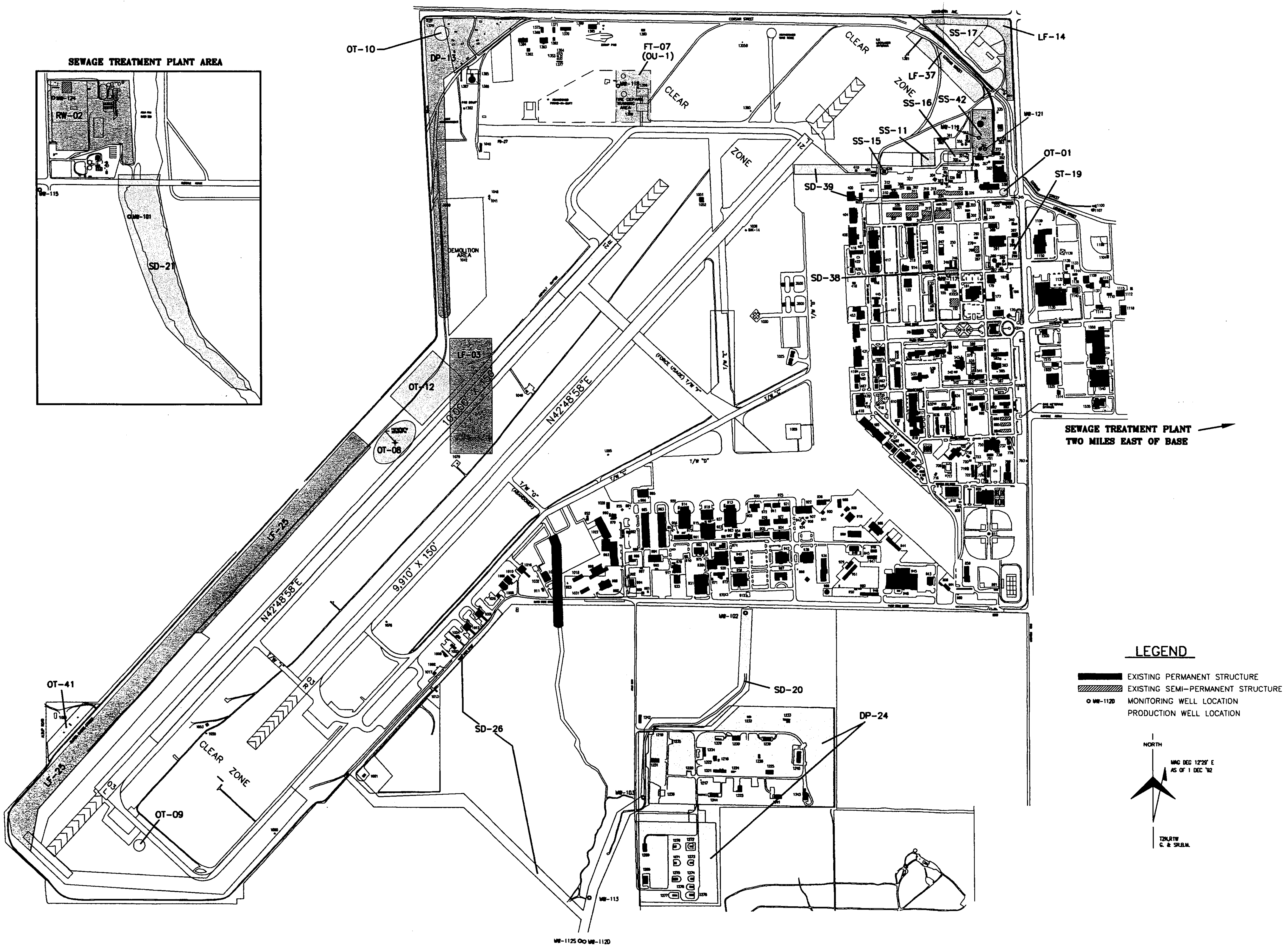
DATE: 01/19/1999 17:36 | PRJ#: AZ 423.011 | FILE: luke\ou-1rod\figures | DRAWING: LUKE-OU1 | CHECKED: SHERRILL | APPROVED: JOHNSON | DRAFTER: STILES

OU-1 POTENTIAL SOURCES OF CONTAMINATION (PSCs) (NO FURTHER ACTION)

OT-01	OLD INCINERATOR SITE
OT-08	F-15 BURIAL SITE
OT-09	CANBERRA BURIAL SITE
OT-10	CONCRETE RUBBLE BURIAL SITE
SS-11	FORMER OUTSIDE TRANSFORMER STORAGE
OT-12	OLD EOD BURIAL PIT
SS-15	FACILITY 328 SPILL SITE
SS-16	FACILITY 321 USTs STORAGE
SS-17	FORMER DPDO YARD
ST-19	BX LEAKING USTs
SD-20	OIL/WATER SEPARATOR CANAL AND EARTH FISSURES
SD-21	SEWAGE TREATMENT PLANT EFFLUENT CANAL
DP-24	BASE AMMO STORAGE AREA
SD-26	HUSH HOUSE CANAL
LF-37	NORTHEAST LANDFILL
SD-39	WASTE DISCHARGE AT OLD LOCKHEED SITE
OT-41	SKEET RANGE

OU-1 POTENTIAL SOURCES OF CONTAMINATION (PSCs) (REQUIRES REMEDIAL ACTION)

RW-02	WASTE TREATMENT ANNEX LANDFILL
LF-03	OUTBOARD RUNWAY LANDFILL
FT-07	NORTH FIRE TRAINING AREA (EASTERN PORTION)
DP-13	DRAINAGE DITCH DISPOSAL AREA
LF-14	OLD SALVAGE YARD BURIAL SITE
LF-25	NORTHWEST LANDFILL
SD-38	SOUTHWEST OIL/WATER SEPARATOR BY THE AUTO HOBBY SHOP
SS-42	BULK FUEL STORAGE AREA

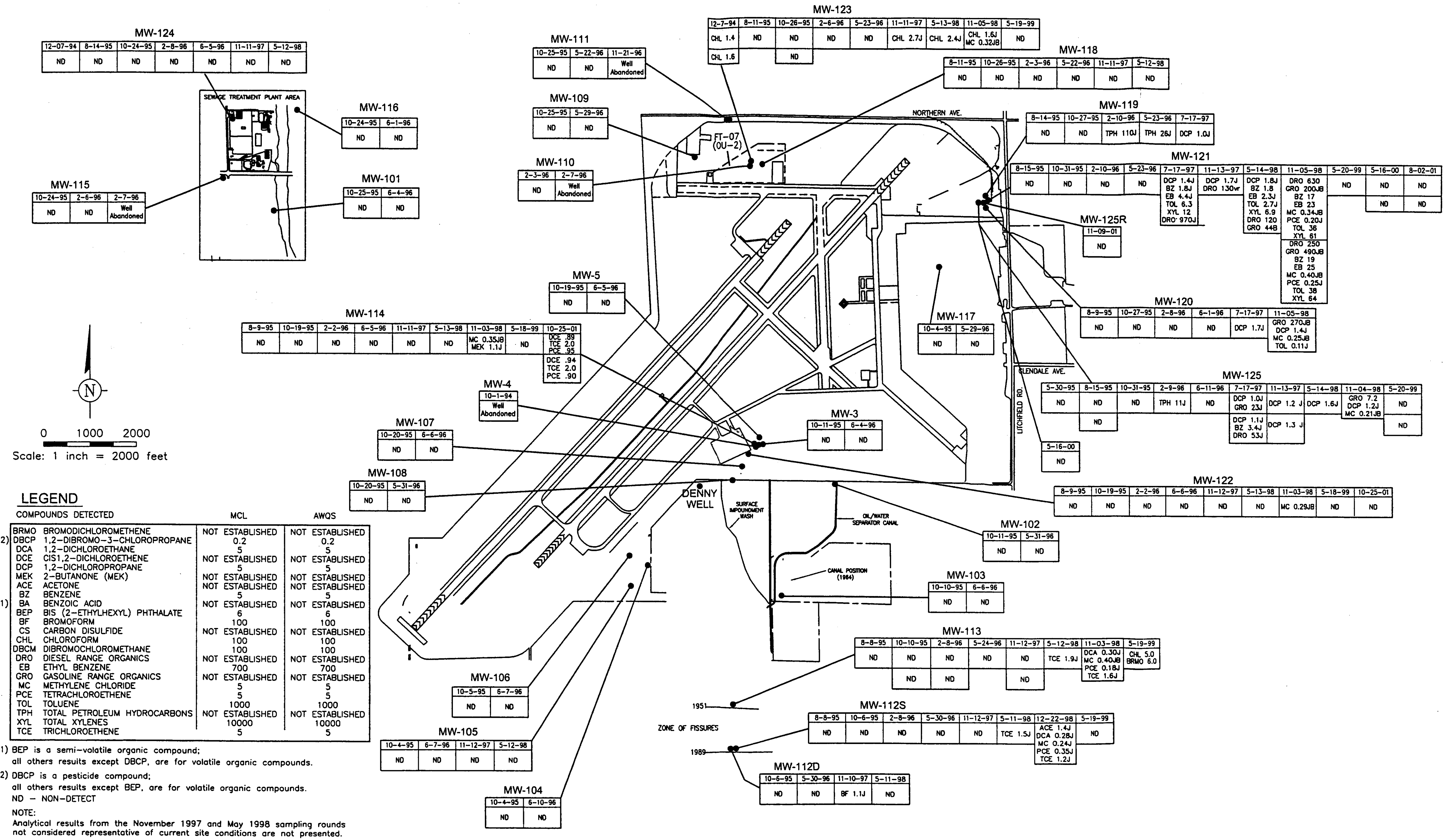


0 700 1400
Scale: 1 inch = 1400 feet

LOCATION OF OU-1 PSCs

LUKE AIR FORCE BASE, ARIZONA

FIGURE 1-3



Scale: 1 inch = 2000 feet

MW-124

12-07-94	8-14-95	10-24-95	2-8-96	6-5-96	11-11-97	5-12-98
ND	ND	ND	ND	ND	ND	ND

MW-116

10-24-95	6-1-96
ND	ND

MW-115

10-24-95	2-6-96	2-7-96
ND	ND	Well Abandoned

MW-101

10-25-95	6-4-96
ND	ND

MW-111

10-25-95	5-22-96	11-21-96
ND	ND	Well Abandoned

MW-109

10-25-95	5-29-96
ND	ND

MW-110

2-3-96	2-7-96
ND	Well Abandoned

MW-123

12-7-94	8-11-95	10-26-95	2-6-96	5-23-96	11-11-97	5-13-98	11-05-98	5-19-99
CHL 1.4	ND	ND	ND	ND	CHL 2.7J	CHL 2.4J	CHL 1.6J MC 0.32JB	ND
CHL 1.6		ND						

MW-118

8-11-95	10-26-95	2-3-96	5-22-96	11-11-97	5-12-98
ND	ND	ND	ND	ND	ND

MW-119

8-14-95	10-27-95	2-10-96	5-23-96	7-17-97
ND	ND	TPH 110J	TPH 26J	DCP 1.0J

MW-121

8-15-95	10-31-95	2-10-96	5-23-96	7-17-97	11-13-97	5-14-98	11-05-98	5-20-99	5-16-00	8-02-01
ND	ND	ND	ND	DCP 1.4J BZ 1.8J EB 4.4J TOL 6.3 XYL 12 DRO 970J	DCP 1.7J DRO 130vr	DCP 1.8J BZ 1.8 EB 2.3J TOL 2.7J XYL 6.9 DRO 120 GRO 44B	DRO 630 GRO 200JB BZ 17 EB 23 MC 0.34JB PCE 0.20J TOL 36 XYL 61	ND	ND	ND
							DRO 250 GRO 490JB BZ 19 EB 25 MC 0.40JB PCE 0.25J TOL 38 XYL 64		ND	ND

MW-125R

11-09-01
ND

MW-5

10-19-95	6-5-96
ND	ND

MW-114

8-9-95	10-19-95	2-2-96	6-5-96	11-11-97	5-13-98	11-03-98	5-18-99	10-25-01
ND	ND	ND	ND	ND	ND	MC 0.35JB MEK 1.1J	ND	DCE .89 TCE 2.0 PCE .95
								DCE .94 TCE 2.0 PCE .90

MW-117

10-4-95	5-29-96
ND	ND

MW-120

8-9-95	10-27-95	2-8-96	6-1-96	7-17-97	11-05-98
ND	ND	ND	ND	DCP 1.7J	GRO 270JB DCP 1.4J MC 0.25JB TOL 0.11J

MW-4

10-1-94
Well Abandoned

MW-125

5-30-95	8-15-95	10-31-95	2-9-96	6-11-96	7-17-97	11-13-97	5-14-98	11-04-98	5-20-99
ND	ND	ND	TPH 11J	ND	DCP 1.0J GRO 23J	DCP 1.2 J	DCP 1.6J	GRO 7.2 DCP 1.2J MC 0.21JB	ND
	ND				DCP 1.1J BZ 3.4J DRO 53J	DCP 1.3 J			ND

5-16-00
ND

MW-107

10-20-95	6-6-96
ND	ND

MW-3

10-11-95	6-4-96
ND	ND

MW-108

10-20-95	5-31-96
ND	ND

MW-122

8-9-95	10-19-95	2-2-96	6-6-96	11-12-97	5-13-98	11-03-98	5-18-99	10-25-01
ND	ND	ND	ND	ND	ND	MC 0.29JB	ND	ND

MW-102

10-11-95	5-31-96
ND	ND

MW-103

10-10-95	6-6-96
ND	ND

MW-113

8-8-95	10-10-95	2-8-96	5-24-96	11-12-97	5-12-98	11-03-98	5-19-99
ND	ND	ND	ND	ND	TCE 1.9J	DCA 0.30J MC 0.40JB PCE 0.18J TCE 1.6J	CHL 5.0 BRMO 6.0
	ND	ND		ND			

MW-106

10-5-95	6-7-96
ND	ND

MW-112S

8-8-95	10-6-95	2-8-96	5-30-96	11-12-97	5-11-98	12-22-98	5-19-99
ND	ND	ND	ND	ND	TCE 1.5J	ACE 1.4J DCA 0.28J MC 0.24J PCE 0.35J TCE 1.2J	ND

MW-105

10-4-95	6-7-96	11-12-97	5-12-98
ND	ND	ND	ND

MW-112D

10-6-95	5-30-96	11-10-97	5-11-98
ND	ND	BF 1.1J	ND

MW-104

10-4-95	6-10-96
ND	ND

LEGEND

	COMPOUNDS DETECTED		MCL	AWQS
	BRMO	BROMODICHLOROMETHENE	NOT ESTABLISHED	NOT ESTABLISHED
(2)	DBCP	1,2-DIBROMO-3-CHLOROPROPANE	0.2	0.2
	DCA	1,2-DICHLOROETHANE	5	5
	DCE	CIS1,2-DICHLOROETHENE	NOT ESTABLISHED	NOT ESTABLISHED
	DCP	1,2-DICHLOROPROPANE	5	5
	MEK	2-BUTANONE (MEK)	NOT ESTABLISHED	NOT ESTABLISHED
	ACE	ACETONE	NOT ESTABLISHED	NOT ESTABLISHED
	BZ	BENZENE	5	5
(1)	BA	BENZOIC ACID	NOT ESTABLISHED	NOT ESTABLISHED
	BEP	BIS (2-ETHYLHEXYL) PHTHALATE	6	6
	BF	BROMOFORM	100	100
	CS	CARBON DISULFIDE	NOT ESTABLISHED	NOT ESTABLISHED
	CHL	CHLOROFORM	100	100
	DBCM	DIBROMOCHLOROMETHANE	100	100
	DRO	DIESEL RANGE ORGANICS	NOT ESTABLISHED	NOT ESTABLISHED
	EB	ETHYL BENZENE	700	700
	GRO	GASOLINE RANGE ORGANICS	NOT ESTABLISHED	NOT ESTABLISHED
	MC	METHYLENE CHLORIDE	5	5
	PCE	TETRACHLOROETHENE	5	5
	TOL	TOLUENE	1000	1000
	TPH	TOTAL PETROLEUM HYDROCARBONS	NOT ESTABLISHED	NOT ESTABLISHED
	XYL	TOTAL XYLENES	10000	10000
	TCE	TRICHLOROETHENE	5	5

(1) BEP is a semi-volatile organic compound;
all others results except DBCP, are for volatile organic compounds.

(2) DBCP is a pesticide compound;
all others results except BEP, are for volatile organic compounds.

ND – NON-DETECT

NOTE:
Analytical results from the November 1997 and May 1998 sampling rounds not considered representative of current site conditions are not presented.

All concentrations reported in micrograms per liter (µg/L)

DATA QUALIFIERS

y – TRIP BLANK CONTAMINATION
z – METHOD BLANK CONTAMINATION
l – LABORATORY CONTROL SAMPLE RECOVERY FAILURE
v – RELIABLE IDENTIFICATION OF A PRODUCT COULD NOT BE ACHIEVED
h – HOLDING TIME VIOLATION
B – COMPOUND ALSO DETECTED IN THE BLANK
J – COMPOUND WAS DETECTED BUT REPORTED VALUE IS ESTIMATED
U – COMPOUND NOT DETECTED ABOVE THE REPORTED SAMPLE QUANTITATION LIMIT

SOURCE: LUKE AFB, ARIZONA 12-5-97

ARCADIS
GERAGHTY&MILLER

GROUNDWATER ANALYTICAL RESULTS

LUKE AIR FORCE BASE, ARIZONA

FIGURE
5-2

Appendix A

PSC – Detailed Descriptions and Background Information

PSC RW-02 Wastewater Treatment Annex

PSC RW-02 consists of a former 28-acre landfill at the Luke AFB wastewater treatment plant (WWTP) annex located north of Glendale Avenue and, two miles east of the main Base. The former landfill is located in the northwestern portion of the WWTP annex, adjacent to the western bank of the Agua Fria River. The site served as the Base's main landfill for the disposal of refuse from 1953 until 1970.

A small quantity of low-level radioactive electron tubes and dials were buried at the site in 1956. The radioactive material was encased in concrete and disposed in a pit 12 feet deep with 4 feet of concrete cover and 6 feet of earth cover. The radioactive material burial site is currently located within the boundaries of the Defense Reutilization Marketing Office (DRMO) storage yard.

During the OU-1 RI, two soil borings (SB-1 and SB-2) were advanced and sampled near the radiological waste containment structure to assess its integrity. The borings were located approximately 15 feet north and south of the radiological monument marker and advanced to a depth of 17 feet below ground surface (bgs). A third soil boring (SB-11) was also advanced 30 feet north of the radiological waste containment to assess background radiological conditions. Two soil samples were collected from each of the borings at depths between 10-12 feet and 15-17 feet bgs. The samples were submitted to IT laboratory and analyzed for total uranium, radium-226, radium-228, gross alpha, and gross beta.

Radiochemical analyses of soil samples adjacent to the monument were not significantly different from the background boring SB-11, and the results of the radiochemical analyses for all samples are within the background ranges for natural soils. Specifically, samples adjacent to the containment structure contained uranium concentrations of 0.3 to 1.0 micrograms/per gram (μg/g). These concentrations are within the background range for natural geologic materials (up to 4.8 μg/g). Radium-226 (alpha radiation emitters associated with the uranium decay series), and radium-228 (a beta radiation emitter associated with the thorium decay series) are also present at concentrations expected in natural soils.

Natural gamma ray geophysical logging was conducted in borings drilled adjacent to the monument (SB-1, SB-2) and at a nearby groundwater monitoring well (MW-115). The natural gamma logs displayed total gamma counts that ranged up to 235 American Petroleum Institute (PSI) units. Gamma radiation in natural geologic materials range from a few API units to more than 300 API units. Thus, no gamma radiation anomalies were noted.

While natural gamma logs and soil sampling results indicate that radioactive materials have not impacted soils adjacent to the containment structure, the mere presence of the low-level radioactive waste containment structure warrants concern. As a result, remedial alternatives were developed and evaluated for PSC RW-02.

PSC LF-03 Outboard Runway

PSC LF-03 consists of a former construction debris landfill located on the western side of the Base near the central part of the outboard runway, south of Taxiway F. The site occupies approximately 21 acres. The outboard runway currently covers 60 percent of the site. The remainder of the site consists of a bare low-lying area with sparse vegetation. The Base reportedly used the site for limited disposal of refuse from 1951 to 1953. Land filling operations at this site ceased when the outboard runway was constructed.

During the OU-1 RI, geophysical and soil gas surveys were conducted to define the landfill boundaries and to select locations for test pits. Six test pits were excavated and sampled to characterize its extent and contents. Two additional soil borings were advanced and sampled in August 1996 to collect additional VOC and BNA data for risk assessment purposes.

Numerous metallic wastes were unearthed at the central portion of PSC LF-03 during test pit excavation. Samples of the wastes collected from Test Pit TP-5 at depths of 8 feet bgs and a 7-8 feet bgs contained chromium at concentrations of 349 and 386 mg/kg, respectively. Because the metallic wastes containing elevated concentrations of chromium are buried and extend below the outboard runway, direct exposure is not likely under current land use scenarios.

The risk assessment concluded that the site does not present unacceptable health risks given its current land uses. However, long-term exposure in unacceptable health risks could result if the runways were removed and the site was developed for residential purposes. As a result, remedial alternatives were developed for the site.

PSC FT-07E East Portion of North Fire Training Area

PSC FT-07E is located in the northern portion of the Base, west of Fire Department Training Facility 1355. Fire training activities in the eastern portion of PSC FT-07E began in 1973 when the Base constructed three fire-training pits (FTPs). The two largest training pits were constructed with sprinkler systems to dispense flammable POL waste onto mock aircraft or similar structures. According to Base records, the three pits were active from 1973 until 1989. The two largest pits were designated as Fire Training Pit #3 (FTP-3) and Fire Training Pit #4 (FTP-4). The third pit was identified as Fire Training Pit #6 (FTP-6).

Luke AFB conducted a soil vapor extraction (SVE) removal action at fire training pits FTP-3 and FTP-4 from April 1992 through December 1992. Calculations indicate that over 14,000 pounds of contaminants were removed from the soil and destroyed by a thermal oxidizer treatment system. The objectives of the OU-1 RI at PSC FT-07E were to assess effectiveness of the removal action, to further evaluate the vertical extent of any constituents still remaining in the soils, and to assess the potential for groundwater impacts beneath the site. Fourteen soil borings were advanced and sampled at the two fire training pits where vapor extraction was performed (FTP-3 and FTP-4). Three soil borings were also advanced and samples at fire training pit FTP-6. Two groundwater monitoring wells (MW-118 and MW-123) were installed during the OU-1 investigation to assess groundwater quality at the site.

Soil sampling results indicated that residual hydrocarbon contamination was effectively reduced at depths greater than 16 feet bgs. Groundwater sampling results indicate the underlying groundwater resources have not been impacted. Vadose zone transport modeling also indicated that residual petroleum hydrocarbon contaminants in the soil would not leach to the underlying groundwater. However, relatively high concentrations (27,000 mg/kg) of total petroleum hydrocarbons (TPH) remained in the soils near the surface. While the current site conditions do not pose a threat to human health or the environment given the its current land use (military/industrial), unacceptable health risks would occur if the site were developed and used for residential purposes. For this reason, remedial alternatives were developed.

PSC SS-11 Former Outside Transformer Storage

PSC SS-11 consists of a 0.79-acre site located in the northeastern portion of Luke AFB, northeast of Facility 328 and west of Building 360. The Luke AFB exterior electric shop used the site prior to 1981 for temporary storage of out-of-service electrical transformers, some of which may have contained polychlorinated biphenyls (PCBs). Approximately 20-percent of the site is covered by bare ground with no vegetation, and the remaining 80-percent is covered with degraded asphalt which has been present for the past 40 years. The transformers were reportedly stored on the bare ground. The shallow soils at this PSC contain PCBs at low concentrations. The Base-wide risk assessment concluded that these levels pose no risk to human health or the environment.

PSC OT-12 Old EOD Site

PSC OT-12 consists of a 15-acre former landfill area located between the outboard runway and the west perimeter road. The majority of the site lies in a low depression covered with exposed soil and grass. The exact dates of operation of the pit could not be determined, however, it was reportedly in existence in the early 1970s. The site is located just south of the EOD Demolition and Burn Facility #1047, which was constructed in 1963. The pit was probably excavated at that time to dispose of residue from the incineration or detonation of unused or outdated ordinance. Currently, all unexploded ordnance is taken to the Luke Air Force Base Range at Gila Bend for demolition and disposal. Prior to remedial investigations, this area was surveyed by air force explosion ordnance disposal technicians and found the site to be free of UneXploded Ordnance (UXO). The soils at this PSC contain TPH, PAHs, arsenic and beryllium. The Base-wide risk assessment concluded these levels pose no risk to human health or the environment.

PSC DP-13 Drainage Ditch Disposal Area

PSC DP-13 is located in the northwest corner of the Base (Figure 8). During the 1940s, this site was the location of a drainage ditch that was reportedly used for refuse disposal. The ditch was filled and covered when the Base was deactivated in 1946. Asphalt and concrete rubble stored in the northwest corner of the site was disposed in a burial pit in 1974. No known or suspected industrial-type wastes or hazardous wastes were disposed at this site. Currently, a majority of the site is covered with bare ground. The northern portion of the site is used as a bivouac area for preparedness training.

Objectives of the RI at PSC DP-13 were to define the boundaries of the former landfill and characterize its contents. Geophysical and soil gas surveys were conducted to define the landfill boundaries and to select locations for test pits. Fifteen test pits were excavated to characterize the extent and contents of the landfill. Ten soil borings were advanced to further define the vertical and lateral extent of constituents of potential concern detected in the test pit samples. In August 1996, three additional soil borings were advanced to collect supplemental VOC and BNA data for risk assessment purposes.

Test Pits TP-12 (located near the side of a maintained road within the bivouac area) intercepted an inactive underground utility line. A paint pail and dried paint residue were also observed in Test Pit TP-12. Wastes collected from that test pit at a depth of 5 feet bgs contained chromium at 15,900 mg/kg and lead at 36,000 mg/kg. Because these wastes are buried and the surface area is maintained, direct exposure is not likely under current land use scenarios. However, exposure to these buried wastes could result if excavation were to occur or if the site were developed for residential purposes.

For this reason, remedial alternatives were developed for PSC DP-13 as a protective measure.

PSC LF-14 Old Salvage Yard Burial Site

PSC LF-14 consists of a former landfill site located in the northeastern corner of the Base. In the 1940s, this site was part of the main drainage canal for the north end of the Base. The canal was abandoned when the drainage was changed in the 1950s. The abandoned canal may have been used as a landfill and was completely filled and covered by 1962. According to interviews with Base personnel, PCB-containing transformer fluids may have been disposed in the ditch in the northern portion of this site. The site is currently unpaved and covered with bare ground.

The objectives of the RI at PSC LF-14 were to define the boundaries of the former drainage ditch landfill and to characterize its content. Geophysical and soil gas surveys were conducted to define the landfill boundaries and to select locations for test pits. Phase II activities consisted of excavating four test pits and sampling 10 soil borings. Two additional soil borings were advanced in August 1996 to collect supplemental VOC and BNA data for risk assessment purposes.

Relatively high PCB concentrations (2,300 mg/kg) were detected at the site, however, the depth at which this concentration was detected was greater than 16 feet bgs and exposure is unlikely. Based on the results of the Base-wide risk assessment, contaminants identified at PSC LF-14 were not present at areas of potential exposure at concentrations high enough to cause adverse health effects under current land use scenarios. However, the concentrations of PCBs and chromium present in soils 0 to 16 feet bgs could theoretically cause adverse health affects in unlikely event that PSC LF-14 were developed for residential purposes in the future. For this reason, remedial alternatives were developed for the site.

PSC SS-17 Former Defense Property Disposal Office (DPDO) Yard

PSC SS-17 consists of the former DPDO yard facility located in the northeastern corner of Luke AFB and occupies approximately 13-acres. Forty percent of the site is paved with old asphalt and concrete pads and 60 percent is soil ground cover. During the 1950s and 1960s, hazardous materials and 55-gallon drums of industrial wastes were stored on the floor of the former DPDO building. The hazardous waste included spent thinners and strippers, paint, solvents, mercury-contaminated rages, and asbestos-containing material. In 1986, all wastes were shipped from the site for proper disposal in California. Soil samples and samples of the concrete pad were collected in May 1986. None of the samples contained detectable concentrations of potential contaminants. The DPDO yard was listed as “closed” on September 21, 1988, with closure acknowledged by ADEQ on September 30, 1988. Despite its “closed” status, PSC SS-17 was included in the OU-1 RI. The soils at this PSC contain TPH, PCBs, arsenic and beryllium. The Base-wide risk assessment concluded these levels pose no risk to human health or the environment.

PSC SD-20 Oil/Water Separator Canal and Earth Fissures

PSC SD-20 consists of a drainage canal located on the southern side of Luke AFB. This unlined canal originates at the Oil/Water Separator 912, approximately 100-feet north of N Street, and extends southward. The 912 oil/water separator system serves two drainage systems, a 30-inch diameter system for the areas to the northwest and a 43-inch diameter system for an area to the northeast. In some instances during past storm events, stagnant oily water in the 30-inch diameter system overflowed into the oil/water separator canal. Recent upgrades to Luke AFB sewer system have eliminated the potential for additional discharges to the canal. Two earth fissures, apparently resulting from differential land subsidence, are present at the end of the drainage canal. The soils at PSC SD-20 contain TRPH, benzo(a)pyrene, arsenic, and beryllium at low concentrations. Groundwater samples collected at the site were found to contain TCE, arsenic and lead. The Base-wide risk assessment concluded these levels pose no risk to human health or the environment.

PSC SD-21 WWTP Effluent Canal

PSC SD-21 is located approximately 3-miles east of the Base, south of Glendale Avenue, adjacent to the west bank of the Agua Fria River. Prior to1997, treated effluent was discharged to this canal from the Base WWTP. The canal and associated wetlands comprise approximately 33-acres. The water in the canal is categorized as effluent dominated surface water according to the ADEQ. In 1997 effluent discharge to the canal was discontinued and discharge was piped to the new Luke AFB golf course for irrigation. The soils at PSC SD-21 contained BNAs, arsenic and beryllium. Sediment samples collected at this PSC contained arsenic and beryllium. Surface water samples collected at this PSC contained arsenic and lead. Samples collected from groundwater monitoring wells at the site contained arsenic and lead. The Base-wide risk assessment concluded these levels pose no risk to human health or the environment.

PSC LF-25 Northwest Landfill

PSC LF-25 consists of an area formerly used for land filling and is located along the southwest boundary of the Base, between the west perimeter and the northwest runway. This narrow site occupies approximately 43-acres. Portions of PSC LF-25 are located immediately downrange of the Base skeet shooting range. Small, localized sections of the site were used as a landfill for construction debris in the past for an undetermined length of time, but it has not been used since 1989.

The objectives of the RI at PSC LF-25 were to define the boundaries of any former landfills and to characterize their content. During the OU-1 RI investigations, geophysical and soil gas surveys were conducted to define landfill boundaries and to select locations for test pits and soil borings.

Lead and antimony were detected in the surface soils adjacent to the skeet range at concentrations that could cause adverse health effects if prolonged exposure, such as excavation work or residential occupation, were to occur. The lead and antimony are present in the form of metal shot that was fired from the adjacent Base skeet shooting range. Metal shot continues to impact the site because the skeet range is still active. As a protective measure, remedial alternatives were developed for the site.

PSC SD-26 Hush House Canal

PSC SD-26 consists of a surface drainage canal located southeast of the Hush Houses. This canal merges with the Oil/Water Separator canal (PSC SD-20) at a location southwest of the Base Ammunition Storage Area. The combined flows discharge to an area of subsidence fissures. From the mid-1960s until 1993, the oil/water separators attached to the Hush Houses discharged directly into PSC SD-26. The oil/water separators were connected to the Base WWTP in 1993 and no longer discharge to the canal. Drainage from the runway and taxiway to the west, and most of the facilities for the 944th Tactical Air Group are also channeled into the Hush House canal. This site was not included in any IRP documents or reports. The soils at this PSC contain TRPH, benzo(a)pyrene, arsenic, and beryllium. The Base-wide risk assessment concluded these levels pose no risk to human health or the environment.

PSC LF-37 Northeast Landfill

PSC LF-37 is located in the northeast corner of Luke AFB and occupies approximately 11.9 acres. The site is currently unpaved except for the perimeter road. Luke AFB canal and a railroad spur are located adjacent to the north side of the site. This site was not investigated in any IRP documents or reports. The soils at PSC LF-37 contain TRPH, benzo(a)pyrene, arsenic, and beryllium. The Base-wide risk assessment concluded these levels pose no risk to human health or the environment.

PSC SD-38 Oil/Water Separator at Auto Hobby Shop

PSC SD-38 is located near the middle of the Base at the northwest corner of "D" Street and 3rd Street. The site consists of the former oil/water separator serving Building 248, the old Base Auto Hobby Shop. In March 1991, the SD-38 oil/water separator was inspected as part of the RCRA Facilities Assessment (RFA). It was discovered that this oil/water separator did not have a concrete bottom. This separator has since been removed. The Base for laboratory analysis submitted samples of the sludge from the bottom of the oil/water separator. Other than the sludge sampling, no previous investigations or environmental sampling was performed at this site prior to the OU-1 RI.

PSC SD-38 was originally assigned to the OU-2 investigation. Because OU-2 data indicated a deep soil impact and thus, a potential threat to groundwater, the site was reclassified as an OU-1 PSC. In May 1992, three soil borings were advanced and sampled to assess the nature and extent of any impacts at the site. During the OU-1 investigation, three soil borings were advanced and sampled to further evaluate the vertical and horizontal extent of any impact. A groundwater monitoring well (MW-117) was also installed and sampled at this time to evaluate groundwater quality at the site. In August 1996, one additional boring was advanced and sampled to collect supplemental VOC and BNA data for use in the risk assessment.

Soil samples collected directly beneath the former oil/water separator at a depth of 8 feet bgs contained TRPH at a concentration of 58,000 mg/kg. Based on the results of the Base-wide risk assessment, prolonged exposure to this concentration of TRPH could potentially cause adverse health affects. Because the soils containing elevated concentrations of TRPH are located at depth, direct exposure is not likely under current land use scenarios. However, prolonged exposure to the TRPH in the subsurface soils could result if the site were developed for residential purposes in the future. For this reason, remedial alternatives were developed for PSC SD-38.

PSC SD-39 Waste Discharge at the Old Lockheed Site

PSC SD-39 consists of two separate areas located near the northern end of the inboard runway. According to information obtained during the RFA conducted in March 1991, Luke AFB used the facilities in the area for aircraft ground equipment maintenance prior to 1964. Lockheed Aircraft Company occupied the facilities in the area from 1964 to 1982. Presently, the 405th TPW Maintenance Shop occupies the facilities. This site was identified as a PSC because of the lack of information on the composition and quantity of wastes released. The soils at PSC SD-39 contain TRPH and arsenic. The Base-wide risk assessment concluded these levels pose no risk to human health or the environment.

PSC OT-41 Skeet Range Canal

PSC OT-41 consists of Luke AFB Skeet Range. The site occupies approximately 3.27 acres located along the western side of Luke AFB near the southern end of the outboard runway in a triangular extension of the western boundary of Luke AFB. The paved west perimeter road comprises 5 percent of the site. The remainder of the site is desert soil and grass, except for an unlined irrigation canal, which passes through the site. The irrigation canal originates off Base and flows south along the west boundary and exits Luke AFB to the south. The site was identified as a PSC because lead shot from skeet shooting could potentially enter the canal and could be transported off of Luke AFB property. The area where lead shot and broken clay pigeons primarily fall is not within the boundary of PSC OT-41. Rather, the impact areas for the skeet range are further to the east of the irrigation canal within the boundaries of PSC LF-25. The boundary of PSC OT-41 was established as such because the irrigation canal was the point of interest for the investigation, not the impact area. Detected lead concentrations were all below the USEPA Region IX residential PRGs, which is 400 mg/Kg.

PSC SS-42 Bulk Fuels Storage Area

PSC SS-42 consists of a former leaking UST site located within the eastern portion of the bulk fuels storage area of Luke AFB. The leaking UST was part of an oil/water separator system that received condensate from the two large aboveground fuel tanks.

In March 1993, the leak detection system for the oil/water separator UST sounded, indicating a release had occurred. According to Base personnel, unusually heavy rains caused the soil around the UST to settle. The settling apparently caused the fill line to dislodge from the tank. In response, the oil/water separator and fiberglass UST were removed from service and excavated.

Environmental investigations by Environmental Engineering Consultants, Inc. (EEC) in response to the release from the oil/water separator UST began in March 1993. EEC advanced seven soil borings (UST-1 through UST-7) adjacent to the oil/water separator and leaking UST. Several of the borings advanced to define the horizontal extent of the impact contained detections of TRPH and benzene, toluene, ethylbenzene, and total xylenes in samples collected at depths between 70 feet and 160 feet bgs. Because of these unexpected detections, the horizontal extent of the impact was not defined by the seven borings advanced by EEC.

After review of the EEC data, the FFA parties added this site as a PSC in the CERCLA investigation. Because of the depth of the impact and magnitude of the release, the FFA parties agreed that additional investigations were warranted because of the potential for groundwater impact. Therefore, PSC SS-42 was assigned to OU-1 in August 1993.

The objectives of the RI at PSC SS-42 were to define the horizontal extent of the impact detected at the former oil/water separator UST, identify other potential sources of contamination at the site, and to assess the groundwater quality. Initial activities included conducting a geophysical survey to identify underground lines and utilities. A soil-gas scan was also conducted to assess the integrity of the underground distribution system and identify other potential sources of contamination. Sixteen soil borings were advanced and sampled to determine the horizontal and vertical extent of the impacts identified at the site. Four groundwater monitoring wells (MW-119 through MW-121, and MW-125) were also installed and sampled to evaluate the groundwater quality.

TPH and BTEX concentrations were detected at depths ranging from 10 to 160 feet bgs. The highest detected concentration of TPH was 33,900 mg/kg at a depth of 70 feet bgs. BTEX compounds were also detected at their highest concentrations at this depth. Based on the results of the Base-wide Risk Assessment, contaminants identified at PSC SS-42 were not present at areas of potential exposure at concentrations high enough to cause adverse health effects under current land use scenarios, or even under residential land use scenarios. However, results of the vadose zone transport modeling indicated that petroleum related contaminants (TPH and BTEX) detected in the soil could migrate to the underlying groundwater resources. For this reason, remedial alternatives were developed for the site.

The remedial alternative selected for PSC SS-42 in the OU-1 ROD was S-11 (In-situ Soil Vapor Extraction with Long-term Groundwater Monitoring). The remedial components included:

- Installing, operating, and maintaining a Soil Vapor Extraction (SVE) System.
- Monitoring soil and groundwater to confirm effectiveness and potential migration of the contaminants.

Because the Base-wide risk assessment concluded that the site did not pose a threat to human health, the only remedial objective was to reduce TPH and BTEX concentrations in the soil to levels that would no longer pose a threat to the underlying groundwater resources. More specifically, ARARs for the site (Arizona Soil Remediation Standards) required that soil remediation continue until contaminants remaining in the soil did not cause or threaten to cause a violation of Aquifer Water Quality Standards at a point of compliance. The Arizona Department of Environmental Quality Groundwater Protection Limit (GPL) screening model was to be used for determining whether residual contaminant concentrations in the soil were protective of groundwater.

Prior to the signing of the OU-1 ROD, the Base initiated a SVE removal action at PSC SS-42. The SVE removal action was performed using a highly modified internal combustion engine (ICE) to create necessary vacuum to draw the contaminated soil vapors from the subsurface. The ICE used the petroleum laden vapors as a fuel source, effectively treating the soil vapors prior to discharge. An on-board computer adjusted carburation to ensure emissions met air quality standards. Supplemental propane was used to fuel the engine as petroleum concentrations in the soil gas decreased. The SVE removal action continued through November 1998. Results of the removal action were documented in a series of letter reports produced by Parsons Engineering Science, Inc.

Data collected during the removal action between August 6, 1996, and November 2, 1998, indicated that over 399,514 pounds of total volatile hydrocarbons (TVH) (approximately 66,586 gallons) were removed from the subsurface soils. BTEX concentrations in the soil gas decreased from 4,590 parts per million by volume (ppmv) to 608 ppmv. This calculates to a reduction of soil gas BTEX concentrations by 87 percent.

In January 1999, following completion of the removal action, a confirmation boring was installed and sampled to evaluate the residual TPH and BTEX concentrations in soil. While TPH and BTEX were still detectable at reduced concentrations at depths between 50 and 180 feet bgs, residual TPH and BTEX were not detected in the upper 40 feet of soil.

Vadose zone transport modeling was conducted following completion of the SVE removal action to determine whether the remaining hydrocarbon contamination could migrate beneath the site and impact the groundwater resources. The ADEQ Groundwater Protection Limit (GPL) model was used for this evaluation. The model results indicated that the residual TPH and BTEX concentrations would not impact groundwater at concentrations above Arizona Aquifer Water Quality Standards, and furthermore, additional remediation was not needed to satisfy all applicable, relevant and appropriate requirements (ARARs). For this reason, the first part of the remedial alternative selected for the site (In-situ Soil Vapor Extraction) was not implemented.

The remedial alternative selected for PSC SS-42 also involved a groundwater monitoring program. At a minimum, groundwater monitoring was to be conducted at the site annually for 5 years.

PSC OT-04 OLD PERIMETER ROAD WASTE DISPOSAL SITE

PSC OT-04 consists of the old perimeter road waste application site. From 1951 until approximately 1970, petroleum, oil, and lubricant (POL) wastes generated during Base operations were sprayed on this section of road to control excessive dust. The old perimeter road disposal site begins approximately 200 feet north of Facility 1080 and runs southwest around the southern portion of the runway, then turns northeast before terminating immediately adjacent to Facility 1082. PSC OT-04 is unpaved and approximately 6800 feet long and 15 to 20 feet wide.

According to the IRP Phase I investigation, the total volume of POL waste generated at the Base prior to 1954 was relatively small and was disposed mainly through fire department training exercises. After 1954, the total volume of POL waste generated by the Base increased significantly. Available records show that up to 50,000 gallons per year of POL wastes were disposed on the perimeter road. The majority of the POL wastes disposed at the site consisted of contaminated JP-4, but may also have included aviation gasoline (AVGAS), diesel fuel, waste engine oils, and waste solvents. Other wastes disposed in this manner included wastes from the Facility 912 oil/water separator and tank sludge from the periodic cleaning of fuel storage tanks. Some of the tank sludge contained lead from cleaning AVGAS storage tanks.

During the IRP, Phase II, Stage 1 investigation, eight two-foot deep soil borings were advanced along the road. Samples were collected from each of the borings at one-foot intervals. In December 1991 during the OU-2 RI, twelve 40-foot deep soil borings (SB-1 through SB-12) were drilled along the length of the roadway. The borings were spaced at approximately 800-foot intervals to provide coverage across the entire length of the site. A total of 51 soil samples (48 primary and 3 duplicate) were collected from the borings and submitted for laboratory analysis. The contract laboratory analyzed samples for TRPH (EPA Method 418.1), VOCs (EPA Method 8240), BNAs (EPA Method 8270), and metals (EPA Method 7421). The subsurface sample from each boring was also analyzed for PCBs (EPA Method 8080). Detailed descriptions of the sampling methodologies and analytical results are presented in the OU-2 RI report.

The surface soils in the southern section of the site were found to contain TRPH at concentrations ranging up to 250 mg/Kg. Although soil borings were advanced to 40 feet bgs, samples collected below 10 feet bgs did not show detectable concentrations of TRPH. VOC compounds were not detected in any of the samples, and the only detected BNA compounds were common laboratory contaminants at low concentrations. With only two exceptions, the metals concentrations detected in soil samples were below their respective background upper confidence limits (UCLs).

During 1992 and 1993, the data collected during the OU-2 field investigation were used to evaluate remedial alternatives for the soils at this site. Based on these results of the OU-2 Risk Assessment and Feasibility Study, no further action alternative was proposed. This alternative was officially adopted in the OU-2 ROD that was signed in January 1994.

Later in 1994, concerns arose about the quality of some of the VOC and BNA data used in the original evaluation of PSC OT-04. In response, seven additional samples were collected in August 1996 to replace the original data of unknown quality. The additional samples were collected from three borings, which were located at the areas of the site, which showed the greatest signs of impact.

The three additional soil borings (SB-13 through SB-15) were located adjacent to Soil Borings SB-5, SB-9, and SB-10, respectively. Three surface and four subsurface samples were collected from the borings and submitted to Quanterra laboratories for analysis. VOC and BNA compounds were not detected in any of the additional samples.

These new sampling data were used with previously collected data of known quality to re-calculate the risk assessment for the site. The results of the risk assessment showed that exposure to the soil at this site would not cause a risk to human health of the environment. Both current and hypothetical future excess lifetime cancer rate (ELCR) and Hazard Index (HI) for exposure to soils at these sites were below the ADEQ and USEPA's residential risk-based remediation benchmarks (ELCR less than 10^{-4}, HI below 1.0). As a result, the original remedial alternative selected for the site (no further action) was re-affirmed.

PSC DP-05 POL DISPOSAL AREA

PSC DP-05 consists of an 18-acre triangular-shaped area located on the southeast side of Taxiway I. Base Production Well 11 and PSC SD-26 (the Hush House Canal) are located adjacent to the site. PSC DP-05 currently consists of bare ground covered with sparse vegetation According to the IRP, Phase I investigation results, this area was used for the disposal of petroleum, oil, and lubricant (POL) waste from approximately 1970 until 1972. POL wastes were delivered to the site in 5,000-gallon tanker trucks and dumped in shallow (1.5 feet deep) trenches. The waste was allowed to weather for 4 to 6 weeks and was then covered with soil. Eleven trenches ranging from approximately 200 to 550 feet in length were identified on aerial photographs taken between 1977 and 1989. A shallow lagoon was also identified at the northeast corner of the site. The lagoon was apparently excavated for additional waste disposal. Undocumented estimates of the POL waste volumes, mostly JP-4, were as high as 100,000 gallons per year at this disposal site from 1970 to 1972.

During the IRP, Phase II, Stage 1 investigation, ten soil borings were drilled and sampled to a depth of 20 feet. A soil gas survey, geophysical survey, and soil boring investigation were conducted during the IRP, Phase II, Stage 2 investigation. The results of the soil gas survey and geophysical survey were used to determine the locations of nine 100-foot soil borings. Monitoring wells MW-104, MW-105, and MW-106 were also installed at the site during the IRP Phase II, Stage 2 investigation. The locations for the monitoring wells were selected to encircle the site as completely as possible.

The OU-2 RI field activities at PSC DP-05 began in December 1991 and continued through June of 1992. Initially, twenty 20-foot deep soil borings (SB-1 through SB-20) were drilled and sampled at the areas of concern identified on aerial photographs. Drilling or two 150-foot deep borings (SB-21 and SB-22) was also initiated in February 1992, however, the borings were not completed due to problems caused by heavy rain. Soil Borings SB-21 and SB-22 were only advanced to depths of 77 feet and 20 feet, respectively. Two 150-foot deep borings were completed as Soil Borings SB-23 and SB-24 in April 1992. After review of the data, borings SB-25, SB-26, SB-27, and SB-28 were drilled as contingency borings in June 1992. The contingency borings were drilled to further characterize the organic compounds detected in samples collected from Soil Boring SB-9. Descriptions of the sampling methodologies and analytical results are presented in the OU-2 RI report

A total of 100 samples (95 primary and 5 duplicate) were collected from the borings and submitted for laboratory analysis. Samples were analyzed for TRPH (EPA Method 418.1), VOCs (EPA Method 8240), BNAs (EPA Method 8270), and metals (EPA Method 7421). The 0-2 foot bgs sample from each boring was also analyzed for PCBs (EPA Method 8080). With the exceptions of two samples collected from Soil Boring SB-8 and three samples collected from Soil Boring SB-22. The ATI Phoenix laboratory conducted analytical procedures. The ATI San Diego laboratory analyzed the three samples collected from Soil Boring SB-22 and both samples collected from Soil Boring SB-8.

Samples from the majority of the soil borings drilled at the site did not contain detectable concentrations of organic compounds or detections were limited to near surface soils. TRPH, BNA, and VOC compounds were detected at their highest concentrations in soil samples collected from the center site where the former disposal pits are located. Soil Boring SB-9 and four contingency borings (SB-25 through SB-28) were drilled in this area of the site during the OU-2 RI.

Soil samples collected from Soil Boring SB-9 at a depth of 6 feet bgs contained the highest concentrations of TRPH (8,300 mg/Kg). TRPH was not detected below the depth of 22-feet in any of the samples collected at the site. Ethyl benzene and xylenes were the only detected VOC compounds. The highest detected concentration of ethyl benzene was 0.9 mg/Kg in the 12-14 foot bgs samples collected from Soil Borings SB-25 and SB-27. The highest detected concentration of xylenes was 86 mg/kg in the 6-foot bgs sample collected from Soil Boring SB-9. VOC compounds were not detected below the depth of 14 feet. Three BNA compounds were detected in the central portion of the site near SB-9. The highest detected concentrations were naphthalene at 4.6 mg/Kg, 2-methylnapthalene at 4.7 mg/Kg, and BEP at 3.7 mg/Kg. BNA compounds were not detected below the depth of 22 feet.

With the exception of lead, all metals results for soil samples collected from PSC DP-05 were either below their respective background UCLs or were within naturally occurring background ranges. The maximum detected concentration of lead (115 mg/Kg) does exceed its background UCL and the upper range of concentrations included in the background data set. Only three samples contained elevated lead concentrations. The surface sample collected from Soil Boring SB-7 contained 115 mg/kg of lead. The two shallowest samples collected from Soil Boring SB-9 contained lead concentrations of 72 mg/kg and 39 mg/kg, respectively. These samples also contained some of the highest concentration of TRPH detected at this site.

Groundwater samples collected from PSC DP-05 did not contain detectable concentrations of organic compounds with just two exceptions. VOC compounds were detected in one sample collected from Monitoring Well MW-104 in November1992. The only VOC compounds detected were acetone and toluene. These compounds were never detected in any of the other samples collected from Monitoring Well MW-104. BEP, a common laboratory contaminant, was the only other organic chemical detected in groundwater samples collected from this site. This BNA compound was not detected in any of the other groundwater samples. Total silver (0.018 mg/L) was detected in one groundwater sample collected from Monitoring Well MW-106. Silver was not detected in any of subsequent groundwater samples events or in any of the other samples collected at the site. All other metals detected in groundwater samples collected from PSC DP-05 were either below their respective background UCLs or were within the range of naturally occurring concentrations included in the background data set.

During 1992 and 1993, the data collected during the OU-2 field investigation were used to evaluate remedial alternatives for the soils at this site. Based on these results of the OU-2 Risk Assessment and Feasibility Study, a no further action alternative was proposed. This alternative was officially adopted in the OU-2 ROD that was signed in January1994.

Later in 1994, concerns arose about the quality of some of the VOC and BNA data used in the original evaluation of PSC DP-05. Because only a limited area near the center of the site was impacted, the FFA parties determined that two additional soil borings (SB-29 and SB-30) would provide the needed data. Both borings were located in near the center of the former disposal pits at the area of the site that showed the greatest sign of impact. Soil Boring SB-29 was located adjacent to Soil Boring SB-27. Soil Boring SB-30 was located adjacent to Soil Boring SB-25. None of the samples collected from the additional soil borings contained detectable concentrations of VOCs or BNAs.

These new sampling data were used with previously collected data of known quality to re-calculate the risk assessment for the site. The results of the risk assessment showed that exposure to the soil at this site would not cause a risk to human health of the environment. Both current and hypothetical future ELCRs and HIs for exposure to soils at these sites were below the ADEQ and USEPA's residential risk-based remediation benchmarks (ELCR less than 10^{-4}, HI below 1.0). As a result, the original remedial alternative selected for the site (no further action) was re-affirmed.

PSC FT-06 SOUTH FIRE TRAINING AREAPSC FT-06 SOUTH FIRE TRAINING AREAPSC FT-06 SOUTH FIRE TRAINING AREAPSC FT-06 SOUTH FIRE TRAINING AREA

PSC FT-06 was the original fire department training area for the Base. PSC FT-06 is located in the southern portion of the Base, east of the Facility 1009 power check pad. The PSC is a rectangular area approximately 8 acres in size. Buildings 1031, 988, and 1018 are located on the site. Eighty percent of the PSC is paved; this includes portions that are under building foundations, parking lot asphalt, and a concrete lined storm drain canal. Twenty percent of the PSC is unpaved including landscaped areas around buildings, parking lots that are covered with gravel, and a bare area north of the perimeter road.

During past operations, standard practice was to transport petroleum, oil, and lubricant waste in 55-gallon drums to the fire department training site. The POL wastes were poured onto an old aircraft or simulated aircraft in a cleared, unlined, bermed circular pit approximately 100-feet in diameter. The structures were then set on fire and extinguished with water and aqueous film forming foam (AFFF). Fire training operations were conducted at this site from 1941 until deactivation of the Base in 1946, and again from the time of Base reactivation in 1951 until approximately 1973. Aerial photographs from 1953, 1962, and 1970 indicate that 13 pits of various dimensions were present at this site.

Ten 20-foot deep soil borings were originally proposed in the IRP, Phase II, and Stage 1 investigation. However, due to construction at the site, drilling of the proposed soil borings was prohibited. Instead, four shallow soil samples (2 to 3-feet total depth) were collected from soil exposed by construction activities. In addition, two 100-foot borings were drilled, and a total of 40 subsurface soil samples were collected during the IRP Phase II, Stage 2 soils investigation.

Two groundwater monitoring wells (MW-107 and MW-108) were installed at this site during the IRP, Phase II, and Stage 2 groundwater investigation. Monitoring well locations were chosen so that MW-107 was located between the former pits and MW-108 was in the presumed down gradient direction. Monitoring Wells MW-107 and MW-108 were included in the Base wide groundwater monitoring and sampling program, which continued through the second quarter of 1996.

From December 1991 through April 1992, 18 soil borings (SB-1 through SB-18) were drilled and sampled at the site during the OU-2 field investigation. Thirteen borings were advanced to 100 feet bgs and five borings were advanced to 20 feet bgs. The locations were selected so that at least one 100-foot deep soil boring would be advanced in each of the former fire training pits identified on the aerial photographs.

TRPH was detected in 14 of the 18 soil borings, with the highest concentration of 18,000 mg/Kg being in the 2-4 foot bgs sample from Soil Boring SB-5. The TRPH values from the remaining borings ranged from 10 to 12,000 mg/Kg. With the exception of Soil Borings SB-5 and SB-18, TRPH was not detected below 20-feet. In Soil Borings SB-5, and SB-18, TRPH was detected at maximum depths of 38 and 24 feet bgs, respectively. VOC compounds including BTEX, TCE, PCE, MEK and methyl isobutyl ketone were detected at depths up to 14 feet bgs. BNA compounds, such as phenanthrene, chrysene, fluoranthene, pyrene, benzo(b)fluroanthene, and benzo(a)pyrene, were detected in samples from 16 borings. Sample collected from Soil Boring SB-8 contained he highest concentrations of BNAs, with 27 BNA compounds detected in the 0-2 foot bgs sample. BNA compounds were detected at depths up to 24 feet bgs. PCBs were not detected in any of the samples collected and analyzed at PSC FT-06.

Three surface soil samples were also collected from PSC FT-06 for dioxin and furan analysis. Two composite soil samples and one background sample were collected and submitted for analysis. Dioxins and furans were not detected in either of the composite samples. However, the background sample did contain heptachlorodibenzo-p-dioxin (HpCDD) at a concentration of 1.2 nanograms per gram (ng/g), octachlordibenzo-p-dioxin (OCDD) at 4.6 ng/g, heptachlorodibenzo-p-furan (HpCDF) at 1.1 ng/g, and octachlordibenzo-p-furan (OCDF) at 2.0 ng/g. Because this sample was not collected in the former fire training pits, the presence of the dioxins and furans is most likely not related to site activities.

The results of the analyses conducted on groundwater samples collected from Monitoring Wells MW-107 and MW-108 indicate VOCs, BNA compounds, and EDB, are not present in the groundwater at this PSC. The agricultural pesticide DBCP (0.05 micrograms per liter) was present in groundwater. Detected metals concentrations in groundwater were within background ranges.

During 1992 and 1993, the data collected during the OU-2 field investigation were used to evaluate remedial alternatives for the soils at this site. Based on these results of the OU-2 Risk Assessment and Feasibility Study, a no further action alternative was proposed. This alternative was officially adopted in the OU-2 ROD that was signed in January 1994.

Later in 1994, concerns arose about the quality of some of the VOC and BNA data used in the original evaluation of PSC FT-06. The FFA parties elected to collect additional data at the site to re-evaluate the original remedial alternative. A total of six additional subsurface soil samples were collected in August of 1996 as part of this additional soil sampling investigation. Surface samples were not collected because the former fire training pits are no longer present and exposure to their surface soils are not possible. For each additional soil boring, the sampling depth was determined based on visual evidence and field screening results noted on the original soil boring logs. Attempts were made to collect soil samples immediately beneath the former fire training pits.

None of the samples collected from additional Soil Borings SB-20, SB-22, or SB-23 contained detectable concentrations of either VOCs or BNAs. The sample collected from Soil Boring SB-19 did not contain detectable concentrations of VOCs; however, di-n-octylphthalate was detected at a concentration of 0.16 mg/Kg. This was the only BNA compound detected at Soil Boring SB-19. Similarly, the sample collected from Soil Boring SB-21 did not contain VOCs, but nine different BNA compounds were detected in the sample collected from this borehole. The highest detected concentration was 0.33 mg/Kg of pyrene. Seven VOC compounds were detected in the subsurface sample collected from Soil Boring SB-24. The highest detected concentration was 23 mg/Kg of xylenes. BNA compounds 2-methylnapthalene (15 mg/Kg) and naphthalene (33 mg/Kg) were also detected in this sample.

These new sampling data were used with previously collected data of known quality to re-calculate the risk assessment for the site. The results of the risk assessment showed that exposure to the soil at this site would not cause a risk to human health of the environment. Both current and hypothetical future ELCRs and HI's for exposure to soils at these sites were below the ADEQ and USEPA's residential risk-based remediation benchmarks (ELCR less than 10^{-4}, HI below 1.0). As a result, the original remedial alternative selected for the site (no further action) was re-affirmed.

PSC FT-07W WESTERN PORTION OF THE NORTH FIRE TRAINING AREA

PSC FT-07W is located in the northern portion of the Base, west of Fire Department Training Facility 1355. PSC FT-07W was previously identified as Site Number 7 in the IRP Phase I, Records Search Report (CH2M HILL, 1982). The North Fire Training Area (NFTA) was divided into an eastern and western portion during the RI. The soils in the western portions were included in the OU-2 investigation. The eastern portion of the site was investigated during the OU-1 RI. Section 13 of this report details the investigative results of the eastern portion of the site.

The western portion of the NFTA occupies approximately 14 acres west of Facility 1356. Approximately 50 percent of the site is currently occupied by a new fire training facility that was constructed in the spring of 1996. The remaining portion of the site is covered by bare ground with sparse vegetation. During past operations at the site, POL waste was poured into circular unlined bermed areas containing mock aircraft and then set on fire for fire fighting training. These fires were extinguished with water and aqueous film forming foam.

During the IRP Phase II, Stage I investigation, Weston identified three former fire-training pits in the western portion of PSC FT-07. Four 20-foot deep soil borings were drilled at these pits. Two 20-foot deep borings were advanced within the biggest pit, while a single 20-foot deep boring was advanced in each of the smaller pits. VOC and Oil & Grease were detected in several samples collected from the pits. Based on the results of this contaminant verification sampling, additional investigation was recommended at two of the pits in the IRP Phase II, Stage 2 investigation. During the IRP Phase II, Stage 2 investigation, Weston advanced a 100-foot soil boring in the two pits recommended for further investigation. Three monitoring wells (MW-109, MW-110, and MW-111) were also installed and sampled by Weston during the IRP Phase II, Stage 2 investigation.

Following completion of Weston's activities, EA Engineering Science and Technology, was contracted to perform additional soil investigations across the entire site at PSC FT-07W. The main objective of the EA Engineering's investigation was to design a soil vapor extraction system for the eastern portion of the site (FTP-3 and FTP-4). However, they did advance four additional borings in each of the three pits identified in the western portion of the site. EA Engineering designated the three pits in the western portion of the site as FTP-1, FTP-2, and FTP-5.

For each of the pits, a deep boring was drilled in the center of the pit and three shallow borings were drilled around its perimeter. The deep borings in FTP-1 and FTP-5 were advanced to a depth of 100 feet bgs. The deep boring for FTP-2 was only advanced to a depth of 50-feet bgs. The shallow borings were all drilled to a depth of 30 feet bgs. Samples collected from these borings were analyzed for TRPH (EPA Method 418.1), VOCs (EPA Method 8240), and metals (EPA Method 7421) by Southwest laboratories of Oklahoma.

Soil sampling data indicated that only low concentrations of acetone and methylene chloride were present in the samples. Although numerous detections of these constituents were attributed to laboratory contamination, the deepest samples collected from FTP-1 and FTP-5 that were analyzed for VOCS did contain detectable concentrations of acetone and methylene chloride that were not flagged as laboratory contaminants. EA Engineering did not detect pOL-related constituents, such as BTEX and TRPH, in any of the samples collected form the western portion of the site.

During the compilation of the planning documents for the OU-2 investigation, Geraghty & Miller identified seven additional fire-training locations in the western portion of the site. These pits were identified on 1965, 1970, and 1973 aerial photographs. A total of 10 former fire-raining pits (FTP-1, FTP-2, FTP-5, and seven un-numbered pits) were included in the OU-2 investigation. During the OU-2 RI, Geraghty & Miller advanced 20 soil borings in the western portion of PSC FT-07. Ten of the borings were drilled to a depth of 100 feet, and ten drilled to a depth of 20-feet. A deep boring was advanced in each of the ten pits. The ten shallow borings were advanced at various locations around the pits to define the horizontal extent of any detected constituents.

Soil samples collected from six of the former fire training pits contained detectable concentrations of organic chemicals. The six pits with organic chemical detections include FTP-1, FTP-2, and FTP-5 and three smaller un-numbered pits. Detected organic constituents are limited to TRPH and BNA compounds. Soils containing detectable concentrations of TRPH range to depths of 100 feet bgs at FTP-2 and 60 feet bgs at FTP-5, but to depths of less than 16 feet bgs in all other areas. BNA compounds were only detected in three samples and were not detected below the depth of 6 feet bgs. Lead was the only inorganic constituent detected above background ranges. Only two samples contained elevated lead concentrations. Both borings with samples containing elevated lead levels also contained detectable concentrations of TRPH.

Based on a review of EA Engineering's data and the data produced during the OU-2 RI, the vertical extent of organic constituents were not defined to within laboratory detection limits at three areas of the site. Samples collected at FTP-2 during the OU-2 RI contained detectable concentrations of TRPH at depths of 100 feet bgs. Samples collected at the center of FTP-1 by EA Engineering contained methylene chloride at a depth of 120 feet bgs. Although methylene chloride is a common laboratory contaminant, this detection at this depth was not qualified. Similarly, samples collected from the center of the FTP-5 at a depth of the 120 feet bgs contained detections of methylene chloride and acetone that were not qualified.

Following completion of the OU-2 investigation, three additional soil borings were advanced and sampled at the site. The purpose of the additional sampling was to define, to laboratory non-detectable levels, the maximum vertical extent of the constituents of potential concern in the soil. TPH was not detected below a depth of 10 feet in any of these three borings. VOCs were not detected in samples collected from Soil Borings SB-24 or SB-25. The only VOC detected in samples collected from Soil Boring SB-27 was acetone; however, based on data validation criteria, all acetone detections were qualified as a laboratory contaminant. Based on the results of the additional sampling investigation, the vertical extent of organic chemicals in the soils beneath each of the former fire training pits at PSC FT-07 have been defined to be less than 120 feet bgs.

These new sampling data were used with previously collected data of known quality to re-calculate the risk assessment for the site. The results of the risk assessment showed that exposure to the soil at this site would not cause a risk to human health of the environment. Both current and hypothetical future ELCR's and HI's for exposure to soils at these sites were below the ADEQ and USEPA's residential risk-based remediation benchmarks (ELCR less than 10^{-4}, HI below 1.0). As a result, the original remedial alternative selected for the site (no further action) was re-affirmed.

PSC ST-18 FACILITY 993

PSC ST-18 consists of a former liquid waste storage facility (Facility 993) located in the southern part of the Base. Facility 993 originally consisted of a single 5,000-gallon refueling tank truck that was coated and buried in 1968. This underground storage tank (UST) was used for the temporary storage of all liquid petroleum, oil, lubricant (POL) and solvent wastes generated at the Base. Prior to 1972, liquid wastes stored at this facility were disposed during road oiling and dust suppression activities (PSC OT-04), in narrow trenches (PSC DP-05), and in fire training activities (PSCs FT-06 and FT-07). In 1972, two 10,000-gallon capacity USTs were installed at the facility, and the area around all three USTs, approximately 0.2 acres, was enclosed with a fence. Also at this time, the Base began selling the liquid wastes to private contractors for recycling.

This facility was classified as an interim status treatment, storage, and disposal (TSD) facility under RCRA in 1979. Part A of a Hazardous Waste Permit application was submitted in 1980. However, closure of this facility began in 1982 to facilitate the construction of a new USAF Reserve maintenance building.

The USAF to direct the closure activities and related subsurface investigations retained Raymond E. Kary, Ph.D., in association with Guitierrez-Palmenberg, Inc. (GPI). Initially, twelve 50-foot deep soil borings were drilled adjacent to the USTs during July and August 1983. The analytical results showed no contaminants. Based on the results of the initial investigation, a partial closure plan was submitted to the Arizona Department of Health Services. The closure plan was approved on October 4, 1983.

The three USTs were removed on October 19, 1983 following this initial investigation. Soil samples collected directly beneath the 5,000-gallon tanker truck and one of the 10,000-gallon USTs showed signs of impact from past releases. The tank pit was excavated to a depth of 16 feet bgs in an attempt to assess the extent of contamination. Based on field observations, highly impacted soils were manifested to a hazardous waste landfill. The moderately contaminated soils were aired for several weeks and replaced in the pit, and the minimally contaminated soils were placed directly back into the pit.

Because this site was an active facility in 1981, it was not identified in the IRP Phase I investigation which was focused on historic waste disposal activities. However, the Base decided to include this site in the IRP Phase II investigation because of the sampling results of the UST closure activities. Between November 4, 1985 and February 6, 1986, Weston continued the investigation of the site during the IRP, Phase II, and Stage 1 investigation. During this investigation, five soil borings were advanced in and around Facility 993. Soil Boring depths ranged from 100-145 feet bgs. In addition, five groundwater monitoring wells (MW-1 through MW-5) were installed. Conclusions presented in the IRP, Phase II, Stage 1 report (Roy F. Weston, 1986) indicated that the soil beneath the former USTs had been impacted by fuel and organic solvents, and the impacted soil extended to the maximum depth of 56.5 feet bgs.

The site was capped with concrete in 1987 as part of the RCRA post-closure requirements for the site. In a letter dated May 13, 1988, the ADEQ stated that they had inspected the concrete cap covering the facility and it was satisfactory. Currently, the Base continues to inspect and maintain the cap to ensure integrity of the concrete and sealed joints.

In September 1990, the Federal Facilities Agreement for Luke AFB was signed and regulatory authority for Facility 993 was transferred from the RCRA program to the CERCLA program as part of RCRA/CERCLA integration. The FFA parties elected to include Facility 993 in the OU-2 remedial investigation as PSC ST-18.

From February to June of 1992, eight soil borings were drilled during the OU-2 investigation to define the horizontal and vertical extent of the soil impact. A total of 37 samples were collected from the borings and submitted to the ATI Phoenix laboratory for analysis. The highest detected concentrations of TRPH were in the samples collected from Soil Borings SB-1 and SB-2, which were drilled at the former leaking UST locations. The highest detected TRPH value in Soil Boring SB-1 was 4,900 mg/Kg in the 12-14 feet bgs sample. Samples collected from Soil Boring SB-2 contained TRPH at concentrations of 10,000 mg/Kg and 17,000 mg/Kg in the 12-14 foot bgs and 20-22 foot bgs samples, respectively. VOC compounds were only detected in Soil Borings SB-1 and SB-2. Detected compounds include: BTEX, 1,1-dichloroethane, 1,1,2,2-tetrachloroethane, TCE, and PCE. The highest concentrations of VOCs were detected in the 20-22 foot bgs sample from Soil Boring SB-2, which was also the sample with the highest TRPH value. BNAs were detected in samples from all eight borings. In general, the detected BNA compounds were all found in samples that also contained TRPH.

Groundwater quality beneath PSC ST-18 was evaluated using analytical results from groundwater samples collected at Groundwater Monitoring Wells MW-2, MW-3, MW-4, MW-5, MW-114, and MW-122. VOCs and BNAs were not detected in Monitoring Wells MW-2, MW-3, MW-5, or MW-122. EDB and DBCP were not reported in any samples collected from Monitoring Wells MW-2, MW-4, MW-5 and MW-114. EDB was also not detected in the samples analyzed from Monitoring Well MW-3.

Toluene was detected at a concentration of 4 µg/L during the first quarter 1992 groundwater sampling event at Monitoring Well MW-4. Toluene has not been reported in subsequent sampling events at Monitoring Well MW-4 or in any of the other wells monitored at ST-18. BEP, a common laboratory contaminant, was detected during the first quarter 1992 and second quarter 1993 in Monitoring Well MW-114. However, BEP was reported in the equipment blank during the first quarter of 1992.

DBCP was reported in Monitoring Well MW-3 at a concentration of 0.07 µg/L in the only sampling event (fourth quarter 1992) for which analyses for DBCP were performed. DBCP is a pesticide that was commonly used in citrus groves from the mid-1950s until it was banned by the USEPA in 1980. Citrus groves may have been located on private lands adjacent to Luke AFB. No citrus groves are currently present at Luke AFB. Although DBCP was not detected in any other wells at ST-18, it was reported in Monitoring Wells MW-107, MW-108 and MW-110.

Throughout 1992 and 1993, the data collected during the OU-2 field investigation were evaluated to determine the appropriate remedial alternative for this site. Based on the results of the OU-2 Risk Assessment and OU-2 Feasibility Study, the remedial action proposed for implementation at PSC ST-18 was capping, surface controls, and monitoring. The FFA parties in the OU-2 ROD that was signed in January 1994 officially adopted this alternative. Although a cap had already been installed at the site, the monitoring requirements for PSC ST-18 were not identified in the OU-2 ROD because they are dependant on the results and conclusions of the groundwater investigation which is included as part of theOU-1 Remedial Investigation Report.

Later in 1994, concerns arose about the quality of some of the VOC and BNA data used in the original evaluation of PSC FT-06. Because CERCLA guidance requires that only data of known quality be used to evaluate remedial alternatives for a site, the FFA parties elected to collect additional data at the site to re-evaluate the original remedial alternatives. Additional data was also to be collected to refine the delineation of the extent of the soil impact. A more refined delineation of the extent of impact was needed to assist in the establishment of long term groundwater monitoring requirements for the site, as required by the original OU-2 ROD.

Nine additional soil borings were advanced and sampled in August of 1996 because of concerns of the quality of the original VOC and BNA data and to refine the delineation of the horizontal and vertical extent of the impacted soil. A total of 36 samples (33 primary and 3 duplicate) were collected from the nine borings and submitted for laboratory analysis.

Analytical results from the additional sampling indicated that TPH concentrations are highest in the area of the former UST pit. TPH concentrations were detected to depths of 48-50 feet bgs in SB-11 and 78-80 feet bgs in SB-10. In both borings, the samples containing the highest detected TPH concentrations (6,800 for SB-10 and 18,000 mg/Kg for SB-11) were collected at a depth of 18-20 foot bgs. This depth corresponds to just below the depth excavated during the removal of the USTs. VOC compounds (including BTEX, TCE and PCE) were detected in Soil Borings SB-10 and SB-11 to depths of 60 feet bgs. BNAs were detected in Soil Borings SB-10 and SB-11, but only in those samples, which also contained TPH. BEP, a common laboratory contaminant, was also detected in Soil Borings SB-9, SB-13, SB-14, and SB-15. Most values were qualified as estimated values.

These new sampling data were used with previously collected data of known quality to re-calculate the risk assessment for the site. The results of the risk assessment showed that exposure to the soil at this site would not cause a risk to human health of the environment. Both current and hypothetical future ELCRs and HIs for exposure to soils at these sites were below the ADEQ and USEPA’s residential risk-based remediation benchmarks (ELCR less than 10^{-4}, HI below 1.0). As a result, the original remedial alternative selected for the site (capping, surface controls, and monitoring) was re-affirmed as protective of human health and the environment.

PSC DP-22 POL TRENCH AT NORTHEAST RUNWAY

PSC DP-22 is an irregular-shaped area located at the north end of the inboard runway. The site occupies approximately 4.6 acres. Approximately 30 percent of the PSC is covered with concrete (the inboard runway), 20 percent is covered with bituminous cover, and 50 percent of the site is covered by gravel with sparse vegetation.

This site may have been used for the disarmament and de-fueling of aircraft during the 1940s and 1950s. Reportedly, waste POL was dumped into shallow trenches at this site. Based on interviews with Base personnel, off-loaded fuel may have been drained into trenches perhaps 600 to 800 feet long and a few feet deep. No evidence of trenches was visible on examination of aerial photographs. During the 1950s, the configuration of the east runway was different than it is at present. The reported disposal site was located approximately 800 feet southwest of where the runway presently ends. Construction of the runway extension in the late 1950s ended disposal of POL in this area. There were no environmental investigations conducted at this site prior to the OU-2 RI.

In January and February of 1992, five soil borings (SB-1 through SB-5) were drilled at PSC DP-22 during the OU-2 investigation. TRPH concentrations were detected in the surface or near surface samples collected at each of the borings. Detected TRPH concentrations generally decreased with increasing depth. The surface sample collected from Soil Boring SB-4 contained the highest detectable concentration of TRPH (970 mg/Kg). Although TRPH was generally not detected in subsurface soils, TRPH was detected at concentrations near the laboratory detection limits in the 98-100 foot bgs samples from Soil Borings SB-3 and SB-4. The only VOC detected was acetone at a concentration of 1.0 mg/Kg in the 10-12 foot bgs sample collected from Soil Boring SB-2. BNA compounds were not detected in any of the 21 soil samples submitted for laboratory analysis. The highest detected concentrations of barium (407 mg/Kg) and lead (30 mg/Kg) do exceed their respective background UCLs. The surface sample collected from Soil Boring SB-3 contained both of these elevated metals concentrations. This sample also contained TRPH. None of the other samples collected from the site contained metals at concentrations above their background UCLs.

During 1992 and 1993, the data collected during the OU-2 field investigation were used to evaluate remedial alternatives for the soils at this site. Based on these results of the OU-2 Risk Assessment and Feasibility Study, a no further action alternative was proposed. This alternative was officially adopted in the OU-2 ROD that was signed in January 1994.

Later in 1994, concerns arose about the quality of some of the VOC and BNA data used in the original evaluation of PSC DP-22. The FFA parties determined these data were of unknown quality. In response, six additional samples (5 primary and one duplicate) were collected in August 1996 to replace the original data of unknown quality. The additional samples were collected from three borings, which were located at the areas of the site, which showed the greatest signs of impact.

The three additional soil borings (SB-6 through SB-8) were located adjacent to Soil Borings SB-3, SB-1, and SB-4, respectively. Three surface and three subsurface samples (5 primary and one duplicate) were collected from the borings and submitted to Quanterra laboratories for analysis. None of the samples collected from the additional soil borings contained detectable concentrations of VOCs. The primary subsurface sample collected from Soil Boring SB-7 contained a concentration of 0.17 mg/Kg of BEP, a common laboratory contaminant. This was the only BNA compound detected in any of the six additional soil samples.

These new sampling data were used with previously collected data of known quality to re-calculate the risk assessment for the site. The results of the risk assessment showed that exposure to the soil at this site would not cause a risk to human health of the environment. Both current and hypothetical ELCRs and HIs for exposure to soils at these sites were below the ADEQ and USEPA’s residential risk-based remediation benchmarks (ELCR less than 10^{-4}, HI below 1.0). As a result, the original remedial alternative selected for the site (no further action) was re-affirmed.

PSC DP-23 OLD SURFACE IMPOUNDMENT AREA

PSC DP-23 consists of the Old Surface Impoundment and associated wash located west of Building 999 and adjacent to the former south fire training area. The old surface impoundment portion of the site is a rectangular-shaped area that occupies approximately 3.3 acres. Currently, 80 percent of this area is either paved with asphalt, under tarmac, or under concrete, which includes the AGE equipment yard. In the late 1940's, an impoundment dam was constructed along an old natural drainage system, which flowed south off of the Base. This area may have been used for the disposal site for POL waste until construction covered the site in 1969. The dam used to create the surface impoundment was buried, but not removed. The wash portion of the site is located to the south of the impoundment area and occupies approximately 19.4 acres. The wash extends off Base and flows south to an area of earth fissures (See PSC SD-20).

In February of 1992, two 150-foot deep borings (SB-2 and SB-4) and four 40-foot deep soil borings (SB-1, SB-3, SB-5, and SB-6) were drilled and sampled at PSC DP-23 during the OU-2 investigation. Sediment samples were collected from ten locations (SD-1 through SD-10) in December of 1991 and February of 1992. A total of 26 soil samples (23 primary and 3 duplicate) and 21 sediment samples (20 primary and 1 duplicate) were collected and submitted for laboratory analysis.

The highest detected concentration of TRPH was 2,000 mg/kg in the 2 to 4 foot bgs sample collected from Soil Boring SB-4. The only detected VOC compounds (trace concentrations of toluene and ethyl benzene) were also detected in this sample. TRPH was generally confined to shallow soils, and the deepest sample with detectable TRPH concentrations was collected at a depth of 8 to 10 feet bgs from SB-5.

Six soil and five sediment samples collected during the OU-2 investigation contained detectable concentrations of BNA compounds. Four samples contained concentrations of Benzo(a)pyrene in excess of its Preliminary Remediation Goal (PRG) of 0.78 mg/kg. These four samples include the surface sample and its duplicate collected from SB-4, the 2 to 4 foot bgs sample collected from SB-4, and the surface sample collected from SB-5. None of the other samples contained BNA compounds at concentrations in excess of their PRGs

The data collected during the OU-2 field investigation were evaluated to determine the appropriate remedial alternative for this site. Based on the results of the OU-2 Risk Assessment and OU-2 Feasibility Study, the remedial action proposed for PSC DP-23 was excavation of all soils with benzo(a)pyrene concentrations above the PRGs, biological treatment to reduce contaminant concentrations, monitoring to confirm effectiveness, and return of the treated soils to the excavation for final disposal. The FFA parties in the OU-2 ROD that was signed in January 1994 officially adopted this alternative.

PSC SD-40 TAXIWAY FUEL DISCHARGE AREA

PSC SD-40 consists of the areas located on both sides of the southeastern end of Taxiway F and on both sides of the south-central section of Taxiway E. The southern area of the PSC (along Taxiway F) covers approximately 3 acres and the northern area (along Taxiway E) covers approximately 7.6 acres. The areas adjacent to the taxiways are covered with a bituminous dust cover of 2-inch thick asphalt. The site has been used to perform limited service of aircraft since the present runway layout was complete in the 1950s. De-fueling of jet aircraft onto the bituminous cover was reportedly conducted for fuel tank maintenance. This de-fueling practice occurred on Taxiway F from the early 1970s until 1990.

Information from interviews with Base personnel indicates that during maintenance activities fuel was drained from the aircraft fuel tanks onto the dust cover adjacent to the taxiways. De-fueling of jets is believed to have been the primary source of releases from the 1970s until the de-fueling procedure was modified in 1990 to control those releases. The amounts of fuel involved in the individual events varied depending on the maintenance involved. In addition, hydrazine may have been discharged onto the surface adjacent to the Foxtrot Extension during F-16 maintenance. Staining of the taxiways and asphalt along the taxiways is documented by historical aerial photographs dating back to 1964. No staining was visible in the 1958 aerial photographs so the maintenance activities may have begun between 1958 and 1964. Information from interviews indicates that for at least 20 years these areas were used as Alternate F-15 fuel tank maintenance areas.

In April of 1992, eleven 100-foot deep borings were drilled at PSC SD-40 during the OU-2 investigation. TRPH was detected in 21 of the 47 samples and in samples collected from ten of the eleven borings. The highest detected concentration of TRPH was 1,200 mg/Kg in the 0-2 feet bgs sample from Soil Boring SB-7. TRPH concentrations were generally confined to 4 feet bgs, with concentrations decreasing with increasing depth. Only three samples collected below the depth of 4 feet contained detectable concentrations of TRPH. The two deepest detections of TRPH were in soil borings SB-3 and SB-7. The 98 to 100 foot bgs sample collected from both of these borings contained 20 mg/kg of TRPH. VOCs were only detected in two samples, SB-2 at 98-100 feet bgs and the surface at SB-7. These results in Soil Boring SB-2 at 98-100 feet bgs are most likely related to either laboratory or field sampling contamination. VOCs (toluene, ethyl benzene, and xylenes) were detected in the 0-2 feet bgs sample collected from Soil Boring SB-7. The BNA compounds naphthalene and 2-methylnapthalene were also detected in this sample. This was the only sample with detectable BNA compounds. PCBs were not detected in any of the samples.

The highest detected concentrations of barium (402 mg/Kg), copper (42.8 mg/Kg), and nickel (35 mg/Kg) slightly exceed their background UCLs. The only sample that contained these metals at levels above the average for the site was collected from SB-8 at a depth of 98 to 100 feet bgs. This sample also contained the highest detected concentration of zinc. No trends were observed with respect to metals results and depth of sample collection.

Throughout 1992 and 1993, the data collected during the OU-2 field investigation were evaluated to determine the appropriate remedial alternative for the soils at this site. Based on the results of the OU-2 Risk Assessment and OU-2 Feasibility Study, a no further action alternative was proposed. The FFA parties in the OU-2 ROD that was signed in January 1994 officially adopted this alternative.

Later in 1994, concerns arose about the quality of some of the VOC and BNA data used in the original evaluation of PSC SD-40. In response, three additional soil borings were advanced at the site in August of 1996. .

A total of seven soil samples (three surface and four subsurface) were collected in August of 1996 during the additional sampling investigation. None of the samples collected from the additional soil borings contained detectable concentrations of VOCs. The 14-16 foot bgs sample collected from Soil Boring SB-12 contained a concentration of 0.075 mg/Kg of bis(2-ethylhexyl)phthalate, a common laboratory contaminant.

These new sampling data were used with previously collected data of known quality to re-calculate the risk assessment for the site. The results of the risk assessment showed that exposure to the soil at this site would not cause a risk to human health of the environment. Both current and hypothetical future ELCRs and HIs for exposure to soils at these sites were below the ADEQ and USEPA's residential risk-based remediation benchmarks (ELCR less than 10^{-4}, HI below 1.0). As a result, the original remedial alternative selected for the site (no further action) was re-affirmed.

Appendix B

Groundwater Monitoring Results for the Period of Record

Sample Date	Location	Organic Constituents					Inorganic Constituents (mg/L)								Inorganic Constituents Continued(mg/L)						
		VOCs (ug/L)	BNAs (ug/L)	TPH (mg/L)	EDB (mg/L)	DBCP (mg/L)	Ag	As	Ba	Be	Cd	Cr	Cu	Hg	Ni	Pb	Sb	Se	Tl	Zn	Bo
12-12-91	MW-104	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.01	<0.005	0.267	<0.005	<0.005	<0.01	0.017	<0.0002	<0.02	0.003	<0.05	<0.005	<0.005	0.354	
Dissolved							<0.01	<0.005	0.285	<0.005	<0.005	<0.01	<0.01	<0.0002	<0.02	<0.002	<0.05	<0.005	<0.005	0.320	
07-16-92	MW-104	ND	ND **J**	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.171	<0.005	<0.0005	0.014	0.012	<0.0002	<0.020	0.006	<0.05	<0.005	<0.005	1.23	NA
Dissolved							<0.010	<0.005	0.168	<0.005	<0.0005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.071	NA
11-19-92	MW-104	ACE 15	ND	NA	<0.01	<0.01															
Total Metals		TOL 5					<0.010	<0.005	0.257	<0.005	<0.0005	<0.010	<0.010	<0.0002	<0.020	0.011	<0.05	<0.005	<0.005	0.977	<0.10
Dissolved		[UQ]	[UQ]				<0.010	<0.005	0.265	<0.005	<0.0005	<0.010	<0.010	<0.0002	<0.020	0.011	<0.05	<0.005	<0.005	0.983	<0.10
11-19-92	MW-104	ACE 13	ND	NA	<0.01	<0.01															
Total Metals	Duplicate	TOL 5					<0.010	<0.005	0.258	<0.005	<0.0005	<0.010	<0.010	<0.0002	<0.020	0.012	<0.05	<0.005	<0.005	0.896	<0.10
Dissolved		[UQ]	[UQ]				<0.010	<0.005	0.264	<0.005	<0.0005	<0.010	<0.010	<0.0002	<0.020	0.011	<0.05	<0.005	<0.005	0.920	<0.10
03-09-93	MW-104	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.229	<0.005	<0.005	<0.010	0.011	<0.0002	<0.020	0.003	<0.05	<0.005	<0.005	0.484	NA
Dissolved							<0.010	<0.005	0.250	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.491	NA
06-09-93	MW-104	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.239	<0.005	<0.005	<0.010	0.011	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.473	NA
Dissolved							<0.010	<0.005	0.266	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.452	NA
11-10-93	MW-104	ND	ND	NA	NA	NA															
Total Metals	Time-series	[UQ]	[UQ]				<0.010	<0.005	0.240	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.285	NA
Dissolved	Initial Sample						<0.010	<0.005	0.241	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.262	NA
11-10-93	MW-104	ND	ND	NA	NA	NA															
Total Metals	Time-series	[UQ]	[UQ]				<0.010	<0.005	0.270	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.220	NA
Dissolved	4-hr sample						<0.010	<0.005	0.286	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.218	NA
05-11-94	MW-104	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.254	<0.004	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.386	NA
Dissolved							<0.010	<0.005	0.279	<0.004	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.380	NA
02-10-95	MW-104	ND	NA	NA	NA	NA															
Total Metals		[UQ]					NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
10-04-95	MW-104	ND	NA	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
06-10-96	MW-104	ND	ND	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
12-13-91	MW-105	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.01	<0.005	0.099	<0.005	<0.005	0.014	<0.01	<0.0002	<0.02	0.003	<0.05	<0.005	<0.005	0.393	
Dissolved							<0.01	<0.005	0.092	<0.005	<0.005	<0.01	<0.01	<0.0002	<0.02	0.002	<0.05	<0.005	<0.005	0.238	
07-17-92	MW-105	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.057	<0.005	<0.0005	<0.010	0.028	<0.0002	<0.020	0.003	<0.05	<0.005	<0.005	0.146	NA
Dissolved							<0.010	<0.005	0.037	<0.005	<0.0005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	<0.010	NA

Sample Date	Location	Organic Constituents					Inorganic Constituents (mg/L)								Inorganic Constituents Continued(mg/L)						
		VOCs (ug/L)	BNAs (ug/L)	TPH (mg/L)	EDB (mg/L)	DBCP (mg/L)	Ag	As	Ba	Be	Cd	Cr	Cu	Hg	Ni	Pb	Sb	Se	Tl	Zn	Bo

Sample	Location	Organic Constituents					Inorganic Constituents (mg/L)								Inorganic Constituents Continued(mg/L)						
Date		VOCs (ug/L)	BNAs (ug/L)	TPH (mg/L)	EDB (mg/L)	DBCP (mg/L)	Ag	As	Ba	Be	Cd	Cr	Cu	Hg	Ni	Pb	Sb	Se	Tl	Zn	Bo
12-16-92	MW-105	ND	ND	NA	<0.01	<0.01															
Total Metals		[UQ]	[UQ]				<0.010	0.006	0.111	<0.005	<0.0005	0.014	0.014	<0.0002	<0.020	0.007	<0.05	<0.005	<0.005	0.508	<0.10
Dissolved							<0.010	<0.005	0.100	<0.005	<0.0005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.375	<0.10
03-09-93	MW-105	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.108	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	0.006	<0.05	<0.005	<0.005	0.363	NA
Dissolved							<0.010	<0.005	0.103	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.350	NA
06-09-93	MW-105	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.106	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	0.003	<0.05	<0.005	<0.005	0.304	NA
Dissolved							<0.010	<0.005	0.103	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.230	NA
11-05-93	MW-105	ND	ND *	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.101	<0.005	<0.005	<0.010J	<0.010	<0.0002	<0.020J	0.002	<0.05	<0.005	<0.005	0.341	NA
Dissolved							<0.010	<0.005	0.104	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.220	NA
05-11-94	MW-105	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.114	<0.004	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.310	NA
Dissolved							<0.010	<0.005	0.114	<0.004	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.257	NA
05-11-94	MW-105	ND	NA	NA	NA	NA															
Total Metals	ADEQ	[UQ]					NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved	Duplicate						NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
02-10-95	MW-105	ND	NA	NA	NA	NA															
Total Metals		[UQ]					NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
10-04-95	MW-105	ND	NA	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
06-07-96	MW-105	ND	ND	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
11-12-97	MW-105	ND	NA	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5-12-98	MW-105	ND	NA	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
12-12-91	MW-106	ACE TrU	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.01	0.014	0.182	<0.005	<0.005	0.032	0.040	<0.0002	<0.02	0.017	<0.05	<0.005	<0.005	1.04	
Dissolved							<0.01	<0.005	0.155	<0.005	<0.005	<0.01	<0.01	<0.0002	<0.02	<0.002	<0.05	<0.005	<0.005	0.356	
12-12-91	MW-106	ND	ND	NA	NA	NA															
Total Metals	Duplicate	[UQ]	[UQ]				<0.01	0.014	0.18	<0.005	<0.005	0.034	0.018	<0.0002	<0.02	0.011	<0.05	<0.005	<0.005	0.986	
Dissolved							<0.01	<0.005	0.158	<0.005	<0.005	<0.01	<0.01	<0.0002	<0.02	<0.002	<0.05	<0.005	<0.005	0.356	
07-16-92	MW-106	ND	BEP 17	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.064	<0.005	<0.0005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.242	NA
Dissolved							<0.010	<0.005	0.117	<0.005	<0.0005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.014	NA

Sample Date	Location	Organic Constituents					Inorganic Constituents (mg/L)								Inorganic Constituents Continued(mg/L)						
		VOCs (ug/L)	BNAs (ug/L)	TPH (mg/L)	EDB (mg/L)	DBCP (mg/L)	Ag	As	Ba	Be	Cd	Cr	Cu	Hg	Ni	Pb	Sb	Se	Tl	Zn	Bo

Sample Date	Location	Organic Constituents					Inorganic Constituents (mg/L)								Inorganic Constituents Continued(mg/L)						
		VOCs (ug/L)	BNAs (ug/L)	TPH (mg/L)	EDB (mg/L)	DBCP (mg/L)	Ag	As	Ba	Be	Cd	Cr	Cu	Hg	Ni	Pb	Sb	Se	Tl	Zn	Bo
11-24-92	MW-106	ND	ND	NA	<0.01	<0.01															
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.174	<0.005	<0.0005	0.012	<0.010	<0.0002	<0.020	0.005	<0.05	<0.005	<0.005	0.421	<0.10
Dissolved							<0.010	<0.005	0.167	<0.005	<0.0005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.386	<0.10
03-22-93	MW-106	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.17	<0.005	<0.0005	<0.010	<0.010	<0.0002	<0.020	0.004	<0.05	<0.005	<0.005	0.410	NA
Dissolved							<0.010	<0.005	0.203	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.304	NA
06-10-93	MW-106	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.154	<0.005	<0.005	0.011	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.284	NA
Dissolved							<0.010	<0.005	0.165	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.224	NA
11-05-93	MW-106	ND	ND *	NA	NA	NA															
Total Metals							<0.010	<0.005	0.173	<0.005	<0.005	0.012	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.587	NA
Dissolved							<0.010	<0.005	0.170	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.522	NA
05-11-94	MW-106	ND	ND *	NA	NA	NA															
Total Metals		[UQ]	[UQ]				0.018	<0.005	0.161	<0.004	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.281	NA
Dissolved							<0.010	<0.005	0.172	<0.004	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.278	NA
02-10-95	MW-106	ND	NA	NA	NA	NA															
Total Metals		[UQ]	[UQ]				NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
10-04-95	MW-106	ND	NA	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
06-07-96	MW-106	ND	ND	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes:

NA	Not analyzed.	TCE	Trichloroethene.
VOCs	Volatile orga	EDB	Ethylene Dibromide.
TPH	Total Petroleum Hydrocarbons	DBCP	1,2-Dibromo-3-chloropropane.
Tr	Trace, unquantifiable amount detected.	PCB	Pentachlorobenzene
ACE	Acetone.	BA	Benzoic Acid
BEP	Bis(2-ethylhexyl)phthalate.	DCP	1,2-Dichloropropane
CHL	Chloroform.	Bo	Boron.
CDS	Carbon Disulfide	*	TICs present.
DCA	1,2-Dichloroethane.	J	Data are qualitative or estimated.
DBCM	Dibromochloromethane.	R	Data are rejected and unusable
ND	Not detected.	U	Data are qualitative and considered to be not detected at the value reported.
BNAs	Base/neutral and acid extractable compounds.		
TOL	Toluene.	[UQ]	ATI-Phoenix data of unknown quality as determined by the FFA Parties
(1)	Well screen submerged below top of water table.		

Method detection limits (mdls) for VOCs and BNAs varied. See laboratory reports for specific mdls.
Metals are as follows: silver (Ag), arsenic (As), beryllium (Be), barium (Ba), cadmium (Cd),
copper (Cu), chromium (Cr), mercury (Hg), nickel (Ni), lead (Pb), antimony (Sb), selenium (Se),
thallium (Tl), and zinc (Zn).

Sample Date	Location						Inorganic Constituents (mg/L)								Inorganic Constituents Continued (mg/L)						
		VOCs (ug/L)	BNAs (ug/L)	TPH (mg/L)	EDB (mg/L)	DBCP (mg/L)	Ag	As	Ba	Be	Cd	Cr	Cu	Hg	Ni	Pb	Sb	Se	Tl	Zn	Bo
01-22-92	MW-107	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.01	<0.05	0.159	<0.005	<0.005	<0.01	<0.01	<0.0002	<0.02	<0.002	<0.05	<0.005	<0.005	0.435	NA
Dissolved							<0.01	<0.05	0.137	<0.005	<0.005	<0.01	<0.01	<0.0002	<0.02	<0.002	<0.05	<0.005	<0.005	0.430	NA
01-22-92	MW-107	ND	ND	NA	NA	NA															
Total Metals	Duplicate	[UQ]	[UQ]				<0.01	<0.05	0.149	<0.005	<0.005	<0.01	<0.01	<0.0002	<0.02	<0.002	<0.05	<0.005	<0.005	0.446	NA
Dissolved							<0.01	<0.05	0.144	<0.005	<0.005	<0.01	<0.01	<0.0002	<0.02	<0.002	<0.05	<0.005	<0.005	0.432	NA
07-17-92	MW-107	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	0.016	0.144	<0.005	<0.0005	0.054	0.018	<0.0002	0.022	0.010	<0.05	<0.005	<0.005	2.05	NA
Dissolved							<0.010	<0.005	0.044	<0.005	<0.0005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.019	NA
12-09-92	MW-107	ND	ND	NA	<0.01	0.05															
Total Metals	Time-series	[UQ]	[UQ]				<0.010	<0.005	0.114	<0.005	<0.0005	<0.010	0.019	<0.0002	<0.020	0.002	<0.05	0.006	<0.005	0.415	<0.10
Dissolved	Initial Sample						<0.010	<0.005	0.117	<0.005	<0.0005	<0.010	0.022	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.357	<0.10
12-09-92	MW-107	ND	NA	NA	<0.01	0.04															
Total Metals	Time-series	[UQ]					NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved	4-hr Sample						NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
03-08-93	MW-107	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.112	<0.005	<0.005	<0.010	0.018	<0.0002	<0.020	0.003	<0.05	0.011	<0.005	0.605	NA
Dissolved							<0.010	<0.005	0.120	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	0.010	<0.005	0.591	NA
06-16-93	MW-107	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.115	<0.005	<0.005	<0.010	0.017	<0.0002	<0.020	0.003	<0.05	<0.005	<0.005	0.530	NA
Dissolved							<0.010	<0.005	0.124	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.484	NA
11-04-93	MW-107	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.116	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.600	NA
Dissolved							<0.010	<0.005	0.114	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.596	NA
05-18-94	MW-107	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.115	<0.004	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.290	NA
Dissolved							<0.010	<0.005	0.120	<0.004	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.287	NA
02-23-95	MW-107	ND	NA	NA	NA	NA															
Total Metals		[UQ]					NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
10-20-95	MW-107	ND	NA	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
6-6-96	MW-107	ND	ND	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
01-23-92	MW-108	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.01	<0.05	0.14	<0.005	<0.005	<0.01	<0.01	<0.0002	<0.02	<0.002	<0.05	0.006	<0.005	0.443	NA
Dissolved							<0.01	<0.05	0.14	<0.005	<0.005	<0.01	<0.01	<0.0002	<0.02	<0.002	<0.05	<0.005	<0.005	0.413	NA

Sample Date	Location						Inorganic Constituents (mg/L)								Inorganic Constituents Continued (mg/L)						
		VOCs (ug/L)	BNAs (ug/L)	TPH (mg/L)	EDB (mg/L)	DBCP (mg/L)	Ag	As	Ba	Be	Cd	Cr	Cu	Hg	Ni	Pb	Sb	Se	Tl	Zn	Bo
7-21-92	MW-108	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.132	<0.005	<0.0005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.281	NA
Dissolved							<0.010	<0.005	0.128	<0.005	<0.0005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.073	NA
11-20-92	MW-108	ND	ND	NA	<0.01	0.02															
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.125	<0.005	<0.0005	<0.010	0.010	<0.0002	<0.020	0.009	<0.05	0.005	<0.005	0.790	<0.10
Dissolved							<0.010	<0.005	0.129	<0.005	<0.0005	<0.010	<0.010	<0.0002	<0.020	0.009	<0.05	<0.005	<0.005	0.828	<0.10
03-11-93	MW-108	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.109	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	0.002	<0.05	<0.005	<0.005	0.712	NA
Dissolved							<0.010	<0.005	0.120	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.463	NA
06-14-93	MW-108	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.118	<0.005	<0.005	<0.010	0.016	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.502	NA
Dissolved							<0.010	<0.005	0.127	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.479	NA
11-04-93	MW-108	ND	ND *	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.114	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.570	NA
Dissolved							<0.010	<0.005	0.124	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.568	NA
05-18-94	MW-108	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.107	<0.004	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.282	NA
Dissolved							<0.010	<0.005	0.118	<0.004	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.280	NA
2-3-95	MW-108	ND	NA	NA	NA	NA															
Total Metals		[UQ]					NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
10-20-95	MW-108	ND	NA	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5-31-96	MW-108	ND	NA	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes:

NA	Not analyzed.	TCE	Trichloroethene.
VOCs	Volatile organi	EDB	Ethylene Dibromide.
TPH	Total Petroleum Hydrocarbons	DBCP	1,2-Dibromo-3-chloropropane.
Tr	Trace, unquantifiable amount detected.	PCB	Pentachlorobenzene
ACE	Acetone.	BA	Benzoic Acid
BEP	Bis(2-ethylhexyl)phthalate.	DCP	1,2-Dichloropropane
CHL	Chloroform.	Bo	Boron.
CDS	Carbon Disulfide	*	TICs present.
DCA	1,2-Dichloroethane.	J	Data are qualitative or estimated.
DBCM	Dibromochloromethane.	R	Data are rejected and unusable
ND	Not detected.	U	Data are qualitative and considered to be not detected at the value reported.
BNAs	Base/neutral and acid extractable compounds.		
TOL	Toluene.	[UQ]	ATI-Phoenix data of unknown quality as determined by the FFA Parties
(1)	Well screen submerged below top of water table.		

Method detection limits (mdls) for VOCs and BNAs varied. See laboratory reports for specific mdls.
Metals are as follows: silver (Ag), arsenic (As), beryllium (Be), barium (Ba), cadmium (Cd), copper (Cu), chromium (Cr), mercury (Hg), nickel (Ni), lead (Pb), antimony (Sb), selenium (Se),

Sample Date	Location						Inorganic Constituents (mg/L)								Inorganic Constituents Continued (mg/L)						
		VOCs (ug/L)	BNAs (ug/L)	TPH (mg/L)	EDB (mg/L)	DBCP (mg/L)	Ag	As	Ba	Be	Cd	Cr	Cu	Hg	Ni	Pb	Sb	Se	Tl	Zn	Bo

thallium (Tl), and zinc (Zn).

Sample Date	Location						Inorganic Constituents (mg/L)								Inorganic Constituents Continued (mg/L)						
		VOCs (ug/L)	**BNAs** (ug/L)	**TPH** (mg/L)	**EDB** (mg/L)	**DBCP** (mg/L)	**Ag**	**As**	**Ba**	**Be**	**Cd**	**Cr**	**Cu**	**Hg**	**Ni**	**Pb**	**Sb**	**Se**	**Tl**	**Zn**	**Bo**
01-27-92 (1)	MW-109	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.146	<0.005	<0.005	0.013	<0.01	<0.0002	<0.020	0.002	<0.05	<0.005	<0.005	0.284	NA
Dissolved							<0.010	<0.005	0.150	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.290	NA
07-17-92 (1)	MW-109	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.044	<0.005	<0.0005	0.011	0.011	<0.0002	<0.020	0.002	<0.05	<0.005	<0.005	1.06	NA
Dissolved							<0.010	<0.005	0.123	<0.005	<0.0005	<0.010	<0.010	<0.0002	0.026	<0.002	<0.05	<0.005	<0.005	0.124	NA
11-30-92 (1)	MW-109	ND	ND	NA	<0.01	<0.01															
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.167	<0.005	<0.0005	0.016	<0.010	<0.0002	<0.020	0.004	<0.05	<0.005	<0.005	0.565	<0.10
Dissolved							<0.010	<0.005	0.168	<0.005	<0.0005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.538	<0.10
03-24-93 (1)	MW-109	ND	ND *	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.146	<0.005	<0.0005	<0.010	<0.010	<0.0002	<0.020	0.003	<0.05	<0.005	<0.005	0.421	NA
Dissolved							<0.010	<0.005	0.175	<0.005	<0.005	0.011	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.433	NA
06-15-93 (1)	MW-109	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.207	<0.005	<0.005	0.015	0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.453	NA
Dissolved							<0.010	<0.005	0.224	<0.005	<0.005	0.013	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.442	NA
11-12-93 (1)	MW-109	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.146	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.296	NA
Dissolved							<0.010	<0.005	0.159	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.299	NA
05-12-94 (1)	MW-109	ND	ND **R**	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.182	<0.004	<0.005	<0.010	0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.305	NA
Dissolved							<0.010	<0.005	0.202	<0.004	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.341	NA
02-01-95	MW-109	ND	NA	NA	NA	NA															
Total Metals		[UQ]					NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
10-25-95	MW-109	ND	NA	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5-29-96	MW-109	ND	ND	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
01-23-92 (1)	MW-110	CHL 1	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.240	<0.005	<0.005	0.024	0.026	<0.0002	<0.020	0.005	<0.05	<0.005	<0.005	0.560	NA
Dissolved							<0.010	<0.005	0.237	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.220	NA
01-23-92 (1)	MW-110	CHL 1	ND	NA	NA	NA															
Total Metals	Duplicate	[UQ]	[UQ]				<0.010	<0.005	0.223	<0.005	<0.005	0.013	0.025	<0.0002	<0.020	0.003	<0.05	<0.005	<0.005	0.512	NA
Dissolved							<0.010	<0.005	0.231	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.471	NA
07-15-92 (1)	MW-110	CHL 2	ND	NA	NA	NA															
Total Metals		DCA 3	[UQ]				<0.010	<0.005	0.125	<0.005	<0.0005	0.023	0.013	<0.0002	<0.020	0.005	<0.05	<0.005	<0.005	0.422	NA
Dissolved		[UQ]					<0.010	<0.005	0.099	<0.005	<0.0005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.056	NA
12-08-92 (1)	MW-110	TOL 3	ND	NA	<0.01	0.11															
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.233	<0.005	<0.0005	0.021	0.021	<0.0002	<0.020	0.006	<0.05	<0.005	<0.005	1.07	<0.10
Dissolved							<0.010	<0.005	0.215	<0.005	<0.0005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.543	<0.10

Sample Date	Location						Inorganic Constituents (mg/L)								Inorganic Constituents Continued (mg/L)						
		VOCs (ug/L)	BNAs (ug/L)	TPH (mg/L)	EDB (mg/L)	DBCP (mg/L)	Ag	As	Ba	Be	Cd	Cr	Cu	Hg	Ni	Pb	Sb	Se	Tl	Zn	Bo
03-16-93 (1)	MW-110	CHL 1	ND	NA	NA	NA															
Total Metals		TOL 2	[UQ]				<0.010	<0.005	0.215	<0.005	<0.005	0.014	<0.010	<0.0002	<0.020	0.005	<0.05	<0.005	<0.005	0.591	NA
Dissolved		[UQ]					<0.010	<0.005	0.228	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.403	NA
03-16-93 (1)	MW-110	CHL 1	ND	NA	NA	NA															
Total Metals	Duplicate	[UQ]	[UQ]				<0.010	<0.005	0.213	<0.005	<0.005	0.013	<0.010	<0.0002	<0.020	0.006	<0.05	<0.005	<0.005	0.501	NA
Dissolved							<0.010	<0.005	0.223	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.486	NA
06-10-93(1)	MW-110	CHL 1	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.214	<0.005	<0.005	0.013	<0.010	<0.0002	<0.020	0.003	<0.05	<0.005	<0.005	0.457	NA
Dissolved							<0.010	<0.005	0.226	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.393	NA
06-10-93 (1)	MW-110	CHL 1	BEP 33	NA	NA	NA															
Total Metals	Duplicate	[UQ]	[UQ]				<0.010	<0.005	0.214	<0.005	<0.005	0.013	<0.010	<0.0002	<0.020	0.003	<0.05	<0.005	<0.005	0.437	NA
Dissolved							<0.010	<0.005	0.226	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.394	NA
11-09-93 (1)	MW-110	CHL 1	ND	NA	NA	NA															
Total Metals	Time-series	[UQ]	[UQ]				<0.010	<0.005	0.230	<0.005	<0.005	0.027	0.012	<0.0002	<0.020	0.009	<0.05	<0.005	<0.005	0.530	NA
Dissolved	Initial Sample						<0.010	<0.005	0.224	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.180	NA
11-09-93 (1)	MW-110	CHL 1	ND	NA	NA	NA															
Total Metals	Time-series	[UQ]	[UQ]				<0.010	<0.005	0.214	<0.005	<0.005	0.014	<0.010	<0.0002	<0.020	0.002	<0.05	<0.005	<0.005	0.377	NA
Dissolved	3.5-hr sample						<0.010	<0.005	0.228	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.296	NA
05-12-94(1)	MW-110	CHL 2	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.226	<0.004	<0.005	0.013	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.432	NA
Dissolved							<0.010	<0.005	0.241	<0.004	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.406	NA
01-31-95(1)	MW-110	CHL 2	NA	NA	NA	NA															
Total Metals		[UQ]					NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5-4-95	MW-110	ND	NA	NA	NA	NA															
Total Metals		[UQ]					NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5-4-95	MW-110 (D)	ND	NA	NA	NA	NA															
Total Metals		[UQ]					NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-3-96	MW-110	ND	NA	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
01-27-92 (1)	MW-111	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.223	<0.005	<0.005	0.013	0.025	<0.0002	<0.020	0.003	<0.05	<0.005	<0.005	0.512	NA
Dissolved							<0.010	<0.005	0.231	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.471	NA
7/15/1992 (1)	MW-111	DCA 1	ND	NA	NA	NA															
Total Metals		DBCM 1	[UQ]				<0.010	<0.005	0.207	<0.005	0.0016	0.022	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.190	NA
Dissolved		[UQ]					<0.010	<0.005	0.135	<0.005	<0.0005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.022	NA
11-25-92 (1)	MW-111	ND	ND	NA	<0.01	<0.01															
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.298	<0.005	<0.0005	0.011	<0.010	<0.0002	<0.020	0.006	<0.05	<0.005	<0.005	0.757	0.26
Dissolved							<0.010	<0.005	0.319	<0.005	<0.0005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.752	0.26

Sample Date	Location						Inorganic Constituents (mg/L)								Inorganic Constituents Continued (mg/L)						
		VOCs (ug/L)	**BNAs** (ug/L)	**TPH** (mg/L)	**EDB** (mg/L)	**DBCP** (mg/L)	**Ag**	**As**	**Ba**	**Be**	**Cd**	**Cr**	**Cu**	**Hg**	**Ni**	**Pb**	**Sb**	**Se**	**Tl**	**Zn**	**Bo**
03-16-93 (1)	MW-111	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.247	<0.005	<0.005	<0.010	0.012	<0.0002	<0.020	0.002	<0.05	<0.005	<0.005	0.535	NA
Dissolved							<0.010	<0.005	0.269	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.517	NA
06-16-93 (1)	MW-111	ND	BEP 15	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.288	<0.005	<0.005	<0.010	0.024	<0.0002	<0.020	0.003	<0.05	<0.005	<0.005	0.722	NA
Dissolved							<0.010	<0.005	0.276	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.570	NA
06-16-93 (1)	MW-111	ND	ND	NA	NA	NA															
Total Metals	Duplicate	[UQ]	[UQ]				<0.010	<0.005	0.272	<0.005	<0.005	<0.010	0.012	<0.0002	<0.020	0.003	<0.05	<0.005	<0.005	0.696	NA
Dissolved							<0.010	<0.005	0.277	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.574	NA
11-12-93 (1)	MW-111	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.263	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.440	NA
Dissolved							<0.010	<0.005	0.285	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.416	NA
5/12/1994 (1)	MW-111	ND	ND **R**	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.244	<0.004	<0.005	0.015	<0.010	<0.0002	<0.020	0.002	<0.05	<0.005	<0.005	0.490	NA
Dissolved							<0.010	<0.005	0.256	<0.004	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.467	NA
2-1-95 (1)	MW-111	ND	NA	NA	NA	NA															
Total Metals		[UQ]					NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
10-25-95	MW-111	ND	NA	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5-22-96	MW-111	ND	ND	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
08-04-93	MW-118	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.323	<0.005	<0.005	0.017	0.032	<0.0002	<0.020	0.002	<0.05	<0.005	<0.005	0.740	NA
Dissolved							<0.010	<0.005	0.335	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.730	NA
08-04-93	MW-118	ND	ND	NA	NA	NA															
Total Metals	Duplicate	[UQ]	[UQ]				<0.010	<0.005	0.320	<0.005	<0.005	0.020	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.714	NA
Dissolved							<0.010	<0.005	0.328	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.708	NA
11-09-93	MW-118	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.276	<0.005	<0.005	0.043 **J**	<0.010	<0.0002	0.023	<0.002	<0.05	<0.005	<0.005	0.499	NA
Dissolved							<0.010	<0.005	0.295	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.476	NA
11-09-93	MW-118	ND	ND *	NA	NA	NA															
Total Metals	Duplicate	[UQ]	[UQ]				<0.010	<0.005	0.294	<0.005	<0.005	0.020 **J**	0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.551	NA
Dissolved							<0.010	<0.005	0.322	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.496	NA
05-17-94	MW-118	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.271	<0.004	<0.005	0.014	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.360	NA
Dissolved							<0.010	<0.005	0.250	<0.004	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.339	NA
01-31-95	MW-118	ND	NA	NA	NA	NA															
Total Metals		[UQ]					NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Sample Date	Location	VOCs (ug/L)	BNAs (ug/L)	TPH (mg/L)	EDB (mg/L)	DBCP (mg/L)	Inorganic Constituents (mg/L)								Inorganic Constituents Continued (mg/L)						
							Ag	**As**	**Ba**	**Be**	**Cd**	**Cr**	**Cu**	**Hg**	**Ni**	**Pb**	**Sb**	**Se**	**Tl**	**Zn**	**Bo**
5-1-95	MW-118	ND	NA	NA	NA	NA															
Total Metals		[UQ]					NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
8-11-95	MW-118	ND	NA	NA	NA	NA															
Total Metals		[UQ]					NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
10-26-95	MW-118	ND	NA	NA	NA	NA															
Total Metals		[UQ]					NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-3-96	MW-118	ND	NA	NA	NA	NA															
Total Metals		[UQ]					NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5-22-96	MW-118	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
11-11-97	MW-118	ND	ND	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5-12-98	MW-118	ND	ND	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
07-14-94	MW-123	BROM 2.3	ND	NA	NA	NA															
Total Metals		CHL 7.9	[UQ]				NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved		DBCM 11					NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
		[UQ]																			
12-07-94	MW-123	CHL 1.4	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010**UJ**	0.0022	0.250	<0.004	<0.005	0.0092**U**	<0.010**U**	<0.0002	0.031**U**	<0.002	<0.05	0.003	<0.005	0.440	NA
Dissolved							<0.010**UJ**	0.0021	0.260	<0.004	<0.005	0.0057 **U**	<0.010**U**	<0.0002	<0.001**U**	<0.002	<0.05	0.0029	<0.005	0.440	NA
12-07-94	MW-123	CHL 1.6	ND	NA	NA	NA															
Total Metals	Duplicate	[UQ]	[UQ]				<0.010**UJ**	0.0023	0.250	<0.004	<0.005	0.0098**U**	0.0043**U**	<0.0002	0.031**U**	<0.002	<0.05	0.0024	<0.005	0.540	NA
							<0.010**UJ**	0.0019	0.26	<0.004	<0.005	<.0029**U**	<.0034**U**	<0.0002	0.022**U**	0.0012	<0.05	0.003	<0.005	0.41	NA
02-23-95	MW-123	CHL 2	NA	NA	NA	NA															
Total Metals		[UQ]					NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5-4-95	MW-123	ND	NA	NA	NA	NA															
Total Metals		[UQ]					NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
8-11-95	MW-123	ND	NA	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
10-26-95	MW-123	ND	NA	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Sample Date	Location						Inorganic Constituents (mg/L)								Inorganic Constituents Continued (mg/L)						
		VOCs (ug/L)	BNAs (ug/L)	TPH (mg/L)	EDB (mg/L)	DBCP (mg/L)	Ag	As	Ba	Be	Cd	Cr	Cu	Hg	Ni	Pb	Sb	Se	Tl	Zn	Bo
10-26-95	MW-123(D)	ND	NA	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-6-96	MW-123	ND	NA	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5-23-96	MW-123	ND	ND	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
11-11-97	MW-123	CHL 2.7J	NA	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5-13-98	MW-123	CHL 2.4J	NA	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
11-05-98	MW-123	CHL 1.6J MC 0.32JB	NA	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5-19-99	MW-123	ND	NA	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes:

NA	Not analyzed.	ND	Not detected.
VOCs	Volatile organic compounds.	BNAs	Base/neutral and acid extractable compounds.
TPH	Total Petroleum Hydrocarbons	TOL	Toluene.
Tr	Trace, unquantifiable amount detected.	TCE	Trichloroethene.
ACE	Acetone.	EDB	Ethylene Dibromide.
BEP	Bis(2-ethylhexyl)phthalate.	DBCP	1,2-Dibromo-3-chloropropane.
CHL	Chloroform.	PCB	Pentachlorobenzene
CDS	Carbon Disulfide	BA	Benzoic Acid
DCA	1,2-Dichloroethane.	DCP	1,2-Dichloropropane
DBCM	Dibromochloromethane.	Bo	Boron.
MC	Methylene Chloride	[UQ]	ATI-Phoenix data of unknown quality as determined by the FFA Parties
*	TICs present.		
J	Data are qualitative or estimated.		
R	Data are rejected and unusable		
U	Data are qualitative and considered to be not detected at the value reported.		
(1)	Well screen submerged below top of water table.		

Method detection limits (mdls) for VOCs and BNAs varied. See laboratory reports for specific mdls.
Metals are as follows: silver (Ag), arsenic (As), beryllium (Be), barium (Ba), cadmium (Cd), copper (Cu), chromium (Cr), mercury (Hg), nickel (Ni), lead (Pb), antimony (Sb), selenium (Se), thallium (Tl), and zinc (Zn).

Sample Date	Location	Organic Constituents					Inorganic Constituents (mg/L)									Inorganic Constituents Continued (mg/L)					
		VOCs (ug/L)	BNAs (ug/L)	TPH (mg/L)	EDB (mg/L)	DBCP (mg/L)	Ag	As	Ba	Be	Cd	Cr	Cu	Hg	Ni	Pb	Sb	Se	Tl	Zn	Bo
07-23-92	MW-115	ND [UQ]	ND [UQ]	NA	NA	NA															
Total Metals							<0.010	0.008	0.064	<0.005	<0.0005	0.043	0.068	<0.0002	0.034	0.004 **J**	<0.05	<0.005	<0.005	0.205	NA
Dissolved							<0.010	0.006	0.052	<0.005	<0.0005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.182	NA
07-23-92	MW-115	ND [UQ]	ND [UQ]	NA	NA	NA															
Total Metals	Duplicate						<0.010	0.007	0.071	<0.005	<0.0005	0.058	0.096	<0.0002	0.042	0.018 **J**	<0.05	<0.005	<0.005	0.236	NA
Dissolved							<0.010	0.006	0.051	<0.005	<0.0005	<0.010	0.012	<0.0002	0.024	<0.002	<0.05	<0.005	<0.005	0.182	NA
11-17-92	MW-115	ND [UQ]	ND [UQ]	NA	<0.01	<0.01															
Total Metals							<0.010	0.006	0.048	<0.005	<0.0005	0.024	<0.010	<0.0002	0.029	0.008	<0.05	<0.005	<0.005	0.860	<0.10
Dissolved							<0.010	0.006	0.053	<0.005	<0.0005	0.014	<0.010	<0.0002	0.026	0.008	<0.05	<0.005	<0.005	0.811	<0.10
03-25-93	MW-115	ND [UQ]	ND [UQ]	NA	NA	NA															
Total Metals							<0.010	0.007	0.049	<0.005	<0.005	0.018	<0.010	<0.0002	<0.020	0.003	<0.05	<0.005	<0.005	0.422	NA
Dissolved							<0.010	0.005	0.193	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.302	NA
06-17-93	MW-115	ND [UQ]	BEP 63 [UQ]	NA	NA	NA															
Total Metals							<0.010	<0.005	0.054	<0.005	<0.005	0.016	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.373	NA
Dissolved							<0.010	<0.005	0.063	<0.005	<0.005	0.013	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.445	NA
11-08-93	MW-115	ND [UQ]	ND [UQ]	NA	NA	NA															
Total Metals							<0.010	0.006	0.053	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.529	NA
Dissolved							<0.010	0.006	0.055	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.551	NA
05-19-94	MW-115	ND [UQ]	BEP 5 **J** [UQ]	NA	NA	NA															
Total Metals							<0.010	0.007	0.051	<0.004	<0.005	0.012	<0.010	<0.0002	<0.020	0.003	<0.05	<0.005	<0.005	0.232	NA
Dissolved							<0.010	0.006	0.057	<0.004	<0.005	0.011	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.235	NA
02-22-95	MW-115	ND [UQ]	NA	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
10-24-95	MW-115	ND	NA	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
02-06-96	MW-115	ND	NA	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
07-23-92	MW-116	ND [UQ]	ND [UQ]	NA	NA	NA															
Total Metals							<0.010	0.016	0.045	<0.005	<0.0005	0.016	0.276	<0.0002	<0.020	0.017	<0.05	<0.005	<0.005	0.437	NA
Dissolved							<0.010	0.015	0.021	<0.005	<0.0005	0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.232	NA
07-23-92	MW-116	ND [UQ]	ND [UQ]	NA	NA	NA															
Total Metals	Duplicate						NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
11-18-92	MW-116	ND [UQ]	ND [UQ]	NA	<0.01	<0.01															

Sample Date	Location	Organic Constituents					Inorganic Constituents (mg/L)									Inorganic Constituents Continued (mg/L)					
		VOCs (ug/L)	BNAs (ug/L)	TPH (mg/L)	EDB (mg/L)	DBCP (mg/L)	Ag	As	Ba	Be	Cd	Cr	Cu	Hg	Ni	Pb	Sb	Se	Tl	Zn	Bo
Total Metals							<0.010	0.017	0.020	<0.005	<0.0005	0.019	<0.010	<0.0002	<0.020	0.004	<0.05	<0.005	<0.005	0.414	<0.10
Dissolved							<0.010	0.014	0.020	<0.005	<0.0005	0.012	<0.010	<0.0002	<0.020	0.004	<0.05	<0.005	<0.005	0.414	<0.10
3/23/93	MW-116	ND [UQ]	ND [UQ]	NA	NA	NA															
Total Metals							<0.010	0.015	0.022	<0.005	<0.005	0.014	0.013	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.782	NA
Dissolved							<0.010	0.014	0.035	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.687	NA
06-17-93	MW-116	ND [UQ]	ND [UQ]	NA	NA	NA															
Total Metals							<0.010	0.012	0.032	<0.005	<0.005	0.013	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.758	NA
Dissolved							<0.010	0.005	0.034	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.834	NA
11-08-93	MW-116	ND [UQ]	ND [UQ]	NA	NA	NA															
Total Metals							<0.010	0.014	0.026	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.548	NA
Dissolved							<0.010	0.014	0.026	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.584	NA
05-19-94	MW-116	ND [UQ]	BEP 8 J [UQ]	NA	NA	NA															
Total Metals							<0.010	0.016	0.023	<0.004	<0.005	0.016	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.382	NA
Dissolved							<0.010	0.016	0.022	<0.004	<0.005	0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.384	NA
02-22-95	MW-116	ND [UQ]	NA	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
10-24-95	MW-116	ND	NA	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
06-01-96	MW-116	ND	ND	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
12-07-94	MW-124	ND [UQ]	ND [UQ]	NA	NA	NA															
Total Metals							<0.010**UJ**	0.0068	0.047	<0.004	<0.005	0.018**U**	<0.010**U**	<0.0002	<.002**U**	0.0013	<0.05	0.0024	<0.005	0.130	NA
Dissolved							<0.010**UJ**	0.0065	0.041	<0.004	<0.005	0.012**U**	<0.010**U**	<0.0002	<0.02**U**	<0.001	<0.05	0.002	<0.005	0.120	NA
02-23-95	MW-124	ND [UQ]	NA	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5-4-95	MW-124	ND [UQ]	NA	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
8-14-95	MW-124	ND	NA	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Groundwater Monitoring Results for the Period of Record at PSC RW-02, OU-1

Sample Date	Location	Organic Constituents					Inorganic Constituents (mg/L)									Inorganic Constituents Continued (mg/L)					
		VOCs (ug/L)	BNAs (ug/L)	TPH (mg/L)	EDB (mg/L)	DBCP (mg/L)	Ag	As	Ba	Be	Cd	Cr	Cu	Hg	Ni	Pb	Sb	Se	Tl	Zn	Bo
10-24-95	MW-124	ND	NA	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-08-96	MW-124	ND	NA	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
6-5-96	MW-124	ND	ND	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
11-11-97	MW-124	ND	NA	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5-12-98	MW-124	ND	NA	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes:

NA	Not analyzed.	TCE	Trichloroethene.
VOCs	Volatile orga	EDB	Ethylene Dibromide.
TPH	Total Petroleum Hydrocarbons	DBCP	1,2-Dibromo-3-chloropropane.
Tr	Trace, unquantifiable amount detect	PCB	Pentachlorobenzene
ACE	Acetone.	BA	Benzoic Acid
BEP	Bis(2-ethylhexyl)phthalate.	DCP	1,2-Dichloropropane
CHL	Chloroform.	Bo	Boron.
CDS	Carbon Disulfide	*	TICs present.
DCA	1,2-Dichloroethane.	J	Data are qualitative or estimated.
DBCM	Dibromochloromethane.	R	Data are rejected and unusable
ND	Not detected.	U	Data are qualitative and considered to be not detected at the value reported.
BNAs	Base/neutral and acid extractable compounds		
TOL	Toluene.		
[UQ]	ATI-Phoenix data of unknown quality as determined by the FFA Parties		

(1) Well screen submerged below top of water table.

Method detection limits (mdls) for VOCs and BNAs varied. See laboratory reports for specific mdls.

Metals are as follows: silver (Ag), arsenic (As), beryllium (Be), barium (Ba), cadmium (Cd), copper (Cu), chromium (Cr), mercury (Hg), nickel (Ni), lead (Pb), antimony (Sb), selenium (Se), thallium (Tl), and zinc (Zn).

Sample Date	**Location**	**Organic Constituents**					Inorganic Constituents (mg/L)								Inorganic Constituents Continued (mg/L)						
		VOCs (ug/L)	**BNAs** (ug/L)	**TPH** (mg/L)	**EDB** (mg/L)	**DBCP** (mg/L)	**Ag**	**As**	**Ba**	**Be**	**Cd**	**Cr**	**Cu**	**Hg**	**Ni**	**Pb**	**Sb**	**Se**	**Tl**	**Zn**	**Bo**
12-12-91	MW-102	ND	BEP 14	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	0.026	0.022	<0.005	<0.005	0.026	0.025	<0.0002	<0.020	0.004	<0.05	<0.005	<0.005	0.025	NA
Dissolved							<0.010	0.028	0.017	<0.005	<0.005	0.020	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	<0.010	NA
07-18-92	MW-102	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	0.016	0.021	<0.005	<0.0005	0.027	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.022	NA
Dissolved							<0.010	0.016	0.019	<0.005	<0.0005	0.021	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	<0.010	NA
11-23-92	MW-102	ND	ND	NA	<0.01	<0.01															
Total Metals		[UQ]	[UQ]				<0.010	0.015	0.019	<0.005	<0.0005	0.024	<0.010	<0.0002	<0.020	0.006	<0.05	<0.005	<0.005	0.492	0.19
Dissolved							<0.010	0.015	0.018	<0.005	<0.0005	0.022	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.216	0.19
03-11-93	MW-102	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	0.020	0.014	<0.005	<0.005	0.023	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.147	NA
Dissolved							<0.010	0.019	<0.010	<0.005	<0.005	0.012	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.058	NA
06-11-93	MW-102	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	0.016	0.018	<0.005	<0.005	0.018	0.016	<0.0002	<0.020	0.003	<0.05	<0.005	<0.005	1.66	NA
Dissolved							<0.010	0.015	0.018	<0.005	<0.005	0.016	<0.010	<0.0002	<0.020	0.002	<0.05	<0.005	<0.005	0.296	NA
11-11-93	MW-102	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	0.016	0.017	<0.005	<0.005	0.023	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	1.06	NA
Dissolved							<0.010	0.015	0.018	<0.005	<0.005	0.022	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.447	NA
05-20-94	MW-102	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	0.016	0.015	<0.004	<0.005	0.027	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.329	NA
Dissolved							<0.010	0.016	0.015	<0.004	<0.005	0.026	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.084	NA
02-06-95	MW-102	ND	NA	NA	NA	NA															
Total Metals		[UQ]					NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
10-11-95	MW-102	ND	NA	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5-31-96	MW-102	ND	ND	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
12-09-91 (1)	MW-103	ND	BEP 32	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	0.015	0.092	<0.005	<0.005	0.025	0.027	<0.0002	<0.020	0.003	<0.05	<0.005	<0.005	0.338	NA
Dissolved							<0.010	0.014	0.090	<0.005	<0.005	0.015	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.321	NA
12-09-91 (1)	MW-103	ND	ND	NA	NA	NA															
Total Metals	Duplicate	[UQ]	[UQ]				<0.010	0.014	0.090	<0.005	<0.005	0.024	0.043	<0.0002	<0.020	0.004	<0.05	<0.005	<0.005	0.374	NA
Dissolved							<0.010	0.014	0.090	<0.005	<0.005	0.015	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.319	NA
7-18-92 (1)	MW-103	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	0.016	0.061	<0.005	<0.0005	0.021	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.118	NA
Dissolved							<0.010	0.013	0.086	<0.005	<0.0005	0.018	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	<0.010	NA

Sample Date	Location	Organic Constituents					Inorganic Constituents (mg/L)								Inorganic Constituents Continued (mg/L)						
		VOCs	BNAs	TPH	EDB	DBCP	Ag	As	Ba	Be	Cd	Cr	Cu	Hg	Ni	Pb	Sb	Se	Tl	Zn	Bo
		(ug/L)	(ug/L)	(mg/L)	(mg/L)	(mg/L)															
11-24-92 (1)	MW-103	ND	ND	NA	<0.01	<0.01															
Total Metals		[UQ]	[UQ]				<0.010	0.019	0.040	<0.005	<0.0005	0.024	<0.010	<0.0002	<0.020	0.004	<0.05	<0.005	<0.005	0.474	0.19
Dissolved							<0.010	0.016	0.037	<0.005	<0.0005	0.011	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.381	0.18
03-11-93 (1)	MW-103	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	0.023	0.032	<0.005	<0.005	0.016	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.150	NA
Dissolved							<0.010	0.020	0.032	<0.005	<0.005	0.014	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.104	NA
06-11-93 (1)	MW-103	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	0.018	0.032	<0.005	<0.005	0.014	0.015	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.090	NA
Dissolved							<0.010	0.015	0.036	<0.005	<0.005	0.014	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.132	NA
11-06-93 (1)	MW-103	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	0.020	0.033	<0.005	<0.005	0.020	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.148	NA
Dissolved							<0.010	0.019	0.032	<0.005	<0.005	0.017	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.095	NA
5/20/94 (1)	MW-103	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	0.025	0.032	<0.004	<0.005	0.026	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.079	NA
Dissolved							<0.010	0.023	0.028	<0.004	<0.005	0.022	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.059	NA
02-06-95	MW-103	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Metals		[UQ]					NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved																					
10-10-95	MW-103	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved																					
6-6-96	MW-103	ND	ND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved																					
12-09-91	MW-112S	TCE Tr	ND	NA	NA	NA															
Total Metals		TOL Tr	[UQ]				<0.010	0.011	0.470	<0.005	<0.005	0.062	0.073	<0.0002	0.035	0.048	<0.05	<0.005	<0.005	0.501	NA
Dissolved		[UQ]					<0.010	0.008	0.066	<0.005	<0.005	0.011	<0.01	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.152	NA
07-22-92	MW-112S	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	0.010	0.119	<0.005	<0.0005	0.020	0.082	<0.0002	<0.020	0.011	<0.05	<0.005	<0.005	0.749	NA
Dissolved							<0.010	0.008	0.078	<0.005	<0.0005	0.014	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.426	NA
12-01-92	MW-112S	TCE 1	ND	NA	<0.01	<0.01															
Total Metals		[UQ]	[UQ]				<0.010	0.007	0.075	<0.005	<0.0005	0.011	<0.010	<0.0002	<0.020	0.002	<0.05	<0.005	<0.005	0.089U	0.22
Dissolved							<0.010	0.007	0.075	<0.005	<0.0005	0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.064U	0.22
03-19-93	MW-112S	TCE 1	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	0.010	0.291	<0.005	<0.0005	0.026	0.012	<0.0002	<0.020	0.004	<0.05	<0.005	<0.005	0.378	NA
Dissolved							<0.010	0.008	0.106	<0.005	<0.005	0.013	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.134	NA
06-08-93 (1)	MW-112S	TCE 1	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	0.009	0.078	<0.005	<0.005	0.013	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.149	NA
Dissolved							<0.010	0.007	0.090	<0.005	<0.005	0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.149	NA

Sample Date	Location	Organic Constituents					Inorganic Constituents (mg/L)								Inorganic Constituents Continued (mg/L)						
		VOCs (ug/L)	BNAs (ug/L)	TPH (mg/L)	EDB (mg/L)	DBCP (mg/L)	Ag	As	Ba	Be	Cd	Cr	Cu	Hg	Ni	Pb	Sb	Se	Tl	Zn	Bo
11-03-93 (1)	MW-112S	ND	BA 40 J	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	0.010	0.086	<0.005	<0.005	0.016	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.620	NA
Dissolved							<0.010	0.007	0.089	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.259	NA
05-10-94	MW-112S	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	0.026	0.097	<0.004	<0.005	0.053	0.022	<0.0002	<0.020	0.008	<0.05	<0.005	<0.005	0.153	NA
Dissolved							<0.010	0.009	0.038	<0.004	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	<0.020	NA
02-07-95	MW-112S	ND	NA	NA	NA	NA															
Total Metals		[UQ]					NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5-3-95	MW-112S	ND	NA	NA	NA	NA															
Total Metals		[UQ]					NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
8-8-95	MW-112S	ND	NA	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
10-6-95	MW-112S	ND	NA	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-8-96	MW-112S	ND	NA	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5-30-96	MW-112S	ND	NA	ND	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
11-12-97	MW-112S	ND	NA	ND	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5-11-98	MW-112S	TCE 1.5J	NA	ND	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
12-22-98	MW-112S	ACE 1.4J DCA 0.28J MC 0.24J PCE 0.35J TCE 1.2J	NA	ND	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
05-19-99	MW-112S	ND	NA	ND	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Sample Date	Location	Organic Constituents					Inorganic Constituents (mg/L)								Inorganic Constituents Continued (mg/L)						
		VOCs (ug/L)	BNAs (ug/L)	TPH (mg/L)	EDB (mg/L)	DBCP (mg/L)	Ag	As	Ba	Be	Cd	Cr	Cu	Hg	Ni	Pb	Sb	Se	Tl	Zn	Bo
12-10-91 (1)	MW-112D	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	0.009	0.044	<0.005	<0.005	0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.101	NA
Dissolved							<0.010	0.009	0.035	<0.005	<0.005	0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.099	NA
7-22-92 (1)	MW-112D	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	0.016	0.097	<0.005	<0.0005	0.032	0.084	<0.0002	<0.020	0.009	<0.05	<0.005	<0.005	0.208	NA
Dissolved							<0.010	0.007	0.039	<0.005	<0.0005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.025	NA
12-01-92 (1)	MW-112D	ND	ND	NA	<0.01	<0.01															
Total Metals		[UQ]	[UQ]				<0.010	0.017	0.076	<0.005	<0.0005	0.032	<0.010	<0.0002	<0.020	0.003	<0.05	<0.005	<0.005	0.140U	0.23
Dissolved							<0.010	0.006	0.035	<0.005	<0.0005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.038	0.22
03-19-93 (1)	MW-112D	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	0.013	0.065	<0.005	<0.005	0.027	<0.010	<0.0002	<0.020	0.005	<0.05	<0.005	<0.005	0.162	NA
Dissolved							<0.010	0.008	0.056	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	<0.010	NA
06-08-93 (1)	MW-112D	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	0.016	0.072	<0.005	<0.005	0.030	0.012	<0.0002	<0.020	0.003	<0.05	<0.005	<0.005	0.151	NA
Dissolved							<0.010	0.007	0.045	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.014	NA
11-03-93 (1)	MW-112D	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	0.023	0.095	<0.005	<0.005	0.049	<0.010	<0.0002	<0.020	0.004	<0.05	<0.005	<0.005	0.149	NA
Dissolved							<0.010	0.009	0.039	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	0.002	<0.05	<0.005	<0.005	<0.010	NA
5-10-94 (1)	MW-112D	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	0.009	0.095	<0.004	<0.005	0.018	0.029	<0.0002	<0.020	0.010	<0.05	<0.005	<0.005	0.699	NA
Dissolved							<0.010	0.006	0.087	<0.004	<0.005	0.012	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.284	NA
5-10-94 (1)	MW-112D	ND	ND	NA	NA	NA															
Total Metals	Duplicate	[UQ]	[UQ]				<0.010	0.009	0.096	<0.004	<0.005	0.014	0.020	<0.0002	<0.020	0.007	<0.05	<0.005	<0.005	0.715	NA
Dissolved							<0.010	0.008	0.086	<0.004	<0.005	0.014	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.269	NA
02-07-95	MW-112D	ND	NA	NA	NA	NA															
Total Metals		[UQ]					NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
02-07-95	MW-112D	ND	NA	NA	NA	NA															
Total Metals		[UQ]					NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
10-6-95	MW-112D	ND	NA	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5-30-96	MW-112D	ND	ND	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
11-10-97	MW-112D	BF 1.1J	NA	ND	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Sample	Location	Organic Constituents					Inorganic Constituents (mg/L)								Inorganic Constituents Continued (mg/L)						
Date		**VOCs** (ug/L)	**BNAs** (ug/L)	**TPH** (mg/L)	**EDB** (mg/L)	**DBCP** (mg/L)	**Ag**	**As**	**Ba**	**Be**	**Cd**	**Cr**	**Cu**	**Hg**	**Ni**	**Pb**	**Sb**	**Se**	**Tl**	**Zn**	**Bo**
5-11-98	MW-112D	ND	NA	ND	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
01-24-92	MW-113	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	0.009	0.064	<0.005	<0.005	0.027	0.016	<0.0002	<0.020	0.004	<0.05	<0.005	<0.005	0.327	NA
Dissolved							<0.010	0.009	0.016	<0.005	<0.005	0.013	<0.010	<0.0002	<0.020	0.004	<0.05	<0.005	<0.005	0.212	NA
07-21-92	MW-113	TCE 1	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	0.020	0.447	<0.005	<0.0005	0.109	0.174	<0.0002	0.071	0.023	<0.05	<0.005	<0.005	0.470	NA
Dissolved							<0.010	0.008	0.014	<0.005	<0.0005	0.012	<0.010	<0.0002	0.030	<0.002	<0.05	<0.005	<0.005	0.018	NA
12-17-92	MW-113	DCA 1	ND	NA	<0.01	<0.01															
Total Metals		TCE 2	[UQ]				<0.010	0.012	0.077	<0.005	<0.0005	0.041	0.017	<0.0002	<0.020	0.005	<0.05	<0.005	<0.005	0.626	0.19
Dissolved		TOL 1					<0.010	0.011	0.014	<0.005	<0.0005	0.012	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.299	0.21
		[UQ]																			
03-18-93	MW-113	DCA 1	ND	NA	NA	NA															
Total Metals	Time-series	TCE 2	[UQ]				<0.010	0.010	0.019	<0.005	<0.005	0.019	<0.010	<0.0002	<0.020	0.002	<0.05	<0.005	<0.005	0.355	NA
Dissolved	Initial Sample	[UQ]					<0.010	0.010	0.015	<0.005	<0.005	0.014	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.250	NA
03-18-93	MW-113	DCA 1	ND	NA	NA	NA															
Total Metals	Time-series	TCE 2	[UQ]				<0.010	0.010	0.020	<0.005	<0.005	0.017	0.011	<0.0002	<0.020	0.002	<0.05	<0.005	<0.005	0.326	NA
Dissolved	Duplicate	[UQ]					<0.010	0.010	0.014	<0.005	<0.005	0.016	<0.010	<0.0002	<0.020	0.004	<0.05	<0.005	<0.005	0.181	NA
03-18-93	MW-113	DCA 1	ND	NA	NA	NA															
Total Metals	Time-series	TCE 2	[UQ]				<0.010	0.011	0.014	<0.005	<0.005	0.019	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.333	NA
Dissolved	4-hr Sample	[UQ]					<0.010	0.010	0.014	<0.005	<0.005	0.014	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.288	NA
06-07-93 (1)	MW-113	DCA 1	ND	NA	NA	NA															
Total Metals		TCE 2	[UQ]				<0.010	0.010	0.017	<0.005	<0.005	0.020	<0.010	<0.0002	<0.020	0.002	<0.05	<0.005	<0.005	0.188	NA
Dissolved		[UQ]					<0.010	0.010	0.015	<0.005	<0.005	0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.137	NA
06-07-93 (1)	MW-113	DCA 1	ND	NA	NA	NA															
Total Metals	Duplicate	TCE 2	[UQ]				<0.010	0.011	0.017	<0.005	<0.005	0.022	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.192	NA
Dissolved		[UQ]					<0.010	0.011	0.015	<0.005	<0.005	0.015	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.130	NA
11-02-93 (1)	MW-113	DCA 1	ND	NA	NA	NA															
Total Metals		TCE 2	[UQ]				<0.010	0.011	0.016	<0.005	<0.005	0.121	<0.010	<0.0002	0.052	<0.002	<0.05	<0.005	<0.005	0.721	NA
Dissolved		[UQ]					<0.010	0.008	0.015	<0.005	<0.005	0.014	<0.010	<0.0002	0.022	<0.002	<0.05	<0.005	<0.005	0.652	NA
5/9/94 (1)	MW-113	TCE 2	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	0.012	0.018	<0.004	<0.005	0.042	<0.010	<0.0002	0.025	<0.002	<0.05	<0.005	<0.005	0.628	NA
Dissolved							<0.010	0.009	0.017	<0.004	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.595	NA
02-11-95	MW-113	TCE 2	NA	NA	NA	NA															
Total Metals		[UQ]					NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5-3-95	MW-113	DCP 4	NA	NA	NA	NA															
Total Metals		[UQ]					NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Sample Date	**Location**	**Organic Constituents**					Inorganic Constituents (mg/L)								Inorganic Constituents Continued (mg/L)						
		VOCs (ug/L)	**BNAs** (ug/L)	**TPH** (mg/L)	**EDB** (mg/L)	**DBCP** (mg/L)	**Ag**	**As**	**Ba**	**Be**	**Cd**	**Cr**	**Cu**	**Hg**	**Ni**	**Pb**	**Sb**	**Se**	**Tl**	**Zn**	**Bo**
8-8-95	MW-113	ND	NA	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
10-10-95	MW-113	ND	NA	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
10-10-95	MW-113	ND	NA	NA	NA	NA															
Total Metals	DUPLICATE						NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-8-96	MW-113	ND	NA	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-8-96	MW-113	ND	NA	NA	NA	NA															
Total Metals	DUPLICATE						NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5-24-96	MW-113	ND	ND	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
11-12-97	MW-113	ND	ND	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
11-12-97	MW-113	ND	ND	NA	NA	NA															
Total Metals	Duplicate						NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5-12-98	MW-113	TCE 1.9J	ND	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
11-03-98	MW-113	DCA 0.30J MC 0.40JB PCE 0.18J TCE 1.6J	NA	ND	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Sample Date	Location	Organic Constituents					Inorganic Constituents (mg/L)								Inorganic Constituents Continued (mg/L)						
		VOCs (ug/L)	BNAs (ug/L)	TPH (mg/L)	EDB (mg/L)	DBCP (mg/L)	Ag	As	Ba	Be	Cd	Cr	Cu	Hg	Ni	Pb	Sb	Se	Tl	Zn	Bo
5-19-99	MW-113	CHL 5.0 BRMO 6.0	NA	ND	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes:

NA	Not analyzed.	ND	Not detected.
VOCs	Volatile organic compounds.	BNAs	Base/neutral and acid extractable compounds.
TPH	Total Petroleum Hydrocarbons	TOL	Toluene.
Tr	Trace, unquantifiable amount detected.	TCE	Trichloroethene.
ACE	Acetone.	EDB	Ethylene Dibromide.
BEP	Bis(2-ethylhexyl)phthalate.	DBCP	1,2-Dibromo-3-chloropropane.
CHL	Chloroform.	PCB	Pentachlorobenzene
CDS	Carbon Disulfide	BA	Benzoic Acid
DCA	1,2-Dichloroethane.	DCP	1,2-Dichloropropane
DBCM	Dibromochloromethane.	Bo	Boron.
MC	Methylene Chloride	PCE	Tetrachloroethelene
Bromo	Bromodichloromethene	[UQ]	ATI-Phoenix data of unknown quality as determined by the FFA Parties
*	TICs present.		
J	Data are qualitative or estimated.		
R	Data are rejected and unusable		
U	Data are qualitative and considered to be not detected at the value reported.		
(1)	Well screen submerged below top of water table.		

Method detection limits (mdls) for VOCs and BNAs varied. See laboratory reports for specific mdls.
Metals are as follows: silver (Ag), arsenic (As), beryllium (Be), barium (Ba), cadmium (Cd), copper (Cu), chromium (Cr), mercury (Hg), nickel (Ni), lead (Pb), antimony (Sb), selenium (Se), thallium (Tl), and zinc (Zn).

Groundwater Monitoring Results for the Period of Record at PSC SD-21, OU-1

Sample Date	Location	Organic Constituents					Inorganic Constituents (mg/L)								Inorganic Constituents Continued (mg/L)						
		VOCs (ug/L)	BNAs (ug/L)	TPH (mg/L)	EDB (mg/L)	DBCP (mg/L)	Ag	As	Ba	Be	Cd	Cr	Cu	Hg	Ni	Pb	Sb	Se	Tl	Zn	Bo
01-21-92 (1)	MW-101	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.103	<0.005	<0.005	<0.010	0.026	<0.0002	<0.020	0.002	<0.05	<0.005	<0.005	0.229	NA
Dissolved							<0.010	<0.005	0.104	<0.005	<0.005	<0.010	0.034	<0.0002	<0.020	0.003	<0.05	<0.005	<0.005	0.236	NA
01-21-92 (1)	MW-101	ND	ND	NA	NA	NA															
Total Metals	Duplicate	[UQ]	[UQ]				<0.010	<0.005	0.100	<0.005	<0.005	<0.010	0.034	<0.0002	<0.020	0.003	<0.05	<0.005	<0.005	0.236	NA
Dissolved							<0.010	<0.005	0.100	<0.005	<0.005	<0.010	0.034	<0.0002	<0.020	0.002	<0.05	<0.005	<0.005	0.236	NA
07-23-92 (1)	MW-101	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.095	<0.005	<0.0005	<0.010	0.092	<0.0002	<0.020	0.007	<0.05	<0.005	<0.005	0.187	NA
Dissolved							<0.010	<0.005	0.100	<0.005	<0.0005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.122	NA
11-18-92 (1)	MW-101	ND	ND	NA	ND	ND															
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.089	<0.005	<0.0005	<0.010	<0.010	<0.0002	<0.020	0.005	<0.05	<0.005	<0.005	0.500	0.250
Dissolved							<0.010	<0.005	0.094	<0.005	<0.0005	<0.010	<0.010	<0.0002	<0.020	0.004	<0.05	<0.005	<0.005	0.489	0.240
3-18-93 (1)	MW-101	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.117	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.219	NA
Dissolved							<0.010	<0.005	0.096	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.197	NA
06-17-93 (1)	MW-101	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	0.011	0.114	<0.005	<0.005	<0.010	0.012	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.184	NA
Dissolved							<0.010	0.011	0.117	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.174	NA
11-08-93 (1)	MW-101	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.103	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.286	NA
Dissolved							<0.010	<0.005	0.114	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.268	NA
5-19-94 (1)	MW-101	ACE 23	BEP 5 J	NA	NA	NA															
Total Metals		CDS 25	* [UQ]				<0.010	<0.005	0.092	<0.004	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.231	NA
Dissolved		[UQ]					<0.010	<0.005	0.095	<0.004	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.227	NA
7-14-94 (1)	MW-101	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.097	<0.004	<0.005	<0.010	<0.010	<0.0002	<0.20	<0.002	<0.05	<0.005	<0.005	0.302	NA
Dissolved							<0.010	<0.005	0.103	<0.004	<0.005	<0.010	<0.010	<0.0002	<0.20	<0.002	<0.05	<0.005	<0.005	0.323	NA
7-14-94 (1)	MW-101	ND	ND	NA	NA	NA															
Total Metals	Duplicate	[UQ]	[UQ]				<0.010	<0.005	0.09	<0.004	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.367	NA
Dissolved							<0.010	<0.005	0.103	<0.004	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.321	NA
03-18-95	MW-101	ND	NA	NA	NA	NA															
Total Metals		[UQ]					NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
10-25-95	MW-101	ND	NA	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Sample Date	Location	Organic Constituents					Inorganic Constituents (mg/L)								Inorganic Constituents Continued (mg/L)							
		VOCs (ug/L)	BNAs (ug/L)	TPH (mg/L)	EDB (mg/L)	DBCP (mg/L)	Ag	As	Ba	Be	Cd	Cr	Cu	Hg	Ni	Pb	Sb	Se	Tl	Zn	Bo
6-4-96	MW-101	ND	ND	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes:

NA	Not analyzed.	ND	Not detected.
VOCs	Volatile organic compounds.	BNAs	Base/neutral and acid extractable compounds.
TPH	Total Petroleum Hydrocarbons	TOL	Toluene.
Tr	Trace, unquantifiable amount detecte	TCE	Trichloroethene.
ACE	Acetone.	EDB	Ethylene Dibromide.
BEP	Bis(2-ethylhexyl)phthalate.	DBCP	1,2-Dibromo-3-chloropropane.
CHL	Chloroform.	PCB	Pentachlorobenzene
CDS	Carbon Disulfide	BA	Benzoic Acid
DCA	1,2-Dichloroethane.	DCP	1,2-Dichloropropane
DBCM	Dibromochloromethane.	Bo	Boron.
*	TICs present.	[UQ]	ATI-Phoenix data of unknown quality as determined by the FFA Parties
J	Data are qualitative or estimated.		
R	Data are rejected and unusable		
U	Data are qualitative and considered to be not detected at the value reported.		
(1)	Well screen submerged below top of water table.		

Method detection limits (mdls) for VOCs and BNAs varied. See laboratory reports for specific mdls.

Metals are as follows: silver (Ag), arsenic (As), beryllium (Be), barium (Ba), cadmium (Cd), copper (Cu), chromium (Cr), mercury (Hg), nickel (Ni), lead (Pb), antimony (Sb), selenium (Se), thallium (Tl), and zinc (Zn).

Sample Date	Location	Organic Constituents					Inorganic Constituents (mg/L)								Inorganic Constituents Continued (mg/L)						
		VOCs (ug/L)	BNAs (ug/L)	TPH (mg/L)	EDB (mg/L)	DBCP (mg/L)	Ag	As	Ba	Be	Cd	Cr	Cu	Hg	Ni	Pb	Sb	Se	Tl	Zn	Bo
05-26-93	MW-117	ND	ND	NA	NA	NA															
Total Metals							<0.010	<0.005	0.146	<0.005	<0.005	<0.010	0.012	<0.0002	<0.020	0.003	<0.05	<0.005	<0.005	0.378	NA
Dissolved							<0.010	<0.005	0.143	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	0.003	<0.05	<0.005	<0.005	0.364	NA
05-26-93	MW-117	ND	ND	NA	NA	NA															
Total Metals	Duplicate	[UQ]	[UQ]				<0.010	<0.005	0.140	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	0.002	<0.05	<0.005	<0.005	0.348	NA
Dissolved							<0.010	<0.005	0.150	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	0.002	<0.05	<0.005	<0.005	0.344	NA
11-12-93	MW-117	ND	ND *	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	0.006	0.137	<0.005	<0.005	0.017	<0.010	<0.0002	0.042	<0.002	<0.05	<0.005	<0.005	0.309	NA
Dissolved							<0.010	0.005	0.145	<0.005	<0.005	<0.010	<0.010	<0.0002	0.049	<0.002	<0.05	<0.005	<0.005	0.298	NA
5-17-93	MW-117	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.149	<0.004	<0.005	0.011	0.017	<0.0002	0.030	0.003	<0.05	<0.005	<0.005	0.317	NA
Dissolved							<0.010	<0.005	0.158	<0.004	<0.005	<0.010	<0.010	<0.0002	0.024	<0.002	<0.05	<0.005	<0.005	0.292	NA
02-13-95	MW-117	ND	NA	NA	NA	NA															
Total Metals		[UQ]	[UQ]				NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
10-4-95	MW-117	ND	NA	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5-29-96	MW-117	ND	ND	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes:

NA	Not analyzed.	ND	Not detected.
[UQ]	ATI-Phoenix data of unkn determined by the FFA Parties		
*	TICs present.		

Method detection limits (mdls) for VOCs and BNAs varied. See laboratory reports for specific mdls.
Metals are as follows: silver (Ag), arsenic (As), beryllium (Be), barium (Ba), cadmium (Cd),
copper (Cu), chromium (Cr), mercury (Hg), nickel (Ni), lead (Pb), antimony (Sb), selenium (Se),
thallium (Tl), and zinc (Zn).

Sample Date	**Location**	**Organic Constituents**					Inorganic Constituents (mg/L)								Inorganic Constituents Continued (mg/L)						
		VOCs (ug/L)	**BNAs** (ug/L)	**TPH** (mg/L)	**EDB** (mg/L)	**DBCP** (mg/L)	**Ag**	**As**	**Ba**	**Be**	**Cd**	**Cr**	**Cu**	**Hg**	**Ni**	**Pb**	**Sb**	**Se**	**Tl**	**Zn**	**Bo**
08-04-93	MW-119	DCP 1	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.097	<0.005	<0.005	0.034	0.019	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	1.88	NA
Dissolved							<0.010	<0.005	0.106	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	1.97	NA
11-05-93	MW-119	DCP 2	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	0.007	0.095	<0.005	<0.005	3.84**J**	0.036	<0.0002	0.103**J**	<0.002	<0.05	0.007	<0.005	2.77	NA
Dissolved							<0.010	<0.005	0.095	<0.005	<0.005	<0.010	<0.010	<0.0002	0.039	<0.002	<0.05	0.007	<0.005	3.00	NA
11-05-93	MW-119	DCP 2	ND *	NA	NA	NA															
Total Metals	Duplicate	[UQ]	[UQ]				<0.010	<0.005	0.090	<0.005	<0.005	1.64**J**	0.022	<0.0002	0.053**J**	<0.002	<0.05	0.008	<0.005	3.09	NA
Dissolved							<0.010	<0.005	0.089	<0.005	<0.005	<0.010	<0.010	<0.0002	0.025	<0.002	<0.05	0.008	<0.005	3.16	NA
05-17-94	MW-119	DCP 2	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.077	<0.004	<0.005	0.073	<0.010	<0.0002	0.254	<0.002	<0.05	<0.005	<0.005	0.640	NA
Dissolved							<0.010	<0.005	0.076	<0.004	<0.005	<0.010	<0.010	<0.0002	0.250	<0.002	<0.05	<0.005	<0.005	0.656	NA
02-02-95	MW-119	DCP 2	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5-2-95	MW-119	ND	NA	ND	NA	NA															
Total Metals		[UQ]					NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
8-14-95	MW-119	ND	NA	ND	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
10-28-95	MW-119	ND	NA	ND	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-10-96	MW-119	ND	NA	110J	NA	NA															
Total Metals				DRO			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5-23-96	MW-119	ND	ND	ND	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5-23-96	MW-119	ND	ND	26J	NA	NA															
Total Metals	DUPLICATE			GRO			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
07-17-97	MW-119	DCP 1.0J	NA	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Sample Date	**Location**	**Organic Constituents**					Inorganic Constituents (mg/L)								Inorganic Constituents Continued (mg/L)						
		VOCs (ug/L)	**BNAs** (ug/L)	**TPH** (mg/L)	**EDB** (mg/L)	**DBCP** (mg/L)	**Ag**	**As**	**Ba**	**Be**	**Cd**	**Cr**	**Cu**	**Hg**	**Ni**	**Pb**	**Sb**	**Se**	**Tl**	**Zn**	**Bo**
01-05-94	MW-120	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.088	<0.005	<0.005	0.092	<0.010	<0.0002	0.086	<0.002	<0.05	0.006	<0.005	2.34	NA
Dissolved							<0.010	<0.005	0.088	<0.005	<0.005	<0.010	<0.010	<0.0002	0.081	<0.002	<0.05	0.005	<0.005	2.32	NA
01-05-94	MW-120	ND	ND *	NA	NA	NA															
Total Metals	Duplicate	[UQ]	[UQ]				<0.010	<0.005	0.090	<0.005	<0.005	0.099	<0.010	<0.0002	0.093	<0.002	<0.05	0.005	<0.005	2.36	NA
Dissolved							<0.010	<0.005	0.088	<0.005	<0.005	<0.010	<0.010	<0.0002	0.086	<0.002	<0.05	<0.005	<0.005	2.34	NA
05-16-94	MW-120	DCP 1	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.116	<0.004	<0.005	0.089	<0.010	<0.0002	0.071	<0.002	<0.05	<0.005	<0.005	2.15	NA
Dissolved							<0.010	<0.005	0.120	<0.004	<0.005	<0.010	<0.010	<0.0002	0.071	<0.002	<0.05	<0.005	<0.005	2.34	NA
02-01-95	MW-120	ND	NA	ND	NA	NA															
Total Metals		[UQ]					NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5-2-95	MW-120	ND	NA	ND	NA	NA															
Total Metals		[UQ]					NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
8-9-95	MW-120	ND	NA	ND	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
10-27-95	MW-120	ND	NA	ND	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-9-96	MW-120	ND	NA	ND	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
6-11-96	MW-120	ND	ND	ND	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
07-17-97	MW-120	DCP 1.7J	NA	ND	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
11-05-98	MW-120	DCP 1,4J MC 0.25JB TOL 0.11J	NA	270JB	NA	NA															
Total Metals				GRO			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Sample Date	**Location**	**Organic Constituents**					Inorganic Constituents (mg/L)								Inorganic Constituents Continued (mg/L)						
		VOCs (ug/L)	**BNAs** (ug/L)	**TPH** (mg/L)	**EDB** (mg/L)	**DBCP** (mg/L)	**Ag**	**As**	**Ba**	**Be**	**Cd**	**Cr**	**Cu**	**Hg**	**Ni**	**Pb**	**Sb**	**Se**	**Tl**	**Zn**	**Bo**
01-05-94	MW-121	ND	ND *	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.139	<0.005	<0.005	0.074	<0.010	<0.0002	0.144	<0.002	<0.05	0.005	<0.005	1.85	NA
Dissolved							<0.010	<0.005	0.136	<0.005	<0.005	<0.010	<0.010	<0.0002	0.143	<0.002	<0.05	<0.005	<0.005	1.76	NA
04-06-94	MW-121	ND	NA	ND	NA	NA															
Total Metals	Time-series	[UQ]					NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved	Initial Sample						NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
04-07-94	MW-121	ND	NA	ND	NA	NA															
Total Metals	Time-series	[UQ]					NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved	24-hr Sample						NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
04-07-94	MW-121	ND	NA	ND	NA	NA															
Total Metals	Time-series	[UQ]					NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved	24-hr Duplicate						NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
05-13-94	MW-121	DCP 2	NA	NA	NA	NA															
Total Metals	ADEQ	[UQ]					NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved	Duplicate						NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
05-16-94	MW-121	DCP 2	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.081	<0.004	<0.005	0.016	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	1.61	NA
Dissolved							<0.010	<0.005	0.084	<0.004	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	1.48	NA
05-16-94	MW-121	DCP 2	ND	NA	NA	NA															
Total Metals	Duplicate	[UQ]	[UQ]				<0.010	<0.005	0.082	<0.004	<0.005	0.026	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	1.69	NA
Dissolved							<0.010	<0.005	0.080	<0.004	<0.005	0.011	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	2.12	NA
02-02-95	MW-121	DCP 2	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
02-02-95	MW-121	DCP 2	ND	NA	NA	NA															
Total Metals	Duplicate	[UQ]	[UQ]				NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5-2-95	MW-121	ND	NA	ND	NA	NA															
Total Metals		[UQ]					NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
8-15-95	MW-121	ND	NA	ND	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Sample Date	Location	Organic Constituents					Inorganic Constituents (mg/L)								Inorganic Constituents Continued (mg/L)						
		VOCs (ug/L)	BNAs (ug/L)	TPH (mg/L)	EDB (mg/L)	DBCP (mg/L)	Ag	As	Ba	Be	Cd	Cr	Cu	Hg	Ni	Pb	Sb	Se	Tl	Zn	Bo
10-31-95	MW-121	ND	NA	ND	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-10-96	MW-121	ND	NA	ND	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5-23-96	MW-121	ND	ND	ND	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
07-17-97	MW-121	DCP 1.4J BZ 1.8J EB 4.4J TOL 6.3 XYL 12	NA	970J	NA	NA															
Total Metals				DRO			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
11-13-97	MW-121	DCP 1.7J	NA	130vr	NA	NA															
Total Metals				DRO			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
05-14-98	MW-121	DCP 1.8J BZ 1.8 EB 2.3J TOL 2.7J XYL 6.9	NA	120, 44B	NA	NA															
Total Metals				DRO, GRO			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
11-05-98	MW-121	BZ 17 EB 23 MC 34JB PCE 0.02J TOL 36 XYL 61	NA	630, 200JB	NA	NA															
Total Metals				DRO,GRO			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
11-05-98	MW-121	BZ 19 EB 25 MC .04JB PCE 0.25J TOL 38 XYL 64	NA	250, 490JB	NA	NA															
Total Metals	Duplicate			DRO, GRO			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Sample	Location	Organic Constituents					Inorganic Constituents (mg/L)								Inorganic Constituents Continued (mg/L)						
Date		VOCs	BNAs	TPH	EDB	DBCP	Ag	As	Ba	Be	Cd	Cr	Cu	Hg	Ni	Pb	Sb	Se	Tl	Zn	Bo
		(ug/L)	(ug/L)	(mg/L)	(mg/L)	(mg/L)															
05-20-99	MW-121	ND	NA	ND	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
05-16-00	MW-121	ND	NA	ND	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
05-16-00	MW-121	ND	NA	ND	NA	NA															
Total Metals	Duplicate						NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
8-2-01	MW-121	ND	NA	ND	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
8-2-01	MW-121	ND	NA	ND	NA	NA															
Total Metals	Duplicate						NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5-30-95	MW-125	ND	NA	ND	NA	NA															
Total Metals		[UQ]					NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
8-15-95	MW-125	ND	NA	ND	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
8-15-95	MW-125	ND	NA	ND	NA	NA															
Total Metals	DUPLICATE						NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
10-31-95	MW-125	ND	NA	ND	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-9-96	MW-125	ND	NA	11 J	NA	NA															
Total Metals				GRO			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
6-11-96	MW-125	ND	NA	ND	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
07-17-97	MW-125	DCP 1.0J	NA	23J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Metals				GRO			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Sample Date	**Location**	**Organic Constituents**					Inorganic Constituents (mg/L)								Inorganic Constituents Continued (mg/L)						
		VOCs (ug/L)	**BNAs** (ug/L)	**TPH** (mg/L)	**EDB** (mg/L)	**DBCP** (mg/L)	**Ag**	**As**	**Ba**	**Be**	**Cd**	**Cr**	**Cu**	**Hg**	**Ni**	**Pb**	**Sb**	**Se**	**Tl**	**Zn**	**Bo**
07-17-97	MW-125	DCP 1.1J BZ 3.4J	NA	53J DRO	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Metals	Duplicate						NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
11-13-97	MW-125	DCP 1.2J	NA	ND	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
11-13-97	MW-125	DCP 1.3J	NA	ND	NA	NA															
Total Metals	Duplicate						NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
05-14-98	MW-125	DCP 1.6J	NA	ND	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
11-04-98	MW-125	DCP 1.2J MC 0.21JB	NA	7.2 GRO	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
05-20-99	MW-125	ND	NA	ND	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
05-16-00	MW-125	ND	NA	ND	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
05-16-00	MW-125	ND	NA	ND	NA	NA															
Total Metals	Duplicate						NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Sample Date	Location	Organic Constituents					Inorganic Constituents (mg/L)								Inorganic Constituents Continued (mg/L)						
		VOCs (ug/L)	BNAs (ug/L)	TPH (mg/L)	EDB (mg/L)	DBCP (mg/L)	Ag	As	Ba	Be	Cd	Cr	Cu	Hg	Ni	Pb	Sb	Se	Tl	Zn	Bo
11-09-01	MW-125R	ND	NA	ND	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes:

NA	Not analyzed.	ND	Not detected.
VOCs	Volatile organic compounds.	BNAs	Base/neutral and acid extractable compounds.
TPH	Total Petroleum Hydrocarbons	TOL	Toluene.
Tr	Trace, unquantifiable amount detected.	TCE	Trichloroethene.
ACE	Acetone.	EDB	Ethylene Dibromide.
BEP	Bis(2-ethylhexyl)phthalate.	DBCP	1,2-Dibromo-3-chloropropane.
CHL	Chloroform.	PCB	Pentachlorobenzene
CDS	Carbon Disulfide	BA	Benzoic Acid
DCA	1,2-Dichloroethane.	DCP	1,2-Dichloropropane
DBCM	Dibromochloromethane.	Bo	Boron.
BZ	Benzene	EB	Ethyl Benzene
PCE	Tetrachloroethene	XYL	Total Xylenes
MC	Methylene Chloride	[UQ]	ATI-Phoenix data of unknown quality as
*	TICs present.	DRO	Diesel Range
GRO	Gasoline Range		determined by the FFA Parties
B	Compound also detected in the blank.		
J	Data are qualitative or estimated.		
R	Data are rejected and unusable		
U	Data are qualitative and considered to be not detected at the value reported.		
v	Reliable identification of a product could not be achieved		
(1)	Well screen submerged below top of water table.		

Method detection limits (mdls) for VOCs and BNAs varied. See laboratory reports for specific mdls.
Metals are as follows: silver (Ag), arsenic (As), beryllium (Be), barium (Ba), cadmium (Cd), copper (Cu), chromium (Cr), mercury (Hg), nickel (Ni), lead (Pb), antimony (Sb), selenium (Se), thallium (Tl), and zinc (Zn).

Groundwater Monitoring Results for the Period of Record at PSC ST-18, OU-2

Sample Date	Location	Organic Constituents					Inorganic Constituents (mg/L)								Inorganic Constituents Continued (mg/L)						
		VOCs (ug/L)	BNAs (ug/L)	TPH (mg/L)	EDB (mg/L)	DBCP (mg/L)	Ag	As	Ba	Be	Cd	Cr	Cu	Hg	Ni	Pb	Sb	Se	Tl	Zn	Bo
07-22-92	MW-2	ND	ND **J**	NA	NA	NA															
Total Metals							<0.010	<0.005	0.139	<0.005	<0.0005	<0.010	0.064	<0.0002	<0.020	0.011	<0.05	<0.005	<0.005	0.338	NA
Dissolved							<0.010	<0.005	0.140	<0.005	<0.0005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.253	NA
11-25-92	MW-2	ND	ND	NA	<0.01	<0.01															
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.127	<0.005	<0.0005	<0.010	<0.010	<0.0002	<0.020	0.006	<0.05	<0.005	<0.005	0.629	<0.10
Dissolved							<0.010	<0.005	0.137	<0.005	<0.0005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.628	<0.10
03-24-93	MW-2	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.126	<0.005	<0.005	<0.010	0.011	<0.0002	<0.020	0.004	<0.05	<0.005	<0.005	0.393	NA
Dissolved							<0.010	<0.005	0.15	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.392	NA
06-18-93	MW-2	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.130	<0.005	<0.005	<0.010	0.013	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.462	NA
Dissolved							<0.010	<0.005	0.138	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.453	NA
07-16-92	MW-3	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.028	<0.005	<0.0005	<0.010	0.015	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.454	NA
Dissolved							<0.010	<0.005	0.038	<0.005	<0.0005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	<0.010	NA
11-24-92	MW-3	ND	ND	NA	<0.01	0.07															
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.098	<0.005	<0.0005	<0.010	<0.010	<0.0002	<0.020	0.005	<0.05	0.006	<0.005	0.764	<0.10
Dissolved							<0.010	<0.005	0.106	<0.005	<0.0005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	0.006	<0.005	0.770	<0.10
03-12-93	MW-3	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.096	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	0.006	<0.005	0.469	NA
Dissolved							<0.010	<0.005	0.096	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	0.006	<0.005	0.465	NA
06-15-93	MW-3	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.099	<0.005	<0.005	<0.010	0.012	<0.0002	0.028	0.003	<0.05	<0.005	<0.005	0.638	NA
Dissolved							<0.010	<0.005	0.110	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.629	NA
11-04-93	MW-3	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.093	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.365	NA
Dissolved							<0.010	<0.005	0.105	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.380	NA
05-13-94	MW-3	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.101	<0.004	<0.005	<0.010	0.034	<0.0002	<0.020	0.003	<0.05	0.006	<0.005	0.488	NA
Dissolved							<0.010	<0.005	0.098	<0.004	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	0.005	<0.005	0.480	NA
2-13-95	MW-3	ND	NA	NA	NA	NA															
Total Metals		[UQ]					NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
10-11-95	MW-3	ND	NA	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
6-4-96	MW-3	ND	ND	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
07-23-92	MW-4	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	0.005	0.121	<0.005	<0.0005	<0.010	0.029	<0.0002	<0.020	0.004	<0.05	<0.005	<0.005	0.204	NA
Dissolved							<0.010	<0.005	0.127	<0.005	<0.0005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.188	NA
12-05-92	MW-4	ND	ND	NA	<0.01	<0.01															
Total Metals	Time-series	[UQ]	[UQ]				<0.010	<0.005	0.127	<0.005	<0.0005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.611	<0.10
Dissolved	Initial Sample						<0.010	<0.005	0.134	<0.005	<0.0005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.352	<0.10
12-05-92	MW-4	ND	NA	NA	<0.01	<0.01															
Total Metals	Time-series	[UQ]					NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved	4-hr Sample						NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
03-24-93	MW-4	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.134	<0.005	<0.005	0.010	<0.010	<0.0002	<0.020	0.003	<0.05	<0.005	<0.005	0.360	NA
Dissolved							<0.010	<0.005	0.154	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.331	NA
06-21-93	MW-4	ND	ND	NA	NA	NA															

Sample Date	Location	Organic Constituents					Inorganic Constituents (mg/L)								Inorganic Constituents Continued (mg/L)						
		VOCs (ug/L)	BNAs (ug/L)	TPH (mg/L)	EDB (mg/L)	DBCP (mg/L)	Ag	As	Ba	Be	Cd	Cr	Cu	Hg	Ni	Pb	Sb	Se	Tl	Zn	Bo
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.114	<0.005	<0.005	0.011	0.021	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.350	NA
Dissolved							<0.010	<0.005	0.124	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.359	NA
11-15-93	MW-4	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.114	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.355	NA
Dissolved							<0.010	<0.005	0.139	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.401	NA
05-13-94	MW-4	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.130	<0.004	<0.005	<0.010	0.011	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.379	NA
Dissolved							<0.010	<0.005	0.138	<0.004	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.375	NA
07-18-92	MW-5	ND	ND **J**	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	0.019	0.204	<0.005	<0.0005	0.115	0.052	<0.0002	0.051	0.026	<0.05	<0.005	<0.005	8.70	NA
Dissolved							<0.010	<0.005	0.082	<0.005	<0.0005	<0.010	<0.010	<0.0002	<0.020	0.004	<0.05	<0.005	<0.005	0.116	NA
11-20-92	MW-5	ND	ND	NA	<0.01	<0.01															
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.199	<0.005	<0.0005	<0.010	<0.010	<0.0002	<0.020	0.008	<0.05	<0.005	<0.005	0.514	<0.10
Dissolved							<0.010	<0.005	0.221	<0.005	<0.0005	<0.010	<0.010	<0.0002	<0.020	0.007	<0.05	<0.005	<0.005	0.572	<0.10
03-23-93	MW-5	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.199	<0.005	<0.005	<0.010	0.012	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.439	NA
Dissolved							<0.010	<0.005	0.222	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.399	NA
06-21-93	MW-5	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.182	<0.005	<0.005	<0.010	0.015	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.454	NA
Dissolved							<0.010	<0.005	0.194	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	0.016	<0.05	<0.005	<0.005	0.506	NA
11-11-93	MW-5	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.196	<0.005	<0.005	0.011	<0.010	<0.0002	<0.020	<0.002	<0.05	0.007	<0.005	0.395	NA
Dissolved							<0.010	<0.005	0.217	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	0.006	<0.005	0.400	NA
05-18-94	MW-5	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.174	<0.004	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.288	NA
Dissolved							<0.010	<0.005	0.174	<0.004	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.286	NA
2-13-95	MW-5	ND	NA	NA	NA	NA															
Total Metals		[UQ]					NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
10-19-95	MW-5	ND	NA	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
6-5-96	MW-5	ND	ND	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
07-22-92	MW-114	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	0.007	0.048	<0.005	<0.0005	0.022	0.133	<0.0002	<0.020	0.011	<0.05	<0.005	<0.005	0.407	NA
Dissolved							<0.010	0.006	0.046	<0.005	<0.0005	0.013	0.020	<0.0002	<0.020	0.003	<0.05	<0.005	<0.005	0.370	NA
11-30-92	MW-114	ND	ND	NA	<0.01	<0.01															
Total Metals		[UQ]	[UQ]				<0.010	0.006	0.063	<0.005	<0.0005	0.017	<0.010	<0.0002	<0.020	0.004	<0.05	<0.005	<0.005	0.344	<0.10
Dissolved							<0.010	0.005	0.060	<0.005	<0.0005	0.018	<0.010	<0.0002	<0.020	0.002	<0.05	<0.005	<0.005	0.310	<0.10
11-30-92	MW-114	ND	ND	NA	<0.01	<0.01															
Total Metals	Duplicate	[UQ]	[UQ]				<0.010	0.006	0.062	<0.005	<0.0005	0.023	<0.010	<0.0002	<0.020	0.003	<0.05	<0.005	<0.005	0.337	<0.10
Dissolved							<0.010	0.006	0.062	<0.005	<0.0005	0.015	<0.010	<0.0002	<0.020	0.002	<0.05	<0.005	<0.005	0.348	<0.10
03-25-93	MW-114	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.262	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.464	NA
Dissolved							<0.010	<0.005	0.285	<0.005	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.453	NA

Sample Date	Location	Organic Constituents					Inorganic Constituents (mg/L)								Inorganic Constituents Continued (mg/L)						
		VOCs (ug/L)	BNAs (ug/L)	TPH (mg/L)	EDB (mg/L)	DBCP (mg/L)	Ag	As	Ba	Be	Cd	Cr	Cu	Hg	Ni	Pb	Sb	Se	Tl	Zn	Bo
06-18-93	MW-114	ND	BEP 40	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	0.005	0.071	<0.005	<0.005	0.020	0.012	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.349	NA
Dissolved							<0.010	<0.005	0.063	<0.005	<0.005	0.016	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.468	NA
11-11-93	MW-114	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.183	<0.005	<0.005	0.011	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.247	NA
Dissolved							<0.010	<0.005	0.273	<0.005	<0.005	0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.181	NA
05-13-94	MW-114	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	<0.005	0.295	<0.004	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.373	NA
Dissolved							<0.010	<0.005	0.311	<0.004	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.400	NA
05-13-94	MW-114	ND	NA	NA	NA	NA															
Total Metals	ADEQ	[UQ]					NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved	Duplicate						NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-14-95	MW-114	ND	NA	NA	NA	NA															
Total Metals		[UQ]					NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5-5-95	MW-114	ND	NA	NA	NA	NA															
Total Metals		[UQ]					NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
8-9-95	MW-114	ND	NA	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
10-19-95	MW-114	ND	NA	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-2-96	MW-114	ND	NA	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
6-5-96	MW-114	ND	ND	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
11-11-97	MW-114	ND	NA	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5-13-98	MW-114	ND	NA	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
11-03-98	MW-114	MC 0.35JB MEK 1.1J	NA	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5-18-99	MW-114	ND	NA	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
10-25-01	MW-114	cis-1,2-Dichloroethene 0.89 TCE 2.0 PCE 0.95	NA	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
10-25-01	MW-114	cis-1,2-Dichloroethene 0.94 TCE 2.0 PCE 0.90	NA	NA	NA	NA															

Sample Date	**Location**	**Organic Constituents**					Inorganic Constituents (mg/L)								Inorganic Constituents Continued (mg/L)						
		VOCs (ug/L)	**BNAs** (ug/L)	**TPH** (mg/L)	**EDB** (mg/L)	**DBCP** (mg/L)	**Ag**	**As**	**Ba**	**Be**	**Cd**	**Cr**	**Cu**	**Hg**	**Ni**	**Pb**	**Sb**	**Se**	**Tl**	**Zn**	**Bo**
Total Metals	Duplicate						NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
07-14-94	MW-122	ND	ND	NA	NA	NA															
Total Metals		[UQ]	[UQ]				<0.010	<0.006	0.065	<0.004	<0.005	0.013	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.313	NA
Dissolved							<0.010	<0.005	0.062	<0.004	<0.005	0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.268	NA
07-14-94	MW-122	ND	ND	NA	NA	NA															
Total Metals	Duplicate	[UQ]	[UQ]				<0.010	<0.006	0.064	<0.004	<0.005	0.012	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.342	NA
Dissolved							<0.010	<0.005	0.062	<0.004	<0.005	<0.010	<0.010	<0.0002	<0.020	<0.002	<0.05	<0.005	<0.005	0.264	NA
2-14-95	MW-122	ND	NA	NA	NA	NA															
Total Metals		[UQ]					NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5-5-95	MW-122	ND	NA	NA	NA	NA															
Total Metals		[UQ]					NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
8-9-95	MW-122	ND	NA	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
10-19-95	MW-122	ND	NA	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-2-96	MW-122	ND	NA	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
6-6-96	MW-122	ND	ND	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
11-12-97	MW-122	ND	NA	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5-13-98	MW-122	ND	NA	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
11-03-98	MW-122	MC 0.29JB	NA	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Sample Date	**Location**	**Organic Constituents**					Inorganic Constituents (mg/L)								Inorganic Constituents Continued (mg/L)						
		VOCs (ug/L)	**BNAs** (ug/L)	**TPH** (mg/L)	**EDB** (mg/L)	**DBCP** (mg/L)	**Ag**	**As**	**Ba**	**Be**	**Cd**	**Cr**	**Cu**	**Hg**	**Ni**	**Pb**	**Sb**	**Se**	**Tl**	**Zn**	**Bo**
5-18-99	MW-122	ND	NA	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
10-25-01	MW-122	ND	NA	NA	NA	NA															
Total Metals							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dissolved							NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes:

NA	Not analyzed.	ND	Not detected.
VOCs	Volatile organic compounds.	BNAs	Base/neutral and acid extractable compounds.
TPH	Total Petroleum Hydrocarbons	TOL	Toluene.
Tr	Trace, unquantifiable amount detected.	TCE	Trichloroethene.
ACE	Acetone.	EDB	Ethylene Dibromide.
BEP	Bis(2-ethylhexyl)phthalate.	DBCP	1,2-Dibromo-3-chloropropane.
CHL	Chloroform.	PCB	Pentachlorobenzene
CDS	Carbon Disulfide	BA	Benzoic Acid
DCA	1,2-Dichloroethane.	DCP	1,2-Dichloropropane
DBCM	Dibromochloromethane.	Bo	Boron.
TCE	Trichloroethene	[UQ]	ATI-Phoenix data of unknown quality as determined by the FFA Parties
PCE	Tetrachloroethene		
MC	Methylene chloride		
MEK	2-Butanone		
*	TICs present.		
J	Data are qualitative or estimated.		
R	Data are rejected and unusable		
U	Data are qualitative and considered to be not detected at the value reported.		
(1)	Well screen submerged below top of water table.		

Method detection limits (mdls) for VOCs and BNAs varied. See laboratory reports for specific mdls.
Metals are as follows: silver (Ag), arsenic (As), beryllium (Be), barium (Ba), cadmium (Cd), copper (Cu), chromium (Cr), mercury (Hg), nickel (Ni), lead (Pb), antimony (Sb), selenium (Se), thallium (Tl), and zinc (Zn).

Appendix C

Changed Standards Comparison for No-Action PSCs

No Action Sites
Combined Suface and Subsurface Soil Constituents

			Maximum Concentration of	USEPA Region IX Industrial PRG (mg/kg)		ADEQ (mg/k
Operable Unit	PSC	COC	COC in soil	1996	2000	Residential
OU-2	OT-04	BNAs				
		Bis(2-ethylhexyl)phthalate	1.3	140	180	320
		Butylbenzylphthalate	0.22	930	100,000	13,000
		TRPH [a]	250	NA	NA	4,100
		Metals				
		Copper	30.5	63,000	76,000	2,800
		Lead	21	400	750	400
OU-2	DP-05	VOCs				
		Ethylbenzene	0.9	690	230	1,500
		Xylenes	86	320	210	2,800
		BNAs				
		Bis(2-ethylhexyl)phthalate	3.7	140	180	320
		2-Methylnaphthalene [d]	4.7	240	190	NE
		Naphthalene	4.6	240	190	2,600
		TRPH [a]	8,300	NA	NA	4,100
		Metals				
		Copper	37.8	63,000	76,000	2,800
		Lead	115	400	750	400
OU-2	FT-06	VOCs				
		2-Butanone (MEK)	0.9	NA	NA	NA
		Ethylbenzene	6	690	230	1,500
		2-Hexanone (MBK)	0.8	110	110	120
		1,1,2,2-Tetrachlorethane	0.4	1.1	0.9	4.4
		Tetrachloroethene	0.05	17	19	53
		Toluene	3	880	520	790
		Trichloroethene	9	7	6.1	27
		Xylenes	43	320	210	2,800
		BNA				
		Acenaphthene	1.8	110	38,000	3,900
		Anthracene	2.6	5.7	100,000	20,000
		Benzo(a)anthracene [e]	27	2.6	2.9	6.1
		Benzo(b)fluoranthene [e]	46	2.6	2.9	6.1
		Benzo(k)fluoranthene	73	26	29	61
		Benzo(g,h,i)perylene [c]	10	100	54,000	NA
		Benzo(a)pyrene [e]	30	0.26	0.29	0.61
		Bis(2-ethylhexyl)phthalate	3.2	140	180	320
		Butylbenzylphthalate	0.68	930	100,000	13,000
		Chrysene	52	7.2	62	610
		Dibenzo(a,h)anthracene [e]	10	0.26	0.29	0.61
		Dibenzofuran	0.67	14,000	5,100	260
		Di-n-butylphthalate	0.46	68,000	88,000	6,500
		Fluoranthene	42	27,000	30,000	2,600
		Fluorene	0.83	90	33,000	2,600
		Indeno(1,2,3-c,d)pyrene	8.1	0.61	0.62	6.1
		2-Methylnaphthalene [d]	3	240	190	NE
		4-Methylphenol	9.1	3,400	4,400	330
		Naphthalene	9.7	240	190	2,600
		Pentachlorophenol	3.1	7.9	11	25
		Phenanthrene [c]	13	100	54,000	NE
		Phenol	3.1	100,000	100,000	39,000
		Pyrene	36	100	54,000	2,000
		TRPH [a]	18,000	NA	NA	4,100
		Metals				

		Copper	40.3	63,000	76,000	2,800
		Lead	101	400	750	400
OU-2	FT-07W	BNAs				
		Benzo(b)fluoranthene [e]	0.26	2.6	2.9	6.1
		Benzo(g,h,i)perylene [c]	0.22	100	54,000	NA
		Bis(2-ethylhexyl)phthalate	0.21	140	180	320
		Chrysene	0.29	7.2	62	610
		Fluoranthene	0.22	27,000	30,000	2,600
		2-Methylnaphthalene [d]	0.91	240	190	NE
		Naphthalene	0.26	240	190	2,600
		Pyrene	0.28	100	54,000	2,000
		TRPH [a]	3,800	NA	NA	4,100
		Metals				
		Copper	37.3	63,000	76,000	2,800
		Lead	172	400	750	400
OU-2	DP-22	VOCs				
		Acetone	1	8,800	6,200	2,100
		TRPH [a]	970	NA	NA	4,100
		Metals				
		Copper	25.8	63,000	76,000	2,800
		Lead	30	400	750	400
OU-2	SD-40	VOCs				
		Acetone	1.8	8,800	6,200	2,100
		Benzene	0.13	1.4	1.5	0.62
		Ethylbenzene	1	690	230	1,500
		Toluene	0.2	880	520	790
		Xylenes	2.4	320	210	2,800
		BNAs				
		2-Methylnaphthalene [d]	2	240	190	NE
		Naphthalene	0.98	240	190	2,600
		TRPH [a]	1,200	NA	NA	4,100
		Metals				
		Copper	42.8	63,000	76,000	2,800
		Lead	20	400	750	400
OU-1	SS-11	PCBs	0.22	0.066	1	2.5
OU-1	OT-12	BNAs				
		Acenaphthylene [c]	0.046	100	54,000	NE
		Anthracene	0.083	5.7	100,000	20,000
		Benzo(a)anthracene [e]	0.66	2.6	2.9	6.1
		Benzo(a)pyrene [e]	0.87	0.26	0.29	0.61
		Benzo(b)fluoranthene [e]	0.97	2.6	2.9	6.1
		Benzo(g,h,i)perylene [c]	0.48	100	54,000	NA
		Benzo(k)fluoranthene	0.69	26	29	61
		Carbazole	0.13	95	120	220
		Chrysene	1.1	7.2	62	610
		Dibenz(a,h)anthracene	0.2	0.26	0.29	0.61
		Fluoranthene	1.1	27,000	30,000	2,600
		Indeno(1,2,3-c,d)pyrene	0.47	0.61	0.62	6.1
		Pentachlorophenol	0.045	7.9	11	25
		Phenanthrene [c]	0.43	100	54,000	NE
		Pyrene	1.4	100	54,000	2,000
		TRPH [a]	1,400	NA	NA	4,100
		Metals				
		Arsenic	11.0	2.4	2.7	10
		Barium	276.0	100,000	100,000	5,300
		Beryllium	0.7	1.1	2,200	1.4
		Cadmium	1.0	850	810	38
		Chromium [b]	33.0	450	450	2,100

		Copper	29.7	63,000	76,000	2,800
		Lead	330.0	400	750	400
		Nickel	17.1	34,000	41,000	1,500
		Zinc	76.3	100,000	100,000	23,000
		Cyanide	2.0	35	35	1,300
OU-1	SS-17	BNAs				
		Chrysene	0.20	7.2	62	610
		Di-n-octyl phthalate	0.17	10,000	10,000	1,300
		Fluoranthene	0.23	27,000	30,000	2,600
		Pyrene	0.18	100	54,000	2,000
		PCBs	0.30	0.34	1	2.5
		TRPH [a]	7,000.00	NA	NA	4,100
		Metals				
		Arsenic	12.40	2.4	2.7	10
		Barium	230.00	100,000	100,000	5,300
		Beryllium	2.60	1.1	2,200	1.4
		Cadmium	24.60	850	810	38
		Chromium [b]	28.40	450	450	2,100
		Copper	189.00	63,000	76,000	2,800
		Lead	169.00	400	750	400
		Nickel	20.00	34,000	41,000	1,500
		Silver	2.00	8,500	10,000	380
		Zinc	366.00	100,000	100,000	23,000
		Cyanide	2.50	35	35	1,300
OU-1	SD-20	VOC				
		Toluene	0.10	880	520	790
		BNAs				
		Benzo(a)anthracene [e]	0.30	2.6	2.9	6.1
		Benzo(a)pyrene [e]	0.30	0.26	0.29	0.61
		Benzo(b)fluoranthene [e]	0.32	2.6	2.9	6.1
		Benzo(g,h,i)perylene [c]	0.22	100	54,000	NA
		Bis(2-ethylhexyl)phthalate	0.54	140	180	320
		Chrysene	0.41	7.2	62	610
		Di-n-octylphthalate	0.18	10,000	10,000	1,300
		Fluoranthene	0.65	27,000	30,000	2,600
		Indeno(1,2,3-c,d)pyrene	0.20	0.61	0.62	6.1
		Phenanthrene [c]	0.32	100	54,000	NE
		Pyrene	0.64	100	54,000	2,000
		TRPH [a]	3,700.0	NA	NA	4,100
		Metals				
		Antimony	0.6	NA	820	31
		Arsenic	26.0	2.4	2.7	10
		Barium	532.0	100,000	100,000	5,300
		Beryllium	0.9	1.1	2,200	1.4
		Cadmium	4.3	850	810	38
		Chromium [b]	81.5	450	450	2,100
		Copper	36.2	63,000	76,000	2,800
		Lead	118.0	400	750	400
		Nickel	26.3	34,000	41,000	1,500
		Zinc	157.0	100,000	100,000	23,000
		BNAs				
		Anthracene	0.085	5.7	100,000	20,000
		Benzo(a)anthracene [e]	0.48	2.6	2.9	6.1
		Benzo(b)fluoranthene [e]	1.5	2.6	2.9	6.1
		Benzo(k)fluoranthene	1.4	26	29	61
		Benzo(g,h,i)perylene [c]	0.42	100	54,000	NA
		Benzo(a)pyrene [e]	0.59	0.26	0.29	0.61
		Chrysene	0.67	7.2	62	610
		Dibenzo(a,h)anthracene [e]	0.085	0.26	0.29	0.61

OU-1	SD-21	Fluoranthene	0.97	27,000	30,000	2,600
		Indeno(1,2,3-c,d)pyrene	0.57	0.61	0.62	6.1
		Phenanthrene [c]	0.4	100	54,000	NE
		Pyrene	0.88	100	54,000	2,000
		TRPH [a]	10	NA	NA	4,100
		Metals				
		Arsenic	8.2	2.4	2.7	10
		Barium	148	100,000	100,000	5,300
		Beryllium	0.6	1.1	2,200	1.4
		Cadmium	1.2	850	810	38
		Chromium [b]	19.4	450	450	2,100
		Copper	32.7	63,000	76,000	2,800
		Lead	16	400	750	400
		Nickel	20	34,000	41,000	1,500
		Silver	2	8,500	10,000	380
		Zinc	69.5	100,000	100,000	23,000
OU-1	SD-26	VOCs				
		Ethylbenzene	4	690	230	1,500
		Toluene	3	880	520	790
		Xylenes (total)	18	320	210	2,800
		BNAs				
		2-Methylnaphthalene [d]	6.5	240	190	NE
		Benzo(a)anthracene [e]	0.097	2.6	2.9	6.1
		Benzo(a)pyrene [e]	0.11	0.26	0.29	0.61
		Benzo(b)fluoranthene [e]	0.18	2.6	2.9	6.1
		Benzo(g,h,i)perylene [c]	0.066	100	54,000	NA
		Benzo(k)fluoranthene	0.086	26	29	61
		Bis(2-ethylhexyl)phthalate	1.7	140	180	320
		Chrysene	0.14	7.2	62	610
		Di-n-butylphthalate	7.3	68,000	88,000	6,500
		Fluoranthene	0.23	27,000	30,000	2,600
		Indeno(1,2,3-cd)pyrene	0.053	0.61	0.62	6.1
		Naphthalene	1.7	240	190	2,600
		Phenanthrene [c]	0.085	100	54,000	NE
		Pyrene	0.23	100	54,000	2,000
		TRPH [a]	19,000	NA	NA	4,100
		Metals				
		Arsenic	20	2.4	2.7	10
		Barium	742	100,000	100,000	5,300
		Beryllium	0.8	1.1	2,200	1.4
		Cadmium	3.7	850	810	38
		Chromium [b]	41.6	450	450	2,100
		Copper	35.1	63,000	76,000	2,800
		Lead	20	400	750	400
		Nickel	21	34,000	41,000	1,500
		Silver	1.4	8,500	10,000	380
		Zinc	199	100,000	100,000	23,000
OU-1	LF-37	BNAs				
		Benzo(a)anthracene [e]	0.054	2.6	2.9	6.1
		Benzo(a)pyrene [e]	0.425	0.26	0.29	0.61
		Benzo(b)fluoranthene [e]	0.425	2.6	2.9	6.1
		Benzo(g,h,i)perylene [c]	0.425	100	54,000	NA
		Benzo(k)fluoranthene	0.425	26	29	61
		Bis(2-ethylhexyl)phthalate	0.425	140	180	320
		Butylbenzylpthalate	1.2	930	100,000	13,000
		Chrysene	0.062	7.2	62	610
		Fluoranthene	0.425	27,000	30,000	2,600
		Pyrene	0.425	100	54,000	2,000
		TRPH [a]	540	NA	NA	4,100
		Metals				

		Arsenic	9.6	2.4	2.7	10
		Barium	334	100,000	100,000	5,300
		Beryllium	0.8	1.1	2,200	1.4
		Cadmium	29.5	850	810	38
		Chromium [b]	28.2	450	450	2,100
		Copper	561	63,000	76,000	2,800
		Lead	597	400	750	400
		Nickel	58.5	34,000	41,000	1,500
		Silver	3.4	8,500	10,000	380
		Zinc	2,270	100,000	100,000	23,000
OU-1	SD-39	<u>BNA</u>				
		Diethyl phthalate	0.042	100,000	100,000	52,000
		<u>TRPH</u> [a]	2,000	NA	NA	4,100
		<u>Metals</u>				
		Arsenic	14	2.4	2.7	10
		Barium	220	100,000	100,000	5,300
		Cadmium	1.6	850	810	38
		Chromium [b]	22.5	450	450	2,100
		Copper	40.1	63,000	76,000	2,800
		Lead	125	400	750	400
		Nickel	25	34,000	41,000	1,500
		Zinc	62.8	100,000	100,000	23,000
OU-1	OT-41	<u>Metal</u>				
		Lead	22	400	750	400
OU-1	OT-01 OT-08 OT-09	An extensive data review of base records indicated that hazardous materials and wastes were never handled or disposed at these locations.				
OU-1	OT-10	This site lies completely within the boundaries of DP-13.				
OU-1	SS-15 SS-16 ST-19	These three sites were removed from the superfund process and placed under the ADEQ UST jurisdiction.				
OU-1	DP-24	Removed from the Superfund process because this site was mistakenly included on the list of potentially contaminated sites.				

[a] n-Hexane us used as a surrogate for comparison to the Region IX PRG.

[b] The chromium PRG is based on total chromium carcinogenic effects and a 1:6 ratio of chromium IV to chromium III.

[c] Pyrene is used as a surrogate for comparison to the Region IX PRG.

[d] Napthalene is used as a surrogate for comparison to the Region IX PRG.

[e] The PRG is based on naphthalene non-carcinogenic effects.

NE Not Established

NA Not Available

SRL g)
Non-Residential
1,400
140,000
18,000
63,000
2,000
2,700
2,800
1,400
NE
27,000
18,000
63,000
2,000
NA
2,700
400
11
170
2,700
70
2,800
41,000
200,000
26
26
260
NA
2.6
1,400
140,000
2,600
26
2,700
68,000
27,000
27,000
26
NE
3,400
27,000
79
NE
410,000
20,000
18,000

63,000
2,000

26
NA
1,400
2,600
27,000
NE
27,000
20,000
18,000

63,000
2,000

8,800
18,000

63,000
2,000

8,800
1.4
2,700
2,700
2,800

NE
27,000
18,000

63,000
2,000
13

NE
200,000
26
2.6
26
NA
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950
2,600
26
27,000
26
79
NE
20,000
18,000

10
110,000
11
850
4,500

63,000
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34,000
510,000

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20,000

13

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4,500
63,000
2,000
34,000
8,500
510,000

14,000

2,700

26
2.6
26
NA
1,400
2,600
14,000
27,000
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NE
20,000

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34,000
8,500
510,000
550,000
18,000
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850
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63,000
2,000
34,000
510,000
2,000

Appendix D

USEPA Region IX PRGs for 1991, 1996 and 2000

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NOV 0 9 2001
ARCADIS Geraghty & Miller

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, CA 94105-3901

RECEIVED
AUG 27 1996
G & M RALEIGH

August 1, 1996

Subject: Region 9 Preliminary Remediation Goals (PRGs) 1996

From: Stanford J. Smucker, Ph.D.
Regional Toxicologist (H-9-3)
Technical Support Team

To: PRG Table Mailing List

Please find the annual update to the Region 9 PRG table. The table has been revised to reflect the most current EPA toxicological and risk assessment information. Updates to EPA toxicity values were obtained from IRIS through July 1996, HEAST through May 1995, and EPA's National Center for Environmental Assessment (NCEA, formerly ECAO).

Region 9 PRGs are "evergreen" and have evolved as new methodologies and parameters have been developed. In several cases the models, equations, and assumptions presented in RAGS HHEM, *Part B, Development of Risk-Based Preliminary Remediation Goals* (1991) have been replaced with new information that is consistent with the document, *Soil Screening Guidance*, recently issued by the Office of Solid Waste and Emergency Response (OSWER), dated April 1996.

The updated PRG table also contains soil screening levels (SSLs) for protection of groundwater. The SSLs were obtained directly from EPA/OSWER's *Soil Screening Guidance* document which is available from NTIS as EPA/540/R-96/018 and EPA/540/R-95/128. Please note that because R 9 PRGs currently evaluate intermedia transfer of volatile organic chemicals (VOCs) and heavy metals from soil to air, the PRG table does not include a separate list of SSLs for the air pathway.

To help users rapidly identify substances with new PRGs, these contaminants are printed in boldface type. Changes in PRG values are either due to new toxicity constants or new physico-chemical information. This version of the table contains revised toxicity values for acetaldehyde, chlorine cyanide, 1,3-dichlorobenzene, 2-dichloroethane, endosulfan, manganese, phosphoric acid, and 1,1,1-trichloroethane. Also, 23 additional VOCs have been identified and evaluated for inhalation exposures resulting from intermedia transfer from soil and water to air.

EPA Region 9 has established a homepage on the World Wide Web which you can find at http://www.epa.gov/region 9/. Our homepage will soon include the PRG table in downloadable form. The electronic table contains additional information not presented in the printed table (e.g. physico-chemical constants, non-cancer PRGs for carcinogens, pathway-specific PRGs, and volatilization factors for VOCs). Meanwhile, we still provide the electronic PRG table (PRG96.zip) on California Regional Water Board's BBS (510.286.0404) for those of you who have a modem.

Before relying on any number in the table, it is recommended that the user verify the numbers with an agency toxicologist or risk assessor because the toxicity / exposure information in the table may contain errors or default assumptions that need to be refined based on further evaluation. If you find an error please send me a note via email at Smucker.Stan@epamail.epa.gov or fax at 415.744.1916.

EXHIBIT 1-1
TYPICAL EXPOSURE PATHWAYS BY MEDIUM FOR RESIDENTIAL AND INDUSTRIAL LAND USES[a]

EXPOSURE PATHWAYS, ASSUMING:		
MEDIUM	RESIDENTIAL LAND USE	INDUSTRIAL LAND USE
Ground Water	***Ingestion from drinking***	Ingestion from drinking
	Inhalation of volatiles	Inhalation of volatiles
	Dermal absorption from bathing	Dermal absorption
Surface Water	***Ingestion from drinking***	Ingestion from drinking
	Inhalation of volatiles	Inhalation of volatiles
	Dermal absorption from bathing	Dermal absorption
	Ingestion during swimming	
	Ingestion of contaminated fish	
Soil	***Ingestion***	***Ingestion***
	Inhalation of particulates	***Inhalation of particulates***
	Inhalation of volatiles	***Inhalation of volatiles***
	Exposure to indoor air from soil gas	Exposure to indoor air from soil gas
	Exposure to ground water contaminated by soil leachate	Exposure to ground water contaminated by soil leachate
	Ingestion via plant, meat, or dairy products	Inhalation of particulates from trucks and heavy equipment
	Dermal absorption	***Dermal absorption***

Footnote:

[a] Exposure pathways considered in the PRG calculations are indicated in boldface italics.

pollutant risks.

In addition to Region 9 PRGs, the PRG table also includes California EPA PRGs ("CAL-Modified PRGs") for specific chemicals where CAL-EPA values may be more restrictive than the federal values; and, soil screening levels (SSLs) for protection of groundwater (see Section 2.3 below).

2.2 Toxicity Values

EPA toxicity values, known as noncarcinogenic reference doses (RfD) and carcinogenic slope factors (SF) were obtained from IRIS through July 1996, HEAST through May 1995, and EPA's National Center for Environmental Assessment (NCEA, formerly ECAO). The priority among sources of toxicological constants used are as follows: (1) IRIS (indicated by "i"), (2) HEAST ("h"), (3) NCEA ("n"), and (4) withdrawn from IRIS or HEAST and under review ("x").

Route-to-route extrapolations ("r") were frequently used when there were no toxicity values available for a given route of exposure. Oral cancer slope factors ("SFo") and reference doses ("RfDo") were used for both oral and inhaled exposures for organic compounds lacking inhalation values. Inhalation slope factors ("SFi") and inhalation reference doses ("RfDi") were used for both inhaled and oral exposures for organic compounds lacking oral values. An additional route extrapolation is the use of oral toxicity values for evaluating dermal exposures. **Although route-to-route methods are a useful screening procedure, the appropriateness of these default assumptions for specific contaminants should be verified by a toxicologist.**

To help users rapidly identify substances with new PRGs, these contaminants are printed in boldface type. This version of the table contains revised toxicity values for acetaldehyde, chlorine cyanide, 1,3-dichlorobenzene, 2-dichloroethane, endosulfan, manganese, phosphoric acid, and 1,1,1-trichloroethane.

2.3 Soil Screening Levels

Generic soil screening levels (SSLs) for the protection of groundwater have been included in the PRG table for 100 of the most common contaminants at Superfund sites. Generic SSLs are derived using default values in standardized equations presented in *Soil Screening Guidance* (available from NTIS as document numbers PB96-963502 and PB96-963505 or EPA/540/R-95/128 and EPA/540/R-96/018).

The SSLs were developed using a default dilution-attenuation factor (DAF) of 20 to account for natural processes that reduce contaminant concentrations in the subsurface. Also included are generic SSLs that assume no dilution or attenuation between the source and the receptor well (i.e., a DAF of 1). These values can be used at sites where little or no dilution or attenuation of soil leachate concentrations is expected at a site (e.g., sites with shallow water

3.1 Developing a Conceptual Site Model

The primary condition for use of PRGs is that exposure pathways of concern and conditions at the site match those taken into account by the PRG framework. Thus, it is always necessary to develop a conceptual site model (CSM) to identify likely contaminant source areas, exposure pathways, and potential receptors. This information can be used to determine the applicability of PRGs at the site and the need for additional information. For those pathways not covered by PRGs, a risk assessment specific to these additional pathways may be necessary. Nonetheless, the PRG lookup values will still be useful in such situations for focusing further investigative efforts on the exposure pathways not addressed.

To develop a site-specific CSM, perform an extensive records search and compile existing data (e.g. available site sampling data, historical records, aerial photographs, and hydrogeologic information). Once this information is obtained, CSM worksheets such as those provided in ASTM's *Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites* (1995) can be used to tailor the generic worksheet model to a site-specific CSM. The final CSM diagram represents linkages among contaminant sources, release mechanisms, exposure pathways and routes and receptors. It summarizes our understanding of the contamination problem.

As a final check, the CSM should answer the following questions:

- Are there potential ecological concerns?
- Is there potential for land use other than those covered by the PRGs (that is, residential and industrial)?
- Are there other likely human exposure pathways that were not considered in development of the PRGs (e.g. impact to groundwater, local fish consumption; raising beef, dairy, or other livestock)?
- Are there unusual site conditions (e.g. large areas of contamination, high fugitive dust levels, potential for indoor air contamination)?

If any of these four conditions exist, the PRG may need to be adjusted to reflect this new information. Suggested references for evaluating pathways not currently evaluated by Region 9 PRG's are presented in Exhibit 3-1.

consulting a staff toxicologist at state and / or federal regulatory agencies.

Where anthropogenic background levels exceed PRGs and EPA has determined that a response action is necessary and feasible, EPA's goal will be to develop a comprehensive response to the widespread contamination. This will often require coordination with different authorities that have jurisdiction over the sources of contamination in the area.

3.3 Risk Screening

A suggested stepwise approach for screening sites with PRGs is as follows:

- Perform an extensive records search and compile existing data.
- Identify site contaminants in the PRG Table. Record the PRG concentrations for various media and note whether PRG is based on cancer risk (indicated by "ca") or noncancer hazard (indicated by "nc"). Segregate cancer PRGs from non-cancer PRGs and exclude (but don't eliminate) non-risk based PRGs ("sat" or "max").
- For cancer risk estimates, take the site-specific concentration (maximum or 95 UCL) and divide by the PRG concentrations that are designated for cancer evaluation ("ca"). Multiply this ratio by 10^{-6} to estimate chemical-specific risk. For multiple pollutants, simply add the risk for each chemical :

$$Risk = [(\frac{conc_x}{PRG_x}) + (\frac{conc_y}{PRG_y}) + (\frac{conc_z}{PRG_z})] \times 10^{-6}$$

- For non-cancer hazard estimates. Divide concentration term by its respective non-cancer PRG designated as "nc" and sum the ratios for multiple contaminants. [Note that carcinogens may also have an associated non-cancer PRG that is not listed in the printed copy of the table and these will also need to be obtained in order to complete the non-cancer evaluation.] The non-cancer ratio represents a hazard index (HI). A hazard index of 1 or less is generally considered safe . A ratio greater than 1 suggests further evaluation:

$$Hazard\ Index = [(\frac{conc_x}{PRG_x}) + (\frac{conc_y}{PRG_y}) + (\frac{conc_z}{PRG_z})]$$

For more information on screening site risks, the reader should contact EPA Region 9's Technical Support Team.

Document (USEPA 1996a,b).

To address the soil-to-air pathways the PRG calculations incorporate volatilization factors (VF_s) for volatile contaminants and particulate emission factors (PEF) for nonvolatile contaminants. These factors relate soil contaminant concentrations to air contaminant concentrations that may be inhaled on-site. The VF_s and PEF equations can be broken into two separate models: an emission model to estimate emissions of the contaminant from the soil and a dispersion model to simulate the dispersion of the contaminant in the atmosphere.

It should be noted that the box model in RAGS Part B has been replaced with a dispersion term (Q/C) derived from a modeling exercise using meteorological data from 29 locations across the United States because the box model may not be applicable to a broad range of site types and meteorology and does not utilize state-of-the-art techniques developed for regulatory dispersion modeling. The dispersion model for both volatiles and particulates is the AREA-ST, an updated version of the Office of Air Quality Planning and Standards, Industrial Source Complex Model, ISC2. However, different Q/C terms are used in the VF and PEF equations. Los Angeles was selected as the 90th percentile data set for volatiles and Minneapolis was selected as the 90th percentile data set for fugitive dusts (USEPA 1996 a,b). A default source size of 0.5 acres was chosen for the PRG calculations. This is consistent with the default exposure area over which Region 9 typically averages contaminant concentrations in soils. If unusual site conditions exist such that the area source is substantially larger than the default source size assumed here, an alternative Q/C could be applied (see USEPA 1996a,b).

Volatilization Factor for Soils

Volatile chemicals, defined as those chemicals having a Henry's Law constant greater than 10^{-5} (atm-m^3/mol) and a molecular weight less than 200 g/mole, were screened for inhalation exposures using a volatilization factor for soils (VF_s). Please note that VF_s's are available in the electronic version of the PRG table.

The emission terms used in the VF_s are chemical-specific and were calculated from physical-chemical information obtained from a number of sources including *Superfund Exposure Assessment Manual* (SEAM, EPA 1988), *Subsurface Contamination Reference Guide* (EPA 1990a), *Fate and Exposure Data* (Howard 1991), and *Superfund Chemical Data Matrix* (USEPA 1994c). In those cases where Diffusivity Coefficients (Di) were not provided in existing literature, Di's were calculated using Fuller's Method described in SEAM. A surrogate term was required for some chemicals that lacked physico-chemical information. In these cases, a proxy chemical of similar structure was used that may over- or under-estimate the PRG for soils. Physico-chemical information is available in the electronic version of the PRG table. To access this information, the user should display the hidden columns in the table.

Equation 4-9 forms the basis for deriving generic soil PRGs for the inhalation pathway. The following parameters in the standardized equation can be replaced with specific site data to

Note: the generic PEF evaluates windborne emissions and does not consider dust emissions from traffic or other forms of mechanical disturbance that could lead to greater emissions than assumed here.

4.2 Dermal Contact with Contaminants in Soil

Much uncertainty surrounds the determination of hazards associated with skin contact with soils. One important data gap is the lack of EPA verified toxicity values for the dermal route. For screening purposes it is assumed that dermal toxicity values can be route-to-route extrapolated from oral values but this may not always be an appropriate assumption and should be checked.

Thus far, chemical-specific absorption values for skin have been recommended for only five chemicals (arsenic, cadmium, pentachlorophenol, PCBs, and dioxin) by EPA's Office of Research and Development. For all other chemicals, default absorption values for inorganics and organics are assumed to be 1 and 10 percent, respectively. At 10 % skin absorption, the dermal dose is estimated to equal an ingestion dose for adults, using the best estimate default values in *Dermal Exposure Assessment: Principles and Applications* (EPA 1992). At 1 % absorption, the dermal dose is estimated to be 10% of the oral dose (i.e. based on an adult ingestion rate of 100 mg per day). Note: worker and children intake rates (50 and 200 mg per day, respectively) yield somewhat different results.

dermal dose = ingestion dose

$$C_{SOIL} \times ABS \times AF \times SA = C_{SOIL} \times IR$$

$$ABS = \frac{(100 mg/day)}{[(0.2 mg/cm^2\text{-}day)(5000 cm^2)]} = 0.10$$

4.3 SSLs for the Migration to Groundwater Pathway

The methodology for calculating SSLs for the migration to groundwater was developed to identify chemical concentrations in soil that have the potential to contaminate groundwater. Migration of contaminants from soil to groundwater can be envisioned as a two-stage process: (1) release of contaminant in soil leachate and (2) transport of the contaminant through the underlying soil and aquifer to a receptor well. The SSL methodology considers both of these fate and transport mechanisms.

SSLs are backcalculated from acceptable ground water concentrations (i.e. nonzero MCLGs, MCLs, or risk-based PRGs). First, the acceptable groundwater concentration is multiplied by a dilution factor to obtain a target leachate concentration. For example, if the dilution factor

(2) skin contact([mg•yr]/[kg•d]:

$$SFS_{adj} = \frac{ED_c \times AF \times SA_c}{BW_c} + \frac{(ED_r - ED_c) \times AF \times SA_a}{BW_a}$$

(3) inhalation ([m^3•yr]/[kg•d]):

$$InhF_{adj} = \frac{ED_c \times IRA_c}{BW_c} + \frac{(ED_r - ED_c) \times IRA_a}{BW_a}$$

4.5 PRG Equations

The equations used to calculate the PRGs for carcinogenic and noncarcinogenic contaminants are presented in Equations 4-1 through 4-8. The PRG equations update RAGS Part B equations. Briefly, PRGs are risk assessments run in reverse. The methodology backcalculates a soil, air, or water concentration level from a target risk (for carcinogens) or hazard quotient (for noncarcinogens). For completeness, the soil equations combine risks from ingestion, skin contact, and inhalation simultaneously. Note: the electronic version of the table also includes pathway-specific PRGs, should the user decide against combining specific exposure pathways; or, the user wants to identify the relative contribution of each pathway to exposure.

To calculate PRGs for volatile chemicals in soil, a chemical-specific volatilization factor is calculated per Equation 4-9. Because of its reliance on Henry's law, the VF_s model is applicable only when the contaminant concentration in soil is at or below saturation (i.e. there is no free-phase contaminant present): Soil saturation ("sat") corresponds to the contaminant concentration in soil at which the adsorptive limits of the soil particles and the solubility limits of the available soil moisture have been reached. Above this point, pure liquid-phase contaminant is expected in the soil. If the PRG calculated using VF_s was greater than the calculated sat, the PRG was set equal to sat, in accordance with *Soil Screening Guidance* (USEPA 1996 a,b). The updated equation for deriving sat is presented in Equation 4-10.

PRG EQUATIONS

Soil Equations: For soils, equations were based on three exposure routes (ingestion, skin contact, and inhalation).

Equation 4-1: Combined Exposures to Carcinogenic Contaminants in Residential Soil

$$C(mg/kg) = \frac{TR \times AT_c}{EF_r\ [(\frac{IFS_{adj} \times CSF_o}{10^6 mg/kg}) + (\frac{SFS_{adj} \times ABS \times CSF_o}{10^6 mg/kg}) + (\frac{InhF_{adj} \times CSF_i}{VF_s^a})]}$$

Equation 4-2: Combined Exposures to Noncarcinogenic Contaminants in Residential Soil

$$C(mg/kg) = \frac{THQ \times BW_c \times AT_n}{EF_r \times ED_c\ [(\frac{1}{RfD_o} \times \frac{IRS_c}{10^6 mg/kg}) + (\frac{1}{RfD_o} \times \frac{SA_c \times AF \times ABS}{10^6 mg/kg}) + (\frac{1}{RfD_i} \times \frac{IRA_c}{VF_s^a})]}$$

Equation 4-3: Combined Exposures to Carcinogenic Contaminants in Industrial Soil

$$C(mg/kg) = \frac{TR \times BW_a \times AT_c}{EF_o \times ED_o\ [(\frac{IRS_o \times CSF_o}{10^6 mg/kg}) + (\frac{SA_a \times AF \times ABS \times CSF_o}{10^6 mg/kg}) + (\frac{IRA_a \times CSF_i}{VF_s^a})]}$$

Equation 4-4: Combined Exposures to Noncarcinogenic Contaminants in Industrial Soil

$$C(mg/kg) = \frac{THQ \times BW_a \times AT_n}{EF_o \times ED_o[(\frac{1}{RfD_o} \times \frac{IRS_o}{10^6 mg/kg}) + (\frac{1}{RfD_o} \times \frac{SA_a \times AF \times ABS}{10^6 mg/kg}) + (\frac{1}{RfD_i} \times \frac{IRA_a}{VF_s^a})]}$$

Footnote:

[a] Use VF_s for volatile chemicals (defined as having a Henry's Law Constant [atm-m^3/mol] greater than 10^{-5} and a molecular weight less than 200 grams/mol) or PEF for non-volatile chemicals.

SOIL-TO-AIR VOLATILIZATION FACTOR (VF_s)

Equation 4-9: Derivation of the Volatilization Factor

$$VF_s(m^3/kg) = (Q/C) \times \frac{(3.14 \times D_A \times T)^{1/2}}{(2 \times \rho_b \times D_A)} \times 10^{-4}(m^2/cm^2)$$

where:

$$D_A = \frac{[(\Theta_a^{10/3} D_i H' + \Theta_w^{10/3} D_w)/n^2]}{\rho_B K_d + \Theta_w + \Theta_a H'}$$

Parameter	Definition (units)	Default
VF_s	Volatilization factor (m^3/kg)	–
D_A	Apparent diffusivity (cm^2/s)	–
Q/C	Inverse of the mean conc. at the center of a 0.5-acre square source (g/m^2-s per kg/m^3)	68.81
T	Exposure interval (s)	9.5×10^8
ρ_b	Dry soil bulk density (g/cm^3)	1.5
Θ_a	Air filled soil porosity (L_{air}/L_{soil})	0.28 or $n-\Theta_w$
n	Total soil porosity (L_{pore}/L_{soil})	0.43 or $1 - (\rho_b/\rho_s)$
Θ_w	Water-filled soil porosity (L_{water}/L_{soil})	0.15
ρ_s	Soil particle density (g/cm^3)	2.65
Di	Diffusivity in air (cm^2/s)	Chemical-specific
H	Henry's Law constant (atm-m^3/mol)	Chemical-specific
H'	Dimensionless Henry's Law constant	Calculated from H by multiplying by 41 (USEPA 1991a)
D_w	Diffusivity in water (cm^2/s)	Chemical-specific
K_d	Soil-water partition coefficient (cm^3/g) = $K_{oc}f_{oc}$	Chemical-specific
K_{oc}	Soil organic carbon-water partition coefficient (cm^3/g)	Chemical-specific
f_{oc}	Fraction organic carbon in soil (g/g)	0.006 (0.6%)

SOIL-TO-AIR PARTICULATE EMISSION FACTOR (PEF)

Equation 4-11: Derivation of the Particulate Emission Factor

$$PEF(m^3/kg) = Q/C \; x \; \frac{3600 s/h}{0.036 \; x \; (1-V) \; x \; (U_m/U_t)^3 \; x \; F(x)}$$

Parameter	Definition (units)	Default
PEF	Particulate emission factor (m^3/kg)	1. 316 x 10^9
Q/C	Inverse of the mean concentration at the center of a 0.5-acre-square source (g/m^2-s per kg/m^3)	90.80
V	Fraction of vegetative cover (unitless)	0.5
U_m	Mean annual windspeed (m/s)	4.69
U_t	Equivalent threshold value of windspeed at 7 m (m/s)	11.32
F(x)	Function dependent on U_m/U_t derived using Cowherd (1985) (unitless)	0.194

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Key: i=IRIS h=HEAST n=NCEA x=WITHDRAWN r=ROUTE EXTRAPOLATION ca=CANCER PRG nc=NONCANCER PRG sat=SOIL SATURATION max=CEILING LIMIT *(where: nc < 100X ca) **(where: nc < 10X ca)

FOR PLANNING PURPOSES

TOXICITY INFORMATION							CONTAMINANT	PRELIMINARY REMEDIAL GOALS (PRGs)				SOIL SCREENING LEVELS Migration to Ground Water	
SFo 1/(mg/kg-d)	RfDo (mg/kg-d)	SFi 1/(mg/kg-d)	RfDi (mg/kg-d)	VOC	skin abs. soils	CAS No.		Residential Soil (mg/kg)	Industrial Soil (mg/kg)	Ambient Air (ug/m^3)	Tap Water (ug/l)	DAF 20 (mg/kg)	DAF 1 (mg/kg)
8.7E-03 i	4.0E-03 i	8.7E-03 r	4.0E-03 r	0	0.10	30560-19-1	Acephate	5.1E+01 ca**	2.2E+02 ca*	7.7E-01 ca*	7.7E+00 ca*		
7.7E-03 r	2.6E-03 r	7.7E-03 i	2.6E-03 i	1	0.10	75-07-0	Acetaldehyde	9.2E+00 ca**	2.1E+01 ca**	8.7E-01 ca*	1.5E+00 ca*		
	2.0E-02 i		2.0E-02 r	0	0.10	34256-82-1	Acetochlor	1.3E+03 nc	1.4E+04 nc	7.3E+01 nc	7.3E+02 nc		
	1.0E-01 i		1.0E-01 r	1	0.10	67-64-1	Acetone	2.1E+03 nc	8.8E+03 nc	3.7E+02 nc	6.1E+02 nc	1.6E+01	8.0E-01
	8.0E-04 h		2.9E-03 x	0	0.10	75-86-5	Acetone cyanohydrin	5.2E+01 nc	5.5E+02 nc	1.0E+01 nc	2.9E+01 nc		
	6.0E-03 i		1.4E-02 h	1	0.10	75-05-8	Acetonitrile	2.2E+02 nc	1.2E+03 nc	5.2E+01 nc	7.1E+01 nc		
	1.0E-01 i		5.7E-06 x	1	0.10	98-86-2	Acetophenone	4.9E-01 nc	1.6E+00 nc	2.1E-02 nc	4.2E-02 nc		
	1.3E-02 i		1.3E-02 r	0	0.10	50594-66-6	Acifluorfen	8.5E+02 nc	8.9E+03 nc	4.7E+01 nc	4.7E+02 nc		
	2.0E-02 h		5.7E-06 i	1	0.10	107-02-8	Acrolein	1.0E-01 nc	3.4E-01 nc	2.1E-02 nc	4.2E-02 nc		
4.5E+00 i	2.0E-04 i	4.5E+00 i	2.0E-04 r	0	0.10	79-06-1	Acrylamide	9.8E-02 ca*	4.2E-01 ca	1.5E-03 ca	1.5E-02 ca		
	5.0E-01 i		2.9E-04 i	0	0.10	79-10-7	Acrylic acid	3.1E+04 nc	2.9E+05 nc	1.0E+00 nc	1.8E+04 nc		
5.4E-01 i	1.0E-03 h	2.4E-01 i	5.7E-04 i	1	0.10	107-13-1	Acrylonitrile	1.9E-01 ca*	4.7E-01 ca*	2.8E-02 ca*	3.7E+00 ca*		
8.1E-02 h	1.0E-02 i	8.0E-02 r	1.0E-02 r	0	0.10	15972-60-8	Alachlor	5.5E+00 ca*	2.4E+01 ca	8.4E-02 ca	8.4E-01 ca		
	1.5E-01 i		1.5E-01 r	0	0.10	1596-84-5	Alar	9.8E+03 nc	1.0E+05 nc	5.5E+02 nc	5.5E+03 nc		
	1.0E-03 i		1.0E-03 r	0	0.10	116-06-3	Aldicarb	6.5E+01 nc	6.8E+02 nc	3.7E+00 nc	3.7E+01 nc		
	1.0E-03 i		1.0E-03 r	0	0.10	1646-88-4	Aldicarb sulfone	6.5E+01 nc	6.8E+02 nc	3.7E+00 nc	3.7E+01 nc		
1.7E+01 i	3.0E-05 i	1.7E+01 i	3.0E-05 r	0	0.10	309-00-2	Aldrin	2.6E-02 ca*	1.1E-01 ca	3.9E-04 ca	4.0E-03 ca	1.2E+04	5.9E+02
	2.5E-01 i		2.5E-01 r	0	0.10	5585-64-8	Ally	1.6E+04 nc	1.0E+05 max	9.1E+02 nc	9.1E+03 nc		
	5.0E-03 x		5.0E-03 r	0	0.10	107-18-6	Allyl alcohol	3.3E+02 nc	3.4E+03 nc	1.8E+01 nc	1.8E+02 nc		
	5.0E-02 h		2.9E-04 i	0	0.10	107-05-1	Allyl chloride	3.2E+03 nc	3.3E+04 nc	1.0E+00 nc	1.8E+03 nc		
	1.0E+00 n			0	0.01	7429-90-5	Aluminum	7.7E+04 nc	1.0E+05 max		3.7E+04 nc		
	4.0E-04 i			0	0.01	20859-73-8	Aluminum phosphide	3.1E+01 nc	6.8E+02 nc		1.5E+01 nc		
	3.0E-04 i		3.0E-04 r	0	0.10	67485-29-4	Amdro	2.0E+01 nc	2.0E+02 nc	1.1E+00 nc	1.1E+01 nc		
	9.0E-03 i		9.0E-03 r	0	0.10	834-12-8	Ametryn	5.9E+02 nc	6.1E+03 nc	3.3E+01 nc	3.3E+02 nc		
	7.0E-02 h		7.0E-02 r	0	0.10	591-27-5	m-Aminophenol	4.6E+03 nc	4.8E+04 nc	2.6E+02 nc	2.6E+03 nc		
	2.0E-05 h		2.0E-05 r	0	0.10	504-24-5	4-Aminopyridine	1.3E+00 nc	1.4E+01 nc	7.3E-02 nc	7.3E-01 nc		
	2.5E-03 i		2.5E-03 r	0	0.10	33089-61-1	Amitraz	1.6E+02 nc	1.7E+03 nc	9.1E+00 nc	9.1E+01 nc		
			2.9E-02 i	n/a	n/a	7664-41-7	Ammonia			1.0E+02 nc			
	2.0E-01 i			0	0.10	7773-06-0	Ammonium sulfamate	1.3E+04 nc	1.0E+05 max		7.3E+03 nc		
5.7E-03 i	2.9E-04 r	5.7E-03 r	2.9E-04 i	0	0.10	62-53-3	Aniline	1.9E+01 nc	2.0E+02 nc	1.0E+00 nc	1.1E+01 nc		
	4.0E-04 i			0	0.01	7440-36-0	Antimony and compounds	3.1E+01 nc	6.8E+02 nc		1.5E+01 nc	5.0E+00	3.0E-01
	5.0E-04 h			0	0.01	1314-60-9	Antimony pentoxide	3.8E+01 nc	8.5E+02 nc		1.8E+01 nc		
	9.0E-04 h			0	0.01	28300-74-5	Antimony potassium tartrate	6.9E+01 nc	1.5E+03 nc		3.3E+01 nc		
	4.0E-04 h			0	0.01	1332-81-6	Antimony tetroxide	3.1E+01 nc	6.8E+02 nc		1.5E+01 nc		
	4.0E-04 h			0	0.01	1309-64-4	Antimony trioxide	3.1E+01 nc	6.8E+02 nc		1.5E+01 nc		
	1.3E-02 i		1.3E-02 r	0	0.10	74115-24-5	Apollo	8.5E+02 nc	8.9E+03 nc	4.7E+01 nc	4.7E+02 nc		
2.5E-02 i	5.0E-02 h	2.5E-02 i	5.0E-02 r	0	0.10	140-57-8	Aramite	1.8E+01 ca*	7.6E+01 ca	2.7E-01 ca	2.7E+00 ca		
	3.0E-04 i			0	0.03	7440-38-2	Arsenic (noncancer endpoint)	2.2E+01 nc					
1.5E+00 i	3.0E-04 i	1.5E+01 i		0	0.03	7440-38-2	Arsenic (cancer endpoint)	3.8E-01 ca*	2.4E+00 ca	4.5E-04 ca	4.5E-02 ca	2.9E+01	1.0E+00
			1.4E-05 i	n/a	n/a	7784-42-1	Arsine			5.2E-02 nc			
	9.0E-03 i		9.0E-03 r	0	0.10	76578-12-6	Assure	5.9E+02 nc	6.1E+03 nc	3.3E+01 nc	3.3E+02 nc		
	5.0E-02 i		5.0E-02 r	0	0.10	3337-71-1	Asulam	3.3E+03 nc	3.4E+04 nc	1.8E+02 nc	1.8E+03 nc		
2.2E-01 h	3.5E-02 h	2.2E-01 r	3.5E-02 h	0	0.10	1912-24-9	Atrazine	2.0E+00 ca	8.6E+00 ca	3.1E-02 ca	3.0E-01 ca		
	4.0E-04 i		4.0E-04 r	0	0.10	71751-41-2	Avermectin B1	2.6E+01 nc	2.7E+02 nc	1.5E+00 nc	1.5E+01 nc		
1.1E-01 i		1.1E-01 i		0	0.10	103-33-3	Azobenzene	4.0E+00 ca	1.7E+01 ca	6.2E-02 ca	6.1E-01 ca		
	7.0E-02 i		1.4E-04 h	0	0.01	7440-39-3	Barium and compounds	5.3E+03 nc	1.0E+05 max	5.2E-01 nc	2.6E+03 nc	1.6E+03	8.2E+01
	4.0E-03 i		4.0E-03 r	0	0.10	114-26-1	Baygon	2.6E+02 nc	2.7E+03 nc	1.5E+01 nc	1.5E+02 nc		

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FOR PLANNING PURPOSES

TOXICITY INFORMATION							CONTAMINANT	PRELIMINARY REMEDIAL GOALS (PRGs)				SOIL SCREENING LEVELS	
												Migration to Ground Water	
SFo 1/(mg/kg-d)	RfDo (mg/kg-d)	SFi 1/(mg/kg-d)	RfDi (mg/kg-d)	VOC	skin abs. soils	CAS No.		Residential Soil (mg/kg)	Industrial Soil (mg/kg)	Ambient Air (ug/m^3)	Tap Water (ug/l)	DAF 20 (mg/kg)	DAF 1 (mg/kg)
	1.0E-02 I		1.0E-02 r	0	0.10	55285-14-8	Carbosulfan	6.5E+02 nc	6.8E+03 nc	3.7E+01 nc	3.7E+02 nc		
	1.0E-01 I		1.0E-01 r	0	0.10	5234-68-4	Carboxin	6.5E+03 nc	6.8E+04 nc	3.7E+02 nc	3.7E+03 nc		
	2.0E-03 I		2:0E-03 r	0	0.10	302-17-0	Chloral	1.3E+02 nc	1.4E+03 nc	7.3E+00 nc	7.3E+01 nc		
	1.5E-02 I		1.5E-02 r	0	0.10	133-90-4	Chloramben	9.8E+02 nc	1.0E+04 nc	5.5E+01 nc	5.5E+02 nc		
4.0E-01 h		4.0E-01 r		0	0.10	118-75-2	Chloranil	1.1E+00 ca	4.7E+00 ca	1.7E-02 ca	1.7E-01 ca		
1.3E+00 I	6.0E-05 I	1.3E+00 I	6.0E-05 r	0	0.10	57-74-9	Chlordane	3.4E-01 ca**	1.5E+00 ca*	5.2E-03 ca*	5.2E-02 ca*	1.0E+01	5.0E-01
	2.0E-02 I		2.0E-02 r	0	0.10	90982-32-4	Chlorimuron-ethyl	1.3E+03 nc	1.4E+04 nc	7.3E+01 nc	7.3E+02 nc		
	1.0E-01 I			0	0.01	7782-50-5	Chlorine	7.7E+03 nc	1.7E+05 nc		3.7E+03 nc		
			5.7E-05 I	n/a	n/a	10049-04-4	Chlorine dioxide			2.1E-01 nc			
				1	0.10	107-20-0	Chloroacetaldehyde						
	2.0E-03 h		2.0E-03 r	0	0.10	79-11-8	Chloroacetic acid	1.3E+02 nc	1.4E+03 nc	7.3E+00 nc	7.3E+01 nc		
	8.6E-06 r		8.6E-06 I	1	0.10	532-27-4	2-Chloroacetophenone	3.2E-02 nc	1.1E-01 nc	3.1E-02 nc	5.2E-02 nc		
	4.0E-03 I		4.0E-03 r	0	0.10	106-47-8	4-Chloroaniline	2.6E+02 nc	2.7E+03 nc	1.5E+01 nc	1.5E+02 nc	7.0E-01	3.0E-02
	2.0E-02 I		5.7E-03 h	1	0.10	108-90-7	Chlorobenzene	6.5E+01 nc	2.2E+02 nc	2.1E+01 nc	3.9E+01 nc	1.0E+00	7.0E-02
2.7E-01 h	2.0E-02 I	2.7E-01 h	2.0E-02 r	0	0.10	510-15-6	Chlorobenzilate	1.6E+00 ca	7.1E+00 ca	2.5E-02 ca	2.5E-01 ca		
	2.0E-01 h		2.0E-01 r	0	0.10	74-11-3	p-Chlorobenzoic acid	1.3E+04 nc	1.0E+05 max	7.3E+02 nc	7.3E+03 nc		
	2.0E-02 h		2.0E-02 r	0	0.10	98-56-6	4-Chlorobenzotrifluoride	1.3E+03 nc	1.4E+04 nc	7.3E+01 nc	7.3E+02 nc		
	2.0E-02 h		2.0E-03 h	1	0.10	126-99-8	2-Chloro-1,3-butadiene	3.6E+00 nc	1.2E+01 nc	7.3E+00 nc	1.4E+01 nc		
	4.0E-01 h		4.0E-01 r	1	0.10	109-69-3	1-Chlorobutane	4.8E+02 sat	4.8E+02 sat	1.5E+03 nc	2.4E+03 nc		
	1.4E+01 r		1.4E+01 I	1	0.10	75-68-3	1-Chloro-1,1-difluoroethane (HCFC-142b)	3.4E+02 sat	3.4E+02 sat	5.2E+04 nc	8.7E+04 nc		
				1	0.10	110-75-8	2-Chloroethyl vinyl ether						
	1.4E+01 r		1.4E+01 I	1	0.10	75-45-6	Chlorodifluoromethane	3.4E+02 sat	3.4E+02 sat	5.1E+04 nc	8.5E+04 nc		
6.1E-03 I	1.0E-02 I	8.1E-02 I	1.0E-02 r	1	0.10	67-66-3	Chloroform	2.5E-01 ca	5.3E-01 ca	8.4E-02 ca	1.6E-01 ca	6.0E-01	3.0E-02
1.3E-02 h		6.3E-03 h		1	0.10	74-87-3	Chloromethane	1.2E+00 ca	2.6E+00 ca	1.1E+00 ca	1.5E+00 ca		
5.8E-01 h		5.8E-01 r		0	0.10	95-69-2	4-Chloro-2-methylaniline	7.7E-01 ca	3.3E+00 ca	1.2E-02 ca	1.2E-01 ca		
4.6E-01 h		4.6E-01 r		0	0.10	3165-93-3	4-Chloro-2-methylaniline hydrochloride	9.7E-01 ca	4.1E+00 ca	1.5E-02 ca	1.5E-01 ca		
	8.0E-02 I		8.0E-02 r	1	0.10	91-58-7	beta-Chloronaphthalene	1.1E+02 sat	1.1E+02 sat	2.9E+02 nc	4.9E+02 nc		
2.5E-02 h		2.5E-02 r	r	0	0.10	88-73-3	o-Chloronitrobenzene	1.8E+01 ca	7.6E+01 ca	2.7E-01 ca	2.7E+00 ca		
1.8E-02 h		1.8E-02 r	r	0	0.10	100-00-5	p-Chloronitrobenzene	2.5E+01 ca	1.1E+02 ca	3.7E-01 ca	3.7E+00 ca		
	5.0E-03 I		5.0E-03 r	1	0.10	95-57-8	2-Chlorophenol	9.1E+01 nc	3.7E+02 nc	1.8E+01 nc	3.8E+01 nc	4.0E+00	2.0E-01
	2.9E-02 r		2.9E-02 h	1	0.10	75-29-6	2-Chloropropane	1.7E+02 nc	5.8E+02 nc	1.0E+02 nc	1.7E+02 nc		
1.1E-02 h	1.5E-02 I	1.1E-02 r	1.5E-02 r	0	0.10	1897-45-6	Chlorothalonil	4.0E+01 ca**	1.7E+02 ca*	6.1E-01 ca*	6.1E+00 ca*		
	2.0E-02 I		2.0E-02 r	1	0.10	95-49-8	o-Chlorotoluene	1.6E+02 nc	5.5E+02 nc	7.3E+01 nc	1.2E+02 nc		
	2.0E-01 I		2.0E-01 r	0	0.10	101-21-3	Chlorpropham	1.3E+04 nc	1.0E+05 max	7.3E+02 nc	7.3E+03 nc		
	3.0E-03 I		3.0E-03 r	0	0.10	2921-88-2	Chlorpyrifos	2.0E+02 nc	2.0E+03 nc	1.1E+01 nc	1.1E+02 nc		
	1.0E-02 h		1.0E-02 r	0	0.10	5598-13-0	Chlorpyrifos-methyl	6.5E+02 nc	6.8E+03 nc	3.7E+01 nc	3.7E+02 nc		
	5.0E-02 I		5.0E-02 r	0	0.10	64902-72-3	Chlorsulfuron	3.3E+03 nc	3.4E+04 nc	1.8E+02 nc	1.8E+03 nc		
	8.0E-04 h		8.0E-04 r	0	0.10	602-38-56-4	Chlorthiophos	5.2E+01 nc	5.5E+02 nc	2.9E+00 nc	2.9E+01 nc		
		4.2E+01 I		0	0.01	n/a	Total Chromium (1/6 ratio Cr VI/Cr III)	2.1E+02 ca	4.5E+02 ca	1.6E-04 ca		3.8E+01	2.0E+00
	5.0E-03 I	2.9E+02 I		0	0.01	7440-47-3	Chromium VI	3.0E+01 ca	6.4E+01 ca	2.3E-05 ca	1.8E+02 nc	3.8E+01	2.0E+00
							"CAL-Modified PRG" (PEA, 1994)	2.0E-01			1.6E-01		
	6.0E-02 n		2.9E-04 n	0	0.01	7440-48-4	Cobalt	4.6E+03 nc	9.7E+04 nc	1.0E+00 nc	2.2E+03 nc		
		2.2E+00 I		0	0.01	8007-45-2	Coke Oven Emissions			3.1E-03 ca			
	3.7E-02 h			0	0.01	7440-50-8	Copper and compounds	2.8E+03 nc	6.3E+04 nc		1.4E+03 nc		
1.9E+00 h	1.0E-02 x	1.9E+00 x	1.0E-02 r	1	0.10	123-73-9	Crotonaldehyde	5.3E-03 ca	1.1E-02 ca	3.5E-03 ca	5.9E-03 ca		
	4.0E-02 I		2.6E-03 h	1	0.10	98-82-8	Cumene	1.9E+01 nc	6.2E+01 nc	9.4E+00 nc	1.9E+01 nc		
8.4E-01 h	2.0E-03 h	8.4E-01 r	2.0E-03 r	0	0.10	21725-46-2	Cyanazine	5.3E-01 ca*	2.3E+00 ca	8.0E-03 ca	8.0E-02 ca		

Key : i=IRIS h=HEAST n=NCEA x=WITHDRAWN r=ROUTE EXTRAPOLATION ca=CANCER PRG nc=NONCANCER PRG sat=SOIL SATURATION max=CEILING LIMIT *(where: nc < 100X ca) **(where: nc < 10X ca)

FOR PLANNING PURPOSES

TOXICITY INFORMATION							CONTAMINANT	PRELIMINARY REMEDIAL GOALS (PRGs)				SOIL SCREENING LEVELS Migration to Ground Water	
SFo 1/(mg/kg-d)	RfDo (mg/kg-d)	SFI 1/(mg/kg-d)	RfDI (mg/kg-d)	VOC	skin abs. soils	CAS No.		Residential Soil (mg/kg)	Industrial Soil (mg/kg)	Ambient Air (ug/m^3)	Tap Water (ug/l)	DAF 20 (mg/kg)	DAF 1 (mg/kg)
	1.0E-02 h		1.0E-02 r	1	0.10	156-59-2	1,2-Dichloroethylene (cis)	3.1E+01 nc	1.0E+02 nc	3.7E+01 nc	6.1E+01 nc	4.0E-01	2.0E-02
	2.0E-02 i		2.0E-02 r	1	0.10	156-60-5	1,2-Dichloroethylene (trans)	7.8E+01 nc	2.7E+02 nc	7.3E+01 nc	1.2E+02 nc	7.0E-01	3.0E-02
	9.0E-03 h		9.0E-03 r	1	0.10	540-59-0	1,2-Dichloroethylene (mixture)	3.5E+01 nc	1.2E+02 nc	3.3E+01 nc	5.5E+01 nc		
	3.0E-03 i		3.0E-03 r	0	0.10	120-83-2	2,4-Dichlorophenol	2.0E+02 nc	2.0E+03 nc	1.1E+01 nc	1.1E+02 nc	1.0E+00	5.0E-02
	8.0E-03 i		8.0E-03 r	0	0.10	94-82-6	4-(2,4-Dichlorophenoxy)butyric Acid (2,4-DB)	5.2E+02 nc	5.5E+03 nc	2.9E+01 nc	2.9E+02 nc		
	1.0E-02 i		1.0E-02 r	0	0.10	94-75-7	2,4-Dichlorophenoxyacetic Acid (2,4-D)	6.5E+02 nc	6.8E+03 nc	3.7E+01 nc	3.7E+02 nc		
6.8E-02 h	1.1E-03 r	6.8E-02 r	1.1E-03 i	1	0.10	78-87-5	1,2-Dichloropropane	3.1E-01 ca*	6.8E-01 ca*	9.9E-02 ca*	1.6E-01 ca*	3.0E-02	1.0E-03
1.8E-01 h	3.0E-04 i	1.3E-01 h	5.7E-03 i	1	0.10	542-75-6	1,3-Dichloropropene	2.5E-01 ca*	5.5E-01 ca	5.2E-02 ca	8.1E-02 ca	4.0E-03	2.0E-04
	3.0E-03 i		3.0E-03 r	0	0.10	616-23-9	2,3-Dichloropropanol	2.0E+02 nc	2.0E+03 nc	1.1E+01 nc	1.1E+02 nc		
2.9E-01 i	5.0E-04 i	2.9E-01 r	1.4E-04 i	0	0.10	62-73-7	Dichlorvos	1.5E+00 ca**	6.6E+00 ca*	2.3E-02 ca*	2.3E-01 ca*		
4.4E-01 x		4.4E-01 r		0	0.10	115-32-2	Dicofol	1.0E+00 ca	4.3E+00 ca	1.5E-02 ca	1.5E-01 ca		
	3.0E-02 h		5.7E-05 h	1	0.10	77-73-6	Dicyclopentadiene			2.1E-01 nc	4.2E-01 nc		
1.6E+01 i	5.0E-05 i	1.6E+01 i	5.0E-05 r	0	0.10	60-57-1	Dieldrin	2.8E-02 ca*	1.2E-01 ca	4.2E-04 ca	4.2E-03 ca	4.0E-03	2.0E-04
	5.7E-03 h		5.7E-03 x	0	0.10	112-34-5	Diethylene glycol, monobutyl ether	3.7E+02 nc	3.9E+03 nc	2.1E+01 nc	2.1E+02 nc		
	2.0E+00 h		2.0E+00 r	0	0.10	111-90-0	Diethylene glycol, monoethyl ether	1.0E+05 max	1.0E+05 max	7.3E+03 nc	7.3E+04 nc		
	1.1E-02 h		1.1E-02 r	0	0.10	617-84-5	Diethylformamide	7.2E+02 nc	7.5E+03 nc	4.0E+01 nc	4.0E+02 nc		
1.2E-03 i	6.0E-01 i	1.2E-03 r	6.0E-01 r	0	0.10	103-23-1	Di(2-ethylhexyl)adipate	3.7E+02 nc	1.6E+03 nc	5.6E+00 nc	5.6E+01 nc		
	8.0E-01 i		8.0E-01 r	0	0.10	84-66-2	Diethyl phthalate	5.2E+04 nc	1.0E+05 max	2.9E+03 nc	2.9E+04 nc		
4.7E+03 h		4.7E+03 r		0	0.10	56-53-1	Diethylstilbestrol	9.5E-05 ca	4.1E-04 ca	1.4E-06 ca	1.4E-05 ca		
	8.0E-02 i		8.0E-02 r	0	0.10	43222-48-6	Difenzoquat (Avenge)	5.2E+03 nc	5.5E+04 nc	2.9E+02 nc	2.9E+03 nc		
	2.0E-02 i		2.0E-02 r	0	0.10	35367-38-5	Diflubenzuron	1.3E+03 nc	1.4E+04 nc	7.3E+01 nc	7.3E+02 nc		
	1.1E+01 r		1.1E+01 i	1	0.10	75-37-6	1,1-Difluoroethane			4.2E+04 nc	6.9E+04 nc		
	8.0E-02 i		8.0E-02 r	0	0.10	1445-75-6	Diisopropyl methylphosphonate	5.2E+03 nc	5.5E+04 nc	2.9E+02 nc	2.9E+03 nc		
	2.0E-02 i		2.0E-02 r	0	0.10	55290-64-7	Dimethipin	1.3E+03 nc	1.4E+04 nc	7.3E+01 nc	7.3E+02 nc		
	2.0E-04 i		2.0E-04 r	0	0.10	60-51-5	Dimethoate	1.3E+01 nc	1.4E+02 nc	7.3E-01 nc	7.3E+00 nc		
1.4E-02 h		1.4E-02 r		0	0.10	119-90-4	3,3'-Dimethoxybenzidine	3.2E+01 ca	1.4E+02 ca	4.8E-01 ca	4.8E+00 ca		
	5.7E-06 r		5.7E-06 x	1	0.10	124-40-3	Dimethylamine	6.5E-02 nc	2.4E-01 nc	2.1E-02 nc	3.5E-02 nc		
	2.0E-03 i		2.0E-03 r	0	0.10	121-69-7	N-N-Dimethylaniline	1.3E+02 nc	1.4E+03 nc	7.3E+00 nc	7.3E+01 nc		
7.5E-01 h		7.5E-01 r		0	0.10	95-68-1	2,4-Dimethylaniline	5.9E-01 ca	2.5E+00 ca	9.0E-03 ca	9.0E-02 ca		
5.8E-01 h		5.8E-01 r		0	0.10	21436-96-4	2,4-Dimethylaniline hydrochloride	7.7E-01 ca	3.3E+00 ca	1.2E-02 ca	1.2E-01 ca		
9.2E+00 h		9.2E+00 r		0	0.10	119-93-7	3,3'-Dimethylbenzidine	4.8E-02 ca	2.1E-01 ca	7.3E-04 ca	7.3E-03 ca		
2.6E+00 x		3.5E+00 x		0	0.10	57-14-7	1,1-Dimethylhydrazine	1.7E-01 ca	7.3E-01 ca	1.9E-03 ca	2.6E-02 ca		
3.7E+01 x		3.7E+01 x		0	0.10	540-73-8	1,2-Dimethylhydrazine	1.2E-02 ca	5.2E-02 ca	1.8E-04 ca	1.8E-03 ca		
	1.0E-01 h		8.6E-03 i	0	0.10	68-12-2	N,N-Dimethylformamide	6.5E+03 nc	6.8E+04 nc	3.1E+01 nc	3.7E+03 nc		
	2.0E-02 i		2.0E-02 r	0	0.10	105-67-9	2,4-Dimethylphenol	1.3E+03 nc	1.4E+04 nc	7.3E+01 nc	7.3E+02 nc	9.0E+00	4.0E-01
	6.0E-04 i		6.0E-04 r	0	0.10	576-26-1	2,6-Dimethylphenol	3.9E+01 nc	4.1E+02 nc	2.2E+00 nc	2.2E+01 nc		
	1.0E-03 i		1.0E-03 r	0	0.10	95-65-8	3,4-Dimethylphenol	6.5E+01 nc	6.8E+02 nc	3.7E+00 nc	3.7E+01 nc		
	1.0E+01 h		1.0E+01 r	0	0.10	131-11-3	Dimethyl phthalate	1.0E+05 max	1.0E+05 max	3.7E+04 nc	3.7E+05 nc		
	1.0E-01 i		1.0E-01 r	0	0.10	120-61-6	Dimethyl terephthalate	6.5E+03 nc	6.8E+04 nc	3.7E+02 nc	3.7E+03 nc		
	2.0E-03 i		2.0E-03 r	0	0.10	131-89-5	4,6-Dinitro-o-cyclohexyl phenol	1.3E+02 nc	1.4E+03 nc	7.3E+00 nc	7.3E+01 nc		
	1.0E-04 i		1.0E-04 r	0	0.10	99-65-0	1,3-Dinitrobenzene	6.5E+00 nc	6.8E+01 nc	3.7E-01 nc	3.7E+00 nc		
	4.0E-04 h		4.0E-04 r	0	0.10	528-29-0	1,2-Dinitrobenzene	2.6E+01 nc	2.7E+02 nc	1.5E+00 nc	1.5E+01 nc		
	4.0E-04 h		4.0E-04 r	0	0.10	100-25-4	1,4-Dinitrobenzene	2.6E+01 nc	2.7E+02 nc	1.5E+00 nc	1.5E+01 nc		
	2.0E-03 i		2.0E-03 r	0	0.10	51-28-5	2,4-Dinitrophenol	1.3E+02 nc	1.4E+03 nc	7.3E+00 nc	7.3E+01 nc	3.0E-01	1.0E-02
6.8E-01 i		6.8E-01 r		0	0.10	25321-14-6	Dinitrotoluene mixture	6.5E-01 ca	2.8E+00 ca	9.9E-03 ca	9.9E-02 ca	8.0E-04	4.0E-05
	2.0E-03 i		2.0E-03 r	0	0.10	121-14-2	2,4-Dinitrotoluene (also see Dinitrotoluene mixture)	1.3E+02 nc	1.4E+03 nc	7.3E+00 nc	7.3E+01 nc	8.0E-04	4.0E-05
	1.0E-03 h		1.0E-03 r	0	0.10	606-20-2	2,6-Dinitrotoluene (also see Dinitrotoluene mixture)	6.5E+01 nc	6.8E+02 nc	3.7E+00 nc	3.7E+01 nc	7.0E-04	3.0E-05

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FOR PLANNING PURPOSES

TOXICITY INFORMATION							CONTAMINANT	PRELIMINARY REMEDIAL GOALS (PRGs)				SOIL SCREENING LEVELS Migration to Ground Water	
SFo 1/(mg/kg-d)	RfDo (mg/kg-d)	SFi 1/(mg/kg-d)	RfDi (mg/kg-d)	V O C	skin abs. soils	CAS No.		Residential Soil (mg/kg)	Industrial Soil (mg/kg)	Ambient Air (ug/m^3)	Tap Water (ug/l)	DAF 20 (mg/kg)	DAF 1 (mg/kg)
1.9E-01 I		1.9E-01 r		0	0.10	72178-02-0	Fomesafen	2.3E+00 ca	1.0E+01 ca	3.5E-02 ca	3.5E-01 ca		
	2.0E-03 I		2.0E-03 r	0	0.10	944-22-9	Fonofos	1.3E+02 nc	1.4E+03 nc	7.3E+00 nc	7.3E+01 nc		
	1.5E-01 I	4.6E-02 I		0	0.10	50-00-0	Formaldehyde	9.8E+03 nc	1.0E+05 nc	1.5E-01 ca	5.5E+03 nc		
	2.0E+00 h		2.0E+00 r	0	0.10	64-18-6	Formic Acid	1.0E+05 max	1.0E+05 max	7.3E+03 nc	7.3E+04 nc		
	3.0E+00 I		3.0E+00 r	0	0.10	39148-24-8	Fosetyl-al	1.0E+05 max	1.0E+05 max	1.1E+04 nc	1.1E+05 nc		
	1.0E-03 I		1.0E-03 r	1	0.10	110-00-9	Furan	2.5E+00 nc	8.5E+00 nc	3.7E+00 nc	6.1E+00 nc		
3.8E+00 h		3.8E+00 r		0	0.10	67-45-8	Furazolidone	1.2E-01 ca	5.0E-01 ca	1.8E-03 ca	1.8E-02 ca		
	3.0E-03 I		1.4E-02 h	0	0.10	98-01-1	Furfural	2.0E+02 nc	2.0E+03 nc	5.2E+01 nc	1.1E+02 nc		
5.0E+01 h		5.0E+01 r		0	0.10	531-82-8	Furium	8.9E-03 ca	3.8E-02 ca	1.3E-04 ca	1.3E-03 ca		
3.0E-02 I		3.0E-02 r		0	0.10	60568-05-0	Furmecyclox	1.5E+01 ca	6.4E+01 ca	2.2E-01 ca	2.2E+00 ca		
	4.0E-04 I		4.0E-04 r	0	0.10	77182-82-2	Glufosinate-ammonium	2.6E+01 nc	2.7E+02 nc	1.5E+00 nc	1.5E+01 nc		
	4.0E-04 I		2.9E-04 h	0	0.10	765-34-4	Glycidaldehyde	2.6E+01 nc	2.7E+02 nc	1.0E+00 nc	1.5E+01 nc		
	1.0E-01 I		1.0E-01 r	0	0.10	1071-83-6	Glyphosate	6.5E+03 nc	6.8E+04 nc	3.7E+02 nc	3.7E+03 nc		
	5.0E-05 I		5.0E-05 r	0	0.10	69806-40-2	Haloxyfop-methyl	3.3E+00 nc	3.4E+01 nc	1.8E-01 nc	1.8E+00 nc		
	1.3E-02 I		1.3E-02 r	0	0.10	79277-27-3	Harmony	8.5E+02 nc	8.9E+03 nc	4.7E+01 nc	4.7E+02 nc		
4.5E+00 I	5.0E-04 I	4.6E+00 I	5.0E-04 r	0	0.10	76-44-8	Heptachlor	9.9E-02 ca	4.2E-01 ca	1.5E-03 ca	1.5E-02 ca	2.3E+01	1.0E+00
9.1E+00 I	1.3E-05 I	9.1E+00 I	1.3E-05 r	0	0.10	1024-57-3	Heptachlor epoxide	4.9E-02 ca**	2.1E-01 ca*	7.4E-04 ca*	7.4E-03 ca*	7.0E-01	3.0E-02
	2.0E-03 I		2.0E-03 r	0	0.10	87-82-1	Hexabromobenzene	1.3E+02 nc	1.4E+03 nc	7.3E+00 nc	7.3E+01 nc		
1.6E+00 I	8.0E-04 I	1.6E+00 I	8.0E-04 r	0	0.10	118-74-1	Hexachlorobenzene	2.8E-01 ca*	1.2E+00 ca	4.2E-03 ca	4.2E-02 ca	2.0E+00	1.0E-01
7.8E-02 I	2.0E-04 h	7.7E-02 I	2.0E-04 r	0	0.10	87-68-3	Hexachlorobutadiene	5.7E+00 ca**	2.4E+01 ca*	8.7E-02 ca*	8.6E-01 ca*	2.0E+00	1.0E-01
6.3E+00 I		6.3E+00 I		0	0.10	319-84-6	HCH (alpha)	7.1E-02 ca	3.0E-01 ca	1.1E-03 ca	1.1E-02 ca	5.0E-04	3.0E-05
1.8E+00 I		1.8E+00 I		0	0.10	319-85-7	HCH (beta)	2.5E-01 ca	1.1E+00 ca	3.7E-03 ca	3.7E-02 ca	3.0E-03	1.0E-04
1.3E+00 h	3.0E-04 I	1.3E+00 r	3.0E-04 r	0	0.10	58-89-9	HCH (gamma) Lindane	3.4E-01 ca*	1.5E+00 ca	5.2E-03 ca	5.2E-02 ca	9.0E-03	5.0E-04
1.8E+00 I		1.8E+00 I		0	0.10	58-89-9	HCH-technical	2.5E-01 ca	1.1E+00 ca	3.8E-03 ca	3.7E-02 ca	3.0E-03	1.0E-04
	7.0E-03 I		2.0E-05 h	0	0.10	77-47-4	Hexachlorocyclopentadiene	4.5E+02 nc	4.6E+03 nc	7.3E-02 nc	2.6E+02 nc	4.0E+02	2.0E+01
6.2E+03 I		4.6E+03 I		0	0.10	19408-74-3	Hexachlorodibenzo-p-dioxin mixture (HxCDD)	7.2E-05 ca	3.1E-04 ca	1.5E-06 ca	1.1E-05 ca		
1.4E-02 I	1.0E-03 I	1.4E-02 I	1.0E-03 r	0	0.10	67-72-1	Hexachloroethane	3.2E+01 ca**	1.4E+02 ca**	4.8E-01 ca**	4.8E+00 ca**	5.0E-01	2.0E-02
	3.0E-04 I		3.0E-04 r	0	0.10	70-30-4	Hexachlorophene	2.0E+01 nc	2.0E+02 nc	1.1E+00 nc	1.1E+01 nc		
1.1E-01 I	3.0E-03 I	1.1E-01 r	3.0E-03 r	0	0.10	121-82-4	Hexahydro-1,3,5-trinitro-1,3,5-triazine	4.0E+00 ca*	1.7E+01 ca	6.1E-02 ca	6.1E-01 ca		
	2.9E-06 r		2.9E-06 I	0	0.10	822-06-0	1,6-Hexamethylene diisocyanate			1.0E-02 nc	1.0E-01 nc		
	6.0E-02 h		5.7E-02 I	1	0.10	110-54-3	n-Hexane	1.1E+02 sat	1.1E+02 sat	2.1E+02 nc	3.5E+02 nc		
	3.3E-02 I		3.3E-02 r	0	0.10	51235-04-2	Hexazinone	2.2E+03 nc	2.2E+04 nc	1.2E+02 nc	1.2E+03 nc		
3.0E+00 I		1.7E+01 I		0	0.10	302-01-2	Hydrazine, hydrazine sulfate	1.5E-01 ca	6.4E-01 ca	3.9E-04 ca	2.2E-02 ca		
			5.7E-03 I	0	0.10	7647-01-0	Hydrogen chloride			2.1E+01 nc			
	3.0E-03 I		2.9E-04 I	1	0.10	7783-06-4	Hydrogen sulfide			1.0E+00 nc	2.0E+00 nc		
	4.0E-02 h		4.0E-02 r	0	0.10	123-31-9	p-Hydroquinone	2.6E+03 nc	2.7E+04 nc	1.5E+02 nc	1.5E+03 nc		
	1.3E-02 I		1.3E-02 r	0	0.10	35554-44-0	Imazalil	8.5E+02 nc	8.9E+03 nc	4.7E+01 nc	4.7E+02 nc		
	2.5E-01 I		2.5E-01 r	0	0.10	81335-37-7	Imazaquin	1.6E+04 nc	1.0E+05 max	9.1E+02 nc	9.1E+03 nc		
	4.0E-02 I		4.0E-02 r	0	0.10	36734-19-7	Iprodione	2.6E+03 nc	2.7E+04 nc	1.5E+02 nc	1.5E+03 nc		
	3.0E-01 I		3.0E-01 r	1	0.10	78-83-1	Isobutanol	1.1E+04 nc	1.0E+05 max	1.1E+03 nc	1.8E+03 nc		
9.5E-04 I	2.0E-01 I	9.5E-04 r	2.0E-01 r	0	0.10	78-59-1	Isophorone	4.7E+02 ca*	2.0E+03 ca*	7.1E+00 ca	7.1E+01 ca	5.0E-01	3.0E-02
	1.5E-02 I		1.5E-02 r	0	0.10	33820-53-0	Isopropalin	9.8E+02 nc	1.0E+04 nc	5.5E+01 nc	5.5E+02 nc		
	1.0E-01 I		1.1E-01 r	0	0.10	1832-54-8	Isopropyl methyl phosphonic acid	6.5E+03 nc	6.8E+04 nc	4.0E+02 nc	3.7E+03 nc		
	5.0E-02 I		5.0E-02 r	0	0.10	82558-50-7	Isoxaben	3.3E+03 nc	3.4E+04 nc	1.8E+02 nc	1.8E+03 nc		
1.8E+01 n		1.8E+01 r		0	0.10	143-50-0	Kepone	2.5E-02 ca	1.1E-01 ca	3.7E-04 ca	3.7E-03 ca		
	2.0E-03 I		2.0E-03 r	0	0.10	77501-63-4	Lactofen	1.3E+02 nc	1.4E+03 nc	7.3E+00 nc	7.3E+01 nc		

Key : i=IRIS h=HEAST n=NCEA x=WITHDRAWN r=ROUTE EXTRAPOLATION ca=CANCER PRG nc=NONCANCER PRG sat=SOIL SATURATION max=CEILING LIMIT *(where: nc < 100X ca) **(where: nc < 10X ca)

FOR PLANNING PURPOSES

TOXICITY INFORMATION							CONTAMINANT	PRELIMINARY REMEDIAL GOALS (PRGs)				SOIL SCREENING LEVELS	
												Migration to Ground Water	
SFo 1/(mg/kg-d)	RfDo (mg/kg-d)	SFi 1/(mg/kg-d)	RfDi (mg/kg-d)	VOC	skin abs. soils	CAS No.		Residential Soil (mg/kg)	Industrial Soil (mg/kg)	Ambient Air (ug/m^3)	Tap Water (ug/l)	DAF 20 (mg/kg)	DAF 1 (mg/kg)
1.1E+00 h		1.1E+00 r		0	0.10	60-34-4	Methyl hydrazine	4.0E-01 ca	1.7E+00 ca	6.1E-03 ca	6.1E-02 ca		
	8.0E-02 h		2.3E-02 h	1	0.10	108-10-1	**Methyl isobutyl ketone**	7.7E+02 nc	2.8E+03 nc	8.3E+01 nc	1.6E+02 nc		
	8.0E-02 h		8.0E-02 r	1	0.10	80-62-6	**Methyl methacrylate**	7.6E+02 nc	2.8E+03 nc	2.9E+02 nc	4.9E+02 nc		
3.3E-02 h		3.3E-02 r		0	0.10	99-55-8	2-Methyl-5-nitroaniline	1.3E+01 ca	5.8E+01 ca	2.0E-01 ca	2.0E+00 ca		
	2.5E-04 i		2.5E-04 r	0	0.10	298-00-0	Methyl parathion	1.6E+01 nc	1.7E+02 nc	9.1E-01 nc	9.1E+00 nc		
	5.0E-02 x		5.0E-02 r	0	0.10	95-48-7	2-Methylphenol	3.3E+03 nc	3.4E+04 nc	1.8E+02 nc	1.8E+03 nc	1.5E+01	8.0E-01
	5.0E-02 x		5.0E-02 r	0	0.10	108-39-4	3-Methylphenol	3.3E+03 nc	3.4E+04 nc	1.8E+02 nc	1.8E+03 nc		
	5.0E-03 h		5.0E-03 r	0	0.10	106-44-5	4-Methylphenol	3.3E+02 nc	3.4E+03 nc	1.8E+01 nc	1.8E+02 nc		
	6.0E-03 h		1.1E-02 h	1	0.10	25013-15-4	Methyl styrene (mixture)	1.2E+02 nc	5.2E+02 nc	4.2E+01 nc	6.0E+01 nc		
	7.0E-02 h		7.0E-02 r	1	0.10	98-83-9	Methyl styrene (alpha)	6.8E+02 sat	6.8E+02 sat	2.6E+02 nc	4.3E+02 nc		
	5.0E-03 n		8.6E-01 i	1	0.10	1634-04-4	**Methyl tertbutyl ether (MTBE)**			3.1E+03 nc	1.8E+02 nc		
	1.5E-01 i		1.5E-01 r	0	0.10	51218-45-2	Metolaclor (Dual)	9.8E+03 nc	1.0E+05 max	5.5E+02 nc	5.5E+03 nc		
	2.5E-02 i		2.5E-02 r	0	0.10	21087-64-9	Metribuzin	1.6E+03 nc	1.7E+04 nc	9.1E+01 nc	9.1E+02 nc		
1.8E+00 h	2.0E-04 i	1.8E+00 r	2.0E-04 r	0	0.10	2385-85-5	Mirex	2.5E-01 ca*	1.1E+00 ca	3.7E-03 ca	3.7E-02 ca		
	2.0E-03 i		2.0E-03 r	0	0.10	2212-67-1	Molinate	1.3E+02 nc	1.4E+03 nc	7.3E+00 nc	7.3E+01 nc		
	5.0E-03 h			0	0.01	7439-98-7	Molybdenum	3.8E+02 nc	8.5E+03 nc		1.8E+02 nc		
	1.0E-01 h		1.0E-01 h	0	0.10	10599-90-3	Monochloramine	6.5E+03 nc	6.8E+04 nc	3.7E+02 nc	3.7E+03 nc		
	2.0E-03 i		2.0E-03 r	0	0.10	300-76-5	Naled	1.3E+02 nc	1.4E+03 nc	7.3E+00 nc	7.3E+01 nc		
	1.0E-01 i		1.0E-01 r	0	0.10	15299-99-7	Napropamide	6.5E+03 nc	6.8E+04 nc	3.7E+02 nc	3.7E+03 nc		
	2.0E-02 i			0	0.01	7440-02-0	Nickel (soluble salts)	1.5E+03 nc	3.4E+04 nc		7.3E+02 nc	1.3E+02	7.0E+00
							"CAL-Modified PRG" (PEA, 1994)	1.5E+02					
		8.4E-01 i		0	0.01	n/a	Nickel refinery dust			8.0E-03 ca			
		1.7E+00 i		0	0.01	12035-72-2	Nickel subsulfide		1.1E+04 ca	4.0E-03 ca			
	1.5E-03 x		1.5E-03 r	0	0.10	1929-82-4	Nitrapyrin	9.8E+01 nc	1.0E+03 nc	5.5E+00 nc	5.5E+01 nc		
	1.6E+00 i			0	0.10	14797-55-8	Nitrate				5.8E+04 nc		
	1.0E-01 x			0	0.10	10102-43-9	Nitric Oxide	6.5E+03 nc	1.0E+05 max		3.7E+03 nc		
	1.0E-01 i			0	0.10	14797-65-0	Nitrite	6.5E+03 nc	1.0E+05 max		3.7E+03 nc		
	6.0E-05 r		5.7E-05 h	0	0.10	88-74-4	2-Nitroaniline	3.9E+00 nc	4.1E+01 nc	2.1E-01 nc	2.2E+00 nc		
				0	0.10	99-09-2	3-Nitroaniline						
				0	0.10	100-01-6	4-Nitroaniline						
	5.0E-04 i		5.7E-04 h	1	0.10	98-95-3	**Nitrobenzene**	1.8E+01 nc	9.4E+01 nc	2.1E+00 nc	3.4E+00 nc	1.0E-01	7.0E-03
	7.0E-02 h		7.0E-02 r	0	0.10	67-20-9	Nitrofurantoin	4.6E+03 nc	4.8E+04 nc	2.6E+02 nc	2.6E+03 nc		
1.5E+00 h		9.4E+00 h		0	0.10	59-87-0	Nitrofurazone	3.0E-01 ca	1.3E+00 ca	7.2E-04 ca	4.5E-02 ca		
	1.0E+00 x			0	0.10	101102-44-0	Nitrogen dioxide						
	1.0E-01 i		1.0E-01 r	0	0.10	556-88-7	Nitroguanidine	6.5E+03 nc	6.8E+04 nc	3.7E+02 nc	3.7E+03 nc		
				0	0.10	100-02-7	4-Nitrophenol						
9.4E+00 r	5.7E-03 r	9.4E+00 h	5.7E-03 i	1	0.10	79-46-9	2-Nitropropane			7.2E-04 ca	3.5E+01 ca		
5.4E+00 i		5.6E+00 i		1	0.10	924-16-3	**N-Nitrosodi-n-butylamine**	2.2E-02 ca	5.5E-02 ca	1.2E-03 ca	2.0E-03 ca		
2.8E+00 i		2.8E+00 r		0	0.10	1116-54-7	N-Nitrosodiethanolamine	1.6E-01 ca	6.8E-01 ca	2.4E-03 ca	2.4E-02 ca		
1.5E+02 i		1.5E+02 i		0	0.10	55-18-5	N-Nitrosodiethylamine	3.0E-03 ca	1.3E-02 ca	4.5E-05 ca	4.5E-04 ca		
5.1E+01 i		4.9E+01 i		0	0.10	62-75-9	N-Nitrosodimethylamine	8.7E-03 ca	3.7E-02 ca	1.4E-04 ca	1.3E-03 ca		
4.9E-03 i		4.9E-03 r		0	0.10	86-30-6	N-Nitrosodiphenylamine	9.1E+01 ca	3.9E+02 ca	1.4E+00 ca	1.4E+01 ca	1.0E+00	6.0E-02
7.0E+00 i		7.0E+00 r		0	0.10	621-64-7	N-Nitroso di-n-propylamine	6.3E-02 ca	2.7E-01 ca	9.6E-04 ca	9.6E-03 ca	5.0E-05	2.0E-06
2.2E+01 i		2.2E+01 r		0	0.10	10595-95-6	N-Nitroso-N-methylethylamine	2.0E-02 ca	8.7E-02 ca	3.1E-04 ca	3.1E-03 ca		
2.1E+00 i		2.1E+00 i		0	0.10	930-55-2	N-Nitrosopyrrolidine	2.1E-01 ca	9.1E-01 ca	3.1E-03 ca	3.2E-02 ca		
	1.0E-02 h		1.0E-02 r	0	0.10	99-08-1	m-Nitrotoluene	6.5E+02 nc	6.8E+03 nc	3.7E+01 nc	3.7E+02 nc		
	1.0E-02 h		1.0E-02 r	0	0.10	99-99-0	p-Nitrotoluene	6.5E+02 nc	6.8E+03 nc	3.7E+01 nc	3.7E+02 nc		

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FOR PLANNING PURPOSES

TOXICITY INFORMATION							CONTAMINANT	PRELIMINARY REMEDIAL GOALS (PRGs)				SOIL SCREENING LEVELS Migration to Ground Water	
SFo 1/(mg/kg-d)	RfDo (mg/kg-d)	SFi 1/(mg/kg-d)	RfDi (mg/kg-d)	VOC	skin abs. soils	CAS No.		Residential Soil (mg/kg)	Industrial Soil (mg/kg)	Ambient Air (ug/m^3)	Tap Water (ug/l)	DAF 20 (mg/kg)	DAF 1 (mg/kg)
							PAHs continued						
7.3E+00 I		7.3E+00 r		0	0.10	50-32-8	Benzo[a]pyrene	6.1E-02 ca	2.6E-01 ca	9.2E-04 ca	9.2E-03 ca	8.0E+00	4.0E-01
							"CAL-Modified PRG" (PEA, 1994)				1.5E-03		
7.3E-03 n		7.3E-03 r		0	0.10	218-01-9	Chrysene	7.2E+00 sat	7.2E+00 sat	9.2E-01 ca	9.2E+00 ca	1.6E+02	8.0E+00
							"CAL-Modified PRG" (PEA, 1994)	6.1E+00					
7.3E+00 n		7.3E+00 r		0	0.10	53-70-3	Dibenz[ah]anthracene	6.1E-02 ca	2.6E-01 ca	9.2E-04 ca	9.2E-03 ca	2.0E+00	8.0E-02
	4.0E-02 I		4.0E-02 r	0	0.10	206-44-0	Fluoranthene	2.6E+03 nc	2.7E+04 nc	1.5E+02 nc	1.5E+03 nc	4.3E+03	2.1E+02
	4.0E-02 I		4.0E-02 r	1	0.10	86-73-7	Fluorene	9.0E+01 sat	9.0E+01 sat	1.5E+02 nc	2.4E+02 nc	5.6E+02	2.8E+01
7.3E-01 n		7.3E-01 r		0	0.10	193-39-5	Indeno[1,2,3-cd]pyrene	6.1E-01 ca	2.6E+00 ca	9.2E-03 ca	9.2E-02 ca	1.4E+01	7.0E-01
	4.0E-02 n		4.0E-02 r	1	0.10	91-20-3	Naphthalene	2.4E+02 sat	2.4E+02 sat	1.5E+02 nc	2.4E+02 nc	8.4E+01	4.0E+00
	3.0E-02 I		3.0E-02 r	1	0.10	129-00-0	Pyrene	1.0E+02 sat	1.0E+02 sat	1.1E+02 nc	1.8E+02 nc	4.2E+03	2.1E+02
1.5E-01 I	9.0E-03 I	1.5E-01 r	9.0E-03 r	0	0.10	67747-09-5	Prochloraz	3.0E+00 ca	1.3E+01 ca	4.5E-02 ca	3.3E+02 ca		
	6.0E-03 h		6.0E-03 r	0	0.10	26399-36-0	Profluralin	3.9E+02 nc	4.1E+03 nc	2.2E+01 nc	2.2E+02 nc		
	1.5E-02 I		1.5E-02 r	0	0.10	1610-18-0	Prometon	9.8E+02 nc	1.0E+04 nc	5.5E+01 nc	5.5E+02 nc		
	4.0E-03 I		4.0E-03 r	0	0.10	7287-19-6	Prometryn	2.6E+02 nc	2.7E+03 nc	1.5E+01 nc	1.5E+02 nc		
	7.5E-02 I		7.5E-02 r	0	0.10	23950-58-5	Pronamide	4.9E+03 nc	5.1E+04 nc	2.7E+02 nc	2.7E+03 nc		
	1.3E-02 I		1.3E-02 r	0	0.10	1918-16-7	Propachlor	8.5E+02 nc	8.9E+03 nc	4.7E+01 nc	4.7E+02 nc		
	5.0E-03 I		5.0E-03 r	0	0.10	709-98-8	Propanil	3.3E+02 nc	3.4E+03 nc	1.8E+01 nc	1.8E+02 nc		
	2.0E-02 I		2.0E-02 r	0	0.10	2312-35-8	Propargite	1.3E+03 nc	1.4E+04 nc	7.3E+01 nc	7.3E+02 nc		
	2.0E-03 I		2.0E-03 r	0	0.10	107-19-7	Propargyl alcohol	1.3E+02 nc	1.4E+03 nc	7.3E+00 nc	7.3E+01 nc		
	2.0E-02 I		2.0E-02 r	0	0.10	139-40-2	Propazine	1.3E+03 nc	1.4E+04 nc	7.3E+01 nc	7.3E+02 nc		
	2.0E-02 I		2.0E-02 r	0	0.10	122-42-9	Propham	1.3E+03 nc	1.4E+04 nc	7.3E+01 nc	7.3E+02 nc		
	1.3E-02 I		1.3E-02 r	0	0.10	60207-90-1	Propiconazole	8.5E+02 nc	8.9E+03 nc	4.7E+01 nc	4.7E+02 nc		
	2.0E+01 h		2.0E+01 r	0	0.10	57-55-6	Propylene glycol	1.0E+05 max	1.0E+05 max	7.3E+04 nc	7.3E+05 nc		
	7.0E-01 h		7.0E-01 r	0	0.10	111-35-3	Propylene glycol, monoethyl ether	4.6E+04 nc	1.0E+05 max	2.6E+03 nc	2.6E+04 nc		
	7.0E-01 h		5.7E-01 I	0	0.10	107-98-2	Propylene glycol, monomethyl ether	4.6E+04 nc	1.0E+05 max	2.1E+03 nc	2.6E+04 nc		
2.4E-01 I	8.6E-03 r	1.3E-02 I	8.6E-03 I	1	0.10	75-56-9	Propylene oxide			5.2E-01 ca	2.2E-01 ca		
	2.5E-01 I		2.5E-01 r	0	0.10	81335-77-5	Pursuit	1.6E+04 nc	1.0E+05 max	9.1E+02 nc	9.1E+03 nc		
	2.5E-02 I		2.5E-02 r	0	0.10	51630-58-1	Pydrin	1.6E+03 nc	1.7E+04 nc	9.1E+01 nc	9.1E+02 nc		
	1.0E-03 I		1.0E-03 r	0	0.10	110-86-1	Pyridine	6.5E+01 nc	6.8E+02 nc	3.7E+00 nc	3.7E+01 nc		
	5.0E-04 I		5.0E-04 r	0	0.10	13593-03-8	Quinalphos	3.3E+01 nc	3.4E+02 nc	1.8E+00 nc	1.8E+01 nc		
1.2E+01 h		1.2E+01 r		0	0.10	91-22-5	Quinoline	3.7E-02 ca	1.6E-01 ca	5.6E-04 ca	5.6E-03 ca		
1.1E-01 I	3.0E-03 I	1.1E-01 r	3.0E-03 r	0	0.10	121-82-4	RDX (Cyclonite)	4.0E+00 ca*	1.7E+01 ca	6.1E-02 ca	6.1E-01 ca		
	3.0E-02 I		3.0E-02 r	0	0.10	10453-86-8	Resmethrin	2.0E+03 nc	2.0E+04 nc	1.1E+02 nc	1.1E+03 nc		
	5.0E-02 h		5.0E-02 r	0	0.10	299-84-3	Ronnel	3.3E+03 nc	3.4E+04 nc	1.8E+02 nc	1.8E+03 nc		
	4.0E-03 I		4.0E-03 r	0	0.10	83-79-4	Rotenone	2.6E+02 nc	2.7E+03 nc	1.5E+01 nc	1.5E+02 nc		
	2.5E-02 I		2.5E-02 r	0	0.10	78578-05-0	Savey	1.6E+03 nc	1.7E+04 nc	9.1E+01 nc	9.1E+02 nc		
	5.0E-03 I			0	0.10	7783-00-8	Selenious Acid	3.3E+02 nc	3.4E+03 nc		1.8E+02 nc		
	5.0E-03 I			0	0.01	7782-49-2	Selenium	3.8E+02 nc	8.5E+03 nc		1.8E+02 nc	5.0E+00	3.0E-01
	5.0E-03 h			0	0.10	630-10-4	Selenourea	3.3E+02 nc	3.4E+03 nc		1.8E+02 nc		
	9.0E-02 I		9.0E-02 r	0	0.10	74051-80-2	Sethoxydim	5.9E+03 nc	6.1E+04 nc	3.3E+02 nc	3.3E+03 nc		
	5.0E-03 I			0	0.01	7440-22-4	Silver and compounds	3.8E+02 nc	8.5E+03 nc		1.8E+02 nc	3.4E+01	2.0E+00
1.2E-01 h	5.0E-03 I	1.2E-01 r	2.0E-03 r	0	0.10	122-34-9	Simazine	3.7E+00 ca*	1.6E+01 ca*	5.6E-02 ca	5.6E-01 ca		
	4.0E-03 I		4.0E-03 r	0	0.10	26628-22-8	Sodium azide	2.6E+02 nc	2.7E+03 nc	1.5E+01 nc	1.5E+02 nc		
2.7E-01 h	3.0E-02 I	2.7E-01 r	3.0E-02 r	0	0.10	148-18-5	Sodium diethyldithiocarbamate	1.6E+00 ca	7.1E+00 ca	2.5E-02 ca	2.5E-01 ca		
	2.0E-05 I		2.0E-05 r	0	0.10	62-74-8	Sodium fluoroacetate	1.3E+00 nc	1.4E+01 nc	7.3E-02 nc	7.3E-01 nc		
	1.0E-03 h		1.0E-03 r	0	0.10	13718-26-8	Sodium metavanadate	6.5E+01 nc	6.8E+02 nc	3.7E+00 nc	3.7E+01 nc		

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FOR PLANNING PURPOSES

TOXICITY INFORMATION							CONTAMINANT	PRELIMINARY REMEDIAL GOALS (PRGs)				SOIL SCREENING LEVELS Migration to Ground Water	
SFo 1/(mg/kg-d)	RfDo (mg/kg-d)	SFI 1/(mg/kg-d)	RfDI (mg/kg-d)	VOC	skin abs. soils	CAS No.		Residential Soil (mg/kg)	Industrial Soil (mg/kg)	Ambient Air (ug/m^3)	Tap Water (ug/l)	DAF 20 (mg/kg)	DAF 1 (mg/kg)
5.7E-02 I	4.0E-03 I	5.6E-02 I	4.0E-03 r	1	0.10	79-00-5	1,1,2-Trichloroethane	6.5E-01 ca	1.5E+00 ca	1.2E-01 ca	2.0E-01 ca	2.0E-02	9.0E-04
1.1E-02 n	6.0E-03 n	6.0E-03 n	6.0E-03 r	1	0.10	79-01-6	Trichloroethylene (TCE)	3.2E+00 ca*	7.0E+00 ca*	1.1E+00 ca*	1.6E+00 ca*	6.0E-02	3.0E-03
	3.0E-01 I		2.0E-01 h	1	0.10	75-69-4	Trichlorofluoromethane	3.8E+02 nc	1.3E+03 nc	7.3E+02 nc	1.3E+03 nc		
	1.0E-01 I		1.0E-01 r	0	0.10	95-95-4	2,4,5-Trichlorophenol	6.5E+03 nc	6.8E+04 nc	3.7E+02 nc	3.7E+03 nc	2.7E+02	1.4E+01
1.1E-02 I		1.1E-02 I		0	0.10	88-06-2	2,4,6-Trichlorophenol	4.0E+01 ca	1.7E+02 ca	6.2E-01 ca	6.1E+00 ca	2.0E-01	8.0E-03
	1.0E-02 I		1.0E-02 r	0	0.10	93-76-5	2,4,5-Trichlorophenoxyacetic Acid	6.5E+02 nc	6.8E+03 nc	3.7E+01 nc	3.7E+02 nc		
	8.0E-03 I		8.0E-03 r	0	0.10	93-72-1	2-(2,4,5-Trichlorophenoxy) propionic acid	5.2E+02 nc	5.5E+03 nc	2.9E+01 nc	2.9E+02 nc		
	5.0E-03 I		5.0E-03 r	1	0.10	598-77-6	1,1,2-Trichloropropane	1.5E+01 nc	5.0E+01 nc	1.8E+01 nc	3.0E+01 nc		
7.0E+00 h	6.0E-03 I	7.0E+00 r	5.0E-03 r	1	0.10	96-18-4	1,2,3-Trichloropropane	1.4E-03 ca	3.1E-03 ca	9.6E-04 ca	1.6E-03 ca		
	5.0E-03 h		5.0E-03 r	1	0.10	96-19-5	1,2,3-Trichloropropene	1.1E+01 nc	3.8E+01 nc	1.8E+01 nc	3.0E+01 nc		
	3.0E+01 I		8.6E+00 h	1	0.10	76-13-1	1,1,2-Trichloro-1,2,2-trifluoroethane	5.6E+03 sat	5.6E+03 sat	3.1E+04 nc	5.9E+04 nc		
	3.0E-03 I		3.0E-03 r	0	0.10	58138-08-2	Tridiphane	2.0E+02 nc	2.0E+03 nc	1.1E+01 nc	1.1E+02 nc		
	2.0E-03 r		2.0E-03 I	1	0.10	121-44-8	Triethylamine	2.3E+01 nc	8.4E+01 nc	7.3E+00 nc	1.2E+01 nc		
7.7E-03 I	7.5E-03 I	7.7E-03 r	7.5E-03 r	0	0.10	1582-09-8	Trifluralin	5.8E+01 ca**	2.5E+02 ca*	8.7E-01 ca*	8.7E+00 ca*		
3.7E-02 h		3.7E-02 r		0	0.10	512-56-1	Trimethyl phosphate	1.2E+01 ca	5.2E+01 ca	1.8E-01 ca	1.8E+00 ca		
	5.0E-05 I		5.0E-05 r	0	0.10	99-35-4	1,3,5-Trinitrobenzene	3.3E+00 nc	3.4E+01 nc	1.8E-01 nc	1.8E+00 nc		
	1.0E-02 h		1.0E-02 r	0	0.10	479-45-8	Trinitrophenylmethylnitramine	6.5E+02 nc	6.8E+03 nc	3.7E+01 nc	3.7E+02 nc		
3.0E-02 I	5.0E-04 I	3.0E-02 r	5.0E-04 r	0	0.10	118-96-7	2,4,6-Trinitrotoluene	1.5E+01 ca**	6.4E+01 ca**	2.2E-01 ca**	2.2E+00 ca**		
	3.0E-03 I			0	0.01	7440-61-1	Uranium (soluble salts)						
	7.0E-03 h			0	0.01	7440-62-2	Vanadium	5.4E+02 nc	1.2E+04 nc		2.6E+02 nc	6.0E+03	3.0E+02
	9.0E-03 I			0	0.01	1314-62-1	Vanadium pentoxide	6.9E+02 nc	1.5E+04 nc		3.3E+02 nc	6.0E+03	3.0E+02
	2.0E-02 h			0	0.01	13701-70-7	Vanadium sulfate	1.5E+03 nc	3.4E+04 nc		7.3E+02 nc	6.0E+03	3.0E+02
	1.0E-03 I		1.0E-03 r	0	0.10	1929-77-7	Vernam	6.5E+01 nc	6.8E+02 nc	3.7E+00 nc	3.7E+01 nc		
	2.5E-02 I		2.5E-02 r	0	0.10	50471-44-8	Vinclozolin	1.6E+03 nc	1.7E+04 nc	9.1E+01 nc	9.1E+02 nc		
	1.0E+00 h		5.7E-02 I	1	0.10	108-05-4	Vinyl acetate	7.8E+02 nc	2.6E+03 nc	2.1E+02 nc	4.1E+02 nc	1.7E+02	8.0E+00
1.1E-01 r	8.6E-04 r	1.1E-01 h	8.6E-04 I	1	0.10	593-60-2	Vinyl bromide (bromoethene)	1.9E-01 ca*	4.1E-01 ca*	6.1E-02 ca*	1.0E-01 ca*		
1.9E+00 h		3.0E-01 h		1	0.10	75-01-4	Vinyl chloride	1.6E-02 ca	3.5E-02 ca	2.2E-02 ca	2.0E-02 ca	1.0E-02	7.0E-04
	3.0E-04 I		3.0E-04 r	0	0.10	81-81-2	Warfarin	2.0E+01 nc	2.0E+02 nc	1.1E+00 nc	1.1E+01 nc		
	2.0E+00 I		2.0E-01 x	1	0.10	108-38-3	m-Xylene	3.2E+02 sat	3.2E+02 sat	7.3E+02 nc	1.4E+03 nc	2.1E+02	1.0E+01
	2.0E+00 I		2.0E-01 x	1	0.10	95-47-6	o-Xylene	3.2E+02 sat	3.2E+02 sat	7.3E+02 nc	1.4E+03 nc	1.9E+02	9.0E+00
				1	0.10	106-42-3	p-Xylene	3.2E+02 sat	3.2E+02 sat			2.0E+02	1.0E+01
	2.0E+00 I		2.0E-01 x	1	0.10	1330-20-7	Xylene (mixed)	3.2E+02 sat	3.2E+02 sat	7.3E+02 nc	1.4E+03 nc	2.0E+02	1.0E+01
	3.0E-01 I			0	0.01	7440-66-6	Zinc	2.3E+04 nc	1.0E+05 max		1.1E+04 nc	1.2E+04	6.2E+02
	3.0E-04 I			0	0.01	1314-84-7	Zinc phosphide	2.3E+01 nc	5.1E+02 nc		1.1E+01 nc		
	5.0E-02 I		5.0E-02 r	0	0.10	12122-67-7	Zineb	3.3E+03 nc	3.4E+04 nc	1.8E+02 nc	1.8E+03 nc		

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FOR PLANNING PURPOSES

TOXICITY INFORMATION											CONTAMINANT	PRELIMINARY REMEDIATION GOALS (PRGs)								SOIL SCREENING LEVELS	
SFo 1/(mg/kg-d)		RfDo (mg/kg-d)		SFi 1/(mg/kg-d)		RfDi (mg/kg-d)		V O C	skin abs soils	CAS No		Residential Soil (mg/kg)		Industrial Soil (mg/kg)		Ambient Air (ug/m^3)		Tap Water (ug/l)		Migration to Ground Water DAF 20 (mg/kg)	DAF 1 (mg/kg)
8.7E-03	i	4.0E-03	i	8.7E-03	r	4.0E-03	r	0		30560-19-1	Acephate	5.6E+01	ca**	2.8E+02	ca*	7.7E-01	ca*	7.7E+00	ca*		
				7.7E-03	i	2.6E-03	i	1		75-07-0	Acetaldehyde	1.1E+01	ca**	2.3E+01	ca**	8.7E-01	ca*	1.7E+00	ca		
		2.0E-02	i			2.0E-02	r	0	0.1	34256-82-1	Acetochlor	1.2E+03	nc	1.8E+04	nc	7.3E+01	nc	7.3E+02	nc		
		1.0E-01	i			1.0E-01	r	1		67-64-1	Acetone	1.6E+03	nc	6.2E+03	nc	3.7E+02	nc	6.1E+02	nc	1.6E+01	8.0E-01
		8.0E-04	h			8.0E-04	r	0	0.1	75-86-5	Acetone cyanohydrin	4.9E+01	nc	7.0E+02	nc	2.9E+00	nc	2.9E+01	nc		
		6.0E-03	x			1.7E-02	i	1		75-05-8	Acetonitrile	2.7E+02	nc	1.7E+03	nc	6.2E+01	nc	7.9E+01	nc		
		1.0E-01	i			5.7E-06	x	1		98-86-2	Acetophenone	4.9E-01	nc	1.6E+00	nc	2.1E-02	nc	4.2E-02	nc		
1.1E-01	o	1.3E-02	i	1.1E-01	r	1.3E-02	r	0	0.1	50594-66-6	Acifluorfen	4.4E+00	ca	2.2E+01	ca	6.1E-02	ca	6.1E-01	ca		
		2.0E-02	h			5.7E-06	i	1		107-02-8	Acrolein	1.0E-01	nc	3.4E-01	nc	2.1E-02	nc	4.2E-02	nc		
4.6E+00	i	2.0E-04	i	4.6E+00	i	2.0E-04	r	0	0.1	79-06-1	Acrylamide	1.1E-01	ca	5.4E-01	ca	1.5E-03	ca	1.5E-02	ca		
		5.0E-01	i			2.9E-04	i	0	0.1	79-10-7	Acrylic acid	2.9E+04	nc	1.0E+05	max	1.0E+00	nc	1.8E+04	nc		
5.4E-01	i	1.0E-03	h	2.4E-01	i	5.7E-04	i	1		107-13-1	Acrylonitrile	2.1E-01	ca*	5.1E-01	ca*	2.8E-02	ca*	3.9E-02	ca*		
8.1E-02	h	1.0E-02	i	8.0E-02	r	1.0E-02	r	0	0.1	15972-60-8	Alachlor	6.0E+00	ca	3.1E+01	ca	8.4E-02	ca	8.4E-01	ca		
		1.5E-01	i			1.5E-01	r	0	0.1	1596-84-5	Alar	9.2E+03	nc	1.0E+05	max	5.5E+02	nc	5.5E+03	nc		
		1.0E-03	i			1.0E-03	r	0	0.1	116-06-3	Aldicarb	6.1E+01	nc	8.8E+02	nc	3.7E+00	nc	3.6E+01	nc		
		1.0E-03	i			1.0E-03	r	0	0.1	1646-88-4	Aldicarb sulfone	6.1E+01	nc	8.8E+02	nc	3.7E+00	nc	3.6E+01	nc		
1.7E+01	i	3.0E-05	i	1.7E+01	i	3.0E-05	r	0	0.1	309-00-2	Aldrin	2.9E-02	ca*	1.5E-01	ca	3.9E-04	ca	4.0E-03	ca	5.0E-01	2.0E-02
		2.5E-01	i			2.5E-01	r	0	0.1	5585-64-8	Ally	1.5E+04	nc	1.0E+05	max	9.1E+02	nc	9.1E+03	nc		
		5.0E-03	i			5.0E-03	r	0	0.1	107-18-6	Allyl alcohol	3.1E+02	nc	4.4E+03	nc	1.8E+01	nc	1.8E+02	nc		
		5.0E-02	x			2.9E-04	i	0	0.1	107-05-1	Allyl chloride	3.0E+03	nc	4.3E+04	nc	1.0E+00	nc	1.8E+03	nc		
		1.0E+00	n			1.4E-03	n	0		7429-90-5	Aluminum	7.6E+04	nc	1.0E+05	max	5.1E+00	nc	3.6E+04	nc		
		4.0E-04	i					0		20859-73-8	Aluminum phosphide	3.1E+01	nc	8.2E+02	nc			1.5E+01	nc		
		3.0E-04	i			3.0E-04	r	0	0.1	67485-29-4	Amdro	1.8E+01	nc	2.6E+02	nc	1.1E+00	nc	1.1E+01	nc		
		9.0E-03	i			9.0E-03	r	0	0.1	834-12-8	Ametryn	5.5E+02	nc	7.9E+03	nc	3.3E+01	nc	3.3E+02	nc		
		7.0E-02	h			7.0E-02	r	0	0.1	591-27-5	m-Aminophenol	4.3E+03	nc	6.2E+04	nc	2.6E+02	nc	2.6E+03	nc		
		2.0E-05	h			2.0E-05	r	0	0.1	504-24-5	4-Aminopyridine	1.2E+00	nc	1.8E+01	nc	7.3E-02	nc	7.3E-01	nc		
		2.5E-03	i			2.5E-03	r	0	0.1	33089-61-1	Amitraz	1.5E+02	nc	2.2E+03	nc	9.1E+00	nc	9.1E+01	nc		
						2.9E-02	i			7664-41-7	Ammonia					1.0E+02	nc				
		2.0E-01	i					0	0.1	7773-06-0	Ammonium sulfamate	1.2E+04	nc	1.0E+05	max			7.3E+03	nc		
5.7E-03	i	7.0E-03	n	5.7E-03	r	2.9E-04	i	0	0.1	62-53-3	Aniline	8.5E+01	ca**	4.3E+02	ca*	1.0E+00	nc	1.2E+01	ca*		
		4.0E-04	i					0		7440-36-0	Antimony and compounds	3.1E+01	nc	8.2E+02	nc			1.5E+01	nc	5.0E+00	3.0E-01
		5.0E-04	h					0		1314-60-9	Antimony pentoxide	3.9E+01	nc	1.0E+03	nc			1.8E+01	nc		
		9.0E-04	h					0		28300-74-5	Antimony potassium tartrate	7.0E+01	nc	1.8E+03	nc			3.3E+01	nc		
		4.0E-04	h					0		1332-81-6	Antimony tetroxide	3.1E+01	nc	8.2E+02	nc			1.5E+01	nc		
		4.0E-04	h			5.7E-05	i	0		1309-64-4	Antimony trioxide	3.1E+01	nc	8.2E+02	nc	2.1E-01	nc	1.5E+01	nc		
		1.3E-02	i			1.3E-02	r	0	0.1	74115-24-5	Apollo	7.9E+02	nc	1.1E+04	nc	4.7E+01	nc	4.7E+02	nc		
2.5E-02	i	5.0E-02	h	2.5E-02	i	5.0E-02	r	0	0.1	140-57-8	Aramite	1.9E+01	ca	9.9E+01	ca	2.7E-01	ca	2.7E+00	ca		
		3.0E-04	i					0	0.03	7440-38-2	Arsenic (noncancer endpoint)	2.2E+01	nc	4.4E+02	nc						
1.5E+00	i	3.0E-04	i	1.5E+01	i			0	0.03	7440-38-2	Arsenic (cancer endpoint)	3.9E-01	ca*	2.7E+00	ca	4.5E-04	ca	4.5E-02	ca	2.9E+01	1.0E+00
						1.4E-05	i	0		7784-42-1	Arsine (see arsenic for cancer endpoint)					5.2E-02	nc				
		9.0E-03	i			9.0E-03	i		0.1	76578-12-6	Assure	5.5E+02	nc	7.9E+03	nc	3.3E+01	nc	3.3E+02	nc		
		5.0E-02	i			5.0E-02	r	0	0.1	3337-71-1	Asulam	3.1E+03	nc	4.4E+04	nc	1.8E+02	nc	1.8E+03	nc		
2.2E-01	h	3.5E-02	h	2.2E-01	r	3.5E-02	r	0	0.1	1912-24-9	Atrazine	2.2E+00	ca	1.1E+01	ca	3.1E-02	ca	3.0E-01	ca		
		4.0E-04	i			4.0E-04	r	0	0.1	71751-41-2	Avermectin B1	2.4E+01	nc	3.5E+02	nc	1.5E+00	nc	1.5E+01	nc		
1.1E-01	i			1.1E-01	i			0	0.1	103-33-3	Azobenzene	4.4E+00	ca	2.2E+01	ca	6.2E-02	ca	6.1E-01	ca		
		7.0E-02	i			1.4E-04	h	0		7440-39-3	Barium and compounds	5.4E+03	nc	1.0E+05	max	5.2E-01	nc	2.6E+03	nc	1.6E+03	8.2E+01
		4.0E-03	i			4.0E-03	r	0	0.1	114-26-1	Baygon	2.4E+02	nc	3.5E+03	nc	1.5E+01	nc	1.5E+02	nc		
		3.0E-02	i			3.0E-02	r	0	0.1	43121-43-3	Bayleton	1.8E+03	nc	2.6E+04	nc	1.1E+02	nc	1.1E+03	nc		
		2.5E-02	i			2.5E-02	r	0	0.1	68359-37-5	Baythroid	1.5E+03	nc	2.2E+04	nc	9.1E+01	nc	9.1E+02	nc		
		3.0E-01	i			3.0E-01	i	0	0.1	1861-40-1	Benefin	1.8E+04	nc	1.0E+05	max	1.1E+03	nc	1.1E+04	nc		
		5.0E-02	i			5.0E-02	r	0	0.1	17804-35-2	Benomyl	3.1E+03	nc	4.4E+04	nc	1.8E+02	nc	1.8E+03	nc		
		3.0E-02	i			3.0E-02	r	0	0.1	25057-89-0	Bentazon	1.8E+03	nc	2.6E+04	nc	1.1E+02	nc	1.1E+03	nc		
		1.0E-01	i			1.0E-01	r	0	0.1	100-52-7	Benzaldehyde	6.1E+03	nc	8.8E+04	nc	3.7E+02	nc	3.6E+03	nc		
5.5E-02	i	3.0E-03	n	2.7E-02	i	1.7E-03	n	1		71-43-2	Benzene	6.5E-01	ca*	1.5E+00	ca*	2.5E-01	ca*	3.5E-01	ca*	3.0E-02	2.0E-03

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FOR PLANNING PURPOSES

TOXICITY INFORMATION											CONTAMINANT	PRELIMINARY REMEDIATION GOALS (PRGs)								SOIL SCREENING LEVELS Migration to Ground Water	
SFo 1/(mg/kg-d)		RfDo (mg/kg-d)		SFi 1/(mg/kg-d)		RfDi (mg/kg-d)		V O C	skin abs soils	CAS No		Residential Soil (mg/kg)		Industrial Soil (mg/kg)		Ambient Air (ug/m^3)		Tap Water (ug/l)		DAF 20 (mg/kg)	DAF 1 (mg/kg)
2.3E+02	i	3.0E-03	i	2.3E+02	i	3.0E-03	r	0	0.1	92-87-5	Benzidine	2.1E-03	ca	1.1E-02	ca	2.9E-05	ca	2.9E-04	ca		
		4.0E+00	i			4.0E+00	r	0	0.1	65-85-0	Benzoic acid	1.0E+05	max	1.0E+05	max	1.5E+04	nc	1.5E+05	nc	4.0E+02	2.0E+01
1.3E+01	i			1.3E+01	r			0	0.1	98-07-7	Benzotrichloride	3.7E-02	ca	1.9E-01	ca	5.2E-04	ca	5.2E-03	ca		
		3.0E-01	h			3.0E-01	r	0	0.1	100-51-6	Benzyl alcohol	1.8E+04	nc	1.0E+05	max	1.1E+03	nc	1.1E+04	nc		
1.7E-01	i			1.7E-01	i			1		100-44-7	Benzyl chloride	8.9E-01	ca	2.3E+00	ca	4.0E-02	ca	6.6E-02	ca		
		2.0E-03	i	8.4E+00	i	5.7E-06	i	0		7440-41-7	Beryllium and compounds	1.5E+02	nc	2.2E+03	ca**	8.0E-04	ca*	7.3E+01	nc	6.3E+01	3.0E+00
		1.0E-04	i			1.0E-04	r	0	0.1	141-66-2	Bidrin	6.1E+00	nc	8.8E+01	nc	3.7E-01	nc	3.6E+00	nc		
		1.5E-02	i			1.5E-02	r	0	0.1	82657-04-3	Biphenthrin (Talstar)	9.2E+02	nc	1.3E+04	nc	5.5E+01	nc	5.5E+02	nc		
		5.0E-02	i			5.0E-02	r	1		92-52-4	1,1-Biphenyl	3.5E+02	sat	3.5E+02	sat	1.8E+02	nc	3.0E+02	nc		
1.1E+00	i			1.2E+00	i			1		111-44-4	Bis(2-chloroethyl)ether	2.1E-01	ca	6.2E-01	ca	5.8E-03	ca	9.8E-03	ca	4.0E-04	2.0E-05
7.0E-02	h	4.0E-02	i	3.5E-02	h	4.0E-02	r	1		108-60-1	Bis(2-chloroisopropyl)ether	2.9E+00	ca	8.1E+00	ca	1.9E-01	ca	2.7E-01	ca		
2.2E+02	i			2.2E+02	i			1		542-88-1	Bis(chloromethyl)ether	1.9E-04	ca	4.4E-04	ca	3.1E-05	ca	5.2E-05	ca		
7.0E-02	h	4.0E-02	i	3.5E-02	h	4.0E-02	r	1		108-60-1	Bis(2-chloro-1-methylethyl)ether	2.9E+00	ca	8.1E+00	ca	1.9E-01	ca	2.7E-01	ca		
1.4E-02	i	2.0E-02	i	1.4E-02	i	2.2E-02	r	0	0.1	117-81-7	Bis(2-ethylhexyl)phthalate (DEHP)	3.5E+01	ca*	1.8E+02	ca	4.8E-01	ca	4.8E+00	ca		
		5.0E-02	i			5.0E-02	r	0	0.1	80-05-7	Bisphenol A	3.1E+03	nc	4.4E+04	nc	1.8E+02	nc	1.8E+03	nc		
		9.0E-02	i			5.7E-03	h	0	0.1	7440-42-8	Boron	5.5E+03	nc	7.9E+04	nc	2.1E+01	nc	3.3E+03	nc		
						2.0E-04	h	0	0.1	7637-07-2	Boron trifluoride					7.3E-01	nc				
		2.0E-02	n			2.9E-03	n	1		108-86-1	Bromobenzene	2.8E+01	nc	9.2E+01	nc	1.0E+01	nc	2.0E+01	nc		
6.2E-02	i	2.0E-02	i	6.2E-02	r	2.0E-02	r	1		75-27-4	Bromodichloromethane	1.0E+00	ca	2.4E+00	ca	1.1E-01	ca	1.8E-01	ca	6.0E-01	3.0E-02
7.9E-03	i	2.0E-02	i	3.9E-03	i	2.0E-02	r	0	0.1	75-25-2	Bromoform (tribromomethane)	6.2E+01	ca*	3.1E+02	ca*	1.7E+00	ca*	8.5E+00	ca*	8.0E-01	4.0E-02
		1.4E-03	i			1.4E-03	i	1		74-83-9	Bromomethane (Methyl bromide)	3.9E+00	nc	1.3E+01	nc	5.2E+00	nc	8.7E+00	nc	2.0E-01	1.0E-02
								0	0.1	101-55-3	4-Bromophenyl phenyl ether										
		5.0E-03	h			5.0E-03	r	0	0.1	2104-96-3	Bromophos	3.1E+02	nc	4.4E+03	nc	1.8E+01	nc	1.8E+02	nc		
		2.0E-02	i			2.0E-02	r	0	0.1	1689-84-5	Bromoxynil	1.2E+03	nc	1.8E+04	nc	7.3E+01	nc	7.3E+02	nc		
		2.0E-02	i			2.0E-02	r	0	0.1	1689-99-2	Bromoxynil octanoate	1.2E+03	nc	1.8E+04	nc	7.3E+01	nc	7.3E+02	nc		
1.8E+00	i			1.8E+00	i			1		106-99-0	1.3-Butadiene	3.5E-03	ca	7.6E-03	ca	3.7E-03	ca	6.2E-03	ca		
		1.0E-01	i			1.0E-01	r	0	0.1	71-36-3	1-Butanol	6.1E+03	nc	8.8E+04	nc	3.7E+02	nc	3.6E+03	nc	1.7E+01	9.0E-01
		5.0E-02	i			5.0E-02	r	0	0.1	2008-41-5	Butylate	3.1E+03	nc	4.4E+04	nc	1.8E+02	nc	1.8E+03	nc		
		1.0E-02	n			1.0E-02	r	1		104-51-8	n-Butylbenzene	1.4E+02	nc	2.4E+02	sat	3.7E+01	nc	6.1E+01	nc		
		1.0E-02	n			1.0E-02	r	1		135-98-8	sec-Butylbenzene	1.1E+02	nc	2.2E+02	sat	3.7E+01	nc	6.1E+01	nc		
		1.0E-02	n			1.0E-02	r	1		98-06-6	tert-Butylbenzene	1.3E+02	nc	3.9E+02	sat	3.7E+01	nc	6.1E+01	nc		
		2.0E-01	i			2.0E-01	r	0	0.1	85-68-7	Butyl benzyl phthalate	1.2E+04	nc	1.0E+05	max	7.3E+02	nc	7.3E+03	nc	9.3E+02	8.1E+02
		1.0E+00	i			1.0E+00	r	0	0.1	85-70-1	Butylphthalyl butylglycolate	6.1E+04	nc	1.0E+05	max	3.7E+03	nc	3.6E+04	nc		
		3.0E-03	h			3.0E-03	r	0	0.1	75-60-5	Cacodylic acid	1.8E+02	nc	2.6E+03	nc	1.1E+01	nc	1.1E+02	nc		
		5.0E-04	i	6.3E+00	i			0	0.001	7440-43-9	Cadmium and compounds	3.7E+01	nc	8.1E+02	nc	1.1E-03	ca	1.8E+01	nc	8.0E+00	4.0E-01
											"CAL-Modified PRG" (PEA, 1994)	9.0E+00									
		5.0E-01	i			5.0E-01	r	0	0.1	105-60-2	Caprolactam	3.1E+04	nc	1.0E+05	max	1.8E+03	nc	1.8E+04	nc		
8.6E-03	h	2.0E-03	i	8.6E-03	r	2.0E-03	r	0	0.1	2425-06-1	Captafol	5.7E+01	ca**	2.9E+02	ca**	7.8E-01	ca**	7.8E+00	ca**		
3.5E-03	h	1.3E-01	i	3.5E-03	r	1.3E-01	r	0	0.1	133-06-2	Captan	1.4E+02	ca*	7.0E+02	ca	1.9E+00	ca	1.9E+01	ca		
		1.0E-01	i			1.0E-01	r	0	0.1	63-25-2	Carbaryl	6.1E+03	nc	8.8E+04	nc	4.0E+02	nc	3.6E+03	nc		
2.0E-02	h			2.0E-02	r			0	0.1	86-74-8	Carbazole	2.4E+01	ca	1.2E+02	ca	3.4E-01	ca	3.4E+00	ca	6.0E-01	3.0E-02
		5.0E-03	i			5.0E-03	r	0	0.1	1563-66-2	Carbofuran	3.1E+02	nc	4.4E+03	nc	1.8E+01	nc	1.8E+02	nc		
		1.0E-01	i			2.0E-01	i	1		75-15-0	Carbon disulfide	3.6E+02	nc	7.2E+02	sat	7.3E+02	nc	1.0E+03	nc	3.2E+01	2.0E+00
1.3E-01	i	7.0E-04	i	5.3E-02	i	7.0E-04	r	1		56-23-5	Carbon tetrachloride	2.4E-01	ca**	5.3E-01	ca*	1.3E-01	ca*	1.7E-01	ca*	7.0E-02	3.0E-03
		1.0E-02	i			1.0E-02	r	0	0.1	55285-14-8	Carbosulfan	6.1E+02	nc	8.8E+03	nc	3.7E+01	nc	3.6E+02	nc		
		1.0E-01	i			1.0E-01	r	0	0.1	5234-68-4	Carboxin	6.1E+03	nc	8.8E+04	nc	3.7E+02	nc	3.6E+03	nc		
		1.5E-02	i			1.5E-02	r	0	0.1	133-90-4	Chloramben	9.2E+02	nc	1.3E+04	nc	5.5E+01	nc	5.5E+02	nc		
4.0E-01	h			4.0E-01	r			0	0.1	118-75-2	Chloranil	1.2E+00	ca	6.1E+00	ca	1.7E-02	ca	1.7E-01	ca		
3.5E-01	i	5.0E-04	i	3.5E-01	i	2.0E-04	i	0	0.04	12789-03-6	Chlordane	1.6E+00	ca*	1.1E+01	ca*	1.9E-02	ca*	1.9E-01	ca*	1.0E+01	5.0E-01
		2.0E-02	i			2.0E-02	r	0	0.1	90982-32-4	Chlorimuron-ethyl	1.2E+03	nc	1.8E+04	nc	7.3E+01	nc	7.3E+02	nc		
		1.0E-01	i			5.7E-05	n			7782-50-5	Chlorine					2.1E-01	nc				
						5.7E-05	i			10049-04-4	Chlorine dioxide					2.1E-01	nc				
								1		107-20-0	Chloroacetaldehyde										
		2.0E-03	h			2.0E-03	r	0	0.1	79-11-8	Chloroacetic acid	1.2E+02	nc	1.8E+03	nc	7.3E+00	nc	7.3E+01	nc		

Key i=IRIS h=HEAST n=NCEA x=WITHDRAWN o=Other EPA DOCUMENTS r=ROUTE EXTRAPOLATION ca=CANCER PRG nc=NONCANCER PRG sat=SOIL SATURATION max=CEILING LIMIT *(where: nc < 100X ca) **(where: nc < 10X ca)

FOR PLANNING PURPOSES

TOXICITY INFORMATION											CONTAMINANT	PRELIMINARY REMEDIATION GOALS (PRGs)								SOIL SCREENING LEVELS	
																				Migration to Ground Water	
SFo 1/(mg/kg-d)		RfDo (mg/kg-d)		SFi 1/(mg/kg-d)		RfDi (mg/kg-d)		VOC	skin abs soils	CAS No		Residential Soil (mg/kg)		Industrial Soil (mg/kg)		Ambient Air (ug/m^3)		Tap Water (ug/l)		DAF 20 (mg/kg)	DAF 1 (mg/kg)
		8.6E-06	r			8.6E-06	i	1		532-27-4	2-Chloroacetophenone	3.3E-02	nc	1.1E-01	nc	3.1E-02	nc	5.2E-02	nc		
		4.0E-03	i			4.0E-03	r	0	0.1	106-47-8	4-Chloroaniline	2.4E+02	nc	3.5E+03	nc	1.5E+01	nc	1.5E+02	nc	7.0E-01	3.0E-02
		2.0E-02	i			1.7E-02	n	1		108-90-7	Chlorobenzene	1.5E+02	nc	5.4E+02	nc	6.2E+01	nc	1.1E+02	nc	1.0E+00	7.0E-02
2.7E-01	h	2.0E-02	i	2.7E-01	h	2.0E-02	r	0	0.1	510-15-6	Chlorobenzilate	1.8E+00	ca	9.1E+00	ca	2.5E-02	ca	2.5E-01	ca		
		2.0E-01	h			2.0E-01	r	0	0.1	74-11-3	p-Chlorobenzoic acid	1.2E+04	nc	1.0E+05	max	7.3E+02	nc	7.3E+03	nc		
		2.0E-02	h			2.0E-02	r	0	0.1	98-56-6	4-Chlorobenzotrifluoride	1.2E+03	nc	1.8E+04	nc	7.3E+01	nc	7.3E+02	nc		
		2.0E-02	h			2.0E-03	h	1		126-99-8	2-Chloro-1,3-butadiene	3.6E+00	nc	1.2E+01	nc	7.3E+00	nc	1.4E+01	nc		
		4.0E-01	h			4.0E-01	r	1		109-69-3	1-Chlorobutane	4.8E+02	sat	4.8E+02	sat	1.5E+03	nc	2.4E+03	nc		
		1.4E+01	r			1.4E+01	i	1		75-68-3	1-Chloro-1,1-difluoroethane (HCFC-142b)	3.4E+02	sat	3.4E+02	sat	5.2E+04	nc	8.7E+04	nc		
		1.4E+01	r			1.4E+01	i	1		75-45-6	Chlorodifluoromethane	3.4E+02	sat	3.4E+02	sat	5.1E+04	nc	8.5E+04	nc		
2.9E-03	n	4.0E-01	n	2.9E-03	r	2.9E+00	i	1		75-00-3	Chloroethane	3.0E+00	ca	6.5E+00	ca	2.3E+00	ca	4.6E+00	ca		
								1		110-75-8	2-Chloroethyl vinyl ether										
6.1E-03	i	1.0E-02	i	8.1E-02	i	8.6E-05	n	1		67-66-3	Chloroform	2.4E-01	ca**	5.2E-01	ca**	8.4E-02	ca**	1.6E-01	ca**	6.0E-01	3.0E-02
1.3E-02	h			6.3E-03	h	8.6E-02	n	1		74-87-3	Chloromethane	1.2E+00	ca	2.7E+00	ca	1.1E+00	ca	1.5E+00	ca		
5.8E-01	h			5.8E-01	r			0	0.1	95-69-2	4-Chloro-2-methylaniline	8.4E-01	ca	4.3E+00	ca	1.2E-02	ca	1.2E-01	ca		
4.6E-01	h			4.6E-01	r			0	0.1	3165-93-3	4-Chloro-2-methylaniline hydrochloride	1.1E+00	ca	5.4E+00	ca	1.5E-02	ca	1.5E-01	ca		
		8.0E-02	i			8.0E-02	r	1		91-58-7	beta-Chloronaphthalene	3.9E+03	nc	2.7E+04	nc	2.9E+02	nc	4.9E+02	nc		
2.5E-02	h			2.5E-02	r		r	1		88-73-3	o-Chloronitrobenzene	8.1E+00	ca	2.3E+01	ca	2.7E-01	ca	4.5E-01	ca		
1.8E-02	h			1.8E-02	r		r	1		100-00-5	p-Chloronitrobenzene	1.1E+01	ca	3.2E+01	ca	3.7E-01	ca	6.2E-01	ca		
		5.0E-03	i			5.0E-03	r	1		95-57-8	2-Chlorophenol	6.3E+01	nc	2.4E+02	nc	1.8E+01	nc	3.0E+01	nc	4.0E+00	2.0E-01
		2.9E-02	r			2.9E-02	h	1		75-29-6	2-Chloropropane	1.7E+02	nc	5.9E+02	nc	1.0E+02	nc	1.7E+02	nc		
1.1E-02	h	1.5E-02	i	1.1E-02	r	1.5E-02	r	0	0.1	1897-45-6	Chlorothalonil	4.4E+01	ca*	2.2E+02	ca*	6.1E-01	ca*	6.1E+00	ca*		
		2.0E-02	i			2.0E-02	r	1		95-49-8	o-Chlorotoluene	1.6E+02	nc	5.7E+02	nc	7.3E+01	nc	1.2E+02	nc		
		2.0E-01	i			2.0E-01	r	0	0.1	101-21-3	Chlorpropham	1.2E+04	nc	1.0E+05	max	7.3E+02	nc	7.3E+03	nc		
		3.0E-03	i			3.0E-03	r	0	0.1	2921-88-2	Chlorpyrifos	1.8E+02	nc	2.6E+03	nc	1.1E+01	nc	1.1E+02	nc		
		1.0E-02	n			1.0E-02	r	0	0.1	5598-13-0	Chlorpyrifos-methyl	6.1E+02	nc	8.8E+03	nc	3.7E+01	nc	3.6E+02	nc		
		5.0E-02	i			5.0E-02	r	0	0.1	64902-72-3	Chlorsulfuron	3.1E+03	nc	4.4E+04	nc	1.8E+02	nc	1.8E+03	nc		
		8.0E-04	h			8.0E-04	r	0	0.1	60238-56-4	Chlorthiophos	4.9E+01	nc	7.0E+02	nc	2.9E+00	nc	2.9E+01	nc		
				4.2E+01	i			0			Total Chromium (1:6 ratio Cr VI:Cr III)	2.1E+02	ca	4.5E+02	ca	1.6E-04	ca			3.8E+01	2.0E+00
		1.5E+00	i							16065-83-1	Chromium III	1.0E+05	max	1.0E+05	max	0.0E+00		5.5E+04	nc		
		3.0E-03	i	2.9E+02	i			0		18540-29-9	Chromium VI	3.0E+01	ca**	6.4E+01	ca	2.3E-05	ca	1.1E+02	nc	3.8E+01	2.0E+00
											"CAL-Modified PRG" (PEA, 1994)	2.0E-01						1.6E-01			
		6.0E-02	n							7440-48-4	Cobalt	4.7E+03	nc	1.0E+05	max			2.2E+03	nc		
				2.2E+00	i			0		8007-45-2	Coke Oven Emissions					3.1E-03	ca				
		3.7E-02	h					0		7440-50-8	Copper and compounds	2.9E+03	nc	7.6E+04	nc			1.4E+03	nc		
1.9E+00	h			1.9E+00	r			1		123-73-9	Crotonaldehyde	5.3E-03	ca	1.1E-02	ca	3.5E-03	ca	5.9E-03	ca		
		1.0E-01	i			1.1E-01	i	1		98-82-8	Cumene (isopropylbenzene)	1.6E+02	nc	5.2E+02	nc	4.0E+02	nc	6.6E+02	nc		
8.4E-01	h	2.0E-03	h	8.4E-01	r	2.0E-03	r	0	0.1	21725-46-2	Cyanazine	5.8E-01	ca	2.9E+00	ca	8.0E-03	ca	8.0E-02	ca		
		2.0E-02	i			8.6E-04	i	1		74-90-8	Cyanide and compounds	1.1E+01	nc	3.5E+01	nc	3.1E+00	nc	6.2E+00	nc		
		4.0E-02	i			4.0E-02	r	1		460-19-5	Cyanogen	1.3E+02	nc	4.3E+02	nc	1.5E+02	nc	2.4E+02	nc		
		9.0E-02	i			9.0E-02	r	1		506-68-3	Cyanogen bromide	2.9E+02	nc	9.7E+02	nc	3.3E+02	nc	5.5E+02	nc		
		5.0E-02	i			5.0E-02	r	1		506-77-4	Cyanogen chloride	1.6E+02	nc	5.4E+02	nc	1.8E+02	nc	3.0E+02	nc		
		5.7E+00	r			5.7E+00	n	1		110-82-7	Cyclohexane	1.4E+02	sat	1.4E+02	sat	2.1E+04	nc	3.5E+04	nc		
		5.0E+00	i			5.0E+00	r	0	0.1	108-94-1	Cyclohexanone	1.0E+05	max	1.0E+05	max	1.8E+04	nc	1.8E+05	nc		
		2.0E-01	i			2.0E-01	r	0	0.1	108-91-8	Cyclohexylamine	1.2E+04	nc	1.0E+05	max	7.3E+02	nc	7.3E+03	nc		
		5.0E-03	i			5.0E-03	r	0	0.1	68085-85-8	Cyhalothrin/Karate	3.1E+02	nc	4.4E+03	nc	1.8E+01	nc	1.8E+02	nc		
		1.0E-02	i			1.0E-02	r	0	0.1	52315-07-8	Cypermethrin	6.1E+02	nc	8.8E+03	nc	3.7E+01	nc	3.6E+02	nc		
		7.5E-03	i			7.5E-03	r	0	0.1	66215-27-8	Cyromazine	4.6E+02	nc	6.6E+03	nc	2.7E+01	nc	2.7E+02	nc		
		1.0E-02	i			1.0E-02	r	0	0.1	1861-32-1	Dacthal	6.1E+02	nc	8.8E+03	nc	3.7E+01	nc	3.6E+02	nc		
		3.0E-02	i			3.0E-02	r	0	0.1	75-99-0	Dalapon	1.8E+03	nc	2.6E+04	nc	1.1E+02	nc	1.1E+03	nc		
		2.5E-02	i			2.5E-02	r	0	0.1	39515-41-8	Danitol	1.5E+03	nc	2.2E+04	nc	9.1E+01	nc	9.1E+02	nc		
2.4E-01	i			2.4E-01	r			0	0.03	72-54-8	DDD	2.4E+00	ca	1.7E+01	ca	2.8E-02	ca	2.8E-01	ca	1.6E+01	8.0E-01
3.4E-01	i			3.4E-01	r			0	0.03	72-55-9	DDE	1.7E+00	ca	1.2E+01	ca	2.0E-02	ca	2.0E-01	ca	5.4E+01	3.0E+00
3.4E-01	i	5.0E-04	i	3.4E-01	i	5.0E-04	r	0	0.03	50-29-3	DDT	1.7E+00	ca*	1.2E+01	ca*	2.0E-02	ca*	2.0E-01	ca*	3.2E+01	2.0E+00

Key i=IRIS h=HEAST n=NCEA x=WITHDRAWN o=Other EPA DOCUMENTS r=ROUTE EXTRAPOLATION ca=CANCER PRG nc=NONCANCER PRG sat=SOIL SATURATION max=CEILING LIMIT *(where: nc < 100X ca) **(where: nc < 10X ca)

FOR PLANNING PURPOSES

TOXICITY INFORMATION											CONTAMINANT	PRELIMINARY REMEDIATION GOALS (PRGs)								SOIL SCREENING LEVELS Migration to Ground Water	
SFo 1/(mg/kg-d)		RfDo (mg/kg-d)		SFi 1/(mg/kg-d)		RfDi (mg/kg-d)		V O C	skin abs soils	CAS No.		Residential Soil (mg/kg)		Industrial Soil (mg/kg)		Ambient Air (ug/m^3)		Tap Water (ug/l)		DAF 20 (mg/kg)	DAF 1 (mg/kg)
		1.0E-02	i			1.0E-02	r	0	0.1	1163-19-5	Decabromodiphenyl ether	6.1E+02	nc	8.8E+03	nc	3.7E+01	nc	3.6E+02	nc		
		4.0E-05	i			4.0E-05	r	0	0.1	8065-48-3	Demeton	2.4E+00	nc	3.5E+01	nc	1.5E-01	nc	1.5E+00	nc		
6.1E-02	h			6.1E-02	r			0	0.1	2303-16-4	Diallate	8.0E+00	ca	4.0E+01	ca	1.1E-01	ca	1.1E+00	ca		
		9.0E-04	n			9.0E-04	r	0	0.1	333-41-5	Diazinon	5.5E+01	nc	7.9E+02	nc	3.3E+00	nc	3.3E+01	nc		
		4.0E-03	n			4.0E-03	r	1		132-64-9	Dibenzofuran	2.9E+02	nc	5.1E+03	nc	1.5E+01	nc	2.4E+01	nc		
		1.0E-02	i			1.0E-02	r	0	0.1	106-37-6	1,4-Dibromobenzene	6.1E+02	nc	8.8E+03	nc	3.7E+01	nc	3.6E+02	nc		
8.4E-02	i	2.0E-02	i	8.4E-02	r	2.0E-02	r	1		124-48-1	Dibromochloromethane	1.1E+00	ca	2.7E+00	ca	8.0E-02	ca	1.3E-01	ca	4.0E-01	2.0E-02
1.4E+00	h	5.7E-05	r	2.4E-03	h	5.7E-05	i	1		96-12-8	1,2-Dibromo-3-chloropropane	4.5E-01	ca**	4.0E+00	ca**	2.1E-01	nc	4.8E-02	ca**		
											"CAL-Modified PRG" (PEA, 1994)	6.0E-02				9.6E-04		4.7E-03			
8.5E+01	i	5.7E-05	r	7.7E-01	i	5.7E-05	h	1		106-93-4	1,2-Dibromoethane	6.9E-03	ca	4.8E-02	ca*	8.7E-03	ca*	7.6E-04	ca		
		1.0E-01	i			1.0E-01	r	0	0.1	84-74-2	Dibutyl phthalate	6.1E+03	nc	8.8E+04	nc	3.7E+02	nc	3.6E+03	nc	2.3E+03	2.7E+02
		3.0E-02	i			3.0E-02	r	0	0.1	1918-00-9	Dicamba		nc	2.6E+04	nc	1.1E+02	nc	1.1E+03	nc		
		9.0E-02	i			5.7E-02	h	1		95-50-1	1,2-Dichlorobenzene	3.7E+02	sat	3.7E+02	sat	2.1E+02	nc	3.7E+02	nc	1.7E+01	9.0E-01
		9.0E-04	n			9.0E-04	r	1		541-73-1	1,3-Dichlorobenzene	1.3E+01	nc	5.2E+01	nc	3.3E+00	nc	5.5E+00	nc		
2.4E-02	h	3.0E-02	n	2.2E-02	n	2.3E-01	i	1		106-46-7	1,4-Dichlorobenzene	3.4E+00	ca	8.1E+00	ca	3.1E-01	ca	5.0E-01	ca	2.0E+00	1.0E-01
4.5E-01	i			4.5E-01	r			0	0.1	91-94-1	3,3-Dichlorobenzidine	1.1E+00	ca	5.5E+00	ca	1.5E-02	ca	1.5E-01	ca	7.0E-03	3.0E-04
		3.0E-02	n			3.0E-02	r		0.1	90-98-2	4,4'-Dichlorobenzophenone	1.8E+03	nc	2.6E+04	nc	1.1E+02	nc	1.1E+03	nc		
6.3E+00	i			6.3E+00	h			1		764-41-0	1,4-Dichloro-2-butene	7.9E-03	ca	1.8E-02	ca	7.2E-04	ca	1.2E-03	ca		
		2.0E-01	i			5.7E-02	h	1		75-71-8	Dichlorodifluoromethane	9.4E+01	nc	3.1E+02	nc	2.1E+02	nc	3.9E+02	nc		
		1.0E-01	h			1.4E-01	h	1		75-34-3	1.1-Dichloroethane	5.9E+02	nc	2.1E+03	nc	5.2E+02	nc	8.1E+02	nc	2.3E+01	1.0E+00
5.7E-03				5.7E-03				1			"CAL-Modified PRG"	3.3E+00	ca	7.1E+00	ca	1.2E+00	ca	2.0E+00	ca		
9.1E-02	i	3.0E-02	n	9.1E-02	i	1.4E-03	n	1		107-06-2	1,2-Dichloroethane (EDC)	3.5E-01	ca*	7.6E-01	ca*	7.4E-02	ca*	1.2E-01	ca*	2.0E-02	1.0E-03
6.0E-01	i	9.0E-03	i	1.8E-01	i	9.0E-03	r	1		75-35-4	1.1-Dichloroethylene	5.4E-02	ca	1.2E-01	ca	3.8E-02	ca	4.6E-02	ca	6.0E-02	3.0E-03
		1.0E-02	h			1.0E-02	r	1		156-59-2	1,2-Dichloroethylene (cis)	4.3E+01	nc	1.5E+02	nc	3.7E+01	nc	6.1E+01	nc	4.0E-01	2.0E-02
		2.0E-02	i			2.0E-02	r	1		156-60-5	1,2-Dichloroethylene (trans)	6.3E+01	nc	2.1E+02	nc	7.3E+01	nc	1.2E+02	nc	7.0E-01	3.0E-02
		3.0E-03	i			3.0E-03	r	0	0.1	120-83-2	2.4-Dichlorophenol	1.8E+02	nc	2.6E+03	nc	1.1E+01	nc	1.1E+02	nc	1.0E+00	5.0E-02
		8.0E-03	i			8.0E-03	r	0	0.1	94-82-6	4-(2,4-Dichlorophenoxy)butyric Acid (2,4-DB)	4.9E+02	nc	7.0E+03	nc	2.9E+01	nc	2.9E+02	nc		
		1.0E-02	i			1.0E-02	r	0	0.05	94-75-7	2,4-Dichlorophenoxyacetic Acid (2,4-D)	6.9E+02	nc	1.2E+04	nc	3.7E+01	nc	3.6E+02	nc		
6.8E-02	h	1.1E-03	i	6.8E-02	r	1.1E-03	i	1		78-87-5	1.2-Dichloropropane	3.5E-01	ca*	7.7E-01	ca*	9.9E-02	ca*	1.6E-01	ca*	3.0E-02	1.0E-03
1.0E-01	i	3.0E-02	i	1.4E-02	i	5.7E-03	i	1		542-75-6	1,3-Dichloropropene	7.0E-01	ca	1.6E+00	ca	4.8E-01	ca	4.0E-01	ca	4.0E-03	2.0E-04
		3.0E-03	i			3.0E-03	r	0	0.1	616-23-9	2,3-Dichloropropanol	1.8E+02	nc	2.6E+03	nc	1.1E+01	nc	1.1E+02	nc		
2.9E-01	i	5.0E-04	i	2.9E-01	i	1.4E-04	i	0	0.1	62-73-7	Dichlorvos	1.7E+00	ca*	8.5E+00	ca*	2.3E-02	ca*	2.3E-01	ca*		
4.4E-01	x			4.4E-01	r			0	0.1	115-32-2	Dicofol	1.1E+00	ca	5.6E+00	ca	1.5E-02	ca	1.5E-01	ca		
		3.0E-02	h			5.7E-05	h	1		77-73-6	Dicyclopentadiene	5.4E-01	nc	1.8E+00	nc	2.1E-01	nc	4.2E-01	nc		
1.6E+01	i	5.0E-05	i	1.6E+01	i	5.0E-05	r	0	0.1	60-57-1	Dieldrin	3.0E-02	ca	1.5E-01	ca	4.2E-04	ca	4.2E-03	ca	4.0E-03	2.0E-04
		5.7E-03	r			5.7E-03	h	0	0.1	112-34-5	Diethylene glycol, monobutyl ether	3.5E+02	nc	5.0E+03	nc	2.1E+01	nc	2.1E+02	nc		
		2.0E+00	h			2.0E+00	r	0	0.1	111-90-0	Diethylene glycol, monoethyl ether	1.0E+05	max	1.0E+05	max	7.3E+03	nc	7.3E+04	nc		
		1.1E-02	h			1.1E-02	i	0	0.1	617-84-5	Diethylformamide	6.7E+02	nc	9.7E+03	nc	4.0E+01	nc	4.0E+02	nc		
1.2E-03	i	6.0E-01	i	1.2E-03	r	6.0E-01	i	0	0.1	103-23-1	Di(2-ethylhexyl)adipate	4.1E+02	ca	2.1E+03	ca	5.6E+00	ca	5.6E+01	ca		
		8.0E-01	i			8.0E-01	r	0	0.1	84-66-2	Diethyl phthalate	4.9E+04	nc	1.0E+05	max	2.9E+03	nc	2.9E+04	nc		
4.7E+03	h			4.7E+03	i			0	0.1	56-53-1	Diethylstilbestrol	1.0E-04	ca	5.2E-04	ca	1.4E-06	ca	1.4E-05	ca		
		8.0E-02	i			8.0E-02	r	0	0.1	43222-48-6	Difenzoquat (Avenge)	4.9E+03	nc	7.0E+04	nc	2.9E+02	nc	2.9E+03	nc		
		2.0E-02	i			2.0E-02	r	0	0.1	35367-38-5	Diflubenzuron	1.2E+03	nc	1.8E+04	nc	7.3E+01	nc	7.3E+02	nc		
		1.1E+01	i			1.1E+01	i	1		75-37-6	1.1-Difluoroethane					4.2E+04	nc	6.9E+04	nc		
		2.0E-02	n			2.0E-02	i		0.1	28553-12-0	**Diisononyl phthalate**	1.2E+03	nc	1.8E+04	nc	7.3E+01	nc	7.3E+02	nc		
		8.0E-02	i			8.0E-02	r	0	0.1	1445-75-6	Diisopropyl methylphosphonate	4.9E+03	nc	7.0E+04	nc	2.9E+02	nc	2.9E+03	nc		
		2.0E-02	i			2.0E-02	r	0	0.1	55290-64-7	Dimethipin	1.2E+03	nc	1.8E+04	nc	7.3E+01	nc	7.3E+02	nc		
		2.0E-04	i			2.0E-04	i	0	0.1	60-51-5	Dimethoate	1.2E+01	nc	1.8E+02	nc	7.3E-01	nc	7.3E+00	nc		
1.4E-02	h			1.4E-02	r			0	0.1	119-90-4	3,3'-Dimethoxybenzidine	3.5E+01	ca	1.8E+02	ca	4.8E-01	ca	4.8E+00	ca		
		5.7E-06	i			5.7E-06	x	1		124-40-3	Dimethylamine	6.7E-02	nc	2.5E-01	nc	2.1E-02	nc	3.5E-02	nc		
		2.0E-03	i			2.0E-03	r	0	0.1	121-69-7	N-N-Dimethylaniline	1.2E+02	nc	1.8E+03	nc	7.3E+00	nc	7.3E+01	nc		
7.5E-01	h			7.5E-01	r			0	0.1	95-68-1	2,4-Dimethylaniline	6.5E-01	ca	3.3E+00	ca	9.0E-03	ca	9.0E-02	ca		
5.8E-01	h			5.8E-01	r			0	0.1	21436-96-4	2.4-Dimethylaniline hydrochloride	8.4E-01	ca	4.3E+00	ca	1.2E-02	ca	1.2E-01	ca		
9.2E+00	h			9.2E+00	r			0	0.1	119-93-7	3,3'-Dimethylbenzidine	5.3E-02	ca	2.7E-01	ca	7.3E-04	ca	7.3E-03	ca		

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FOR PLANNING PURPOSES

TOXICITY INFORMATION											CONTAMINANT	PRELIMINARY REMEDIATION GOALS (PRGs)								SOIL SCREENING LEVELS	
																				Migration to Ground Water	
SFo 1/(mg/kg-d)		RfDo (mg/kg-d)		SFi 1/(mg/kg-d)		RfDi (mg/kg-d)		VOC	skin abs soils	CAS No.		Residential Soil (mg/kg)		Industrial Soil (mg/kg)		Ambient Air (ug/m^3)		Tap Water (ug/l)		DAF 20 (mg/kg)	DAF 1 (mg/kg)
2.6E+00	x			3.5E+00	x			0	0.1	57-14-7	1,1-Dimethylhydrazine	1.9E-01	ca	9.5E-01	ca	1.9E-03	ca	2.6E-02	ca		
3.7E+01	x			3.7E+01	x			0	0.1	540-73-8	1,2-Dimethylhydrazine	1.3E-02	ca	6.7E-02	ca	1.8E-04	ca	1.8E-03	ca		
		1.0E-01	h			8.6E-03	i	0	0.1	68-12-2	N,N-Dimethylformamide	6.1E+03	nc	8.8E+04	nc	3.1E+01	nc	3.6E+03	nc		
		1.0E-03	n			1.0E-03	r	0	0.1	122-09-8	Dimethylphenethylamine	6.1E+01	nc	8.8E+02	nc	3.7E+00	nc	3.6E+01	nc		
		2.0E-02	i			2.0E-02	r	0	0.1	105-67-9	2,4-Dimethylphenol	1.2E+03	nc	1.8E+04	nc	7.3E+01	nc	7.3E+02	nc	9.0E+00	4.0E-01
		6.0E-04	i			6.0E-04	r	0	0.1	576-26-1	2,6-Dimethylphenol	3.7E+01	nc	5.3E+02	nc	2.2E+00	nc	2.2E+01	nc		
		1.0E-03	i			1.0E-03	r	0	0.1	95-65-8	3,4-Dimethylphenol	6.1E+01	nc	8.8E+02	nc	3.7E+00	nc	3.6E+01	nc		
		1.0E+01	x			1.0E+01	r	0	0.1	131-11-3	Dimethyl phthalate	1.0E+05	max	1.0E+05	max	3.7E+04	nc	3.6E+05	nc		
		1.0E-01	i			1.0E-01	r	0	0.1	120-61-6	Dimethyl terephthalate	6.1E+03	nc	8.8E+04	nc	3.7E+02	nc	3.6E+03	nc		
		2.0E-03	i			2.0E-03	r	0	0.1	131-89-5	4,6-Dinitro-o-cyclohexyl phenol	1.2E+02	nc	1.8E+03	nc	7.3E+00	nc	7.3E+01	nc		
		4.0E-04	h			4.0E-04	r	0	0.1	528-29-0	1,2-Dinitrobenzene	2.4E+01	nc	3.5E+02	nc	1.5E+00	nc	1.5E+01	nc		
		1.0E-04	i			1.0E-04	r	0	0.1	99-65-0	1,3-Dinitrobenzene	6.1E+00	nc	8.8E+01	nc	3.7E-01	nc	3.6E+00	nc		
		4.0E-04	h			4.0E-04	r	0	0.1	100-25-4	1,4-Dinitrobenzene	2.4E+01	nc	3.5E+02	nc	1.5E+00	nc	1.5E+01	nc		
		2.0E-03	i			2.0E-03	r	0	0.1	51-28-5	2,4-Dinitrophenol	1.2E+02	nc	1.8E+03	nc	7.3E+00	nc	7.3E+01	nc	3.0E-01	1.0E-02
6.8E-01	i			6.8E-01	i			0	0.1	25321-14-6	Dinitrotoluene mixture	7.2E-01	ca	3.6E+00	ca	9.9E-03	ca	9.9E-02	ca	8.0E-04	4.0E-05
		2.0E-03	i			2.0E-03	r	0	0.1	121-14-2	2,4-Dinitrotoluene (see Dinitrotoluene mixture)	1.2E+02	nc	1.8E+03	nc	7.3E+00	nc	7.3E+01	nc	8.0E-04	4.0E-05
		1.0E-03	h			1.0E-03	r	0	0.1	606-20-2	2,6-Dinitrotoluene (see Dinitrotoluene mixture)	6.1E+01	nc	8.8E+02	nc	3.7E+00	nc	3.6E+01	nc	7.0E-04	3.0E-05
		1.0E-03	i			1.0E-03	r	0	0.1	88-85-7	Dinoseb	6.1E+01	nc	8.8E+02	nc	3.7E+00	nc	3.6E+01	nc		
		2.0E-02	h			2.0E-02	r	0	0.1	117-84-0	di-n-Octyl phthalate	1.2E+03	nc	1.0E+04	sat	7.3E+01	nc	7.3E+02	nc	1.0E+04	1.0E+04
1.1E-02	i			1.1E-02	i			0	0.1	123-91-1	1,4-Dioxane	4.4E+01	ca	2.2E+02	ca	6.1E-01	ca	6.1E+00	ca		
1.5E+05	h			1.5E+05	h			0	0.03	1746-01-6	Dioxin (2,3,7,8-TCDD)	3.9E-06	ca	2.7E-05	ca	4.5E-08	ca	4.5E-07	ca		
		3.0E-02	i			3.0E-02	r	0	0.1	957-51-7	Diphenamid	1.8E+03	nc	2.6E+04	nc	1.1E+02	nc	1.1E+03	nc		
		2.5E-02	i			2.5E-02	r	0	0.1	122-39-4	Diphenylamine	1.5E+03	nc	2.2E+04	nc	9.1E+01	nc	9.1E+02	nc		
		3.0E-04	n			3.0E-04	r		0.1	74-31-7	**N,N-Diphenyl-1,4 benzenediamine (DPPD)**	1.8E+01	nc	2.6E+02	nc	1.1E+00	nc	1.1E+01	nc		
8.0E-01	i			7.7E-01	i			0	0.1	122-66-7	1,2-Diphenylhydrazine	6.1E-01	ca	3.1E+00	ca	8.7E-03	ca	8.4E-02	ca		
		9.0E-03	n			9.0E-03	r	0	0.1	127-63-9	Diphenyl sulfone	5.5E+02	nc	7.9E+03	nc	3.3E+01	nc	3.3E+02	nc		
		2.2E-03	i			2.2E-03	r	0	0.1	85-00-7	Diquat	1.3E+02	nc	1.9E+03	nc	8.0E+00	nc	8.0E+01	nc		
8.6E+00	h			8.6E+00	r			0	0.1	1937-37-7	Direct black 38	5.7E-02	ca	2.9E-01	ca	7.8E-04	ca	7.8E-03	ca		
8.1E+00	h			8.1E+00	r			0	0.1	2602-46-2	Direct blue 6	6.0E-02	ca	3.0E-01	ca	8.3E-04	ca	8.3E-03	ca		
9.3E+00	h			9.3E+00	r			0	0.1	16071-86-6	Direct brown 95	5.2E-02	ca	2.7E-01	ca	7.2E-04	ca	7.2E-03	ca		
		4.0E-05	i			4.0E-05	r	0	0.1	298-04-4	Disulfoton	2.4E+00	nc	3.5E+01	nc	1.5E-01	nc	1.5E+00	nc		
		1.0E-02	i			1.0E-02	r	0	0.1	505-29-3	1,4-Dithiane	6.1E+02	nc	8.8E+03	nc	3.7E+01	nc	3.6E+02	nc		
		2.0E-03	i			2.0E-03	r	0	0.1	330-54-1	Diuron	1.2E+02	nc	1.8E+03	nc	7.3E+00	nc	7.3E+01	nc		
		4.0E-03	i			4.0E-03	r	0	0.1	2439-10-3	Dodine	2.4E+02	nc	3.5E+03	nc	1.5E+01	nc	1.5E+02	nc		
		2.0E-01	n							7429-91-6	**Dysprosium**	1.6E+04	nc	1.0E+05	max			7.3E+03	nc		
		6.0E-03	i			6.0E-03	r	0	0.1	115-29-7	Endosulfan	3.7E+02	nc	5.3E+03	nc	2.2E+01	nc	2.2E+02	nc	1.8E+01	9.0E-01
		2.0E-02	i			2.0E-02	r	0	0.1	145-73-3	Endothall	1.2E+03	nc	1.8E+04	nc	7.3E+01	nc	7.3E+02	nc		
		3.0E-04	i			3.0E-04	r	0	0.1	72-20-8	Endrin	1.8E+01	nc	2.6E+02	nc	1.1E+00	nc	1.1E+01	nc	1.0E+00	5.0E-02
9.9E-03	i	2.0E-03	h	4.2E-03	i	2.9E-04	i	1		106-89-8	Epichlorohydrin	7.6E+00	nc	2.6E+01	nc	1.0E+00	nc	2.0E+00	nc		
		5.7E-03	r			5.7E-03	i	0	0.1	106-88-7	1,2-Epoxybutane	3.5E+02	nc	5.0E+03	nc	2.1E+01	nc	2.1E+02	nc		
		2.5E-02	i			2.5E-02	r	0	0.1	759-94-4	EPTC (S-Ethyl dipropylthiocarbamate)	1.5E+03	nc	2.2E+04	nc	9.1E+01	nc	9.1E+02	nc		
		5.0E-03	i			5.0E-03	r	0	0.1	16672-87-0	Ethephon (2-chloroethyl phosphonic acid)	3.1E+02	nc	4.4E+03	nc	1.8E+01	nc	1.8E+02	nc		
		5.0E-04	i			5.0E-04	r	0	0.1	563-12-2	Ethion	3.1E+01	nc	4.4E+02	nc	1.8E+00	nc	1.8E+01	nc		
		4.0E-01	h			5.7E-02	i	0	0.1	110-80-5	2-Ethoxyethanol	2.4E+04	nc	1.0E+05	max	2.1E+02	nc	1.5E+04	nc		
		3.0E-01	h			3.0E-01	r	0	0.1	111-15-9	2-Ethoxyethanol acetate	1.8E+04	nc	1.0E+05	max	1.1E+03	nc	1.1E+04	nc		
		9.0E-01	i			9.0E-01	r	1		141-78-6	Ethyl acetate	1.9E+04	nc	3.7E+04	sat	3.3E+03	nc	5.5E+03	nc		
4.8E-02	h			4.8E-02	r			1		140-88-5	Ethyl acrylate	2.1E-01	ca	4.5E-01	ca	1.4E-01	ca	2.3E-01	ca		
		1.0E-01	i			2.9E-01	i	1		100-41-4	Ethylbenzene	2.3E+02	sat	2.3E+02	sat	1.1E+03	nc	1.3E+03	nc	1.3E+01	7.0E-01
2.9E-03	n	4.0E-01	n	2.9E-03	r	2.9E+00	i	1		75-00-3	Ethyl chloride	3.0E+00	ca	6.5E+00	ca	2.3E+00	ca	4.6E+00	ca		
		3.0E-01	h			3.0E-01	r	0	0.1	109-78-4	Ethylene cyanohydrin	1.8E+04	nc	1.0E+05	max	1.1E+03	nc	1.1E+04	nc		
		2.0E-02	h			2.0E-02	r	0	0.1	107-15-3	Ethylene diamine	1.2E+03	nc	1.8E+04	nc	7.3E+01	nc	7.3E+02	nc		
		2.0E+00	i			2.0E+00	r	0	0.1	107-21-1	Ethylene glycol	1.0E+05	max	1.0E+05	max	7.3E+03	nc	7.3E+04	nc		
		5.0E-01	i			3.7E+00	i	0	0.1	111-76-2	**Ethylene glycol, monobutyl ether**	3.1E+04	nc	1.0E+05	max	1.4E+04	nc	1.8E+04	nc		
1.0E+00	h			3.5E-01	h			1		75-21-8	Ethylene oxide	1.4E-01	ca	3.6E-01	ca	1.9E-02	ca	2.4E-02	ca		

Key i=IRIS h=HEAST n=NCEA x=WITHDRAWN o=Other EPA DOCUMENTS r=ROUTE EXTRAPOLATION ca=CANCER PRG nc=NONCANCER PRG sat=SOIL SATURATION max=CEILING LIMIT *(where: nc < 100X ca) **(where: nc < 10X ca)

FOR PLANNING PURPOSES

TOXICITY INFORMATION											CONTAMINANT	PRELIMINARY REMEDIATION GOALS (PRGs)								SOIL SCREENING LEVELS Migration to Ground Water	
SFo 1/(mg/kg-d)		RfDo (mg/kg-d)		SFi 1/(mg/kg-d)		RfDi (mg/kg-d)		V O C	skin abs. soils	CAS No.		Residential Soil (mg/kg)		Industrial Soil (mg/kg)		Ambient Air (ug/m^3)		Tap Water (ug/l)		DAF 20 (mg/kg)	DAF 1 (mg/kg)
1.1E-01	h	8.0E-05	i	1.1E-01	r	8.0E-05	r	0	0.1	96-45-7	Ethylene thiourea (ETU)	4.4E+00	ca**	2.2E+01	ca**	6.1E-02	ca**	6.1E-01	ca**		
		2.0E-01	i			2.0E-01	r	1		60-29-7	Ethyl ether	1.8E+03	sat	1.8E+03	sat	7.3E+02	nc	1.2E+03	nc		
		9.0E-02	h			9.0E-02	r	1		97-63-2	Ethyl methacrylate	1.4E+02	sat	1.4E+02	sat	3.3E+02	nc	5.5E+02	nc		
		1.0E-05	i			1.0E-05	r	0	0.1	2104-64-5	Ethyl p-nitrophenyl phenylphosphorothioate	6.1E-01	nc	8.8E+00	nc	3.7E-02	nc	3.6E-01	nc		
		3.0E+00	i			3.0E+00	r	0	0.1	84-72-0	Ethylphthalyl ethyl glycolate	1.0E+05	max	1.0E+05	max	1.1E+04	nc	1.1E+05	nc		
		8.0E-03	i			8.0E-03	r	0	0.1	101200-48-0	Express	4.9E+02	nc	7.0E+03	nc	2.9E+01	nc	2.9E+02	nc		
		2.5E-04	i			2.5E-04	r	0	0.1	22224-92-6	Fenamiphos	1.5E+01	nc	2.2E+02	nc	9.1E-01	nc	9.1E+00	nc		
		1.3E-02	i			1.3E-02	r	0	0.1	2164-17-2	Fluometuron	7.9E+02	nc	1.1E+04	nc	4.7E+01	nc	4.7E+02	nc		
		6.0E-02	i					0	0.1	16984-48-8	Flouride	3.7E+03	nc	5.3E+04	nc			2.2E+03	nc		
		8.0E-02	i			8.0E-02	r	0	0.1	59756-60-4	Fluridone	4.9E+03	nc	7.0E+04	nc	2.9E+02	nc	2.9E+03	nc		
		2.0E-02	i			2.0E-02	r	0	0.1	56425-91-3	Flurprimidol	1.2E+03	nc	1.8E+04	nc	7.3E+01	nc	7.3E+02	nc		
		6.0E-02	i			6.0E-02	r	0	0.1	66332-96-5	Flutolanil	3.7E+03	nc	5.3E+04	nc	2.2E+02	nc	2.2E+03	nc		
		1.0E-02	i			1.0E-02	r	0	0.1	69409-94-5	Fluvalinate	6.1E+02	nc	8.8E+03	nc	3.7E+01	nc	3.6E+02	nc		
3.5E-03	i	1.0E-01	i	3.5E-03	r	1.0E-01	r	0	0.1	133-07-3	Folpet	1.4E+02	ca*	7.0E+02	ca	1.9E+00	ca	1.9E+01	ca		
1.9E-01	i			1.9E-01	r			0	0.1	72178-02-0	Fomesafen	2.6E+00	ca	1.3E+01	ca	3.5E-02	ca	3.5E-01	ca		
		2.0E-03	i			2.0E-03	r	0	0.1	944-22-9	Fonofos	1.2E+02	nc	1.8E+03	nc	7.3E+00	nc	7.3E+01	nc		
		1.5E-01	i	4.6E-02	i			0	0.1	50-00-0	Formaldehyde	9.2E+03	nc	1.0E+05	nc	1.5E-01	ca	5.5E+03	nc		
		2.0E+00	h			2.0E+00	r	0	0.1	64-18-6	Formic Acid	1.0E+05	max	1.0E+05	max	7.3E+03	nc	7.3E+04	nc		
		3.0E+00	i			3.0E+00	r	0	0.1	39148-24-8	Fosetyl-al	1.0E+05	max	1.0E+05	max	1.1E+04	nc	1.1E+05	nc		
		3.0E+01	i			8.6E+00	h	1		76-13-1	Freon 113	5.6E+03	sat	5.6E+03	sat	3.1E+04	nc	5.9E+04	nc		
		1.0E-03	i			1.0E-03	r	1		110-00-9	Furan	2.5E+00	nc	8.5E+00	nc	3.7E+00	nc	6.1E+00	nc		
3.8E+00	h			3.8E+00	r			0	0.1	67-45-8	Furazolidone	1.3E-01	nc	6.5E-01	nc	1.8E-03	nc	1.8E-02	ca		
		3.0E-03	i			1.4E-02	h	0	0.1	98-01-1	Furfural	1.8E+02	nc	2.6E+03	nc	5.2E+01	nc	1.1E+02	nc		
5.0E+01	h			5.0E+01	r			0	0.1	531-82-8	Furium	9.7E-03	ca	4.9E-02	ca	1.3E-04	ca	1.3E-03	ca		
3.0E-02	i			3.0E-02	r			0	0.1	60568-05-0	Furmecyclox	1.6E+01	ca	8.2E+01	ca	2.2E-01	ca	2.2E+00	ca		
		4.0E-04	i			4.0E-04	r	0	0.1	77182-82-2	Glufosinate-ammonium	2.4E+01	nc	3.5E+02	nc	1.5E+00	nc	1.5E+01	nc		
		4.0E-04	i			2.9E-04	h	0	0.1	765-34-4	Glycidaldehyde	2.4E+01	nc	3.5E+02	nc	1.0E+00	nc	1.5E+01	nc		
		1.0E-01	i			1.0E-01	r	0	0.1	1071-83-6	Glyphosate	6.1E+03	nc	8.8E+04	nc	3.7E+02	nc	3.6E+03	nc		
		5.0E-05	i			5.0E-05	r	0	0.1	69806-40-2	Haloxyfop-methyl	3.1E+00	nc	4.4E+01	nc	1.8E-01	nc	1.8E+00	nc		
		1.3E-02	i			1.3E-02	r	0	0.1	79277-27-3	Harmony	7.9E+02	nc	1.1E+04	nc	4.7E+01	nc	4.7E+02	nc		
4.5E+00	i	5.0E-04	i	4.6E+00	i	5.0E-04	i	0	0.1	76-44-8	Heptachlor	1.1E-01	ca	5.5E-01	ca	1.5E-03	ca	1.5E-02	ca	2.3E+01	1.0E+00
9.1E+00	i	1.3E-05	i	9.1E+00	i	1.3E-05	i	0	0.1	1024-57-3	Heptachlor epoxide	5.3E-02	ca*	2.7E-01	ca*	7.4E-04	ca*	7.4E-03	ca*	7.0E-01	3.0E-02
		2.0E-03	i			2.0E-03	r	0	0.1	87-82-1	Hexabromobenzene	1.2E+02	nc	1.8E+03	nc	7.3E+00	nc	7.3E+01	nc		
1.6E+00	i	8.0E-04	i	1.6E+00	i	8.0E-04	r	0	0.1	118-74-1	Hexachlorobenzene	3.0E-01	ca	1.5E+00	ca	4.2E-03	ca	4.2E-02	ca	2.0E+00	1.0E-01
7.8E-02	i	3.0E-04	n	7.8E-02	i	3.0E-04	r	0	0.1	87-68-3	Hexachlorobutadiene	6.2E+00	ca**	3.2E+01	ca**	8.6E-02	ca*	8.6E-01	ca*	2.0E+00	1.0E-01
6.3E+00	i			6.3E+00	i			0	0.04	319-84-6	HCH (alpha)	9.0E-02	ca	5.9E-01	ca	1.1E-03	ca	1.1E-02	ca	5.0E-04	3.0E-05
1.8E+00	i			1.8E+00	i			0	0.04	319-85-7	HCH (beta)	3.2E-01	ca	2.1E+00	ca	3.7E-03	ca	3.7E-02	ca	3.0E-03	1.0E-04
1.3E+00	h	3.0E-04	i	1.3E+00	r	3.0E-04	r	0	0.04	58-89-9	HCH (gamma) Lindane	4.4E-01	ca*	2.9E+00	ca	5.2E-03	ca	5.2E-02	ca	9.0E-03	5.0E-04
1.8E+00	i			1.8E+00	i			0	0.04	608-73-1	HCH-technical	3.2E-01	ca	2.1E+00	ca	3.8E-03	ca	3.7E-02	ca	3.0E-03	1.0E-04
		7.0E-03	i			2.0E-05	h	0	0.1	77-47-4	Hexachlorocyclopentadiene	4.2E+02	nc	5.9E+03	nc	7.3E-02	nc	2.6E+02	nc	4.0E+02	2.0E+01
6.2E+03	i			4.6E+03	i			0	0.1	19408-74-3	Hexachlorodibenzo-p-dioxin mixture (HxCDD)	7.8E-05	ca	4.0E-04	ca	1.5E-06	ca	1.1E-05	ca		
1.4E-02	i	1.0E-03	i	1.4E-02	i	1.0E-03	r	0	0.1	67-72-1	Hexachloroethane	3.5E+01	ca**	1.8E+02	ca**	4.8E-01	ca**	4.8E+00	ca**	5.0E-01	2.0E-02
		3.0E-04	i			3.0E-04	r	0	0.1	70-30-4	Hexachlorophene	1.8E+01	nc	2.6E+02	nc	1.1E+00	nc	1.1E+01	nc		
1.1E-01	i	3.0E-03	i	1.1E-01	r	3.0E-03	r	0	0.1	121-82-4	Hexahydro-1,3,5-trinitro-1,3,5-triazine	4.4E+00	ca*	2.2E+01	ca	6.1E-02	ca	6.1E-01	ca		
		2.9E-06	r			2.9E-06	i	0	0.1	822-06-0	1,6-Hexamethylene diisocyanate	1.7E-01	nc	2.5E+00	nc	1.0E-02	nc	1.0E-01	nc		
		6.0E-02	h			5.7E-02	i	1		110-54-3	n-Hexane	1.1E+02	sat	1.1E+02	sat	2.1E+02	nc	3.5E+02	nc		
		3.3E-02	i			3.3E-02	r	0	0.1	51235-04-2	Hexazinone	2.0E+03	nc	2.9E+04	nc	1.2E+02	nc	1.2E+03	nc		
		5.0E-02	i			5.0E-02	r	0	0.1	2691-41-0	HMX	3.1E+03	nc	4.4E+04	nc	1.8E+02	nc	1.8E+03	nc		
3.0E+00	i			1.7E+01	i			0	0.1	302-01-2	Hydrazine, hydrazine sulfate	1.6E-01	ca	8.2E-01	ca	3.9E-04	ca	2.2E-02	ca		
3.0E+00	n			1.7E+01	n				0.1	60-34-4	Hydrazine, monomethyl	1.6E-01	ca	8.2E-01	ca	4.0E-04	ca	2.2E-02	ca		
3.0E+00	n			1.7E+01	n				0.1	57-14-7	Hydrazine, dimethyl	1.6E-01	ca	8.2E-01	ca	4.0E-04	ca	2.2E-02	ca		
						5.7E-03	i			7647-01-0	Hydrogen chloride					2.1E+01	nc				
		3.0E-03	i			2.9E-04	i			7783-06-4	Hydrogen sulfide					1.0E+00	nc	1.1E+02	nc		
		4.0E-02	h			4.0E-02	r	0	0.1	123-31-9	p-Hydroquinone	2.4E+03	nc	3.5E+04	nc	1.5E+02	nc	1.5E+03	nc		

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FOR PLANNING PURPOSES

TOXICITY INFORMATION											CONTAMINANT	PRELIMINARY REMEDIATION GOALS (PRGs)								SOIL SCREENING LEVELS Migration to Ground Water	
SFo 1/(mg/kg-d)		RfDo (mg/kg-d)		SFi 1/(mg/kg-d)		RfDi (mg/kg-d)		VOC	skin abs. soils	CAS No.		Residential Soil (mg/kg)		Industrial Soil (mg/kg)		Ambient Air (ug/m^3)		Tap Water (ug/l)		DAF 20 (mg/kg)	DAF 1 (mg/kg)
		1.3E-02	i			1.3E-02	r	0	0.1	35554-44-0	Imazalil	7.9E+02	nc	1.1E+04	nc	4.7E+01	nc	4.7E+02	nc		
		2.5E-01	i			2.5E-01	r	0	0.1	81335-37-7	Imazaquin	1.5E+04	nc	1.0E+05	max	9.1E+02	nc	9.1E+03	nc		
		4.0E-02	i			4.0E-02	r	0	0.1	36734-19-7	Iprodione	2.4E+03	nc	3.5E+04	nc	1.5E+02	nc	1.5E+03	nc		
		3.0E-01	n					0		7439-89-6	Iron	2.3E+04	nc	1.0E+05	max			1.1E+04	nc		
		3.0E-01	i			3.0E-01	r	1		78-83-1	Isobutanol	1.3E+04	nc	4.0E+04	sat	1.1E+03	nc	1.8E+03	nc		
9.5E-04	i	2.0E-01	i	9.5E-04	r	2.0E-01	r	0	0.1	78-59-1	Isophorone	5.1E+02	ca*	2.6E+03	ca*	7.1E+00	ca	7.1E+01	ca	5.0E-01	3.0E-02
		1.5E-02	i			1.5E-02	r	0	0.1	33820-53-0	Isopropalin	9.2E+02	nc	1.3E+04	nc	5.5E+01	nc	5.5E+02	nc		
		1.0E-01	i			1.1E-01	r	0	0.1	1832-54-8	Isopropyl methyl phosphonic acid	6.1E+03	nc	8.8E+04	nc	4.0E+02	nc	3.6E+03	nc		
		5.0E-02	i			5.0E-02	r	0	0.1	82558-50-7	Isoxaben	3.1E+03	nc	4.4E+04	nc	1.8E+02	nc	1.8E+03	nc		
1.8E+01	n			1.8E+01	r			0	0.1	143-50-0	Kepone	2.7E-02	ca	1.4E-01	ca	3.7E-04	ca	3.7E-03	ca		
		2.0E-03	i			2.0E-03	r	0	0.1	77501-63-4	Lactofen	1.2E+02	nc	1.8E+03	nc	7.3E+00	nc	7.3E+01	nc		
PRGs Based on EPA Models (IEUBK 1994 and TRW 1996)										7439-92-1	Lead	4.0E+02	nc	7.5E+02	nc						
		1.0E-07	i					0	0.1	78-00-2	Lead (tetraethyl)	6.1E-03	nc	8.8E-02	nc			3.6E-03	nc		
		2.0E-03	i			2.0E-03	r	0	0.1	330-55-2	Linuron	1.2E+02	nc	1.8E+03	nc	7.3E+00	nc	7.3E+01	nc		
		2.0E-02	x					0		7439-93-2	Lithium	1.6E+03	nc	4.1E+04	nc			7.3E+02	nc		
		2.0E-01	i			2.0E-01	r	0	0.1	83055-99-6	Londax	1.2E+04	nc	1.0E+05	max	7.3E+02	nc	7.3E+03	nc		
		2.0E-02	i			2.0E-02	r	0	0.1	121-75-5	Malathion	1.2E+03	nc	1.8E+04	nc	7.3E+01	nc	7.3E+02	nc		
		1.0E-01	i			1.0E-01	r	0	0.1	108-31-6	Maleic anhydride	6.1E+03	nc	8.8E+04	nc	3.7E+02	nc	3.6E+03	nc		
		5.0E-01	i			5.0E-01	r	1		123-33-1	Maleic hydrazide	1.7E+03	nc	2.4E+03	sat	1.8E+03	nc	3.0E+03	nc		
		2.0E-05	h			2.0E-05	r	0	0.1	109-77-3	Malononitrile	1.2E+00	nc	1.8E+01	nc	7.3E-02	nc	7.3E-01	nc		
		3.0E-02	h			3.0E-02	r	0	0.1	8018-01-7	Mancozeb	1.8E+03	nc	2.6E+04	nc	1.1E+02	nc	1.1E+03	nc		
6.0E-02	o	5.0E-03	i	6.0E-02	r	5.0E-03	r	0	0.1	12427-38-2	Maneb	8.1E+00	ca*	4.1E+01	ca	1.1E-01	ca	1.1E+00	ca		
		2.4E-02	i			1.4E-05	i	0		7439-96-5	Manganese and compounds	1.8E+03	nc	3.2E+04	nc	5.1E-02	nc	8.8E+02	nc		
		9.0E-05	h			9.0E-05	r	0	0.1	950-10-7	Mephosfolan	5.5E+00	nc	7.9E+01	nc	3.3E-01	nc	3.3E+00	nc		
		3.0E-02	i			3.0E-02	r	0	0.1	24307-26-4	Mepiquat	1.8E+03	nc	2.6E+04	nc	1.1E+02	nc	1.1E+03	nc		
2.9E-02	n	1.0E-01	n	2.9E-02	r	1.0E-01	r	0	0.1	149-30-4	2-Mercaptobenzothiazole	1.7E+01	ca	8.5E+01	ca	2.3E-01	ca	2.3E+00	ca		
		3.0E-04	i					0		7487-94-7	Mercury and compounds	2.3E+01	nc	6.1E+02	nc			1.1E+01	nc		
						8.6E-05	i			7439-97-6	Mercury (elemental)					3.1E-01	nc				
		1.0E-04	i					0	0.1	22967-92-6	Mercury (methyl)	6.1E+00	nc	8.8E+01	nc			3.6E+00	nc		
		3.0E-05	i			3.0E-05	r	0	0.1	150-50-5	Merphos	1.8E+00	nc	2.6E+01	nc	1.1E-01	nc	1.1E+00	nc		
		3.0E-05	i			3.0E-05	r	0	0.1	78-48-8	Merphos oxide	1.8E+00	nc	2.6E+01	nc	1.1E-01	nc	1.1E+00	nc		
		6.0E-02	i			6.0E-02	r	0	0.1	57837-19-1	Metalaxyl	3.7E+03	nc	5.3E+04	nc	2.2E+02	nc	2.2E+03	nc		
		1.0E-04	i			2.0E-04	h	1		126-98-7	Methacrylonitrile	2.1E+00	nc	8.8E+00	nc	7.3E-01	nc	1.0E+00	nc		
		5.0E-05	i			5.0E-05	r	0	0.1	10265-92-6	Methamidophos	3.1E+00	nc	4.4E+01	nc	1.8E-01	nc	1.8E+00	nc		
		5.0E-01	i			5.0E-01	r	0	0.1	67-56-1	Methanol	3.1E+04	nc	1.0E+05	max	1.8E+03	nc	1.8E+04	nc		
		1.0E-03	i			1.0E-03	r	0	0.1	950-37-8	Methidathion	6.1E+01	nc	8.8E+02	nc	3.7E+00	nc	3.6E+01	nc		
		2.5E-02	i			2.5E-02	r	1		16752-77-5	Methomyl	4.4E+01	nc	1.5E+02	nc	9.1E+01	nc	1.5E+02	nc		
		5.0E-03	i			5.0E-03	r	0	0.1	72-43-5	Methoxychlor	3.1E+02	nc	4.4E+03	nc	1.8E+01	nc	1.8E+02	nc	1.6E+02	8.0E+00
		1.0E-03	h			5.7E-03	i	0	0.1	109-86-4	2-Methoxyethanol	6.1E+01	nc	8.8E+02	nc	2.1E+01	nc	3.6E+01	nc		
		2.0E-03	h			2.0E-03	r	0	0.1	110-49-6	2-Methoxyethanol acetate	1.2E+02	nc	1.8E+03	nc	7.3E+00	nc	7.3E+01	nc		
4.6E-02	h			4.6E-02	r			0	0.1	99-59-2	2-Methoxy-5-nitroaniline	1.1E+01	ca	5.4E+01	ca	1.5E-01	ca	1.5E+00	ca		
		1.0E+00	h			1.0E+00	r	1		79-20-9	Methyl acetate	2.2E+04	nc	9.6E+04	nc	3.7E+03	nc	6.1E+03	nc		
		3.0E-02	h			3.0E-02	r	1		96-33-3	Methyl acrylate	7.0E+01	nc	2.3E+02	nc	1.1E+02	nc	1.8E+02	nc		
2.4E-01	h			2.4E-01	r			0	0.1	95-53-4	2-Methylaniline (o-toluidine)	2.0E+00	ca	1.0E+01	ca	2.8E-02	ca	2.8E-01	ca		
1.8E-01	h			1.8E-01	r			0	0.1	636-21-5	2-Methylaniline hydrochloride	2.7E+00	ca	1.4E+01	ca	3.7E-02	ca	3.7E-01	ca		
		1.0E+00	x			1.0E+00	r	0	0.1	79-22-1	Methyl chlorocarbonate	6.1E+04	nc	1.0E+05	max	3.7E+03	nc	3.6E+04	nc		
		5.0E-04	i			5.0E-04	r	0	0.1	94-74-6	2-Methyl-4-chlorophenoxyacetic acid	3.1E+01	nc	4.4E+02	nc	1.8E+00	nc	1.8E+01	nc		
		1.0E-02	i			1.0E-02	r	0	0.1	94-81-5	4-(2-Methyl-4-chlorophenoxy) butyric acid	6.1E+02	nc	8.8E+03	nc	3.7E+01	nc	3.6E+02	nc		
		1.0E-03	i			1.0E-03	r	0	0.1	93-65-2	2-(2-Methyl-4-chlorophenoxy) propionic acid	6.1E+01	nc	8.8E+02	nc	3.7E+00	nc	3.6E+01	nc		
		1.0E-03	i			1.0E-03	r	0	0.1	16484-77-8	2-(2-Methyl-1,4-chlorophenoxy) propionic acid	6.1E+01	nc	8.8E+02	nc	3.7E+00	nc	3.6E+01	nc		
		8.6E-01	r			8.6E-01	h	1		108-87-2	Methylcyclohexane	2.6E+03	nc	8.8E+03	nc	3.1E+03	nc	5.2E+03	nc		
2.5E-01	h			2.5E-01	r			0	0.1	101-77-9	4,4'-Methylenebisbenzeneamine	1.9E+00	ca	9.9E+00	ca	2.7E-02	ca	2.7E-01	ca		
1.3E-01	h	7.0E-04	h	1.3E-01	h	7.0E-04	r	0	0.1	101-14-4	4,4'-Methylene bis(2-chloroaniline)	3.7E+00	ca*	1.9E+01	ca*	5.2E-02	ca*	5.2E-01	ca*		
4.6E-02	i			4.6E-02	r			0	0.1	101-61-1	4,4'-Methylene bis(N,N'-dimethyl)aniline	1.1E+01	ca	5.4E+01	ca	1.5E-01	ca	1.5E+00	ca		

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FOR PLANNING PURPOSES

TOXICITY INFORMATION											CONTAMINANT	PRELIMINARY REMEDIATION GOALS (PRGs)								SOIL SCREENING LEVELS Migration to Ground Water	
SFo 1/(mg/kg-d)		RfDo (mg/kg-d)		SFi 1/(mg/kg-d)		RfDi (mg/kg-d)		VOC	skin abs. soils	CAS No		Residential Soil (mg/kg)		Industrial Soil (mg/kg)		Ambient Air (ug/m^3)		Tap Water (ug/l)		DAF 20 (mg/kg)	DAF 1 (mg/kg)
		1.0E-02	h			1.0E-02	r	1		74-95-3	Methylene bromide	6.7E+01	nc	2.4E+02	nc	3.7E+01	nc	6.1E+01	nc		
7.5E-03	i	6.0E-02	i	1.6E-03	i	8.6E-01	n	1		75-09-2	Methylene chloride	8.9E+00	ca	2.1E+01	ca	4.1E+00	ca	4.3E+00	ca	2.0E-02	1.0E-03
		1.7E-04	i			1.7E-04	i	0	0.1	101-68-8	4,4'-Methylene diphenyl diisocyanate	1.0E+01	nc	1.5E+02	nc	6.2E-01	nc	6.2E+00	nc		
		6.0E-01	i			2.9E-01	i	1		78-93-3	Methyl ethyl ketone	7.3E+03	nc	2.8E+04	nc	1.0E+03	nc	1.9E+03	nc		
1.1E+00	n			1.1E+00	r			0	0.1	60-34-4	Methyl hydrazine	4.4E-01	ca	2.2E+00	ca	6.1E-03	ca	6.1E-02	ca		
		8.0E-02	h			2.3E-02	h	1		108-10-1	Methyl isobutyl ketone	7.9E+02	nc	2.9E+03	nc	8.3E+01	nc	1.6E+02	nc		
		5.7E-04	i			5.7E-04	n	0	0.1	74-93-1	Methyl Mercaptan	3.5E+01	nc	5.0E+02	nc	2.1E+00	nc	2.1E+01	nc		
		1.4E+00	i			2.0E-01	i	1		80-62-6	Methyl methacrylate	2.2E+03	nc	2.7E+03	sat	7.3E+02	nc	1.4E+03	nc		
3.3E-02	n			3.3E-02	r			0	0.1	99-55-8	2-Methyl-5-nitroaniline	1.5E+01	ca	7.5E+01	ca	2.0E-01	ca	2.0E+00	ca		
		2.5E-04	i			2.5E-04	r	0	0.1	298-00-0	Methyl parathion	1.5E+01	nc	2.2E+02	nc	9.1E-01	nc	9.1E+00	nc		
		5.0E-02	i			5.0E-02	r	0	0.1	95-48-7	2-Methylphenol	3.1E+03	nc	4.4E+04	nc	1.8E+02	nc	1.8E+03	nc	1.5E+01	8.0E-01
		5.0E-02	i			5.0E-02	r	0	0.1	108-39-4	3-Methylphenol	3.1E+03	nc	4.4E+04	nc	1.8E+02	nc	1.8E+03	nc		
		5.0E-03	h			5.0E-03	r	0	0.1	106-44-5	4-Methylphenol	3.1E+02	nc	4.4E+03	nc	1.8E+01	nc	1.8E+02	nc		
		2.0E-02	n			2.0E-02	r	0	0.1	993-13-5	Methyl phosphonic acid	1.2E+03	nc	1.8E+04	nc	7.3E+01	nc	7.3E+02	nc		
		6.0E-03	h			1.1E-02	h	1		25013-15-4	Methyl styrene (mixture)	1.3E+02	nc	5.6E+02	nc	4.2E+01	nc	6.0E+01	nc		
		7.0E-02	h			7.0E-02	r	1		98-83-9	Methyl styrene (alpha)	6.8E+02	sat	6.8E+02	sat	2.6E+02	nc	4.3E+02	nc		
						8.6E-01	i	1		1634-04-4	Methyl tertbutyl ether (MTBE)					3.1E+03	nc	2.0E+01	nc/ca		
1.8E-03				1.8E-03				1			"CAL-Modified PRG"	1.7E+01	ca	3.7E+01	ca	3.7E+00	ca	6.2E+00	ca		
		1.5E-01	i			1.5E-01	r	0	0.1	51218-45-2	Metolaclor (Dual)	9.2E+03	nc	1.0E+05	max	5.5E+02	nc	5.5E+03	nc		
		2.5E-02	i			2.5E-02	i	0	0.1	21087-64-9	Metribuzin	1.5E+03	nc	2.2E+04	nc	9.1E+01	nc	9.1E+02	nc		
1.8E+00	x	2.0E-04	i	1.8E+00	r	2.0E-04	r	0	0.1	2385-85-5	Mirex	2.7E-01	ca*	1.4E+00	ca	3.7E-03	ca	3.7E-02	ca		
		2.0E-03	i			2.0E-03	r	0	0.1	2212-67-1	Molinate	1.2E+02	nc	1.8E+03	nc	7.3E+00	nc	7.3E+01	nc		
		5.0E-03	n					0		7439-98-7	Molybdenum	3.9E+02	nc	1.0E+04	nc			1.8E+02	nc		
		1.0E-01	h			1.0E-01	h	0	0.1	10599-90-3	Monochloramine	6.1E+03	nc	8.8E+04	nc	3.7E+02	nc	3.6E+03	nc		
		2.0E-03	i			2.0E-03	r	0	0.1	300-76-5	Naled	1.2E+02	nc	1.8E+03	nc	7.3E+00	nc	7.3E+01	nc		
		1.0E-01	i			1.0E-01	r	0	0.1	15299-99-7	Napropamide	6.1E+03	nc	8.8E+04	nc	3.7E+02	nc	3.6E+03	nc		
		2.0E-02	i					0		7440-02-0	Nickel (soluble salts)	1.6E+03	nc	4.1E+04	nc			7.3E+02	nc	1.3E+02	7.0E+00
											"CAL-Modified PRG" (PEA, 1994)	1.5E+02									
				8.4E-01	i			0			Nickel refinery dust					8.0E-03	ca				
				1.7E+00	i			0		12035-72-2	Nickel subsulfide			1.1E+04	ca	4.0E-03	ca				
		1.5E-03	x			1.5E-03	r	0	0.1	1929-82-4	Nitrapyrin	9.2E+01	nc	1.3E+03	nc	5.5E+00	nc	5.5E+01	nc		
Tap Water PRG Based on Infant NOAEL (see IRIS)										14797-55-8	Nitrate							1.0E+04	nc		
		1.0E-01	x							10102-43-9	Nitric Oxide	7.8E+03	nc	1.0E+05	max			3.6E+03	nc		
Tap Water PRG Based on Infant NOAEL (see IRIS)										14797-65-0	Nitrite							1.0E+03	nc		
		5.7E-05	i			5.7E-05	h	0	0.1	88-74-4	2-Nitroaniline	3.5E+00	nc	5.0E+01	nc	2.1E-01	nc	2.1E+00	nc		
		5.0E-04	i			5.7E-04	h	1		98-95-3	Nitrobenzene	2.0E+01	nc	1.1E+02	nc	2.1E+00	nc	3.4E+00	nc	1.0E-01	7.0E-03
		7.0E-02	h			7.0E-02	r	0	0.1	67-20-9	Nitrofurantoin	4.3E+03	nc	6.2E+04	nc	2.6E+02	nc	2.6E+03	nc		
1.5E+00	h			9.4E+00	h			0	0.1	59-87-0	Nitrofurazone	3.2E-01	ca	1.6E+00	ca	7.2E-04	ca	4.5E-02	ca		
1.4E-02	n			1.4E-02	r			0	0.1	55-63-0	Nitroglycerin	3.5E+01	ca	1.8E+02	ca	4.8E-01	ca	4.8E+00	ca		
		1.0E-01	i			1.0E-01	r	0	0.1	556-88-7	Nitroguanidine	6.1E+03	nc	8.8E+04	nc	3.7E+02	nc	3.6E+03	nc		
		8.0E-03	n			8.0E-03	r	0	0.1	100-02-7	4-Nitrophenol	4.9E+02	nc	7.0E+03	nc	2.9E+01	nc	2.9E+02	nc		
9.4E+00	r	5.7E-03	r	9.4E+00	h	5.7E-03	i	1		79-46-9	2-Nitropropane					7.2E-04	ca	1.2E-03	ca		
5.4E+00	i			5.6E+00	i			1		924-16-3	N-Nitrosodi-n-butylamine	2.4E-02	ca	6.1E-02	ca	1.2E-03	ca	2.0E-03	ca		
2.8E+00	i			2.8E+00	r			0	0.1	1116-54-7	N-Nitrosodiethanolamine	1.7E-01	ca	8.8E-01	ca	2.4E-03	ca	2.4E-02	ca		
1.5E+02	i			1.5E+02	i			0	0.1	55-18-5	N-Nitrosodiethylamine	3.2E-03	ca	1.6E-02	ca	4.5E-05	ca	4.5E-04	ca		
5.1E+01	i			4.9E+01	i			0	0.1	62-75-9	N-Nitrosodimethylamine	9.5E-03	ca	4.8E-02	ca	1.4E-04	ca	1.3E-03	ca		
4.9E-03	i			4.9E-03	r			0	0.1	86-30-6	N-Nitrosodiphenylamine	9.9E+01	ca	5.0E+02	ca	1.4E+00	ca	1.4E+01	ca	1.0E+00	6.0E-02
7.0E+00	i			7.0E+00	r			0	0.1	621-64-7	N-Nitroso di-n-propylamine	6.9E-02	ca	3.5E-01	ca	9.6E-04	ca	9.6E-03	ca	5.0E-05	2.0E-06
2.2E+01	i			2.2E+01	r			0	0.1	10595-95-6	N-Nitroso-N-methylethylamine	2.2E-02	ca	1.1E-01	ca	3.1E-04	ca	3.1E-03	ca		
2.1E+00	i			2.1E+00	i			0	0.1	930-55-2	N-Nitrosopyrrolidine	2.3E-01	ca	1.2E+00	ca	3.1E-03	ca	3.2E-02	ca		
		1.0E-02	n			1.0E-02	r	1		99-08-1	m-Nitrotoluene	3.7E+02	nc	1.0E+03	sat	3.7E+01	nc	6.1E+01	nc		
		1.0E-02	h			1.0E-02	r	1		88-72-2	o-Nitrotoluene	3.7E+02	nc	1.0E+03	sat	3.7E+01	nc	6.1E+01	nc		
		1.0E-02	h			1.0E-02	r	1		99-99-0	p-Nitrotoluene	3.7E+02	nc	1.0E+03	sat	3.7E+01	nc	6.1E+01	nc		
		4.0E-02	i			4.0E-02	i	0	0.1	27314-13-2	Norflurazon	2.4E+03	nc	3.5E+04	nc	1.5E+02	nc	1.5E+03	nc		

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FOR PLANNING PURPOSES

TOXICITY INFORMATION											CONTAMINANT	PRELIMINARY REMEDIATION GOALS (PRGs)								SOIL SCREENING LEVELS Migration to Ground Water	
SFo 1/(mg/kg-d)		RfDo (mg/kg-d)		SFi 1/(mg/kg-d)		RfDi (mg/kg-d)		V O C	skin abs. soils	CAS No		Residential Soil (mg/kg)		Industrial Soil (mg/kg)		Ambient Air (ug/m^3)		Tap Water (ug/l)		DAF 20 (mg/kg)	DAF 1 (mg/kg)
		7.0E-04	i			7.0E-04	r	0	0.1	85509-19-9	NuStar	4.3E+01	nc	6.2E+02	nc	2.6E+00	nc	2.6E+01	nc		
		3.0E-03	i			3.0E-03	r	0	0.1	32536-52-0	Octabromodiphenyl ether	1.8E+02	nc	2.6E+03	nc	1.1E+01	nc	1.1E+02	nc		
		2.0E-03	h			2.0E-03	r	0	0.1	152-16-9	Octamethylpyrophosphoramide	1.2E+02	nc	1.8E+03	nc	7.3E+00	nc	7.3E+01	nc		
		5.0E-02	i			5.0E-02	r	0	0.1	19044-88-3	Oryzalin	3.1E+03	nc	4.4E+04	nc	1.8E+02	nc	1.8E+03	nc		
		5.0E-03	i			5.0E-03	r	0	0.1	19666-30-9	Oxadiazon	3.1E+02	nc	4.4E+03	nc	1.8E+01	nc	1.8E+02	nc		
		2.5E-02	i			2.5E-02	r	0	0.1	23135-22-0	Oxamyl	1.5E+03	nc	2.2E+04	nc	9.1E+01	nc	9.1E+02	nc		
		3.0E-03	i			3.0E-03	r	0	0.1	42874-03-3	Oxyfluorfen	1.8E+02	nc	2.6E+03	nc	1.1E+01	nc	1.1E+02	nc		
		1.3E-02	i			1.3E-02	r	0	0.1	76738-62-0	Paclobutrazol	7.9E+02	nc	1.1E+04	nc	4.7E+01	nc	4.7E+02	nc		
		4.5E-03	i			4.5E-03	r	0	0.1	4685-14-7	Paraquat	2.7E+02	nc	4.0E+03	nc	1.6E+01	nc	1.6E+02	nc		
		6.0E-03	h			6.0E-03	r	0	0.1	56-38-2	Parathion	3.7E+02	nc	5.3E+03	nc	2.2E+01	nc	2.2E+02	nc		
		5.0E-02	n			5.0E-02	r	0	0.1	1114-71-2	Pebulate	3.1E+03	nc	4.4E+04	nc	1.8E+02	nc	1.8E+03	nc		
		4.0E-02	i			4.0E-02	r	0	0.1	40487-42-1	Pendimethalin	2.4E+03	nc	3.5E+04	nc	1.5E+02	nc	1.5E+03	nc		
2.3E-02	h			2.3E-02	r			0	0.1	87-84-3	Pentabromo-6-chloro cyclohexane	2.1E+01	ca	1.1E+02	ca	2.9E-01	ca	2.9E+00	ca		
		2.0E-03	i			2.0E-03	r	0	0.1	32534-81-9	Pentabromodiphenyl ether	1.2E+02	nc	1.8E+03	nc	7.3E+00	nc	7.3E+01	nc		
		8.0E-04	i			8.0E-04	r	0	0.1	608-93-5	Pentachlorobenzene	4.9E+01	nc	7.0E+02	nc	2.9E+00	nc	2.9E+01	nc		
2.6E-01	h	3.0E-03	i	2.6E-01	r	3.0E-03	r	0	0.1	82-68-8	Pentachloronitrobenzene	1.9E+00	ca*	9.5E+00	ca	2.6E-02	ca	2.6E-01	ca		
1.2E-01	i	3.0E-02	i	1.2E-01	r	3.0E-02	r	0	0.25	87-86-5	Pentachlorophenol	3.0E+00	ca	1.1E+01	ca	5.6E-02	ca	5.6E-01	ca	3.0E-02	1.0E-03
		5.0E-04	x					0		7601-90-3	Perchlorate	3.9E+01	nc	1.0E+03	nc			1.8E+01	nc		
		5.0E-02	i			5.0E-02	r	0	0.1	52645-53-1	Permethrin	3.1E+03	nc	4.4E+04	nc	1.8E+02	nc	1.8E+03	nc		
		2.5E-01	i			2.5E-01	r	0	0.1	13684-63-4	Phenmedipham	1.5E+04	nc	1.0E+05	max	9.1E+02	nc	9.1E+03	nc		
		6.0E-01	i			6.0E-01	r	0	0.1	108-95-2	Phenol	3.7E+04	nc	1.0E+05	max	2.2E+03	nc	2.2E+04	nc	1.0E+02	5.0E+00
		2.0E-03	n			2.0E-03	r	0	0.1	92-84-2	Phenothiazine	1.2E+02	nc	1.8E+03	nc	7.3E+00	nc	7.3E+01	nc		
		6.0E-03	i			6.0E-03	r	0	0.1	108-45-2	m-Phenylenediamine	3.7E+02	nc	5.3E+03	nc	2.2E+01	nc	2.2E+02	nc		
		1.9E-01	h			1.9E-01	r	0	0.1	106-50-3	p-Phenylenediamine	1.2E+04	nc	1.0E+05	max	6.9E+02	nc	6.9E+03	nc		
		8.0E-05	i			8.0E-05	r	0	0.1	62-38-4	Phenylmercuric acetate	4.9E+00	nc	7.0E+01	nc	2.9E-01	nc	2.9E+00	nc		
1.9E-03	h			1.9E-03	r			0	0.1	90-43-7	2-Phenylphenol	2.5E+02	ca	1.3E+03	ca	3.5E+00	ca	3.5E+01	ca		
		2.0E-04	h			2.0E-04	r	0	0.1	298-02-2	Phorate	1.2E+01	nc	1.8E+02	nc	7.3E-01	nc	7.3E+00	nc		
		2.0E-02	i			2.0E-02	r	0	0.1	732-11-6	Phosmet	1.2E+03	nc	1.8E+04	nc	7.3E+01	nc	7.3E+02	nc		
		3.0E-04	h			8.6E-05	i	0	0.1	7803-51-2	Phosphine	1.8E+01	nc	2.6E+02	nc	3.1E-01	nc	1.1E+01	nc		
						2.9E-03	i			7664-38-2	Phosphoric acid					1.0E+01	nc				
		2.0E-05	i					0		7723-14-0	Phosphorus (white)	1.6E+00	nc	4.1E+01	nc			7.3E-01	nc		
		1.0E+00	n			1.0E+00	r	0	0.1	100-21-0	p-Phthalic acid	6.1E+04	nc	1.0E+05	max	3.7E+03	nc	3.6E+04	nc		
		2.0E+00	i			3.4E-02	h	0	0.1	85-44-9	Phthalic anhydride	1.0E+05	max	1.0E+05	max	1.2E+02	nc	7.3E+04	nc		
		7.0E-02	i			7.0E-02	r	0	0.1	1918-02-1	Picloram	4.3E+03	nc	6.2E+04	nc	2.6E+02	nc	2.6E+03	nc		
		1.0E-02	i			1.0E-02	r	0	0.1	23505-41-1	Pirimiphos-methyl	6.1E+02	nc	8.8E+03	nc	3.7E+01	nc	3.6E+02	nc		
8.9E+00	h	7.0E-06	h	8.9E+00	r	7.0E-06	r	0	0.1		Polybrominated biphenyls	5.5E-02	ca**	2.8E-01	ca*	7.6E-04	ca*	7.6E-03	ca*		
2.0E+00	i			2.0E+00	i			0	0.14	1336-36-3	Polychlorinated biphenyls (PCBs)	2.2E-01	ca	1.0E+00	ca	3.4E-03	ca	3.4E-02	ca		
7.0E-02	i	7.0E-05	i	7.0E-02	i	7.0E-05	r	0	0.14	12674-11-2	Aroclor 1016	3.9E+00	nc	2.9E+01	ca**	9.6E-02	ca**	9.6E-01	ca**		
2.0E+00	i			2.0E+00	i			0	0.14	11104-28-2	Aroclor 1221	2.2E-01	ca	1.0E+00	ca	3.4E-03	ca	3.4E-02	ca		
2.0E+00	i			2.0E+00	i			0	0.14	11141-16-5	Aroclor 1232	2.2E-01	ca	1.0E+00	ca	3.4E-03	ca	3.4E-02	ca		
2.0E+00	i			2.0E+00	i			0	0.14	53469-21-9	Aroclor 1242	2.2E-01	ca	1.0E+00	ca	3.4E-03	ca	3.4E-02	ca		
2.0E+00	i			2.0E+00	i			0	0.14	12672-29-6	Aroclor 1248	2.2E-01	ca	1.0E+00	ca	3.4E-03	ca	3.4E-02	ca		
2.0E+00	i	2.0E-05	i	2.0E+00	i	2.0E-05	r	0	0.14	11097-69-1	Aroclor 1254	2.2E-01	ca**	1.0E+00	ca*	3.4E-03	ca*	3.4E-02	ca*		
2.0E+00	i			2.0E+00	i			0	0.14	11096-82-5	Aroclor 1260	2.2E-01	ca	1.0E+00	ca	3.4E-03	ca	3.4E-02	ca		
									0.13		Polynuclear aromatic hydrocarbons (PAHs)										
		6.0E-02	i			6.0E-02	r	1		83-32-9	Acenaphthene	3.7E+03	nc	3.8E+04	nc	2.2E+02	nc	3.7E+02	nc	5.7E+02	2.9E+01
		3.0E-01	i			3.0E-01	r	1		120-12-7	Anthracene	2.2E+04	nc	1.0E+05	max	1.1E+03	nc	1.8E+03	nc	1.2E+04	5.9E+02
7.3E-01	n			3.1E-01	n			0	0.13	56-55-3	Benz[a]anthracene	6.2E-01	ca	2.9E+00	ca	2.2E-02	ca	9.2E-02	ca	2.0E+00	8.0E-02
7.3E-01	n			3.1E-01	n			0	0.13	205-99-2	Benzo[b]fluoranthene	6.2E-01	ca	2.9E+00	ca	2.2E-02	ca	9.2E-02	ca	5.0E+00	2.0E-01
7.3E-02	n			3.1E-02	n			0	0.13	207-08-9	Benzo[k]fluoranthene	6.2E+00	ca	2.9E+01	ca	2.2E-01	ca	9.2E-01	ca	4.9E+01	2.0E+00
											"CAL-Modified PRG" (PEA, 1994)	6.1E-01									
7.3E+00	i			3.1E+00	n			0	0.13	50-32-8	Benzo[a]pyrene	6.2E-02	ca	2.9E-01	ca	2.2E-03	ca	9.2E-03	ca	8.0E+00	4.0E-01
											"CAL-Modified PRG" (PEA, 1994)							1.5E-03			
7.3E-03	n			3.1E-03	n			0	0.13	218-01-9	Chrysene	6.2E+01	ca	2.9E+02	ca	2.2E+00	ca	9.2E+00	ca	1.6E+02	8.0E+00

Key i=IRIS h=HEAST n=NCEA x=WITHDRAWN o=Other EPA DOCUMENTS r=ROUTE EXTRAPOLATION ca=CANCER PRG nc=NONCANCER PRG sat=SOIL SATURATION max=CEILING LIMIT *(where: nc < 100X ca) **(where: nc < 10X ca)

FOR PLANNING PURPOSES

TOXICITY INFORMATION											CONTAMINANT	PRELIMINARY REMEDIATION GOALS (PRGs)								SOIL SCREENING LEVELS Migration to Ground Water	
SFo 1/(mg/kg-d)		RfDo (mg/kg-d)		SFi 1/(mg/kg-d)		RfDi (mg/kg-d)		VOC	skin abs. soils	CAS No		Residential Soil (mg/kg)		Industrial Soil (mg/kg)		Ambient Air (ug/m^3)		Tap Water (ug/l)		DAF 20 (mg/kg)	DAF 1 (mg/kg)
											"CAL-Modified PRG" (PEA, 1994)	6.1E+00									
7.3E+00	n			3.1E+00	n			0	0.13	53-70-3	Dibenz[ah]anthracene	6.2E-02	ca	2.9E-01	ca	2.2E-03	ca	9.2E-03	ca	2.0E+00	8.0E-02
		4.0E-02	i			4.0E-02	r	0	0.13	206-44-0	Fluoranthene	2.3E+03	nc	3.0E+04	nc	1.5E+02	nc	1.5E+03	nc	4.3E+03	2.1E+02
		4.0E-02	i			4.0E-02	r	1		86-73-7	Fluorene	2.6E+03	nc	3.3E+04	nc	1.5E+02	nc	2.4E+02	nc	5.6E+02	2.8E+01
7.3E-01	n			3.1E-01	n			0	0.13	193-39-5	Indeno[1,2,3-cd]pyrene	6.2E-01	ca	2.9E+00	ca	2.2E-02	ca	9.2E-02	ca	1.4E+01	7.0E-01
		2.0E-02	i			8.6E-04	i	1		91-20-3	Naphthalene	5.6E+01	nc	1.9E+02	nc	3.1E+00	nc	6.2E+00	nc	8.4E+01	4.0E+00
		3.0E-02	i			3.0E-02	r	1		129-00-0	Pyrene	2.3E+03	nc	5.4E+04	nc	1.1E+02	nc	1.8E+02	nc	4.2E+03	2.1E+02
1.5E-01	i	9.0E-03	i	1.5E-01	r	9.0E-03	r	0	0.1	67747-09-5	Prochloraz	3.2E+00	ca	1.6E+01	ca	4.5E-02	ca	4.5E-01	ca		
		6.0E-03	h			6.0E-03	r	0	0.1	26399-36-0	Profluralin	3.7E+02	nc	5.3E+03	nc	2.2E+01	nc	2.2E+02	nc		
		1.5E-02	i			1.5E-02	r	0	0.1	1610-18-0	Prometon	9.2E+02	nc	1.3E+04	nc	5.5E+01	nc	5.5E+02	nc		
		4.0E-03	i			4.0E-03	r	0	0.1	7287-19-6	Prometryn	2.4E+02	nc	3.5E+03	nc	1.5E+01	nc	1.5E+02	nc		
		7.5E-02	i			7.5E-02	r	0	0.1	23950-58-5	Pronamide	4.6E+03	nc	6.6E+04	nc	2.7E+02	nc	2.7E+03	nc		
		1.3E-02	i			1.3E-02	r	0	0.1	1918-16-7	Propachlor	7.9E+02	nc	1.1E+04	nc	4.7E+01	nc	4.7E+02	nc		
		5.0E-03	i			5.0E-03	r	0	0.1	709-98-8	Propanil	3.1E+02	nc	4.4E+03	nc	1.8E+01	nc	1.8E+02	nc		
		2.0E-02	i			2.0E-02	r	0	0.1	2312-35-8	Propargite	1.2E+03	nc	1.8E+04	nc	7.3E+01	nc	7.3E+02	nc		
		2.0E-03	i			2.0E-03	r	0	0.1	107-19-7	Propargyl alcohol	1.2E+02	nc	1.8E+03	nc	7.3E+00	nc	7.3E+01	nc		
		2.0E-02	i			2.0E-02	r	0	0.1	139-40-2	Propazine	1.2E+03	nc	1.8E+04	nc	7.3E+01	nc	7.3E+02	nc		
		2.0E-02	i			2.0E-02	r	0	0.1	122-42-9	Propham	1.2E+03	nc	1.8E+04	nc	7.3E+01	nc	7.3E+02	nc		
		1.3E-02	i			1.3E-02	r	0	0.1	60207-90-1	Propiconazole	7.9E+02	nc	1.1E+04	nc	4.7E+01	nc	4.7E+02	nc		
		1.0E-01	i			1.1E-01	i	1		98-82-8	Isopropylbenzene (Cumene)	1.6E+02	nc	5.2E+02	nc	4.0E+02	nc	6.6E+02	nc		
		1.0E-02	n			1.0E-02	r	1		103-65-1	n-Propylbenzene	1.4E+02	nc	2.4E+02	sat	3.7E+01	nc	6.1E+01	nc		
		2.0E+01	n			2.0E+01	r	0	0.1	57-55-6	Propylene glycol	1.0E+05	max	1.0E+05	max	7.3E+04	nc	7.3E+05	nc		
		7.0E-01	n			7.0E-01	r	0	0.1	111-35-3	Propylene glycol, monoethyl ether	4.3E+04	nc	1.0E+05	max	2.6E+03	nc	2.6E+04	nc		
		7.0E-01	h			5.7E-01	i	0	0.1	107-98-2	Propylene glycol, monomethyl ether	4.3E+04	nc	1.0E+05	max	2.1E+03	nc	2.6E+04	nc		
2.4E-01	i	8.6E-03	i	1.3E-02	i	8.6E-03	i	1		75-56-9	Propylene oxide	1.9E+00	ca*	9.1E+00	ca*	5.2E-01	ca*	2.2E-01	ca		
		2.5E-01	i			2.5E-01	r	0	0.1	81335-77-5	Pursuit	1.5E+04	nc	1.0E+05	max	9.1E+02	nc	9.1E+03	nc		
		2.5E-02	i			2.5E-02	r	0	0.1	51630-58-1	Pydrin	1.5E+03	nc	2.2E+04	nc	9.1E+01	nc	9.1E+02	nc		
		1.0E-03	i			1.0E-03	r	0	0.1	110-86-1	Pyridine	6.1E+01	nc	8.8E+02	nc	3.7E+00	nc	3.6E+01	nc		
		5.0E-04	i			5.0E-04	r	0	0.1	13593-03-8	Quinalphos	3.1E+01	nc	4.4E+02	nc	1.8E+00	nc	1.8E+01	nc		
1.2E+01	h			1.2E+01	r			0	0.1	91-22-5	Quinoline	4.1E-02	ca	2.1E-01	ca	5.6E-04	ca	5.6E-03	ca		
1.1E-01	i	3.0E-03	i	1.1E-01	r	3.0E-03	r	0	0.1	121-82-4	RDX (Cyclonite)	4.4E+00	ca*	2.2E+01	ca	6.1E-02	ca	6.1E-01	ca		
		3.0E-02	i			3.0E-02	r	0	0.1	10453-86-8	Resmethrin	1.8E+03	nc	2.6E+04	nc	1.1E+02	nc	1.1E+03	nc		
		5.0E-02	h			5.0E-02	r	0	0.1	299-84-3	Ronnel	3.1E+03	nc	4.4E+04	nc	1.8E+02	nc	1.8E+03	nc		
		4.0E-03	i			4.0E-03	r	0	0.1	83-79-4	Rotenone	2.4E+02	nc	3.5E+03	nc	1.5E+01	nc	1.5E+02	nc		
		2.5E-02	i			2.5E-02	r	0	0.1	78587-05-0	Savey	1.5E+03	nc	2.2E+04	nc	9.1E+01	nc	9.1E+02	nc		
		5.0E-03	i					0	0.1	7783-00-8	Selenious Acid	3.1E+02	nc	4.4E+03	nc			1.8E+02	nc		
		5.0E-03	i					0		7782-49-2	Selenium	3.9E+02	nc	1.0E+04	nc			1.8E+02	nc	5.0E+00	3.0E-01
		5.0E-03	h					0	0.1	630-10-4	Selenourea	3.1E+02	nc	4.4E+03	nc			1.8E+02	nc		
		9.0E-02	i			9.0E-02	r	0	0.1	74051-80-2	Sethoxydim	5.5E+03	nc	7.9E+04	nc	3.3E+02	nc	3.3E+03	nc		
		5.0E-03	i					0		7440-22-4	Silver and compounds	3.9E+02	nc	1.0E+04	nc			1.8E+02	nc	3.4E+01	2.0E+00
1.2E-01	h	5.0E-03	i	1.2E-01	r	2.0E-03	r	0	0.1	122-34-9	Simazine	4.1E+00	ca*	2.1E+01	ca	5.6E-02	ca	5.6E-01	ca		
		4.0E-03	i							26628-22-8	Sodium azide										
2.7E-01	h	3.0E-02	i	2.7E-01	r	3.0E-02	r	0	0.1	148-18-5	Sodium diethyldithiocarbamate	1.8E+00	ca	9.1E+00	ca	2.5E-02	ca	2.5E-01	ca		
		2.0E-05	i			2.0E-05	r	0	0.1	62-74-8	Sodium fluoroacetate	1.2E+00	nc	1.8E+01	nc	7.3E-02	nc	7.3E-01	nc		
		1.0E-03	h			1.0E-03	r	0	0.1	13718-26-8	Sodium metavanadate	6.1E+01	nc	8.8E+02	nc	3.7E+00	nc	3.6E+01	nc		
		6.0E-01	i					0		7440-24-6	Strontium, stable	4.7E+04	nc	1.0E+05	max			2.2E+04	nc		
		3.0E-04	i			3.0E-04	r	0	0.1	57-24-9	Strychnine	1.8E+01	nc	2.6E+02	nc	1.1E+00	nc	1.1E+01	nc		
		2.0E-01	i			2.9E-01	i	1		100-42-5	Styrene	1.7E+03	sat	1.7E+03	sat	1.1E+03	nc	1.6E+03	nc	4.0E+00	2.0E-01
		1.0E-03	n			1.0E-03	r			80-07-9	1,1'-Sulfonylbis (4-chlorobenzene)	7.8E+01	nc	2.0E+03	nc	3.7E+00	nc	3.6E+01	nc		
		2.5E-02	i			2.5E-02	r	0	0.1	88671-89-0	Systhane	1.5E+03	nc	2.2E+04	nc	9.1E+01	nc	9.1E+02	nc		
1.5E+05	h			1.5E+05	h			0	0.03	1746-01-6	2,3,7,8-TCDD (dioxin)	3.9E-06	ca	2.7E-05	ca	4.5E-08	ca	4.5E-07	ca		
		7.0E-02	i			7.0E-02	r	0	0.1	34014-18-1	Tebuthiuron	4.3E+03	nc	6.2E+04	nc	2.6E+02	nc	2.6E+03	nc		
		2.0E-02	h			2.0E-02	r	0	0.1	3383-96-8	Temephos	1.2E+03	nc	1.8E+04	nc	7.3E+01	nc	7.3E+02	nc		
		1.3E-02	i			1.3E-02	r	0	0.1	5902-51-2	Terbacil	7.9E+02	nc	1.1E+04	nc	4.7E+01	nc	4.7E+02	nc		

Key i=IRIS h=HEAST n=NCEA x=WITHDRAWN o=Other EPA DOCUMENTS r=ROUTE EXTRAPOLATION ca=CANCER PRG nc=NONCANCER PRG sat=SOIL SATURATION max=CEILING LIMIT *(where: nc < 100X ca) **(where. nc < 10X ca)

FOR PLANNING PURPOSES

TOXICITY INFORMATION											CONTAMINANT	PRELIMINARY REMEDIATION GOALS (PRGs)								SOIL SCREENING LEVELS	
SFo 1/(mg/kg-d)		RfDo (mg/kg-d)		SFi 1/(mg/kg-d)		RfDi (mg/kg-d)		V O C	skin abs. soils	CAS No		Residential Soil (mg/kg)		Industrial Soil (mg/kg)		Ambient Air (ug/m^3)		Tap Water (ug/l)		Migration to Ground Water DAF 20 (mg/kg)	DAF 1 (mg/kg)
		2.5E-05	h			2.5E-05	r	0	0.1	13071-79-9	Terbufos	1.5E+00	nc	2.2E+01	nc	9.1E-02	nc	9.1E-01	nc		
		1.0E-03	i			1.0E-03	r	0	0.1	886-50-0	Terbutryn	6.1E+01	nc	8.8E+02	nc	3.7E+00	nc	3.6E+01	nc		
		3.0E-04	i			3.0E-04	r	0	0.1	95-94-3	1,2,4,5-Tetrachlorobenzene	1.8E+01	nc	2.6E+02	nc	1.1E+00	nc	1.1E+01	nc		
2.6E-02	i	3.0E-02	i	2.6E-02	i	3.0E-02	r	1		630-20-6	1,1,1,2-Tetrachloroethane	3.0E+00	ca	7.0E+00	ca	2.6E-01	ca	4.3E-01	ca		
2.0E-01	i	6.0E-02	n	2.0E-01	i	6.0E-02	r	1		79-34-5	1,1,2,2-Tetrachloroethane	3.8E-01	ca	9.0E-01	ca	3.3E-02	ca	5.5E-02	ca	3.0E-03	2.0E-04
5.2E-02	n	1.0E-02	i	2.0E-03	n	1.1E-01	n	1		127-18-4	Tetrachloroethylene (PCE)	5.7E+00	ca*	1.9E+01	ca*	3.3E+00	ca	1.1E+00	ca	6.0E-02	3.0E-03
											"CAL-Modified PRG" (PEA, 1994)					3.2E-01					
		3.0E-02	i			3.0E-02	r	0	0.1	58-90-2	2,3,4,6-Tetrachlorophenol	1.8E+03	nc	2.6E+04	nc	1.1E+02	nc	1.1E+03	nc		
2.0E+01	h			2.0E+01	r			0	0.1	5216-25-1	p,a,a,a-Tetrachlorotoluene	2.4E-02	ca	1.2E-01	ca	3.4E-04	ca	3.4E-03	ca		
2.4E-02	h	3.0E-02	i	2.4E-02	r	3.0E-02	r	0	0.1	961-11-5	Tetrachlorovinphos	2.0E+01	ca*	1.0E+02	ca	2.8E-01	ca	2.8E+00	ca		
		5.0E-04	i			5.0E-04	r	0	0.1	3689-24-5	Tetraethyldithiopyrophosphate	3.1E+01	nc	4.4E+02	nc	1.8E+00	nc	1.8E+01	nc		
7.6E-03	n	2.1E-01	n	6.8E-03	n	8.6E-02	n	0	0.1	109-99-9	Tetrahydrofuran	6.4E+01	ca	3.2E+02	ca	9.9E-01	ca	8.8E+00	ca		
		6.6E-05	i					0		7446-18-6	**Thallium and compounds**	5.2E+00	nc	1.3E+02	nc			2.4E+00	nc		
		1.0E-02	i			1.0E-02	r	0	0.1	28249-77-6	Thiobencarb	6.1E+02	nc	8.8E+03	nc	3.7E+01	nc	3.6E+02	nc		
		1.0E-01	n			1.0E-01	r	0	0.1	N/A	Thiocyanate	6.1E+03	nc	1.0E+05	max	3.7E+02	nc	3.6E+03	nc		
		3.0E-04	h			3.0E-04	r	0	0.1	39196-18-4	Thiofanox	1.8E+01	nc	2.6E+02	nc	1.1E+00	nc	1.1E+01	nc		
		8.0E-02	i			8.0E-02	r	0	0.1	23564-05-8	Thiophanate-methyl	4.9E+03	nc	7.0E+04	nc	2.9E+02	nc	2.9E+03	nc		
		5.0E-03	i			5.0E-03	r	0	0.1	137-26-8	Thiram	3.1E+02	nc	4.4E+03	nc	1.8E+01	nc	1.8E+02	nc		
		6.0E-01	h					0			Tin (inorganic, see tributyltin oxide for organic tin)	4.7E+04	nc	1.0E+05	max			2.2E+04	nc		
		2.0E-01	i			1.1E-01	h	1		108-88-3	Toluene	5.2E+02	sat	5.2E+02	sat	4.0E+02	nc	7.2E+02	nc	1.2E+01	6.0E-01
3.2E+00	h			3.2E+00	r			0	0.1	95-80-7	Toluene-2,4-diamine	1.5E-01	ca	7.7E-01	ca	2.1E-03	ca	2.1E-02	ca		
		6.0E-01	h			6.0E-01	r	0	0.1	95-70-5	Toluene-2,5-diamine	3.7E+04	nc	1.0E+05	max	2.2E+03	nc	2.2E+04	nc		
		2.0E-01	h			2.0E-01	r	0	0.1	823-40-5	Toluene-2,6-diamine	1.2E+04	nc	1.0E+05	max	7.3E+02	nc	7.3E+03	nc		
1.9E-01	i			1.9E-01	r			0	0.1	106-49-0	p-Toluidine	2.6E+00	ca	1.3E+01	ca	3.5E-02	ca	3.5E-01	ca		
1.1E+00	i			1.1E+00	i			0	0.1	8001-35-2	Toxaphene	4.4E-01	ca	2.2E+00	ca	6.0E-03	ca	6.1E-02	ca	3.1E+01	2.0E+00
		7.5E-03	i			7.5E-03	r	0	0.1	66841-25-6	Tralomethrin	4.6E+02	nc	6.6E+03	nc	2.7E+01	nc	2.7E+02	nc		
		1.3E-02	i			1.3E-02	r	0	0.1	2303-17-5	Triallate	7.9E+02	nc	1.1E+04	nc	4.7E+01	nc	4.7E+02	nc		
		1.0E-02	i			1.0E-02	r	0	0.1	82097-50-5	Triasulfuron	6.1E+02	nc	8.8E+03	nc	3.7E+01	nc	3.6E+02	nc		
		5.0E-03	i			5.0E-03	r	0	0.1	615-54-3	1,2,4-Tribromobenzene	3.1E+02	nc	4.4E+03	nc	1.8E+01	nc	1.8E+02	nc		
		3.0E-04	i					0	0.1	56-35-9	Tributyltin oxide (TBTO)	1.8E+01	nc	2.6E+02	nc			1.1E+01	nc		
3.4E-02	h			3.4E-02	r			0	0.1	634-93-5	2,4,6-Trichloroaniline	1.4E+01	ca	7.3E+01	ca	2.0E-01	ca	2.0E+00	ca		
2.9E-02	h			2.9E-02	r			0	0.1	33663-50-2	2,4,6-Trichloroaniline hydrochloride	1.7E+01	ca	8.5E+01	ca	2.3E-01	ca	2.3E+00	ca		
		1.0E-02	i			5.7E-02	h	1		120-82-1	1,2,4-Trichlorobenzene	6.5E+02	nc	3.0E+03	sat	2.1E+02	nc	1.9E+02	nc	5.0E+00	3.0E-01
		2.0E-02	n			2.9E-01	n	1		71-55-6	1,1,1-Trichloroethane	6.3E+02	nc	1.4E+03	sat	1.0E+03	nc	5.4E+02	nc	2.0E+00	1.0E-01
5.7E-02	i	4.0E-03	i	5.6E-02	i	4.0E-03	r	1		79-00-5	1,1,2-Trichloroethane	8.4E-01	ca*	1.9E+00	ca*	1.2E-01	ca	2.0E-01	ca	2.0E-02	9.0E-04
1.1E-02	n	6.0E-03	x	6.0E-03	n	6.0E-03	r	1		79-01-6	Trichloroethylene (TCE)	2.8E+00	ca**	6.1E+00	ca*	1.1E+00	ca*	1.6E+00	ca*	6.0E-02	3.0E-03
		3.0E-01	i			2.0E-01	h	1		75-69-4	Trichlorofluoromethane	3.9E+02	nc	2.0E+03	sat	7.3E+02	nc	1.3E+03	nc		
		1.0E-01	i			1.0E-01	r	0	0.1	95-95-4	2,4,5-Trichlorophenol	6.1E+03	nc	8.8E+04	nc	3.7E+02	nc	3.6E+03	nc	2.7E+02	1.4E+01
1.1E-02	i			1.1E-02	i			0	0.1	88-06-2	2,4,6-Trichlorophenol	4.4E+01	ca	2.2E+02	ca	6.2E-01	ca	6.1E+00	ca	2.0E-01	8.0E-03
		1.0E-02	i			1.0E-02	r	0	0.1	93-76-5	2,4,5-Trichlorophenoxyacetic Acid	6.1E+02	nc	8.8E+03	nc	3.7E+01	nc	3.6E+02	nc		
		8.0E-03	i			8.0E-03	r	0	0.1	93-72-1	2-(2,4,5-Trichlorophenoxy) propionic acid	4.9E+02	nc	7.0E+03	nc	2.9E+01	nc	2.9E+02	nc		
		5.0E-03	i			5.0E-03	r	1		598-77-6	1,1,2-Trichloropropane	1.5E+01	nc	5.1E+01	nc	1.8E+01	nc	3.0E+01	nc		
7.0E+00	h	6.0E-03	i	7.0E+00	r	5.0E-03	r	1		96-18-4	1,2,3-Trichloropropane	1.4E-03	ca	3.1E-03	ca	9.6E-04	ca	1.6E-03	ca		
		5.0E-03	n			5.0E-03	r	1		96-19-5	1,2,3-Trichloropropene	1.2E+01	nc	3.9E+01	nc	1.8E+01	nc	3.0E+01	nc		
		3.0E+01	i			8.6E+00	h	1		76-13-1	1,1,2-Trichloro-1,2,2-trifluoroethane	5.6E+03	sat	5.6E+03	sat	3.1E+04	nc	5.9E+04	nc		
		3.0E-03	i			3.0E-03	r	0	0.1	58138-08-2	Tridiphane	1.8E+02	nc	2.6E+03	nc	1.1E+01	nc	1.1E+02	nc		
		2.0E-03	i			2.0E-03	i	1		121-44-8	Triethylamine	2.3E+01	nc	8.8E+01	nc	7.3E+00	nc	1.2E+01	nc		
7.7E-03	i	7.5E-03	i	7.7E-03	r	7.5E-03	r	0	0.1	1582-09-8	Trifluralin	6.3E+01	ca**	3.2E+02	ca*	8.7E-01	ca*	8.7E+00	ca*		
		1.4E-04	i			1.4E-04	n		0.1	552-30-7	**Trimellitic Anhydride (TMAN)**	8.6E+00	nc	1.2E+02	nc	5.1E-01	nc	5.1E+00			
		5.0E-02	n			1.7E-03	n	1		95-63-6	1,2,4-Trimethylbenzene	5.2E+01	nc	1.7E+02	nc	6.2E+00	nc	1.2E+01	nc		
		5.0E-02	n			1.7E-03	n	1		108-67-8	1,3,5-Trimethylbenzene	2.1E+01	nc	7.0E+01	nc	6.2E+00	nc	1.2E+01	nc		
3.7E-02	h			3.7E-02	r			0	0.1	512-56-1	Trimethyl phosphate	1.3E+01	ca	6.7E+01	ca	1.8E-01	ca	1.8E+00	ca		
		3.0E-02	i			3.0E-02	r	0	0.1	99-35-4	1,3,5-Trinitrobenzene	1.8E+03	nc	2.6E+04	nc	1.1E+02	nc	1.1E+03	nc		
		1.0E-02	h			1.0E-02	r	0	0.1	479-45-8	Trinitrophenylmethylnitramine	6.1E+02	nc	8.8E+03	nc	3.7E+01	nc	3.6E+02	nc		

Key: i=IRIS h=HEAST n=NCEA x=WITHDRAWN o=Other EPA DOCUMENTS r=ROUTE EXTRAPOLATION ca=CANCER PRG nc=NONCANCER PRG sat=SOIL SATURATION max=CEILING LIMIT *(where: nc < 100X ca) **(where: nc < 10X ca)

FOR PLANNING PURPOSES

TOXICITY INFORMATION											CONTAMINANT	PRELIMINARY REMEDIATION GOALS (PRGs)								SOIL SCREENING LEVELS Migration to Ground Water	
SFo 1/(mg/kg-d)		RfDo (mg/kg-d)		SFi 1/(mg/kg-d)		RfDi (mg/kg-d)		VOC	skin abs soils	CAS No		Residential Soil (mg/kg)		Industrial Soil (mg/kg)		Ambient Air (ug/m^3)		Tap Water (ug/l)		DAF 20 (mg/kg)	DAF 1 (mg/kg)
3.0E-02	i	5.0E-04	i	3.0E-02	r	5.0E-04	r	0	0.1	118-96-7	2,4,6-Trinitrotoluene	1.6E+01	ca**	8.2E+01	ca**	2.2E-01	ca**	2.2E+00	ca**		
		1.0E-01	n			1.0E-01	r		0.1	791-28-6	**Triphenylphosphine oxide**	6.1E+03	nc	8.8E+04	nc	3.7E+02	nc	3.6E+03	nc		
1.4E-02	n	3.0E-01	n	1.4E-02	r	3.0E-01	r		0.1	115-96-8	**Tris(2-chloroethyl) phosphate**	3.5E+01	ca	1.8E+02	ca	4.8E-01	ca	4.8E+00	ca		
		2.0E-04	n							7440-61-0	**Uranium (chemical toxicity only)**	1.6E+01	nc	4.1E+02	nc			7.3E+00	nc		
		7.0E-03	h					0		7440-62-2	Vanadium and compounds	5.5E+02	nc	1.4E+04	nc			2.6E+02	nc	6.0E+03	3.0E+02
		1.0E-03	i			1.0E-03	r	0	0.1	1929-77-7	Vernam	6.1E+01	nc	8.8E+02	nc	3.7E+00	nc	3.6E+01	nc		
		2.5E-02	i			2.5E-02	r	0	0.1	50471-44-8	Vinclozolin	1.5E+03	nc	2.2E+04	nc	9.1E+01	nc	9.1E+02	nc		
		1.0E+00	h			5.7E-02	i	1		108-05-4	Vinyl acetate	4.3E+02	nc	1.4E+03	nc	2.1E+02	nc	4.1E+02	nc	1.7E+02	8.0E+00
1.1E-01	r	8.6E-04	r	1.1E-01	h	8.6E-04	i	1		593-60-2	Vinyl bromide (bromoethene)	1.9E-01	ca*	4.2E-01	ca*	6.1E-02	ca*	1.0E-01	ca*		
1.5E+00	i	3.0E-03	i	3.1E-02	i	2.9E-02	i	1		75-01-4	**Vinyl chloride (child/adult)**	1.5E-01	ca			2.2E-01	ca	4.1E-02	ca	1.0E-02	7.0E-04
7.5E-01	i	3.0E-03	i	1.6E-02	i	2.9E-02	i	1		75-01-4	**Vinyl chloride (adult)**			8.3E-01	ca						
		3.0E-04	i			3.0E-04	r	0	0.1	81-81-2	Warfarin	1.8E+01	nc	2.6E+02	nc	1.1E+00	nc	1.1E+01	nc		
		2.0E+00	i			2.0E-01	x	1	0.1	1330-20-7	Xylenes	2.1E+02	sat	2.1E+02	sat	7.3E+02	nc	1.4E+03	nc	2.1E+02	1.0E+01
		3.0E-01	i					0		7440-66-6	Zinc	2.3E+04	nc	1.0E+05	max			1.1E+04	nc	1.2E+04	6.2E+02
		3.0E-04	i					0		1314-84-7	Zinc phosphide	2.3E+01	nc	6.1E+02	nc			1.1E+01	nc		
		5.0E-02	i			5.0E-02	r	0	0.1	12122-67-7	Zineb	3.1E+03	nc	4.4E+04	nc	1.8E+02	nc	1.8E+03	nc		

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Risk Assessment Guidance for Superfund: Volume I — Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals)

Interim

Office of Emergency and Remedial Response
U.S. Environmental Protection Agency
Washington, DC 20460

NOTICE

The policies set out in this document are intended solely as guidance; they are not final U.S. Environmental Protection Agency (EPA) actions. These policies are not intended, nor can they be relied upon, to create any rights enforceable by any party in litigation with the United States. EPA officials may decide to follow the guidance provided in this document, or to act at variance with the guidance, based on an analysis of specific site circumstances. The Agency also reserves the right to change this guidance at any time without public notice.

This guidance is based on policies in the Final Rule of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), which was published on March 8, 1990 (55 *Federal Register* 8666). The NCP should be considered the authoritative source.

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CONTENTS (Continued)

CONTENTS (Continued)

EXHIBITS

DEFINITIONS

Term	Definition
Applicable or Relevant and Appropriate Requirements (ARARs)	"Applicable" requirements are those clean-up standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) site. "Relevant and appropriate" requirements are those clean-up standards which, while not "applicable" at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well-suited to the particular site. ARARs can be action-specific, location-specific, or chemical-specific.
Cancer Risk	Incremental probability of an individual's developing cancer over a lifetime as a result of exposure to a potential carcinogen.
Conceptual Site Model	A "model" of a site developed at scoping using readily available information. Used to identify all potential or suspected sources of contamination, types and concentrations of contaminants detected at the site, potentially contaminated media, and potential exposure pathways, including receptors. This model is also known as "conceptual evaluation model".
Exposure Parameters	Variables used in the calculation of intake (e.g., exposure duration, inhalation rate, average body weight).
Exposure Pathway	The course a chemical or physical agent takes from a source to an exposed organism. An exposure pathway describes a unique mechanism by which an individual or population is exposed to chemicals or physical agents at or originating from a site. Each exposure pathway includes a source or release from a source, an exposure point, and an exposure route. If the exposure point differs from the source, a transport/exposure medium (e.g., air) or media (in cases of intermedia transfer) also would be indicated.
Exposure Point	A location of potential contact between an organism and a chemical or physical agent.
Exposure Route	The way a chemical or physical agent comes in contact with an organism (i.e., by ingestion, inhalation, dermal contact).
Final Remediation Levels	Chemical-specific clean-up levels that are documented in the Record of Decision (ROD). They may differ from preliminary remediation goals (PRGs) because of modifications resulting from consideration of various uncertainties, technical and exposure factors, as well as all nine selection-of-remedy criteria outlined in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP).

DEFINITIONS (Continued)

Term	Definition
Hazard Index (HI)	The sum of two or more hazard quotients for multiple substances and/or multiple exposure pathways.
Hazard Quotient (HQ)	The ratio of a single substance exposure level over a specified time period to a reference dose for that substance derived from a similar exposure period.
"Limiting" Chemical(s)	Chemical(s) that are the last to be removed (or treated) from a medium by a given technology. In theory, the cumulative residual risk for a medium may approximately equal the risk associated with the limiting chemical(s).
Preliminary Remediation Goals (PRGs)	Initial clean-up goals that (1) are protective of human health and the environment and (2) comply with ARARs. They are developed early in the process based on readily available information and are modified to reflect results of the baseline risk assessment. They also are used during analysis of remedial alternatives in the remedial investigation/feasibility study (RI/FS).
Quantitation Limit (QL)	The lowest level at which a chemical can be accurately and reproducibly quantitated. Usually equal to the method detection limit multiplied by a factor of three to five, but varies for different chemicals and different samples.
Reference Dose (RfD)	The Agency's preferred toxicity value for evaluating potential noncarcinogenic effects in humans resulting from contaminant exposures at CERCLA sites. (See RAGS/HHEM Part A for a discussion of different kinds of reference doses and reference concentrations.)
Risk-based PRGs	Concentration levels set at scoping for individual chemicals that correspond to a specific cancer risk level of 10^{-6} or an HQ/HI of 1. They are generally selected when ARARs are not available.
Slope Factor (SF)	A plausible upper-bound estimate of the probability of a response per unit intake of a chemical over a lifetime. The slope factor is used to estimate an upper-bound probability of an individual's developing cancer as a result of a lifetime of exposure to a particular level of a potential carcinogen.
Target Risk	A value that is combined with exposure and toxicity information to calculate a risk-based concentration (e.g., PRG). For carcinogenic effects, the target risk is a cancer risk of 10^{-6}. For noncarcinogenic effects, the target risk is a hazard quotient of 1.

ACRONYMS/ABBREVIATIONS

Acronym/ Abbreviation	Definition
ARARs	Applicable or Relevant and Appropriate Requirements
CAA	Clean Air Act
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CWA	Clean Water Act
EAG	Exposure Assessment Group
ECAO	Environmental Criteria and Assessment Office Superfund Health Risk Technical Support Center
EF	Exposure Frequency
EPA	U.S. Environmental Protection Agency
FWQC	Federal Water Quality Criteria
HEAST	Health Effects Assessment Summary Tables
HHEM	Human Health Evaluation Manual
HI	Hazard Index
HQ	Hazard Quotient
HRS	Hazard Ranking System
IRIS	Integrated Risk Information System
LLW	Low-level Radioactive Waste
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPL	National Priorities List
OSWER	Office of Solid Waste and Emergency Response
OERR	Office of Emergency and Remedial Response

ACRONYMS/ABBREVIATIONS (Continued)

Acronyms/ Abbreviation	Definition
PA/SI	Preliminary Assessment/Site Inspection
PEF	Particulate Emission Factor
PRG	Preliminary Remediation Goal
RAGS	Risk Assessment Guidance for Superfund
RCRA	Resource Conservation and Recovery Act
RfC	Reference Concentration
RfD	Reference Dose
RI/FS	Remedial Investigation/Feasibility Study
RME	Reasonable Maximum Exposure
ROD	Record of Decision
RPM	Remedial Project Manager
SARA	Superfund Amendments and Reauthorization Act
SDWA	Safe Drinking Water Act
SF	Slope Factor
TR	Target Risk
VF	Volatilization Factor
WQS	State Water Quality Standards

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PREFACE

Risk Assessment Guidance for Superfund: Volume I — Human Health Evaluation Manual (RAGS/HHEM) Part B is one of a three-part series. Part A addresses the baseline risk assessment; Part C addresses human health risk evaluations of remedial alternatives. Part B provides guidance on using U.S. Environmental Protection Agency (EPA) toxicity values and exposure information to derive risk-based preliminary remedial goals (PRGs) for a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) site. Initially developed at the scoping phase using readily available information, risk-based PRGs generally are modified based on site-specific data gathered during the remedial investigation/feasibility study (RI/FS). This guidance does not discuss the risk management decisions that are necessary at a CERCLA site (e.g., selection of final remediation goals). The potential users of Part B are those involved in the remedy selection and implementation process, including risk assessors, risk assessment reviewers, remedial project managers, and other decision-makers.

This manual is being distributed as an interim document to allow for a period of field testing and review. RAGS/HHEM will be revised in the future, and Parts A, B, and C will be incorporated into a single final guidance document. Additional information for specific subject areas is being developed for inclusion in a later revision. These areas include:

- development of goals for additional land uses and exposure pathways;
- development of short-term goals;
- additional worker health and safety issues; and
- determination of final remediation goals (and attainment).

Comments addressing usefulness, changes, and additional areas where guidance is needed should be sent to:

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CHAPTER 1

INTRODUCTION

The purpose of this guidance is to assist risk assessors, remedial project managers (RPMs), and others involved with risk assessment and decision-making at Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) sites in developing preliminary remediation goals (PRGs). This guidance is the second part (Part B) in the series *Risk Assessment Guidance for Superfund: Volume I — Human Health Evaluation Manual* (RAGS/HHEM).

Part A of this series (EPA 1989d) assists in defining and completing a site-specific baseline risk assessment; much of the information in Part A is necessary background for Part B. Part B provides guidance on using U.S. Environmental Protection Agency (EPA) toxicity values and exposure information to derive risk-based PRGs. Initially developed at the scoping phase using readily available information, risk-based PRGs generally are modified based on site-specific data gathered during the remedial investigation/feasibility study (RI/FS). Part C of this series (EPA 1991d) assists RPMs, site engineers, risk assessors, and others in using risk information both to evaluate remedial alternatives during the FS and to evaluate the selected remedial alternative during and after its implementation. Exhibit 1-1 illustrates how the three parts of RAGS/HHEM are all used during the RI/FS and other stages of the site remediation process.

The remainder of this introduction addresses the definition of PRGs, the scope of Part B, the statutes, regulations, and guidance relevant to PRGs, steps in identifying and modifying PRGs, the communication and documentation of PRGs, and the organization of the remainder of this document.

1.1 DEFINITION OF PRELIMINARY REMEDIATION GOALS

In general, PRGs provide remedial design staff with long-term targets to use during analysis and selection of remedial alternatives. Ideally, such goals, if achieved, should both comply with applicable or relevant and appropriate requirements (ARARs) and result in residual risks that fully satisfy the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) requirements for the protection of human health and the environment. By developing PRGs early in the decision-making process (before the RI/FS and the baseline risk assessment are completed), design staff may be able to streamline the consideration of remedial alternatives.

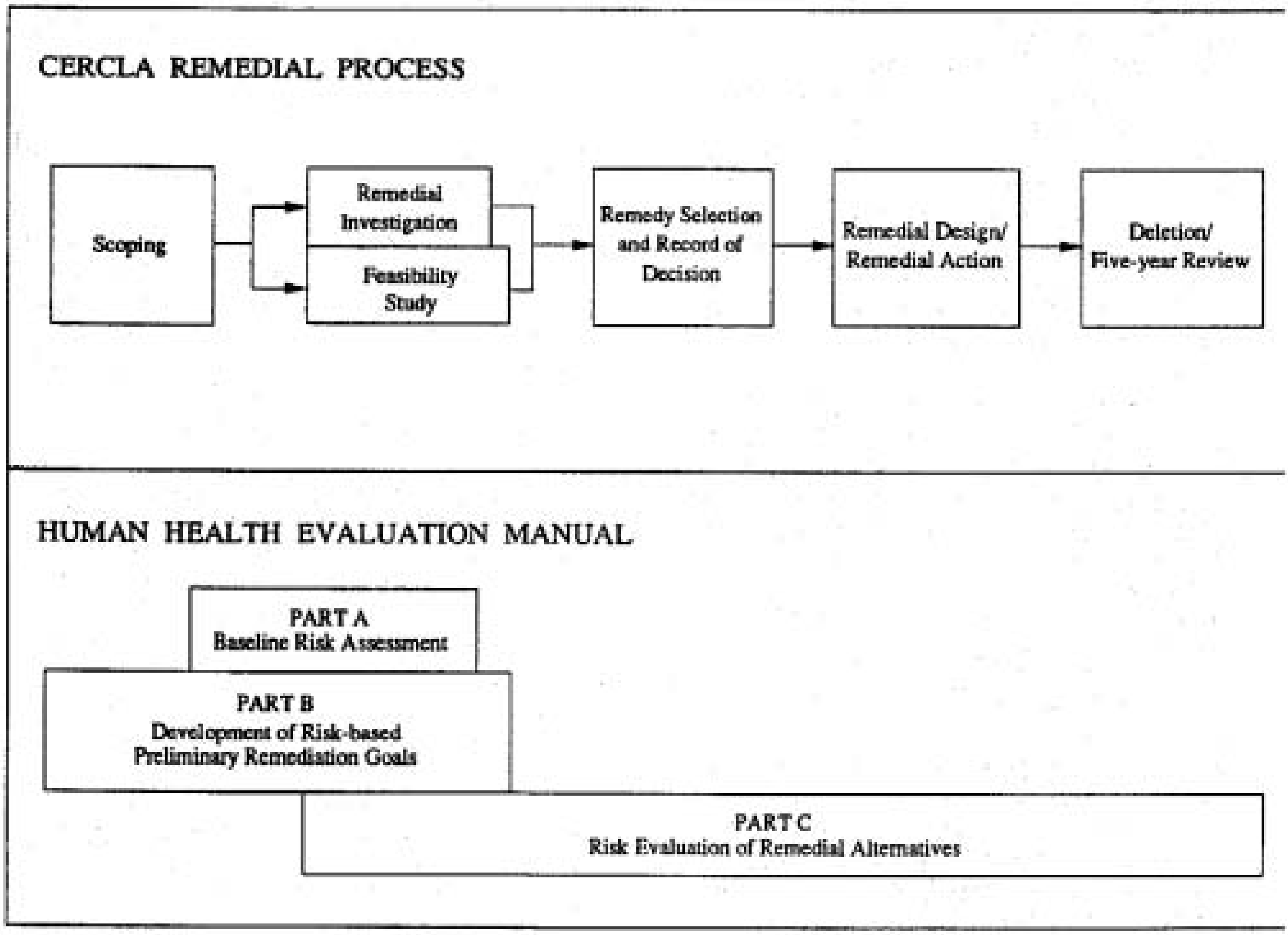
Chemical-specific PRGs are concentration goals for individual chemicals for specific medium and land use combinations at CERCLA sites. There are two general sources of chemical-specific PRGs: (1) concentrations based on ARARs and (2) concentrations based on risk assessment. ARARs include concentration limits set by other environmental regulations (e.g., non-zero maximum contaminant level goals [MCLGs] set under the Safe Drinking Water Act [SDWA]). The second source for PRGs, and the focus of this document, is risk assessment or risk-based calculations that set concentration limits using carcinogenic and/or noncarcinogenic toxicity values under specific exposure conditions.

1.2 SCOPE OF PART B

The recommended approach for developing remediation goals is to identify PRGs at scoping, modify them as needed at the end of the RI or during the FS based on site-specific information from the baseline risk assessment, and ultimately select remediation levels in the Record of Decision (ROD). In order to set chemical-specific PRGs in a site-specific context, however, assessors must answer fundamental questions about the site. Information on the chemicals that are present onsite, the specific contaminated media, land-use assumptions, and the exposure assumptions behind pathways of individual exposure is necessary in order to develop chemical-specific PRGs. Part B provides guidance for considering this information in developing chemical-specific PRGs.

EXHIBIT 1-1

RELATIONSHIP OF THE HUMAN HEALTH EVALUATION TO THE CERCLA PROCESS



Because Part B focuses on developing chemical-specific PRGs based on protection of human health, there are important types of information that are not considered and that may significantly influence the concentration goals needed to satisfy the CERCLA criteria for selection of a remedy. For example, no consideration is given to ecological effects in this guidance. Other types of remedial action "goals" not addressed in detail include action-specific ARARs (e.g., technology- or performance-based standards) and location-specific ARARs.

Throughout Part B, the term "chemical-specific" should be understood to refer to both nonradioactive and radioactive chemical hazardous substances, pollutants, or contaminants. Therefore, the process described in this guidance of selecting and modifying PRGs at a site should be applied to each radionuclide of potential concern. Chapter 10 of RAGS/HHEM Part A provides background information concerning radionuclides, and Chapter 4 of RAGS/HHEM Part B includes radionuclide risk-based equations and a case study of a hypothetical radiation site.

This guidance only addresses in detail the initial selection of risk-based PRGs. Detailed guidance regarding other factors that can be used to further modify PRGs during the remedy selection process is presented in other documents (see Section 1.3).

1.3 RELEVANT STATUTES, REGULATIONS, AND GUIDANCE

This section provides relevant background on the CERCLA statute and the regulations created to implement the statute (i.e., the NCP). In addition, other CERCLA guidance documents are listed and their relationship to the site remediation process is discussed.

1.3.1 CERCLA/SARA

CERCLA, as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), is the authority for EPA to take response actions. (Throughout this guidance, reference to CERCLA should be understood to mean "CERCLA as amended by SARA.")

Several sections of CERCLA, especially section 121 (Clean-up Standards), set out the requirements and goals of CERCLA. Two fundamental requirements are that selected remedies be protective of human health and the environment, and comply with ARARs. CERCLA indicates a strong preference for the selection of remedial alternatives that permanently and significantly reduce the volume, toxicity, or mobility of wastes. To the maximum extent practicable, the selected remedial alternatives should effect permanent solutions by using treatment technologies. Both the law and the regulation (see below) call for cost-effective remedial alternatives.

1.3.2 NATIONAL CONTINGENCY PLAN

Regulations implementing CERCLA are found in Volume 40 of the Code of Federal Regulations (CFR), Part 300, and are referred to collectively as the NCP. Section 300.430 of the NCP, and several portions of the preambles in the *Federal Register* (55 *Federal Register* 8666, March 8, 1990 and 53 *Federal Register* 51394, December 21, 1988), address how the Superfund and other CERCLA programs are to implement the Act's requirements and goals concerning clean-up levels.

Nine criteria have been developed in the NCP to use in selecting a remedy. These criteria are listed in the next box. The first criterion — overall protection of human health and the environment — is the focus of this document. This criterion coupled with compliance with ARARs are referred to as "threshold criteria" and must be met by the selected remedial alternative. PRGs are developed to quantify the standards that remedial alternatives must meet in order to achieve these threshold criteria. See the second box on the next page for highlights from the NCP on remediation goals.

1.3.3 GUIDANCE DOCUMENTS

There are several existing documents that provide gudiance on related steps of the site remediation process. These documents are described in the box on page five. When documents are referenced throughout this guidance, the abbreviated titles, indicated in parentheses after the full titles and bibliographic information, are used.

NINE EVALUATION CRITERIA FOR ANALYSIS OF REMEDIAL ALTERNATIVES
(40 CFR 300.430(e)(9)(iii))

Threshold Criteria:
- Overall Protection of Human Health and the Environment
- Compliance with ARARs

Balancing Criteria:
- Long-term Effectiveness and Permanence
- Reduction of Toxicity, Mobility, or Volume Through Treatment
- Short-term Effectiveness
- Implementability
- Cost

Modifying Criteria:
- State Acceptance
- Community Acceptance

1.4 INITIAL DEVELOPMENT OF PRELIMINARY REMEDIATION GOALS

The NCP preamble indicates that, typically, PRGs are developed at scoping or concurrent with initial RI/FS activities (i.e., prior to completion of the baseline risk assessment). This early determination of PRGs facilitates development of a range of appropriate remedial alternatives and can focus selection on the most effective remedy.

Development of PRGs early in the RI/FS requires the following site-specific data:

- media of potential concern;
- chemicals of potential concern; and
- probable future land use.

This information may be found in the preliminary assessment/site inspection (PA/SI) reports or in the conceptual site model that is developed prior to or during scoping. (When a site is listed on the National Priorities List [NPL], much of this information is compiled during the PA/SI as part of the Hazard Ranking System [HRS] documentation record.) Once these factors are known, all potential ARARs must be identified. When ARARs do not exist, risk-based PRGs are calculated using EPA health criteria (i.e., reference doses or cancer slope factors) and default or site-specific exposure assumptions.

NCP RULE HIGHLIGHTS
RISK AND REMEDIATION GOALS
(40 CFR 300.430(e)(2))

"In developing and, as appropriate, screening ... alternatives, the lead agency shall: (i) Establish remedial action objectives specifying contaminants and media of concern, potential exposure pathways, and remediation goals. Initially, preliminary remediation goals are developed based on readily available information, such as chemical-specific ARARs or other reliable information. Preliminary remediation goals should be modified, as necessary, as more information becomes available during the RI/FS. Final remediation goals will be determined when the remedy is selected. Remediation goals shall establish acceptable exposure levels that are protective of human health and the environment and shall be developed by considering the following:

(A) Applicable or relevant and appropriate requirements ..., and the following factors:

(1) For systemic toxicants, acceptable exposure levels shall represent concentration levels to which the human population, including sensitive subgroups, may be exposed without adverse effect during a lifetime or part of a lifetime, incorporating an adequate margin of safety;

(2) For known or suspected carcinogens, acceptable exposure levels are generally concentration levels that represent an excess upper-bound lifetime cancer risk to an individual of between 10^{-4} and 10^{-6} using information on the relationship between dose and response. The 10^{-6} risk level shall be used as the point of departure for determining remediation goals for alternatives when ARARs are not available or are not sufficiently protective because of multiple contaminants at a site or multiple pathways of exposure ..."

It is important to remember that risk-based PRGs (either at scoping or later on) are initial guidelines. They do not establish that cleanup to meet these goals is warranted. A risk-based concentration, as calculated in this guidance, will be considered a final remediation level only after appropriate analysis in the RI/FS and ROD.

GUIDANCE DOCUMENTS

- *Risk Assessment Guidance for Superfund: Volume I — Human Health Evaluation Manual Part A* (EPA 1989a) (RAGS/HHEM Part A) contains background information and is particularly relevant for developing exposure and toxicity assessments that are required when refining chemical-specific risk-based concentrations, and accounting for site-specific factors such as multiple exposure pathways.

- *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (EPA 1988c) (RI/FS Guidance) presents detailed information about implementing the RI/FS and general information on the use of risk-based factors and ARARs in the context of the RI/FS.

- *Guidance on Remedial Action for Contaminated Ground Water at Superfund Sites* (EPA 1988d) (Ground-water Guidance) details some of the key issues in development, evaluation, and selection of ground-water remedial actions at CERCLA sites.

- *CERCLA Compliance with Other Laws Manuals* (Part I, EPA 1988a; and Part II, EPA 1989a) (CERCLA Compliance Manuals) provide guidance for complying with ARARs. Part I addresses the Resource Conservation and Recovery Act (RCRA), the Clean Water Act (CWA), and the SDWA; Part II addresses the Clean Air Act (CAA), other federal statutes, and state requirements.

- *Methods for Evaluating the Attainment of Cleanup Standards (Volume 1: Soils and Solid Waste)* (EPA 1989e) and *Methods for Evaluating the Attainment of Cleanup Standards (Volume 2: Water)* (Draft, 1988, EPA, Statistical Policy Branch) (Attainment Guidance) provide guidance on evaluating the attainment of remediation levels, including appropriate sampling and statistical procedures to test whether the chemical concentrations are significantly below the remediation levels.

- *Interim Final Guidance on Preparing Superfund Decision Documents* (EPA 1989b) (ROD Guidance) provides guidance that: (1) presents standard formats for documenting CERCLA remedial action decisions; (2) clarifies the roles and responsibilities of EPA, states, and other federal agencies in developing and issuing decision documents; and (3) explains how to address changes made to proposed and selected remedies.

- *Catalog of Superfund Program Publications*, Chapter 5 (EPA 1990a) lists all ARARs guidance documents that have been issued by EPA, shown in order of date of issuance.

- *Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions* (EPA 1991c) provides clarification on the role of the baseline risk assessment in developing and selecting CERCLA remedial alternatives.

- *Guidance for Data Useability in Risk Assessment* (EPA 1990b) (Data Useability Guidance) provides guidance on how to obtain a minimum level of quality for all environmental analytical data required for CERCLA risk assessments. It can assist with determining sample quantitation limits (SQLs) for chemical-specific analyses.

- *Guidance on Remedial Actions for Superfund Sites with PCB Contamination* (EPA 1990c) describes the recommended approach for evaluating and remediating CERCLA sites having PCB contamination.

- *Conducting Remedial Investigations/Feasibility Studies for CERCLA Municipal Landfill Sites* (EPA 1991a) (Municipal Landfill Guidance) offers guidance on how to streamline both the RI/FS and the selection of a remedy for municipal landfills.

1.5 MODIFICATION OF PRELIMINARY REMEDIATION GOALS

The initial list of PRGs may need to be revised as new data become available during the RI/FS. Therefore, upon completion of the baseline risk assessment, it is important to review the media and chemicals of potential concern, future land use, and exposure assumptions originally identified at scoping. Chemicals may be added or dropped from the list, and risk-based PRGs may need to be recalculated using site-specific exposure factors. PRGs that are modified based on the results of the baseline risk assessment must still meet the "threshold criteria" of: (1) protection of human health and the environment and (2) compliance with ARARs. However, the NCP also allows for modification of PRGs during final remedy selection based on the "balancing" and "modifying" criteria and factors relating to uncertainty, exposure, and technical feasibility.

Final remediation levels are not determined until the site remedy is ready to be selected; final remediation levels are then set out in the ROD. PRGs are refined into final remediation goals throughout the process leading up to remedy selection. The ROD itself, however, should include a statement of final clean-up levels based on these goals, as noted in NCP section 300.430(e)(2)(i)(A). In the ROD, it is preferable to use the term "remediation level" rather than "remediation goal" in order to make clear that the selected remedy establishes binding requirements.

1.6 DOCUMENTATION AND COMMUNICATION OF PRELIMINARY REMEDIATION GOALS

Clear and concise communication of risk-based PRGs among the risk assessor, the RPM, the ARARs coordinator, site engineers, analytical chemists, hydrogeologists, and others is important in the development of PRGs. The involvement of the RPM in the direction and development of risk-based PRGs is important to ensure that communication is facilitated and that the PRGs are used effectively in streamlining the RI/FS process.

Because PRGs are most useful during the RI/FS (e.g., for streamlining the consideration of remedial alternatives), it is important to communicate them to site engineers as soon as possible. A memorandum from either the site risk assessor or the RPM to the site engineers and others concerned with PRGs would be appropriate for transmitting the initial PRGs. A brief cover page could highlight key assumptions, as well as changes, if any, to the standard equations (i.e., those presented in this guidance). Following this brief discussion, the PRGs could be presented using a table similar to that in Section 3.4 of this guidance.

The RI/FS Guidance recommends that "chemical- and/or risk-based remedial objectives associated with the alternative should be documented in the final RI/FS report to the extent possible." Therefore, the RI/FS report is a logical place to present PRGs that have been modified after the baseline risk assessment. A summary table such as the one developed in Section 3.4 of Part B could be incorporated into the RI/FS following the presentation of the baseline risk assessment. Along with the table, a discussion of issues of particular interest, such as assumptions used and the relationship between ARARs and risk-based PRGs at the site, could be included. Also, it is always appropriate to discuss how findings of the baseline risk assessment were incorporated into the calculation of PRGs.

1.7 ORGANIZATION OF DOCUMENT

The remainder of this guidance is organized into three additional chapters and two appendices. Chapter 2 discusses the initial identification of PRGs and provides guidance for modifying appropriate values during the RI/FS. Chapter 3 outlines equations that can be used to calculate risk-based PRGs for residential and commercial/industrial land uses. These equations are presented in both "reduced" format (i.e., incorporating certain default assumptions discussed in Chapter 2) and expanded format (i.e., with all variables included so that the user of this guidance can incorporate site-specific values). Particular considerations regarding radionuclides are provided in Chapter 4.

Appendix A supports several points made in Chapter 2 by providing illustrations of remedial alternatives where one or more chemicals "limit" remediation and, thus, represent a major portion of the residual risk. Appendix B lists equations for media-specific exposure pathways, enabling the risk assessor to derive site-specific equations that differ from those presented in Chapter 3.

Throughout Chapters 2, 3, and 4, case studies are presented that illustrate the process of determining PRGs. These case studies are contained in boxes with a shadow box appearance. Other types of boxed information (e.g., NCP quotes) is contained in boxes such as those in Chapter 1, which have thicker lines on the top and bottom than on the sides.

CHAPTER 2

IDENTIFICATION OF PRELIMINARY REMEDIATION GOALS

This chapter provides guidance on the initial identification of PRGs during the scoping phase of the RI/FS. As discussed in Chapter 1, medium-specific PRGs (ARAR-based and/or risk-based) should be identified during scoping for all chemicals of potential concern using readily available information. Sections are provided in this chapter on how to use this information to identify media and chemicals of potential concern, the most appropriate future land use, potential exposure pathways, toxicity information, potential ARARs, and risk-based PRGs. Finally, a section is provided on the modification of PRGs.

When using PRGs developed during scoping, the design engineers should understand that these may be modified significantly depending on information gathered about the site. The subsequent process of identifying key site contaminants, media, and other factors (i.e., during the baseline risk assessment) may require that the focus of the RI/FS be shifted (e.g., chemicals without ARARs may become more or less important). Thus, the design of remedial alternatives should remain flexible until the modified (i.e., more final) PRGs are available.

Prior to identifying PRGs during scoping, a conceptual site model should be developed (see the next box). Originally developed to aid in planning site activities (e.g., the RI/FS), the conceptual site model also contains information that is valuable for identifying PRGs. For example, it can be relied upon to identify which media and chemicals need PRGs. More information on developing and using a conceptual site model during the RI/FS process can be found in Chapter 2 of the RI/FS Guidance and Chapter 4 of RAGS/HHEM Part A.

CONCEPTUAL SITE MODEL

During project planning, the RPM gathers and analyzes available information and develops the conceptual site model (also called the conceptual evaluation model). This model is used to assess the nature and the extent of contamination. It also identifies potential contaminant sources, potential exposure pathways, and potential human and/or environmental receptors. Further, this model helps to identify data gaps and assists staff in developing strategies for data collection. Site history and PA/SI data generally are extremely useful sources of information for developing this model. The conceptual site model should include known and suspected sources of contamination, types of contaminants and affected media, known and potential routes of migration, and known or potential human and environmental receptors.

To illustrate the process of calculating risk-based PRGs at the scoping stage of remediation, hypothetical CERCLA sites will be examined in boxes in appropriate sections throughout Chapters 2, 3, and 4. See the box on the next page for an introduction to the first site. (The radiation case study is addressed in Chapter 4.) The information (e.g., toxicity values) contained in these case studies is for illustration only, and should not be used for any other purpose. These case studies have been simplified (e.g., only ground water will be examined) so that the steps involved in developing risk-based PRGs can be readily discerned.

2.1 MEDIA OF CONCERN

During scoping, the first step in developing PRGs is to identify the media of potential concern. The conceptual site model should be very useful for this step. These media can be either:

- currently contaminated media to which individuals may be exposed or through which chemicals may be transported to potential receptors; or

CASE STUDY: INTRODUCTION

The XYZ Co. site contains an abandoned industrial facility that is adjacent to a high-density residential neighborhood. Remnants of drums, lagoons, and waste piles were found at the site. Ground water in the area of the site is used by residents as a domestic water supply. There is also a small lake downgradient from the site that is used by some of the local residents for fishing and swimming.

- currently uncontaminated media that may become contaminated in the future due to contaminant transport.

Several important media often requiring direct remediation are ground water, surface water, soil, and sediment. Currently, only the first three of these media are discussed in this chapter and addressed by the equations provided in Chapters 3 and 4. If other media that may require the development of risk-based concentrations (e.g., sediments) are identified at scoping, appropriate equations for those media should be developed. Regional risk assessors should be consulted as early as possible to assist with this process.

CASE STUDY: IDENTIFY MEDIA OF CONCERN

The PA/SI for the example site indicates that ground water beneath the site is contaminated. The source of this contamination appears to have been approximately 100 leaking drums of various chemicals that were buried in the soil but have since been removed. Lagoons and waste piles also may have contributed to the contamination. Thus, ground water and soil are media of concern.

Although evidence of lake water contamination was not found during the PA/SI, there is a reasonable possibility that it may become contaminated in the future due to contaminant transport either via ground-water discharge or surface water run-off. Thus, surface water (the lake) and sediments also may be media of concern.

2.2 CHEMICALS OF CONCERN

This step involves developing an initial list of chemicals for which PRGs need to be developed. Chapters 4 and 5 of RAGS/HHEM Part A provide important additional information on identifying chemicals of potential concern for a site and should be consulted prior to development of the conceptual site model and PRGs at scoping.

Initially, the list of chemicals of potential concern should include any chemical reasonably expected to be of concern at the site based on what is known during scoping. For example, important chemicals previously detected at the site, based on the PA/SI, the conceptual site model, or other prior investigations, generally should be included. In addition, the list may include chemicals that the site history indicates are likely to be present in significant quantities, even though they may not yet be detected. Sources of this latter type of information include records of chemicals used or disposed at the facility, and interviews with current or former employees. The list also may include chemicals that are probable degradation products of site contaminants where these are determined to be potential contributors of significant risk. An environmental chemist should be consulted for assistance in determining the probable degradation products of potential site-related chemicals and their persistence under site conditions. Generally, the chemicals for which PRGs should be developed will correspond to the list of suspected site contaminants included in the sampling and analysis plan.

2.3 FUTURE LAND USE

This step involves identifying the most appropriate future land use for the site so that the appropriate exposure pathways, parameters, and equations (discussed in the next section) can be used to calculate risk-based PRGs. RAGS/HHEM Part A (Chapter 6) and an EPA Office of Solid Waste and Emergency Response (OSWER) directive on the role of the baseline risk assessment in remedy selection decisions (EPA 1991b) provide additional guidance on identifying future land use. The standard default equations provided in Chapter 3 of Part B only address residential and commercial/industrial land uses. If land uses other than these are to be assumed (e.g., recreational), then exposure pathways, parameters,

CASE STUDY: IDENTIFY CHEMICALS OF CONCERN

The PA/SI for the XYZ Co. site identified the following seven chemicals in ground-water samples: benzene, ethylbenzene, hexane, isophorone, triallate, 1,1,2-trichloroethane, and vinyl chloride. Therefore, these chemicals are obvious choices for chemicals of potential concern.

Although not detected in any of the PA/SI samples, site history indicates that one other solvent — carbon tetrachloride — also was used in significant quantities by the facility that operated at the site. This chemical, therefore, is added to the list of chemicals of potential concern.

and equations will need to be developed for the others as well.

In general, residential areas should be assumed to remain residential. Sites that are surrounded by operating industrial facilities can be assumed to remain industrial areas unless there is an indication that this is not appropriate. Lacking site-specific information (e.g., at scoping), it may be appropriate to assume residential land use. This assumption will generally lead to conservative (i.e., lower concentration) risk-based PRGs. If not enough site-specific information is readily available at scoping to select one future land use over another, it may be appropriate to develop a separate set of risk-based PRGs for each possible land use.

When waste will be managed onsite, land-use assumptions and risk-based PRG development become more complicated because the assumptions for the site itself may be different from the land use in the surrounding area. For example, if waste is managed onsite in a residential area, the risk-based PRGs for the ground water beneath the site (or at the edge of the waste management unit) may be based on residential exposures, but the risk-based PRGs for the site soils may be based on an industrial land use with some management or institutional controls.

If a land-use assumption is used that is less conservative (i.e., leads to higher risk-based concentrations) than another, it generally will be necessary to monitor the future uses of that site. For example, if residential land use is not deemed to be appropriate for a particular site because local zoning laws prohibit residential development, any changes in local zoning would need to be monitored. Such considerations should be clearly documented in the site's ROD.

CASE STUDY: IDENTIFY FUTURE LAND USE

Based on established land-use trends, local renovation projects, and population growth projections in the area of the XYZ Co. site, the most reasonable future use of the land is determined to be residential use. Thus, site-specific information is sufficient to show that the generally more conservative assumption of residential land use should serve as the basis for development of risk-based PRGs.

2.4 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Chemical-specific ARARs are evaluated as PRGs because they are often readily available and provide a preliminary indication about the goals that a remedial action may have to attain. This step involves identifying all readily available chemical-specific potential ARARs for the chemicals of potential concern (for each medium and probable land use). Because at scoping it often is uncertain which potential ARAR is the most likely one to become the ARAR-based PRG, all potential ARARs should be included in a tabular summary (i.e., no potential ARAR should be discarded). If there is doubt about whether a value is a potential ARAR, and therefore whether it could be used as a PRG, it should be included at this stage.

This section summarizes the concept of ARARs and identifies the major types of ARARs, but provides only limited guidance on identifying the most appropriate (likely) ARAR of all possible ARARs to use as the chemical-specific PRG. More detailed information about the identification and evaluation of ARARs is available from two important sources:

- the NCP (see specifically 55 *Federal Register* 8741-8766 for a description of ARARs, and

8712-8715 for using ARARs as PRGs; see also 53 *Federal Register* 51394); and

- CERCLA Compliance Manuals (EPA 1988a and 1989a).

2.4.1 CHEMICAL-, LOCATION-, AND ACTION-SPECIFIC ARARs

The Agency has identified three general types of federal and state ARARs:

- chemical-specific, are usually health- or risk management-based numbers or methodologies that, when applied to site-specific conditions, result in the establishment of numerical values (e.g., chemical-specific concentrations in a given medium);
- location-specific, are restrictions placed upon the concentration of hazardous substances or the conduct of activities solely because they are in special locations (e.g., wetlands); and
- action-specific, are usually technology- or activity-based requirements or limitations on actions taken with respect to hazardous wastes.

This guidance primarily addresses only chemical-specific ARARs since it focuses on the identification of chemical-specific concentrations that represent target goals (e.g., PRGs) for a given medium.

2.4.2 SELECTION OF THE MOST LIKELY ARAR-BASED PRG FOR EACH CHEMICAL

This section briefly describes which, if any, of several potential ARAR values for a given chemical is generally selected as the most likely ARAR-based PRG (and therefore the most likely PRG at this point). Although the process for identifying the most likely ARAR-based PRG is specific to the medium, in general the process depends on two considerations: (1) the applicability of the ARAR to the site; and (2) the comparative stringency of the standards being evaluated. The previously cited documents should be carefully considered for specific recommendations on identifying ARARs.

Ground Water. SDWA maximum contaminant levels (MCLs), non-zero MCLGs, state drinking water standards, and federal water quality criteria (FWQC) are common ARARs (and, therefore, potential PRGs) for ground water. Other types of laws, such as state anti-degradation laws, may be PRGs if they are accompanied by allowable concentrations of a chemical. (Although state anti-degradation laws that are expressed as qualitative standards may also be potential ARARs, they generally would not be considered PRGs.)

As detailed in the NCP (see next box), the first step in identifying ground-water PRGs is to determine whether the ground water is a current or potential source of drinking water. If the aquifer is a potential source of drinking water, then potential ARARs generally will include the federal non-zero MCLG, MCL, or state drinking water standard, and the most stringent (i.e., the lowest concentration) is identified as the most likely ARAR-based PRG.

NCP ON GROUND-WATER GOALS
(NCP Preamble;
55 *Federal Register* 8717, March 8, 1990)

> "Ground water that is not currently a drinking water source but is potentially a drinking water source in the future would be protected to levels appropriate to its use as a drinking water source. Ground water that is not an actual or potential source of drinking water may not require remediation to a 10^{-4} to 10^{-6} level (except when necessary to address environmental concerns or allow for other beneficial uses; . . .)."

If the aquifer is not a potential source of drinking water, then MCLs, MCLGs, state drinking water requirements, or other health-based levels generally are not appropriate as PRGs. Instead, environmental considerations (i.e., effects on biological receptors) and prevention of plume expansion generally determine clean-up levels. If an aquifer that is not a potential source of drinking water is connected to an aquifer that is a drinking water source, it may be appropriate to use PRGs to set clean-up goals for the point of interconnection.

For chemicals without MCLs, state standards, or non-zero MCLGs, the FWQC may be potentially relevant and appropriate for ground water when that ground water discharges to surface water that is used for fishing or shellfishing.

Surface Water. FWQC and state water quality standards (WQS) are common ARARs for surface water. An important determination for identifying ARARs and other criteria as potential PRGs for surface water is the current designated and future expected use of the water body. Because surface water potentially could serve many uses (e.g., drinking and fishing), several ARARs may be identified as potential PRGs for a chemical, with each ARAR corresponding to an identified use. A state WQS is generally the most likely ARAR for surface water unless a federal standard is more stringent.

If surface water is a current or potential source of drinking water, MCLs, state drinking water standards, non-zero MCLGs, and FWQC are potential ARARs. The analysis to determine which of these drinking water standards is the most likely ARAR-based PRG is the same as that conducted for ground water. An FWQC based on ingestion of water and fish might be an ARAR for surface water used for drinking.

If the designated or future expected use of surface water is fishing or shellfishing, and the state has not promulgated a WQS, an FWQC should be considered as a potential ARAR. The particular FWQC (i.e., for water and fish ingestion or fish ingestion alone) selected as the potential ARAR depends on whether exposure from one or both of the routes is likely to occur and, therefore, on the designated use of the water body. If other uses of the water are designated (e.g., swimming), a state WQS may be available.

Soil. In general, chemical-specific ARARs may not be available for soil. Certain states, however, have promulgated or are about to promulgate soil standards that may be ARARs and thus may be appropriate to use as PRGs. In addition, several EPA policies may be appropriate to use in developing PRGs (e.g., see EPA 1990c for guidance on PCB clean-up levels).

2.5 EXPOSURE PATHWAYS, PARAMETERS, AND EQUATIONS

This step is generally conducted for each medium and land-use combination and involves identifying the most appropriate (1) exposure pathways and routes (e.g., residential ingestion of drinking water), (2) exposure parameters (e.g., 2 liters/day of water ingested), and (3) equations (e.g., to incorporate intake). The equations include calculations of total intake from a given medium and are based on the identified exposure pathways and associated parameters. Information gathered in this step should be used to calculate risk-based PRGs using the default equations identified in Chapters 3 and 4. Site-specific equations can be derived if a different set of exposure pathways is identified for a particular medium; this option also is discussed in Chapters 3 and 4.

When risk-based concentrations are developed during scoping, readily available site-specific information may be adequate to identify and develop the exposure pathways, parameters, and equations (e.g., readily available information may indicate that the exposure duration should be 40 years instead of the standard default of 30 years). In the absence of readily available site-specific information, the standard default information in Chapters 3 and 4 generally should be used for the development of risk-based PRGs.

Exhibit 2-1 lists a number of the potential exposure pathways that might be present at a CERCLA site. The exposure pathways included in the medium-specific standard default equations (see Chapters 3 and 4) are italicized in this exhibit. Note that Chapters 3 and 4 may not address all of the exposure pathways of possible importance at a given CERCLA site. For example, the consumption of ground water that continues to be contaminated by soil leachate is not addressed. Guidance on goal-setting to address this exposure pathway is currently under development by EPA. In addition, the standard default equations do not address pathways such as plant and animal uptake of contaminants from soil with subsequent human ingestion. Under certain circumstances, these or other exposure pathways may present significant risks to human health. The standard default information, however, does address the quantifiable exposure pathways that are often significant contributors of risk for a particular medium and land use.

Chapters 3 and 4 show how exposures from several pathways are addressed in a single equation for a medium. For example, in the equation for ground water and surface water under the residential land-use assumption, the coefficients incorporate default parameter values for ingestion of drinking water and inhalation of volatiles during

EXHIBIT 2-1

TYPICAL EXPOSURE PATHWAYS BY MEDIUM FOR RESIDENTIAL AND COMMERCIAL/INDUSTRIAL LAND USES[a,b]

Medium	Exposure Pathways, Assuming: Residential Land Use	Exposure Pathways, Assuming: Commercial/Industrial Land Use
Ground Water	*Ingestion from drinking*	Ingestion from drinking[d]
	Inhalation of volatiles	Inhalation of volatiles
	Dermal absorption from bathing	Dermal absorption
	Immersion - external[c]	
Surface Water	*Ingestion from drinking*	Ingestion from drinking[d]
	Inhalation of volatiles	Inhalation of volatiles
	Dermal absorption from bathing	Dermal absorption
	Ingestion during swimming	
	Ingestion of contaminated fish	
	Immersion - external[c]	
Soil	*Ingestion*	*Ingestion*
	Inhalation of particulates	*Inhalation of particulates*
	Inhalation of volatiles	*Inhalation of volatiles*
	Direct external exposure[c]	*Direct external exposure*[c]
	Exposure to ground water contaminated by soil leachate	Exposure to ground water contaminated by soil leachate
	Ingestion via plant uptake	Inhalation of particulates from trucks and heavy equipment
	Dermal absorption from gardening	

[a] Lists of land uses, media, and exposure pathways are not comprehensive.

[b] Exposure pathways included in RAGS/HHEM Part B standard default equations (Chapters 3 and 4) are italicized.

[c] Applies to radionuclides only.

[d] Because the NCP encourages protection of ground water to maximize its beneficial use, risk-based PRGs generally should be based on residential exposures once ground water is determined to be suitable for drinking. Similarly, when surface water will be used for drinking, general standards (e.g., ARARs) are to be achieved that define levels protective for the population at large, not simply worker populations. Residential exposure scenarios should guide risk-based PRG development for ingestion and other uses of potable water.

household water use. Full details of parameters used to develop each equation and a summary of the "reduced" standard default equations are provided in the text of these chapters.

Certain modifications of the default equations may be desirable or necessary. For example, if an exposure pathway addressed by an equation in Chapter 3 seems inappropriate for the site (e.g., because the water contains no volatiles and, therefore, inhalation of volatiles is irrelevant), or if information needed for a pathway (e.g., a chemical-specific inhalation slope factor [see Section 2.6]) is not readily available or derivable, then that pathway can be disregarded at this stage.

The decision about whether the risk assessor should collect site-specific human exposure pathway information (e.g., exposure frequency, duration, or intake rate data) is very important. There will frequently be methods available to gather such information, some of which are more expensive and elaborate than others. Determining whether the resulting data are reasonably representative of populations in the surrounding area, however, is often difficult. Collecting data by surveying those individuals most convenient or accessible to RPMs or risk assessors may not present a complete population exposure picture. In fact, poorly planned data gathering efforts may complicate the assessment process. For example, those surveyed may come to believe that their contributions will play a more meaningful role in the risk assessment than that planned by the risk assessors; this can result in significant demands on the risk assessor's time.

Before such data collection has begun, the risk assessor should determine, with the aid of screening analyses, what benefits are likely to result. <u>Collection of the exposure data discussed in this section generally should not be attempted unless significant differences are likely to result in final reasonable maximum exposure (RME) risk estimates</u>. If data collection is warranted, systematic and well-considered efforts that minimize biases in results should be undertaken. Estimates of future exposures are likely to rely heavily on conservative exposure assumptions. By definition, these assumptions will be unaffected by even the most extensive efforts to characterize current population activity.

At this stage, the risk assessor, site engineer, and RPM should discuss information concerning the absence or presence of important exposure pathways, because remediation goals should be designed for specific areas of the site that a particular remedy must address, and exposures expected for one area of the site may differ significantly from those expected in another area.

2.5.1 GROUND WATER/SURFACE WATER

The residential land-use default equations presented in Chapters 3 and 4 for ground water or surface water are based on ingestion of drinking water and inhalation of volatile (vapor phase) chemicals originating from the household water supply (e.g., during dish washing, clothes laundering, and showering).

Ingestion of drinking water is an appropriate pathway for all chemicals with an oral cancer slope factor or an oral chronic reference dose. For the purposes of this guidance, however, inhalation of volatile chemicals from water is considered routinely only for chemicals with a Henry's Law constant of 1×10^{-5} atm-m^3/mole or greater <u>and</u> with a molecular weight of less than 200 g/mole. Before determining inhalation toxicity values for a specific chemical (Section 2.6), it should be confirmed that the Henry's Law constant and molecular weight are in the appropriate range for inclusion in the inhalation pathway for water.

Default equations addressing industrial use of ground water are not presented. Because the NCP encourages protection of ground water to its maximum beneficial use, once ground water is determined to be suitable for drinking, risk-based PRGs generally should be based on residential exposures. Even if a site is located in an industrial area, the ground water underlying a site in an industrial area may be used as a drinking water source for residents several miles away due to complex geological interconnections.

2.5.2 SOIL

The residential land-use standard default equations for the soil pathway are based on exposure pathways of ingestion of chemicals in soil or dust. The industrial land-use equations are based on three exposure pathways: ingestion of soil and dust, inhalation of particulates, and inhalation of volatiles. Again, for the purposes of this guidance, inhalation of volatile chemicals is relevant only for chemicals with a Henry's Law constant of 1×10^{-5} atm-m^3/mole or greater and with a molecular weight of less than 200 g/mole. For the inhalation pathways, in addition to toxicity information, several chemical- and site-specific values are needed. These values include molecular diffusivity, Henry's Law constant, organic carbon partition coefficient, and soil moisture content (see Chapter 3 for details).

CASE STUDY: IDENTIFY EXPOSURE PATHWAYS, PARAMETERS, AND EQUATIONS

For the potential residential land use identified at the XYZ Co. site, the contaminated ground water (one of several media of potential concern) appears to be an important source of future domestic water. Because site-specific information is not initially available to develop specific exposure pathways, parameters, and equations, the standard default assumptions and equations provided in Chapter 3 will be used to calculate risk-based PRGs. Exposure pathways of concern for ground water, therefore, are assumed to be ingestion of ground water as drinking water and inhalation of volatiles in ground water during household use.

2.6 TOXICITY INFORMATION

This step involves identifying readily available toxicity values for all of the chemicals of potential concern for given exposure pathways so that the appropriate slope factors (SFs; for carcinogenic effects) and reference doses (RfDs; for noncarcinogenic effects) are identified or derived for use in the site-specific equations or the standard default equations. Therefore, Chapter 7 of RAGS/HHEM Part A should be reviewed carefully before proceeding with this step.

The hierarchy for obtaining toxicity values for risk-based PRGs is essentially the same as that used in the baseline risk assessment. Briefly, Integrated Risk Information System (IRIS) is the primary source for toxicity information; if no verified toxicity value is available through IRIS, then Health Effects Assessment Summary Tables (HEAST) is the next preferred source. When the development of a toxicity value is required (and appropriate data are available), consultation with the Superfund Health Risk Assessment Technical Support Center is warranted. EPA staff can contact the Center by calling FTS-684-7300 (513-569-7300) or by FAX at FTS-684-7159 (513-569-7159). Others must fax to the above number or write to:

Superfund Health Risk Technical Support Center
Environmental Criteria and Assessment Office
U.S. Environmental Protection Agency
Mail Stop 114
26 West Martin Luther King Drive
Cincinnati, Ohio 45268

Other toxicity information that should be obtained includes EPA's weight-of-evidence classification for carcinogens (e.g., A, B1) and the source of the information (e.g., IRIS, HEAST).

Note that throughout this document, the term hazard index (HI) is used to refer to the risk level associated with noncarcinogenic effects. An HI is the sum of two or more hazard quotients (HQs). An HQ is the ratio of an exposure level of a single substance to the RfD for that substance. Because RfDs are generally exposure pathway-specific (e.g., inhalation RfD), the HQ is a single substance/single exposure pathway ratio. An HI, on the other hand, is usually either a single substance/multiple exposure pathway ratio, a multiple substance/single exposure pathway ratio, or a multiple substance/multiple exposure pathway ratio. In this document, however, only one exposure pathway is included in the default equation for some land-use and medium combinations (e.g., residential soil). In order to remain consistent, the term HI has been used throughout RAGS/HHEM Part B, even though for such a pathway, the term HQ could apply.

2.7 TARGET RISK LEVELS

This step involves identifying target risk concentrations for chemicals of potential concern. The standard default equations presented in Chapters 3 and 4 are based on the following target risk levels for carcinogenic and noncarcinogenic effects.

- For carcinogenic effects, a concentration is calculated that corresponds to a 10^{-6} incremental risk of an individual developing cancer over a lifetime as a result of exposure to the potential carcinogen from all significant exposure pathways for a given medium.

CASE STUDY: IDENTIFY TOXICITY INFORMATION[a]

Reference toxicity values for cancer and noncancer effects (i.e., SFs and RfDs, respectively) are required for chemicals without ARAR-based PRGs (only the case study chemicals without ARARs are listed here). Considering the ground-water medium only, ingestion and inhalation are exposure pathways of concern. Toxicity information is obtained from IRIS and HEAST, and is shown in the table below.

Chemical	RfD (mg/kg-day)	Source	SF (mg/kg-day)$^{-1}$	Weight of Evidence	Source
EXPOSURE ROUTE: INGESTION					
Hexane	0.06	HEAST	—	—	—
Isophorone	0.2	IRIS	0.0039	C	HEAST
Triallate	0.013	IRIS	—	—	—
EXPOSURE ROUTE: INHALATION					
Hexane	0.04	HEAST	—	—	—
Isophorone	—	—	—	C	HEAST
Triallate	—	—	—	—	—

[a] All information in this example is for illustration purposes only.

- For noncarcinogenic effects, a concentration is calculated that corresponds to an HI of 1, which is the level of exposure to a chemical from all significant exposure pathways in a given medium below which it is unlikely for even sensitive populations to experience adverse health effects.

At scoping, it generally is appropriate to use the standard default target risk levels described above and discussed in the NCP. That is, an appropriate point of departure for remediation of carcinogenic risk is a concentration that corresponds to a risk of 10^{-6} for one chemical in a particular medium. For noncarcinogenic effects, the NCP does not specify a range, but it generally is appropriate to assume an HI equal to 1.

2.8 MODIFICATION OF PRELIMINARY REMEDIATION GOALS

Upon completion of the baseline risk assessment (or as soon as data are available), it is important to review the future land use, exposure assumptions, and the media and chemicals of potential concern originally identified at scoping, and determine whether PRGs need to be modified. Modification may involve adding or subtracting chemicals of concern, media, and pathways or revising individual chemical-specific goals.

2.8.1 REVIEW OF ASSUMPTIONS

Media of Concern. As a guide to determining the media and chemicals of potential concern, the OSWER directive *Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions* (EPA 1991c) indicates that action is generally warranted at a site when the cumulative carcinogenic risk is greater than 10^{-4} or the cumulative noncarcinogenic HI exceeds 1 based on RME assumptions. Thus, where the baseline risk assessment indicates that either the cumulative current or future risk associated with a medium is greater than 10^{-4} or that the HI is greater than 1, that medium presents a concern, and it generally is appropriate to maintain risk-based PRGs for contaminants in that medium or develop risk-based PRGs for additional media where PRGs are not clearly defined by ARARs.

When the cumulative current or future baseline cancer risk for a medium is within the range of 10^{-6} to 10^{-4}, a decision about whether or not to take action is a site-specific determination. Generally, risk-based PRGs are not needed for any chemicals in a medium with a cumulative cancer risk of less than 10^{-6}, where an HI is less than or equal to 1, or where the PRGs are clearly defined by ARARs. However, there may be cases where a medium appears to meet the protectiveness criterion but contributes to the contamination of another medium (e.g., soil contributing to ground-water contamination). In these cases, it may be appropriate to modify existing or develop new risk-based PRGs for chemicals of concern in the first medium, assuming that fate and transport models can adequately predict the impacts of concern on other media. EPA is presently developing guidance on quantifying the impact of soil contamination on underlying aquifers.

Chemicals of Concern. As with the initial media of potential concern, the initial list of specific chemicals of potential concern in a given medium may need to be modified to reflect increased information from the RI/FS concerning the importance of the chemicals to the overall site risk. Chemicals detected during the RI/FS that were not anticipated during scoping should be considered for addition to the list of chemicals of potential concern; chemicals anticipated during scoping that were not detected during the RI/FS should be deleted from the list. Ultimately, the identity and number of contaminants that may require risk-based PRGs depends both on the results of the baseline risk assessment and the extent of action required, given site-specific circumstances.

Following the baseline risk assessment, any chemical that has an associated cancer risk (current or future) within a medium of greater than 10^{-6} or an HI of greater than 1 should remain on the list of chemicals of potential concern for that medium. Likewise, chemicals that present cancer risks of less than 10^{-6} generally should not be retained on the list unless there are significant concerns about multiple contaminants and pathways.

Land Use. After the RI/FS, one future land use can usually be selected based on the results of the baseline risk assessment and discussions with the RPM. In many cases, this land use will be the same as the land use identified at scoping. In other cases, however, additional information from the baseline risk assessment that was not available at scoping may suggest modifying the initial land-use and exposure assumptions. A qualitative assessment should be made — and should be available from the baseline risk assessment — of the likelihood that the assumed future land use will occur.

Exposure Pathways, Parameters, and Equations. For exposure pathways, this process of modifying PRGs consists of adding or deleting exposure pathways from the medium-specific equations in Chapters 3 and 4 to ensure that the equation accounts for all significant exposure pathways associated with that medium at the site. For example, the baseline risk assessment may indicate that dermal exposure to contaminants in soil is a significant contributor to site risk. In this case, the risk-based PRGs may be modified by adding equations for dermal exposure. EPA policy on assessing this pathway is currently under development; the risk assessor should consult the Superfund Health Risk Technical Support Center (FTS-684-7300 or 513-569-7300) to determine the current status of guidance. Likewise, when appropriate data (e.g., on exposure frequency and duration) have been collected during the RI/FS, site-specific values can be substituted for the default values in the medium-specific equations.

2.8.2 IDENTIFICATION OF UNCERTAINTIES

The uncertainty assessment for PRGs can serve as an important basis for recommending further modifications to the PRGs prior to setting final remediation goals. It also can be used during the post-remedy assessment (see Section 2.8.4) to identify areas needing particular attention.

Risk-based PRGs are associated with varied levels of uncertainty, depending on many factors (e.g., confidence that anticipated future land use is correct). To place risk-based PRGs that have been developed for a site in proper perspective, an assessment of the uncertainties associated with the concentrations should be conducted. This assessment is similar to the uncertainty assessment conducted during the baseline risk assessment (see RAGS/HHEM Part A, especially Chapters 6, 7, and 8). In fact, much of the uncertainty assessment conducted for a site's baseline risk assessment will be directly applicable to the uncertainty assessment of the risk-based PRGs.

In general, each component of risk-based PRGs discussed in this chapter — from media of potential concern to target risk level — should be examined, and the major areas of uncertainty highlighted. For example, the uncertainty associated with the selected future land use should be discussed. Furthermore, the accuracy of the technical models used (e.g., for volatilization of contaminants from soil) to reflect site-specific conditions (present and future) should be discussed. If site-specific exposure assumptions have been made, it is particularly important to document the data supporting those assumptions and to assess their relevance for potentially exposed populations.

As the chemical- and medium-specific PRGs are developed, many assumptions regarding the RME individual(s) are incorporated. Although PRGs are believed to be fully protective for the RME individual(s), the proximity of other nearby sources of exposure (e.g., other CERCLA sites, RCRA facilities, naturally occurring background contamination) and/or the existence of the same contaminants in multiple media or of multiple chemicals affecting the same population(s), may lead to a situation where, even after attainment of all PRGs, protectiveness is not clearly achieved (e.g., cumulative risks may fall outside the risk range). The more likely it is that multiple contaminants, pathways, operable units, or other sources of toxicants will affect the RME individual(s), the more likely it will be that protectiveness is not achieved. This likelihood should be addressed when identifying uncertainties.

2.8.3 OTHER CONSIDERATIONS IN MODIFYING PRGs

The NCP preamble and rule state that factors related to exposure, technical limitations, and uncertainty should be considered when modifying PRGs (see next two boxes) and setting final remediation levels.

While the final remedial action objectives must satisfy the original "threshold criteria" of protection of human health and the environment and compliance with ARARs, the factors in the "balancing and modifying criteria" (listed in Section 1.3.2) also are considered in the detailed analysis for choosing among remedial alternatives. In cases where the alternative that represents the best balance of factors is not able to attain cancer risks within the risk range or an HI of 1, institutional controls may be used to supplement treatment and/or containment-based remedial action to ensure protection of human health and the environment.

NCP PREAMBLE: EXPOSURE, TECHNICAL, AND UNCERTAINTY FACTORS
(55 *Federal Register* 8717, March 8, 1990)

"Preliminary remediation goals ... may be revised ... based on the consideration of appropriate factors including, but not limited to: exposure factors, uncertainty factors, and technical factors. Included under exposure factors are: cumulative effect of multiple contaminants, the potential for human exposure from other pathways at the site, population sensitivities, potential impacts on environmental receptors, and cross-media impacts of alternatives. Factors related to uncertainty may include: the reliability of alternatives, the weight of scientific evidence concerning exposures and individual and cumulative health effects, and the reliability of exposure data. Technical factors may include: detection/quantification limits for contaminants, technical limitations to remediation, the ability to monitor and control movement of contaminants, and background levels of contaminants. The final selection of the appropriate risk level is made when the remedy is selected based on the balancing of criteria...."

NCP RULE: EXPOSURE, TECHNICAL, AND UNCERTAINTY FACTORS
(40 CFR 300.430(e)(2)(i))

"(i)...Remediation goals...shall be developed by considering the following:

"(A) Applicable or relevant and appropriate requirements...and the following factors:

"(*1*) For systemic toxicants, acceptable exposure levels...;

"(*2*) For known or suspected carcinogens, acceptable exposure levels...;

"(*3*) Factors related to technical limitations such as detection/quantification limits for contaminants;

"(*4*) Factors related to uncertainty; and

"(*5*) Other pertinent information."

Note that in the absence of ARARs, the 10^{-6} cancer risk "point of departure" is used as a starting point for analysis of remedial alternatives, which reflects EPA's preference for managing risks at the more protective end of the risk range, other things being equal. Use of "point of departure" target risks in this guidance does not reflect a presumption that the final remedial action should attain such goals. (See NCP preamble, 55 *Federal Register* 8718-9.)

2.8.4 POST-REMEDY ASSESSMENT

To ensure that protective conditions exist after the remedy achieves all individual remediation levels set out in the ROD, there generally will be a site-wide evaluation conducted following completion of a site's final operable unit (e.g., during the five-year review). This site-wide evaluation should adequately characterize the residual contaminant levels and ensure that the post-remedy cumulative site risk is protective. More detailed guidance on the post-remedy assessment of site "protectiveness" is currently under development by EPA.

CHAPTER 3

CALCULATION OF RISK-BASED PRELIMINARY REMEDIATION GOALS

This chapter presents standardized exposure parameters, the derivation of risk equations, and the corresponding "reduced" equations, for calculating risk-based PRGs at scoping for the media and land-use assumptions discussed in Chapter 2 (i.e., ground water, surface water, and soil for residential land use, and soil for commercial/industrial land use). Both carcinogenic and noncarcinogenic effects are addressed. Standardized default exposure parameters consistent with OSWER Directive 9285.6-03 (EPA 1991b) are used in this chapter; where default parameters are not available in that guidance, the references used are cited. If other media requiring risk-based PRGs are identified during the RI/FS, or other exposure parameters or land uses are assumed, then appropriate equations will need to be modified or new ones developed.

Risk-based equations have been derived in order to reflect the potential risk from exposure to a chemical, given a specific pathway, medium, and land-use combination. By setting the total risk for carcinogenic effects at a target risk level of 10^{-6} (the NCP's point of departure for analysis of remedial alternatives), it is possible to solve for the concentration term (i.e., the risk-based PRG). The total risk for noncarcinogenic effects is set at an HI of 1 for each chemical in a particular medium. Full equations with pathway-specific default exposure factors are presented in boxes with uniformly thin borders. Reduced equations are presented in the standard boxes (i.e., thicker top and bottom borders). At the end of this chapter, the case study that began in Chapter 2 is concluded (by showing how to calculate and present risk-based PRGs).

In general, the equations described in this chapter are sufficient for calculating the risk-based PRGs at the scoping stage of the RI/FS. Note, however, that these equations are based on standard default assumptions that may or may not reflect site-specific conditions. When risk-based PRGs are to be calculated based on site-specific conditions, the risk assessor should modify the full equations, and/or develop additional ones. Risk equations for individual exposure pathways for a given medium are presented in Appendix B of this document, and may be used to develop and/or modify the full equations. (See the introduction to Appendix B for more detailed instructions.)

Before examining the calculation of risk-based PRGs, several important points should be noted:

- Use of toxicity values in the equations as written currently assumes 100 percent absorption effeciency. That is, for the sake of simplicity at scoping, it is assumed that the dose administered to test animals in toxicity studies on which toxicity values are based was fully absorbed. This assumption may need to be revised in cases where toxicity values based on route-to-route extrapolation are used, or there are significant differences in absorption likely between contaminants in site media and the contaminants in the vehicle used in the toxicity study. Chapter 7 and Appendix A in RAGS/HHEM Part A (EPA 1989d) provide additional details on this point.

- The risk-based PRGs should contain at most two significant figures even though some of the parameters used in the reduced equations carry additional significant figures.

- The equations presented in this chapter calculate risk-based concentrations using inhalation reference doses (RfD_is) and inhalation slope factors (SF_is). If only the reference concentration (RfC) and/or inhalation unit risk are available for a particular compound in IRIS, conversion to an RfD_i and/or SF_i will be necessary. Many converted toxicity values are available in HEAST.

- All standard equations presented here incorporate pathway-specific default exposure factors that generally reflect RME conditions. As detailed in Chapter 8 of RAGS/HHEM Part A (in the discussion on combining pathway risks [Section 8.3]), RME risks from one pathway should be combined with RME risks from another pathway only where there is good reason. Typically, RME from one pathway is not likely to occur with RME from another (unless there is a strong logical dependent relationship between exposures from the two pathways). If risk-based concentrations are developed for both the water and the soil pathways, the risk assessor ultimately may need to adjust exposure assumptions from one pathway (i.e., the one with the lower RME) to less conservative (more typical) values.

3.1 RESIDENTIAL LAND USE

3.1.1 GROUND WATER OR SURFACE WATER

Under residential land use, risk from surface water or ground-water contaminants is assumed to be due primarily to direct ingestion and to inhalation of volatiles from household water use. Therefore, only these exposure pathways are considered in this section. Additional exposure pathways (e.g., dermal absorption) are possible and may be significant at some sites for some contaminants, while perhaps only one exposure pathway (e.g., direct ingestion of water only) may be relevant at others. In any case, the risk-based PRG for each chemical should be calculated by considering all of the relevant exposure pathways.

In the case illustrated here, risks from two exposure pathways from ground water or surface water are combined, and the risk-based concentration is derived to be protective for exposures from both pathways. Default risk from ground water or surface water would be calculated as follows ("total" risk, as used below, refers to the combined risk for a single chemical from all exposure pathways for a given medium):

Total risk from water = Risk from ingestion of water (adult) + Risk from inhalation of volatiles from household water (adult)

At scoping, risk from indoor inhalation of volatiles is assumed to be relevant only for chemicals that easily volatilize. Thus, the risk equation incorporates a water-air concentration relationship that is applicable only to chemicals with a Henry's Law constant of greater than 1 x 10^{-5} atm-m^3/mole <u>and</u> a molecular weight of less than 200 g/mole. These criteria are <u>not</u> used to screen out chemicals that are not of potential concern for this exposure pathway but only to identify those that generally <u>should</u> be considered for the inhalation pathway when developing risk-based PRGs early in the process. Chemicals that do not meet these criteria may pose significant site risks (and require risk-based goals) through volatiles inhalation. The ultimate decision regarding which contaminants should be considered in the FS must be made on a site-specific basis following completion of the baseline risk assessment.

Based primarily on experimental data on the volatilization of radon from household uses of water, Andelman (1990) derived an equation that defines the relationship between the concentration of a contaminant in household water and the average concentration of the volatilized contaminant in air. In the derivation, all uses of household water were considered (e.g., showering, laundering, dish washing). The equation uses a default "volatilization" constant (K) upper-bound value of 0.0005 x 1000 L/m^3. (The 1000 L/m^3 conversion factor is incorporated into the equation so that the resulting air concentration is expressed in mg/m^3.) Certain assumptions were made in deriving the default constant K (Andelman 1990). For example, it is assumed that the volume of water used in a residence for a family of four is 720 L/day, the volume of the dwelling is 150,000 L and the air exchange rate is 0.25 m^3/hr. Furthermore, it is assumed that the average transfer efficiency weighted by water use is 50 percent (i.e., half of the concentration of each chemical in water will be transfered into air by all water uses [the range extends from 30% for toilets to 90% for dishwashers]). See the Andelman paper for further details.

Concentrations Based on Carcinogenic Effects. Total risk for carcinogenic effects of certain volatile chemicals would be calculated by combining the appropriate inhalation and oral SFs with the two intakes from water:

Total risk = SF_o x Intake from ingestion of water + SF_i x Intake from inhalation of volatiles from water

Adding appropriate parameters, and then rearranging the equation to solve for concentration, results in Equation (1).

Equation (1′) on the next page is the reduced version of Equation (1) using the standard default parameters, and is used to calculate the risk-based PRG at a prespecified cancer risk level of 10^{-6}. It combines the toxicity information of a chemical with standard default exposure parameters for residential land use to generate the concentration of that chemical that corresponds to a 10^{-6} carcinogenic risk level due to that chemical. If either the SF_o or SF_i in Equation (1′) is not available for a particular chemical, the term containing that variable in the equation can be ignored or equated to zero (e.g., for a chemical that does not have SF_i, the term $7.5(SF_i)$ in Equation (1′) is ignored). <u>If any of the default parameter values are changed to reflect site-specific conditions, the reduced equation cannot be used.</u>

RESIDENTIAL WATER — CARCINOGENIC EFFECTS

$$TR = \frac{SF_o \times C \times IR_w \times EF \times ED}{BW \times AT \times 365 \text{ days/yr}} + \frac{SF_i \times C \times K \times IR_a \times EF \times ED}{BW \times AT \times 365 \text{ days/yr}}$$

$$= \frac{EF \times ED \times C \times [(SF_o \times IR_w) + (SF_i \times K \times IR_a)]}{BW \times AT \times 365 \text{ days/yr}}$$

$$C \text{ (mg/L; risk-based)} = \frac{TR \times BW \times AT \times 365 \text{ days/yr}}{EF \times ED \times [(SF_i \times K \times IR_a) + (SF_o \times IR_w)]} \quad (1)$$

where:

Parameters	Definition (units)	Default Value
C	chemical concentration in water (mg/L)	—
TR	target excess individual lifetime cancer risk (unitless)	10^{-6}
SF_i	inhalation cancer slope factor ((mg/kg-day)$^{-1}$)	chemical-specific
SF_o	oral cancer slope factor ((mg/kg-day)$^{-1}$)	chemical-specific
BW	adult body weight (kg)	70 kg
AT	averaging time (yr)	70 yr
EF	exposure frequency (days/yr)	350 days/yr
ED	exposure duration (yr)	30 yr
IR_a	daily indoor inhalation rate (m^3/day)	15 m^3/day
IR_w	daily water ingestion rate (L/day)	2 L/day
K	volatilization factor (unitless)	0.0005 x 1000 L/m^3 (Andelman 1990)

REDUCED EQUATION: RESIDENTIAL WATER — CARCINOGENIC EFFECTS

$$\text{Risk-based PRG (mg/L; } TR = 10^{-6}) = \frac{1.7 \times 10^{-4}}{2(SF_o) + 7.5(SF_i)} \quad (1')$$

where:

SF_o = oral slope factor in (mg/kg-day)$^{-1}$
SF_i = inhalation slope factor in (mg/kg-day)$^{-1}$

Concentrations Based on Noncarcinogenic Effects. Total HI would be calculated by combining the appropriate oral and inhalation RfDs with the two intakes from water:

$$HI = \frac{\text{Intake from oral ingestion}}{RfD_o} + \frac{\text{Intake from inhalation}}{RfD_i}$$

Adding appropriate parameters, and then rearranging the equation to solve for concentration, results in Equation (2).

Equation (2´) on the next page is the reduced version of Equation (2) using the standard default parameters, and is used to calculate the risk-based PRG at a prespecified HI of 1. It combines the toxicity information of a chemical with standard exposure parameters for residential land use to generate the concentration of that chemical that corresponds to an HI of 1. If either the RfD_o or RfD_i in Equation (2´) is not available for a particular chemical, the term containing that variable in the equation can be ignored or equated to zero (e.g., for a chemical that does not have RfD_i, the term $7.5/RfD_i$ in Equations (2´) is ignored).

RESIDENTIAL WATER — NONCARCINOGENIC EFFECTS

$$THI = \frac{C \times IR_w \times EF \times ED}{RfD_o \times BW \times AT \times 365 \text{ days/yr}} + \frac{C \times K \times IR_a \times EF \times ED}{RfD_i \times BW \times AT \times 365 \text{ days/yr}}$$

$$= \frac{EF \times ED \times C \times [(1/RfD_o \times IR_w) + (1/RfD_i \times K \times IR_a)]}{BW \times AT \times 365 \text{ days/yr}}$$

$$C \text{ (mg/L; risk-based)} = \frac{THI \times BW \times AT \times 365 \text{ days/yr}}{EF \times ED \times [(1/RfD_i \times K \times IR_a) + (1/RfD_o \times IR_w)]} \qquad (2)$$

where:

Parameters	Definition	Default Value
C	chemical concentration in water (mg/L)	—
THI	target hazard index (unitless)	1
RfD_o	oral chronic reference dose (mg/kg-day)	chemical-specific
RfD_i	inhalation chronic reference dose (mg/kg-day)	chemical-specific
BW	adult body weight (kg)	70 kg
AT	averaging time (yr)	30 yr (for noncarcinogens, equal to ED)
EF	exposure frequency (days/yr)	350 days/yr
ED	exposure duration (yr)	30 yr
IR_a	daily indoor inhalation rate (m^3/day)	15 m^3/day
IR_w	daily water ingestion rate (L/day)	2 L/day
K	volatilization factor (unitless)	0.0005 x 1000 L/m^3 (Andelman 1990)

REDUCED EQUATION: RESIDENTIAL WATER — NONCARCINOGENIC EFFECTS

$$\text{Risk-based PRG (mg/L; THI = 1)} = \frac{73}{[7.5/RfD_i + 2/RfD_o]} \qquad (2´)$$

where:

RfD_o = oral chronic reference dose in mg/kg-day

RfD_i = inhalation chronic reference dose in mg/kg-day

3.1.2 SOIL.

Under residential land use, risk of the contaminant from soil is assumed to be due to direct ingestion of soil only.

Total risk from soil = Risk from ingestion of soil (child to adult)

Because the soil ingestion rate is different for children and adults, the risk due to direct ingestion of soil is calculated using an age-adjusted ingestion factor. The age-adjusted soil ingestion factor ($IF_{soil/adj}$) takes into account the difference in daily soil ingestion rates, body weights, and exposure durations for two exposure groups — children of one to six years and others of seven to 31 years. Exposure frequency (EF) is assumed to be identical for the two exposure groups. For convenience, this factor is calculated separately as a time-weighted soil intake, normalized to body weight, that can then be substituted in the total intake equation. Calculated in this manner, the factor leads to a more protective risk-based concentration compared to an adult-only assumption. Note that the ingestion factor is in units of mg-yr/kg-day, and therefore is not directly comparable to daily soil intake rate in units of mg/kg-day. See the box containing Equation (3) for the calculation of this factor.

Additional exposure pathways (e.g., inhalation of particulates, inhalation of volatiles, ingestion of foodcrops contaminated through airborne particulate deposits, consumption of ground water contaminated by soil leachate) are possible at some sites. The risk assessor should evaluate whether inhalation or other exposure pathways are significant at the site. Generally, for many undisturbed sites with vegetative cover such as those found in areas of residential land use, air pathways are relatively minor contributors of risk. Greater concern for baseline risk via air pathways exists under commercial/industrial land-use assumptions, given the increased activity levels likely (see Section 3.2.2). Air pathway risks also tend to be major concerns during remedial action (see RAGS/HHEM Part C). If these other pathways are known to be significant at scoping, Appendix B and/or other information should be used to develop site-specific equations for the risk-based PRGs.

Concentrations Based on Carcinogenic Effects. Total risk for carcinogenic effects would be calculated by combining the appropriate oral SF with the intake from soil:

Total risk = SF_o x Intake from ingestion of soil

Adding appropriate parameters, and then rearranging the equation to solve for concentration, results in Equation (4).

Equation (4') below is the reduced version of Equation (4) using the standard default parameters, and is used to calculate the risk-based PRG at a prespecified cancer risk level of 10^{-6}. It combines the toxicity information of a chemical with standard exposure parameters for residential land use to generate the concentration of that chemical that corresponds to a 10^{-6} carcinogenic risk level due to that chemical.

AGE-ADJUSTED SOIL INGESTION FACTOR

$$IF_{soil/adj}\ (\text{mg-yr/kg-day}) = \frac{IR_{soil/age1\text{-}6} \times ED_{age1\text{-}6}}{BW_{age1\text{-}6}} + \frac{IR_{soil/age7\text{-}31} \times ED_{age7\text{-}31}}{BW_{age7\text{-}31}} \quad (3)$$

Parameter	Definition	Default Value
$IF_{soil/adj}$	age-adjusted soil ingestion factor (mg-yr/kg-day)	114 mg-yr/kg-day
$BW_{age1\text{-}6}$	average body weight from ages 1-6 (kg)	15 kg
$BW_{age7\text{-}31}$	average body weight from ages 7-31 (kg)	70 kg
$ED_{age1\text{-}6}$	exposure duration during ages 1-6 (yr)	6 yr
$ED_{age7\text{-}31}$	exposure duration during ages 7-31 (yr)	24 yr
$IR_{soil/age1\text{-}6}$	ingestion rate of soil age 1 to 6 (mg/day)	200 mg/day
$IR_{soil/age7\text{-}31}$	ingestion rate of soil all other ages (mg/day)	100 mg/day

RESIDENTIAL SOIL — CARCINOGENIC EFFECTS

$$TR = \frac{SF_o \text{ x } C \text{ x } 10^{-6} \text{ kg/mg x } EF \text{ x } IF_{soil/adj}}{AT \text{ x } 365 \text{ days/yr}}$$

$$C \text{ (mg/kg; risk-based)} = \frac{TR \text{ x } AT \text{ x } 365 \text{ days/year}}{SF_o \text{ x } 10^{-6} \text{ kg/mg x } EF \text{ x } IF_{soil/adj}} \qquad (4)$$

where:

Parameters	Definition (units)	Default Value
C	chemical concentration in soil (mg/kg)	—
TR	target excess individual lifetime cancer risk (unitless)	10^{-6}
SF_o	oral cancer slope factor ((mg/kg-day)$^{-1}$)	chemical-specific
AT	averaging time (yr)	70 yr
EF	exposure frequency (days/yr)	350 days/yr
$IF_{soil/adj}$	age-adjusted ingestion factor (mg-yr/kg-day)	114 mg-yr/kg-day (see Equation (3))

REDUCED EQUATION: RESIDENTIAL SOIL — CARCINOGENIC EFFECTS

$$\text{Risk-based PRG (mg/kg; TR} = 10^{-6}) = \frac{0.64}{SF_o} \qquad (4')$$

where:

SF_o = oral slope factor in (mg/kg-day)$^{-1}$

Concentrations Based on Noncarcinogenic Effects. Total HI would be calculated by combining the appropriate oral RfD with the intake from soil:

$$HI = \frac{\text{Intake from ingestion}}{RfD_o}$$

Adding appropriate parameters, and then rearranging the equation to solve for concentration, results in Equation (5).

Equation (5′) is the reduced version of Equation (5) using the standard default parameters, and is for calculating the risk-based PRG at a prespecified HI of 1. It combines the toxicity information of a chemical with standard exposure parameters for residential land use to generate the concentration of that chemical that corresponds to an HI of 1.

3.2 COMMERCIAL/INDUSTRIAL LAND USE

3.2.1 WATER

Once ground water is determined to be suitable for drinking, risk-based concentrations should be based on residential exposures. This is because the NCP seeks to require protection of ground water to allow for its maximum beneficial use (see Section 2.3). Thus, under the commercial/industrial land-use scenario, risk-based PRGs for ground water are calculated according to procedures detailed in Section 3.1.1. Similarly, for surface water that is to be used for drinking, the risk-based PRGs should be calculated for residential populations, and not simply worker populations.

RESIDENTIAL SOIL — NONCARCINOGENIC EFFECTS

$$\text{THI} = \frac{\text{C} \times 10^{-6}\ \text{kg/mg} \times \text{EF} \times \text{IF}_{\text{soil/adj}}}{\text{RfD}_{\text{o}} \times \text{AT} \times 365\ \text{days/yr}}$$

$$\text{C (mg/kg; risk-based)} = \frac{\text{THI} \times \text{AT} \times 365\ \text{days/yr}}{1/\text{RfD}_{\text{o}} \times 10^{-6}\ \text{kg/mg} \times \text{EF} \times \text{IF}_{\text{soil/adj}}} \qquad (5)$$

where:

Parameters	Definition (units)	Default Value
C	chemical concentration in soil (mg/kg)	—
THI	target hazard index (unitless)	1
RfD_{o}	oral chronic reference dose (mg/kg-day)	chemical-specific
AT	averaging time (yr)	30 yr (for noncarcinogens, equal to ED [which is incorporated in $\text{IF}_{\text{soil/adj}}$])
EF	exposure frequency (days/yr)	350 days/yr
$\text{IF}_{\text{soil/adj}}$	age-adjusted ingestion factor (mg-yr/kg-day)	114 mg-yr/kg-day (see Equation (3))

REDUCED EQUATION: RESIDENTIAL SOIL — NONCARCINOGENIC EFFECTS

$$\text{Risk-based PRG (mg/kg; THI = 1)} = 2.7 \times 10^{5}\ (\text{RfD}_{\text{o}}) \qquad (5')$$

where:

RfD_{o} = oral chronic reference dose in mg/kg-day

3.2.2 SOIL

Under commercial/industrial land use, risk of the contaminant from soil is assumed to be due to direct ingestion, inhalation of volatiles from the soil, and inhalation of particulates from the soil, and is calculated for an adult worker only. For this type of land use, it is assumed for calculating default risk-based PRGs that there is greater potential for use of heavy equipment and related traffic in and around contaminated soils and thus greater potential for soils to be disturbed and produce particulate and volatile emissions than in most residential land-use areas. Additional exposure pathways (e.g., dermal exposure) are possible at some sites, while perhaps only one exposure pathway (e.g., direct ingestion of soil only) may be relevant at others; Appendix B may be used to identify relevant exposure pathways to be combined. In such cases, the risk is calculated by considering all the relevant exposure pathways identified in the RI.

In the default case illustrated below, intakes from the three exposure pathways are combined and the risk-based PRG is derived to be protective for exposures from all three pathways. In this case, the risk for a specific chemical from soil due to the three exposure pathways would be calculated as follows:

Total risk from soil = Risk from ingestion of soil (worker)
+ Risk from inhalation of volatiles from soil (worker)
+ Risk from inhalation of particulates from soil (worker)

It is possible to consider only exposure pathways of site-specific importance by deriving a site-specific risk-based PRG (e.g., using the equations in Appendix B).

Concentrations Based on Carcinogenic Effects. Total risk for carcinogenic effects would be calculated by combining the appropriate inhalation and oral SFs with the three intakes from soil:

Total risk = SF_o x Intake from ingestion of soil (worker)
+ SF_i x Intake from inhalation of volatiles from soil (worker)
+ SF_i x Intake from inhalation of particulates (worker)

Adding appropriate parameters, and then rearranging the equation to solve for concentration, results in Equation (6). As discussed in more detail in Section 3.3.1, Equation (6a) is used to test the results of Equation (6).

Equation (6′) is the reduced version of Equation (6) using the standard default parameters, and is used to calculate the risk-based PRG at a prespecified cancer risk level of 10^{-6}. It combines the toxicity information of a chemical with standard exposure parameters for commercial/industrial land use to generate the concentration of that chemical that corresponds to a 10^{-6} carcinogenic risk level due to that chemical.

Concentrations Based on Noncarcinogenic Effects. Total HI would be calculated by combining the appropriate oral and inhalation RfDs with the three intakes from soil:

$$HI = \frac{\text{Intake from ingestion}}{RfD_o} + \frac{\text{(Intake from inhalation of volatiles and particulates)}}{RfD_i}$$

Adding appropriate parameters, and then rearranging the equation to solve for concentration, results in Equation (7).

Equation (7′) is the reduced version of Equation (7) using the standard default parameters, and is used to calculate the risk-based PRG at a prespecified HI of 1. It combines the toxicity information of a chemical with standard exposure parameters for commercial/industrial land use to generate the concentration of that chemical that corresponds to an HI of 1.

3.3 VOLATILIZATION AND PARTICULATE EMISSION FACTORS

3.3.1 SOIL-TO-AIR VOLATILIZATION FACTOR

The volatilization factor (VF) is used for defining the relationship between the concentration of contaminants in soil and the volatilized contaminants in air. This relationship was established as a part of the Hwang and Falco (1986) model developed by EPA's Exposure Assessment Group (EAG). Hwang and Falco present a method intended primarily to estimate the permissible residual levels associated with the cleanup of contaminated soils. This method has been used by EPA in estimating exposures to PCBs and 2,3,7,8-TCDD from contaminated soil (EPA 1986; EPA 1988a). One of the pathways considered in this method is the intake by inhalation of volatilized contaminants.

The basic principle of the Hwang and Falco model is applicable only if the soil contaminant concentration is at or below saturation. Saturation is the soil contaminant concentration at which the adsorptive limits of the soil particles and the solubility limits of the available soil moisture have been reached. Above saturation, pure liquid-phase contaminant is present in the soil. Under such conditions, the partial pressure of the pure contaminant and the partial pressure of air in the interstitial soil pore spaces cannot be calculated without first knowing the mole fraction of the contaminant in the soil. Therefore, above saturation, the PRG cannot be accurately calculated based on volatilization. Because of this limitation, the chemical concentration in soil (C) calculated using the VF must be compared with the soil saturation concentration (C_{sat}) calculated using Equation (6a) or (7a). If C is greater than C_{sat}, then the PRG is set equal to C_{sat}.

The VF presented in this section assumes that the contaminant concentration in the soil is homogeneous from the soil surface to the depth of concern and that the contaminated material is not covered by contaminant-free soil material. For the purpose of calculating VF, depth of concern is defined as the depth at which a near impenetrable layer or the permanent ground-water level is reached.

COMMERCIAL/INDUSTRIAL SOIL — CARCINOGENIC EFFECTS

$$TR = \frac{SF_o \times C \times 10^{-6}\ kg/mg \times EF \times ED \times IR_{soil}}{BW \times AT \times 365\ days/yr} + \frac{SF_i \times C \times EF \times ED \times IR_{air} \times (1/VF + 1/PEF)}{BW \times AT \times 365\ days/yr}$$

$$C\ (mg/kg;\ risk\text{-}based) = \frac{TR \times BW \times AT \times 365\ days/yr}{EF \times ED \times [(SF_o \times 10^{-6}\ kg/mg \times IR_{soil}) + (SF_i \times IR_{air} \times [1/VF + 1/PEF])]} \qquad (6)$$

where:

Parameters	Definition (units)	Default Value
C	chemical concentration in soil (mg/kg)	—
TR	target excess individual lifetime cancer risk (unitless)	10^{-6}
SF_i	inhalation cancer slope factor ($(mg/kg\text{-}day)^{-1}$)	chemical-specific
SF_o	oral cancer slope factor ($(mg/kg\text{-}day)^{-1}$)	chemical-specific
BW	adult body weight (kg)	70 kg
AT	averaging time (yr)	70 yr
EF	exposure frequency (days/yr)	250 days/yr
ED	exposure duration (yr)	25 yr
IR_{soil}	soil ingestion rate (mg/day)	50 mg/day
IR_{air}	workday inhalation rate (m^3/day)	20 m^3/day
VF	soil-to-air volatilization factor (m^3/kg)	chemical-specific (see Section 3.3.1)
PEF	particulate emission factor(m^3/kg)	$4.63 \times 10^9\ m^3/kg$ (see Section 3.3.2)

$$C_{sat} = (K_d \times s \times n_m) + (s \times \theta_m) \qquad (6a)$$

where:

Parameters	Definition (units)	Default Value
C_{sat}	soil saturation concentration (mg/kg)	—
K_d	soil-water partition coefficient (L/kg)	chemical-specific, or $K_{oc} \times OC$
K_{oc}	organic carbon partition coefficient (L/kg)	chemical-specific
OC	organic carbon content of soil (fraction)	site-specific, or 0.02
s	solubility (mg/L-water)	chemical-specific
n_m	soil moisture content, expressed as a weight fraction	site-specific
θ_m	soil moisture content, expressed as L-water/kg-soil	site-specific

REDUCED EQUATION: COMMERCIAL/INDUSTRIAL SOIL — CARCINOGENIC EFFECTS

$$Risk\text{-}based\ PRG\ (mg/kg;\ TR = 10^{-6}) = \frac{2.9 \times 10^{-4}}{[((5 \times 10^{-5}) \times SF_o) + (SF_i \times ((20/VF) + (4.3 \times 10^{-9})))]} \qquad (6')$$

where:

SF_o = oral slope factor in $(mg/kg\text{-}day)^{-1}$
SF_i = inhalation slope factor in $(mg/kg\text{-}day)^{-1}$
VF = chemical-specific soil-to-air volatilization factor in m^3/kg (see Section 3.3.1)

If PRG > C_{sat}, then set PRG = C_{sat} (where C_{sat} = soil saturation concentration (mg/kg); see Equation (6a) and Section 3.3.1).

COMMERCIAL/INDUSTRIAL SOIL — NONCARCINOGENIC EFFECTS

$$\text{THI} = \frac{\text{C x } 10^{-6} \text{ kg/mg x EF x ED x IR}_{soil}}{\text{RfD}_o \text{ x BW x AT x 365 days/yr}} + \frac{\text{C x EF x ED x IR}_{air} \text{ x (1/VF + 1/PEF)}}{\text{RfD}_i \text{ x BW x AT x 365 days/yr}}$$

$$\text{C (mg/kg; risk-based)} = \frac{\text{THI x BW x AT x 365 days/yr}}{\text{ED x EF x [((1/RfD}_o\text{) x } 10^{-6} \text{ kg/mg x IR}_{soil}\text{) + ((1/RfD}_i\text{) x IR}_{air} \text{ x (1/VF + 1/PEF))]}} \quad (7)$$

where:

Parameters	Definition (units)	Default Value
C	chemical concentration in soil (mg/kg)	—
THI	target hazard index (unitless)	1
RfD_o	oral chronic reference dose (mg/kg-day)	chemical-specific
RfD_i	inhalation chronic reference dose (mg/kg-day)	chemical-specific
BW	adult body weight (kg)	70 kg
AT	averaging time (yr)	25 yr (always equal to ED)
EF	exposure frequency (days/yr)	250 days/yr
ED	exposure duration (yr)	25 yr
IR_{soil}	soil ingestion rate (mg/day)	50 mg/day
IR_{air}	workday inhalation rate (m^3/day)	20 m^3/day
VF	soil-to-air volatilization factor (m^3/kg)	chemical-specific (see Section 3.3.1)
PEF	particulate emission factor (m^3/kg)	4.63 x 10^9 m^3/kg (see Section 3.3.2)

$$C_{sat} = (K_d \text{ x s x } n_m) + (\text{s x } \theta_m) \quad (7a)$$

where:

Parameters	Definition (units)	Default Value
C_{sat}	soil saturation concentration (mg/kg)	—
K_d	soil-water partition coefficient (L/kg)	chemical-specific, or K_{oc} x OC
K_{oc}	organic carbon partition coefficient (L/kg)	chemical-specific
OC	organic carbon content of soil (fraction)	site-specific, or 0.02
s	solubility (mg/L-water)	chemical-specific
n_m	soil moisture content, expressed as a weight fraction	site-specific
θ_m	soil moisture content, expressed as L-water/kg-soil	site-specific

REDUCED EQUATION: COMMERCIAL/INDUSTRIAL SOIL — NONCARCINOGENIC EFFECTS

$$\text{Risk-based PRG (mg/kg; THI = 1)} = \frac{102}{[(5 \text{ x } 10^{-5}/\text{RfD}_o) + ((1/\text{RfD}_i) \text{ x } ((20/\text{VF}) + (4.3 \text{ x } 10^{-9})))]} \quad (7')$$

where:

RfD_o = oral chronic reference dose in mg/kg-day

RfD_i = inhalation chronic reference dose in mg/kg-day

VF = chemical-specific soil-to-air volatilization factor in m^3/kg (see Section 3.3.1)

If PRG > C_{sat}, then set PRG = C_{sat} (where C_{sat} = soil saturation concentration (mg/kg); see Equation (7a) and Section 3.3.1).

A chemical-specific value for VF is used in the standard default equations (Equations (6), (6´), (7), and (7´) in Section 3.2.2) and is developed in Equation (8). The VF value calculated using Equation (8) has been developed for specific use in the other equations in this guidance; it may not be applicable in other technical contexts. Equation (8) lists the standard default parameters for calculating VF. If site-specific information is available, Equation (8) may be modified to calculate a VF that is more appropriate for the particular site. Supporting references should be consulted when substituting site-specific data to ensure that the model and specific parameters can be appropriately applied to the given site.

3.3.2 PARTICULATE EMISSION FACTOR

The particulate emission factor (PEF) relates the contaminant concentration in soil with the concentration of respirable particles (PM_{10}) in the air due to fugitive dust emissions from surface contamination sites. This relationship is derived by Cowherd (1985) for a rapid assessment procedure applicable to a typical hazardous waste site where the surface contamination provides a relatively continuous and constant potential for emission over an extended period of time (e.g., years). The particulate emissions from contaminated sites are due to wind erosion and, therefore, depend on the erodibility of the surface

SOIL-TO-AIR VOLATILIZATION FACTOR

$$\mathrm{VF}\ (\mathrm{m^3/kg}) = \frac{(\mathrm{LS} \times \mathrm{V} \times \mathrm{DH})}{\mathrm{A}} \times \frac{(3.14 \times \alpha \times \mathrm{T})^{1/2}}{(2 \times D_{ei} \times \mathrm{E} \times K_{as} \times 10^{-3}\ \mathrm{kg/g})} \qquad (8)$$

where:

$$\alpha\ (\mathrm{cm^2/s}) = \frac{(D_{ei} \times \mathrm{E})}{\mathrm{E} + (\rho_s)(1-\mathrm{E})/K_{as}}$$

Standard default parameter values that can be used to reduce Equation (8) are listed below. These represent "typical" values as identified in a number of sources. For example, when site-specific values are not available, the length of a side of the contaminated area (LS) is assumed to be 45 m; this is based on a contaminated area of 0.5 acre which approximates the size of an average residential lot. The "typical" values LS, DH, and V are from EPA 1986. "Typical" values for E, OC, and ρ_s are from EPA 1984, EPA 1988b, and EPA 1988f. Site-specific data should be substituted for the default values listed below wherever possible. Standard values for chemical-specific D_i, H, and K_{oc} can be obtained by calling the Superfund Health Risk Technical Support Center.

Parameter	Definition (units)	Default
VF	volatilization factor (m^3/kg)	--
LS	length of side of contaminated area (m)	45 m
V	wind speed in mixing zone (m/s)	2.25 m/s
DH	diffusion height (m)	2 m
A	area of contamination (cm^2)	20,250,000 cm^2
D_{ei}	effective diffusivity (cm^2/s)	$D_i \times E^{0.33}$
E	true soil porosity (unitless)	0.35
K_{as}	soil/air partition coefficient (g soil/cm^3 air)	$(H/K_d) \times 41$, where 41 is a units conversion factor
ρ_s	true soil density or particulate density (g/cm^3)	2.65 g/cm^3
T	exposure interval (s)	7.9×10^8 s
D_i	molecular diffusivity (cm^2/s)	chemical-specific
H	Henry's law constant ($atm\text{-}m^3/mol$)	chemical-specific
K_d	soil-water partition coefficient (cm^3/g)	chemical-specific, or $K_{oc} \times OC$
K_{oc}	organic carbon partition coefficient (cm^3/g)	chemical-specific
OC	organic carbon content of soil (fraction)	site-specific, or 0.02

material. The equation presented below, Equation (9), is representative of a surface with "unlimited erosion potential," which is characterized by bare surfaces of finely divided material such as sandy agricultural soil with a large number ("unlimited reservoir") of erodible particles. Such surfaces erode at low wind speeds, and particulate emission rates are relatively time-independent at a given wind speed.

This model was selected for use in RAGS/HHEM Part B because it represents a conservative estimate for intake of particulates; it is used to derive Equations (6) and (7) in Section 3.2.2.

Using the default parameter values given in the box for Equation (9), the default PEF is equal to 4.63×10^9 m^3/kg. The default values necessary to calculate the flux rate for an "unlimited reservoir" surface (i.e., G, U_m, U_t, and F(x)) are provided by Cowherd (1985), and the remaining default values (i.e., for LS, V, and DH) are "typical" values (EPA 1986). If site-specific information is available, Equation (9) may be modified to calculate a PEF that is more appropriate for the particular site. Again, the original reference should be consulted when substituting site-specific data to ensure applicability of the model to specific site conditions.

PARTICULATE EMISSION FACTOR

$$\text{PEF (m}^3\text{/kg)} = \frac{\text{LS x V x DH x 3600 s/hr}}{\text{A}} \times \frac{\text{1000 g/kg}}{0.036 \times (1-G) \times (U_m/U_t)^3 \times F(x)} \qquad (9)$$

where:

Parameter	Definition (units)	Default
PEF	particulate emission factor (m^3/kg)	4.63×10^9 m^3/kg
LS	width of contaminated area (m)	45 m
V	wind speed in mixing zone (m/s)	2.25 m/s
DH	diffusion height (m)	2 m
A	area of contamination (m^2)	2025 m^2
0.036	respirable fraction (g/m^2-hr)	0.036 g/m^2-hr
G	fraction of vegetative cover (unitless)	0
U_m	mean annual wind speed (m/s)	4.5 m/s
U_t	equivalent threshold value of wind speed at 10 m (m/s)	12.8 m/s
F(x)	function dependent on U_m/U_t (unitless)	0.0497 (determined using Cowherd 1985)

3.4 CALCULATION AND PRESENTATION OF RISK-BASED PRGs

The equations presented in this chapter can be used to calculate risk-based PRGs for both carcinogenic and noncarcinogenic effects. If both a carcinogenic and a noncarcinogenic risk-based PRG are calculated for a particular chemical, then the lower of the two values is considered the appropriate risk-based PRG for any given contaminant. The case-study box below illustrates a calculation of a risk-based PRG. A summary table — such as that in the final case-study box — should be developed to present both the risk-based PRGs and the ARAR-based PRGs. The table should be labeled as to whether it presents the concentrations that were developed during scoping or after the baseline risk assessment.

CASE STUDY: CALCULATE RISK-BASED PRGs[a]

Risk-based PRGs for ground water for isophorone, one of the chemicals detected in ground-water monitoring wells at the site, are calculated below. Initial risk-based PRGs for isophorone (carcinogenic and noncarcinogenic effects) are derived using Equations (1´) and (2´) in Section 3.1.1. Equations (1´) and (2´) combine the toxicity information of the chemical (oral RfD of 0.2 mg/kg-day and oral SF of 0.0039 $[\text{mg/kg-day}]^{-1}$; inhalation values are not available and, therefore, only the oral exposure route is considered) with standard exposure parameters. The calculated concentrations in mg/L correspond to a target risk of 10^{-6} and a target HQ of 1, as follows:

$$\text{Carcinogenic risk-based PRG} = \frac{1.7 \times 10^{-4}}{2(SF_o)} = \frac{1.7 \times 10^{-4}}{2(0.0039)} = 0.022 \text{ mg/L}$$

$$\text{Noncarcinogenic risk-based PRG} = \frac{73}{2/RfD_o} = \frac{73}{2/0.2} = 7.3 \text{ mg/L}$$

The lower of the two values (i.e., 0.022 mg/L) is selected as the appropriate risk-based PRG. Risk-based PRGs are calculated similarly for the other chemicals of concern.

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[a] All information in this example is for illustration purposes only.

CASE STUDY: PRESENT PRGs DEVELOPED DURING SCOPING[a]

Site: XYZ Co.
Location: Anytown, Anystate
Medium: Ground Water

Land Use: Residential
Exposure Routes: Water Ingestion, Inhalation of Volatiles

Chemical	Risk-based PRGs (mg/L)*		ARAR-based PRG	
	10^{-6}	HQ = 1	Type	Concentration (mg/L)
Benzene	—	—	MCL	0.005
Carbon Tetrachloride	—	—	MCL	0.005
Ethylbenzene	—	—	MCLG	0.7***
			MCL	0.7
Hexane	—	0.33	—	—
Isophorone	0.022**	7.3	—	—
Triallate	—	0.47	—	—
1,1,2-Trichloroethane	—	—	MCLG	0.003***
			MCL	0.005
Vinyl chloride	—	—	MCL	0.002

[a] All information in this example is for illustration purposes only.

* These concentrations were calculated using the standard default equations in Chapter 3.

** Of the two potential risk-based PRGs for this chemical, this concentration is the selected risk-based PRG.

*** Of the two potential ARAR-based PRGs for this chemical, this concentration is selected as the ARAR-based PRG.

CHAPTER 4

RISK-BASED PRGs FOR RADIOACTIVE CONTAMINANTS

This chapter presents standardized exposure parameters, derivations of risk equations, and "reduced" equations for calculating risk-based PRGs for radioactive contaminants for the pathways and land-use scenarios discussed in Chapter 2. In addition, a radiation site case study is provided at the end of the chapter to illustrate (1) how exposure pathways and radionuclides of potential concern (including radioactive decay products) are identified, (2) how initial risk-based PRGs for radionuclides are calculated using reduced equations based on information available at the scoping phase, and (3) how risk-based PRGs can be re-calculated using full risk equations and site-specific data obtained during the baseline risk assessment. Chapters 1 through 3 and Appendices A and B provide the basis for many of the assumptions, equations, and parameters used in this chapter, and therefore should be reviewed before proceeding further into Chapter 4. Also, Chapter 10 in RAGS/HHEM Part A should be consulted for additional guidance on conducting baseline risk assessments at sites contaminated with radioactive substances.

In general, standardized default exposure equations and parameters used to calculate risk-based PRGs for radionuclides are similar in structure and function to those equations and parameters developed in Chapter 3 for nonradioactive chemical carcinogens. Both types of risk equations:

- Calculate risk-based PRGs for each carcinogen corresponding to a pre-specified target cancer risk level of 10^{-6}. As mentioned in Section 2.8, target risk levels may be modified after the baseline risk assessment based on site-specific exposure conditions, technical limitations, or other uncertainties, as well as on the nine remedy selection criteria specified in the NCP.
- Use standardized default exposure parameters consistent with OSWER Directive 9285.6-03 (EPA 1991b). Where default parameters are not available in that guidance document, other appropriate reference values are used and cited.
- Incorporate pathway-specific default exposure factors that generally reflect RME conditions.

There are, however, several important areas in which risk-based PRG equations and assumptions for radioactive contaminants differ substantially from those used for chemical contaminants. Specifically, unlike chemical equations, risk equations for radionuclides:

- Accept input quantities in units of activity (e.g., picocuries (pCi)) rather than in units of mass (e.g., milligrams (mg)). Activity units are more appropriate for radioactive substances because concentrations of radionuclides in sample media are determined by direct physical measurements of the activity of each nuclide present, and because adverse human health effects due to radionuclide intake or exposure are directly related to the amount, type, and energy of the radiation deposited in specific body tissues and organs.
- Consider the carcinogenic effects of radionuclides only. EPA designates all radionuclides as Class A carcinogens based on their property of emitting ionizing radiation and on the extensive weight of epidemiological evidence of radiation-induced cancer in humans. At most CERCLA radiation sites, potential health risks are usually based on the radiotoxicity, rather than the chemical toxicity, of each radionuclide present.
- Use cancer slope factors that are best estimates (i.e., median or 50th percentile values) of the age-averaged, lifetime excess total cancer risk per unit intake of a radionuclide (e.g., per pCi inhaled or ingested) or per unit external radiation exposure (e.g., per microRoentgen) to gamma-emitting

radionuclides. Slope factors given in IRIS and HEAST have been calculated for individual radionuclides based on their unique chemical, metabolic, and radiological properties and using a non-threshold, linear dose-response model. This model accounts for the amount of each radionuclide absorbed into the body from the gastrointestinal tract (by ingestion) or through the lungs (by inhalation), the distribution and retention of each radionuclide in body tissues and organs, as well as the age, sex, and weight of an individual at the time of exposure. The model then averages the risk over the lifetime of that exposed individual (i.e., 70 years). Consequently, radionuclide slope factors are not expressed as a function of body weight or time, and do not require corrections for gastrointestinal absorption or lung transfer efficiencies.

Risk-based PRG equations for radionuclides presented in the following sections of this chapter are derived initially by determining the total risk posed by each radioactive contaminant in a given pathway, and then by rearranging the pathway equation to solve for an activity concentration set equal to a target cancer risk level of 10^{-6}. At the scoping phase, these equations are "reduced" — and risk-based PRGs are calculated for each radionuclide of concern — using standardized exposure assumptions for each exposure route within each pathway and land-use combination. After the baseline risk assessment, PRGs can be recalculated using full risk equations and site-specific exposure information obtained during the RI.

4.1 RESIDENTIAL LAND USE

4.1.1 GROUND WATER OR SURFACE WATER

Under the residential land-use scenario, risk from ground-water or surface water radioactive contaminants is assumed to be due primarily to direct ingestion and inhalation of volatile radionuclides released from the water to indoor air. However, because additional exposure routes (e.g., external radiation exposure due to immersion) are possible at some sites for some radionuclides, while only one exposure route may be relevant at others, the risk assessor always should consider all relevant exposure routes and add or modify exposure routes as appropriate.

In the case illustrated below, risks from the two default exposure routes are combined, as follows:

Total risk from water = Risk from ingestion of radionuclides in water (adult)
+ Risk from indoor inhalation of volatile radionuclides released from water (adult)

At the scoping phase, risk from indoor inhalation of volatile radionuclides is assumed to be relevant only for radionuclides with a Henry's Law constant of greater than 1×10^{-5} atm-m^3/mole and a molecular weight of less than 200 g/mole. However, radionuclides that do not meet these criteria also may, under certain site-specific water-use conditions, be volatilized into the air from water, and thus pose significant site risks (and require risk-based goals). Therefore, the ultimate decision regarding which contaminants should be considered must be made by the risk assessor on a site-specific basis following completion of the baseline risk assessment.

Total carcinogenic risk is calculated for each radionuclide separately by combining its appropriate oral and inhalation SFs with the two exposure pathways for water, as follows:

Total risk = SF_o x Intake from ingestion of of radionuclides
+ SF_i x Intake from inhalation of volatile radionuclides

By including appropriate exposure parameters for each type of intake, rearranging and combining exposure terms in the total risk equation, and setting the target cancer risk level equal to 10^{-6}, the risk-based PRG equation is derived as shown in Equation (10).

Equation (10′), presented in the next box, is the reduced version of Equation (10) based on the standard default values listed below. It is used to calculate risk-based PRGs for radionuclides in water at a pre-specified cancer risk level of 10^{-6} by combining each radionuclide's toxicity data with the standard default values for residential land-use exposure parameters.

After the baseline risk assessment, the risk assessor may choose to modify one or more of the exposure parameter default values or assumptions

RADIONUCLIDE PRGs: RESIDENTIAL WATER — CARCINOGENIC EFFECTS

$$\text{Total risk} = [SF_o \times RW \times IR_w \times EF \times ED] + [SF_i \times RW \times K \times IR_a \times EF \times ED]$$

$$\text{RW (pCi/L; risk-based)} = \frac{TR}{EF \times ED \times [(SF_o \times IR_w) + (SF_i \times K \times IR_a)]} \qquad (10)$$

where:

Parameters	Definition (units)	Default Value
RW	radionuclide PRG in water (pCi/L)	—
TR	target excess individual lifetime cancer risk (unitless)	10^{-6}
SF_i	inhalation slope factor (risk/pCi)	radionuclide-specific
SF_o	oral (ingestion) slope factor (risk/pCi)	radionuclide-specific
EF	exposure frequency (days/yr)	350 days/yr
ED	exposure duration (yr)	30 yr
IR_a	daily indoor inhalation rate (m^3/day)	15 m^3/day
	daily water ingestion rate (L/day)	2 L/day
K	volatilization factor (unitless)	0.0005 x 1000 L/m^3 (Andelman 1990)

REDUCED EQUATION FOR RADIONUCLIDE PRGs: RESIDENTIAL WATER — CARCINOGENIC EFFECTS

$$\text{Risk-based PRG (pCi/L; TR} = 10^{-6}) = \frac{9.5 \times 10^{-11}}{2(SF_o) + 7.5(SF_i)} \qquad (10')$$

where:

SF_o = oral (ingestion) slope factor (risk/pCi)
SF_i = inhalation slope factor (risk/pCi)

in the risk equations to reflect site-specific conditions. In this event, radionuclide PRGs should be calculated using Equation (10) instead of Equation (10′).

4.1.2 SOIL

Under residential land-use conditions, risk from radionuclides in soil is assumed to be due to direct ingestion and external exposure to gamma radiation. Soil ingestion rates differ for children and adults, therefore age-adjusted ingestion rate factors are used in the soil pathway equation. Calculation of the risk from the external radiation exposure route assumes that any gamma-emitting radionuclide in soil is uniformly distributed in that soil within a finite soil depth and density, and dispersed in an infinite plane geometry.

The calculation of external radiation exposure risk also includes two additional factors, the gamma shielding factor (S_e) and the gamma exposure time factor (T_e), which can be adjusted to account for both attenuation of radiation fields due to shielding (e.g., by structures, terrain, or engineered barriers) and for exposure times of less than 24-hours per day, respectively. S_e is expressed as a fractional value between 0 and 1, delineating the possible risk reduction range from 0% to 100%, respectively, due to shielding. The default value of 0.2 for S_e for both residential and commercial/industrial land-use scenarios reflects the initial conservative assumption of a 20% reduction in external exposure due to shielding from structures (see EPA 1981). T_e is expressed as the quotient of the daily number of hours an individual is exposed directly to an external radiation field divided by the total number of exposure hours assumed each day for a given land-use scenario (i.e., 24 hours for residential and 8 hours for commercial/industrial). The default value of 1 for T_e for both land-use scenarios reflects the conservative assumptions of a 24-hr exposure duration for residential populations (i.e., 24/24 = 1) and an 8-hr exposure duration for workers (i.e., 8/8 = 1). Values for both factors can (and, if appropriate, should) be modified by the risk assessor based on site-specific conditions.

In addition to direct ingestion of soil contaminated with radionuclides and exposure to external radiation from gamma-emitting radionuclides in soil, other soil exposure routes are possible, such as inhalation of resuspended radioactive particles, inhalation of volatile radionuclides, or ingestion of foodcrops contaminated by root or leaf uptake. The risk assessor should therefore identify all relevant exposure routes within the soil pathway and, if necessary, develop equations for risk-based PRGs that combine these exposure routes.

In the case illustrated below, the risk-based PRG is derived to be protective for exposure from the direct ingestion and external radiation routes. Total risk from soil due to ingestion and external radiation is calculated as follows:

Total risk from soil = Risk from direct ingestion of radionuclides in soil (child to adult)
\+ Risk from external radiation from gamma-emitting radionuclides in soil

Total risk for carcinogenic effects from each radionuclide of potential concern is calculated by combining the appropriate oral slope factor, SF_o, with the total radionuclide intake from soil, plus the appropriate external radiation slope factor, SF_e, with the radioactivity concentration in soil:

Total risk = SF_o x Intake from direct ingestion of soil
\+ SF_e x Concentration of gamma-emitting radionuclides in soil

Adding appropriate parameters, then combining and rearranging the equation to solve for concentration, results in Equation (11).

Equation (11') is the reduced version of Equation (11) based on the standard default values listed below. Risk-based PRGs for radionuclides in soil are calculated for a pre-specified cancer risk level of 10^{-6}.

The age-adjusted soil ingestion factor ($IF_{soil/adj}$) used in Equation (11) takes into account the difference in soil ingestion for two exposure groups — children of one to six years and all other individuals from seven to 31 years. $IF_{soil/adj}$ is calculated for radioactive contaminants as shown in Equation (12). Section 3.1.2 provides additional discussion on the age-adjusted soil ingestion factor.

If any parameter values or exposure assumptions are adjusted after the baseline risk assessment to reflect site-specific conditions, soil PRGs should be calculated using Equation (11).

4.2 COMMERCIAL/INDUSTRIAL LAND USE

4.2.1 WATER

Under the commercial/industrial land use scenario, risk-based PRGs for radionuclides in ground water (and for radionuclides in surface water used for drinking water purposes) are based on residential exposures and calculated according to the procedures detailed in Section 4.1.1 (see Section 3.2.1 for the rationale for this approach). Risk-based PRGs should be calculated considering the possibility that both the worker and general population at large may be exposed to the same contaminated water supply.

4.2.2 SOIL

Under the commercial/industrial land use scenario, four soil exposure routes — direct ingestion, inhalation of volatile radionuclides, inhalation of resuspended radioactive particulates, and external exposure due to gamma-emitting radionuclides — are combined to calculate risk-based radionuclide PRGs in soil for adult worker exposures. Additional exposure routes (e.g., ingestion of foodcrops contaminated by radionuclide uptake) are possible at some sites, while only one exposure route (e.g., external radiation exposure only) may be relevant at others. The risk assessor should therefore consider and combine all relevant soil exposure routes, as necessary and appropriate, based on site-specific conditions.

RADIONUCLIDE PRGs: RESIDENTIAL SOIL — CARCINOGENIC EFFECTS

$$\text{Total risk} = RS \times [(SF_o \times 10^{-3}\text{g/mg} \times EF \times IF_{soil/adj}) + (SF_e \times 10^{3}\text{g/kg} \times ED \times D \times SD \times (1\text{-}S_e) \times T_e)]$$

$$\text{RS (pCi/g: risk-based)} = \frac{TR}{(SF_o \times 10^{-3} \times EF \times IF_{soil/adj}) + (SF_e \times 10^{3} \times ED \times D \times SD \times (1\text{-}S_e) \times T_e)} \quad (11)$$

where:

Parameters	Definition (units)	Default Value
RS	radionuclide PRG in soil (pCi/g)	—
TR	target excess individual lifetime cancer risk (unitless)	10^{-6}
SF_o	oral (ingestion) slope factor (risk/pCi)	radionuclide-specific
SF_e	external exposure slope factor (risk/yr per pCi/m^2)	radionuclide-specific
EF	exposure frequency (days/yr)	350 days/yr
ED	exposure duration (yr)	30 yr
$IF_{soil/adj}$	age-adjusted soil ingestion factor (mg-yr/day)	3600 mg-yr/day (see Equation (12))
D	depth of radionuclides in soil (m)	0.1 m
SD	soil density (kg/m^3)	1.43×10^{3} kg/m^3
S_e	gamma shielding factor (unitless)	0.2 (see Section 4.1.2)
T_e	gamma exposure time factor (unitless)	1 (see Section 4.1.2)

REDUCED EQUATION FOR RADIONUCLIDE PRGs: RESIDENTIAL SOIL — CARCINOGENIC EFFECTS

$$\text{Risk-based PRG (pCi/g; TR} = 10^{-6}) = \frac{1 \times 10^{-6}}{1.3 \times 10^{3}\,(SF_o) + 3.4 \times 10^{6}\,(SF_e)} \quad (11')$$

where:

SF_o = oral (ingestion) slope factor (risk/pCi)
SF_e = external exposure slope factor (risk/yr per pCi/m^2)

AGE-ADJUSTED SOIL INGESTION FACTOR

$$IF_{soil/adj}\ \text{(mg-yr/day)} = (IR_{soil/age\ 1\text{-}6} \times ED_{age\ 1\text{-}6}) + (IR_{soil/age\ 7\text{-}31} \times ED_{age\ 7\text{-}31}) \quad (12)$$

where:

Parameters	Definition (units)	Default Value
$IF_{soil/adj}$	age-adjusted soil ingestion factor (mg-yr/day)	3600 mg-yr/day
$IR_{soil/age\ 1\text{-}6}$	ingestion rate of soil ages 1-6 (mg/day)	200 mg/day
$IR_{soil/age\ 7\text{-}31}$	ingestion rate of soil ages 7-31 (mg/day)	100 mg/day
$ED_{age\ 1\text{-}6}$	exposure duration during ages 1-6 (yr)	6 yr
$ED_{age\ 7\text{-}31}$	exposure duration during ages 7-31 (yr)	24 yr

In the case illustrated below, total risk from radionuclides in soil is calculated as the summation of the individual risks from each of the four exposure routes listed above:

Total risk from soil = Risk from direct ingestion of radionuclides in soil (worker)

+ Risk from inhalation of volatile radionuclides (worker)

+ Risk from inhalation of resuspended radioactive particulates (worker)

+ Risk from external radiation from gamma-emitting radionuclides (worker)

Total risk for carcinogenic effects for each radionuclide is calculated by combining the appropriate ingestion, inhalation, and external exposure SF values with relevant exposure parameters for each of the four soil exposure routes as follows:

Total risk = SF_o x Intake from direct ingestion of radionuclides in soil (worker)

+ SF_i x Intake from inhalation of volatile radionuclides (worker)

+ SF_i x Intake from inhalation of resuspended radioactive particulates (worker)

+ SF_e x Concentration of gamma-emitting radionuclides in soil (worker)

Adding appropriate parameters, and then combining and rearranging the equation to solve for concentration, results in Equation (13).

Equation (13´) below is the reduced version of Equation (13) based on the standard default values below and a pre-specified cancer risk level of 10^{-6}. It combines the toxicity information of a radionuclide with standard exposure parameters for commercial/industrial land use to generate the concentration of that radionuclide corresponding to a 10^{-6} carcinogenic risk level due to that radionuclide.

If any parameter default values or assumptions are changed after the baseline risk assessment to reflect site-specific conditions, radionuclide soil PRGs should be derived using Equation (13).

4.2.3 SOIL-TO-AIR VOLATILIZATION FACTOR

The VF, defined in Section 3.3.1 for chemicals, also applies for radioactive contaminants with the following exceptions.

- Most radionuclides are heavy metal elements and are non-volatile under normal, ambient conditions. For these radionuclides, VF values need not be calculated and the risk due to the inhalation of volatile forms of these nuclides can be ignored for the purposes of determining PRGs.
- A few radionuclides, such as carbon-14 (C-14), tritium (H-3), phosphorus-32 (P-32), sulfur-35 (S-35), and other isotopes, are volatile under certain chemical or environmental conditions, such as when they are combined chemically with volatile organic compounds (i.e., the so-called radioactively-labeled or "tagged" organic compounds), or when they can exist in the environment in a variety of physical forms, such as C-14 labeled carbon dioxide (CO_2) gas and tritiated water vapor. For these radionuclides, VF values should be calculated using the Hwang and Falco (1986) equation provided in Section 3.3.1 based on the chemical species of the compound with which they are associated.
- The naturally occurring, non-volatile radioisotopes of radium, namely Ra-226 and Ra-224, undergo radioactive decay and form inert, gaseous isotopes of radon, i.e., Rn-222 (radon) and Rn-220 (thoron), respectively. Radioactive radon and thoron gases emanate from their respective parent radium isotopes in soil, escape into the air, and can pose cancer risks if inhaled. For Ra-226 and Ra-224 in soil, use the default values shown in the box on page 40 for VF and for SF_i in Equation (12) and Equation (12´).

4.3 RADIATION CASE STUDY

This section presents a case study of a hypothetical CERCLA radiation site, the ACME Radiation Co. site, to illustrate the process of calculating pathway-specific risk-based PRGs for radionuclides using the risk equations and assumptions presented in the preceding sections of this chapter. The radiation site case study is modeled after the XYZ Co. site study discussed in

RADIONUCLIDE PRGs: COMMERCIAL/INDUSTRIAL SOIL — CARCINOGENIC EFFECTS

$$\text{Total risk} = RS \times ED \times [(SF_o \times 10^{-3}\text{g/mg} \times EF \times IR_{soil}) + (SF_i \times 10^{3}\text{g/kg} \times EF \times IR_{air} \times 1/VF) + (SF_i \times 10^{3}\text{g/kg} \times EF \times IR_{air} \times 1/PEF) + (SF_e \times 10^{3}\text{g/kg} \times D \times SD \times (1-S_e) \times T_e)]$$

$$\underset{\text{(pCi/g; risk-based)}}{RS} = \frac{TR}{ED \times [(SF_o x 10^{-3} x EF x IR_{soil}) + (SF_i x 10^{3} x EF x IR_{air}) \times (1/VF + 1/PEF) + (SF_e x 10^{3} x D x SD x (1-S_e) x T_e)]} \qquad (13)$$

where:

Parameters	Definition (units)	Default Value
RS	radionuclide PRG in soil (pCi/g)	—
TR	target excess individual lifetime cancer risk (unitless)	10^{-6}
SF_i	inhalation slope factor (risk/pCi)	radionuclide-specific
SF_o	oral (ingestion) slope factor (risk/pCi)	radionuclide-specific
SF_e	external exposure slope factor (risk/yr per pCi/m^2)	radionuclide-specific
EF	exposure frequency (days/yr)	250 days/yr
ED	exposure duration (yr)	25 yr
IR_{air}	workday inhalation rate of air (m^3/day)	20 m^3/day
IR_{soil}	daily soil ingestion rate (mg/day)	50 mg/day
VF	soil-to-air volatilization factor (m^3/kg)	radionuclide-specific (see Section 4.2.3)
PEF	particulate emission factor (m^3/kg)	4.63 x 10^9 m^3/kg (see Section 3.3.2)
✓D	depth of radionuclides in soil (m)	0.1 m
✓SD	soil density (kg/m^3)	1.43 x 10^3 kg/m^3
✓S_e	gamma shielding factor (unitless)	0.2 (see Section 4.1.2)
✓T_e	gamma exposure factor (unitless)	1 (see Section 4.1.2)

REDUCED EQUATION FOR RADIONUCLIDE PRGs: COMMERCIAL/INDUSTRIAL SOIL — CARCINOGENIC EFFECTS*

$$\underset{(\text{pCi/g; } TR = 10^{-6})}{\text{Risk-based PRG}} = \frac{1 \times 10^{-6}}{[(3.1 \times 10^{2}(SF_o)) + ((1.3 \times 10^{8}/VF + 2.7 \times 10^{-2})(SF_i)) + (2.9 \times 10^{6}(SF_e))]} \qquad (13')$$

where:

SF_o = oral (ingestion) slope factor (risk/pCi)
SF_i = inhalation slope factor (risk/pCi)
SF_e = external exposure slope factor (risk/yr per pCi/m^2)
VF = *radionuclide-specific soil-to-air volatilization factor in* m^3/kg (see Section 3.3.1)

*NOTE: See Section 4.2.3 when calculating PRGs for Ra-226 and Ra-224.

Chapters 2 and 3. It generally follows a two-phase format which consists of a "at the scoping stage" phase wherein risk-based PRGs for radionuclides of potential concern are calculated initially using reduced equations based on PA/SI data, and then a second, "after the baseline risk assessment" phase wherein radionuclide PRGs are recalculated using full equations and modified site-specific parameter values based on RI/FS data.

Following an overview of the history and current status of the site presented in Section 4.3.1, Section 4.3.2 covers a number of important steps taken early in the scoping phase to calculate preliminary risk-based PRGs assuming a specific

SOIL DEFAULT VALUES FOR VF AND SF, FOR Ra-226 AND Rn-224

Radium	Default VF Value $\left(\frac{pCi/kg\ Ra}{pCi/m^3\ Rn^*}\right)$	Inhalation Slope Factor, SF_i (risk/pCi)**
Ra-226	8	1.1E-11
Rn-224	200	4.7E-11

* Calculated using values taken from NCRP 1976 and UNSCEAR 1982: Assumptions: (1) an average Ra-226 soil concentration of 1 pCi/g associated with an average ambient Rn-222 air concentration of 120 pCi/m^3 and (2) an average Ra-224 soil concentration of 1 pCi/g associated with an average ambient Rn-220 air concentration of 5 pCi/m^3.

** Slope factor values are for Rn-222 (plus progeny) and for Rn-220 (plus progeny).

land-use scenario. Section 4.3.3 then discusses how initial assumptions and calculations can be modified when additional site-specific information becomes available.

4.3.1 SITE HISTORY

The ACME Radiation Co. site is an abandoned industrial facility consisting of a large factory building situated on ten acres of land surrounded by a high-density residential neighborhood. Established in 1925, the ACME Co. manufactured luminous watch dials and gauges using radium-based paint and employed approximately 100 workers, mostly women. With the declining radium market, ACME phased out dial production and expanded its operations in 1960 to include brokering (collection and disposal) of low-level radioactive waste (LLW). After the company was issued a state license in 1961, ACME began receiving LLW from various nearby hospitals and research laboratories. In 1975, acting on an anonymous complaint of suspected mishandling of radioactive waste, state officials visited the ACME Co. site and cited the company for numerous storage and disposal violations. After ACME failed to rectify plant conditions identified in initial and subsequent citations, the state first suspended, and then later revoked its operating license in 1978. Around the same time, officials detected radium-226 (Ra-226) contamination at a few neighboring locations off site. However, no action was taken against the company at that time. When ACME filed for bankruptcy in 1985, it closed its facility before completing cleanup.

In 1987, the state and EPA conducted an aerial gamma survey over the ACME Radiation Co. site and surrounding properties to investigate the potential extent of radioactive contamination in these areas. The overflight survey revealed several areas of elevated exposure rate readings, although individual gamma-emitting radionuclides could not be identified. When follow-up ground level surveys were performed in 1988, numerous "hot spots" of Ra-226 were pinpointed at various locations within and around the factory building. Three large soil piles showing enhanced concentrations of Ra-226 were discovered along the southern border. Approximately 20 rusting drums labelled with LLW placards also were discovered outside under a covered storage area. Using ground-penetrating radar, EPA detected subsurface magnetic anomalies in a few locations within the property boundary which suggested the possibility of buried waste drums. Based on interviews with people living near the site and with former plant workers, the state believes that radium contaminated soil may have been removed from the ACME site in the past and used locally as fill material for the construction of new homes and roadbeds. Site access is currently limited (but not entirely restricted) by an existing security fence.

In 1988, EPA's regional field investigation team completed a PA/SI. Based on the PA/SI data, the ACME Radiation Co. site scored above 28.50 using the HRS and was listed on the National Priorities List in 1989. Early in 1990, an RI/FS was initiated and a baseline risk assessment is currently in progress.

4.3.2 AT THE SCOPING PHASE

In this subsection, several steps are outlined to show by example how initial site data are used at the scoping phase to calculate risk-based PRGs for radionuclides in specific media of concern. Appropriate sections of Chapters 2 and 3 should be consulted for more detailed explanations for each step considered below.

Identify Media of Concern. A large stream runs along the western border of the site and feeds into a river used by some of the local residents for fishing and boating. Supplemental water intake ducts for the municipal water treatment plant are located approximately 300 yards downriver, and the site is situated over an aquifer which serves as the primary drinking water supply for a community of approximately 33,000 people.

Analyses of ground water, soil, and stream sediment samples taken during the PA/SI revealed significant levels of radionuclide contamination. Potential sources of contamination include the soil piles, process residues in soil, and radionuclides leaking from buried drums. Air filter samples and surface water samples from the stream and river showed only background levels of activity. (Background concentrations were determined from analyses conducted on a limited number of air, ground water, surface water, and soil samples collected approximately one mile from the site.)

The data show that the media of potential concern at this site include ground water and soil. Although stream water and river water were not found to be contaminated, both surface water bodies may become contaminated in the future due to the migration of radionuclides from sediment, from the exposed soil piles, or from leaking drums. Thus, surface water is another medium of potential concern.

For simplicity, only soil will be discussed as the medium of concern during the remainder of this case study. Procedures discussed for this medium can nevertheless be applied in a similar manner to all other media of concern.

Identify Initial List of Radionuclides of Concern. The PA/SI for the ACME Radiation Co. site identified elevated concentrations of five radionuclides in soil (Ra-226, tritium (H-3), carbon-14 (C-14), cesium (Cs-137), and strontium (Sr-90)). These comprise the initial list of radionuclides of potential concern.

Site records indicate that radioisotopes of cobalt (Co-60), phosphorus (P-32), sulfur (S-35), and americium (Am-241 and Am-243) were included on the manifests of several LLW drums in the storage area and on the manifests of other drums suspected to be buried onsite. Therefore, although not detected in any of the initial soil samples analyzed, Co-60, P-32, S-35, Am-241, and Am-243 are added to the list for this medium because of their potential to migrate from leaking buried drums into the surrounding soil.

Identify Probable Land Uses. The ACME Radiation Co. site is located in the center of a rapidly developing suburban community comprised of single and multiple family dwellings. The area immediately encircling the site was recently re-zoned for residential use only; existing commercial and light industrial facilities are currently being relocated. Therefore, residential use is determined to be the most reasonable future land use for this site.

Identify Exposure Pathways, Parameters, and Equations. During the scoping phase, available site data were neither sufficient to identify all possible exposure pathways nor adequate enough to develop site-specific fate and transport equations and parameters. Therefore, in order to calculate initial risk-based PRGs for radionuclides of potential concern in soil, the standardized default soil exposure equation and assumptions provided in this chapter for residential land use in Section 4.1.2 are selected. (Later in this case study, examples are provided to illustrate how the full risk equation (Equation (11)) and assumptions are modified when baseline risk assessment data become available.)

For the soil pathway, the exposure routes of concern are assumed to be direct ingestion of soil contaminated with radionuclides and exposure to external radiation from gamma-emitting radionuclides. Again, although soil is the only medium discussed throughout this case study, exposure pathways, parameters, equations, and eventually risk-based concentrations would need to be identified and developed for all other media and exposure pathways of potential concern at an actual site.

Identify Toxicity Information. To calculate media-specific risk-based PRGs, reference toxicity values for radiation-induced cancer effects are required (i.e., SFs). As stated previously, soil ingestion and external radiation are the exposure routes of concern for the soil pathway. Toxicity information (i.e., oral, inhalation, and external exposure SFs) for all radionuclides of potential concern at the ACME Radiation Co. site are obtained from IRIS or HEAST, and are shown in the box on the following page.

RADIATION CASE STUDY:
TOXICITY INFORMATION FOR RADIONUCLIDES OF POTENTIAL CONCERN*

Radionuclides	Radioactive Half-life (yr)	Decay Mode	ICRP Lung Classification	Inhalation Slope Factor (risk/pCi)	Ingestion Slope Factor (risk/pCi)	External Exposure Slope Factor (risk/yr per pCi/m^2)
H-3	12	beta	g	7.8E-14	5.5E-14	NA
C-14	5730	beta	g	6.4E-15	9.1E-13	NA
P-32	0.04	beta	D	3.0E-12	3.5E-12	NA
S-35	0.24	beta	D	1.9E-13	2.2E-13	NA
Co-60	5	beta/gamma	Y	1.6E-10	1.5E-11	1.3E-10
Sr-90	29	beta	D	5.6E-11	3.3E-11	NA
Cs-137	30	beta	D	1.9E-11	2.8E-11	NA
Ra-226	1600	alpha/gamma	W	3.0E-09	1.2E-10	4.2E-13
Am-241	432	alpha/gamma	W	4.0E-08	3.1E-10	1.6E-12
Am-243	7380	alpha/gamma	W	4.0E-08	3.1E-10	3.6E-12

* Sources: HEAST and Federal Guidance Report No. 11. All information in this example is for illustration only.

NA = Not applicable (i.e., these radionuclides are not gamma-emitters and the direct radiation exposure pathway can be ignored).

Calculate Risk-based PRGs. At this step, risk-based PRGs are calculated for each radionuclide of potential concern using the reduced risk Equation (11´) in Section 4.1.2, SF values obtained from IRIS and HEAST, and standardized default values for parameters for the residential land-use scenario. To calculate the risk-based PRG for Co-60 at a pre-specified target risk level of 10^{-6}, for example, its ingestion SF of 1.5×10^{-11} and its external exposure SF of 1.3×10^{-10} are substituted into Equation (11´), along with the standardized default values, as follows:

$$\text{Risk-based PRG for Co-60 (pCi/g; TR} = 10^{-6}) = \frac{1 \times 10^{-6}}{1.3 \times 10^{3}\,(SF_o) + 3.4 \times 10^{6}\,(SF_e)}$$

where:

SF_o = oral (ingestion) slope factor for Co-60 = 1.5×10^{-11} (risk/pCi)

SF_e = external exposure slope factor for Co-60 = 1.3×10^{-10} (risk/yr per pCi/m^2)

Substituting the values for SF_o and SF_e for Co-60 into Equation (11´) results in:

Risk-based PRG for Co-60 (pCi/g; TR = 10^{-6}) =

$$\frac{1 \times 10^{-6}}{[(1.3 \times 10^{3})(1.5 \times 10^{-11}) + (3.4 \times 10^{6})(1.3 \times 10^{-10})]}$$

$$= 0.002 \text{ pCi of Co-60/g of soil}$$

In a similar manner, risk-based PRGs can be calculated for all other radionuclides of concern in soil at the ACME Radiation Co. site. These PRGs are presented in the next box.

4.3.3 AFTER THE BASELINE RISK ASSESSMENT

In this subsection, several steps are outlined which demonstrate how site-specific data obtained during the baseline risk assessment can be used to recalculate risk-based PRGs for radionuclides in soil. Appropriate sections of Chapters 2 and 3 should be consulted for more detailed explanations for each step considered below.

Review Media of Concern. During the RI/FS, gamma radiation surveys were conducted in the yards of several homes located within a two-block radius of the ACME Radiation Co. site. Elevated exposure rates, ranging from approximately two to four times the natural background rate, were measured on properties immediately bordering the site. Measurements onsite ranged from 10 to 50 times background. In both cases, enhanced soil concentrations of Ra-226 (and decay products) and several other gamma-emitting radionuclides were discovered to be the sources of these elevated exposure rates. Therefore, soil continues as a medium of potential concern.

**RADIATION CASE STUDY:
INITIAL RISK-BASED PRGs FOR
RADIONUCLIDES IN SOIL***

Radionuclides	Risk-based Soil PRG (pCi/g)
H-3	14,000
Sr-90 (only)	23
P-32	220
S-35	3,500
C-14	850
Co-60	0.002
Cs-137 (only)	27
Ra-226 (only)	0.6
Am-241	0.2
Am-243 (only)	7.9×10^{-2}

* Calculated for illustration only using Equation (11´) in Section 4.1.2. Values have been rounded off.

Modify List of Radionuclides of Concern. During scoping, five radionuclides (Ra-226, H-3, C-14, Cs-137, and Sr-90) were detected in elevated concentrations in soil samples collected at the ACME Radiation Co. site. These made up the initial list of radionuclides of potential concern. Although not detected during the first round of sampling, five additional radionuclides (P-32, S-35, Co-60, Am-241, and Am-243) were added to this list because of their potential to migrate from buried leaking drums into the surrounding soil.

With additional RI/FS data, some radionuclides are now added to the list, while others are dropped. For example, soil analyses failed to detect P-32 (14-day half-life) or S-35 (87-day half-life) contamination. Decay correction calculations strongly suggest that these radionuclides should not be present onsite in detectable quantities after an estimated burial time of 30 years. Therefore, based on these data, P-32 and S-35 are dropped from the list. Soil data also confirm that decay products of Ra-226, Sr-90, Cs-137, and Am-243 (identified in the first box below) are present in secular equilibrium (i.e., equal activity concentrations) with their respective parent isotopes.

Assuming secular equilibrium, slope factors for the parent isotope and each of its decay series members are summed. Parent isotopes are designated with a "+D" to indicate the composite slope factors of its decay chain (shown in bold face in the second box below). Thus, Ra-226+D, Sr-90+D, Cs-137+D, and Am-243+D replace their respective single-isotope values in the list of radionuclides of potential concern, and their composite SFs are used in the full soil pathway equation to recalculate risk-based concentrations.

RADIATION CASE STUDY: DECAY PRODUCTS

Parent Radionuclide	Decay Product(s) (Half-life)
Ra-226	Rn-222 (4 days), Po-218 (3 min), Pb-214 (27 min), Bi-214 (20 min), Po-214 (<1 s), Pb-210 (22 yr), Bi-210 (5 days), Po-210 (138 days)
Sr-90	Y-90 (14 hr)
Cs-137	Ba-137m (2 min)
Am-243	Np-239 (2 days)

RADIATION CASE STUDY: SLOPE FACTORS FOR DECAY SERIES[a]

	Slope Factors		
Decay Series	Inhalation	Ingestion	External
Ra-226	3.0E-09	1.2E-10	4.2E-13
Rn-222	7.2E-13	—	2.2E-14
Po-218	5.8E-13	2.8E-14	0.0E+00
Pb-214	2.9E-12	1.8E-13	1.5E-11
Bi-214	2.2E-12	1.4E-13	8.0E-11
Po-214	2.8E-19	1.0E-20	4.7E-15
Pb-210	1.7E-09	6.5E-10	1.8E-13
Bi-210	8.1E-11	1.9E-12	0.0E+00
Po-210	2.7E-09	2.6E-10	4.8E-16
Ra-226+D	**7.5E-09**	**1.0E-09**	**9.6E-11**
Sr-90	5.6E-11	3.3E-11	0.0E+00
Y-90	5.5E-12	3.2E-12	0.0E+00
Sr-90+D	**6.2E-11**	**3.6E-11**	**0.0E+00**
Cs-137	1.9E-11	2.8E-11	0.0E+00
Ba-137m	6.0E-16	2.4E-15	3.4E-11
Cs-137+D	**1.9E-11**	**2.8E-11**	**3.4E-11**
Am-243	4.0E-08	3.1E-10	3.6E-12
Np-239	1.5E-12	9.3E-13	1.1E-11
Am-243+D	**4.0E-08**	**3.1E-10**	**1.5E-11**

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[a] All information in this example is for illustration purposes only.

Review Land-use Assumptions. At this step, the future land-use assumption chosen during scoping is reviewed. Since the original assumption of future residential land use is supported by RI/FS data, it is not modified.

Modify Exposure Pathways, Parameters, and Equations. Based on site-specific information, the upper-bound residence time for many of the individuals living near the ACME Radiation Co. site is determined to be 45 years rather than the default value of 30 years. Therefore, the exposure duration parameter used in Equation (11) in Section 4.1.2 is substituted accordingly. It is also determined that individuals living near the site are only exposed to the external gamma radiation field approximately 18 hours each day, and that their homes provide a shielding factor of about 0.5 (i.e., 50%). Therefore, values for T_e and S_e are changed to 0.75 (i.e., 18 hr/24 hr) and 0.5, respectively.

Modify Toxicity Information. As discussed above in the section on modifying the list of radionuclides of concern, oral, inhalation, and external exposure slope factors for Ra-226, Sr-90, Cs-137, and Am-243 were adjusted to account for the added risks (per unit intake and/or exposure) contributed by their respective decay series members that are in secular equilibrium.

Recalculate Risk-based PRGs. At this step, risk-based PRGs are recalculated for all remaining radionuclides of potential concern using the full risk equation for the soil pathway (i.e., Equation (11)) modified by revised site-specific assumptions regarding exposures, as discussed above.

To recalculate the risk-based PRG for Co-60 at a pre-specified target risk level of 10^{-6}, for example, its ingestion SF of 1.5×10^{-11}, and its external exposure SF of 1.3×10^{-10} are substituted into Equation (11), along with other site-specific parameters, as shown in the next box.

In a similar manner, risk-based PRGs can be recalculated for all remaining radionuclides of potential concern in soil at the ACME Radiation Co. site. These revised PRGs are presented in the box on the next page. In those cases where calculated risk-based PRGs for radionuclides are below current detection limits, risk assessors should contact the Superfund Health Risk Technical Support Center for additional guidance.

RADIATION CASE STUDY: REVISED RISK EQUATION FOR RESIDENTIAL SOIL

$$\text{RS for Co-60 (pCi/g; risk-based)} = \frac{TR}{(SF_o \times 10^{-3} \times EF \times IF_{soil/adj}) + (SF_e \times 10^{3} \times ED \times D \times SD \times (1-S_e) \times T_e)}$$

$$= 0.003 \text{ pCi/g}$$

where:

Parameters	Definition (units)	Revised Value
RS	radionuclide PRG in soil (pCi/g)	—
TR	target excess individual lifetime cancer risk (unitless)	10^{-6}
SF_o	oral (ingestion) slope factor (risk/pCi)	1.5×10^{-11} (risk/pCi)
SF_e	external exposure slope factor (risk/yr per pCi/m^2)	1.3×10^{-10} (risk/yr per pCi/m^2)
EF	exposure frequency (days/yr)	350 days/yr
ED	exposure duration (yr)	45 yr
$IF_{soil/adj}$	age-adjusted soil ingestion factor (mg-yr/day)	5100 mg-yr/day
D	depth of radionuclides in soil (m)	0.1 m
SD	soil density (kg/m^3)	1.43×10^3 kg/m^3
S_e	gamma shielding factor (unitless)	0.5
T_e	gamma exposure time factor (unitless)	0.75

(Note: To account for the revised upper-bound residential residency time of 45 years, the age-adjusted soil ingestion factor was recalculated using the equation in Section 4.1.2 and an adult exposure duration of 39 years for individuals 7 to 46 years of age.)

RADIATION CASE STUDY:
REVISED RISK-BASED PRGs FOR RADIONUCLIDES IN SOIL.*

Radionuclides	Risk-based Soil PRG (pCi/g)
H-3	10,200
Sr-90+D	20
C-14	620
Co-60	0.003
Cs-137+D	0.01
Ra-226+D	0.004
Am-241	0.2
Am-243+D	0.03

* Calculated for illustration only. Values have been rounded off.

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APPENDIX A

ILLUSTRATIONS OF CHEMICALS THAT "LIMIT" REMEDIATION

In many cases, one or two chemicals will drive the cleanup at a site, and the resulting cumulative medium or site risk will be approximately equal to the potential risk associated with the individual remediation goals for these chemicals. These "limiting chemicals" are generally either chemicals that are responsible for much of the baseline risk (because of either high toxicity or presence in high concentrations), or chemicals that are least amenable to the selected treatment method. By cleaning up these chemicals to their goals, the other chemicals typically will be cleaned up to levels much lower than their corresponding goals. The example given in the box below provides a simple illustration of this principle.

The actual circumstances for most remediations will be much more complex than those described in the example (e.g., chemicals will be present at different baseline concentrations and will be treated/removed at differing rates); however, the same principle of one or perhaps two chemicals limiting the site cleanup usually applies, even in more complex cases.

Unless much is known about the performance of a remedy with respect to all the chemicals present at the site, it may not be possible to determine which of the site contaminants will drive the final risk until well into remedy implementation. Therefore, it generally is not possible to predict the cumulative risk that will be present at the site during or after remediation. In some situations, enough will be known about the site conditions and the performance of the remedy to estimate post-remedy concentrations of chemicals or to identify the chemical(s) that will dominate the residual risk. If this type of information is available, it may be necessary to modify the risk-based remediation goals for individual chemicals.

SIMPLE ILLUSTRATION OF A CHEMICAL THAT LIMITS REMEDIATION

Two chemicals (A and B) are present in ground water at a site at the same baseline concentrations. Remediation goals were identified for both A and B. Chemical A's goal is 0.5 ug/L, which is associated with a potential risk of 10^{-6}. Chemical B's goal is 10 ug/L, which is also associated with a potential risk of 10^{-6}. The calculated cumulative risk at remediation goals is therefore 2×10^{-6}. Assuming for the purposes of this illustration that A and B are treated or removed at the same rate, then the first chemical to meet its goal will be B. Remediation must continue at this site, however, until the goal for chemical A has been met. When the concentration of A reaches 0.5 ug/L, then remediation is complete. A is at its goal and has a risk of 10^{-6}. B is at 1/20 of its goal with a risk of 5×10^{-8}. The total risk ($1 \times 10^{-6} + 5 \times 10^{-8}$) is approximately 10^{-6} and is due to the presence of A.

This example illustrates that the final risk for a chemical may not be equal to the potential risk associated with its remediation goal, and, in fact, can be much less than this risk. Although the potential risk associated with Chemical B's goal is 10^{-6}, the final residual risk associated with B is 5×10^{-8}. Thus, if one were to calculate the cumulative risk at PRGs prior to remedy implementation, one would estimate total medium risk of 2×10^{-6}, however, the residual cumulative risk after remediation is 1×10^{-6}.

APPENDIX B

RISK EQUATIONS FOR INDIVIDUAL EXPOSURE PATHWAYS

This appendix presents individual risk equations for each exposure pathway presented in Chapter 3. These individual risk equations can be used and rearranged to derive full risk equations required for calculating risk-based PRGs. Depending on the exposure pathways that are of concern for a land-use and medium combination, different individual risk equations can be combined to derive the full equation reflecting the cumulative risk for each chemical within the medium. See Chapter 3 for examples of how equations are combined and how they need to be rearranged to solve for risk-based PRGs. Note that in this appendix, the term HQ is used to refer to the risk level associated with noncarcinogenic effects since the equations are for a single contaminant in an individual exposure pathway.

The following sections list individual risk equations for the ground water, surface water, and soil pathways. Risk equations for exposure pathways not listed below can be developed and combined with those listed. In particular, dermal exposure and ingestion of ground water contaminated by soil leachate, for which guidance is currently being developed by EPA, could be included in the overall exposure pathway evaluation.

B.1 GROUND WATER OR SURFACE WATER — RESIDENTIAL LAND USE

Both the ingestion of water and the inhalation of volatiles are included in the standard default equations in Section 3.1.1. If only one of these exposure pathways is of concern at a particular site, or if one or both of these pathways needs to be combined with additional pathways, a site-specific equation can be derived.

The parameters used in the equations presented in the remainder of this section are explained in the following text box.

B.1.1 INGESTION

The cancer risk due to ingestion of a contaminant in water is calculated as follows:

PARAMETERS FOR SURFACE WATER/GROUND WATER — RESIDENTIAL LAND USE

Parameter	Definition	Default Value
C	chemical concentration in water (mg/L)	—
SF_i	inhalation cancer slope factor ($(mg/kg\text{-}day)^{-1}$)	chemical-specific
SF_o	oral cancer slope factor ($(mg/kg\text{-}day)^{-1}$)	chemical-specific
RfD_o	oral chronic reference dose (mg/kg-day)	chemical-specific
RfD_i	inhalation chronic reference dose (mg/kg-day)	chemical-specific
BW	adult body weight (kg)	70 kg
AT	averaging time (yr)	70 yr for cancer risk 30 yr for noncancer HI (equal to ED)
EF	exposure frequency (days/yr)	350 days/yr
ED	exposure duration (yr)	30 yr
K	volatilization factor (L/m^3)	0.0005 x 1000 L/m^3 (Andelman 1990)
IR_a	daily indoor inhalation rate (m^3/day)	15 m^3/day
IR_w	daily water ingestion rate (L/day)	2 L/day

$$\text{Risk from ingestion of water (adult)} = \frac{SF_o \times C \times IR_w \times EF \times ED}{BW \times AT \times 365\ \text{days/yr}}$$

The noncancer HQ due to ingestion of a contaminant in water is calculated as follows:

$$\text{HQ due to ingestion of water (adult)} = \frac{C \times IR_w \times EF \times ED}{RfD_o \times BW \times AT \times 365\ \text{days/yr}}$$

B.1.2 INHALATION OF VOLATILES

The cancer risk due to inhalation of a volatile contaminant in water is calculated as follows:

$$\text{Risk from inhalation of volatiles in water (adult)} = \frac{SF_i \times C \times K \times IR_a \times EF \times ED}{BW \times AT \times 365\ \text{days/yr}}$$

The noncancer HQ due to inhalation of a volatile contaminant in water is calculated as follows:

$$\text{HQ due to inhalation of volatiles in water (adult)} = \frac{C \times K \times IR_a \times EF \times ED}{RfD_i \times BW \times AT \times 365\ \text{days/yr}}$$

B.2 SOIL — RESIDENTIAL LAND USE

Only the first exposure pathway below — ingestion of soil — is included in the standard default equations in Section 3.1.2. If additional exposure pathways, including inhalation of volatiles and/or inhalation of particulates, are of concern at a particular site, then a site-specific equation can be derived.

The parameters used in the equations presented in the remainder of this section are explained in the text box below.

B.2.1 INGESTION OF SOIL

The cancer risk from ingestion of contaminated soil is calculated as follows:

$$\text{Risk from ingestion of soil} = \frac{SF_o \times C \times 10^{-6}\ \text{kg/mg} \times EF \times IF_{soil/adj}}{AT \times 365\ \text{days/yr}}$$

The noncancer HQ from ingestion of contaminated soil is calculated as follows:

$$\text{HQ from ingestion of soil} = \frac{C \times 10^{-6}\ \text{kg/mg} \times EF \times IF_{soil/adj}}{RfD_o \times AT \times 365\ \text{days/yr}}$$

B.2.2 INHALATION OF VOLATILES

The cancer risk caused by inhalation of volatiles released from contaminated soil is:

$$\text{Risk from inhalation of volatiles} = \frac{SF_i \times C \times ED \times EF \times IR_{air} \times (1/VF)}{AT \times BW \times 365\ \text{days/yr}}$$

The equation for calculating the noncancer HQ from inhalation of volatiles released from soil is:

PARAMETERS FOR SOIL — RESIDENTIAL LAND USE

Parameter	Definition	Default Value
C	chemical concentration in soil (mg/kg)	—
SF_i	inhalation cancer slope factor ((mg/kg-day)$^{-1}$)	chemical-specific
SF_o	oral cancer slope factor ((mg/kg-day)$^{-1}$)	chemical-specific
RfD_o	oral chronic reference dose (mg/kg-day)	chemical-specific
RfD_i	inhalation chronic reference dose (mg/kg-day)	chemical-specific
BW	adult body weight (kg)	70 kg
AT	averaging time (yr)	70 yr for cancer risk 30 yr for noncancer HI (equal to ED)
EF	exposure frequency (days/yr)	350 days/yr
ED	exposure duration (yr)	30 yr
IR_a	daily indoor inhalation rate (m^3/day)	15 m^3/day
$IF_{soil/adj}$	age-adjusted soil ingestion factor (mg-yr/kg-day)	114 mg-yr/kg-day
VF	soil-to-air volatilization factor (m^3/kg)	chemical specific (see Section 3.3.1)
PEF	particulate emission factor (m^3/kg)	4.63 x 10^9 m^3/kg (see Section 3.3.2)

$$\text{HQ from inhalation of volatiles} = \frac{C \times ED \times EF \times IR_{air} \times (1/VF)}{RfD_i \times BW \times AT \times 365\ \text{days/yr}}$$

B.2.3 INHALATION OF PARTICULATES

Cancer risk due to inhalation of contaminated soil particulates is calculated as:

$$\text{Risk from inhalation of particulates} = \frac{SF_i \times C \times ED \times EF \times IR_{air} \times (1/PEF)}{AT \times BW \times 365\ \text{days/yr}}$$

The noncancer HQ from particulate inhalation is calculated using this equation:

$$\text{HQ from inhalation of particulates} = \frac{C \times ED \times EF \times IR_{air} \times (1/PEF)}{RfD_i \times BW \times AT \times 365\ \text{days/yr}}$$

B.3 SOIL — COMMERCIAL/ INDUSTRIAL LAND USE

All three of the exposure pathways detailed below are included in the standard default equation in Section 3.2.2. If only one or some combination of these exposure pathways are of concern at a particular site, a site-specific equation can be derived.

The parameters used in the equations presented in the remainder of this section are explained in the text box below.

B.3.1 INGESTION OF SOIL

The cancer risk from ingestion of contaminated soil is calculated as follows:

$$\text{Risk from ingestion of soil} = \frac{SF_o \times C \times 10^{-6}\ \text{kg/mg} \times EF \times ED \times IR_{soil}}{BW \times AT \times 365\ \text{days/yr}}$$

The noncancer HQ from ingestion of contaminated soil is calculated as follows:

$$\text{HQ from ingestion of soil} = \frac{C \times 10^{-6}\ \text{kg/mg} \times EF \times ED \times IR_{soil}}{RfD_o \times BW \times AT \times 365\ \text{days/yr}}$$

B.3.2 INHALATION OF VOLATILES

The cancer risk caused by inhalation of volatiles released from contaminated soil is:

$$\text{Risk from inhalation of volatiles} = \frac{SF_i \times C \times ED \times EF \times IR_{air} \times (1/VF)}{AT \times BW \times 365\ \text{days/yr}}$$

The equation for calculating the noncancer HQ from inhalation of volatiles released from soil is:

$$\text{HQ from inhalation of volatiles} = \frac{C \times ED \times EF \times IR_{air} \times (1/VF)}{RfD_i \times BW \times AT \times 365\ \text{days/yr}}$$

Note that the VF value has been developed specifically for these equations; it may not be applicable in other technical contexts.

PARAMETERS FOR SOIL — COMMERCIAL/INDUSTRIAL LAND USE

Parameter	Definition	Default Value
C	chemical concentration in soil (mg/kg)	—
SF_i	inhalation cancer slope factor ($(\text{mg/kg-day})^{-1}$)	chemical-specific
SF_o	oral cancer slope factor ($(\text{mg/kg-day})^{-1}$)	chemical-specific
RfD_o	oral chronic reference dose (mg/kg-day)	chemical-specific
RfD_i	inhalation chronic reference dose (mg/kg-day)	chemical-specific
BW	adult body weight (kg)	70 kg
AT	averaging time (yr)	70 yr for cancer risk 30 yr for noncancer HI (equal to ED)
EF	exposure frequency (days/yr)	250 days/yr
ED	exposure duration (yr)	25 yr
IR_{air}	workday inhalation rate (m^3/day)	20 m^3/day
IR_{soil}	soil ingestion rate (mg/day)	50 mg/day
VF	soil-to-air volatilization factor (m^3/kg)	chemical specific (see Section 3.3.1)
PEF	particulate emission factor (m^3/kg)	4.63×10^9 m^3/kg (see Section 3.3.2)

B.3.3 INHALATION OF PARTICULATES

Cancer risk due to inhalation of contaminated soil particulates is calculated as:

$$\text{Risk from inhalation of particulates} = \frac{SF_i \times C \times ED \times EF \times IR_{air} \times (1/PEF)}{AT \times BW \times 365 \text{ days/yr}}$$

The noncancer HQ from particulate inhalation is calculated using this equation:

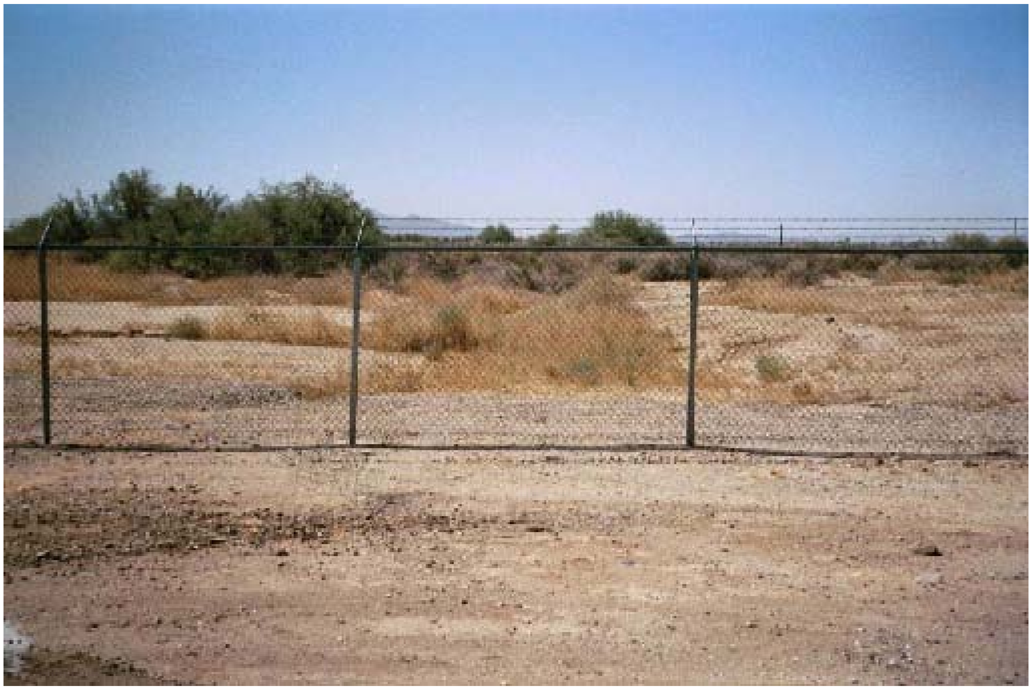
$$\text{HQ from inhalation} = \frac{C \times ED \times EF \times IR_{air} \times (1/PEF)}{RfD_i \times BW \times AT \times 365 \text{ days/yr}}$$

Appendix E

Photo Log

ST-18

ST-18



DP-23 looking south

DP-23 looking north

RW-02

Inside Tire Barrier

View of Bank Stabilization at RW-02

SS-42 pad where SVE pad was

SS-42 General View

FT-07 E

ARCADIS GERAGHTY & MILLER	Photographic Summary Luke Air Force Base Five Year Review	Photographs 9 and 10

LF-14

LF-03

OT-41

LF-25

OT-41

DP-05

DP-05

DP-05

Appendix F

Interview Notes

Lang, Kent

From: Rothrock Charles J Civilian 56 CES/CEVC [charles.rothrock@luke.af.mil]
Sent: Monday, August 13, 2001 7:30 AM
To: klang@arcadis-us.com
Subject: FW: Five-Year Review Project-Interviews

Kent,

Not exactly in the right format, but I guess we can include it.

Jeff

-----Original Message-----
From: MGprts@aol.com [mailto:MGprts@aol.com]
Sent: Sunday, August 12, 2001 5:17 PM
To: charles.rothrock@luke.af.mil
Subject: Re: Five-Year Review Project-Interviews

Jeff; I'm still on the road....For some reason I could not open the file on my laptop and the Original is at home...So here is a letter that I hope will keep your feet out of the fire...Sorry I let this slip....
Jeff

August 10, 2001

RE: "A Look Back"

Seven years, almost eight; it was early in 1994 that I saw the advertisement looking for Citizens to serve on the Luke AFB RAB.

I answered the advertisement with a letter and I am glad now that I did.

I liked the concept of civilian input into the matter of planning the clean up effort.

From the start we enjoyed a spirit of coopertion with both the Command and the Environmental Staff. The attitude was, "we have this problem and let's get it identified and do what we need to do to put it behind us".

Going about setting in place a structured system that would prevent these problems in the future was our goal.

As sites were identified, we looked at the best and most cost effective ways of mitigating the situation at hand.

We always felt we were well informed and included in the decision making regarding what could and had to be done.

Luke stands out as an example of how to do it right. This was very obvious when I attended a conference in San Francisco and found that of all the attendees from across the nation only Luke and one other East Coast Base enjoyed a relationship with the Command and Staff that we did.

In most cases the RAB's had an adversarial relationship that made it hard to get anything done.

In our case at Luke the Base Commanders and the Environmental Staff established a situation of openness and trust that made us a team.

Now that the Base is cleaned up some sites require long term monitoring, so we feel it important that together, we, from time to time sit down and review just how things are going.

It has been a great joint effort that worked well and the Base and all the people involved should be commended.

Martin Jeffries

Luke AFB
Five-Year Review
Interview Questions
Belle Matthews (Luke AFB)

1. What is your understanding of the overall project at the Site?

I am thoroughly familiar with all the sites.

2. Please describe your involvement or participation at the Site.

I am the IRP manager for the last three years

3. What is your general impression of the project (Site)?

The projects were thoroughly investigated and appropriate remediation performed.

4. What effects have the site operation had on you (or the surrounding community)?

The surrounding community participated in the restoration project. They partnered in the research investigation and choices of remediation.

5. Are you aware of any community concerns regarding the Site or its operation and administration? Give any details.

The community has addressed concerns for future continuity of the environmental program. The Restoration Advisory Board rewrote the charter and developed an ongoing community outreach called the Citizens' Advisory Board (CAB) which will continue to meet and be involved in the reviewing the environmental program.

6. Are you aware of any unusual events, incidents or activities at the Site (vandalism, trespassing, unauthorized activities, or emergency response)? Give details.

No.

7. Do you feel well informed about the Site's activities and progress?

Yes

8. Do you have any other comments, suggestions or recommendations regarding the Site's management or operation?

Development of a newsletter by the CAB to keep the surrounding community informed about environmental operations.

9. Have there been routine communications or activities (site visits, inspections, reports, sampling, etc) conducted by your office? Give pertinent details.

10. Have any problems been noticed which may require changes in the remedial action taken for this Site or in any of the decision documents?

No

11. Please describe current O&M procedures.

12. Have there been any unexpected O&M difficulties or costs at the Site? Give details.

13. Do you feel there are opportunities for optimizing the O&M or sampling efforts at the Site?

After the Five Year Review Program is completed, a comprehensive list of sampling and O&M should be developed. The sampling program should be orchestrated to reflect optimum savings. By mid-cycle, the sampling plan should be reviewed; and requests for reducing the numbers of sampling episodes should be explored with AzDEQ and US EPA. Funded through HQ AETC should be secured.

Luke AFB
Five-Year Review
Interview Questions
Nancy Lou Minkler (ADEQ)

1. What is your understanding of the overall project at the Site?

Luke AFB was placed on the EPA's National Priorities List (NPL) in August 1987. This placement identified Luke AFB as a priority site for investigation and cleanup under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by Superfund Amendments and Reauthorization Act (SARA). The sites were separated into two Operable Units, OU-1 and OU-2. The Records of Decision (ROD) were signed by ADEQ for OU-2 on January 10, 1994, and for OU-1 on August 16, 1999.

Luke AFB has satisfied the criteria for deletion in that the remediation selected in the OU-2 and OU-1 RODs have been fully implemented.

2. Please describe your involvement or participation at the Site.

I am the ADEQ Project Manager, and have worked on this site since September 1997.

3. What is your general impression of the project (Site)?

The Air Force has done/is doing a thorough job of the investigation, remediation and operation and maintenance of areas of concern at this Site.

4. What effects have the site operation had on you (or the surrounding community)?

I have worked with the Air Force during the drafting and finalization of the OU-1 ROD, the implementation of selected remedies and the delisting process.

5. Are you aware of any community concerns regarding the Site or its operation and administration? Give any details.

To my knowledge, the Air Force has always been informative and accommodating to the Restoration Advisory Board (RAB), now the Community Advisory Board (CAB), which has been actively involved for several years. This "oversight" has conveyed a greater sense of ease within the general community. Community issues are expressed in the RAB or CAB meetings.

6. Are you aware of any unusual events, incidents or activities at the Site (vandalism, trespassing, unauthorized activities, or emergency response)? Give details.

Not to my knowledge.

7. Do you feel well informed about the Site's activities and progress?

Yes.

8. Do you have any other comments, suggestions or recommendations regarding the Site's management or operation?

No, as long as the Institutional Control Plan (ICP) is enforced.. ADEQ will continue to oversee the O&M activities at Luke Air Force Base, and be involved in the 5-year reviews, as long as the base remains open.

9. Have there been routine communications or activities (site visits, inspections, reports, sampling, etc) conducted by your office? Give pertinent details.

The Air Force has been in regular contact with ADEQ. There have been regular site visits and inspections by our office. ADEQ split sample remediated soils during the lead shot removal activities at the shooting range on December 20, 1999. Occasionally, ADEQ will split sample during routine groundwater monitoring events, such as during the May 16, 2000 sampling event for monitor wells at SS-42.

10. Have any problems been noticed which may require changes in the remedial action taken for this Site or in any of the decision documents?

Not at this time.

11. Please describe current O&M procedures.

Long-term monitoring at SS-42 and at RW-02.. Base-wide groundwater monitoring is required during every 5-year review event. (Including this one)

12. Have there been any unexpected O&M difficulties or costs at the Site? Give details.

The only unexpected O&M difficulties or costs associated with the site at this time, to my knowledge, was the request of the EPA to install two additional monitoring wells at RW-02.

13. Do you feel there are opportunities for optimizing the O&M or sampling efforts at the Site?

Probably yes. After the Base-wide groundwater monitoring report is submitted, and after several rounds of monitoring, where required, there may be some modifications necessary. This would be determined later, probably during the next 5-year review.