FINAL SITE CHARACTERIZATION RISK ASSESSMENT TECHNICAL REPORT FOR FIRE TRAINING AREA 2 WITH TRANSMITTAL LETTER NAS FORT WORTH TX
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NAVAL AIR STATION FORT WORTH JRB CARSWELL FIELD TEXAS

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11-3517-3209

INSTALLATION RESTORATION PROGRAM (IRP)
SITE CHARACTERIZATION/RISK ASSESSMENT TECHNICAL REPORT
FOR
FIRE TRAINING AREA 2

Naval Air Station Fort Worth
Joint Reserve Base, Carswell Field
Fort Worth, Texas

April 1996

Final

PREPARED FOR

AIR FORCE BASE CONVERSION AGENCY (AFBCA/OL-H)
NAVAL AIR STATION FORT WORTH JOINT RESERVE BASE, CARSWELL FIELD
FORT WORTH, TEXAS 76127-5000

UNITED STATES AIR FORCE
AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE (AFCEE/ERB)
BROOKS AIR FORCE BASE, TEXAS 78235-5363

CONTRACT NO.: F41624-94-D-8050

DELIVERY ORDER 0009

LAW
ENGINEERING AND ENVIRONMENTAL SERVICES, INC.

May 1, 1996

Mr. Charles A. Rice, Team Chief
Air Force Center for Environmental Excellence
HQ AFCEE/ERB
3207 North Road, Building 532
Brooks Air Force Base, TX 78235-5363

Subject: **Final Site Characterization/Risk Assessment**
Technical Report for Fire Training Area 2
Naval Air Station Fort Worth Joint Reserve Base, Carswell Field
Contract No. F41624-94-D-8050, Delivery Order No. 0009

Dear Mr. Rice:

Law Environmental, Inc., is pleased to submit the enclosed nine copies of the Final Site Characterization/Risk Assessment Report for Fire Training Area 2 to the Air Force Center for Environmental Excellence (AFCEE).

If you have questions or comments, please contact us at (770) 499-6800.

Sincerely,

LAW ENVIRONMENTAL, INC.

James R. Forbes, P.E.
Project Manager

E. Fred Sharpe, Jr., P.E.
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3517-3209.28

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LAW ENVIRONMENTAL, INC. (LAW), UNDER THE AIR FORCE INSTALLATION RESTORATION PROGRAM (IRP), HAS PREPARED A SITE CHARACTERIZATION/RISK ASSESSMENT TECHNICAL REPORT FOR FIRE TRAINING AREA NUMBER 2 AT THE NAVAL AIR STATION FORT WORTH JOINT RESERVE BASE, CARSWELL FIELD.

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INSTALLATION RESTORATION PROGRAM (IRP)
FINAL SITE CHARACTERIZATION/RISK ASSESSMENT TECHNICAL REPORT
FIRE TRAINING AREA 2

FOR

NAVAL AIR STATION FORT WORTH
JOINT RESERVE BASE, CARSWELL FIELD
FORT WORTH, TEXAS 76127-5000

APRIL 1996

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Contract No. F41624-94-D-8050
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TABLE OF CONTENTS

TABLE OF CONTENTS
(Continued)

LIST OF FIGURES

LIST OF TABLES

LIST OF ACRONYMS AND ABBREVIATIONS

AFB	Air Force Base
AFCEE	Air Force Center for Environmental Excellence
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, and xylene
cm^2	square centimeters
COPCs	constituents of potential concern
FTA-2	Fire Training Area 2
GWP-Ind	Ground-Water Protection Standard for Industrial Use
LAW	Law Environmental, Inc.
mg/day	milligrams per day
mg/kg	milligrams per kilogram
MSCs	media-specific concentrations
ppm	parts per million
RAGS	Risk Assessment Guidance for Superfund
RfC	Reference Concentration
RfD	Reference Dose
RI/FS	remedial investigation/feasibility study
RME	reasonable maximum exposure
RRS	Risk Reduction Standard
SAI-Ind	Soil/Air and Ingestion Standard for Industrial Use
SF	Slope Factor
SWMU	solid waste management unit
TAC	Texas Administrative Codes
TCE	trichloroethene
THI	target hazard index
TNRCC	Texas Natural Resources Conservation Commission
TPH	total petroleum hydrocarbon
USEPA	U.S. Environmental Protection Agency
VOCs	volatile organic compounds

EXECUTIVE SUMMARY

Law Environmental, Inc. (LAW) has been contracted by the United States Air Force Center for Environmental Excellence (AFCEE) to perform environmental investigations at the Naval Air Station Fort Worth Joint Reserve Base, Carswell Field. This facility, formerly known as Carswell Air Force Base (AFB), is located in Fort Worth, Texas.

The purpose of this report is to provide a site characterization/risk assessment in support of closure for contaminated soils at Solid Waste Management Unit 19 (SWMU 19), Fire Training Area 2 (FTA-2). The primary focus of this report is soils because a ground-water remediation system is currently in place downgradient of the FTA-2.

This report uses data from the Remedial Investigation/Feasibility Study conducted by Radian Corporation in 1988, and remediation activities conducted by Dames & Moore in 1995. Near-surface soils from the FTA-2 were excavated and bioremediated by Dames & Moore. Also, before the remediated soils were returned to the excavation, a low permeability compacted clay liner was placed over subsurface soils to prevent infiltration of rainwater and generation of leachate. Finally, the FTA-2 was graded to a gentle slope to encourage runoff, and the surface was seeded with grass.

A conceptual site model was prepared and an exposure assessment was conducted to evaluate pathways for exposure under current and potential future conditions. A plausible scenario for exposure was deemed to be exposure to a groundskeeper during mowing of the grass that covers the FTA-2. It was determined that there is currently no plausible exposure pathway for exposure to subsurface soil, and future exposures can be prevented by the use of deed restrictions. Exposure to ground water was not considered because it is believed that the impermeable clay liner at the FTA-2 prevents percolating rainwater from reaching the contaminated subsurface soils.

A baseline risk assessment was prepared to evaluate the potential risk to groundskeepers potentially exposed to surface soil. Using reasonable maximum exposure assumptions, the estimated carcinogenic and noncarcinogenic risks did not exceed threshold levels.

In accordance with the Texas Natural Resource Conservation Commission's Risk Reduction Standard (RRS) 3, media cleanup levels were calculated for surface soil using a target risk range of 1×10^{-5} for carcinogens, and a threshold level of one for noncarcinogens. The concentrations of constituents detected in surface soils by previous investigations at the FTA-2 were all below the calculated media cleanup levels.

This document shows that, using RRS 3, closure with no additional removal is appropriate since:

- Concentrations of constituents in surface soil do not exceed media cleanup levels.
- Cross-media contamination from surface soil to air or soil to surface water is unlikely because surface soils have been remediated, soils are covered by grass, and the FTA-2 is graded to encourage runoff.
- Cross-media contamination from subsurface soil to ground water is unlikely because of the low permeability clay liner in place and the grading of the FTA-2.
- Constituents of concern in subsurface soils at the FTA-2 are not a concern for exposure to receptors provided that deed restrictions are established to prevent soil excavation.

1.0 INTRODUCTION

Law Environmental, Inc., (LAW) has been contracted by the United States Air Force Center for Environmental Excellence (AFCEE) to perform environmental investigations at the Naval Air Station Fort Worth Joint Reserve Base, Carswell Field (NAS Fort Worth). This facility, formerly known as Carswell Air Force Base (AFB), is located in Fort Worth, Texas.

1.1 PURPOSE OF REPORT

The purpose of this report is to provide a site characterization/risk assessment in support of closure for contaminated soils at Solid Waste Management Unit 19 (SWMU 19), Fire Training Area 2 (FTA-2). The primary focus of this report is soils because a ground-water remediation system is currently in place downgradient of the FTA-2. The ground-water extraction and treatment system is designed to remove trichloroethene (TCE) in the uppermost aquifer in the Terrace Alluvium Deposits (IT, 1994).

This report has been prepared in accordance with Title 31, Texas Administrative Codes (TAC), Sections 335.551 through 335.569 (Subchapter S, Risk Reduction Standards). Based on the currently available site information it appears that the most applicable standard is Risk Reduction Standard (RRS) 3. Data included in this report show that constituents in environmental media at the site exceed the levels set for RRS 2. The requirements of RRS 3 call for a discussion of the nature and extent of contamination, an evaluation of the potential for constituent migration, a baseline risk assessment, and calculation of proposed media cleanup levels. The nature and extent of contamination has been described in reports by previous investigators, as presented in Section 1.2.

1.2 BACKGROUND INFORMATION

SWMU 19 consists of the FTA-2, which was used by the fire department for training exercises to simulate an aircraft fire. The FTA-2 consists of an oval area that originally included two

berms. The outer berm was constructed of a clayey soil. It was approximately 2 feet high, about 260 feet in diameter, and enclosed an area of approximately 1.2 acres. The inner berm was also 2 feet high and was also constructed of a clayey soil. The approximate diameter of the inner berm was 120 feet, and the total area was 0.25 acre (Dames & Moore, 1995). The location of the FTA-2 is shown on Figure 1-1.

The nature, extent, direction of movement, volume, and composition of environmental contaminants have been previously described by Radian Corporation and documented in their remedial investigation/feasibility study (RI/FS) report dated April 1989. Environmental investigations completed at the SWMU included installation of five ground-water monitoring wells and five separate soil borings by Radian Corporation. The results of soil samples indicated that volatile and semi-volatile petroleum hydrocarbons were the major constituents of concern in soil. Total petroleum hydrocarbon (TPH) concentrations in soil ranged from below detection limit to 5,790 ppm at the 19-foot sand layer. Benzene, toluene, ethylbenzene, and xylene(s) (BTEX) concentrations ranged from below detection limit to 47 ppm. Semi-volatiles in soil ranged from below detection limit to 17 ppm. In addition, trichloroethene (TCE) was detected in ground water in the upper zone of the aquifer, primarily downgradient of the FTA-2 (Radian, 1989). Dames & Moore conducted remediation activities at the SWMU consisting of bioremediation of the top 3 feet of soil (Dames & Moore, 1995). The near-surface soils from the FTA-2 were excavated and treated by bioremediation on what was called a "biocell." Following treatment, BTEX constituents were below the detection limit, and total petroleum hydrocarbons (TPH) were less than 100 parts per million (ppm) using EPA method 8000, which is specific for fuel constituents. The detection limits were not reported. A 32-inch thick low permeability compacted clay liner was placed on the bottom of the excavation at the FTA-2, and the bioremediated soil was returned to the excavation. The final elevation of the FTA-2 was contoured to facilitate run-off of rainwater, and the site was seeded with grass to prevent erosion.

According to the contractor that collected the referenced data, the sand layer is not saturated at boring location 12H (where the maximum TPH was detected). In their RI/FS Stage 2, Draft

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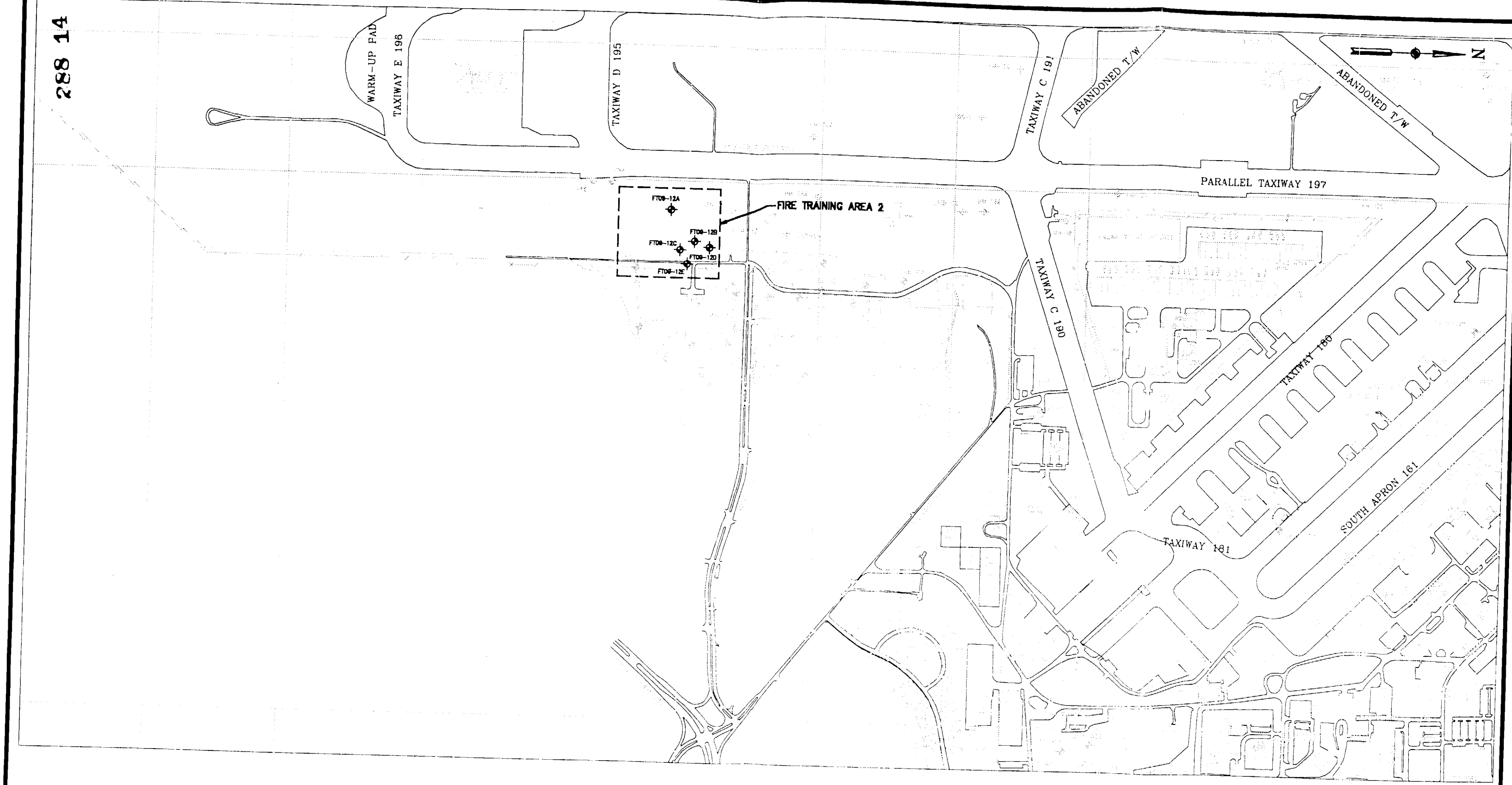

NAVAL AIR STATION
FORT WORTH JOINT RESERVE BASE
FORT WORTH, TEXAS

RISK ASSESSMENT TECHNICAL REPORT
FIRE TRAINING AREA 2

SITE LOCATION MAP

PREPARED BY:	DSS	FIGURE NUMBER: 1-1	FILE DATE: 30.OCT.95
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Final Technical Report, Radian states that "Ground water occurs in the upper zone materials underlying Site 12 at depths ranging from 15 feet at 12A to 30 feet at 12B and 12C. The ground water exists under unconfined (water table) condition in the upper zone materials. However, observation during drilling of several boreholes (12G, 12H, and 12J) indicates that the upper zone is locally dry (Radian, 1989)." A review of Radian's boring logs for boreholes 12I and 12K shows that water was not encountered at either location. Boring 12I was terminated at 24 feet in limestone and 12K was terminated at 25 feet in the sand layer. This information suggests that the sand layer is not part of a potential ground-water pathway.

2.0 BASELINE RISK ASSESSMENT

The approach taken to assess risk at the site is in accordance with the Texas Natural Resources Conservation Commission (TNRCC) RRS 3, and the U.S. Environmental Protection Agency's (USEPA) Risk Assessment Guidance for Superfund (RAGS), (USEPA, 1989a). The approach consists of the following steps:

1. Identification of constituents of potential concern (COPCs)

2. Evaluation of potential for cross-media migration

3. Exposure assessment

   - Identification of potential exposure pathways
   - Estimation of exposure point concentrations
   - Estimation of long-term daily intake values

4. Toxicity assessment

   - Identification of critical toxicity values

5. Risk characterization

   - Estimation of risk taking into account the site-specific exposure assessment and chemical-specific toxicity assessment

6. Development and comparison of RRS 3 media-specific cleanup levels to site-specific analytical data

7. Discussion of assumptions and uncertainty

Following the risk assessment, the proposed media-specific cleanup levels are presented for both surface soil and ground water.

2.1 IDENTIFICATION OF CONSTITUENTS OF POTENTIAL CONCERN

This section presents a brief review of analytical results of previous investigations. It is LAW's understanding that a comprehensive basewide background study to characterize concentrations

of naturally occurring constituents at Carswell Field is planned for fiscal year 1996. Because background concentrations are not available at this time, COPCs are considered to be those constituents which were detected by laboratory analyses. In characterizing the site, COPCs were compared to the Media-Specific Concentrations (MSCs) for nonresidential land use established under RRS 2. The MSCs for soil consist of the Ground-Water Protection Standard (GWP-Ind) for industrial use of soil, and the Soil/Air and Ingestion Standard for industrial use (SAI-Ind). The GWP-Ind is the concentration of a contaminant in soil that is assumed to be protective of ground water considering cross-media contamination from soil. Constituents in ground water are not discussed in this report because (as discussed below) soils at the FTA-2 are unlikely to impact ground water under current conditions, and ground water is under remediation downgradient of the site. The SAI-Ind is the concentration of a contaminant in soil that is protective of human health for exposure by ingestion of soils and inhalation of volatiles and particulates.

2.1.1 Surface Soils

In 1994, soils from 0 to 3 feet were subjected to bioremediation by Dames & Moore. The biocell verification sampling conducted by Dames & Moore shows that BTEX isomers were below the detection limits (Dames & Moore, 1994). However, the bioremediated soils were not tested for metals or semi-volatile organic compounds. Therefore, historical data were evaluated to determine if concentrations of these constituents were above the TNRCC soil criteria for RRS 2. Radian Corporation collected samples from soil borings in and around the FTA-2 during their investigation. There was one sample that was representative of surface soils. Soil boring 12H from within the FTA-2 included the interval from 0 to 4 feet (Radian, 1989). Monitoring well and boring locations are shown in Figure 2-1. The metals arsenic, beryllium, cadmium, chromium, lead, and selenium exceeded their MSCs, as shown in Table 2-1.

TABLE 2-1

COMPARISON OF DETECTED SURFACE SOIL CONCENTRATIONS TO TYPE 2 MEDIUM SPECIFIC CONCENTRATIONS (mg/kg)
Naval Air Station Fort Worth Joint Reserve Base, Carswell Field
Fort Worth, Texas

Parameter	Maximum Detected Concentration (a) (mg/kg)	GWP-Ind (mg/kg)	SAI-Ind (mg/kg)
INORGANICS:			
Aluminum	13,000	NA	NA
Arsenic	***30***	5	3.27
Barium	86	200	137,000
Beryllium	***0.7***	0.4	1.33
Calcium	41,000	NA	NA
Cadmium	***0.6***	0.5	1,020
Cobalt	4.6	610	123,000
Chromium	***14***	10	5,110
Copper	3.4	130	75,800
Iron	12,000	NA	NA
Lead	***16***	1.5	1,000
Magnesium	1,700	NA	NA
Manganese	250	1,400	286,000
Nickel	10	10	20,400
Potassium	1,100	NA	NA
Selenium	***50***	5	10,200
Silicon	350	NA	NA
Sodium	74	NA	NA
Vanadium	30	72	14,300
Zinc	18	3,100	613,000
SEMI-VOLATILES:			
bis(2-Ethylhexyl)phthalate	0.53	2.04	409
Di-n-octyl phthalate	0.15	204	40,900
Dibenzofuran	0.17	0.409	8,176
2-Methylnaphthalene	8.7	41	81,760
4-Methylphenol	4.2	410	51,100
Naphthalene	3.9	409	7,720
Phenol	0.5	6,130	NA

GWP-Ind - Groundwater Protection Standard for Industrial Use.
SAI-Ind - Soil/Air and Ingestion Standard for Industrial Use.
Bold indicates the concentration exceeds the Type 2 Risk Reduction Standard for Soil.
NA - Not available.
(a) Sample 12H-1 (0 - 4 feet), collected February 23, 1988, by Radian Corporation.

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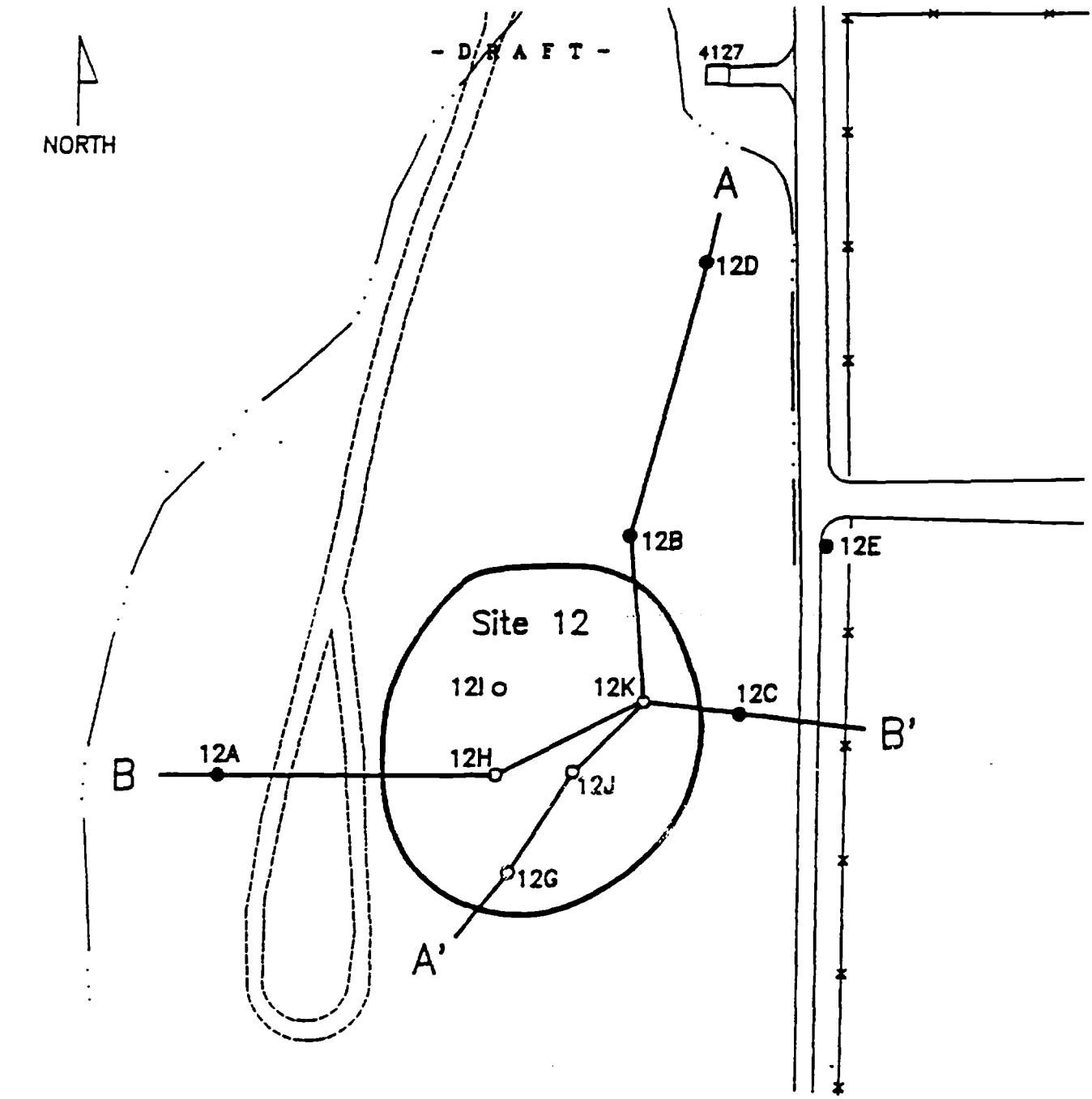

UNITED STATES AIR FORCE
NAVAL AIR STATION FORT WORTH
JOINT RESERVE BASE, CARSWELL FIELD

LOCATIONS OF MONITOR WELLS AND BOREHOLES AT FTA-2

FROM RADIAN, APRIL 1989

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CHECKED/DATE: EFS 30 OCT 95		PLOT DATE:	30 OCT 95
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2.1.2 Subsurface Soils

Subsurface soils from within the FTA-2 are not discussed in this report because:

- Currently, there is no plausible exposure pathway for contact with subsurface soil.
- Under RRS 3, deed restrictions may be established to prevent the disturbance of soil.
- The control measures in place (i.e., low permeability compacted clay liner) are expected to eliminate the potential for cross-media contamination of ground water.

Soil boring samples from outside the FTA-2 were collected by Radian during the Stage I investigation (Radian, 1986). The maximum detections in soils from monitoring well locations 12A, 12B, and 12C of metals and volatile organic compounds (VOCs) are discussed in this report. Lead and selenium were the only metals that exceeded the GWP-Ind. Lead was detected at 10.6 milligram per kilogram (mg/kg) (GWP-Ind = 1.5 mg/kg), and selenium at 12.2 mg/kg (GWP-Ind = 5.0 mg/kg), as shown in Table 2-2. The elevated levels were detected in boring 12B at a depth of 9 to 10 feet below ground surface (bgs). Purgeable halocarbons were not detected in any samples collected outside the FTA-2 area. Purgeable aromatics (BTEX) were tested for, but only ethylbenzene and toluene were detected (in boring 12B), and the concentrations were below the GWP-Ind.

2.2 POTENTIAL FOR CROSS-MEDIA MIGRATION

Potential exposure of human or environmental receptors to a constituent is determined, in part, by the potential for migration and persistence of the constituent in the environmental medium of interest. This section reviews the potential for soils at the site to impact surface water, air, and ground water due to cross-media contamination.

TABLE 2–2

COMPARISON OF DETECTED SUBSURFACE SOIL CONCENTRATIONS TO TYPE 2 MEDIUM SPECIFIC CONCENTRATIONS (mg/kg)
Naval Air Station Fort Worth Joint Reserve Base, Carswell Field
Fort Worth, Texas

Parameter	Maximum Detected Concentration* (mg/kg)	GWP–Ind (mg/kg)	SAI–Ind (mg/kg)
INORGANICS:			
Barium	34	200	137,000
Cadmium	0.45	0.5	1,020
Chromium	5	10	5,110
Lead	***10.6***	1.5	1,000
Selenium	***12.2***	5	10,200
Silver	0.81	51.1	10,200
VOLATILES:			
Ethylbenzene	2.9	70	17,000
Toluene	1.4	100	3,630

GWP–Ind – Groundwater Protection Standard for Industrial Use.
SAI–Ind – Soil/Air and Ingestion Standard for Industrial Use.
Bold indicates the concentration exceeds the Type 2 Risk Reduction Standard for Soil.
NA – Not available.
* Soil boring locations 12A, 12B, and 12C from outside FTA–2 area.

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The evaluation considered the following potential pathways for cross-media migration for constituents in soil:

- Release to the atmosphere as fugitive dust
- Transport as suspended sediment with surface run-off
- Transport as leachate with run-off
- Migration from soil to ground water, as leachate

The potential for impact to humans by the air pathway under current conditions is considered insignificant, because release by volatilization or release of fugitive dust is considered unlikely. Release of volatiles is unlikely because the bioremediation of surface soils reduced the levels of BTEX below the detection limits. Release of dust is unlikely because the site is covered with grass. Although a release could occur if excavation were to take place, soil disturbance is unlikely unless there is additional remediation of the FTA-2. Potential exposures due to this pathway can be effectively eliminated by use of deed restrictions. Therefore, cross-media contamination by the air pathway does not present a concern to human health.

The potential for transport as suspended sediment with surface run-off is minimal because surface soils at the site are covered with grass and graded to drain away from and above the FTA-2 area. The concentrations of constituents that remain after treatment are unlikely to contain levels of constituents that would be a concern to human health.

Ground water could be a potential receiving medium if constituents were to be leached from the soil in the unsaturated zone. However, a low permeability clay liner is in place beneath the bioremediated soils which should provide a barrier to the downward movement of rainwater and effectively prevent percolation through the underlying soils. If there is little or no infiltration, then generation of leachate can be considered insignificant. Therefore, impact to ground water is not a concern.

2.3 EXPOSURE ASSESSMENT

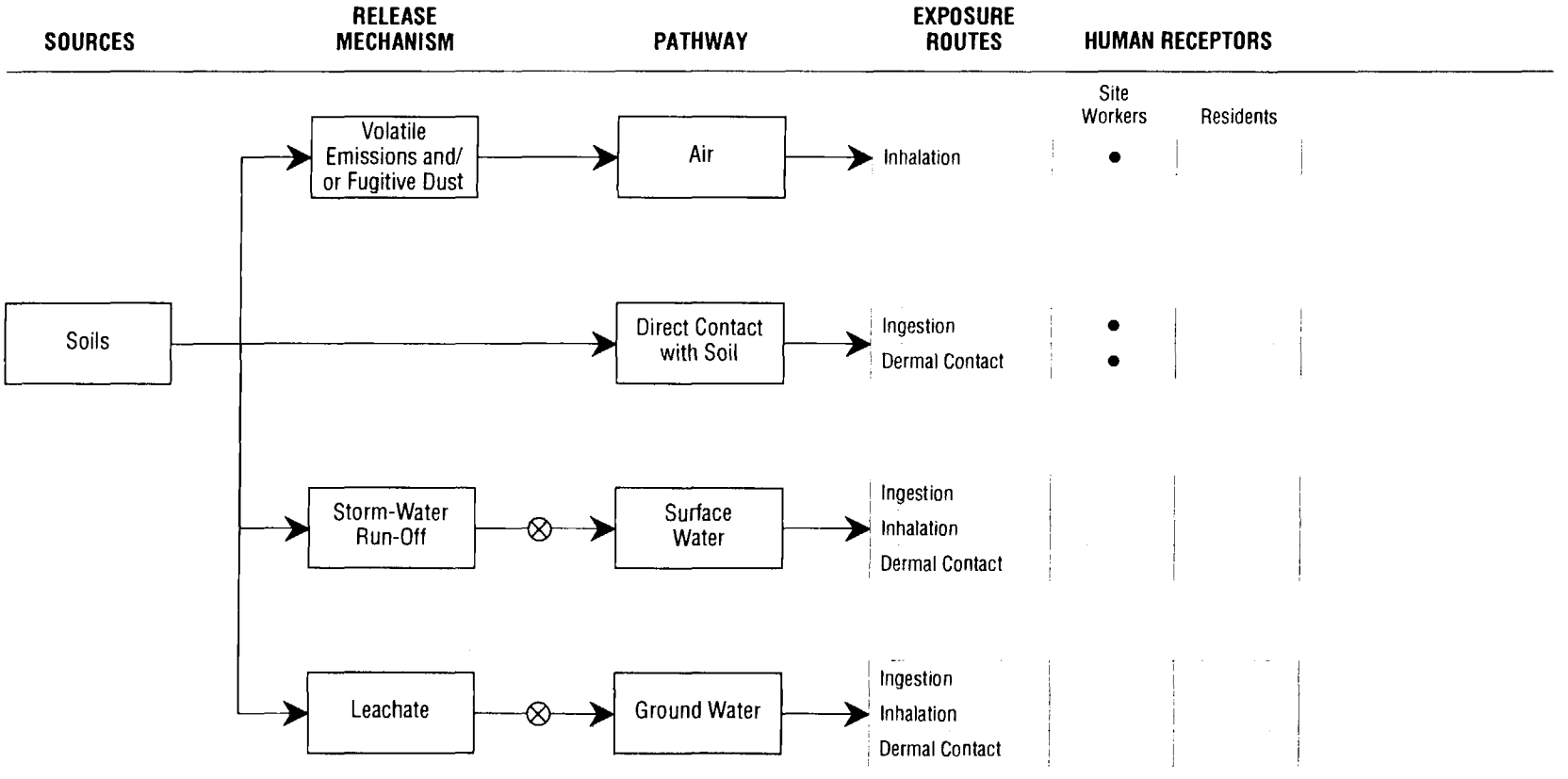
In order to evaluate the exposure pathways that may be present at or adjacent to the subject area, an exposure assessment was conducted. The primary purpose of an exposure assessment is to identify the potential for exposure to human or environmental receptors, and the routes by which receptors could be exposed. The routes of exposure are evaluated by developing a conceptual site model that includes plausible scenarios for potential exposure. The conceptual site model was developed based on a review of available information on the environmental setting at and adjacent to the FTA-2. The conceptual site model, depicted in Figure 2-2, shows the exposure pathways that are potentially complete at the site under current and potential future conditions.

2.3.1 Exposure Setting

The FTA-2 is located in the southern part of NAS Fort Worth just west of the radar facility. The site is currently an oval mound covered with grass. Land use in the surrounding area is industrial, commercial, and residential. Air Force Plant 4 is an industrial facility northwest of the FTA-2. Commercial property extends to the south, and residential development exists within one-quarter to one-half mile to the southeast and northeast of the FTA-2. The shallow ground water beneath the FTA-2 is not currently used as a drinking water source.

For the potential exposure scenario to be viable, there must be a complete exposure pathway. The components of a complete pathway are:

- A source of hazard
- A release from the source
- A transport mechanism from (or through) the contaminated media to the exposure point
- A receptor at the exposure point



⊗ Incomplete Release Mechanism

● Potential Complete Pathway, Current Conditions

UNITED STATES AIR FORCE
NAVAL AIR STATION FORT WORTH
JOINT RESERVE BASE, CARSWELL FIELD

CONCEPTUAL SITE MODEL

FIRE TRAINING AREA NO. 2

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If any component is missing, the pathway is incomplete and no exposure can occur. A description of the source has been provided in the discussion of COPCs (Section 2.1), and potential release and transport mechanisms are discussed in Section 2.2.

2.3.2 Receptors

The presence of receptors at the subject area depends on the current and potential future land use of the site and the surrounding area. Land use at the site under current and potential future use is considered nonresidential. The facility is currently used as a training airfield by reserve units of the Air Force and the Navy.

Under nonresidential use, potential human receptors would only be those who would be in the vicinity of the subject area as part of their normal job duties. A plausible scenario for exposure to surface soil at the FTA-2 would be exposure of a groundskeeper during mowing of the grass that covers the site.

2.3.3 Estimation of Exposure Concentrations and Exposure Intake Values

The next step in the exposure assessment is to quantify the magnitude, frequency, and duration of exposure for the population and pathway selected for quantitative evaluation. Because of the limited data set available for this site, the maximum detected concentrations were used as the exposure point concentrations. Intake variables and exposure point concentrations were selected so that the combination of all variables results in an estimate of the reasonable maximum exposure (RME) for each pathway. The RME is the maximum exposure that is reasonably expected to occur at a site.

Pathway-specific exposure intakes have been quantified by defining a series of variables that describe the exposed population, such as contact rate, exposure frequency and duration, and body weight. The specific calculation procedures and variables used to determine pathway-specific intakes for dermal contact with and ingestion of soil are described below. These

exposure variables have been multiplied by the exposure point concentrations to yield estimates of the chemical-specific intakes for these pathways.

2.3.3.1 Dermal Intake of Soil - The equation for determining chemical intakes from dermal contact with soil is shown in Table 2-3. Intakes calculated for groundskeepers assume an exposed surface area equal to 3,070 square centimeters (cm^2) which represents the surface area of the forearms, hands, and head of an adult (USEPA, 1989b). Groundskeepers were assumed to weigh 70 kilograms and be exposed to soil for 1 hour a day for 39 days per year (i.e., 1 day per week in a 9-month growing season) (LAW, 1995). The averaging time was assumed to be 25 years for noncarcinogens (9,125 days) and 70 years (25,550 days) for carcinogens (USEPA, 1991a). Chemical-specific absorption factors are not available for the COPCs. Therefore, a surrogate value of 6 percent was used for semi-volatiles, and 1 percent was used for metals. These surrogate values are those that have been published for tetrachlorobiphenyl and cadmium, respectively (USEPA, 1992a).

2.3.3.2 Ingestion Intake for Soil - The intake calculation for incidental ingestion of soil is shown in Table 2-4. It was assumed that all of the ingested soil was from the FTA-2 (fraction ingested = 1), and that the ingestion rate is 100 milligrams per day (mg/day). The factors for body weight, exposure duration, and exposure frequency are the same as for the dermal exposure scenario.

2.4 TOXICITY ASSESSMENT

The USEPA has developed toxicity values which reflect the magnitude of the adverse noncarcinogenic and carcinogenic effects from exposure to specific chemicals. Toxicity values for the chemicals of potential concern at this site are presented in the following sections. Reference toxicity values such as the Reference Dose (RfD) or Reference Concentration (RfC) and the Slope Factor (SF) are based primarily on human and animal studies with supportive evidence from pharmacokinetics, mutagenicity, and chemical structure studies.

TABLE 2-3

INTAKE FACTORS
DERMAL CONTACT WITH SOILS BY GROUNDSKEEPERS
Naval Air Station Fort Worth Joint Reserve Base, Carswell Field
Fort Worth, Texas

DERMAL INTAKE (mg/kg-day) = $\frac{CS \times SA \times AF \times ABS \times EF \times ED \times CF}{BW \times AT}$

Where:			
	CS	=	Concentration in Soil (mg/kg)
	SA	=	Surface Area of Exposed Skin (cm^2/day)
	AF	=	Soil to Skin Adherance Factor (mg/cm^2)
	ABS	=	Absorption Factor (unitless)
	EF	=	Exposure Frequency (days/year)
	ED	=	Exposure Duration (years)
	BW	=	Body Weight (kg)
	AT	=	Averaging Time (days)
	CF	=	Conversion Factor (1E-06 kg/mg)

Exposure Variable		Occupational Receptor Groundskeeper
SA	(Adult)	3,070 (a)
AF		1.0
ABS		CHEMICAL SPECIFIC (b)
EF	(Adult)	39 (c)
ED	(Adult)	25
BW	(Adult)	70
AT	(Noncarcinogens - Adult)	9,125
AT	(Carcinogens - Adult)	25,550
CF		1E-06

PATHWAY-SPECIFIC INTAKES:

Dermal Intake:

			SEMI-VOLATILES:	METALS:
Groundskeeper Adult (Noncarcinogens)	=	CS x	2.81E-07	4.69E-08
Groundskeeper Adult (Carcinogens)	=	CS x	1.00E-07	1.67E-08

(a) Surface area measurement for forearms, hands, and head of an adult.
(b) Interim Guidance for Dermal Exposure Assessment: Principles and Applications (USEPA, 1992).
The value for semi-volatiles is based on tetrachlorobiphenyls (0.06) and the value for metals is based on cadmium (0.01).
(c) One day per week for nine months (excluding winter).

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INTAKE FACTORS
INCIDENTAL INGESTION OF SOILS BY GROUNDSKEEPERS
Naval Air Station Fort Worth Joint Reserve Base, Carswell Field
Fort Worth, Texas

$$\text{INGESTION INTAKE (mg/kg-day)} = \frac{CS \times IR \times EF \times ED \times CF \times FI}{BW \times AT}$$

Where:	CS	=	Concentration in Soils (mg/kg)
	FI	=	Fraction Ingested from Contaminant Source (unitless)
	IR	=	Ingestion Rate (mg/day)
	EF	=	Exposure Frequency (days/year)
	ED	=	Exposure Duration (years)
	BW	=	Body Weight (kg)
	AT	=	Averaging Time (days)
	CF	=	Conversion Factor (1E-06 kg/mg)

Exposure Variable		Occupational Receptor Groundskeeper
FI		1
IR	(Adult)	100
EF	(Adult)	39 (a)
ED	(Adult)	25
BW	(Adult)	70
AT	(Noncarcinogens - Adult)	9,125
AT	(Carcinogens)	25,550
CF		1E-06

PATHWAY-SPECIFIC INTAKES:

Ingestion of Soil:

Groundskeeper Adult (Noncarcinogens)	= CS *	1.53E-07
Groundskeeper Adult (Carcinogens)	= CS *	5.45E-08

(a) One day per week for nine months (excluding winter).

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2.4.1 Noncarcinogenic Effects

Chemicals that give rise to toxic endpoints other than cancer and gene mutations are often referred to as "systemic toxicants" because of their effects on the function of various organ systems. Chemicals considered to be systemic toxicants can also exhibit systemic carcinogenic effects. For many noncarcinogenic effects, protective mechanisms (i.e., exposure or dose thresholds) are believed to exist that must be overcome before an adverse effect is manifested. This characteristic distinguishes systemic toxicants from carcinogens and mutagens which are often treated as acting without a distinct threshold. As a result, a range of exposure exists from zero to some finite value that can be tolerated with essentially no chance of the organism expressing adverse effects. In developing toxicity values for evaluating noncarcinogenic effects, the standard approach is to identify the upper boundary of this tolerance range or threshold and to establish the toxicity values based on this threshold.

The toxicity value most often used in evaluating noncarcinogenic effects is the RfD. Various types of RfDs are available depending on the exposure route of concern (e.g., oral or inhalation, RfD_o and RfD_i respectively), the critical effect of the chemical (e.g., developmental or other), and the length of exposure being evaluated (e.g., chronic or subchronic).

The chronic RfD is defined as an estimate of a daily exposure level for the human population, including sensitive subpopulations, that is likely to be without appreciable risk of deleterious effects during a lifetime. Chronic RfDs are specifically developed to be protective for long-term exposures, i.e., 7 years to a lifetime (70 years). Although site construction workers are not assumed to be exposed over a long time, chronic RfDs were used for the risk calculations because subchronic values were not available. Use of chronic RfDs to evaluate short-term exposures (e.g., one year) is a conservative assumption which will overestimate potential risk at the site. The chronic RfDs for the chemicals of concern at the site were primarily derived from the USEPA's Integrated Risk Information System data base (IRIS, 1995) and the Health Effects Assessment Summary Tables (HEAST, 1994).

2.4.2 Carcinogenic Effects

Carcinogens are generally thought to have nonthreshold effects. In other words, USEPA assumes that a small number of molecular events can cause changes in a single cell that can lead to uncontrolled cellular growth. This hypothesis for carcinogenesis is referred to as "nonthreshold" because there is believed to be essentially no level of exposure to such a chemical that does not pose a finite probability of generating a carcinogenic response.

To evaluate carcinogenic effects, USEPA uses a two-part evaluation in which the chemical is first assigned a weight-of-evidence classification, and then a toxicity value, the slope factor (SF), is calculated. The weight-of-evidence classification is based on an evaluation of the available data to determine the likelihood that the chemical is a human carcinogen. Chemicals with the strongest evidence of human carcinogenicity are denoted Class A, B1, or B2, while chemicals with less supporting evidence are classified as C or D. The SF quantitatively defines the relationship between the dose and the response. The SF is generally expressed as a plausible upper-bound estimate of the probability of response occurring per unit of chemical. The carcinogenic SF factors for the chemicals of concern at the site were derived from IRIS (1995) or HEAST (1994).

2.4.3 Toxicity Assessment for Dermal Exposure

RfDs and SFs have not been derived specifically for dermal absorption. Therefore, in accordance with USEPA guidance, risks associated with dermal exposures were evaluated with Oral RfDs or Oral SFs.

2.5 RISK CHARACTERIZATION

The risk characterization integrates the results of the exposure and toxicity assessments into quantitative and qualitative expressions of risk for potentially complete pathways of exposure at the site. To characterize potential noncarcinogenic effects, comparisons are made between the

estimated chemical intakes and the RfDs for those chemicals; to characterize potential carcinogenic effects, estimated chemical intakes are multiplied by the chemical-specific SFs to yield chemical-specific information regarding potential risk.

2.5.1 Noncarcinogenic Risk Characterization

Noncarcinogenic risks are characterized by comparing the estimated chemical intakes to the appropriate RfD value. When the estimated chronic daily intake of a site-related chemical exceeds the appropriate RfD, there may be a concern for potential noncancer effects from exposure to that chemical. The ratio of the chronic daily intake to the chronic RfD is referred to as the "hazard quotient." It is important to note that the hazard quotient does not represent a statistical probability. Rather, a hazard quotient greater than 1.0 indicates that the "threshold" for acceptable exposure to that chemical has been exceeded. The chemical-specific hazard quotient values for exposure to surface soil by the dermal and ingestion routes are presented in Tables 2-5 and 2-6, respectively. All of the hazard quotient values for exposure to surface soil are well below the threshold value of 1.

The USEPA assumes additivity of effects in evaluating noncarcinogenic effects from a mixture of chemicals. The chemical-specific hazard quotients are summed to yield an overall pathway-specific hazard index; pathway-specific hazard indices are then summed to yield a total hazard index for the relevant population.

The total hazard index for dermal contact with soil is 0.007, and for ingestion of soil, 0.02. The total hazard index for the soil pathway is 0.027, which is well below the threshold level.

2.5.2 Carcinogenic Risk Characterization

Risks from potential carcinogens are estimated as probabilities of excess cancers as a result of exposure to chemicals from the site. The SF correlates estimated total chronic daily intake to incremental cancer risk. Chemical-specific cancer risks are estimated by multiplying the SF by

TABLE 2-5

CALCULATIONS OF RISK, MAXIMUM CONCENTRATIONS
POTENTIAL FUTURE OCCUPATIONAL EXPOSURE
DERMAL CONTACT WITH SURFACE SOILS
Naval Air Station Fort Worth Joint Reserve Base, Carswell Field
Fort Worth, Texas

Parameter	Maximum Exposure Point Concentration (mg/kg) (a)	Intake Factor (kg/kg-d)		Chronic Intake (mg/kg-d) (b)		Toxicity Values		Adult Hazard Quotient (c) (unitless)	Excess Cancer Risk (d) (unitless)
		Noncarc. (Adult)	Carcinogen (Lifetime)	Noncarc. (Adult)	Carcinogen (Lifetime)	Oral RfD (mg/kg-d)	Slope Factor (kg-d/mg)		
SEMI-VOLATILES:									
bis(2-Ethylhexyl)phthalate	0.53	2.81E-07	1.00E-07	1.49E-07	5.30E-08	2.00E-02	1.40E-02	7.45E-06	7.42E-10
Di-n-octyl phthalate	0.15	2.81E-07	1.00E-07	4.21E-08	1.50E-08	2.00E-02	NA	2.11E-06	NA
Dibenzofuran	0.17	2.81E-07	1.00E-07	4.78E-08	1.70E-08	4.00E-03	NA	1.19E-05	NA
2-Methylnaphthalene	8.7	2.81E-07	1.00E-07	2.44E-06	8.70E-07	NA	NA	NA	NA
4-Methylphenol	4.2	2.81E-07	1.00E-07	1.18E-06	4.20E-07	5.00E-03	NA	2.36E-04	NA
Naphthalene	3.9	2.81E-07	1.00E-07	1.10E-06	3.90E-07	4.00E-02	NA	2.74E-05	NA
Phenol	0.5	2.81E-07	1.00E-07	1.40E-07	5.00E-08	6.00E-01	NA	2.34E-07	NA
INORGANICS:									
Aluminum	13000	4.69E-08	1.67E-08	6.10E-04	2.17E-04	1.00E+00	NA	6.10E-04	NA
Arsenic	30	4.69E-08	1.67E-08	1.41E-06	5.01E-07	3.00E-04	1.50E+00	4.69E-03	7.52E-07
Barium	86	4.69E-08	1.67E-08	4.03E-06	1.44E-06	7.00E-02	NA	5.76E-05	NA
Beryllium	0.7	4.69E-08	1.67E-08	3.28E-08	1.17E-08	5.00E-03	4.30E+00	6.57E-06	5.03E-08
Calcium	41000	4.69E-08	1.67E-08	1.92E-03	6.85E-04	NA	NA	NA	NA
Cadmium	0.6	4.69E-08	1.67E-08	2.81E-08	1.00E-08	1.00E-03	NA	2.81E-05	NA
Cobalt	4.6	4.69E-08	1.67E-08	2.16E-07	7.68E-08	6.00E-02	NA	3.60E-06	NA
Chromium	14	4.69E-08	1.67E-08	6.57E-07	2.34E-07	5.00E-03	NA	1.31E-04	NA
Copper	3.4	4.69E-08	1.67E-08	1.59E-07	5.68E-08	3.71E-02	NA	4.30E-06	NA
Iron	12000	4.69E-08	1.67E-08	5.63E-04	2.00E-04	NA	NA	NA	NA
Lead	16	4.69E-08	1.67E-08	7.50E-07	2.67E-07	NA	NA	NA	NA
Magnesium	1700	4.69E-08	1.67E-08	7.97E-05	2.84E-05	NA	NA	NA	NA
Manganese	250	4.69E-08	1.67E-08	1.17E-05	4.17E-06	1.40E-01	NA	8.37E-05	NA
Nickel	10	4.69E-08	1.67E-08	4.69E-07	1.67E-07	2.00E-02	NA	2.35E-05	NA
Potassium	1100	4.69E-08	1.67E-08	5.16E-05	1.84E-05	NA	NA	NA	NA
Selenium	50	4.69E-08	1.67E-08	2.34E-06	8.35E-07	5.00E-03	NA	4.69E-04	NA
Silicon	350	4.69E-08	1.67E-08	1.64E-05	5.84E-06	NA	NA	NA	NA
Sodium	74	4.69E-08	1.67E-08	3.47E-06	1.24E-06	NA	NA	NA	NA
Vanadium	30	4.69E-08	1.67E-08	1.41E-06	5.01E-07	7.00E-03	NA	2.01E-04	NA
Zinc	18	4.69E-08	1.67E-08	8.44E-07	3.01E-07	3.00E-01	NA	2.81E-06	NA
							TOTAL:	0.007	8E-07

(a) Exposure Point Concentrations consist of the maximum detected concentration.
(b) Chronic Intake = Exposure Point Concentration x Intake Factor
(c) Hazard Quotient (Noncarcinogens) = Chronic Intake / Oral RfD
(d) Excess Cancer Risk (Carcinogens) = Slope Factor x Chronic Intake

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TABLE 2-6

CALCULATIONS OF RISK, MAXIMUM CONCENTRATIONS
POTENTIAL FUTURE OCCUPATIONAL EXPOSURE
INCIDENTAL INGESTION OF SURFACE SOILS
Naval Air Station Fort Worth Joint Reserve Base, Carswell Field
Fort Worth, Texas

Parameter	Maximum Exposure Point Concentration (mg/kg) (a)	Intake Factor (kg/kg-d)		Chronic Intake (mg/kg-d) (b)		Toxicity Values		Adult Hazard Quotient (c) (unitless)	Excess Cancer Risk (d) (unitless)
		Noncarc. (Adult)	Carcinogen (Lifetime)	Noncarc. (Adult)	Carcinogen (Lifetime)	Oral RfD (mg/kg-d)	Slope Factor (kg-d/mg)		
SEMI-VOLATILES:									
bis(2-Ethylhexyl)phthalate	0.53	1.53E-07	5.45E-08	8.11E-08	2.89E-08	2.00E-02	1.40E-02	4.05E-06	4.04E-10
Di-n-octyl phthalate	0.15	1.53E-07	5.45E-08	2.30E-08	8.17E-09	2.00E-02	NA	1.15E-06	NA
Dibenzofuran	0.17	1.53E-07	5.45E-08	2.60E-08	9.27E-09	4.00E-03	NA	6.50E-06	NA
2-Methylnaphthalene	8.7	1.53E-07	5.45E-08	1.33E-06	4.74E-07	NA	NA	NA	NA
4-Methylphenol	4.2	1.53E-07	5.45E-08	6.43E-07	2.29E-07	5.00E-03	NA	1.29E-04	NA
Naphthalene	3.9	1.53E-07	5.45E-08	5.97E-07	2.13E-07	4.00E-02	NA	1.49E-05	NA
Phenol	0.5	1.53E-07	5.45E-08	7.65E-08	2.73E-08	6.00E-01	NA	1.28E-07	NA
INORGANICS:									
Aluminum	13000	1.53E-07	5.45E-08	1.99E-03	7.09E-04	1.00E+00	NA	1.99E-03	NA
Arsenic	30	1.53E-07	5.45E-08	4.59E-06	1.64E-06	3.00E-04	1.50E+00	1.53E-02	2.45E-06
Barium	86	1.53E-07	5.45E-08	1.32E-05	4.69E-06	7.00E-02	NA	1.88E-04	NA
Beryllium	0.7	1.53E-07	5.45E-08	1.07E-07	3.81E-08	5.00E-03	4.30E+00	2.14E-05	1.64E-07
Calcium	41000	1.53E-07	5.45E-08	6.27E-03	2.23E-03	NA	NA	NA	NA
Cadmium	0.6	1.53E-07	5.45E-08	9.18E-08	3.27E-08	1.00E-03	NA	9.18E-05	NA
Cobalt	4.6	1.53E-07	5.45E-08	7.04E-07	2.51E-07	6.00E-02	NA	1.17E-05	NA
Chromium	14	1.53E-07	5.45E-08	2.14E-06	7.63E-07	5.00E-03	NA	4.28E-04	NA
Copper	3.4	1.53E-07	5.45E-08	5.20E-07	1.85E-07	3.71E-02	NA	1.40E-05	NA
Iron	12000	1.53E-07	5.45E-08	1.84E-03	6.54E-04	NA	NA	NA	NA
Lead	16	1.53E-07	5.45E-08	2.45E-06	8.72E-07	NA	NA	NA	NA
Magnesium	1700	1.53E-07	5.45E-08	2.60E-04	9.27E-05	NA	NA	NA	NA
Manganese	250	1.53E-07	5.45E-08	3.83E-05	1.36E-05	1.40E-01	NA	2.73E-04	NA
Nickel	10	1.53E-07	5.45E-08	1.53E-06	5.45E-07	2.00E-02	NA	7.65E-05	NA
Potassium	1100	1.53E-07	5.45E-08	1.68E-04	6.00E-05	NA	NA	NA	NA
Selenium	50	1.53E-07	5.45E-08	7.65E-06	2.73E-06	5.00E-03	NA	1.53E-03	NA
Silicon	350	1.53E-07	5.45E-08	5.36E-05	1.91E-05	NA	NA	NA	NA
Sodium	74	1.53E-07	5.45E-08	1.13E-05	4.03E-06	NA	NA	NA	NA
Vanadium	30	1.53E-07	5.45E-08	4.59E-06	1.64E-06	7.00E-03	NA	6.56E-04	NA
Zinc	18	1.53E-07	5.45E-08	2.75E-06	9.81E-07	3.00E-01	NA	9.18E-06	NA
						TOTAL:		0.02	3E-06

NA Not available or applicable
(a) Exposure Point Concentrations consist of the maximum detected concentration.
(b) Chronic Intake = Exposure Point Concentration x Intake Factor
(c) Hazard Quotient (Noncarcinogens) = Chronic Intake / Oral RfD
(d) Excess Cancer Risk (Carcinogens) = Slope Factor x Chronic Intake

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the chronic daily intake estimates. The results of the carcinogenic risk characterization are expressed as upper-bound estimates of the potential carcinogenic risk for each exposure point. To assess the overall potential for cancer effects posed by the mixture of chemicals present at a site, USEPA guidance assumes additivity. Therefore, cancer risks are estimated for each chemical, then chemical-specific risks are summed to yield an estimate of the overall pathway-specific cancer risk. The TNRCC Risk Reduction Standards define the target risk range as concentration levels that represent an excess upper-bound lifetime cancer risk to an individual of between 1×10^{-4} and 1×10^{-6} (TNRCC, 1993).

The chemical-specific risks for exposures to soil by dermal contact and ingestion are shown in Tables 2-5 and 2-6, respectively. The excess cancer risk for exposure to soil by the dermal route is below the target risk range, at a level of 8×10^{-7}. The estimated risk for the ingestion route is 3×10^{-6}, which is within the target risk range of 1×10^{-4} to 1×10^{-6}. The total cancer risk for the soil pathway is rounded off to 3×10^{-6}.

2.6 ASSUMPTIONS AND UNCERTAINTIES

While evaluating this risk assessment, several assumptions and uncertainties need to be noted which may have impact upon the total risk.

- The maximum detected concentrations were used for the risk calculations due to the limited data set. This will tend to overestimate potential risks.
- The comparison of surface soil analytical results for semi-volatiles and metals was based on a single soil sample because no other data were available. The use of a single datum to represent surface soils may underestimate or overestimate the concentrations of constituents at the site.
- Subchronic RfDs were not available for the chemicals of potential concern; therefore, chronic RfDs were used for the risk calculations. This is a conservative assumption which will overestimate potential risk at the site.

- RfDs and SFs were not available for several constituents. Thus, the noncarcinogenic and carcinogenic risks calculated for the pathways of interest at the site may be underestimated.

- Chemical-specific dermal absorption information was not available for the constituents of potential concern, so oral RfDs and SFs were used. This may overestimate or underestimate the potential risk at the site.

- An assumption was made that exposures would occur at a constant rate over the estimated duration of exposure. Site-specific exposure parameters may vary from those used to estimate exposures for receptors.

- In evaluating risks from future exposures to site media, the assumption was made that future constituent concentrations will remain the same as current concentrations. Dilution, decay, degradation, and attenuation of constituents occur naturally over time, and site contaminants would thus present a reduced risk in future scenarios.

This baseline risk assessment should not be viewed as an absolute quantitative measure of the risk to public health presented by site-specific contaminants. The assumptions and inherent uncertainties in the risk assessment process do not allow this level of confidence. However, this risk assessment does provide a reasonable indication of the potential for risk due to exposure to site-specific chemicals.

3.0 MEDIA CLEANUP LEVELS

This section discusses the procedure used to calculate media cleanup levels according to RRS 3 and provides a comparison of the calculated MSC level values to site constituent concentrations.

3.1 CALCULATION OF MEDIA CLEANUP LEVELS

The site-specific media cleanup levels were calculated in accordance with the guidelines given in the TNRCC Risk Reduction Standards and the USEPA Risk Assessment Guidance for Superfund: Volume 1 - Human Health Evaluation Manual (Part B, Development of Risk-Based Preliminary Remediation Goals), (USEPA, 1991b).

The equations used to calculate the risk-based carcinogenic and noncarcinogenic cleanup levels for soil are shown on the bottom of Table 3-1. The equations are comprised of one component for the dermal exposure route, and one component for the ingestion route. The cumulative excess target lifetime cancer risk (TR) to exposed populations for all the known or suspected carcinogens cannot exceed 1 in 10,000 (10^{-4}). Individual TR values range between an excess upperbound lifetime risk of 1 in 10,000 (10^{-4}) and 1 in 1,000,000 (10^{-6}). The cumulative excess lifetime cancer risk (TR) used in Table 3-1 is 1 in 100,000 (10^{-5}) For systemic toxicants, the target hazard index (THI) for a single constituent is 1. The cumulative hazard index, i.e., the sum of the THIs for single or multiple systematic toxicants which affect the same organ or act by the same method of toxicity, cannot exceed 1. Due to these cumulative limits, the individual TR and THI values were reduced for some constituents, as shown at the bottom of Table 3-1.

3.2 COMPARISON OF SITE CONSTITUENT CONCENTRATIONS TO CALCULATED MEDIA CLEANUP LEVELS FOR RRS 3

The maximum detected concentrations of constituents in surface soil at the FTA-2 were all below the calculated media cleanup levels of RRS 3, as shown in Table 3-2.

TABLE 3-1

CURRENT EXPOSURE
TYPE 3 MEDIA CLEANUP LEVELS FOR SOIL
USING SITE-SPECIFIC ASSUMPTIONS
Naval Air Station Fort Worth Joint Reserve Base, Carswell Field
Fort Worth, Texas

Parameter	Chronic Reference Dose Oral (mg/kg/day)	Cancer Slope Factor Oral (mg/kg/day)-1	Target Organ	Source	Type 3 Standard (mg/kg) Construction Worker Carcinogenic	Noncarcinogenic
INORGANICS:						
Aluminum	1.00E+00	NA	Nervous System	ECAO	NA	9204018
Arsenic	3.00E-04	1.50E+00	Skin	IRIS	172	8367
Barium	7.00E-02	NA	Blood	IRIS	NA	488092
Beryllium	5.00E-03	4.30E+00	No Adverse Effects	IRIS	60	46020
Calcium	NA	NA			NA	NA
Cadmium	1.00E-03	NA	Kidney	IRIS	NA	13945
Cobalt	6.00E-02	NA	Lung	ECAO	NA	1673458
Chromium	5.00E-03	NA	No Adverse Effects	IRIS	NA	46020
Copper	3.71E-02	NA	Gastrointestinal	HEAST	NA	1034755
Iron	NA	NA			NA	NA
Lead	NA	NA			NA	NA
Magnesium	NA	NA			NA	NA
Manganese	1.40E-01	NA	Nervous System	IRIS	NA	1288562
Nickel	2.00E-02	NA	Body Weight	IRIS	NA	278910
Potassium	NA	NA			NA	NA
Selenium	5.00E-03	NA	Blood	IRIS	NA	34864
Silicon	NA	NA			NA	NA
Sodium	NA	NA			NA	NA
Vanadium	7.00E-03	NA	No Adverse Effects	HEAST	NA	64428
Zinc	3.00E-01	NA	Blood	IRIS	NA	2091822
SEMI-VOLATILES:						
bis(2-Ethylhexyl)phthalate	2.00E-02	1.40E-02	Liver	IRIS	6671	101079
Di-n-octyl phthalate	2.00E-02	NA	Kidney, Liver	IRIS	NA	101079
Dibenzofuran	4.00E-03	NA	Blood	ECAO	NA	10108
2-Methylnaphthalene	NA	NA			NA	NA
4-Methylphenol	5.00E-03	NA	Nervous System, Body Weight	IRIS	NA	16678
Naphthalene	4.00E-02	NA	Body Weight	Withdrawn from IRIS	NA	202158
Phenol	6.00E-01	NA	Fetal Development	IRIS	NA	6064737

TABLE 3-1

CURRENT EXPOSURE
TYPE 3 MEDIA CLEANUP LEVELS FOR SOIL
USING SITE-SPECIFIC ASSUMPTIONS
Naval Air Station Fort Worth Joint Reserve Base, Carswell Field
Fort Worth, Texas

Equation (Noncarcinogens):

$$C = \frac{THI \times BW \times AT}{EF \times ED \times CF} \times \left[\frac{RfD}{IR \times FI} + \frac{RfD}{SA \times AF \times ABS} \right]$$

Equation (Carcinogens):

$$C = \frac{TR \times BW \times AT}{EF \times ED \times CF} \times \left[\frac{1}{IR \times FI \times CSF} + \frac{1}{SA \times AF \times ABS \times CSF} \right]$$

Where:

THI = Target Hazard Index =	1 for skin, lung, gastrointestinal, and fetal development
	0.5 for liver, body weight, and kidney
	0.33 for central nervous system and no adverse effects
	0.25 for blood
BW = Body Weight =	70 kg
AT = Averaging Time =	9,125 days for Noncarcinogens; 25,550 days for Carcinogens
EF = Exposure Frequency =	39 day/year
ED = Exposure Duration =	25 years
CF = Conversion Factor =	1E-06 kilograms/milligram
IR = Ingestion Rate =	100 milligrams/day
FI = Fraction Ingested =	1 unitless
SA = Surface Area of Exposed Skin =	3,070 square centimeters / day
AF = Soil to Skin Adherence Factor =	1 milligrams / square centimeter
ABS = Absorption Factor =	0.01 for metals; 0.06 for semi-volatiles
RfD = Oral Reference Dose =	Chemical Specific
TR = Target Risk =	3.3E-06 for Carcinogens
CSF = Oral Cancer Slope Factor =	Chemical Specific

Source: IRIS - Integrated Risk Information System, USEPA (IRIS, 1995).
HEAST - Health Effects Assessment Summary Table FY1994, USEPA (HEAST, 1994).
ECAO - Environmental Criteria and Assessment Office, USEPA (ECAO, 1995).

PREPARED/DATE: EFC/10-27-95
CHECKED/DATE: WJM/10-27-95

TABLE 3–2

COMPARISON OF DETECTED SURFACE SOIL CONCENTRATIONS TO TYPE 3 MEDIA CLEANUP LEVELS (mg/kg)
Naval Air Station Fort Worth Joint Reserve Base, Carswell Field
Fort Worth, Texas

Parameter	Maximum Detected Concentrations (mg/kg)	Type 3 Risk Reduction Standard Values (mg/kg) Noncarcinogenic Effect	Carcinogenic Effect
SEMI–VOLATILES:			
bis(2–Ethylhexyl)phthalate	0.53	100,000	6,671
Di–n–octyl phthalate	0.15	100,000	NA
Dibenzofuran	0.17	10,000	NA
2–Methylnaphthalene	8.7	NA	NA
4–Methylphenol	4.2	17,000	NA
Naphthalene	3.9	200,000	NA
Phenol	0.5	6,100,000	NA
INORGANICS:			
Aluminum	13,000	9,200,000	NA
Arsenic	30	8,400	172
Barium	86	490,000	NA
Beryllium	0.7	46,000	60
Calcium	41,000	NA	NA
Cadmium	0.6	14,000	NA
Cobalt	4.6	1,700,000	NA
Chromium	14	46,000	NA
Copper	3.4	1,000,000	NA
Iron	12,000	NA	NA
Lead	16	NA	NA
Magnesium	1,700	NA	NA
Manganese	250	1,300,000	NA
Nickel	10	280,000	NA
Potassium	1,100	NA	NA
Selenium	50	35,000	NA
Silicon	350	NA	NA
Sodium	74	NA	NA
Vanadium	30	64,000	NA
Zinc	18	2,100,000	NA

NA – Not available

PREPARED/DATE: EFC/10–27–95
CHECKED/DATE: WJM/10–27–95

4.0 CONCLUSIONS AND RECOMMENDATIONS

This document shows that closure under RRS 3 (with no additional removal) is appropriate for the subject area, for the following reasons:

- Cross-media contamination from soil to air or soil to surface water is unlikely because there has been remediation of surface soils, and because soils are covered by grass.
- Concentrations of constituents in surface soil at the FTA-2 do not exceed the calculated media cleanup levels using site-specific exposure scenarios.
- Constituents of concern in subsurface soils at the FTA-2 are not a concern provided that deed restrictions are established to prevent soil excavation.

Based on the information provided in this report, LAW recommends closure of the FTA-2.

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FINAL PAGE

ADMINISTRATIVE RECORD

FINAL PAGE

FINAL PAGE

ADMINISTRATIVE RECORD

FINAL PAGE