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THE MEMPHIS DEPOT
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Human Health and Ecological Risk Assessment Approach at the Depot, Dunn Field

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1.0 Introduction

A baseline human health and ecological risk assessment will be conducted at the Depot's Dunn Field, following U.S. Environmental Protection Agency (EPA) and State of Tennessee guidance. The risk assessment will document the potential adverse effects to human health and the environment, under both current and future land-use conditions. The results of this risk assessment will serve as the basis for site decisions by the site risk managers. Following the precedent set by the Main Installation Risk Assessment, RAGS Part D formatting for human health risk tables will not be implemented at Dunn Field.

The human health risk assessment approach at Dunn Field is conceptually similar to that currently being conducted at the Main Installation but differs in implementation due to differences in the nature of environmental contamination. As further discussed in Section 2.1, three areas are defined within Dunn Field corresponding to areas of common waste disposal practices evident from historical waste management information and results of geophysics and soil gas screening analysis. These disposal areas are analogous to the Main Installation's Functional Unit concept.

Thirty-seven individual known or potential waste management sites have been identified at Dunn Field. As further discussed herein, geophysical analysis and soil gas screening indicated that materials and organic contamination that were disposed of did not correlate well with the mapped locations of these sites. Therefore, the investigation at Dunn Field focused on areas of elevated screening parameters. As discussed in Section 2.3, these areas, as further delineated with soil sampling, comprise the candidate surrogate "sites" that are evaluated within each of the three Dunn Field disposal areas. An area of elevated contamination within Dunn Field is analogous to an individual waste management site at the Main Installation.

2.0 Human Health Risk Assessment Approach

This section discusses the general approach for the human health risk assessment to be conducted at Dunn Field. The specific details of the exposure scenarios, complete pathways, exposure assumptions, land use, acceptable risk levels, and so forth are presented within this memorandum for review by EPA, the Tennessee Department of Environment and

Conservation (TDEC), and the Defense Logistics Agency (DLA). The risk assessment will use methods recommended by the EPA guidance (listed below) and other applicable regional EPA (Region IV) and Tennessee state guidances:

- EPA, 1989. *Risk Assessment Guidance for Superfund (RAGS), Volume I, Human Health Evaluation Manual (Part A).* EPA/540/1-89/002.
- EPA, 1989. *Risk Assessment Guidance for Superfund (RAGS), Volume II, Environmental Evaluation Manual.* EPA-540/1-89/001.
- EPA, 1990. *Guidance for Data Usability in Risk Assessment.* EPA/540/G-90/008.
- EPA, 1997. *Exposure Factors Handbook.* August 1997. //www.epa.gov/ncea/exposfac.htm.
- EPA, 1998. *Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part D, Standardized Planning, Reporting, and Review of Superfund Risk Assessments).* Publication 9285.7-01D. January 1998.

The human health risk assessment will include the following major components in the evaluation process:

- Spatial extent of risk assessment
- Identification of contaminants of potential concern (COPCs)
- Exposure assessment
- Toxicity assessment
- Risk characterization

A conceptual site model will be developed to present an overview of site conditions and to identify potential migration pathways, receptors, and exposure routes. This will serve as the basis for the exposure pathway evaluations in the human health and ecological risk assessments.

As appropriate for risk management decision-making purposes, a discussion of remedial goal options (RGOs) will be included for the sites that present excess risk or hazard,.

2.1 Spatial Extent of Risk Assessment

As documented in the Final Field Sampling Addendum for Operable Unit 1 (CH2M HILL, March 1999), geophysics and soil gas analysis at Dunn Field identified areas of contamination that did not always correlate spatially with the individual disposal sites documented in the Operable Unit 1 Field Sampling Plan. As a result, the environmental assessment in Dunn Field was performed in general areas corresponding to soil gas or geophysical anomaly(ies) rather than the individual suspected disposal sites. Based on common expected future land use and past practices, separate risk assessments will be performed for each of the following three sites (see Figure 1).

Northeast Open Area – The Northeast Open Area consists of the mowed forested area in the northeast corner of Dunn Fields, and contains Areas G and H identified in the OU-1 sampling plan addendum, as well as Site 21 (Pistol Range), Site 50 (Dunn Field Northeast Quadrant Drainage Ditch), and Site 60 (Pistol Range Impact Area and

Bullet Stop). The Memphis Depot Redevelopment Plan (Pathfinders, 1997) identified this area as future public open space for recreational purposes.

Disposal Area – The Disposal Area consists of the pits and trenches in the northwest portion of Dunn Field, including the mustard gas neutralization pits, Site 24 (Former Burn Site). This area corresponds to areas A through F identified in the OU-1 sampling plan addendum. The past disposal practices within the Disposal Area are subsurface disposal of hazardous and nonhazardous waste materials including Chemical Warfare Material (CWM) constituents and neutralization byproducts. The anticipated land use within this area is light industrial (Pathfinders, 1997).

Stockpile Area – The Stockpile Area is the aboveground bauxite and fluorspar storage areas: Sites 62, 63, and 64. Past practices in this area were generally aboveground storage of mineral ores and other materials. Subsurface disposal has not been documented. Similar to the Disposal Area, the anticipated land use within this area is also light industrial (Pathfinders, 1997).

2.2 Identification of Contaminants of Potential Concern

Existing analytical data from each of the sites will be evaluated for a quantitative risk assessment. Data are in electronic form and have undergone a process of data quality evaluation. The COPCs that represent site conditions will be selected using the monitoring data from each site. The selection process will include chemicals that are a direct exposure concern and chemicals that may be of interest from migration to groundwater, air, and/or surface water bodies.

The groundwater data from unfiltered samples will be used for quantitative risk assessment. Any filtered samples will be used to assess the potential migration in the aquifer.

2.3 Exposure Assessment

An exposure assessment will be used to evaluate the potential exposure to the site media and to identify the potential receptor population for each site. The exposure assessment will be conducted to identify potential exposure pathways for human receptors, to assess the potential routes of exposure, and to document the behavior of the assumed receptor into exposure factors for quantitation of the potential exposure. The specific assumptions will be discussed with the risk assessors from reviewing agencies prior to inclusion in the quantitative risk assessments. A conceptual site model will be developed to identify the source, the migration pathways, and the potential receptors at each site.

The site and its surrounding land use will be documented in the best possible manner, as the onsite land use is subject to change in the near future due to planned property leasing. The offsite well information will be documented based on the available information from local government records. Land-use assumptions for current and future land uses at each site and area surrounding Dunn Field will be discussed. Because the future land use may be unlimited, a default residential scenario will be evaluated for each site. Although a residential scenario will be evaluated, its applicability for the site management decisions shall be carefully assessed. Because the majority of Dunn Field is planned to be industrial, a default future industrial scenario will also be evaluated.

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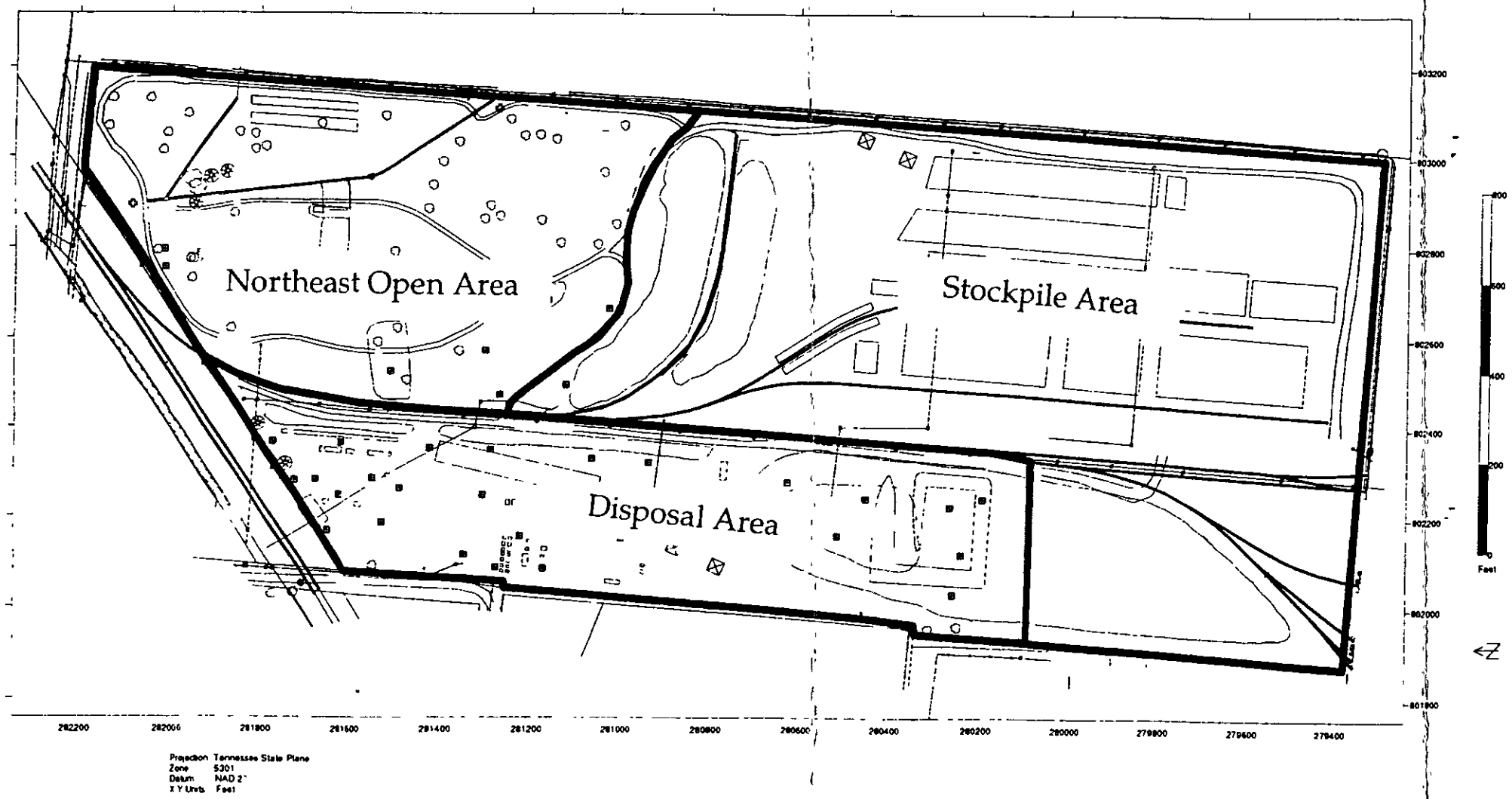
Figure 1

Dunn Field Risk Assessment

Defense Distribution Depot
Memphis, Tennessee



Tables 1, 2, and 3 present a preliminary list of the default exposure factors that will be used in the future industrial and residential exposure scenario risk estimations. Additionally, current exposure scenarios will include a site-specific most likely use scenario and will be evaluated for each site, as appropriate. A recreational scenario will be evaluated for the Northeast Open Area.

A minimum of one site-specific and one default future exposure scenario will be evaluated using the site-specific land-use information for each site. Fate and transport of the COPCs identified for each medium will be evaluated, and discussions will be provided. Much of the fate and transport discussions will be qualitative, although quantitative modeling may be employed to evaluate transport of the offsite groundwater plume at Dunn Field.

The dose (chronic daily intakes [CDIs]) will be estimated using exposure point concentrations (EPCs) for each receptor and exposure route for the identified complete exposure pathways. Exposure pathways for risk assessment will be selected based on the site activities and surrounding area and the conceptual site model developed prior to risk assessment. Exposure pathways to be quantified will be determined in accordance with EPA guidance and will include the direct exposure pathways to soil, groundwater, sediments, and surface water as necessary. Appropriate representative exposure pathways will be included for quantitative analysis and other potentially complete, less conservative pathways will be discussed qualitatively.

The EPCs will be the upper 95 percent confidence limit estimates on the mean concentrations (UCL95). The non-detect samples will be included at half the detection limit levels in these UCL95 estimates. These estimations will be performed using the underlying data distributions (normal versus log-normal) according to the EPA guidance. The lower of the maximum detected concentration and the UCL95 estimated will be selected as the EPC.

Within each of the three areas described in Section 2.1, risk assessment will be performed for three exposure scenarios:

1. The potential residential exposure scenario will be evaluated in a manner similar to that performed for the Main Installation. A ½-acre lot will be positioned in the most conservative configuration that intersects samples with the highest concentrations of COPCs. The risk assessment will be performed using maximum concentrations at these intersected sample locations.

2. The industrial scenario will be evaluated using all data within each area. A UCL95 will be calculated using all surface and subsurface data within each of the three geographic areas.

3. The industrial scenario will be evaluated for the worst-case "site" within each geographic area. The "site" will not be composed of the disposal sites as described in the Operable Unit 1 Field Sampling Plan, but surface and subsurface soil areas containing elevated chemical concentrations. Although a Preliminary Risk Evaluation (PRE) was performed for the Main Installation risk assessment, a PRE was not performed for Dunn Field. Therefore, these risks are not available to identify sample locations of elevated risk. As a means to identify sample locations with maximum risk, for each sample the ratio between the chemical concentration and the Region III Risk-Based Criteria (RBC) will be calculated and summed separately for carcinogenic and non-carcinogenic

Table 1
Exposure Factors for Soil
Memphis Depot Main Installation RI
Dunn Field

Symbols	Parameter	FUTURE									
		Maintenance Worker		Utility Worker		Industrial Worker		Onsite Resident (Adult)		Onsite Resident (Child)	
BW	Body Weight (kg)	70	a	70	a	70	a	70	a	15	a
IR_Inh	Inhalation Rate (m^3/day)	20	a	20	a	20	a	20	a	15	a
IR_Inh_adj	Inhalation Rate_ age-adjusted	N/A		N/A		N/A		12 86	a,m	N/A	
AT_C	Averaging Time - Carcinogenic	70x365	a	70x365	a	70x365	a	70x365	a	N/A	a
AT_NC	Averaging Time - Noncarcinogenic	25x365	a	25x365	a	25x365	a	30x365	a	6x365	a
	Soils										
IR_Ing	Incidental Ingestion Rate (mg/day)	50	p	100	p	50	p	100	p	200	p
IR_adj_Ing	Age-adjusted Incidental Ingestion Rate (mg/day)	N/A		N/A		N/A		114 29	p,n	N/A	
FI	Fraction Ingested	0 5	b	0 5	b	1	b	1	b	1	b
SA	Skin Surface Area (cm^2)	2,679	c	2,679	c	2,679	c	5,049	d	2,351	e
SA_adj	Age-adjusted Skin Surface Area (cm^2)	N/A		N/A		N/A		2,671	d,o	N/A	
AF	Adherence Factor for dry soil (mg/cm^2)	0 03	f	0 1	g	0 03	f	0 03	f	0 15	h
PEF	Particulate Emission Factor (m^3/kg)	1 32E+09	i	1 32E+09	i	1 32E+09	i	1 32E+09	i	1 32E+09	i
ET	Exposure Time (hours/day)	8	a	8	a	8	a	4	j	4	j
EF	Exposure Frequency (days/year)	50	k	24	l	250	a	350	a	350	a
ED	Exposure Duration (years)	25	a	25	a	25	a	30	a	6	a

Notes

All current scenario exposure factors are subject to re-evaluation based on site-specific information

a Default exposure factors adapted from EPA, Human Health Evaluation Manual Supplemental Guidance "Standard Default Exposure Factors" OSWER Directive 9285 6-03 March 25 1991

b Fraction injested assumed by the nature of the activity

c Worker soil exposure is adapted from EPA Exposure Factor Handbook, August 1997 & is protective of 1/2 head (face), hands & forearms (see Appendix G)

d Residential adult soil exposure is adapted from EPA Exposure Factor Handbook August 1997 & is protective of 1/2 head (face), hands forearms & lower legs (see Appendix G)

e Residential child soil exposure is adapted from EPA Exposure Factor Handbook, August 1997 & is protective of 1/2 head (face), hands forearms, lower legs & feet (see Appendix G)

f 0 03 = Groundskeeper No 2 (exposure scenarios similar to urban horticulture center, campus grounds, arboretum) AFs chosen from Soil Loading calculations (see Appendix G)

g 0 1 = Construction Worker (heavy digging, exposure to mixed bare earth concrete surfaces dust & debris) AFs chosen from Soil Loading calculations (see Appendix G)

h 0 15 = Daycare Kids No 1b (indoor exposure to linoleum; outdoor exposure to grass bare earth, no shoes) AFs chosen from Soil Loading calculations (see Appendix G)

i PEF adapted from EPA 1996, Soil Screening Guidance Technical Background Document

j 4 hours soil exposure are assumed for residential dermal contact and inhalation exposure time

k Worker soil exposure is assumed to be once a week per year minus vaction time

l Worker soil exposure is assumed to be twice a month

m Age-adjusted inhalation rate for residential adult

$$IR\text{-}Inh\ adj = \frac{IR\ Inhc \times EDc}{BWc} + \frac{IR\ Inha \times (EDa - EDc)}{BWa} = \frac{15 \times 6}{15} + \frac{20 \times (30-6)}{70} = 12\ 86\ (m^3\text{-year})/(kg\text{-day})$$

n Age-adjusted ingestion rate for residential adult:

$$IRadj = \frac{IRc \times EDc}{BWc} + \frac{IRa \times (EDa - EDc)}{BWa} = \frac{200 \times 6}{15} + \frac{100 \times (30-6)}{70} = 114\ 29\ (mg\text{-year})/(kg\text{-day})$$

o Age-adjusted dermal contact for residential adult

$$SAadj = \frac{SAc \times EDc}{BWc} + \frac{SAa \times (EDa - EDc)}{BWa} = \frac{2351 \times 6}{15} + \frac{5049 \times (30-6)}{70} = 2671\ (cm^2\text{-year})/(kg)$$

p Ingestion rates adapted from EPA Supplemental Guidance to RAGS Region 4 Bulletins Human Health Risk Assessment Interim, November 1995

cm^2	centimeters squared
days/year	days per year
hours/day	hours per day
kg	kilograms
m^3/day	cubic meters per day
m^3/kg	cubic meters per kilogram
mg/cm^2	milligrams per centimeters squared
mg/day	milligrams per day
N/A	Not applicable for this receptor

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Table 2

Exposure Factors for Sediment and Surface Water

Memphis Depot Main Installation RI

Dunn field

Symbols	Parameter	FUTURE											
		Maintenance Worker		Industrial Worker - ponds		Industrial Worker - sumps/ditches		Residential/ Recreational (Adult)		Residential/ Recreational (Youth)		Residential/ Recreational (Child)	
BW	Body Weight (kg)	70	a	70	a	70	a	70	a	45	a	15	a
IR_Inh	Inhalation Rate (m^3/day)	20	a	20	a	20	a	20	a	20	a	15	a
AT_C	Averaging Time - Carcinogenic	70x365	a	70x365	a	70x365	a	70x365	a	70x365	a	N/A	
AT_NC	Averaging Time - Noncarcinogenic	25x365	a	25x365	a	25x365	a	30x365	a	10x365	a	6x365	a
	Surface Water												
IR_Ing_w	Incidental Ingestion - Wading (L/hour)	0 01	b	0 01	b	0 01	b	N/A		N/A		N/A	
IR_Ing_s	Incidental Ingestion - Swimming (L/hour)	N/A		N/A		N/A		0 05	c	0 05	c	0 05	c
SA_w	Skin Surface Area - Wading (cm^2)	2 679	d	2,679	d	2,679	d	N/A		N/A		N/A	
SA_s	Skin Surface Area -Swimming (cm^2)	N/A		N/A		N/A		20,000	e	13,118	f	6,557	p
ET	Exposure -Time (hours/day)	4	g	4	g	1 or 2	r	6	h	6	h	6	h
EF	Exposure Frequency (days/year)	12	i	50	s	50	s	45	j	45	j	45	j
ED	Exposure Duration (years)	25	a	25	a	25	a	30	a	10	j	6	a
	Sediments												
IR_Ing	Incidental Ingestion - Wading (mg/day)	50	k	50	k	50	k	100	k	100	k	200	k
FI	Fraction Ingested	1	l	1	l	1	l	1	l	1	l	1	l
SA	Skin Surface Area - Wading (cm^2)	2,679	d	2,679	d	2,679	d	5 671	m	4,785	n	1,851	q
AF	Adherence Factor for wet soil (mg/cm^2)	0 1	o	0 1	o	0 1	o	0 1	o	0 1	o	0 1	o
ET	Exposure Time (hours/day)	4	g	4	g	1 or 2	r	6	h	6	h	6	h
EF	Exposure Frequency (days/year)	12	i	50	s	50	s	45	j	45	j	45	j
ED	Exposure Duration (years)	25	a	25	a	25	a	30	a	10	j	6	a

Notes	All current scenario exposure factors are subject to re-evaluation based on site-specific information
a	Default exposure factors adapted from EPA, Human Health Evaluation Manual, Supplemental Guidance "Standard Default Exposure Factors" OSWER Directive 9285 6-03, March 25, 1991
b	Surface water ingestion while wading adapted from Supplemental Guidance to RAGS Region 4 Bulletins, Human Health Risk Assessment, Interim, November 1995
c	Surface water ingestion while swimming adapted from Supplemental Guidance to RAGS Region 4 Bulletins, Human Health Risk Assessment, Interim, November 1995
d	Worker surface water/sediment exposure is adapted from EPA Exposure Factor Handbook, August 1997 & is protective of 1/2 head (face), hands & forearms (see Appendix G)
e	Recreational adult total body surface area is adapted from EPA Exposure Factor Handbook, August 1997 & is protective of all body parts (see Appendix G)
f	Recreational youth total body surface area is adapted from EPA Exposure Factor Handbook, August 1997 & is protective of all body parts (see Appendix G)
g	4 hours surface water/sediment exposure are assumed for workers based on the nature of the activities
h	6 hours surface water/sediment exposure are assumed for recreational adults/youths based on the nature of the activities
I	Maintenance Worker surface water/sediment exposure is assumed to be once a month
j	Recreational factors adapted from Supplemental Guidance to RAGS Region 4 Bulletins, Human Health Risk Assessment, Interim, November 1995
k	Sediment ingestion rates adapted from Supplemental Guidance to RAGS Region 4 Bulletins, Human Health Risk Assessment, Interim, November 1995
l	Fraction Ingested assumed by the nature of the activity
m	Recreational adult sediment exposure is adapted from EPA Exposure Factor Handbook, August 1997 & is protective of hands, forearms, lower legs & feet (see Appendix G)
n	Recreational youth sediment exposure is adapted from EPA Exposure Factor Handbook, August 1997 &is protective of hands, forearms, lower legs & feet (see Appendix G)
o	0 1 = Construction Worker (heavy digging, exposure to mixed bare earth, concrete surfaces dust & debris) AFs chosen from Soil Loading calculations (see Appendix G)
p	Recreational child total body surface area is adapted from EPA Exposure Factor Handbook, August 1997 & is protective of all body parts (see Appendix G)
q	Recreational child sediment exposure is adapted from EPA Exposure Factor Handbook, August 1997 & is protective of hands, forearms, lower legs & feet (see Appendix G)
r	1-2 hours exposure to sump (1) or ditch (2) sediment is assumed for workers based on the nature of the activities
s	Industrial Worker surface water & sediment exposure (sump, ditch or impoundment) is assumed to be once a week
cm^2	centimeters squared
days/year	days per year
hours/day	hours per day
kg	kilograms
L/hour	liters per hour
m^3/day	cubic meters per day
m^3/kg	cubic meters per kilogram
mg/cm^2	milligrams per centimeters squared
mg/day	milligrams per day
N/A	Not applicable for this receptor

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Table 3

Exposure Factors for Groundwater

Memphis Depot ~~Main Installation~~ RI

Dunn Field

Symbols	Parameter	FUTURE Industrial Worker		FUTURE Onsite Resident (Adult)		FUTURE Onsite Resident (Child)	
BW	Body Weight (kg)	70	a	70	a	15	a
IR_Inh	Inhalation Rate (m^3/day)	*		*		*	
AT_C	Averaging Time - Carcinogenic	70x365	a	70x365	a	N/A	
AT_NC	Averaging Time - Noncarcinogenic	25x365	a	30x365	a	6x365	a
	Groundwater						
IR_Ing	Ingestion Rate of Water (L/day)	1	a	2	a	1	a
IR_adj_Ing	Age-adjusted Incidental Ingestion Rate (L/day)	N/A		1 1	a,f	N/A	
SA	Skin Surface Area (cm^2)	2679	b	20,000	c	6,557	d
SA_adj	Age-adjusted Skin Surface Area (cm^2)	N/A		9480	c,g	N/A	
ET	Exposure Time (hours/day)	0 007	e	0 007	e	0 007	e
EF	Exposure Frequency (days/year)	250	a	350	a	350	a
ED	Exposure Duration (years)	25	a	30	a	6	a

Notes:

* Inhalation exposures to volatiles in the groundwater are equal to the ingestion exposures as per EPA Region IV policy

a Default exposure factors adapted from EPA, Human Health Evaluation Manual, Supplemental Guidance "Standard Default Exposure Factors" OSWER Directive 9285 6-03, March 25, 1991

b Worker groundwater exposure is adapted from EPA Exposure Factor Handbook, August 1997 & is protective of 1/2 head (face), hands & forearms (see Appendix G)

c Residential adult total body surface area is adapted from EPA Exposure Factor Handbook, August 1997 & is protective of all body parts (see Appendix G)

d Residential child total body surface area is adapted from EPA Exposure Factor Handbook, August 1997 & is protective of all body parts (see Appendix G)

e Calculation for Shower dermal exposure time 10 minute event x 1 hour/60 minutes x 1 day/ 24 hours = 0 007 event/day

f Age-adjusted ingestion rate for residential adult $IRadj = \frac{IRc \times EDc}{BWc} + \frac{IRa \times (EDa - EDc)}{BWa} = \frac{1 \times 6}{15} + \frac{2 \times (30-6)}{70} = 1\ 09$ *(L-year)/(kg-day)*

g Age-adjusted dermal contact for residential adult $SAadj = \frac{SAc \times EDc}{BWc} + \frac{SAa \times (EDa - EDc)}{BWa} = \frac{6557 \times 6}{15} + \frac{20000 \times (30-6)}{70} = 9480$ *(cm^2-year)/(kg)*

cm^2	centimeters squared
days/year	days per year
hours/day	hours per day
kg	kilograms
L/day	liters per day
m^3/day	cubic meters per day
N/A	Not applicable for this receptor

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compounds. These ratios will be evaluated and areas containing samples with elevated ratios will be identified. These areas will constitute worst-case "sites" within each of the three geographic areas for evaluation of industrial exposure.

Both surface and subsurface soils will be evaluated for human health exposure. Subsurface soils within the uppermost 10 feet will be evaluated for direct exposure during excavation. In addition, exposures to vapor inhalation at the surface and within building foundations will also be evaluated.

As shown in Figure 2, there are two distinct groundwater plumes within Dunn Field: the main plume emanating from sources located in the northwest corner and a secondary plume along the northern perimeter. Both plumes have an offsite component, although the offsite component of the main plume is more extensive. For organic chemicals that behave in a plume-like manner, within each of the two plumes an average of the three highest detected concentrations will be selected as the EPC. For chemicals that are not distributed in distinct plumes, typically inorganics, the average of the three maximum values for all Dunn Field groundwater will be used as the EPC. Groundwater is currently being intercepted by the pumping system along the western edge of Dunn Field. Risks associated with potential exposure to this residual offsite plume will be evaluated using the average of the three maximum concentrations within the offsite plume.

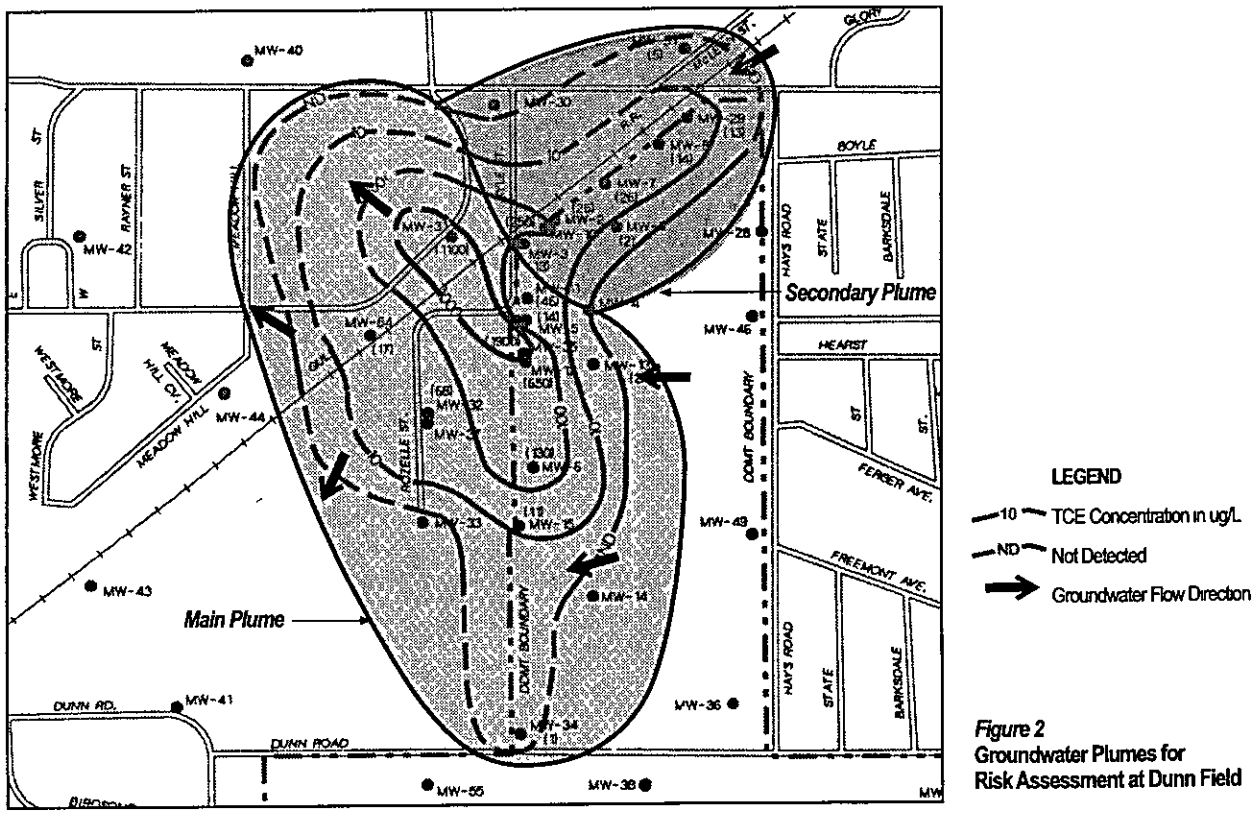

Figure 2
Groundwater Plumes for Risk Assessment at Dunn Field

A fate and transport evaluation will include discussion of environmental behavior of the COPCs identified during the nature and extent investigations in the surface and subsurface soils, sediment, and surface water, as well as potential impacts to site groundwater.

The behavior of the chemicals shall be determined by both individual chemical properties, as well as by facility characteristics including water flow velocity, soil permeability, infiltration, temperature, and presence of conditions that support microbial population. Potential pathways—including air emissions, transport, or persistence—shall be assessed in accordance with site-specific information and chemical properties. Fate and transport evaluation will include potential offsite impacts from the site contaminants by evaluating the site COPCs and their potential for offsite migration through groundwater or surface runoff or volatilization from the site media. This will be a qualitative evaluation. The groundwater monitoring data will serve as the indicator for quantitative assessment of the potential migration. No quantitative modeling will be performed as part of this fate and transport evaluation.

2.4 Toxicity Assessment

The human health evaluation will include a toxicity assessment section that compiles the toxicity criteria for risk and hazard index estimates. The toxicity criteria will be obtained from the EPA toxicity databases (i.e., Integrated Risk Information System [IRIS] and Health Effects Assessment Summary Tables [HEAST]). Any interim values from EPA available through other sources (e.g., EPA Region III RBC tables) will be used in the absence of a value in the EPA toxicity databases. Uncertainties associated with the toxicity criteria estimations will be discussed. The target organs for the selected toxicity factors will be selected from the existing toxicity databases, as suggested by EPA. The toxicity equivalency factors (TEFs) will be used for polycyclic aromatic hydrocarbons (PAHs) and dioxins as appropriate. Three sets of toxicity factors are available for polychlorinated biphenyls (PCBs). The conservative set of toxicity factors will be used for risk estimations.

2.5 Risk Characterization

The exposure and toxicity information from the previous sections will be integrated in this section to estimate the potential risks and Hazard Indices (HIs). The estimated risks and HIs represent the site (area) being investigated for site-specific risk management decisions. The cumulative risks and HIs will be compared against the acceptable risk ranges. Summary and conclusions will be provided for each of the receptor populations and sites. Risks will be totaled by medium, and combined risks across media and pathways will be presented as appropriate.

3.0 Ecological Risk Assessment Approach

An ecological risk assessment (ERA) will be conducted to document the potential adverse effects to the environment as a result of contamination present at Dunn Field. The EPA's program guidance for ecological risk assessments, *Ecological Risk Assessment Guidance for Superfund, Process for Designing and Conducting Ecological Risk Assessments*. Interim Final, June 5, 1997 (EPA 540-R-97-006), will be the primary ERA guidance. The stepwise process outlined in this guidance will serve as the basic framework for the ERA portion of the Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI). Steps 1, 2, and 3 of the guidance will be followed in the RFI; these are outlined below.

3.1 Step 1 – Screening-Level Problem Formulation and Ecological Effects Evaluation

This is the initial step in the ERA and will include all the elements of a problem formulation and ecological effects analysis but on a screening level. The results of this step will support the exposure estimates and risk calculation in Step 2 (which follows).

3.1.1 Screening-Level Problem Formulation

For the screening-level problem formulation, a conceptual site model will be developed that addresses the five issues outlined below:

- **Environmental Setting and Contaminants at the Site.** An overall characterization of the environmental setting and chemical contamination will be developed from existing site reports, as well as from a completed site environmental checklist. Information will include onsite and offsite land uses, detected contaminants at the site, potential contaminant migration pathways, a description of natural or man-made ecological habitats (e.g., wetlands, impoundments), a description of observed or potentially occurring plant and animal species, and identification of any protected species or critical habitats.

- **Contaminant Fate and Transport.** Potential pathways for migration of site contaminants will be identified (e.g., surface water runoff and soil erosion). A list of detected contaminants in surface soil, surface water, and/or sediment will be identified, along with the maximum detected concentrations that will be used as ecological EPCs in the screening assessment.

- **Complete Exposure Pathways.** An evaluation of potential ecological exposure pathways will be conducted. For a pathway to be complete, a contaminant must travel from the source medium to an ecological receptor, and be taken up by the receptor by one or more exposure routes. Although ecological habitats are minimal in most portions of Dunn Field, a conservative approach will be used in this screening evaluation so that potential ecological risks are not missed. More realistic exposure assumptions will be considered later in Step 3, if needed.

- **Assessment and Measurement Endpoints.** Assessment endpoints, which are expressions of the environmental values to be protected, will be developed on the basis of those ecological exposure pathways considered potentially complete. Measurement endpoints are measurable ecological characteristics of the assessment endpoint. In this screening-level evaluation, the measurement endpoint will be the comparison of maximum EPCs to conservative screening level benchmarks.

3.1.2 Screening-Level Ecological Effects Evaluation

In this section, conservative thresholds for adverse ecological effects, or screening ecotoxicity values, will be presented for contaminants detected in each of the site media (surface water, sediment, and surface soil). These values will be as follows:

- **Surface Water.** The surface water ecotoxicity screening values will be chronic values obtained from EPA Region 4 Supplemental Guidance to RAGS: Region 4 Bulletins, Freshwater Surface Water Screening Values for Hazardous Waste Sites (EPA, 1995).

- **Sediment.** The sediment ecotoxicity screening values will be obtained from EPA Region 4 Supplemental Guidance to RAGS: Region 4 Bulletins, Sediment Screening Values for Hazardous Waste Sites (EPA, 1995).

Soil. The soil ecotoxicity values will be obtained from EPA Region 4, Draft Ecological Screening Levels for Soil from "Memorandum – Ecological Risk Assessment at Military Bases: Process Considerations, Timing of Activities, and Inclusion of Stakeholders," December 22, 1998.

3.1.3 Uncertainty Assessment

Uncertainty is inherent in each step of the screening-level ecological risk assessment. Professional judgment will be used to determine the uncertainty associated with information taken from the literature and any extrapolations used in developing screening ecotoxicity values.

3.2 Step 2 – Screening-Level Exposure Estimate and Risk Calculation

This step includes estimating exposure levels and screening for ecological risks as the last two phases of the screening-level ERA. At the end of Step 2, a scientific management decision point (SMDP) will be made to determine if ecological risks are negligible or if further evaluation is warranted.

3.2.1 Screening-Level Exposure Estimates

The maximum detected concentration of all chemicals detected in surface water, sediment, or soil at the Main Installation will be used as the EPC for estimating risk to aquatic fish, aquatic invertebrates, and directly exposed terrestrial organisms.

3.2.2 Screening-Level Risk Calculation

The quantitative screening-level risk estimate will be conducted using the Hazard Quotient (HQ) approach. This approach divides the EPCs with the screening ecotoxicity values. An HQ of less than 1 indicates that the contaminant is unlikely to cause adverse effects; therefore, these contaminants will not be assessed further. Contaminants with an HQ greater than or equal to 1 will be considered a potential ecological risk and will be carried forward as COPCs to Step 3, as will contaminants that do not have ecotoxicity screening criteria.

3.2.3 Scientific Management Decision Point

At the end of Step 2, a decision is made regarding whether the information available is adequate to make a risk management decision. The three possible decisions at this point include the following:

- There is adequate information to conclude that ecological risks are negligible and therefore no need for remediation on the basis of ecological risk.

- The information is not adequate to make a decision at this point, and the ERA process will continue to Step 3.

- The information indicates a potential for adverse ecological effects, and a more thorough assessment is warranted.

3.3 Step 3 – Baseline Risk Assessment Problem Formulation

Step 3 refines the problem formulation developed in the screening-level assessment. In this step, the results of the screening-level assessment and additional site-specific information are used to determine the scope and goals of the baseline ERA.

3.3.1 Refinement of Preliminary Constituents of Concern

Because of the conservative assumptions used during screening Steps 1 and 2, some COPCs retained for Step 3 may still pose negligible risk. Therefore, in this first phase of Step 3, further evaluation of the assumptions used and other site-specific information are considered to refine the COPCs. For example, the risk management team may agree to eliminate from further consideration those contaminants for which the HQs drop to near or below 1.

In this refinement phase, the revised assumptions and site-specific considerations to be used are as follows:

- Arithmetic average contaminant concentrations will be considered along with maximum concentrations.

- Contaminant concentrations will be compared to background.

- Frequency of detection will be considered.

- Acute, lowest observed adverse effect level (LOAEL) or other less conservative ecotoxicity screening values will be considered from the various literature sources used by EPA Region 4.

- Other literature sources of ecotoxicity screening values may be included where appropriate (e.g., if no ecotoxicity screening value was available in Step 2).

These additional considerations will be used to calculate a range of HQs as follows:

- Maximum versus chronic criteria /no observed adverse effect level (NOAEL)
- Maximum versus acute criteria /LOAEL
- Average versus chronic criteria /NOAEL
- Average versus acute criteria /LOAEL

Maximum and average values will also be compared to background concentrations.

In addition, the conservative ecological exposure pathways used in Step 2 will be reevaluated based on actual site conditions. All this information will provide a weight-of-evidence to determine which, if any, contaminants should be recommended for further evaluation in a baseline ERA. If there are no constituents or exposure pathways of concern

following the refinement process, an SMDP will be described indicating that ecological risks are negligible and, therefore, no remediation is needed on the basis of ecological risk.

If contaminants of concern remain following the Step 3 refinement process, further baseline risk evaluation needs to be completed within the remaining phases of Step 3, as well as all of Steps 4 through 8. These evaluations are outside the scope of this RI and would, therefore, be conducted separately.

4.0 Remedial Goal Options

The RGOs will be estimated for the pathway and the receptor that is identified to have excessive risks. Media with risks and HIs below the acceptable levels will not be further evaluated in this section. An RGO will be estimated for media presenting excess risk (e.g. $>10^{-4}$) or an unacceptable HI (>1.0). A quantitative cleanup level will not be estimated for the media presenting low human health or ecological risks. Concentrations will be compared with available applicable or relevant and appropriate requirements (ARARs), and discussion of remedial options by medium for each site will be provided.

4.1 Applicable or Relevant and Appropriate Requirements and To Be Considered Requirements

The existing ARARs and to be considered (TBC) requirements will be reviewed and modified, as necessary. ARARs and TBCs will be used to evaluate subsequent proposed remedial actions. Location-specific ARARs and activity-specific ARARs will be developed. Applicability of the ARARs and TBCs for these RCRA sites will be determined by site risk managers.

4. 2 Risk Based RGOs

For sites presenting excess human health or ecological risk, RGOs will be developed as per EPA Region IV guidance. A quantitative RGO will be calculated for those media and chemicals presenting excess cancer risk or HI above an acceptable risk range or HI value. Chemicals and media that represent low risks and HIs will not be included for an RGO estimation.

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