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TECHNICAL MEMORANUDUM REGARDING REVISION 1 GENERAL HUMAN HEALTH RISK ASSESSMENT APPROACH MILLINGTON SUPPACT TN

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ENSAFE ALLEN AND HOSHALL

EnSafe / Allen & Hoshall

a joint venture for professional services

Program Management Office
Shelby Oaks Plaza
5909 Shelby Oaks Dr.
Suite 201
Memphis, TN 38134
Phone (901) 383-9115
Fax (901) 383-1743

EnSafe/Allen & Hoshall Branch Offices:

Charleston
935 Houston Northcutt Blvd.
Suite 113
Mt. Pleasant, SC 29464
Phone (803) 884-0029
Fax (803) 856-0107

Cincinnati
400 TechneCenter Dr.
Suite 301
Milford, OH 45150
Phone (513) 248-8449
Fax (513) 248-8447

Pensacola
2114 Airport Blvd.
Suite 1150
Pensacola, FL 32504
Phone (904) 479-4595
Fax (904) 479-9120

Norfolk
303 Butler Farm Road
Suite 113
Hampton, VA 23666
Phone (804) 766-9556
Fax (804) 766-9558

Raleigh
5540 Centerview Drive
Suite 205
Raleigh, NC 27606
Phone (919) 851-1886
Fax (919) 851-4043

Nashville
311 Plus Park Blvd.
Suite 130
Nashville, TN 37217
Phone (615) 399-8800
Fax (615) 399-7467

Dallas
4545 Fuller Drive
Suite 326
Irving, TX 75038
Phone (214) 791-3222
Fax (214) 791-0405

TECHNICAL MEMORANDUM

TO: Mark Taylor/David Porter, SOUTHDIV
Tonya Barker/Rob Williamson, NSA Memphis
Brian Donaldson, USEPA
Jim Morrison, TDEC
Jack Carmichael, USGS
Brenda Duggar, MSCHD
E/A&H Project Team

FROM: Brian Mulhearn, E/A&H BM

DATE: February 4, 1997

RE: Revision 1 General Human Health Risk Assessment (HHRA) Approach for NSA Memphis

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This memorandum discusses the general HHRA approach for NSA Memphis and incorporates USEPA's suggestions received during the January 28, 1997 Base Realignment and Closure (BRAC) Cleanup Team meeting. This text will not be reproduced in subsequent HHRAs with the exception of the final report, where the text will be included as an appendix. Initially, HHRAs will include only site-specific information and will reference this memorandum, reducing the bulk necessary to present site-specific risk information to risk managers. Deviations from these general methods will be justified and discussed in site-specific HHRAs.

1 BASELINE RISK ASSESSMENT

1.1 Introduction

A baseline risk assessment (BRA) establishes a baseline of risk to facilitate risk management decisions. Risk is the estimated potential for toxic effects on actual or hypothetical human or ecological receptors, while baseline risk refers to risk arising from exposures to chemicals assuming site conditions remain unchanged. BRAs are used by risk managers to decide if remedial actions are necessary and to determine the extent of remediation necessary to reduce the risk to acceptable levels. Generally, a BRA is divided into two sections, one assessing human health risk, and a second addressing ecological risk. This section addresses generally applied HHRA methods, while ecological risk assessment methods will be addressed in the site-specific assessments. Data management and analysis methods which will be used to reach the conclusions of site-specific HHRAs are discussed below. The following sections describe the methods, procedures, considerations, toxicological information, and related uncertainties possibly affecting HHRAs at NSA Memphis.

1.2 Background

The site background will be summarized in this section of the site-specific HHRAs.

2 General Guidance

HHRAs will generally be prepared in accordance with the guidelines set forth in the following documents, although some may not apply to every site:

- *Provisional Guidance for Quantitative Risk Assessment of PAHs*, U.S. Environmental Protection Agency, ECAO-CIN-842, EPA/600/BP92/001C, July 1993.

- *Risk Assessment Guidance for Superfund (RAGS), Volume I — Human Health Evaluation Manual, Part A*, U.S. Environmental Protection Agency/Office of Emergency and Remedial Response (OERR), EPA/540/1-89/002, December 1989 (Interim).

2.1 Objectives

The objectives of the BRA will be to:

- Characterize the source media and determine the chemicals of potential concern (COPCs) for affected environmental media.

- Identify potential receptors and quantify their potential exposures under current and future conditions for all affected environmental media.

- Qualitatively and quantitatively evaluate the adverse effects associated with the site-specific COPCs in each medium.

- Characterize the baseline carcinogenic and noncarcinogenic risks associated with exposure to environmental media at the site(s) under current and future land use conditions.

- Evaluate the uncertainties related to exposure predictions, toxicological data, and resulting carcinogenic risk and noncarcinogenic hazard estimations.

- Establish Remedial Goal Options (RGOs) for chemicals of concern (COC) in each environmental medium based on risk/hazard to facilitate risk management decision-making.

The value of the risk assessment as a basis for making remedial decisions and determining whether detected site concentrations have the potential for toxic effects or increased cancer incidences depends upon adequately characterizing chemical contamination. Variables considered in characterizing the study area and its associated risk will include the amount, type, and location of sources; the pathways of exposure (media type and migration routes); and the

- *Uncertainty*: discussion and evaluation of the areas of recognized uncertainty in human health risk assessments in addition to medium - and exposure pathway-specific influences.

- *Risk/hazard summary*: presentation and discussion of the results of the quantification of exposure (risk and hazard) for the potential receptors and their exposure pathways identified under the current and future conditions.

- *RGOs*: computation of exposure concentrations corresponding to risk projections within the USEPA target risk range of 1E-6 to 1E-4 for carcinogenic COCs and hazard quotient goals of 0.1, 1, and 3 for noncarcinogenic COCs.

3 Site Characterization

When performing a HHRA, environmental media data are compiled to determine potential site-related chemicals and exposures as outlined in RAGS Part A. The steps identifying COPCs are discussed below.

3.1 Data Sources

The number of samples collected from each medium will be detailed in this section of the site-specific HHRAs, and tables will show which sample designations will be included and how data are grouped (when applicable). In addition, the analytical methods, the name of the analyzing laboratory, and data quality objectives will be referenced at this point in the HHRA.

3.2 Data Validation

Data validation is an after-the-fact, independent, systematic process of evaluating data and comparing them to established criteria to confirm they are of the technical quality necessary to support the decisions made in the RFI process. Parameters specific to the data are reviewed to determine whether they meet the stipulated DQOs. The quality objectives address five principal parameters: precision, accuracy, completeness, comparability, and representativeness. To

each "U" value will be compared to one-half of the lowest hit (normally "J" qualified) at the same site. The lesser of these two values will be used as the best estimate of the concentration potentially present below the sample quantitation limit, and will be inserted into the adjusted dataset. For inorganic chemicals, the rule is simpler: One-half of each "U" value will be used to represent the concentration of the corresponding sample when compiling the adjusted dataset. If two nondetects are reported for any one location (a result of QA/QC samples), one-half the lesser of the "U" values will be compared to the lowest hit at the site (for organics, as above) or applied directly (for inorganics) to estimate a concentration value to be used in the NSA Memphis risk calculations. If a parameter is not detected at a site, neither data management method will be applied, and the parameter will not be considered in screening or formal assessment.

Once the dataset is complete, statistical methods will be used to evaluate the analytical results to (1) identify COPCs and (2) establish exposure point concentrations (EPCs) at potential receptor locations. The statistical methods used in data evaluation are discussed below. The rationale used to develop this methodology and the statistical techniques is based on the following sources:

- RAGS Part A
- *Supplemental Guidance to RAGS: Calculating the Concentration Term*, May 1992
- *Statistical Methods for Environmental Pollution Monitoring* (Gilbert, 1987)

Microsoft Fox Pro and Borland[1] Quattro Pro will typically be used for data management and statistical calculations. For each set of data used to describe the concentration of chemicals in a contaminated area, the following information will be tabulated in accordance with RAGS: frequency of detection, range of quantitation limits, range of detected values, and average of

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1 *References to specific software products are not to be construed as an endorsement by the U.S. Navy or E/A&H.*

The maximum concentration reported for each carcinogenic polycyclic aromatic hydrocarbon (PAH) will be compared to its corresponding screening value. In addition, all carcinogenic PAH concentrations reported at that location will be converted to the benzo(a)pyrene equivalent concentration (BEQ), which will be compared to the screening value for benzo(a)pyrene. PAH conversions will be performed using current Toxic Equivalency Factors (TEFs) for PAHs in accordance with USEPA Region IV *Supplemental Guidance to RAGS Bulletin 2* (USEPA, November 1995).

3.4.2 Comparison of Site-Related Data to Background Concentrations

Background data for NSA Memphis will be referenced in this section, or background reference concentrations from E/A&H's August 27, 1996 *Reference Concentrations* technical memorandum will be used. Following comparison to risk- and hazard-based screening values, CPSSs whose maximum detected concentrations exceeded corresponding background reference concentrations will be formally assessed in the HHRA, unless otherwise noted.

The maximum reported concentration of a CPSS will be compared to its reference background concentration (when applicable). This comparison helps account for naturally occurring elements, such as beryllium, manganese, and arsenic. Thus, risk and/or hazard associated with naturally occurring elements are not addressed where their concentrations are similar to corresponding background.

In the HHRA, if the maximum concentration of a CPSS is determined to be less than either two-times mean background or the risk-based screening values, then the CPSS will not be considered further unless deemed appropriate based on chemical-specific characteristics (e.g., degradation product with greater toxicity).

An exposure scenario of concern will be identified as a scenario with incremental excess lifetime cancer risk (ILCR) estimated greater than 1E-4 or a hazard index (HI) estimated greater than 1. In the next step, COPCs exceeding 1E-6 ILCR or a HQ greater than 0.1 in a scenario of concern are retained as COCs. Section 5, Toxicity Assessment, discusses cancer risk thresholds and noncancer toxicity in detail.

4 Exposure Assessment

This section of the HHRAs will determine the magnitude of contact that a potential receptor may have with site-related COPCs. Exposure assessment involves four stages:

- Characterizing the physical setting and land use of the site.
- Identifying COPC release and migration pathway(s).
- Identifying the potential receptors, under various land use or site condition scenarios, and the pathways through which they might be exposed.
- Quantifying the intake rates, or contact rates, of COPCs.

4.1 Exposure Setting and Land Use

The site setting and land use will be detailed or referenced in this section of the site-specific HHRAs. This information is used to develop appropriate exposure estimates for different land use assumptions. If the future use of the area in question is known, this information will be used to define exposure assumptions used when calculating risk (e.g., sites known to be commercially zoned will not be assessed for residential land use). Future land use will be specified with as much accuracy as possible in site-specific HHRAs, particularly for property being transferred from the Navy to the City of Millington.

USEPA Region IV guidance calls for assuming lognormal distributions for environmental data and the calculation of 95% UCL on the mean for use in exposure quantification. Applying the UCL is generally inappropriate with less than 10 samples. Therefore, the maximum concentrations detected will be used for all datasets with less than 10 samples. In general, outliers have been included when calculating the UCL because high values seldom appear as outliers for a lognormal distribution. Including outliers increases the overall uncertainty of the calculated risks and conservatively biases exposure estimates.

For sample sets of 10 and greater, the UCL will be calculated for a lognormal distribution as follows:

$$UCL = e^{\left(\bar{a}+0.5s_a^2 + \frac{H_{0.95}\ x\ s_a}{\sqrt{n-1}}\right)}$$

where:

$\bar{a}$	=	$\Sigma a/n$ = sample arithmetic mean of the log-transformed data, $a = \ln(x)$
s_a	=	sample standard deviation of the log-transformed data
n	=	number of samples in the data set
$H_{0.95}$	=	value for computing the one-sided upper 95% confidence limit on the lognormal mean from standard statistical tables (Gilbert, 1987)

EPCs and UCLs will be summarized and tabulated when applicable in the site-specific HHRA.

4.5 Quantification of Exposure

This section describes the models, equations, and intake model variables used to quantify doses or intakes of the COPCs for the surface soil and groundwater exposure pathways. The models are designed to estimate route- and medium-specific factors, which are multiplied by the EPC

Table 1
Parameters Used to Estimate CDI

Pathway Parameters	Resident Adult	Resident Child	Adult Worker	Trespassing Child (age 7-16)	Units
Surface Soil Ingestion and Dermal Contact					
Ingestion Rate (soil)	100[a]	200[a]	50[a]	100[a]	mg/day
Ingestion Rate (water)	2	1	1	NA	L/day
Exposure Frequency	350[b]	350[b]	250[b]	52[f]	days/year
Exposure Duration	24[c]	6[c]	25[c]	10[g]	years
Dermal Contact Area	4,100[a]	2,900[a]	4,100[a]	4,100[a]	cm^2
Skin Adherence Factor	1	1	1	1	mg/cm^2
Absorption Factor	0.01 (organics) 0.001 (inorganics)	0.01 (organics) 0.001 (inorganics)	0.01 (organics) 0.001 (inorganics)	0.01 (organics) 0.001 (inorganics)	unitless
Oral Absorption Efficiency	0.8 (VOCs) 0.5 (other organic compounds) 0.2 (inorganics)	0.8 (VOCs) 0.5 (other organic compounds) 0.2 (inorganics)	0.8 (VOCs) 0.5 (other organic compounds) 0.2 (inorganics)	0.8 (VOCs) 0.5 (other organic compounds) 0.2 (inorganics)	unitless
Conversion Factor	1E-6	1E-6	1E-6	1E-6	kg/mg
Body Weight	70[a]	15[a]	70[a]	45[a]	kg
Averaging Time, Noncancer	8,760[d]	2,190[d]	9,125[d]	3,650[d]	days
Averaging Time, Cancer	25,550[e]	25,550[e]	25,550[e]	25,550[e]	days

Notes:
a — USEPA (1989a) *Risk Assessment Guidance for Superfund Vol. I, Human Health Evaluation Manual (Part A).*
b — USEPA (1991b) *Risk Assessment Guidance for Superfund Vol. I: Human Health Evaluation Manual Supplemental Guidance, Standard Default Exposure Factors, Interim Final*, OSWER Directive: 9285.6-03.EPA/600/8-89/043.
c — USEPA (1991a), *Risk Assessment Guidance for Superfund: Vol. I — Human Health Evaluation Manual (Part B, Development of Risk-Based Preliminary Remediation Goals)*, OSWER Directive 9285.7-01B.
d — Calculated as the product of ED (years) x 365 days/year.
e — Calculated as the product of 70 years (assumed lifetime) x 365 days per year.
f — Assuming one day per week exposure.
g — Assuming trespassing occurs during the 10-year adolescent/teenage period.
NA — Not applicable.

The FI/FC factors modify the concentrations to more closely approximate site-wide exposure conditions for a given exposure unit area. When the UCL is used as EPC, no FI/FC adjustments will be made. In addition, CPSSs not eliminated from the HHRAs based on the screening comparisons described in Section 3.4 may be eliminated as a COPC because the UCL concentration does not exceed the corresponding background concentration or RBC. This will be discussed on a site-specific basis.

Consequently, CDI for carcinogens would be calculated as follows for site residents:

$$CDI_s = (EPC_s)(EF)(LWA)(F)(FI)/(AT)$$

where:

CDI_s = ingested dose (mg/kg-day)

EPC_s = exposure point concentration of contaminant in soil (mg/kg)

EF = exposure frequency (days/year)

F = conversion factor (1E-6 kg/mg)

FI = fraction ingested from contaminated source (unitless)

AT = averaging time (days)

LWA = lifetime weighted average

Dermal Contact with COPCs in Surface Soil

The following equation is used to estimate intake due to dermal contact with COPCs in soil:

$$CDI_{sd} = (EPC_s)(CF)(EF)(ED)(F)(FC)(ABS)(AF)/(BW)(AT)$$

where:

CDI_{sd} = dermal dose (mg/kg-day)

EPC_s = exposure point concentration of contaminant in soil (mg/kg)

CF = contact factor (cm^2)

EF = exposure frequency (days/year)

ED = exposure duration (years)

F = conversion factor (1E-6 kg/mg)

FC = fraction contacted from contaminated source (unitless)

ABS = absorption factor (unitless value, specific to organic versus inorganic compounds)

AF = adherence factor (milligrams per square centimeter [mg/cm^2])

BW = body weight (kg)

AT = averaging time (days)

Table 2

Multipliers[a] Used to Estimate Chronic Daily Intake

		Soil		Groundwater
		Ingestion	*Dermal Contact*	*Ingestion*
Exposure Scenario	**Exposure Type**	**All Chemicals**	**Organics[b]**	**All Chemicals[c]**
Resident	Noncarcinogens (adult)	1.37E-6	5.62E-7	2.74E-2
	Noncarcinogens (child)	1.28E-5	1.85E-6	6.39E-2
	Carcinogens (LWA)	1.57E-6	3.51E-7	1.49E-2
Trespasser	Noncarcinogens	3.17E-7	1.30E-7	NA
(age 7-16)	Carcinogens	4.52E-8	1.85E-8	NA
Site Worker	Noncarcinogens	4.89E-7	4.01E-7	9.78E-3
	Carcinogens	1.75E-7	1.43E-7	3.49E-3

Notes:
NA — Not applicable
LWA — Lifetime weighted average
[a] — The product of the multiplier and the exposure point concentration equals the chronic daily intake for a given chemical assuming a reasonable maximal exposure scenario.
[b] — The multiplier for inorganics is multiplied by a factor of 0.1 to account for the dermal absorption factor of 0.001 for inorganics; the multiplier for organic compounds includes the 0.01 factor.
[c] — The ingestion intake is also used to address inhalation risk in accordance with USEPA's Supplemental Guidance To RAGS Bulletin 3; ingestion risk is approximately equal to risk posed by dermal and inhalation exposure while showering, and this is applied to volatile organic compounds only.

toxicological values are used in risk formulae to assess the upper-bound level of cancer risk and noncancer hazard associated with exposure to a given chemical concentration.

For carcinogens, the potential risk posed by a chemical is computed by multiplying the CDI (as mg/kg-day) by the SF (in reciprocal mg/kg-day). The HQ (for noncarcinogens) is computed by dividing the CDI by the RfD. USEPA has set standard limits (or points of departure) for carcinogens and noncarcinogens to evaluate whether significant risk is posed by a chemical (or combination of chemicals). For carcinogens, the point-of-departure range is 1E-6, with a generally accepted range of 1E-6 to 1E-4. These risk values correlate with one in 10,000 (1E-4) and one in 1 million (1E-6) excess cancer incidence resulting from exposure to toxic compounds from outside the body.

For noncarcinogens, other toxic effects are generally considered possible if the HQ (or sum of HQs for a pathway-hazard index) exceeds the threshold value of 1. Although both cancer risk and noncancer hazard are generally additive only if the target organ is common to multiple chemicals, a most conservative estimate of each may be obtained by summing the individual risks or hazards, regardless of target organ. Site-specific HHRAs for NSA Memphis will take the universal summation approach for each class of toxicant. Details regarding the risk formulae applied to site data are provided in Section 6, Risk Characterization.

Critical studies used in establishing toxicity classifications by USEPA are shown in the IRIS database, which is the primary source for information necessary to estimate risk. HEAST, Fiscal Year 1995 is the secondary source for this information. In addition, USEPA's National Center for Environmental Assessment (NCEA) will be used as a source when necessary. In accordance with RAGS, a table will summarize toxicological data in the site-specific HHRAs in the form of RfDs and SFs obtained for COPCs identified in site media, as well uncertainty/modifying factors, target organs, and cancer classes (where available).

are developed for individual chemicals, exposure pathways, transfer media, and source media, and for each receptor for all media to which one may be exposed. The qualitative component usually involves comparing COC concentrations in media with established criteria or standards for chemicals for which there are no corresponding toxicity values. The risk characterization helps guide risk-management decisions.

Generally, the risk characterization will follow the methodology prescribed by RAGS Part A, as modified by more recent information and supplemental guidance cited in the earlier sections of this memorandum. *The USEPA methods are designed to be health-protective and tend to overestimate risk rather than underestimate it. The risk results, therefore, are generally overly conservative, because risk characterization involves summing the overestimated risk estimates.*

6.1 Risk Characterization Methodology

Potential excess risks to humans following exposure to COPCs will be estimated using methods established by USEPA, when available. As discussed above, these methods are health-protective and are likely to overestimate risk. Risks from hazardous chemicals are calculated for either carcinogenic or noncarcinogenic effects. Some carcinogenic chemicals may also pose a noncarcinogenic hazard. The potential human health effects associated with chemicals that produce carcinogenic and other toxic effects will be characterized separately, as discussed below.

6.1.1 Carcinogenic Effects of Chemicals

The risk attributed to exposure to carcinogens is estimated as the probability of an individual developing cancer over a lifetime as a result of exposure to a potential carcinogen. In the low-dose range, which would be expected for most environmental exposures, cancer risk is estimated from the following linear equation (EPA, 1989a):

$$ILCR=(CDI)(SF)$$

Chemical noncarcinogenic effects are evaluated on a chronic basis, using chronic RFD values. An HQ of 1 indicates that the estimated intake equals the RfD. If the HQ is greater than unity, there may be a concern for potential adverse health effects.

In the case of simultaneous exposure of a receptor to several chemicals, an HI will be calculated as the sum of the HQs by:

$$HI = HQ_1 + HQ_2 + \ldots HQ_i$$

where:

HI	=	Hazard Index (unitless)
HQ	=	Hazard Quotient (unitless)

Risk and hazard projections will be summarized in tabular format on a medium- and exposure pathway-specific basis in the HHRAs.

6.2 Surface Soil Pathways

Generally, the incidental ingestion and dermal contact pathways will be characterized for surface soil. Surface soil onsite will be evaluated under scenarios and exposure pathways outlined in the site-specific HHRAs.

6.3 Groundwater Pathways

Groundwater pathways will typically consist of ingestion and inhalation of volatilized chemicals in groundwater. The site-specific HHRAs will detail the pathways which will be addressed. Most groundwater pathways are not complete because municipal water supplies are used, and this will be discussed in the HHRAs.

9 Remedial Goal Options

RGOs are chemical concentrations computed to equate with specific risk and/or hazard goals that may be established for a particular site. As previously discussed, COCs are identified as any COPC that significantly contributes to a scenario of concern. RGOs will be calculated for each land use scenario with cumulative risk estimates greater than 1E-4 or cumulative hazard indices greater than 1.0. Based on this method, COCs may be identified, requiring RGO calculation. Inclusion in the RGO table does not necessarily indicate that remedial action will be required to address a specific chemical. Instead, RGOs are provided to facilitate risk-management decisions.

In accordance with USEPA Supplemental RGO Guidance, RGOs will be calculated at 1E-4, 1E-5, and 1E-6 risk levels for carcinogenic COCs and HI goals of 3, 1, and 0.1 for noncarcinogenic COCs. RGOs will be based on specific scenarios which will be identified in the site-specific HHRAs.