N00164.AR.000849
NSWC CRANE
5090.3a

DEPARTMENT OF THE NAVY
CRANE DIVISION
NAVAL SURFACE WARFARE CENTER
300 HIGHWAY 361
CRANE INDIANA 47522-5001

IN REPLY REFER TO:

5090/S4.7.3
Ser RP3/3390

18 NOV 2003

U.S. Environmental Protection Agency, Region V
Waste, Pesticides, & Toxics Division
Waste Management Branch
Illinois, Indiana, and Michigan Section
ATTN: Mr. Peter Ramanauskas (DW-8J)
77 West Jackson Blvd.
Chicago, IL 60604

Dear Mr. Ramanauskas:

Crane Division, Naval Surface Warfare Center (NSWC Crane) submits responses to comments for the Draft Old Rifle Range (ORR), Solid Waste Management Unit 07/09, RCRA Facility Investigation (RFI) Report as enclosure (1). Included in enclosure (1) is the Voluntary Interim Measures (VIM) Letter Report. The VIM is provided for assistance in reviewing the response to comments. The VIM will also be submitted as an appendix to the Final RFI Report. The permit required Certification Statement is provided as enclosure (2).

NSWC Crane point of contact is Mr. Thomas J. Brent, Code RP3-TB, telephone 812-854-6160.

Sincerely,

for JAMES M. HUNSICKER
Manager, Environmental Protection
By direction of the Commanding Officer

Encl:
(1) ORR RFI Response to Comments
(2) Certification Statement

Copy to:
ADMINISTRATIVE RECORD
SOUTHNAVFACENGCOM (Code ES32) (w/o encl)
IDEM (Doug Griffin)
TTNUS (Roger Clark) (w/o encl)

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Jerry L McCracken

SIGNATURE

for Environmental Protection Department Manager 11/18/03

TITLE DATE

U.S. EPA REGION 5 COMMENTS (May 29, 2003)

on

NAVY RESPONSES TO U.S. EPA REGION 5 COMMENTS (dated February 18, 2003; emailed to EPA by the Navy April 11, 2003)

on

DRAFT RFI REPORT (November 2002)

for

NSWC CRANE SWMU 7 (OLD RIFLE RANGE [ORR])

The Navy is responding to the comments referenced above as received, based on the information that was available at the time the comment was made. However, EPA should be aware that the Navy conducted a Voluntary Interim Measure (VIM) to excavate the localized high concentrations of 2,4,6-trinitrotoluene (TNT) at SB16 and SB47, which represented ~95% of the site calculated risk presented in the November 2002 Draft RFI Report. The VIM resulted in significantly lower TNT concentrations and associated significant reductions in risk. Recalculations of risk have been finalized and are provided in the VIM Letter Report attached to these Responses to Comments. The VIM Report has been attached so that the remaining EPA comments can be put in context with the actions taken during the summer of 2003 to address site environmental concerns. The Navy is not requesting a formal review of the VIM Report (as it was a voluntary action), but provides it to support the greatly reduced risks presented by the site. The Navy also intends to attach the VIM Report to the RFI Report as a new Appendix (Appendix I).

<u>EPA comments from Mr. Peter Ramanauskas dated May 29, 2003:</u>

We (EPA) have reviewed Crane's responses to comments for the ORR RFI.

Background Sample Comment: One question that persists by the reviewers is the use of limited background data for comparisons of certain soil types. I understand and appreciate that for the basewide background study the Navy attempted on two separate occasions to collect sufficient numbers of samples. The final Basewide Background Study report mentions collecting SWMU specific background samples where beneficial (e.g., soil types with low sample number

sets). For future work, would the Navy consider collecting additional background samples at SWMUs where soils types are present for which the BW Background study was unable to collect greater than 5 data points?

Response to Background Sample Comment:

In response to EPA's comment on limited background data for the ORR, please note that the Navy has prepared a response and submitted it to EPA on August 26, 2003 for the same background soils comment on the Dye Burial Ground RFI Report. The text of that response is also repeated here (as modified for the ORR) for the sake of continuity.

It should be noted that a larger number of background samples, by itself, does not necessarily result in greater statistical validity. The degree of confidence that is obtained in decision making is influenced by the amount of variability in the data and the minimum difference that must be detected between the data statistic (e.g., the mean) and an action level or another statistic. The degree of confidence generally increases with the number of samples but specifying a minimum number of samples for collection without consideration of these other factors may lead to decision confidence that is too low (or too high, depending on the cost of data collection, etc.). The Navy considered decision errors when planning the NSWC Crane base-wide background soil investigation. It was those considerations that led to the conclusion that three samples were needed to satisfy the specified decision error criteria. That is, collecting at least three samples from each soil type would provide a sufficient amount of data to meet the specification -- under the assumed conditions. Recognizing that the assumptions could be in error, the Navy decided to collect at least *five* samples of each soil type rather than just three.

The Navy has already identified situations where additional background samples may be collected. In cases where local conditions such as adjacent site operations or localized geology can affect background or parameters analyzed, additional background samples may be collected. Details are provided in Section 3.3.1 of the Background Report (TtNUS, January 2001).

The Navy will also consider collection of additional background samples in situations where soil groups are encountered for which less than six samples were collected during

the background study. Any such decisions would be made either during the planning or field investigation phases. If discovered during the planning phase, the locations of additional background samples will be addressed in the planning document. US EPA Region 5 will be able to review and approve the locations of background samples during review of the planning document (QAPP). If the need to collect additional background samples is discovered during the field investigation phase, collection of additional background samples and their locations will be determined in the field. The additional data would only be used for the calculation of a new background for the soil group.

Although the Navy is willing to consider collection of additional background samples as described above, in most instances collection of additional background samples acceptable for use in the database may be extremely difficult. Numerous criteria were identified in the Background Study (Section 3.3.1) for determining acceptable locations of background samples. These criteria are as follows.

1. Within NSWC Crane boundary
2. Soil composition similar to the soils encountered in the presently defined SWMUs and across NSWC Crane.
3. Unaffected by past or present Navy activities
4. Approximately 400 feet from primary or secondary roads
5. Approximately 400 feet from any developed areas
6. Upwind from any sites releasing airborne emissions
7. Not down slope from any slope

The Navy anticipates that it will be extremely difficult to find locations meeting all of these criteria. The selection of sites unaffected by past or present Navy activities is the most difficult criterion to meet. In the initial background study an objective was established to collect five samples for each soil group. After two sampling rounds it was determined that it would be cost prohibitive (over $250,000 was expended) to collect additional backgrounds samples. Given the efforts conducted to date to create the background database, the Navy does not believe it is cost-beneficial to attempt a third round of sampling for two soil groups.

Remaining comments follow:

Human Health Screening Evaluation Comments

Comment 2: The response appears to adequately address the original comment. The calculation worksheets showing the derivation of the Soil Screening Level (SSL) for soil to groundwater migration for RDX, TNT, and manganese should be added to the revised RFI Report.

Response: Agreed. Also see response to EPA Comment 10.

Comment 3: The response appears to adequately address the original comment. Additional text should be added to the second bullet point on page 4-2 clarifying that while waste may be burned six days per week, an individual worker might only be present at the site (and thereby exposed to existing contamination) up to five days per week. Therefore, use of the PRGs to evaluate risks to the industrial worker does address a five day per week exposure.

Response: Agreed. The following sentence will be added to the end of the second bullet on page 4-2, "However, both military and civilian workers assigned to NSWC Crane work a typical 5 day/40 hours per week schedule."

Comment 5: The response appears to partially address the original comment. While it is understood that NSWC Crane wishes to focus the discussion of risks on TNT, the major risk driver, the text of the report continues to read as if only risks exceeding 1 x 10-4 warrant a detailed discussion and that only risks exceeding 1 x 10-4 may warrant remediation. The revised RFI Report should delete the sentence on page 4-4 that reads "As presented in Tables 4-1 through 4-8 and described above, only the risk estimates developed for the maximum 2,4,6-TNT concentration in surface soils clearly exceed the U.S. EPA risk benchmarks frequently used to determine the need for environmental remediation." A new sentence should be added in its place acknowledging the percentage of the total risk that is attributable to TNT.

Prior to the discussion of TNT as the primary risk driver, a new paragraph should be added to the Risk Characterization (Section 4.3) that explicitly acknowledges that arsenic in surface and subsurface soils at both the Old Rifle Range (ORR) and Old Pistol Range (OPR), as well as benzo(a)pyrene in subsurface soils at the ORR have associated risks exceeding U.S. EPA's risk range lower bound level of 1 x 10-6. Text should then be added discussing that the site will continue to be used for ammunition burning and that additional contaminants are likely to be added as a result of Subpart X open burning. The text should recommend, given that the risks associated with these other constituents total 4 x 10-5 or less and are within the range of background, that the need for remediation be deferred until closure of the unit, when the risks associated with all constituents at the open burning grounds will be reevaluated.

Response: The comment is understood. Based on the VIM activities conducted during the summer of 2003, Section 4 has been completely revised to reflect the lower TNT risks and new risk drivers. The revised Section 4 is attached to this Response to Comments document. The paragraph in question has been changed to reflect the intent of this comment, but more importantly to present the new risk characterization now that the high concentrations of TNT have been removed.

Comment 8: The response appears to partially address the original comment. NSWC Crane has explained its intention to focus the Risk Characterization (Section 4.3) on TNT. However, as explained in the review of response to Specific Comment Number 5 above, additional text will need to be added acknowledging the constituents contributing risks exceeding 1 x 10-6 and recommending that the need for any remediation of these other constituents be deferred until closure of the Subpart X open burning unit.

Response: See response to EPA Comment No. 5.

Comment 9: The response appears to adequately address the original comment.

Note that Appendix H Attachments 2 and 3 will also require updating in the revised RFI Report. The worksheets in these attachments that calculate industrial

worker exposure for 2 days/year and 6 days/year continue to use the dated (and lower) soil ingestion rate of 50 mg/kg.

Additionally, the revised Section 4 tables provided with the response to comments indicate that a lognormal 95% Upper Confidence Limit (UCL) has been used for arsenic and manganese instead of the maximum detected value used in the previous Section 4 tables. This will require that the bottom of page 4-2 of the RFI Report be revised to clearly explain why the maximum detected values have been used for some constituents while the 95% UCL has been used for other constituents. Supporting information must also be added to the revised RFI Report describing the statistical evaluations that were conducted to determine appropriate data distribution (normal or lognormal). Recent U.S. EPA guidance Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites (OSWER Directive 9285.6-10, December 2002) should be consulted to ensure that methods to calculate upper confidence limits (UCLs) are appropriate. Note that this guidance also provides methodology to address a situation when the data appear to be neither normally, nor log-normally, distributed.

Response: The Appendix H worksheets addressing industrial worker exposure for 2 days/year and 6 days/year have been updated as shown in Attachment 1 to this document. Revised versions of Tables 4-9 through 4-15 which contain an evaluation of the 95 % UCL concentration (where possible) will be incorporated into the risk assessment section of the report. The additional analysis was conducted as part of the Navy's response to EPA Comments 12 and 13. Additionally the following narrative and attached statistical tables that demonstrate for the reader the calculation/determination of the exposure point concentration will be included in Appendix H:

> The exposure point concentrations (EPCs) presented in Tables 4-9 through 4-15 were determined using the guidance presented in the U.S. EPA reference titled, ***Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites*** (December 2002). The methodology is outlined in Exhibit 14 of the UCL guidance (see Attachment 2). Prior to the calculation of the EPC, the distribution of a data set (normal, lognormal, undefined) was

determined using the Shapiro-Wilk W-test. Then, the 95 percent upper confidence limit (UCL) for the arithmetic mean was calculated per one of the three methodologies presented below. The UCLs for data sets determined to be normally distributed were calculated using the Student's *t* statistic. The UCLs for data sets determined to be lognormally distributed were calculated using the Land method. The UCLs for data sets not determined to be normally or lognormally distributed were calculated using the non-parametric Standard Bootstrap Procedure. The resulting 95% UCL for a parameter was compared to the maximum detected concentration in the data set and was selected as the EPC if the 95 % UCL was less than the maximum detected concentration. Otherwise, the maximum detected concentration was selected as the EPC.

Method 1 - 95 % UCL Calculation for Normally Distributed Data – The Student's *t* Statistic

The 95 percent upper confidence limit (one-tailed test) is calculated as follows:

$$UCL_{0.95} = \bar{x} + t_{0.95,n-1} \frac{S_x}{\sqrt{n}}$$

where: $\bar{X} = \frac{1}{n}\sum_{i=1}^{n} x_i$ = arithmetic mean

$$S_x = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n-1}}$$ = the sample standard deviation

$t_{0.95,\ n-1}$ = Value found in t-distribution table

Method 2 – 95 % UCL Calculation for Log-normally Distributed Data – The Land Method

The following formula is used to calculate the upper 95% confidence interval (UCL95%) for the geometric mean (x_g):

$$UCL_{0.95} = \exp\left[\bar{y} \pm 0.5(S_y)^2 + \frac{S_y(H_{0.95,n})}{\sqrt{n-1}}\right]$$

where: $\bar{y}_1$ = arithmetic mean of the log-transformed data, y = ln(x)

Sy = standard deviation of y

$H_{0.95,n}$ = factor for sample size n

Method 3 - 95 % UCL Calculation when the Distribution of the Data is Undefined – The Standard Bootstrap Procedure

In the bootstrap procedure, repeated samples of size n are drawn with replacement from the given set of observations. The process is repeated a large number of times and each time an estimate of θ is computed.

Step 1: Let (x_{i1}, x_{i2}, … , x_{in}) represent the ith sample of size n with replacement from the original data set (x_1, x_2, …, x_n). Then compute the sample mean and denote it $\bar{x}_i$.

Step 2: Perform Step 1 independently N times (e.g., 1000-2000) each time calculating a new estimate. Denote those estimates by $\bar{x}_1$, $\bar{x}_2$, $\bar{x}_3$,…, $\bar{x}_n$. The bootstrap estimate of the population mean is the arithmetic mean $\bar{x}_B$, of the N

estimates $\bar{x}_i$: i = 1,2, ...,N. The bootstrap estimate of the standard error is given by:

$$\hat{\sigma_B} = \sqrt{\frac{1}{N-1}\sum_{i=1}^{N}(\bar{x}_i - \bar{x}_B)^2}$$

The (1-α) 100% standard bootstrap UCL for θ is given by:

$$UCL = \hat{\theta} + z_\alpha \hat{\sigma}_\beta$$

It should be noted for all the above procedures, the 95 percent confidence interval for a second sample of size n drawn from the same population will most likely not be the same as that for the first sample. In theory, if an interval estimate is calculated for the means of a very large set of samples of size n, the true population mean will be within 95 percent of this limit.

Comment 10: The response appears to adequately address the original comment. The calculation worksheets showing the derivation of the SSL for soil to groundwater migration for RDX, TNT, and manganese should be added to the revised RFI Report.

However, note that the calculation worksheets for SSLs based on soil to groundwater migration for RDX, TNT, and manganese introduces a new issue. It is not clear why the 2,4,6-TNT and manganese SSLs corresponding to a Dilution Attenuation Factor (DAF) of 1 in Tables 4-16 through 4-19 are not the same as those calculated in the newly provided worksheet. This issue should be addressed and corrections made as appropriate.

Furthermore, the newly provided SSL worksheet states that a DAF of 1 is the most appropriate for use at NSWC Crane based on karst geology. However, an explanation is needed regarding why the discussion of soil contaminant migration to groundwater on page 4-5 of the RFI Report discusses only the results of a

comparison of soil concentrations to a DAF of 20. Consideration of the more protective DAF would indicate that in addition to the 2,4,6-TNT and 2,6-dinitrotoluene already identified as exceeding screening levels, arsenic, manganese, benzo(a)anthracene, and benzo(b)fluoranthene also exceed screening levels based on the protection of groundwater from soil contaminant migration. The revised RFI Report should revisit the results of the screening of constituents against soil migration SSLs. Explain what action may be necessary to protect groundwater from contaminant migration from soil. Additionally, it is recommended that any environmental monitoring programs (e.g., soil and groundwater) that may be conducted during operation of the Subpart X open burn unit be described along with a discussion of how these monitoring programs are intended to protect human health and the environment.

Response: The Navy agrees that there is a difference between the SSLs for groundwater protection presented for 2,4,6-TNT and manganese in Tables 4-16 and 4-19 and those presented on the referenced worksheets. SSLs for these chemicals were not presented in the EPA 1996 Soil Screening Guidance: Technical Background Document. Consequently, the Navy calculated the SSLs per the guidelines and equations presented in that guidance during the preparation of planning documents for SWMU No. 7 in 1998 (as presented in the worksheets). The SSLs were re-checked against information presented in the EPA Region 9 Preliminary Remediation Goal (PRG) tables during the preparation of the Phase III Soils RFI for SWMU 7 in 2002. Again, the SSLs for 2,4,6-TNT and manganese are not presented in the EPA Region 9 PRG tables. Consequently, the Navy used the SSL calculation tool presented on the EPA SSL website to re-check the values originally presented in the worksheets (http://risk.lsd.ornl.gov/cgi-bin/epa/ssl2.cgi) (see Attachment 3). The values from the website were correctly presented in Tables 4-16 through 4-19. While all the intermediate calculation values are not shown when using the EPA SSL calculation tool, the difference between the EPA web site and the worksheet values for manganese (38 mg/kg [worksheet value] versus 110 mg/kg [web site]) is likely to be primarily the result of the selected acceptable groundwater concentration (1,700 ug/L [web-site value, a true risk-based concentration selected by the EPA website tool] versus 50 ug/L [worksheet value, the federal Safe Drinking secondary maximum contaminant level]). The difference between the web site and worksheet values for 2,4,6-TNT (5.7E-04 mg/kg versus 2E-04

mg/kg, respectively) is less pronounced and most likely due to minor differences in the physical constants used in the calculations. Please note that, conservatively, the worksheets and the Section 4 tables present the SSL for a DAF of 1. The Section 4 tables also present SSLs based on a DAF of 20. COPC concentrations are compared to SSLs based on both a DAF of 1 and a DAF of 20 in Section 4 of the report. For purposes of clarity and completeness, the following discussion will be added to the end of Section 4.3 regarding the exceedances of SSLs based on a DAF of 1:

> As summarized on Tables 4-16 through 4-19, 2,4,6-TNT, 2,6-dinitrotoluene, benzo(a)anthracene, benzo(b)fluoranthene, arsenic, and manganese were the COPCs detected in surface or subsurface soils at concentrations exceeding EPA SSLs for the migration of chemicals from soils to groundwater using a DAF of 1. 2,4,6-TNT and 2,6-dinitrotoluene have been discussed previously. Based on analytical data presented in the CCCRA, benzo(a)anthracene was selected as a COPC for the human health risk assessment of groundwater contaminants presented in that assessment (benzo[b]fluoranthene was not). However, as discussed in Section 4.4, PAHs were detected ***very infrequently*** in soil samples at the ORR. Consequently, the soils are unlikely to be a significant continuing source of contamination to groundwater. Arsenic and manganese were also selected as COPCs for groundwater in the CCCRA. However, based on the statistics and discussions presented in Section 3.0, arsenic and manganese in the surface and subsurface soils at the ORR and the OPR also do not present a significant source of contamination to groundwater. Manganese was not detected in surface soil samples from the ORR and the OPR or in the subsurface soil samples from the ORR at concentrations exceeding background. The manganese concentrations in the subsurface soils at the OPR marginally exceed background, if at all. Arsenic was not detected in the subsurface soils at the ORR at concentrations exceeding background. The statistical analyses and kriging plots presented in Section 3 suggest that the arsenic concentrations in the surface soils at the ORR and the OPR and in the subsurface soils at the ORR are marginally greater than background concentrations. The areal extent of the arsenic contamination is very limited.

Attachment 4 lists the environmental monitoring program being conducted to comply with 40 CFR 264 Subpart F requirements associated with operation of the Subpart X open burn unit at the ORR. The following sentence will be added as the last paragraph of Section 4.3:

> On-going environmental monitoring of the ORR is covered under NSWC Crane's Subpart X Permit for this operating unit.

Comment 11: The response appears to adequately address the original comment. It is recommended that the table of information provided in the response to comment be included in the revised RFI Report to further support the conclusion that polynuclear aromatic hydrocarbons (PAHs) are not significant soil contaminants at SWMU 7.

Response: Agreed. The table of information will be incorporated into Section 4.4, Uncertainty Analysis.

Comment 13: The response appears to partially address the original comment. The revised RFI Report should include additional text acknowledging in the Risk Characterization (Section 4.3) those exposures that have arsenic risk exceeding a 1 x 10-6 level. The revised RFI Report should further discuss and justify deferring any potential need to remediate arsenic until closure of the Subpart X unit. Finally, the revised RFI Report should identify any environmental monitoring programs (e.g., soil and groundwater) that may be conducted during Subpart X open burning operations that will ensure ongoing evaluation of arsenic levels at the unit.

Response: See response to EPA Comment No. 5. As stated by EPA Region 5 in Comment No. 5, the risks associated with arsenic total 4 x 10-5 or less and are within the range of background. Thus, the need for remediation will be deferred until closure of the unit, when the risks associated with all constituents at the open burning grounds will be reevaluated.

Attachment 4 lists the environmental monitoring program being conducted to comply with 40 CFR 264 Subpart F requirements associated with operation of the Subpart X open burn unit at the ORR and arsenic is included in this program. The following sentence will be added as the last paragraph of Section 4.3:

> On-going environmental monitoring of the ORR is covered under NSWC Crane's Subpart X Permit for this operating unit.

ATTACHMENT 1

TETRA TECH NUS, INC. **CALCULATION WORKSHEET**

CLIENT	JOB NUMBER
NSWC Crane	3961 hw0090150

SUBJECT: Carcinogenic and Non-carcinogenic PRGs for 2,4,6-TNT – 2 day/yr exposure frequency

BASED ON	DRAWING NUMBER
Region 9 PRG Equations	

BY	CHECKED BY	APPROVED BY	DATE
L.A. SINAGOGA	R Jupe		

Objective: Calculate the carcinogenic and non-carcinogenic PRGs for 2,4,6-TNT for an industrial worker with 2 days/year exposure frequency.

Equation 4-3 from Region 9, PRG guidance:

$$C_{mg/Kg} = \frac{TR \otimes BW_a \otimes AT_c}{EF_c \otimes ED_c \left[\left(\frac{IRS_o \otimes CSF_o}{10^6\ mg/Kg} \right) \oplus \left(\frac{SA_a \otimes AF \otimes ABS \otimes CSF_o}{10^6\ mg/Kg} \right) \oplus \left(\frac{IRA_a \times CSF_i}{PEF} \right) \right]}$$

Where:

C (mg/Kg) = PRG for combined exposure to carcinogenic chemical in soil
TR (unitless) = 1×10^{-6} = Target cancer risk
BW_a (Kg) = Body weight of an adult = 70 Kg
AT_c (days) = Averaging time for carcinogens = 25550 days.
EF_c (days) = Exposure frequency occupational = 2 days/yr
ED_c (yrs) = Exposure duration = 25 yrs
IRS_o (mg/d) = Soil ingestion rate = 100 mg/d
CSF_o $(mg/Kg/d)^{-1}$ = Cancer slope factor for the oral route of exposure = 3E-02 $(mg/Kg/d)^{-1}$
SA_a (cm^2/day) = Exposed surface area of adult worker = 3300 cm^2/day
AF_a (mg/cm^2) = Skin adherence factor = 0.2 mg/cm^2
ABS (unitless) = Skin absorption factor = 0.1
IRA_a (m^3/d) = Inhalation rate for an adult = 20 m^3/d
CSF_i $(mg/Kg/d)^{-1}$ = Cancer slope factor for the inhalation route of exposure = 3E-02 $(mg/Kg/d)^{-1}$
PEF (m^3/Kg) = Particulate emission factor = $1.316 \times 10^9\ m^3/Kg$

$$C_{mg/Kg} = \frac{1 \times 10^{-6} \otimes \overbrace{70\ Kg \otimes 25550\ days}^{1.7888\,5}}{2d/y \otimes 25yrs \otimes \left[\underbrace{\left(\frac{100\ mg/d \otimes 3E\text{-}2 \left(\frac{mg}{Kg\text{-}d}\right)^{-1}}{10^6\ mg/Kg} \right)}_{3E\text{-}6} \oplus \overbrace{\left(\frac{3300\ \frac{cm^2}{d} \otimes 0.2\ \frac{mg}{cm^2} \otimes 0.1 \otimes 3E\text{-}2 \left(\frac{mg}{Kg\text{-}d}\right)^{-1}}{10^6\ mg/Kg} \right)}^{1.98E\text{-}06} \oplus \underbrace{\left(\frac{20\ m^3/d \otimes 3E\text{-}02 \left(\frac{mg}{Kg\text{-}d}\right)^{-1}}{1.316E+9\ m^3/Kg} \right)}_{4.6E\text{-}10} \right]} =$$

$= 7.2E+3$ mg/Kg ✓

TETRA TECH NUS, INC. **CALCULATION WORKSHEET**

CLIENT: NSWC		JOB NUMBER:	
SUBJECT: Carcinogenic and Noncarcinogenic PRGs for 2,4,6-TNT - 2day/yr Exposure Frequency			
BASED ON: Region 9 PRG Equations		DRAWING NUMBER:	
BY: L.A. SINAGOGA	CHECKED BY: [illegible]	APPROVED BY:	DATE:

Equation 4-4 from Region 9, PRG Guidance:

$$C\left(\frac{mg}{Kg}\right) = \frac{THQ \otimes BW_a \otimes AT_n}{EF_o \otimes ED_o \otimes \left[\left(\frac{1}{RfD_o} \otimes \frac{IRS_o}{10^6 mg/Kg}\right) \oplus \left(\frac{1}{RfD_o} \otimes \frac{SA_o \otimes AF \otimes ABS}{10^6 mg/Kg}\right) + \left(\frac{1}{RfD_i} \otimes \frac{IRA_o}{PEF}\right)\right]}$$

where: THQ = Target hazard quotient = 1 (unitless)
C(mg/Kg) = PRG for combined exposure to non-carcinogenic chemical in soil
AT_n(days) = Averaging time for non-carcinogens = (25 yrs) × (365 d/yr) = 9125 days
RfD_o(mg/Kg/d) = Reference Dose for oral route of exposure = 5E-04 mg/Kg/d
RfD_i(mg/Kg/d) = Reference Dose for inhalation route of exposure = 5E-04 mg/Kg/d
All other parameters are defined on page 1.

$$C\left(\frac{mg}{Kg}\right) = \frac{1.0 \otimes 70 Kg \otimes 9125 days}{2 d/yr \otimes 25 yrs \otimes \left[\underbrace{\left(\frac{1}{5E\text{-}04 \frac{mg}{Kg\text{-}d}} \otimes \frac{100 mg/d}{10^6 mg/Kg}\right)}_{2.E\text{-}1} \oplus \overbrace{\left(\frac{1}{5E\text{-}04 \frac{mg}{Kg\text{-}d}} \otimes \frac{3300 \frac{cm^2}{d} \otimes 0.2 \frac{mg}{cm^2} \otimes 0.1}{10^6 mg/Kg}\right)}^{1.32E\text{-}01} + \underbrace{\left(\frac{1}{5E\text{-}04 \frac{mg}{Kg\text{-}d}} \otimes \frac{20 m^3/d}{1.316E+9 \frac{m^3}{Kg}}\right)}_{3.04E\text{-}05}\right]}$$

$$= 3.9E+4 \ mg/Kg$$

3.3E-01

1.66 E+1

TETRA TECH NUS, INC. **CALCULATION WORKSHEET**

CLIENT	JOB NUMBER		
NSWC Crane			
SUBJECT: Carcinogenic and Noncarcinogenic PRGs for 2,4,6-TNT – 6 days/yr exposure frequency			
BASED ON: Region 9 PRGs Equations	DRAWING NUMBER		
BY: L.A. SINAGOGA	CHECKED BY: RJ	APPROVED BY	DATE

Objective: Calculate the carcinogenic and non-carcinogenic PRGs for 2,4,6-TNT for an industrial with a 6 days/year exposure frequency.

Equation 4-3 from Region 9 PRG guidance:

$$C_{mg/kg} = \frac{TR \otimes BW_a \otimes AT_c}{EF_c \otimes ED_c \otimes \left[\left(\frac{IRS_c \otimes CSF_i}{10^6\ mg/kg}\right) \oplus \left(\frac{SA_a \otimes AF \otimes ABS \otimes CSF_o}{10^6\ mg/kg}\right) \oplus \left(\frac{IRA_a \otimes CSF_i}{PEF}\right)\right]}$$

where:

EF_c (days) = Exposure frequency occupational = 6 days/yr

All other parameters are defined on page 1.

$$C_{\left(\frac{mg}{kg}\right)} = \frac{1\times10^{-6} \otimes 70\ kg \otimes 25550\ days}{6\ d/yr \otimes 25\ yrs \otimes \left[\left(\frac{100\ mg/d \otimes 3E\text{-}2\left(\frac{mg}{kg\text{-}d}\right)^{-1}}{10^6\ mg/kg}\right) \oplus \left(\frac{3300\ \frac{cm^2}{d} \otimes 0.2\ \frac{mg}{cm^2} \otimes 0.1 \otimes 3E\text{-}2\left(\frac{mg}{kg}\right)^{-1}}{10^6\ mg/kg}\right) \oplus \left(\frac{20\ m^3/d \otimes 3E\text{-}02\left(\frac{mg}{kg\text{-}d}\right)^{-1}}{1.316E+9\ m^3/kg}\right)\right]} =$$

7.5E-4

$= 2.4\ E+3\ mg/kg$

TETRA TECH NUS, INC. **CALCULATION WORKSHEET**

CLIENT	JOB NUMBER		
NSWC Crane			
SUBJECT: Carcinogenic and Non-Carcinogenic PRGs for 2,4,6 TNT - 6 days per year exposure frequency			
BASED ON: Region 9 PRG Equations	DRAWING NUMBER		
BY: L.A. SINAGOGA	CHECKED BY: [illegible]	APPROVED BY	DATE

Objective: As stated on page 3.

Equation 4-4 from Region 9, PRG Guidance:

$$C\left(\frac{mg}{kg}\right) = \frac{THQ \otimes BW_a \otimes AT_n}{EF_o \otimes ED_o \otimes \left[\left(\frac{1}{RfD_o} \otimes \frac{IRS_o}{10^6 \frac{mg}{kg}}\right) \oplus \left(\frac{1}{RfD_o} \otimes \frac{SA_a \otimes AF_a}{10^6 mg/kg}\right) \oplus \left(\frac{1}{RfD_i} \otimes \frac{IRA_a}{PEF}\right)\right]}$$

where:

EF_o (days) = Exposure frequency occupational = 6 days/yr

All other parameters as defined on page 2

$$C\left(\frac{mg}{kg}\right) = \frac{\overbrace{1.0 \otimes 70 kg \otimes 9125 days}^{6.39 E5}}{6 d/yr \otimes 25 yrs \otimes \left[\left(\frac{1}{5E\text{-}04 \frac{mg}{kg\text{-}d}} \otimes \frac{100 mg/d}{10^6 mg/kg}\right) \oplus \left(\frac{1}{5E\text{-}04 \frac{mg}{kg\text{-}d}} \otimes \frac{3300 \frac{mm^2}{d} \otimes 0.2 \frac{mg}{cm^2} \otimes 0.1}{10^6 mg/kg}\right) \oplus \left(\frac{1}{5E\text{-}04 \frac{mg}{kg\text{-}d}} \otimes \frac{20 m^3/d}{1.316E+9 \frac{m^3}{kg}}\right)\right]}$$

$= 1.3E4$

49.5

TETRA TECH NUS, INC. CALCULATION WORKSHEET

CLIENT: NSWC Crane	JOB NUMBER: 3961 hW0090150
SUBJECT: Carcinogenic/Non-carcinogenic risks for 2,4,6-TNT (2day Worker Exposure)	
BASED ON: PRGs for 2-day Worker Exposure	DRAWING NUMBER:
BY: L.A. SINAGOGA / CHECKED BY: [illegible]	APPROVED BY: / DATE: 10/31/03

Objective: Calculate risks for 2-day/year worker based on receptor-specific PRGs and risk-ratio method.

Risk ratio equation:

$$\frac{\text{Receptor-specific PRG}}{\text{EPC for COPC}} = \frac{\text{Hazard Index of 1 or Cancer Risk of 1E-06}}{\text{?? Hazard Index or Cancer Risk Estimate}}$$

Solve for ??

Risk Estimates for Worker visiting the site 2days/year:

PRG_{cancer} = 7,200 mg/Kg
$PRG_{noncancer}$ = 39,000 mg/Kg
EPC for 2,4,6-TNT = 17.9 mg/Kg (95% UCL) ; (250 mg/Kg = Max)

$HI_{max\ concentration}$ = (250 mg/Kg × 1) ÷ 39,000 mg/Kg = 6.4E-03 ✓

$CancerRisk_{max\ concentration}$ = (250 mg/Kg × 1E-06) ÷ 7,200 mg/Kg = 3.5E-08 ✓

$HI_{95\%\ UCL}$ = (17.9 mg/Kg × 1) ÷ 39,000 mg/Kg = 4.6E-04 ✓

$CancerRisk_{95\%\ UCL}$ = (17.9 mg/Kg × 1E-06) ÷ 7,200 mg/Kg = 2.5E-09 ✓

TETRA TECH NUS, INC. CALCULATION WORKSHEET

CLIENT	JOB NUMBER
NSWC Crane	3961hn 0090150
SUBJECT: Carcinogenic/Noncarcinogenic Risks for 2,4,6-TNT (6 days/yr and 250 days/year)	
BASED ON: PRGs for 6 day + 250 days per year	DRAWING NUMBER
BY: LA SINAGOGA / CHECKED BY: [illegible]	APPROVED BY / DATE: 10/31/03

Risk Estimate for Worker visiting site 6 days/year:

PRG cancer = 2400 mg/kg
PRG non-cancer = 13000 mg/kg
EPC for TNT = 17.9 mg/kg (95% UCL); 250 mg/kg (max)

$HI_{max\ conc}$ = (250 mg/kg × 1) ÷ 13,000 mg/kg = 1.9E-02 ✓

Cancer $Risk_{max\ conc}$ = (250 mg/kg × 1E-06) ÷ ~~7,200~~ 2,400 mg/kg = 1E-07 ✓

$HI_{95\%\ UCL}$ = (17.9 mg/kg × 1) ÷ 13000 mg/kg = 1.4E-03 ✓

Cancer $Risk_{95\%\ UCL}$ = (17.9 mg/kg × 1E-06) ÷ ~~7,200~~ 2400 mg/kg = 7.5E-09 ✓

Risk Estimate for Worker working 250 days/year:

PRG_{cancer} = 57 mg/kg $PRG_{Non\text{-}cancer}$ = 310 mg/kg
EPC for TNT = 17.9 mg/kg (95% UCL); 250 mg/kg (max)

$HI_{max\ conc}$ = (250 mg/kg × 1) ÷ ~~13,000~~ 310 mg/kg = 8.1E-01 ✓

Cancer $risk_{max\ conc}$ = (250 mg/kg × 1E-06) ÷ 57 mg/kg = 4.4E-06 ✓

$HI_{95\%\ UCL}$ = (17.9 mg/kg × 1) ÷ 310 mg/kg = 5.8E-02 ✓

Cancer $risk_{95\%\ UCL}$ = (17.9 mg/kg × 1E-06) ÷ 57 mg/kg = 3.1E-07 ✓

ATTACHMENT 2

Exhibit 14
Summary of UCL Calculation Methods

Method	Applicability	Advantages	Disadvantages	Reference
For Normal or Lognormal Distributions				
Student's *t*	means normally distributed, samples random	simple, robust if *n* is large	distribution of means must be normal	Gilbert 1987; EPA 1992
Land's *H*	lognormal data, small variance, large *n*, samples random	good coverage[1]	sensitive to deviations from lognormality, produces very high values for large variance or small *n*	Gilbert 1987; EPA 1992
Chebyshev Inequality (MVUE)	skewness and variance small or moderate, samples random	often smaller than Land	may need to resort to higher confidence levels for adequate coverage	Singh et al. 1997
Wong	gamma distribution	second order accuracy[2]	requires numerical solution of an improper integral	Schulz and Griffin 1999; Wong 1993
Nonparametric/Distribution-free Methods				
Central Limit Theorem - Adjusted	large *n*, samples random	simple, robust	sample size may not be sufficient	Gilbert 1987; Singh et al. 1997
Bootstrap t Resampling	sampling is random and representative	useful when distribution cannot be identified	inadequate coverage for some distributions; computationally intensive	Singh et al. 1997; Efron 1982
Hall's Bootstrap Procedure	sampling is random and representative	useful when distribution cannot be identified; takes bias and skewness into account	inadequate coverage for some distributions; computationally intensive	Hall 1988; Hall 1992; Manly 1997; Schultz and Griffin 1999
Jackknife Procedure	sampling is random and representative	useful when distribution cannot be identified	inadequate coverage for some distributions; computationally intensive	Singh et al. 1997
Chebyshev Inequality	skewness and variance small or moderate, samples random	useful when distribution cannot be identified	inappropriate for small sample sizes when skewness or variance is large	Singh et al. 1997; EPA 2000c

[1] Coverage refers to whether a UCL method performs in accordance with its definition.
[2] As opposed to maximum likelihood estimation, which offers first order accuracy.

CRANE 160 - OLD RIFLE RANGE - SURFACE SOIL
DESCRIPTIVE STATISTICS AND 95% UPPER CONFIDENCE LIMITS

PARAMETER	DETECTS	COUNT	AVERAGE	ACTUAL DISTRIBUTION	DETECTS - MAX	95% UCL
Semivolatile Organics (ug/kg)						
BENZO(A)ANTHRACENE	3	28	7	UNDEFINED	46	7
BENZO(A)PYRENE	5	28	8	UNDEFINED	70	8
BENZO(B)FLUORANTHENE	7	28	8	UNDEFINED	52	9
DIBENZO(A,H)ANTHRACENE	1	28	5	UNDEFINED	16	5
INDENO(1,2,3-CD)PYRENE	3	28	7	UNDEFINED	44	7
HEPTACHLOR EPOXIDE	1	28	1	UNDEFINED	3	1
Energetics (mg/kg)						
2,4,6-TRINITROTOLUENE	4	35	310	UNDEFINED	9900	377 (1)
2,6-DINITROTOLUENE	1	35	0.30	UNDEFINED	2	2 (2)
Inorganics (mg/kg)						
ARSENIC	28	28	8.2	LOGNORMAL	13.8	9.26
BERYLLIUM	1	28	0.48	UNDEFINED	0.98	0.483
MANGANESE	28	28	757	LOGNORMAL	1930	901

(1) Pre-VIM calculated Upper Confidence Limit.
(2) Bootstrap T UCL could not be calculated due to the random generation of data sets inability to have data variation.
The maximum concentration was defaulted as the 95% upper confidence limit.

CRANE 160 - OLD RIFLE RANGE - SURFACE SOIL
DESCRIPTIVE STATISTICS AND 95% UPPER CONFIDENCE LIMIT

PARAMETER	DETECTS	COUNT	AVERAGE	ACTUAL DISTRIBUTION	DETECTS - MAX	95% UCL (1)
Energetics (mg/kg)						
2,4,6-TRINITROTOLUENE	6	39	8	UNDEFINED	250	18

(1) UCL based on PROUCL Standard Bootstrap Calculation. Result of Post-VIM data results.

CRANE 160 - OLD RIFLE RANGE - SUBSURFACE SOIL
DESCRIPTIVE STATISTICS AND 95% UPPER CONFIDENCE LIMITS

PARAMETER	DETECTS	COUNT	AVERAGE	ACTUAL DISTRIBUTION	DETECTS - MAX	95% UCL
Semivolatile Organics (ug/kg)						
BENZO(A)ANTHRACENE	1	28	11	UNDEFINED	200	200 (1)
BENZO(A)PYRENE	1	28	10	UNDEFINED	180	180 (1)
BENZO(B)FLUORANTHENE	1	28	14	UNDEFINED	270	270 (1)
DIBENZO(A,H)ANTHRACENE	1	28	6	UNDEFINED	46	46 (1)
INDENO(1,2,3-CD)PYRENE	1	28	7.8	UNDEFINED	110	110 (1)
Energetics (mg/kg)						
2,4,6-TRINITROTOLUENE	1	35	0.4	UNDEFINED	4	4 (1)
Inorganics (mg/kg)						
ARSENIC	28	28	7.7	LOGNORMAL	15.4	8.8
BERYLLIUM	6	28	0.57	UNDEFINED	1.1	0.58
MANGANESE	28	28	758	NORMAL	1860	911

(1) Bootstrap T UCL could not be calculated due to the random generation of data sets inability to have data variation.
The maximum concentration was defaulted as the 95% upper confidence limit.

CRANE 160 - OLD PISTOL RANGE - SURFACE SOIL
DESCRIPTIVE STATISTICS AND 95% UPPER CONFIDENCE LIMITS

PARAMETER	DETECTS	COUNT	AVERAGE	ACTUAL DISTRIBUTION	DETECTS - MAX	95% UCL
Semivolatile Organics (ug/kg)						
BENZO(A)ANTHRACENE	1	18	4	UNDEFINED	9	4
BENZO(A)PYRENE	1	18	4	UNDEFINED	10	4
BENZO(B)FLUORANTHENE	2	18	6	UNDEFINED	22	6
Inorganics (mg/kg)						
ARSENIC	18	18	8.7	LOGNORMAL	12.8	9.7
BERYLLIUM	10	18	0.86	UNDEFINED	1.3	0.89
MANGANESE	18	18	1221	NORMAL	1960	1390

CRANE 160 - OLD PISTOL RANGE - SUBSURFACE SOIL
DESCRIPTIVE STATISTICS AND 95% UPPER CONFIDENCE LIMITS

PARAMETER	DETECTS	COUNT	AVERAGE	ACTUAL DISTRIBUTION	DETECTS - MAX	95% UCL
Inorganics (mg/kg)						
ARSENIC	18	18	12.7	LOGNORMAL	24.9	15.4
BERYLLIUM	13	18	1.2	UNDEFINED	1.9	1.2
MANGANESE	18	18	1303	NORMAL	2110	1543

ATTACHMENT 3

U.S. Environmental Protection Agency

Superfund

Soil Screening Guidance for Chemicals

SELECTION:

Method 1 was used

Your **Analytes** are:
Manganese (Water)
Your **Pathways** are
Soil to Groundwater
Default Parameters
Each pathway you have selected is given below along with the applicable Equations and its associated Default Parameters. For each equation, the default values will be used unless you enter a different value.

Soil to Ground Water

Soil Screening Level - METHOD 1
Partitioning Equation for Migration to Ground Water

$$SL(mg/kg) = C_w\left[K_d + \frac{(\theta_w + \theta_a H')}{\rho_b}\right]$$

1 dilution factor (used to calcualte C_w)

0.002 foc (fraction organic carbon in soil) g/g

0.3 θ_w (water-filled soil porosity) L_{water}/L_{soil}

1.5 ρ_b (dry soil bulk density) kg/L

2.65 ρ_s (soil particle density) kg/L

The dilution factor defaults to 20 for a 0.5-acre source. If you have all of the parameters needed to

Soil Screening Level - METHOD 2
Mass-Limit Equation for Migration to Ground Water

$$SL(mg/kg) = \frac{C_w \times I \times ED}{\rho_b \times d_s}$$

with:

$$\text{dilution factor} = 1 + \frac{Kid}{IL}$$

where:

$$d = (0.0112L^2)^{0.5} + d_a\left[1 - \exp\left(\frac{-I}{Kid_a}\right)\right]$$

0.18 I (Infiltration Rate) m/yr

1.5 ρ_b (dry soil bulk density) kg/L

70 ED (Exposure Duration) yr

0 d_s (depth of source) m - site-specific

K (aquifer hydraulic conductivity) m/yr

i (hydraulic gradient) m/m

L (source length parallel to

calculate a dilution factor, you may use method 2.	ground water flow) m [ ] d_a (aquifer thickness) m - site-specific **Do not use this method unless you have values for all of the parameters.**

Soil to Ground Water Notes

Method for Calculating Soil to Goundwater

Method 1 ◉ Method 2 ○

NOTES:

1. C_w(target soil leachate concentration) mg/L = nonzero MCLG, MCL, or HBL x dilution factor (which may be calculated or set to a site-specific default)
2. θ_a(air-filled soil porosity) $L_{air}/L_{soil} = n - \theta_w$
3. H' (dimensionless Henry's law constant) - chemical specific
4. n (total soil porosity) $L_{pore}/L_{soil} = 1-(\rho_b/\rho_s)$
5. K_d (soil-water partition coefficient) L/kg = K_{oc} x f_{oc} (organics) - chemical-specific
6. K_{oc} (soil organic carbon/water partition coefficient) L/kg - chemical specific
7. d (mixing zone depth) m - Calculated and used in the dilution factor equation.

You must select one of the following output options

◉ View on Screen

○ Tab delimited file

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RETRIEVE | clear selection

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Superfund

Superfund FOR KIDS!

Soil Screening Guidance for Chemicals

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Equation Values for Soil to Ground Water

Partitioning Equation Parameter	Value
Dilution factor (unitless)	1
Fraction organic carbon in soil (unitless)	0.002
Water-filled soil porosity (L_{water}/L_{soil})	0.3
Dry soil bulk density (kg/L)	1.5
Soil particle density (kg/L)	2.65

Soil Screening Levels for Soil to Ground Water (mg/kg)

Analyte	Cas Number	Ground Water Concentration* (mg/L)	Ground Water Concentration Source	Soil Screening Level
Manganese	7439965	1.7E+00	HBL	1.1E+02

110 mg/Kg

versus 50 ug/L

*Ground Water Concentration=Ground Water Concentration Source × Dilution Factor

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U.S. Environmental Protection Agency

Superfund

Soil Screening Guidance for Chemicals

SELECTION:

Method 1 was used

Your **Analytes** are:
Trinitrotoluene, 2,4,6-
Your **Pathways** are
Soil to Groundwater
Default Parameters
Each pathway you have selected is given below along with the applicable Equations and its associated Default Parameters. For each equation, the default values will be used unless you enter a different value.

Soil to Ground Water

Soil Screening Level - METHOD 1 Partitioning Equation for Migration to Ground Water

$$SL(mg/kg) = C_w\left[K_d + \frac{(\theta_w + \theta_a H')}{\rho_b}\right]$$

1 dilution factor (used to calcualte C_w)

0.002 foc (fraction organic carbon in soil) g/g

0.3 θ_w (water-filled soil porosity) L_{water}/L_{soil}

1.5 ρ_b (dry soil bulk density) kg/L

2.65 ρ_s (soil particle density) kg/L

The dilution factor defaults to 20 for a 0.5-acre source. If you have all of the parameters needed to

Soil Screening Level - METHOD 2 Mass-Limit Equation for Migration to Ground Water

$$SL(mg/kg) = \frac{C_w \times I \times ED}{\rho_b \times d_s}$$

with:

$$\text{dilution factor} = 1 + \frac{Kid}{IL}$$

where:

$$d = (0.0112L^2)^{0.5} + d_s\left[1 - \exp\left(\frac{-I}{Kid_s}\right)\right]$$

0.18 I (Infiltration Rate) m/yr

1.5 ρ_b (dry soil bulk density) kg/L

70 ED (Exposure Duration) yr

0 d_s (depth of source) m - site-specific

K (aquifer hydraulic conductivity) m/yr

i (hydraulic gradient) m/m

L (source length parallel to

calculate a dilution factor, you may use method 2.	ground water flow) m [ ] d_a (aquifer thickness) m - site-specific **Do not use this method unless you have values for all of the parameters.**

Soil to Ground Water Notes

Method for Calculating Soil to Goundwater

Method 1 ◉ Method 2 ○

NOTES:

1. C_w(target soil leachate concentration) mg/L = nonzero MCLG, MCL, or HBL x dilution factor (which may be calculated or set to a site-specific default)
2. θ_a(air-filled soil porosity) $L_{air}/L_{soil} = n - \theta_w$
3. H' (dimensionless Henry's law constant) - chemical specific
4. n (total soil porosity) $L_{pore}/L_{soil} = 1-(\rho_b/\rho_s)$
5. K_d (soil-water partition coefficient) L/kg = K_{oc} x f_{oc} (organics) - chemical-specific
6. K_{oc} (soil organic carbon/water partition coefficient) L/kg - chemical specific
7. d (mixing zone depth) m - Calculated and used in the dilution factor equation.

You must select one of the following output options

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Soil Screening Guidance for Chemicals

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Equation Values for Soil to Ground Water

Partitioning Equation Parameter	Value
Dilution factor (unitless)	1
Fraction organic carbon in soil (unitless)	0.002
Water-filled soil porosity (L_{water}/L_{soil})	0.3
Dry soil bulk density (kg/L)	1.5
Soil particle density (kg/L)	2.65

Soil Screening Levels for Soil to Ground Water (mg/kg)

Analyte	Cas Number	Ground Water Concentration* (mg/L)	Ground Water Concentration Source	Soil Screening Level
Trinitrotoluene, 2,4,6-	118967	2.8E-03	HBL	5.7E-04

*Ground Water Concentration=Ground Water Concentration Source × Dilution Factor

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Similar to 2.2 mg/L used in Kansas comments

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ATTACHMENT 4

8.0 OLD RIFLE RANGE GROUND WATER MONITORING

This section contains a description of the ground water monitoring programs at the NSWC Crane ORR. Ground water monitoring is being conducted at the ORR to meet the requirements of 40 CFR 264 Subpart F.

8.1 GROUND WATER MONITORING AT THE OLD RIFLE RANGE [40 CFR 264 SUBPART F]

Compliance Monitoring [40 CFR 264.99]

Interim status ground water monitoring results show that hazardous constituents have entered the ground water. Therefore, in compliance with 40 CFR 264.99, a compliance-monitoring program is being implemented at the ORR to determine whether the ORR is in compliance with the ground water protection standard established under 40 CFR 264.92.

Table 8-1 lists each of the monitoring points at the ORR and the purposes for which each point is being monitored. Table 8-2 lists the analyses conducted at each monitoring point each quarter. Table 8-3 lists the analyses conducted during the annual Appendix IX monitoring. Figure 8-1 shows the locations of the ground water monitoring points at the ORR. The upgradient well for the ORR screened in the Big Clifty/Beech Creek aquifer, 06C08, is also the upgradient well for the DR. Figure 9-1 shows the location of this well in relation to the DR and ORR.

8.2 COMPLIANCE MONITORING [40 CFR 264.99]

Compliance-monitoring programs at the ORR must meet the requirements of 40 CFR 264.99.

40 CFR 264.99(a) requires that ground water be monitored to determine whether regulated units are in compliance with ground water protection standards under 264.92. The permit must specify the following:

- A list of hazardous constituents identified under 264.93.
- Concentration limits under 264.94 for each hazardous constituent. Concentration limits must not exceed background at the time that limit is specified in the permit, or the specified concentrations for constituents listed in Table 1 of 264.94, or alternate limits established by the regional administrator.

TABLE 8-1

OLD RIFLE RANGE
MONITORING WELL SUMMARY
NAVAL SURFACE WARFARE CENTER
CRANE, INDIANA

Wells	Screened Formation	Objective
06C08	BC/BC	Upgradient
06C11	BC/BC	Downgradient (POC)
06C11P2	BCU	Downgradient (POC)
06C12	BC/BC	Downgradient (POC)
06C13	BC/BC	Downgradient (POC)
06C13P2	BCU	Downgradient (POC)
06C14	BC/BC	Downgradient (POC)
06C14P2	BCU	Upgradient
06C15	BC/BC	Downgradient (POC)
06C16	BC/BC	Downgradient (POC)
06C18	BC/BC	Downgradient (POC)
06C18P2	BCU	Downgradient (POC)
06C19	BC/BC	Downgradient
06C19P2	BCU	Downgradient

Notes:

BCU - Big Clifty Upper
BC/BC - Big Clifty/Beech Creek
POC - Point-of-Compliance

TABLE 8-2

OLD RIFLE RANGE
QUARTERLY MONITORING
NAVAL SURFACE WARFARE CENTER
CRANE, INDIANA

Wells	Field[1]	Explosives[1]	Ammonia	Appendix IX Metals[1] (Total)	Appendix IX Metals[1] (Dissolved)	Cyanide	TOX	TOC
06C08[2]	A	A, C	•	A, D	A, D	•	•	•
06C11	A	A, C	•	A, D	A, D	•	•	•
06C11P2	A	A, C	•	A, D	A, D	•	•	•
06C12	A	A, C	•	A, D	A, D	•	•	•
06C13	A	A, C	•	A, D	A, D	•	•	•
06C13P2	A	A, C	•	A, D	A, D	•	•	•
06C14	A	A, C	•	A, D	A, D	•	•	•
06C14P2	A	A, C	•	A, D	A, D	•	•	•
06C15	A	A, C	•	A, D	A, D	•	•	•
06C16	A	A, C	•	A, D	A, D	•	•	•
06C18	A	A, C	•	A, D	A, D	•	•	•
06C18P2	A	A, C	•	A, D	A, D	•	•	•
06C19	A	A, C	•	A, D	A, D	•	•	•
06C19P2	A	A, C	•	A, D	A, D	•	•	•

1 The letters A, B, C, etc. indicate subsets of the parameter group shown in the column headings. Specific parameters included in each subset are listed in Appendix D of the approved FSP.

2 Monitoring well 06C08 is also an upgradient well for the DR. Analyses are also listed in Table 9-2.

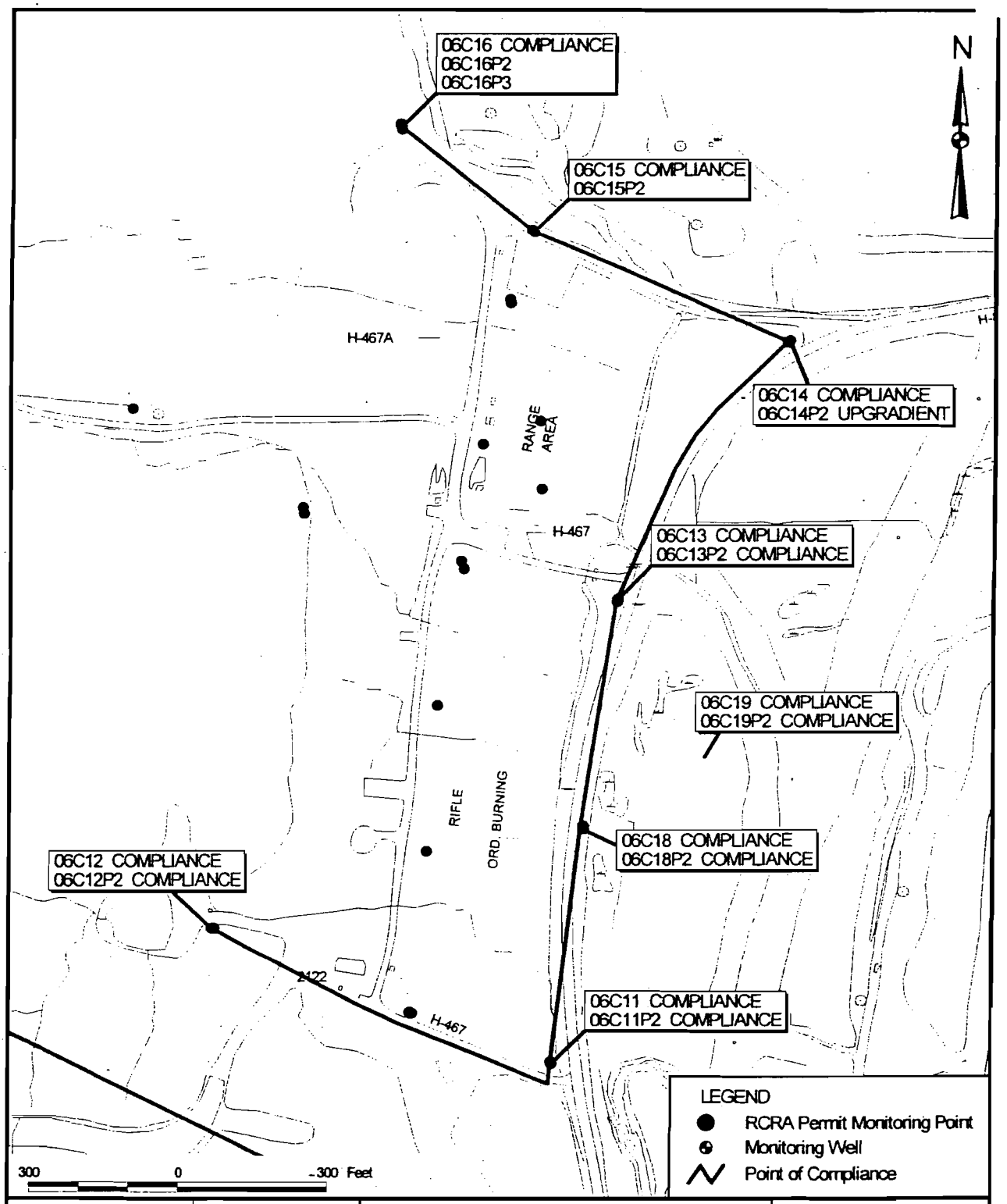
TABLE 8-3

OLD RIFLE RANGE
ANNUAL APPENDIX IX GROUND WATER MONITORING
NAVAL SURFACE WARFARE CENTER
CRANE, INDIANA

Wells	Appendix IX Volatile Organic Compounds (1)	Appendix IX Semivolatile Organic Compounds (1)	Appendix IX Pesticides/ PCBs (1)	Appendix IX Herbicides (1)	Dioxins/ Furans (1)	Sulfide
06C08	A	A	A	A	A	•
06C11	A	A	A	A	A	•
06C11P 2	A	A	A	A	A	•
06C12	A	A	A	A	A	•
06C13	A	A	A	A	A	•
06C13P 2	A	A	A	A	A	•
06C14	A	A	A	A	A	•
06C14P 2	A	A	A	A	A	•
06C15	A	A	A	A	A	•
06C16	A	A	A	A	A	•
06C18	A	A	A	A	A	•
06C18P 2	A	A	A	A	A	•
06C19	A	A	A	A	A	•
06C19P 2	A	A	A	A	A	•

1 The letters A, B, C, etc. indicate subsets of the parameter group shown in the column headings. Specific parameters included in each subset are listed in Appendix D of the approved FSP.

Note: Annual Appendix IX monitoring will be performed in conjunction with quarterly monitoring.



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SCALE AS NOTED	

OLD RIFLE RANGE
POINT OF COMPLIANCE WELLS & UNIT BOUNDARY
NAVAL SURFACE WARFARE CENTER
CRANE, INDIANA

CONTRACT NUMBER	
—	
APPROVED BY —	DATE —
APPROVED BY —	DATE —
DRAWING NO. FIGURE 8-1	REV 0

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- The compliance point under 264.95.

- The compliance period under 264.96.

NSWC Crane meets these requirements for compliance monitoring at the ORR. Hazardous constituents identified under 40 CFR 264.93 that will be monitored include metals. In addition to metals, explosives will be monitored. A detailed listing of constituents, including hazardous constituents, in each of these categories is included in Table 1-2. Alternate concentration limits (risk-based target levels), established under 40 CFR 264.94(a)(3), are also listed in Table 1-2. The compliance point at which the ground water protection standard applies is the vertical surface located at the hydraulically downgradient limit of the waste management area. Figure 8-1 shows the compliance point. The period of compliance will include the entire active life of the ORR and the closure period. The compliance period will be extended if corrective action is occurring at the ORR until it is demonstrated for a period of 3 years that the ground water protection levels (risk-based target levels listed in Table 1-2) are attained.

40 CFR 264.99(b) requires the installation of a ground water monitoring system at the compliance point. The ground water monitoring system must represent the quality of ground water passing the point of compliance [264.97(a)(2)]. Where the facility contains more than one regulated unit, separate ground water monitoring systems are not required for each regulated unit if the provisions for sampling will enable detection and measurement of hazardous constituents that have entered the ground water. The waste management area is described by an imaginary line circumscribing the several regulated units (40 CFR 264.95(b)(2). Monitoring wells must meet the casing, screening, and annual space sealing requirements in 40 CFR 264.97(c). NSWC Crane meets these requirements. Compliance ground water monitoring wells at the ORR are placed at the edge of the waste management area and monitor ground water in the uppermost aquifer system. Table 8-1 lists the ORR compliance wells. Figure 8-1 shows the locations of these wells at the compliance point. The ORR contains several waste management units. Figure 8-1 shows that a line circumscribing the regulated units describes the waste management area. The ORR monitoring wells meet the construction requirements of 40 CFR 264.97(c). ORR monitoring well construction diagrams are shown in Figure 6-5.

40 CFR 264.99(c) requires the specification of sampling procedures and statistical methods appropriate for the constituents and the facility, consistent with 264.97(g) and (h). 40 CFR 264.97(g) requires that data be collected on each hazardous constituent specified in the permit at background and compliance point wells. The numbers and kinds of samples collected to establish background will be appropriate for

the form of statistical test employed. The sampling procedure must consist of a sequence of at least four samples taken at intervals sufficient to assure that an independent sample is obtained that considers the aquifer's characteristics and the fate and transport characteristics of the potential contaminants. 40 CFR 26497(h) contains requirements for statistical evaluations. NSWC Crane will collect data each quarter at the ORR background and compliance point wells listed in Table 7-1. After four rounds of data are available, background will be re-established and statistical comparisons will be made to downgradient wells. Statistical procedures are described in Section 10.

40 CFR 264.99(d) requires the determination at the frequency specified in the permit, of whether there is statistically significance evidence of increased contamination for chemical parameters or hazardous constituents specified in the permit. The statistical method must meet 40 CFR 264.97(h) requirements. A time period for completion of statistical evaluations must be included in the permit. NSWC Crane will conduct four rounds of ground water sampling and re-establish background concentrations for the ORR. After background is re-established, statistical evaluations will be conducted each quarter. The statistical evaluation procedure contained in Section 10 meets the requirements of 40 CFR 264.97(h). Results of the statistical evaluations will be submitted to the Regional Administrator within 45 days of the date that the complete analytical results are available from the laboratory.

40 CFR 264.99(e) requires annual determination of ground water flow rate and direction in the uppermost aquifer. NSWC Crane will prepare an annual ground water monitoring report, as described in Section 1.3.4. This report will include maps showing ground water flow rate and direction for the Big Clifty Upper and Big Clifty/Beech Creek aquifers. Appendix 6-1 describes how the ground water flow rates and direction will be determined.

40 CFR 264.99(f) requires specification in the permit of the frequencies for collecting samples and conducting statistical tests in accordance with 264.97(g). NSWC Crane will collect data each quarter at the ORR background and compliance point wells listed in Table 7-1. After four rounds of data are available, background will be re-established and statistical comparisons will be made to downgradient wells. Once background is re-established, statistical evaluations will be conducted every quarter.

40 CFR 264.99(g) requires analysis of samples, at least annually, from all wells at the compliance point for all constituents contained in Appendix IX, part 264, to determine whether additional hazardous constituents have entered the ground water. Requirements for confirmation analysis, reports to the regional administrator, and additions of new hazardous constituents to the monitoring list are included.

NSWC will annually monitor wells at the ORR compliance point for Appendix IX constituents. If these analyses show the presence of hazardous constituents in the ground water that are not already identified in the permit as monitoring requirements, the wells may be resampled within 1 month to confirm the presence of the hazardous constituents. If this is confirmed, NSWC Crane will report the concentrations of these additional hazardous constituents to the regional administrator within 7 days and add them to the compliance-monitoring list. If NSWC Crane chooses not to resample the wells, the concentrations will be reported to the regional administrator within 7 days and added to the monitoring list.

40 CFR 264.99(h) contains requirements for notification and submission of a permit modification for establishment of a Corrective Action Program where concentration limits established under 264.94 are being exceeded. NSWC will implement the procedures described in Section 1.3.2.3 if it is determined that the alternate concentration limits (risk-based target levels) listed in Table 1-2 are exceeded for any compliance well at the ORR.

40 CFR 264.99(i) contains procedures for demonstrations that sources other than the regulated unit caused the exceedence at the compliance point. NSWC Crane will notify the regional administrator that a demonstration will be made that the contamination is not due to the regulated unit if contamination resulting in exceedence(s) of the ground water protection standard at the compliance point are not due to the regulated unit (ORR). This notification will be made within 7 days after the completion of the analysis.

If it is determined that the compliance monitoring program no longer meets the requirements of Subpart F, 40 CFR 264(99)(j), within 90 days, a permit application will be submitted for a permit modification for appropriate changes. NSWC Crane will evaluate the compliance-monitoring program at the ORR each quarter. If it is determined that the ORR compliance monitoring program no longer meets 40 CFR 264 Subpart F requirements, NSWC Crane will submit a permit application to modify the ORR ground water monitoring program to meet the requirements of 264 Subpart F.

The ORR compliance-monitoring program must also meet the general ground water monitoring requirements described in 40 CFR 264.97. Compliance with general ground water monitoring requirements is described in Section 6.

FIELD PARAMETERS SUBSET A

Measured by meter:
Dissolved oxygen (DO)
pH
Specific conductance (SC)
Temperature (T)
Turbidity
Oxidation-reduction potential (ORP)
Water level (by water level meter)

FIELD PARAMETERS SUBSET B

Measured by test kit:
Alkalinity (carbonate, bicarbonate, hydroxide)

FIELD PARAMETERS SUBSET C

Measured by test kit:
Carbon dioxide
Dissolved oxygen
Ferrous iron
Hydrogen sulfide
Nitrite
Nitrate

VOLATILES SUBSET A

Appendix IX volatiles listed in Table 1-3 of the approved QAPP

VOLATILES SUBSET B

Trichloroethene (TCE)
1,1-Dichloroethene
cis-1,2-Dichloroethene
trans-1,2-Dichloroethene
Vinyl chloride

VOLATILES SUBSET C

Benzene
Toluene
Ethylbenzene
Total xylenes
Tetrachloroethene
1,1,1-Trichloroethane
1,1-Dichloroethane
1,2-Dichloroethane
Carbon tetrachloride
Chloroethane
Chloroform
Methylene chloride

DISSOLVED GASES SUBSET A

Methane
Ethane
Ethene

SEMIVOLATILES SUBSET A

Appendix IX semivolatile organic compounds listed in Table 1-3 of the approved QAPP.

PESTICIDES/PCBs SUBSET A

Appendix IX pesticide/PCB compounds listed in Table 1-3 of the approved QAPP.

HERBICIDES SUBSET A

Appendix IX herbicides listed in Table 1-3 of the approved QAPP.

METALS SUBSET A

Appendix IX metals listed in Table 1-3 of the approved QAPP.

METALS SUBSET B

Iron

METALS SUBSET C

Potassium
Sodium
Calcium
Magnesium

METALS SUBSET D

Manganese

DIOXINS/FURANS SUBSET A

Appendix IX dioxins/furans listed in Table 1-3 of the approved QAPP.

EXPLOSIVES SUBSET A

1,3,5-Trinitrobenzene
1,3-Dinitrobenzene
TNT
2,4-Dinitrotoluene
2,6-Dinitrotoluene
HMX
2-Nitrotoluene
3-Nitrotoluene
4-Nitrotoluene
4-Amino-2,6-dinitrotoluene
2-Amino-4,6-dinitrotoluene
Tetryl
Nitrobenzene
RDX
Nitroglycerin
PETN
Nitrocellulose

EXPLOSIVES SUBSET B

2,4-Diamino-6-nitrotoluene
2,6-Diamino-4-nitrotoluene
2,2',6,6'-Tetranitro-4,4'-azoxytoluene
3,5-Dinitroaniline
TNX
MNX
Picric acid

EXPLOSIVES SUBSET C

Picric acid
Picramic acid

REVISED SECTION 4

PHASE III SOILS RFI

NSWC CRANE SWMU 7

OLD RIFLE RANGE

4.0 HUMAN HEALTH SCREENING EVALUATION

This section presents the results of the human health screening evaluation (HHSE) of chemical concentrations detected in surface and subsurface soil samples collected at the Old Rifle Range (ORR) and Old Pistol Range (OPR), SWMU 7, in 2001, 2002, and 2003. Information on the selection of chemicals of potential concern (COPCs), exposure assessment, characterization of estimated potential human health risks, uncertainty analyses, and summary and conclusions for the risk screening are contained in Sections 4.1, 4.2, 4.3, 4.4, and 4.5, respectively. This HHSE reflects the risks presented by the site following implementation of a Voluntary Interim Measure (VIM) conducted in the summer of 2003 to remove a localized area of elevated 2,4,6-trinitrotoluene (TNT) contamination at the ORR (the complete VIM Report is provided in Appendix I).

4.1 CHEMICALS OF POTENTIAL CONCERN

COPCs for this HHSE are identified below and are those chemicals detected in the ORR and OPR surface and subsurface soil samples at maximum concentrations exceeding the Region 9 industrial or residential preliminary remediation goals (PRGs), and the site-specific background concentrations (See Tables 4-1 through 4-8):

SITE	LAND USE	SOIL	COPCs
Old Rifle Range	Industrial	Surface	2,4,6-trinitrotoluene Arsenic
Old Rifle Range	Industrial	Subsurface	None
Old Rifle Range	Residential	Surface	Benzo(a)pyrene 2,4,6-trinitrotoluene Arsenic
Old Rifle Range	Residential	Subsurface	Benzo(a)pyrene 2,4,6-trinitrotoluene
Old Pistol Range	Industrial	Surface	Arsenic
Old Pistol Range	Industrial	Subsurface	Arsenic Manganese
Old Pistol Range	Residential	Surface	Arsenic
Old Pistol Range	Residential	Subsurface	Arsenic Manganese

Prior to VIM activities, 2,4,6-TNT was detected in 4 of 35 surface soil samples at the ORR at a concentration range of 0.71 to 9,900 mg/kg. All positive 2,4,6-TNT detections were reported for locations in the general vicinity (to the north/northwest) of the RCRA-permitted burn pit area. Analytical

results reported for all other locations samples (see Figure 3-17) were less than PRGs indicating that the 2,4,6-TNT contamination was in a highly localized area (less than 1 acre in size) only and the contamination was not pervasive across SWMU 7. Non-detect analytical results for borings to the southwest, south, and northeast supported this conclusion. Based on this highly localized area of 2,4,6-TNT contamination, and the fact that 2,4,6-TNT was the predominant soil contaminant at the ORR, the Navy decided to conduct the VIM. A thorough discussion of VIM activities is provided in Appendix I. Preceding VIM activities, the maximum concentration of 2,4,6-TNT was 9,900 mg/kg. Following VIM activities, the maximum concentration reported for 2,4,6-TNT was 250 mg/kg.

4.2 EXPOSURE ASSESSMENT

This section presents the exposure assessment for the ORR and OPR. The ORR is a relatively flat, rectangular area approximately 20 acres in size. The site is mostly grass-covered and is bisected from north to south by a maintained gravel road. The OPR is an area approximately 10 acres in size and is located immediately adjacent and to the north of the ORR.

There is a RCRA-permitted burn pit located in the north-central part of the ORR. It is permitted for burning Yellow D (ammonium picrate) powder. The maximum concentrations of 2,4,6-TNT and 2,6-dinitrotoluene (2,6-DNT) were reported for borings located close to, and to the north of this area. The kriged area of 2,4,6-TNT concentrations exceeding the RBTL prior to the VIM conducted in 2003 is shown in Figure 3-17. Energetics were either detected at low concentrations or were not detected in surface and subsurface soil samples collected outside this area.

The base does not have any current plans to develop SWMU 7. Consequently, under current and anticipated future land use, the following receptors are the most likely individuals to be exposed to COPCs in soils at the site:

- **Base personnel engaged in site maintenance activities (grass mowing, etc.) or minor construction activities.** The facility reports that grass mowing and minor construction activities occur a couple of times a year.

- **Base personnel engaged in ammunition burning** (e.g., flashing of metal scrap from the Demolition Range). The facility reports that this is estimated to occur approximately five to six days per year; approximately four hours per day. The facility also reports that routine demolition of Yellow D may occur at the ORR (approximately six days a week) at some time in the future. However, both military and civilian workers assigned to NWSC Crane work a typical 5 day/40 hours per week schedule.

Risks associated with RCRA-permitted treatment activities at SWMU 7 are addressed in the RCRA Subpart X permit for this operation.

- **Trespassers.** These receptors may be exposed to COPCs in surface soils via direct contact (i.e., incidental ingestion and dermal contact) or via inhalation of airborne soil particulates from the site. Exposure to subsurface soil and groundwater is unlikely because these receptors are not expected to be engaged routinely in ground-intrusive activities. However, for the purposes of this risk screening, the exposure assessment will assume that a hypothetical future resident or typical industrial worker may be exposed to the COPCs in surface or subsurface soils. The exposure assessment assumptions (e.g., soil ingestion rates, etc.) are those specified in the calculation of the Region 9 PRGs for the hypothetical future resident and the typical industrial worker (Appendix H, Attachment 1). Risk estimates are not calculated for the trespasser because he/she would be exposed less frequently than a hypothetical resident or an industrial worker. Consequently, any risk management decisions based on the results of the hypothetical resident or an industrial worker will be protective of the trespasser. Risk Based Target Levels for this project were developed as described in Section 1.4.1.2 of the approved QAPP.

4.3 RISK CHARACTERIZATION

Tables 4-9 through 4-15 present the results of the risk characterization conducted for this HHSE. Cancer and non-cancer risk estimates were developed for the hypothetical future resident and typical industrial worker using exposure point concentrations (EPCs) as determined according to guidance presented in the U.S. EPA reference titled, ***Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites*** (December, 2002) and available Region 9 PRGs. Prior to the calculation of the EPC, the distribution of a data set (normal, lognormal, undefined) was determined using the Shapiro-Wilk W-test. Then, the 95 percent upper confidence limit (UCL) for the arithmetic mean was calculated per methodologies presented in the guidance. The UCLs for data sets determined to be normally distributed were calculated using the Student's *t* statistic. The UCLs for data sets determined to be lognormally distributed were calculated using the Land method. The UCLs for data sets not determined to be normally or lognormally distributed were calculated using the non-parametric Standard Bootstrap Procedure. The resulting 95% UCL for a parameter was compared to the maximum detected concentration in the data set and was selected as the EPC if the 95 % UCL was less than the maximum detected concentration. Otherwise, the maximum detected concentration was selected as the EPC. The EPA Region 9 PRGs represent the 1E-06 cancer risk level for carcinogenic chemicals (i.e., one additional cancer risk in one million people exposed) and a Hazard Index of 1 (i.e., the no adverse effect

concentration) for non-carcinogens. Thus, risk estimates were developed using a simple ratioing technique:

$$\frac{\text{EPA Region 9 PRG}}{\text{EPC for COPC}} = \frac{\text{Hazard Index of 1 or Cancer Risk Estimate of 1E - 06}}{\text{?? Hazard Index or Cancer Risk Estimate}}$$

Risk estimates for the hypothetical future resident and the typical industrial worker are summarized below:

	Old Rifle Range		Old Pistol Range	
	Surface Soil[1]	**Subsurface Soil**	**Surface Soil**	**Subsurface Soil**
Hazard Index (Industrial land use)	9.4E-02	NA	3.7E-02	8.1E-02
Cancer Risk Estimate (Industrial land use)	6.1E-06	NA	6.1E-06	9.6E-06
Hazard Index (Residential land use)	1.0 E+00	1.2E-01	4.4E-01	1.6[2]
Cancer Risk Estimate (Residential land use)	2.5E-05	3.1E-06	2.5E-05	3.9E-05

1 Cancer risk estimates and Hazard Indices based on the pre-VIM maximum 2,4,6-TNT concentration (9,900 mg/kg) exceeded 1E-04 and 1, respectively. However, following completion of VIM activities, cancer risk estimates and hazard indices associated with 2,4,6-TNT (95% UCL concentrations) do not exceed 1E-05 and 1, respectively. Cancer risk estimates and hazard indices for the industrial worker based on the maximum post-VIM 2,4,6-TNT concentration (250 mg/kg) do not exceed 2E-05 and 1, respectively. Post-VIM activities, arsenic is the primary COPC contributing to cancer risk estimates.

2 The hazard index summed for arsenic (0.7) and manganese (0.9) **marginally** exceed 1; adverse non-carcinogenic health effects are not anticipated.

The cancer risk estimates presented above do not exceed the EPA risk management range (1E-04 to 1E-06 [i.e., one additional cancer risk in ten thousand exposed individuals to one additional cancer risk in one million exposed individuals]) often used by the EPA to determine the need for environmental remediation or set standards and criteria. However, risk estimates calculated for arsenic in surface and/or subsurface soils at the ORR and OPR, for 2,4,6-TNT in the surface soils at the ORR, and for benzo(a)pyrene in subsurface soils at the ORR have associated risks exceeding the lower bound of the U.S. EPA's risk range (i.e., 1E-06). Only the cancer risks developed for arsenic (hypothetical future resident) exceed the 1E-05 risk level. (Over 95 percent of the carcinogenic risk estimated for the surface soils at the ORR is attributable to arsenic.) Because the risks associated with arsenic and benzo(a)pyrene total 4E-05 or less and are within the range of background and because the risks associated with 2,4,6-TNT are less than 1E-05, decisions regarding the need to remediate these constituents will be deferred until closure of the unit. Additionally, it should be noted that the ORR will continue to be used for ammunition burning and

that additional contaminants may be added to the soils as a result of the Subpart X open burning. Risks associated with any additional contamination will also be evaluated during the closure of the unit.

The total hazard indices calculated for the ORR surface and subsurface soils are equal to, or less than the EPA benchmark of 1.0. At the ORR, 2,4,6-TNT is the major contributor to the non-carcinogenic risk. The hazard index calculated for the hypothetical future resident exposed to COPCs in subsurface soils at the OPR marginally exceeds the EPA benchmark of 1. Arsenic and manganese are the major contributors to the non-carcinogenic risk at the OPR; however, adverse non-carcinogenic health effects are not anticipated for exposure to these metals.

Risk estimates for 2,4-6-TNT for ***current workers infrequently visiting*** the site two days a year (i.e., as described above, mowing the grass, minor construction or maintenance activities) are less than the aforementioned EPA cancer and non-cancer risk benchmarks (see Appendix H, Attachment 2):

- Cancer estimate: 2.5E-09
- Non-cancer risk estimate (hazard index): 4.6E-04

These risk estimates are less than those presented previously for the typical industrial worker because of the infrequent nature of the exposure (i.e., the PRGs for the typical industrial worker assume ***daily*** exposure to site soils). The risk estimates presented in Appendix H, Attachment 2 were calculated using the 95% UCL concentration as the exposure point concentration (17.9 mg/kg) and exposure assumptions used to calculate the PRG for the industrial worker except that it was assumed that this worker visits the site 2 days a year only. (Risk estimates based on the maximum, post-VIM 2,4,6-TNT concentration (250 mg/kg) are 6.4E-03 [hazard index] and 3.5E-08 [cancer risk estimate]).

Risk estimates for 2,4,6-TNT for ***current/future workers*** who may engage in RCRA-permitted burning activities five or six days a year (i.e., as described previously, flashing of scrap metal, demolition of Yellow D) are less than the aforementioned EPA cancer and non-cancer risk benchmarks (see Appendix H, Attachment 3):

- Cancer estimate: 7.5E-09
- Non-cancer risk estimate (hazard index): 1.4E-03

The risk estimates are less than those presented previously for the typical industrial worker because of the infrequent nature of the exposure (i.e., the PRGs for the industrial worker assume ***daily*** exposure to site soils). The risk estimates presented in Appendix H, Attachment 3 were calculated using the 95% UCL concentration as the exposure point concentration (17.9 mg/kg) and the exposure assumptions used to calculate the PRG for the industrial worker except that it was assumed that this worker visits the site 6 days a year only. (Risk estimates based on the maximum, post-VIM 2,4,6-TNT concentration (250 mg/kg) are 1.9E-02 [hazard index] and 1E-07 [cancer risk estimate]).

As summarized on Tables 4-16 through 4-19, 2,4,6-TNT, 2,6-dinitrotoluene, benzo(a)anthracene, benzo(b)fluoranthene, arsenic, and manganese were the COPCs detected in surface or subsurface soils at concentrations exceeding EPA SSLs for the migration of chemicals from soils to groundwater using a DAF of 1. 2,4,6-TNT and 2,6-dinitrotoluene were discussed previously. Based on analytical data presented in the CCCRA, benzo(a)anthracene was selected as a COPC for the human health risk assessment of groundwater contaminants presented in that assessment (benzo[b]fluoranthene was not). However, as discussed in Section 4.4, PAHs were detected ***very infrequently*** in soil samples at the ORR. Consequently, the soils are unlikely to be a significant continuing source of contamination to groundwater. Arsenic and manganese were also selected as COPCs for groundwater in the CCCRA. However, based on the statistics and discussions presented in Section 3.0, arsenic and manganese in the surface and subsurface soils at the ORR and the OPR also do not present a significant source of contamination to groundwater. Manganese was not detected in surface soil samples from the ORR and the OPR or in the subsurface soil samples from the ORR at concentrations exceeding background. The manganese concentrations in the subsurface soils at the OPR marginally exceed background, if at all. Arsenic was not detected in the subsurface soils at the ORR at concentrations exceeding background. The statistical analyses and kriging plots presented in Section 3 suggest that the arsenic concentrations in the surface soils at the ORR and the OPR and in the subsurface soils at the ORR are marginally greater than background concentrations. The areal extent of the arsenic contamination is very limited.

On-going environmental monitoring of the ORR is covered under NSWC Crane's Subpart X Permit for this operating unit.

4.4 UNCERTAINTY ANALYSIS

The following sources of uncertainty should be considered when interpreting the results of this HHSE and all of the analytical results for surface and subsurface soils at SWMU 7:

The following metals were detected at maximum concentrations exceeding COPC screening levels but were eliminated as COPCs based on the comparison of site concentrations to background concentrations:

- Manganese in surface soils at the ORR (C_{max} = 1930 mg/kg; 95 % UCL = 901 mg/kg).
- Arsenic in subsurface soils at the ORR (C_{max} = 15.4 mg/kg; 95 % UCL = 8.76 mg/kg).
- Manganese in subsurface soils at the ORR (C_{max} = 1860 mg/kg; 95 % UCL = 911 mg/kg).
- Manganese in surface soil at the OPR (C_{max} = 1960 mg/kg; 95 % UCL = 1390 mg/kg).

The maximum manganese concentrations detected in the surface and subsurface soils at the ORR and in the surface soil at the OPR exceed the current Region 9 PRG for residential land use (1,800 mg/kg). However, the 95% UCL concentrations do not. Consequently, HIs developed based on the 95% UCL and the PRG would not exceed 1. The arsenic concentrations in the subsurface soils at the ORR also exceed the Region 9 PRG for residential land use (0.39 mg/kg). The PRG for arsenic is set at the $1x10^{-6}$ cancer risk level. Consequently, the maximum arsenic concentration detected in the ORR subsurface soils would be associated with $4x10^{-5}$ cancer risk level assuming a residential land use scenario. The 95 % UCL concentration for the ORR subsurface soils is 8.76 mg/kg. This concentration is associated with a $2.3x10^{-5}$ cancer risk level assuming a residential land use scenario.

- Five carcinogenic PAHs (benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, dibenzo[a,h]anthracene, indeno[1,2,3-cd]pyrene) were selected as COPCs for the human health risk assessment of soil contaminants in the CCCRA (TtNUS, 1999a). (The CCCRA risk assessment was based on 4 samples only.) Consequently, additional surface and subsurface soil samples were collected and analyzed for these carcinogenic PAHs in 2001. The maximum detected concentrations detected in the 2001 soil samples are now an order of magnitude less than those reported in the CCCRA (TtNUS, 1999a) and the data suggest that the carcinogenic PAHs are not pervasive contaminants at the site:

Analytical Results for ORR

Parameter	CCCRA Results Max/Mean (mg/kg)	2001 Results Max/Mean (mg/kg) Surface (Subsurface)	PRG (Res) (mg/kg)	PRG (Ind) (mg/kg)
Benzo(a)anthracene	2.5/0.62	**0.046/0.0065 (0.2/0.011)**	0.62	2.9
Benzo(a)pyrene	2.8/0.669	**0.07/0.008 (0.18/0.0103)**	0.062	0.29
Benzo(b)fluoranthene	3.7/0.807	**0.052/0.0084 (0.27/0.0135)**	0.62	2.9
Dibenzo(a,h)anthracene	0.84/0.036	**0.016/0.0051 (0.046/0.00552)**	0.062	0.29
Indeno(1,2,3-cd)pyrene	2.2/0.57	**0.044/0.0065 (0.110/0.0078)**	0.62	2.9

As noted above, only benzo(a)pyrene was detected in the 2001 samples at a maximum concentration exceeding (marginally) a PRG. Process/site knowledge suggests that PAHs were not anticipated to be site-related contaminants. A review of literature regarding anthropogenic background concentrations of PAHs indicate that non-site related anthropogenic sources may have contributed to the PAH concentrations noted in the surface and subsurface soils. (see Appendix H, Attachment 4). Additionally, the following information, summarized from Tables 3-6 through 3-8, supports the conclusion that PAHs are not significant soil contaminants at SWMU 7:

Analytical Data (2001) for ORR and OPR

PAH	Frequency of Positive Detections	Number of Results (including duplicates) Above RBTL	Location of RBTL Exceedances and Concentrations	Magnitude of Exceedance
Benzo(a)anthracene	5 out of 92	1 out of 92	SB04 at 2-4' bgs 200ug/kg vs. 80ug/kg RBTL	2.5 times the RBTL
Benzo(a)pyrene	7 out of 92	2 out of 92	SB04 at 1-2' bgs 70ug/kg vs. 62ug/kg RBTL SB04 at 2-4' bgs 180ug/kg vs. 62ug/kg RBTL	1.1 times the RBTL 2.9 times the RBTL
Benzo(b)fluoranthene	10 out of 92	1 out of 92	SB04 at 2-4' bgs 270ug/kg vs. 200ug/kg RBTL	1.4 times the RBTL

- The Region 9 PRG for manganese in soil assuming a residential land use scenario (1,800 mg/kg) is based on a reference dose (i.e., the non-carcinogenic toxicity criteria) of 0.024 mg/kg/day. However, based on guidance received courtesy EPA Region 1, a more appropriate risk-based concentration would be 5,500 mg/kg. The current RfD presented on IRIS is 0.14 mg/kg/day and the RfD presented in the Region 9 table is 0.024 mg/kg/day which is the RfD modified by subtracting the average dietary intake of manganese and applying a modifying factor of 3 for non-dietary exposures (e.g., drinking water exposure). EPA Region 1 suggests that a RfD of $7x10^{-2}$ for risk evaluations involving soil exposure which is the IRIS RfD modified by subtracting the average dietary intake, however no modifying factor is applied. The guidance states, "A modifying factor of 3 may be appropriate for assessing risks via exposure to soils if neonates (a child 12 months or younger) are a potentially exposed population. For most RCRA and Superfund risk assessments, neonates are unlikely to be exposed to significant amounts of soils. Therefore, applying a modifying factor of 1 is appropriate. Assuming exposure to a young child under a residential scenario, a hazard index of 1 for manganese would correspond to a soil concentration of 5,500 mg/kg." The maximum manganese concentration in SWMU 7 soils was 2,110 mg/kg (see Appendix H, Attachment 5).

- Although the arsenic concentrations detected in the soils at SWMU 7 may exceed base-specific background concentrations (surface soil at the ORR; surface and subsurface soil at the OPR), arsenic is a naturally occurring metal and may occur naturally in some locations (e.g., in the western United States) at concentrations exceeding 90 mg/kg. Arsenic concentrations detected in soils at the ORR and OPR are well within the range of natural background concentrations reported in the literature (see Appendix H, Attachment 6).

4.5 SUMMARY AND CONCLUSIONS

4.5.1 ORR

The cancer risk estimates for surface and subsurface soils do not exceed the EPA risk management range (1E-04 to 1E-06) often used by the EPA to determine the need for environmental remediation or set standards and criteria. However, risk estimates calculated for the hypothetical future resident and/or for the hypothetical typical industrial worker (exposed 250 days/year) for arsenic in surface soils, for 2,4,6-TNT in the surface soils, and/or for benzo(a)pyrene in subsurface soils have associated risks exceeding the lower bound of the U.S. EPA's risk range (i.e., 1E-06). Only the cancer risks developed for arsenic (hypothetical future resident) exceed the 1E-05 risk level. (Over 95 percent of the carcinogenic risk estimated for the surface soils at the ORR is attributable to arsenic.) Because the risks associated with arsenic and benzo(a)pyrene total 4E-05 or less and are within the range of background and because the risks associated with the residual 2,4,6-TNT contamination are less than 1E-05, the decision regarding the need to remediate for these constituents will be deferred until closure of the unit. Additionally, it should be noted that the ORR will continue to be used for ammunition burning and that additional contaminants may be added to the soils as a result of the Subpart X open burning. Risks associated with any additional contamination will also be evaluated during the closure of the unit. Based on all of the above, no further action is recommended for this site at this time.

4.5.2 OPR

Risk estimates developed for the future typical worker or resident hypothetically exposed to surface/subsurface soils at the OPR do not exceed the EPA benchmarks typically used to determine the need for environmental remediation. Consequently, no further action is recommended for this site.

TABLE 4-1

COPC SELECTION TABLE
OLD RIFLE RANGE - SURFACE SOIL
INDUSTRIAL LAND USE
NSWC CRANE, INDIANA

Parameter[1]	Maximum Concentration	Carcinogenic PRG - Industrial[2,3]	Non-Carcinogenic PRG - Industrial[2,4]	Statistically Greater than Background and RBTL?[5,6,7]
Surface	(mg/kg)	(mg/kg)	(mg/kg)	
Semivolatile Organics				
BENZO(A)ANTHRACENE	0.046	2.1	NA	ND
BENZO(A)PYRENE	0.07	0.21	NA	ND
BENZO(B)FLUORANTHENE	0.052	2.1	NA	ND
DIBENZO(A,H)ANTHRACENE	0.016	0.21	NA	ND
INDENO(1,2,3-CD)PYRENE	0.044	2.1	NA	ND
Energetics				
2,4,6-TRINITROTOLUENE	250	57	310	ND
2,6-DINITROTOLUENE	1.9	NA	620	ND
RDX	ND	16	1800	ND
Pesticides				
HEPTACHLOR EPOXIDE	0.003	0.19	8.0	ND
Inorganics				
ARSENIC	13.8	1.6	260	Yes
BERYLLIUM	0.98	2200	1900	No
MANGANESE	1930	NA	19000	No

Footnotes:

1 - Analyte name is shaded if site concentrations are greater than background as discussed in Section 3.2 and either the Region 9 carcinogenic PRG or 1/10th the Region 9 noncarcinogenic PRG. The shaded analytes were selected as chemicals of potential concern (COPCs) for the human health screening evaluation (HHSE).
2 - Region IX - Preliminary Remediation Goals (PRGs) Tables, October 1, 2002.
3 - Value is shaded if maximum detected concentration exceeds PRG.
4 - Value is shaded if maximum detected concentration exceeds 1/10th PRG.
5 - Cell is shaded if site concentrations are greater than background.
6 - Based on Table 3-7 and statistical evaluation described in Section 3.2.
7 - Organics (Semivolatiles, Energetics, and Pesticides) are labeled as nondetects (ND) because they are not considered present in the background soil. They are shaded if the maximum site concentration is greater than zero.

Abbreviations:

COPC - Chemical of Potential Concern
NA - Not available
ND - Nondetect
PRG - Preliminary Remediation Goal
RBTL - Risk Based Target Level

TABLE 4-2

COPC SELECTION TABLE
OLD RIFLE RANGE - SUBSURFACE SOIL
INDUSTRIAL LAND USE
NSWC CRANE, INDIANA

Parameter[1]	Maximum Concentration	Carcinogenic PRG - Industrial[2,3]	Non-Carcinogenic PRG - Industrial[2,4]	Statistically Greater than Background and RBTL?[5,6,7]
Surface	(mg/kg)	(mg/kg)	(mg/kg)	
Semivolatile Organics				
BENZO(A)ANTHRACENE	0.2	2.1	NA	ND
BENZO(A)PYRENE	0.18	0.21	NA	ND
BENZO(B)FLUORANTHENE	0.27	2.1	NA	ND
DIBENZO(A,H)ANTHRACENE	0.046	0.21	NA	ND
INDENO(1,2,3-CD)PYRENE	0.11	2.1	NA	ND
Energetics				
2,4,6-TRINITROTOLUENE	3.8	57	310	ND
2,6-DINITROTOLUENE	ND	NA	620	ND
RDX	ND	16	1800	ND
Pesticides				
HEPTACHLOR EPOXIDE	ND	0.19	8.0	ND
Inorganics				
ARSENIC	15.4	1.6	260	No
BERYLLIUM	1.1	2200	1900	No
MANGANESE	1860	NA	19000	No

Footnotes:

1 - Analyte name is shaded if site concentrations are greater than background as discussed in Section 3.2 and either the Region 9 carcinogenic PRG or 1/10th the Region 9 noncarcinogenic PRG. The shaded analytes were selected as chemicals of potential concern (COPCs) for the human health screening evaluation (HHSE).
2 - Region IX - Preliminary Remediation Goals (PRGs) Tables, October 1, 2002.
3 - Value is shaded if maximum detected concentration exceeds PRG.
4 - Value is shaded if maximum detected concentration exceeds 1/10th PRG.
5 - Cell is shaded if site concentrations are greater than background.
6 - Based on Table 3-7 and statistical evaluation described in Section 3.2.
7 - Organics (Semivolatiles, Energetics, and Pesticides) are labeled as nondetects (ND) because they are not considered present in the background soil. They are shaded if the maximum site concentration is greater than zero.

Abbreviations:

COPC - Chemical of Potential Concern
NA - Not available
ND - Nondetect
PRG - Preliminary Remediation Goal
RBTL - Risk Based Target Level

TABLE 4-3

COPC SELECTION TABLE
OLD RIFLE RANGE - SURFACE SOIL
RESIDENTIAL LAND USE
NSWC CRANE, INDIANA

Parameter[1]	Maximum Concentration	Carcinogenic PRG - Residential[2,3]	Non-Carcinogenic PRG - Residential[2,4]	Statistically Greater than Background and RBTL?[5,6,7]
Surface	(mg/kg)	(mg/kg)	(mg/kg)	
Semivolatile Organics				
BENZO(A)ANTHRACENE	0.046	0.62	NA	ND
BENZO(A)PYRENE	0.07	0.062	NA	ND
BENZO(B)FLUORANTHENE	0.052	0.62	NA	ND
DIBENZO(A,H)ANTHRACENE	0.016	0.062	NA	ND
INDENO(1,2,3-CD)PYRENE	0.044	0.62	NA	ND
Energetics				
2,4,6-TRINITROTOLUENE	250	16.0	31.0	ND
2,6-DINITROTOLUENE	1.9	NA	61.0	ND
RDX	ND	4.40	180	ND
Pesticides				
HEPTACHLOR EPOXIDE	0.003	0.053	0.79	ND
Inorganics				
ARSENIC	13.8	0.39	22.0	Yes
BERYLLIUM	0.98	1100	150	No
MANGANESE	1930	NA	1800	No

Footnotes:

1 - Analyte name is shaded if site concentrations are greater than background as discussed in Section 3.2 and either the Region 9 carcinogenic PRG or 1/10th the Region 9 noncarcinogenic PRG. The shaded analytes were selected as chemicals of potential concern (COPCs) for the human health screening evaluation (HHSE).
2 - Region IX - Preliminary Remediation Goals (PRGs) Tables, October 1, 2002.
3 - Value is shaded if maximum detected concentration exceeds PRG.
4 - Value is shaded if maximum detected concentration exceeds 1/10th PRG.
5 - Cell is shaded if site concentrations are greater than background.
6 - Based on Table 3-7 and statistical evaluation described in Section 3.2.
7 - Organics (Semivolatiles, Energetics, and Pesticides) are labeled as nondetects (ND) because they are not considered present in the background soil. They are shaded if the maximum site concentration is greater than zero.

Abbreviations:

COPC - Chemical of Potential Concern
NA - Not available
ND - Nondetect
PRG - Preliminary Remediation Goal
RBTL - Risk Based Target Level

TABLE 4-4

COPC SELECTION TABLE
OLD RIFLE RANGE - SUBSURFACE SOIL
RESIDENTIAL LAND USE
NSWC CRANE, INDIANA

Parameter[1]	Maximum Concentration	Carcinogenic PRG - Residential[2,3]	Non-Carcinogenic PRG - Residential[2,4]	Statistically Greater than Background and RBTL?[5,6,7]
Surface	(mg/kg)	(mg/kg)	(mg/kg)	
Semivolatile Organics				
BENZO(A)ANTHRACENE	0.2	0.62	NA	ND
BENZO(A)PYRENE	0.18	0.062	NA	ND
BENZO(B)FLUORANTHENE	0.27	0.62	NA	ND
DIBENZO(A,H)ANTHRACENE	0.046	0.062	NA	ND
INDENO(1,2,3-CD)PYRENE	0.11	0.62	NA	ND
Energetics				
2,4,6-TRINITROTOLUENE	3.8	16.0	31.0	ND
2,6-DINITROTOLUENE	ND	NA	61.0	ND
RDX	ND	4.40	180	ND
Pesticides				
HEPTACHLOR EPOXIDE	ND	0.053	0.79	ND
Inorganics				
ARSENIC	15.4	0.39	22.0	No
BERYLLIUM	1.1	1100	150	No
MANGANESE	1860	NA	1800	No

Footnotes:

1 - Analyte name is shaded if site concentrations are greater than background as discussed in Section 3.2 and either the Region 9 carcinogenic PRG or 1/10th the Region 9 noncarcinogenic PRG. The shaded analytes were selected as chemicals of potential concern (COPCs) for the human health screening evaluation (HHSE).
2 - Region IX - Preliminary Remediation Goals (PRGs) Tables, October 1, 2002.
3 - Value is shaded if maximum detected concentration exceeds PRG.
4 - Value is shaded if maximum detected concentration exceeds 1/10th PRG.
5 - Cell is shaded if site concentrations are greater than background.
6 - Based on Table 3-7 and statistical evaluation described in Section 3.2.
7 - Organics (Semivolatiles, Energetics, and Pesticides) are labeled as nondetects (ND) because they are not considered present in the background soil. They are shaded if the maximum site concentration is greater than zero.

Abbreviations:

COPC - Chemical of Potential Concern
NA - Not available
ND - Nondetect
PRG - Preliminary Remediation Goal
RBTL - Risk Based Target Level

TABLE 4-5

COPC SELECTION TABLE
OLD PISTOL RANGE - SURFACE SOIL
INDUSTRIAL LAND USE
NSWC CRANE, INDIANA

Parameter[1]	Maximum Concentration	Carcinogenic PRG - Industrial[2,3]	Non-Carcinogenic PRG - Industrial[2,4]	Statistically Greater than Background and RBTL?[5,6,7]
Surface	(mg/kg)	(mg/kg)	(mg/kg)	
Semivolatile Organics				
BENZO(A)ANTHRACENE	0.009	2.1	NA	ND
BENZO(A)PYRENE	0.01	0.21	NA	ND
BENZO(B)FLUORANTHENE	0.022	2.1	NA	ND
DIBENZO(A,H)ANTHRACENE	ND	0.21	NA	ND
INDENO(1,2,3-CD)PYRENE	ND	2.1	NA	ND
Energetics				
2,4,6-TRINITROTOLUENE	ND	57	310	ND
2,6-DINITROTOLUENE	ND	NA	620	ND
RDX	ND	16	1800	ND
Pesticides				
HEPTACHLOR EPOXIDE	ND	0.19	8.0	ND
Inorganics				
ARSENIC	12.8	1.6	260	Yes
BERYLLIUM	1.3	2200	1900	No
MANGANESE	1960	NA	19000	No

Footnotes:

1 - Analyte name is shaded if site concentrations are greater than background as discussed in Section 3.2 and either the Region 9 carcinogenic PRG or 1/10th the Region 9 noncarcinogenic PRG. The shaded analytes were selected as chemicals of potential concern (COPCs) for the human health screening evaluation (HHSE).
2 - Region IX - Preliminary Remediation Goals (PRGs) Tables, October 1, 2002.
3 - Value is shaded if maximum detected concentration exceeds PRG.
4 - Value is shaded if maximum detected concentration exceeds 1/10th PRG.
5 - Cell is shaded if site concentrations are greater than background.
6 - Based on Table 3-7 and statistical evaluation described in Section 3.2.
7 - Organics (Semivolatiles, Energetics, and Pesticides) are labeled as nondetects (ND) because they are not considered present in the background soil. They are shaded if the maximum site concentration is greater than zero.

Abbreviations:

COPC - Chemical of Potential Concern
NA - Not available
ND - Nondetect
PRG - Preliminary Remediation Goal
RBTL - Risk Based Target Level

TABLE 4-6

COPC SELECTION TABLE
OLD PISTOL RANGE - SUBSURFACE SOIL
INDUSTRIAL LAND USE
NSWC CRANE, INDIANA

Parameter[1]	Maximum Concentration	Carcinogenic PRG - Industrial[2,3]	Non-Carcinogenic PRG - Industrial[2,4]	Statistically Greater than Background and RBTL?[5,6,7]
Surface	(mg/kg)	(mg/kg)	(mg/kg)	
Semivolatile Organics				
BENZO(A)ANTHRACENE	ND	2.1	NA	ND
BENZO(A)PYRENE	ND	0.21	NA	ND
BENZO(B)FLUORANTHENE	ND	2.1	NA	ND
DIBENZO(A,H)ANTHRACENE	ND	0.21	NA	ND
INDENO(1,2,3-CD)PYRENE	ND	2.1	NA	ND
Energetics				
2,4,6-TRINITROTOLUENE	ND	57	310	ND
2,6-DINITROTOLUENE	ND	NA	620	ND
RDX	ND	16	1800	ND
Pesticides				
HEPTACHLOR EPOXIDE	ND	0.19	8.0	ND
Inorganics				
ARSENIC	24.9	1.6	260	Yes
BERYLLIUM	1.9	2200	1900	No
MANGANESE	2110	NA	19000	Yes

Footnotes:

1 - Analyte name is shaded if site concentrations are greater than background as discussed in Section 3.2 and either the Region 9 carcinogenic PRG or 1/10th the Region 9 noncarcinogenic PRG. The shaded analytes were selected as chemicals of potential concern (COPCs) for the human health screening evaluation (HHSE).
2 - Region IX - Preliminary Remediation Goals (PRGs) Tables, October 1, 2002.
3 - Value is shaded if maximum detected concentration exceeds PRG.
4 - Value is shaded if maximum detected concentration exceeds 1/10th PRG.
5 - Cell is shaded if site concentrations are greater than background.
6 - Based on Table 3-7 and statistical evaluation described in Section 3.2.
7 - Organics (Semivolatiles, Energetics, and Pesticides) are labeled as nondetects (ND) because they are not considered present in the background soil. They are shaded if the maximum site concentration is greater than zero.

Abbreviations:

COPC - Chemical of Potential Concern
NA - Not available
ND - Nondetect
PRG - Preliminary Remediation Goal
RBTL - Risk Based Target Level

TABLE 4-7

COPC SELECTION TABLE
OLD PISTOL RANGE - SURFACE SOIL
RESIDENTIAL LAND USE
NSWC CRANE, INDIANA

Parameter[1]	Maximum Concentration	Carcinogenic PRG - Residential[2,3]	Non-Carcinogenic PRG - Residential[2,4]	Statistically Greater than Background and RBTL?[5,6,7]
Surface	(mg/kg)	(mg/kg)	(mg/kg)	
Semivolatile Organics				
BENZO(A)ANTHRACENE	0.009	0.62	NA	ND
BENZO(A)PYRENE	0.01	0.062	NA	ND
BENZO(B)FLUORANTHENE	0.022	0.62	NA	ND
DIBENZO(A,H)ANTHRACENE	ND	0.062	NA	ND
INDENO(1,2,3-CD)PYRENE	ND	0.62	NA	ND
Energetics				
2,4,6-TRINITROTOLUENE	ND	16.0	31.0	ND
2,6-DINITROTOLUENE	ND	NA	61.0	ND
RDX	ND	4.40	180	ND
Pesticides				
HEPTACHLOR EPOXIDE	ND	0.053	0.79	ND
Inorganics				
ARSENIC	12.8	0.39	22.0	Yes
BERYLLIUM	1.3	1100	150	No
MANGANESE	1960	NA	1800	No

Footnotes:

1 - Analyte name is shaded if site concentrations are greater than background as discussed in Section 3.2 and either the Region 9 carcinogenic PRG or 1/10th the Region 9 noncarcinogenic PRG. The shaded analytes were selected as chemicals of potential concern (COPCs) for the human health screening evaluation (HHSE).
2 - Region IX - Preliminary Remediation Goals (PRGs) Tables, October 1, 2002.
3 - Value is shaded if maximum detected concentration exceeds PRG.
4 - Value is shaded if maximum detected concentration exceeds 1/10th PRG.
5 - Cell is shaded if site concentrations are greater than background.
6 - Based on Table 3-7 and statistical evaluation described in Section 3.2.
7 - Organics (Semivolatiles, Energetics, and Pesticides) are labeled as nondetects (ND) because they are not considered present in the background soil. They are shaded if the maximum site concentration is greater than zero.

Abbreviations:

COPC - Chemical of Potential Concern
NA - Not available
ND - Nondetect
PRG - Preliminary Remediation Goal
RBTL - Risk Based Target Level

TABLE 4-8

COPC SELECTION TABLE
OLD PISTOL RANGE - SUBSURFACE SOIL
RESIDENTIAL LAND USE
NSWC CRANE, INDIANA

Parameter[1]	Maximum Concentration	Carcinogenic PRG - Residential[2,3]	Non-Carcinogenic PRG - Residential[2,4]	Statistically Greater than Background and RBTL?[5,6,7]
Surface	(mg/kg)	(mg/kg)	(mg/kg)	
Semivolatile Organics				
BENZO(A)ANTHRACENE	ND	0.62	NA	ND
BENZO(A)PYRENE	ND	0.062	NA	ND
BENZO(B)FLUORANTHENE	ND	0.62	NA	ND
DIBENZO(A,H)ANTHRACENE	ND	0.062	NA	ND
INDENO(1,2,3-CD)PYRENE	ND	0.62	NA	ND
Energetics				
2,4,6-TRINITROTOLUENE	ND	16.0	31.0	ND
2,6-DINITROTOLUENE	ND	NA	61.0	ND
RDX	ND	4.40	180	ND
Pesticides				
HEPTACHLOR EPOXIDE	ND	0.053	0.79	ND
Inorganics				
ARSENIC	24.9	0.39	22.0	Yes
BERYLLIUM	1.9	1100	150	No
MANGANESE	2110	NA	1800	Yes

Footnotes:

1 - Analyte name is shaded if site concentrations are greater than background as discussed in Section 3.2 and either the Region 9 carcinogenic PRG or 1/10th the Region 9 noncarcinogenic PRG. The shaded analytes were selected as chemicals of potential concern (COPCs) for the human health screening evaluation (HHSE).
2 - Region IX - Preliminary Remediation Goals (PRGs) Tables, October 1, 2002.
3 - Value is shaded if maximum detected concentration exceeds PRG.
4 - Value is shaded if maximum detected concentration exceeds 1/10th PRG.
5 - Cell is shaded if site concentrations are greater than background.
6 - Based on Table 3-7 and statistical evaluation described in Section 3.2.
7 - Organics (Semivolatiles, Energetics, and Pesticides) are labeled as nondetects (ND) because they are not considered present in the background soil. They are shaded if the maximum site concentration is greater than zero.

Abbreviations:

COPC - Chemical of Potential Concern
NA - Not available
ND - Nondetect
PRG - Preliminary Remediation Goal
RBTL - Risk Based Target Level

Table 4-9

SUMMARY OF INDUSTRIAL HUMAN HEALTH RISKS AND HAZARDS FOR SURFACE SOIL (0' - 1') - EPC = 95% UCL
OLD RIFLE RANGE
NSWC CRANE, INDIANA

Parameter	Incremental Lifetime Carcinogenic Risk (ILCR)			Estimated Non-Carcinogenic Hazard Quotient (HQ)			Maximum Background Concentration
	UCL[3,4]	PRG - Industrial[1]	Estimated ILCR	Primary Target Organs[2]	PRG - Industrial[1]	Estimated HQ	
Surface	(mg/kg)	(mg/kg)			(mg/kg)		(mg/kg)
Energetics							
2,4,6-TRINITROTOLUENE	17.9	5.7E+01	3.1E-07	Liver	3.1E+02	5.8E-02	NA
Inorganics							
ARSENIC	9.26	1.6E+00	5.8E-06	Skin	2.6E+02	3.6E-02	10.2
		Total Carcinogenic Risk	6.1E-06		**Total HI**	9.4E-02	

Target Organ HIs

Total Liver HI =	5.8E-02
Total Skin HI =	3.6E-02

Footnotes:
1 - Region IX - Preliminary Remediation Goals (PRGs) Tables, October 1, 2002.
2 - Primary Target Organs - Integrated Risk Information System (IRIS).
3 - Value for arsenic is Lognormal 95% UCL.
4 - The 95% UCL presented for TNT is based on Bootstrap calculation method (EPA, December 2002). The 95% UCL presented for TNT also reflects soil conditions post the soil removal action conducted by the Navy during the summer of 2003.

Abbreviations:
HI - Hazard Index
HQ - Hazard Quotient
ILCR - Incremental Lifetime Carcinogenic Risk
NA - Not available
PRG - Preliminary Remediation Goal
UCL - Upper Confidence Limit

Table 4-10

SUMMARY OF RESIDENTIAL HUMAN HEALTH RISKS AND HAZARDS FOR SURFACE SOIL (0' - 1') - EPC = 95% UCL
OLD RIFLE RANGE
NSWC CRANE, INDIANA

Parameter	Incremental Lifetime Carcinogenic Risk (ILCR)			Estimated Non-Carcinogenic Hazard Quotient (HQ)			Maximum Background Concentration
	UCL[3,4]	PRG - Residential[1]	Estimated ILCR	Primary Target Organs[2]	PRG - Residential[1]	Estimated HQ	
Surface	(mg/kg)	(mg/kg)			(mg/kg)		(mg/kg)
Semivolatile Organics							
BENZO(A)PYRENE	0.0085	6.2E-02	1.4E-07		NA	---	NA
Energetics							
2,4,6-TRINITROTOLUENE	17.9	1.6E+01	1.1E-06	Liver	3.1E+01	5.8E-01	NA
Inorganics							
ARSENIC	9.26	3.9E-01	2.4E-05	Skin	2.2E+01	4.2E-01	10.2
		Total Carcinogenic Risk	2.5E-05		**Total HI**	1.0E+00	

Target Organ HIs

Total Liver HI =	5.8E-01
Total Skin HI =	4.2E-01

Footnotes:
1 - Region IX - Preliminary Remediation Goals (PRGs) Tables, October 1, 2002.
2 - Primary Target Organs - Integrated Risk Information System (IRIS).
3 - Value for arsenic is Lognormal 95% UCL.
4 - The 95% UCLs presented for BaP and TNT are based on Bootstrap calculation method (EPA, December 2002).

Abbreviations:
HI - Hazard Index
HQ - Hazard Quotient
ILCR - Incremental Lifetime Carcinogenic Risk
NA - Not available
PRG - Preliminary Remediation Goal
UCL - Upper Confidence Limit

Table 4-11

SUMMARY OF RESIDENTIAL HUMAN HEALTH RISKS AND HAZARDS FOR SUBSURFACE SOIL (2' - 4') - EPC = 95% UCL
OLD RIFLE RANGE
NSWC CRANE, INDIANA

Parameter	Incremental Lifetime Carcinogenic Risk (ILCR)			Estimated Non-Carcinogenic Hazard Quotient (HQ)			Maximum Background Concentration
	UCL[3]	PRG - Residential[1]	Estimated ILCR	Primary Target Organs[2]	PRG - Residential[1]	Estimated HQ	
Subsurface	(mg/kg)	(mg/kg)			(mg/kg)		(mg/kg)
Semivolatile Organics							
BENZO(A)PYRENE	0.18	6.2E-02	2.9E-06		NA	---	NA
Energetics							
2,4,6-TRINITROTOLUENE	3.8	1.6E+01	2.4E-07	Liver	3.1E+01	1.2E-01	NA
		Total Carcinogenic Risk	3.1E-06		**Total HI**	1.2E-01	

Target Organ HIs

Total Liver HI = 1.2E-01

Footnotes:
1 - Region IX - Preliminary Remediation Goals (PRGs) Tables, October 1, 2002.
2 - Primary Target Organs - Integrated Risk Information System (IRIS).
3 - 95% UCL could not be calculated using parametric or non-parametric methods presented in EPA December 2002 guidance. Consequently, the maximum concentration is selected as the UCL. Only one positive detection was reported for the analytes.

Abbreviations:
HI - Hazard Index
HQ - Hazard Quotient
ILCR - Incremental Lifetime Carcinogenic Risk
NA - Not available
PRG - Preliminary Remediation Goal

Table 4-12

SUMMARY OF INDUSTRIAL HUMAN HEALTH RISKS AND HAZARDS FOR SURFACE SOIL (0' - 1') - EPC = 95% UCL
OLD PISTOL RANGE
NSWC CRANE, INDIANA

Parameter	Incremental Lifetime Carcinogenic Risk (ILCR)			Estimated Non-Carcinogenic Hazard Quotient (HQ)			Maximum Background Concentration
	UCL[3]	PRG - Industrial[1]	Estimated ILCR	Primary Target Organs[2]	PRG - Industrial[1]	Estimated HQ	
Surface	(mg/kg)	(mg/kg)			(mg/kg)		(mg/kg)
Inorganics							
ARSENIC	9.69	1.6E+00	6.1E-06	Skin	2.6E+02	3.7E-02	10.2
		Total Carcinogenic Risk	6.1E-06		**Total HI**	3.7E-02	

Target Organ HIs

Total Skin HI = 3.7E-02

Footnotes:
1 - Region IX - Preliminary Remediation Goals (PRGs) Tables, October 1, 2002.
2 - Primary Target Organs - Integrated Risk Information System (IRIS).
3 - Value is Lognormal 95% UCL.

Abbreviations:
HI - Hazard Index
HQ - Hazard Quotient
ILCR - Incremental Lifetime Carcinogenic Risk
PRG - Preliminary Remediation Goal
UCL - Upper Confidence Limit

Table 4-13

SUMMARY OF INDUSTRIAL HUMAN HEALTH RISKS AND HAZARDS FOR SUBSURFACE SOIL (2' - 4') - EPC = 95% UCL
OLD PISTOL RANGE
NSWC CRANE, INDIANA

Parameter	Incremental Lifetime Carcinogenic Risk (ILCR)			Estimated Non-Carcinogenic Hazard Quotient (HQ)			Maximum Background Concentration
	UCL[3]	PRG - Industrial[1]	Estimated ILCR	Primary Target Organs[2]	PRG - Industrial[1]	Estimated HQ	
Subsurface	(mg/kg)	(mg/kg)			(mg/kg)		(mg/kg)
Inorganics							
ARSENIC	15.4	1.6E+00	9.6E-06	Skin	2.6E+02	5.9E-02	9
MANGANESE	1543	NA	----	CNS	1.9E+04	8.1E-02	1410
		Total Carcinogenic Risk	9.6E-06		**Total HI**	1.4E-01	

Target Organ HIs

Total Skin HI =	5.9E-02
Total CNS=	8.1E-02

Footnotes:
1 - Region IX - Preliminary Remediation Goals (PRGs) Tables, October 1, 2002.
2 - Primary Target Organs - Integrated Risk Information System (IRIS).
3 - Value for arsenic is Lognormal 95% UCL; value for manganese is Normal 95 % UCL.

Abbreviations:
HI - Hazard Index
HQ - Hazard Quotient
ILCR - Incremental Lifetime Carcinogenic Risk
PRG - Preliminary Remediation Goal
UCL - Upper Confidence Limit
CNS - Central Nervous System

Table 4-14

SUMMARY OF RESIDENTIAL HUMAN HEALTH RISKS AND HAZARDS FOR SURFACE SOIL (0' - 1') - EPC = 95% UCL
OLD PISTOL RANGE
NSWC CRANE, INDIANA

Parameter	Incremental Lifetime Carcinogenic Risk (ILCR)			Estimated Non-Carcinogenic Hazard Quotient (HQ)			Maximum Background Concentration
	UCL[3]	PRG - Residential[1]	Estimated ILCR	Primary Target Organs[2]	PRG - Residential[1]	Estimated HQ	
Surface	(mg/kg)	(mg/kg)			(mg/kg)		(mg/kg)
Inorganics							
ARSENIC	9.69	3.9E-01	2.5E-05	Skin	2.2E+01	4.4E-01	10.2
		Total Carcinogenic Risk	2.5E-05		**Total HI**	4.4E-01	

Target Organ HIs

Total Skin HI = 4.4E-01

Footnotes:
1 - Region IX - Preliminary Remediation Goals (PRGs) Tables, October 1, 2002.
2 - Primary Target Organs - Integrated Risk Information System (IRIS).
3 - Value is Lognormal 95% UCL

Abbreviations:
HI - Hazard Index
HQ - Hazard Quotient
ILCR - Incremental Lifetime Carcinogenic Risk
PRG - Preliminary Remediation Goal
UCL - Upper Confidence Limit

Table 4-15

SUMMARY OF RESIDENTIAL HUMAN HEALTH RISKS AND HAZARDS FOR SUBSURFACE SOIL (2' - 4') - EPC = 95% UCL
OLD PISTOL RANGE
NSWC CRANE, INDIANA

Parameter	Incremental Lifetime Carcinogenic Risk (ILCR)			Estimated Non-Carcinogenic Hazard Quotient (HQ)			Maximum Background Concentration
	UCL[3]	PRG - Residential[1]	Estimated ILCR	Primary Target Organs[2]	PRG - Residential[1]	Estimated HQ	
Subsurface	**(mg/kg)**	**(mg/kg)**			**(mg/kg)**		**(mg/kg)**
Inorganics							
ARSENIC	15.4	3.9E-01	3.9E-05	Skin	2.2E+01	7.0E-01	9
MANGANESE	1543	NA	---	CNS	1.8E+03	8.6E-01	1410
		Total Carcinogenic Risk	3.9E-05		**Total HI**	1.6E+00	

Target Organ HIs

Total Skin HI =	7.0E-01
Total Neurological HI =	8.6E-01

Footnotes:
1 - Region IX - Preliminary Remediation Goals (PRGs) Tables, October 1, 2002.
2 - Primary Target Organs - Integrated Risk Information System (IRIS).
3 - Value for arsenic is Lognormal 95% UCL, value for manganese is Normal 95% UCL.

Abbreviations:
CNS - Central Nervous System
HI - Hazard Index
HQ - Hazard Quotient
ILCR - Incremental Lifetime Carcinogenic Risk
NA - Not available
PRG - Preliminary Remediation Goal
UCL - Upper Confidence Limit

TABLE 4-16

SOIL SCREENING LEVELS MIGRATION TO GROUNDWATER
SURFACE SOIL (0' - 1')
OLD RIFLE RANGE
NSWC CRANE, INDIANA

Parameter	Maximum Concentration	SSL Migration to Groundwater	
		DAF 20	DAF 1
	(mg/kg)	(mg/kg)	(mg/kg)
Semivolatile Organics			
BENZO(A)ANTHRACENE	0.046	2.00	0.08
BENZO(A)PYRENE	0.07	8.00	0.40
BENZO(B)FLUORANTHENE	0.052	5.00	0.20
DIBENZO(A,H)ANTHRACENE	0.016	2.00	0.08
INDENO(1,2,3-CD)PYRENE	0.044	14.0	0.70
Energetics			
2,4,6-TRINITROTOLUENE	250	0.01	0.00057
2,6-DINITROTOLUENE	1.9	0.0007	0.00003
Pesticides			
HEPTACHLOR EPOXIDE	0.003	0.70	0.03
Inorganics			
ARSENIC	13.8	29.0	1.00
BERYLLIUM	0.98	63.0	3.00
MANGANESE	1930	2200	110

Abbreviations:
DAF - Dilution and Attenuation Factor
SSL - Soil Screening Level

TABLE 4-17

SOIL SCREENING LEVELS MIGRATION TO GROUNDWATER
SUBSURFACE SOIL (2' - 4')
OLD RIFLE RANGE
NSWC CRANE, INDIANA

Parameter	Maximum Concentration	SSL Migration to Groundwater	
		DAF 20	DAF 1
	(mg/kg)	(mg/kg)	(mg/kg)
Semivolatile Organics			
BENZO(A)ANTHRACENE	0.2	2.00	0.08
BENZO(A)PYRENE	0.18	8.00	0.40
BENZO(B)FLUORANTHENE	0.27	5.00	0.20
DIBENZO(A,H)ANTHRACENE	0.046	2.00	0.08
INDENO(1,2,3-CD)PYRENE	0.11	14.0	0.70
Energetics			
2,4,6-TRINITROTOLUENE	3.8	0.01	0.00057
Inorganics			
ARSENIC	15.4	29.0	1.00
BERYLLIUM	1.1	63.0	3.00
MANGANESE	1860	2200	110

Abbreviations:
DAF - Dilution and Attenuation Factor
SSL - Soil Screening Level

TABLE 4-18

SOIL SCREENING LEVELS MIGRATION TO GROUNDWATER
SURFACE SOIL (0' - 1')
OLD PISTOL RANGE
NSWC CRANE, INDIANA

Parameter	Maximum Concentration	SSL Migration to Groundwater	
		DAF 20	DAF 1
	(mg/kg)	(mg/kg)	(mg/kg)
Semivolatile Organics			
BENZO(A)ANTHRACENE	0.009	2.00	0.08
BENZO(A)PYRENE	0.01	8.00	0.40
BENZO(B)FLUORANTHENE	0.022	5.00	0.20
Inorganics			
ARSENIC	12.8	29.0	1.00
BERYLLIUM	1.3	63.0	3.00
MANGANESE	1960	2200	110

Abbreviations:
DAF - Dilution and Attenuation Factor
SSL - Soil Screening Level

TABLE 4-19

SOIL SCREENING LEVELS MIGRATION TO GROUNDWATER
SUBSURFACE SOIL (2' - 4')
OLD PISTOL RANGE
NSWC CRANE, INDIANA

Parameter	Maximum Concentration	SSL Migration to Groundwater	
		DAF 20	DAF 1
	(mg/kg)	(mg/kg)	(mg/kg)
Inorganics			
ARSENIC	24.9	29.0	1.00
BERYLLIUM	1.9	63.0	3.00
MANGANESE	2110	2200	110

Abbreviations:
DAF - Dilution and Attenuation Factor
SSL - Soil Screening Level