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TECHNICAL POSITION REPORT IN SUPPORT OF THE RELEASE BLOCK H RESIDUAL RISK EVALUATION

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TECHNICAL POSITION REPORT IN SUPPORT OF THE RELEASE BLOCK H RESIDUAL RISK EVALUATION

1.0 BACKGROUND AND PURPOSE

The original Residual Risk Evaluation (RRE) for Release Block (RB) H was published in August of 1997. Since that time, some of the risk conversion factors for chemicals and radionuclides have changed. Additionally, some errors in the soil and groundwater sections of the RRE have been detected. Also, new soil samples were collected from RB H in February of 1999. As a result, the Mound 2000 Core Team requested a review of the RRE for RB H. This report summarizes the review. The review addressed the following questions:

(1) what hazard and risk conversion factors have changed since the Mound Guideline Values (GVs) were established,
(2) what errors were present in the original RRE,
(3) how do those changes/errors affect the collection of compounds that screened through, or were eliminated from, the RB H hazard and risk calculations, and
(4) what is a reasonable estimate of the overall impact of the changes identified above on the hazard and risk analyses performed for RB H.

2.0 METHODOLOGY

Chronologies of change for the Health Effects Assessment Summary Tables (HEAST) and Integrated Risk Information System (IRIS) data bases were developed. The chronologies document changes to HEAST and IRIS since the Mound Plant GVs were published. As a result of this exercise, previously conducted for RB D, a listing of the changes to risk data for compounds of interest to Mound was generated (Table 2-1).

Updated reference dose and slope factor data were then compared to values used in the RRE to ensure: (1) the appropriate collection of compounds was carried through the RRE process, and (2) the appropriate risk conversion factors (e.g., reference doses, slope factors) were used. This review was conducted first for compounds detected in RB H soil, then for compounds detected, or projected to be present, in the groundwater regimes of the Buried Valley Aquifer and/or the Mound Plant bedrock. The risk data associated with ambient air pathways (inhalation of tritium and isotopes of plutonium) were also reviewed. All results are presented in Section 3.

Table 2-1. IRIS and HEAST Chronologies of Change for Compounds of Interest to the Mound Plant Exit Project.

Chemical	IRIS Updated	Description of Changes
INORGANICS		
Antimony	Feb-91	
Arsenic	Apr-98	No change to RfD, UR for INH established (4.3E-3/ug/m3), INH SF withdrawn, INH UR established (4.3E-3/ug/m3), Oral SF established (1.5E0/mg/kg-d), DW UR established (5E-5/ug/L water)
Barium	Jan-99	Text changes to oral RfD section (numerical value unchanged)
Beryllium	Apr-98	Lowered the RfD (5E-3 -> 2E-3), added an RfC (2E-2ug/m3), replaced INH SF with UR (2.4E-3/ug/m3), withdrew oral SF
Bismuth	X	
Cadmium	Feb-94	
Calcium	X	
Chloride	X	
Chromium (III)	Sep-98	Raised RfD slightly (1.0E0 -> 1.5E0 mg/kg-d), no RfC value
Chromium (VI)	Sep-98	Reduced RfD from 5E-3 -> 3E-3 mg/kg-d, added RfC (8E-6 mg/m3), no SFs
Cobalt	X	
Copper	Aug-91	
Cyanide	Feb-93	
Fluoride		
Iron	X	
Lead	Nov-93	
Lithium	X	
Magnesium	X	
Manganese	Dec-96	No change to RfD, RfC
Mercury	Jun-95	No change to RfC
Molybdenum	Aug-93	
Nickel	Dec-96	No change to RfD
Nitrate	Oct-91	
Nitrate/Nitrite	X	
Phosphate	X	
Potassium	X	
Silicon	X	
Silver	Dec-96	No change to RfD
Sulfate	X	
Thallium	X	
Tin	X	
Vandium (pentoxide)	Dec-96	RfD raised from 7E-3 -> 9E-3 mg/kg-d
Zinc	Oct-92	

Table 2-1 (continued).

Chemical	IRIS Updated	Description of Changes
ORGANICS		
Acenaphthene	Apr-94	
Acenaphthylene	Jan-91	
Acetone	Aug-93	
Anthracene	Sep-94	
Aroclor-1016	Nov-96	RfD = 7E-5 mg/kg-d
Aroclor-1248	Nov-96	RfD data deemed inadequate
Aroclor-1254	Nov-96	RfD deemed OK
Aroclor-1260	X	
Benzene	Oct-98	Oral SF established (2.9E-2/mg/kg-d), DW UR established (8.3E-7/ug/L water), INH UR established (≤7.8E-6/ug/m3)
Benz(a)anthracene	Sep-94	
Benzo(a)pyrene	Nov-94	
Benzo(b)fluoranthene	Mar-94	
Benzo(g,h,i)perylene	Dec-90	
Benzo(k)fluoranthene	Mar-94	
Benzoic acid	Jul-93	
Bromodichloromethane	Mar-93	
2-Butanone (methyl ethyle ketone)	May-93	
Carbazole	X	
Carbon disulfide	Aug-95	Established RfC (0.7 mg/m3)
Carbon tetrachloride	Jun-91	
Chloroform	Sep-92	
2-Chlorophenol	Jul-93	
Chrysene	Mar-94	
Dibutyl phthalate	Feb-93	
Di-n-octyl phthalate	X	
Dibenz(a,h)anthracene	Mar-94	
Dibenzofuran	May-92	
1,1-Dichloroethane	Dec-96	(no RfC, no RfD)
1,1-Dichloroethene	X	
1,2-Dichloroethene	X	
1,2-cis-Dichloroethene	X	
1,2-trans-Dichloroethene	X	
Dichloromethane	Feb-95	Oral SF = 7.5E-3/mg/kg-d, DW UR = 2.1E-7/ug/L water
Ethylbenzene	Aug-91	
bis(2-ethylhexyl) phthalate	X	
Fluoranthene	Sep-94	
Fluorene	Dec-90	Note: Oral RfD in past RRE documents = 0.4 mg/kg-d Correct oral RfD = 0.04 mg/kg-d

Table 2-1 (continued).

Chemical	IRIS Updated	Description of Changes
Indeno(1,2,3-cd) pyrene	Mar-94	
Isophorone	Nov-92	
Methoxychlor	Dec-93	
2-Methylnaphthalene	X	
4-Methyl-2-pentanone = MIBK	Aug-93	
4-Methylphenol	Aug-93	
Naphthalene	Sep-98	Oral RfD reduced from 50 -> 0.02 mg/kg-d Carcinogen class changed to C
N-Nitrosodiphenylamine	Jul-93	
Pentachlorophenol	Jul-93	
Phenol	Mar-91	
Pyrene	Sep-94	
Tetrachloroethene	X	
1,1,1-Trichloroethane	Feb-96	Oral RfD withdrawn
Trichloroethene	X	
Trichloroethylene	Jul-94	
Trichlorofluoromethane	Aug-92	
1,1,2-Trichloro-1,2,2-trifluoroethane	Feb-96	RfD = 3E+1mg/kg-d
Toluene	Apr-94	
Xylenes	Mar-91	

Table 2-1 (continued).

HEAST STATUS

RADIONUCLIDES	Slope Factors Ingestion (risk/pCi)	Inhalation (risk/pCi)	External (risk/yr/pCi/g soil)
Ac-227+D	6.26E-10	7.87E-08	***9.30E-07***
Bi-210	7.29E-12	5.12E-11	N/A
Cs-137+D	3.16E-11	1.91E-11	2.09E-06
H-3	7.15E-14	9.59E-14	N/A
K-40	1.25E-11	7.46E-12	6.11E-07
Pb-210+D	***1.01E-09***	***3.86E-09***	***1.45E-10***
Pu-238	2.95E-10	2.74E-08	1.94E-11
Pu-239/240	3.16E-10	2.78E-08	1.26E-11
Pu-242	3.00E-10	2.64E-08	1.55E-11
Ra-224	1.49E-10	2.25E-09	2.48E-08
Ra-226+D	2.96E-10	2.75E-09	6.74E-06
Ra-228+D	2.48E-10	9.94E-10	3.28E-06
Sr-85	1.40E-12	1.14E-12	1.54E-06
Sr-90	5.59E-11	6.93E-11	N/A
Th-228+D	2.31E-10	9.68E-08	***6.20E-06***
Th-230	3.75E-11	1.72E-08	4.40E-11
Th-232	3.28E-11	1.93E-08	1.97E-11
Th-234	1.93E-11	1.90E-11	3.50E-09
U-233/234	4.48E-11	1.41E-08	3.52E-11
U-235+D	4.70E-11	1.30E-08	2.65E-07
U-238+D	6.20E-11	1.24E-08	***6.57E-08***

Values in bold, italics were not considered during the development of the Guideline Values for Mound.

3.0 RESULTS

3.1 Soil Data

Based on the review, new risk information for three (3) chemicals of concern detected in RB H soil required evaluation. Additionally, the original RRE erroneously reported that slope factors were not available for two (2) radionuclides: potassium-40 and plutonium-242. Also, radium-226 was screened out from the RRE on the basis of its parent-daughter relationship with thorium-232. However, the Th-232 slope factor does not include decay products. Therefore, supplemental radionuclide risk data were required and are described below. (Note that given the natural occurrence of potassium-40, and the levels of K-40 detected in RB H relative to background, residual risks from this radionuclide are inconsequential and not further evaluated in this report.)

Necessary corrections and changes to the RRE have been made; the calculations and resultant risk or hazard quotient (HQ) values are shown in the Appendix to this report. The changes are also described below. As documented in Tables 3.1a and 3.1b, the Hazard Indices (HIs) and risk values did change appreciably but remain in the acceptable range. In the interest of completeness, revised (relative to the 1997 RRE) Tables II.1, V.1, V.4, F.7, F.10, F.19, and F.22 have also been included in the Appendix to this report. Note that the additional sampling performed in February of 1999 did not impact the RRE. More specifically, the new results did not change the list of compounds that screened through, or were screened out of, the RRE.

3.1.1 Arsenic

The IRIS oral slope factor for arsenic has been reduced from 15 mg/kg-d to 1.5 mg/kg-d. Therefore, the incremental risks from the ingestion of arsenic in soil for the construction worker and site employee were reduced from 1.2×10^{-5} to 1.2×10^{-6} and from 6.0×10^{-6} to 6.0×10^{-7}, respectively. (The risk calculations have been reproduced in Appendix B.) Given the linear nature of the risk calculations, the background and total risks from ingestion of arsenic in soil were also reduced by an order of magnitude. Neither the risks for other pathways, nor the HQs for all pathways, were affected by this change.

3.1.2 α- and γ-Chlordane

In 1998, the oral slope factor for chlordane was reduced from 1.3 to 0.35. Similarly, the oral reference dose was increased from 6.0×10^{-5} to 5.0×10^{-4}.

Therefore, the incremental and total risks and HQs from ingestion of chlordane in soil changed for both forms of chlordane, and for both the construction worker and site employee exposure scenarios. For the construction worker, the incremental/total HQ decreased from 7.8×10^{-4} to 9.4×10^{-5} and from 5.8×10^{-4} to 7.0×10^{-5} for α- and γ-chlordane, respectively. For the construction worker, the incremental/total risks decreased from 4.4×10^{-9} to1.2×10^{-9} and from 3.2×10^{-9} to 8.7×10^{-10} for α- and γ-chlordane, respectively. (The risk calculations have been reproduced in Appendix B.)

For the site employee, the incremental/total HQ decreased from 8.2×10^{-5} to 9.8×10^{-6} and from 6.0×10^{-5} to 7.2×10^{-6} for α- and γ-chlordane, respectively. For the site employee, the incremental/total risks decreased from 2.3×10^{-9} to 6.1×10^{-10} and from 1.7×10^{-9} to 4.5×10^{-10} for α- and γ-chlordane, respectively.

(Note: Incremental and total risks are numerically equivalent because the background risk is assumed to be zero. This assumption also applies to Sections 3.1.3 and 3.1.4 below.)

3.1.3 Lead-210 + Daughters

During the February 1999 sampling event, lead-210 was detected in five of 11 soil samples. Since neither a risk-based GV nor a background level had been established for this radionuclide, a technical basis for evaluating the data was needed. To determine if Pb-210 should be carried through or screened from the RRE, guideline values were developed. The resultant GVs were 1.7 pCi/g and 3.2 pCi/g for the construction worker and site employee, respectively. (GV calculations are shown in Appendix B.) Based on the GVs, lead-210 was screened from the RRE.

3.1.4 Naphthalene

The appropriate oral RfD for naphthalene is 0.02 mg/kg-d (down from 50 mg/kg-d). The HQs for incremental and total soil ingestion were therefore increased from 2.5×10^{-7} to 6.2×10^{-4} and from 2.6×10^{-8} to 6.4×10^{-5}, respectively, for the construction worker and site employee. (The risk calculations have been reproduced in Appendix B.)

3.1.5 Plutonium-242

The RRE reported that HEAST data were not available for Pu-242. However, ingestion, inhalation, and external exposure slope factors are available. Based on the HEAST data, the incremental and total soil risk values for the construction worker are 2.6×10^{-9}, 2.2×10^{-12}, and 3.3×10^{-13} for the ingestion, inhalation, and external exposure pathways, respectively. For the site employee, the incremental and total soil risk values are 1.3×10^{-9}, 1.1×10^{-11}, and 3.7×10^{-13} for the ingestion, inhalation, and external exposure pathways, respectively. (The risk calculations have been reproduced in Appendix B.)

3.1.6 Radium-226

The RRE excluded Ra-226 from analysis based on the parent-daughter relationship with Th-232. However, the Th-232 slope factor does not include decay products. Based on HEAST data for Ra-226 + D, the incremental soil risk values for the construction worker are 2.0×10^{-7}, 1.8×10^{-11}, and 1.2×10^{-5} for the ingestion, inhalation, and external exposure pathways, respectively. For the site employee, the incremental soil risk values are 1.1×10^{-7}, 9.2×10^{-11}, and 1.3×10^{-5} for the ingestion, inhalation, and external exposure pathways, respectively. (The risk calculations have been reproduced in Appendix B.)

3.1.7 Thorium-228 + Daughters

The RRE used an older external exposure slope factor. The new slope factor, and the resulting new GV, were used to re-evaluate Th-228 risks. Using the newer values, Th-228 still screens out from the RRE. (The GV calculations have been reproduced in Appendix B.)

3.2 Groundwater Data

Based on the review of groundwater data conducted during the validation of the RB D RRE, numerous corrections and updates were necessary. Many of the same changes were required for the RB H RRE and are documented below. However, as also shown below, additional corrections, beyond those required for the RB D RRE, were required for the RB H RRE. All groundwater calculations have been reviewed and validated. Tables II.2. and II.3 from the RRE have been revised and appear in the Appendix. The resultant risks shown in Tables 3-1a and 3-1b reflect all necessary corrections and/or updates.

3.2.1 Beryllium

Beryllium was not included in the current groundwater scenario, but was projected to present in future groundwater. The oral RfD for beryllium has been lowered by a factor of 2.5 and the oral slope factor has been withdrawn. These updates would trigger a change in the beryllium HQ for future incremental groundwater ingestion from $2x10^{-4}$ to $4.9x10^{-4}$ for both the construction worker and site employee. The updated risk data would also eliminate the carcinogenic risk estimate for beryllium since the slope factor has been withdrawn. Given the magnitude of the contribution to the HQ from beryllium, these changes are not significant.

3.2.2 Chromium

Chromium is present in the bedrock under various areas of the site, but was not included in the current groundwater scenario because the maximum concentration detected was below the guideline value. The chromium is, however, assumed to enter the BVA and be consumed in the future. As such, chromium is a dominant contributor to the future groundwater hazard index.

Since the 1997 RRE, the oral RfD for chromium (VI) was lowered by a factor of 1.7. This update would trigger a change in the chromium (VI) HQ for future incremental groundwater ingestion from 0.96 to 1.6 for both the construction worker and site employee. Though the increase in the HQ is significant, the possible need to apply institutional controls to restrict future groundwater consumption was recognized via the RB D RRE. Therefore, the conclusions regarding chromium remain valid. However, given that all chromium detected in groundwater is not in the hexavalent state, some consideration should be given to normalizing the chromium HQ to account for the ratio of chromium (VI) to chromium (III). The data needed to determine this ratio will be collected as part of an on-going investigation of chromium sources and their migration patterns. When the investigation is complete, the groundwater RRE will require re-evaluation.

3.2.3 1,1,1-Trichloroethane

The oral RfD for 1,1,1-trichloroethane has been withdrawn. Revisiting the RRE is not recommended.

3.2.4 1,1,1-Trichloro-1,2,2-trifluoroethane

An oral RfD was added for 1,1,1-trichloro-1,2,2-trifluoroethane. Given that the oral RfD is 30 mg/kg-d, the RRE would not be significantly affected. Specifically, the contribution to the HQ for incremental groundwater ingestion for both the construction worker and site employee is 2.8×10^{-6}.

3.2.5 Bismuth-210

Risk calculations for Bi-210 were not performed for the RRE; the RRE indicated slope factors were not available. Bi-210 slope factors are available; however, the missed risks were 3.6×10^{-9} and 1.8×10^{-8} for the construction worker and site employee, respectively. These risk increments are not significant.

3.2.6 Strontium-85

Stronium-85 erroneously appears in specific risk tables of the RRE (e.g., V.2, V.3, and V.5). For groundwater, there was a single detect for Sr-85. Based on a single positive result and the short half-life of Sr-85, it was appropriate to screen the radionuclide from the RRE. Therefore, the fact that the tables incorrectly state that toxicity data are not available for Sr-85 is of no consequence to the analysis.

3.2.7 Thorium-228 + Daughters

In the RRE, Th-228 + D was reported as eliminated (i.e., not carried through the RRE) because Th-228 is a decay product of Th-232. However, the Th-232 slope factors do not include daughters, and Th-232 was subsequently screened from the RRE because the 95% UCL concentration was less than background. Additionally, although Th-228 was reportedly screened out of the RRE, Th-228 risk values appear sporadically in tables. For example, Th-228 risk values are included in Table V.5 but not in Table V.6. Because of the inconsistencies encountered in the RRE, all thorium-228 + daughter intake and risk calculations were re-calculated as described below.

Using the maximum concentration of Th-228 detected/projected for current and future BVA, the radionuclide risk values for groundwater ingestion were calculated for this report. For the current use scenario, the overall radionuclide total risk from groundwater ingestion increased from 2.4×10^{-6} to 3.0×10^{-6} (construction worker), and from 1.2×10^{-5} to 1.5×10^{-5} (site employee). For the

future use scenario, the total risk from groundwater ingestion of radionuclides would have increased from 2.7×10^{-6} to 3.4×10^{-6} (construction worker), and from 1.3×10^{-5} to 3.2×10^{-5} (site employee).

Though the magnitude of these changes is significant on a relative basis, the overall risks remain in the acceptable range and the conclusions of the RRE remain valid.

3.2.8 Tritium

In the RRE, tritium was not listed in Table V.2, but the "shower inhalation" and "groundwater dermal" risk values for tritium were included and are numerically correct. The "groundwater ingestion" risk value, however, is missing from the table, but is not a significant contributor to risk (1.1×10^{-7}). The corrected risk value appears in Tables 3-1a and 3-1b.

3.2.9 Uranium-234, Uranium-238

Risk data for these radionuclides were omitted from Table V.5 of the RRE. The missed risks were 2.0×10^{-6} and 2.9×10^{-6}, respectively, for U-234 and U-238. The corrected risk values appear in Tables 3-1a and 3-1b.

3.3 Air Data

For purposes of evaluating cumulative residual risk, air pathway data are also reported in each RRE. Per the Residual Risk Evaluation Methodology document, 1994 data collected at the Mound Plant perimeter air sampling stations are used to bound the concentrations and therefore the risks from inhalation of radionuclides present in ambient air. The risk data for tritium (HTO), Pu-238, and Pu-239/240 reported in the RB H RRE were reviewed and found to require no update or changes. It was observed, however, that the site employee risk calculations did not include an adjustment factor to account for the time spent indoors. While this approach is inconsistent with that applied to analogous outdoor pathways, it is conservative in nature.

3.4 Risk Data Summary

The residual risks for RB H, adjusted for updated and corrected data, are shown in Tables 3-1a and 3-1b for the construction worker and site employee, respectively. These data are appropriate for use in documenting the current and cumulative residual risks for Release Block H.

4.0 CONCLUSIONS AND RECOMMENDATIONS

For purposes of evaluating the need for institutional controls, the RB H RRE adequately characterizes the residual risks associated with the release block. However, changes to the risk data in IRIS and HEAST do occur and should be anticipated. IRIS updates are published monthly; HEAST updates occur much less frequently. A mechanism should be developed to ensure such changes are reviewed and adopted as appropriate.

It is also recommended that the changes noted in this report for groundwater-related risks be formally adopted. Since the groundwater risks will be identical for many of the parcels, a stand-alone report documenting the changes may be appropriate. The report should note prominently, though, that each subsequent RRE must be evaluated for parcel-specific leaching concerns that were not included in the site-wide analysis. Given that groundwater from numerous parcels may migrate toward the BVA, this evaluation should apply to any parcel in which new groundwater concerns arise – not just the parcel under consideration for sale.

A final recommendation is that consideration be given to the mechanism to update/re-validate the guideline values. The GV manual is a large document to which a small number of changes need to be made. The appropriate vehicle for documenting and adopting those changes should be identified.

Table 3-1a. Current and Cumulative RB H RRE Data for the Construction Worker.

Construction Worker	Hazard Index (HI) or Risk		
	Incremental	Background	Total
Soil – current			
HI	4.0E-02	1.3E-01	1.7E-01
Non-rad risk	4.7E-06	5.2E-06	9.9E-06
Rad risk	1.7E-05	2.3E-05	4.0E-05
Groundwater – current			
HI	3.7E-02	9.6E-05	3.7E-02
Non-rad risk	N/A	N/A	N/A
Rad risk	2.5E-06	5.1E-07	3.0E-06
Air – current (1994)			
HI	N/A	N/A	N/A
Non-rad risk	N/A	N/A	N/A
Rad risk	2.0E-07	7.7E-09	2.1E-07
Totals – current			
HI	7.7E-02	1.3E-01	2.1E-01
Non-rad risk	4.7E-06	5.2E-06	9.9E-06
Rad risk	2.0E-05	2.3E-05	4.3E-05
Groundwater – future			
HI	1.6E+00	3.1E-02	1.7E+00
Non-rad risk	N/A	N/A	N/A
Rad risk	2.9E-06	5.1E-07	3.4E-06
Totals – cumulative			
HI	1.7E+00	1.6E-01	1.9E+00
Non-rad risk	4.7E-06	5.2E-06	9.9E-06
Rad risk	2.3E-05	2.4E-05	4.7E-05

Notes: N/A = Not applicable.
Data represent RRE calculations prior to the implementation of the remedy.
HI calculated based on assumption that all chromium is Cr(VI). This approach significantly over-estimates the Cr risk as not all chromium present in groundwater is in the hexavalent state.

Table 3-1b. Current and Cumulative RB H RRE Data for the Site Employee.

Site Employee	Hazard Index (HI) or Risk		
	Incremental	Background	Total
Soil – current			
HI	4.0E-03	1.4E-02	1.8E-02
Non-rad risk	2.0E-06	2.3E-06	4.3E-06
Rad risk	1.8E-05	2.4E-05	4.2E-05
Groundwater – current			
HI	3.7E-02	7.6E-05	3.7E-02
Non-rad risk	N/A	N/A	N/A
Rad risk	1.3E-05	2.5E-06	1.5E-05
Air – current (1994)			
HI	N/A	N/A	N/A
Non-rad risk	N/A	N/A	N/A
Rad risk	9.9E-07	3.9E-08	1.0E-06
Totals – current			
HI	4.1E-02	1.4E-02	5.5E-02
Non-rad risk	2.0E-06	2.3E-06	4.3E-06
Rad risk	3.2E-05	2.6E-05	5.8E-05
Groundwater – future			
HI	1.6E+00	3.1E-02	1.6E+00
Non-rad risk	N/A	N/A	N/A
Rad risk	1.4E-05	2.5E-06	1.7E-05
Totals – cumulative			
HI	1.6E+00	4.5E-02	1.7E+00
Non-rad risk	2.0E-06	2.3E-06	4.3E-06
Rad risk	4.6E-05	2.9E-05	7.5E-05

Notes: N/A = Not applicable.
Data represent RRE calculations prior to the implementation of the remedy.
HI calculated based on assumption that all chromium is Cr(VI). This approach significantly over-estimates the Cr risk as not all chromium present in groundwater is in the hexavalent state.

5.0 REFERENCES

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6. **Mound 2000 Residual Risk Evaluation Methodology, Mound Plant**, U.S. Department of Energy, Miamisburg, Ohio, January 1997.

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APPENDIX A
Updated RRE Data Tables

II.1 Summary Table of All Soil Contaminants Detected in Release Block H

II.2 Summary Table of All Current Groundwater Contaminants Detected in BVA Production Wells

II.3 Summary Table of All Future Groundwater Contaminants Assumed to be in BVA Production Wells with Input from the Bedrock Aquifer

V1 Characterization of Residual Risks at Release Block H - Construction Worker - Soil Pathways - Incremental

V4 Characterization of Residual Risks at Release Block H - Site Employee - Soil Pathways - Incremental

F7 Characterization of Residual Risks at Release Block H - Construction Worker - Soil Pathways - Background

F10 Characterization of Residual Risks at Release Block H - Site Employee - Soil Pathways - Background

F19 Characterization of Residual Risks at Release Block H - Construction Worker - Soil Pathways - Total

F22 Characterization of Residual Risks at Release Block H - Site Employee - Soil Pathways - Total

Revised Table II.1. Summary Table of All Soil Contaminants Detected in Release Block H

Soil contaminants above detection limit	Maximum concentration Any Depth	Maximum concentration Shallow - only	Soil background	G.V. for construction worker	G.V. for site employee	Detects / Analyses	Carried through RRE?	Reason
ORGANICS (mg/kg)								
Acenaphthene	0.18	0.18				3/10	Yes	F.O.D.[7] = 30%
Acenaphthylene	0.7	0.7				1/10	Yes	F.O.D.[7] = 10%
Acetone	0.0355	0.0355		21000[2]	200000[2]	2/10	No	Conc. < G.V.
Aldrin	0.0031	0.0031				2 /11	Yes	F.O.D.[7] = 18%
Anthracene	1.25	1.25		64000[2]	610000[2]	2/10	No	Conc. < G.V.
Aroclor-1254	0.0037	0.0037	58	4.3[2]	41[2]	1/11	No	Conc. < G.V. and Bkgd.
Benzene	0.0015	0.0015		32[3]	8.9[3]	1/10	No	Conc. < G.V.
Benzo(a)anthracene	1.4	1.4		4.1[4]	7.8[4]	5/10	No	Conc. < G.V.
Benzo(a)pyrene	1.115	1.115		0.41[4]	0.78[4]	5/10	Yes	Conc. > G.V.
Benzo(b)fluoranthene	0.9125	0.9125		4.1[4]	7.8[4]	5/10	No	Conc < G.V.
Benzo(g,h,i) perylene	1.0625	1.0625				4/10	Yes	F.O.D.[7] = 40%
Benzo(k)fluoranthene	0.915	0.915		41[4]	78[4]	3/10	No	Conc < G.V.
Benzoic acid	0.072	0.072		850000[2]	8200000[2]	1/9	No	Conc. < G.V.
delta-BHC	0.00025	0.00025				1/11	Yes	F.O.D.[7] = 9%
2-Butanone	0.0115	0.0115		9300[1]	9300[1]	1/10	No	Conc. < G.V.
Carbazole	0.5875	0.5875				1/6	Yes	F.O.D.[7] = 17%
alpha Chlordane	0.01	0.01				4/7	Yes	F.O.D.[7] = 57%
gamma Chlordane	0.0074	0.0074				4/7	Yes	F.O.D.[7] = 57%
4-chloro-3-methyl phenol	0.047	0.047				1/10	Yes	F.O.D.[7] = 10%
Chrysene	1.4	1.4		410[4]	780[4]	5/10	No	Conc. < G.V.
Dibenzo(a,h)anthracene	0.78	0.78		0.41[4]	0.78[4]	2/10	Yes	Conc. > G.V.
Dibenzofuran	1.035	1.035				1/10	Yes	F.O.D.[7] = 10%
Dieldrin	0.145	0.145		0.185[3]	0.36[3]	3/11	No	Conc. < G.V.
bis(2-ethylhexyl)phthalate	3.4	0.13		215[4]	410[4]	5/10	No	Conc. < G.V.
Fluoranthene	2.325	2.325		8500[2]	82000[2]	7/10	No	Conc. < G.V.
Fluorene	1.45	1.45				1/10	Yes	F.O.D.[7] = 10%

Revised Table II.1. Summary Table of All Soil Contaminants Detected in Release Block H

Soil contaminants above detection limit	Maximum concentration Any Depth	Maximum concentration Shallow - only	Soil background	G.V. for construction worker	G.V. for site employee	Detects / Analyses	Carried through RRE?	Reason
Heptachlor epoxide	0.0022	0.0022				2/11	Yes	F.O.D.[7] = 18%
Indeno(1,2,3-cd)pyrene	0.99	0.99		4.1[4]	7.8[4]	5/10	No	Conc. < G.V.
Methylene chloride	0.0065	0.0065		1000[1]	1000[1]	4/10	No	Conc. < G.V.
2-Methylnaphthalene	0.92	0.92				1/10	Yes	F.O.D.[7] = 10%
Napthalene	2.625	2.625				1/10	Yes	F.O.D.[7] = 10%
Phenanthrene	3.75	3.75				5/10	Yes	F.O.D.[7] = 50%
Pyrene	1.975	1.975		6400[2]	61000[2]	6/10	No	Conc. < G.V.
Toluene	0.002	0.002		250[1]	250[1]	1/10	No	Conc. < G.V.
1,1,2-Trichloro-1,2,2-trifluoroethane	0.002	0.002				1/5	Yes	F.O.D.[7] = 20%
Xylenes, total	0.0018	0.0018		430000[2]	4100000[2]	1/10	No	Conc. < G.V.
INORGANICS (mg/kg)								
Aluminum	15900	13500	19000			11/11	No	Conc. < Bkgd.
Antimony	0.235	0.235		85[2]	820[2]	1/8	No	Conc. < G.V.
Arsenic (total)	10.9	10.9	8.6	64[2]	610[2]	11/11	Yes	Conc. > G.V. & Bkgd.
Barium (total)	249	249	180	15000[1]	140000[1]	11/11	No	Conc. < G.V.
Beryllium	0.89	0.89	1.3	0.7[3]	1.3[3]	11/11	No	Conc. < Bkgd.
Bismuth	58.6	58.6				4/7	Yes	F.O.D.[7] = 57%
Cadmium (total)	0.35	0.255	2.1	210[2]	2000[2]	12/22	No	Conc. < Bkgd. & G.V.
Calcium (total)	152000	152000	310000			11/11	No	Conc. < Bkgd.
Chloride	1300	1300	107			6/6	No	Common soil constituent
Chromium (total)	23.9	19.8	20	1100[2]	10000[2]	22/22	No	Conc. < G.V.
Cobalt (total)	12.3	12.3	19			11/11	No	Conc. < Bkgd.
Copper (total)	26.4	22.1	26			11/11	Yes	Conc. > Bkgd.
Cyanide	1.7	1.7		4300[2]	41000[2]	2/11	No	Conc. < G.V.
Fluoride	7.8	7.8	6.7			6/6	No	Common soil constituent
Iron (total)	34700	34700	35000			11/11	No	Conc. < Bkgd.
Lead (total)	163	163	48			22/22	Yes	Conc. > Bkgd.

Revised Table II.1. Summary Table of All Soil Contaminants Detected in Release Block H

Soil contaminants above detection limit	Maximum concentration Any Depth	Maximum concentration Shallow - only	Soil background	G.V. for construction worker	G.V. for site employee	Detects / Analyses	Carried through RRE?	Reason
Lithium	40.2	19	26			2/2	Yes	Conc. > Bkgd.
Magnesium (total)	54100	39900	40000			11/11	No	Common soil constituent
Manganese (total)	1200	1200	1400	27000[1]	150000[1]	11/11	No	Conc. < G.V. & Bkgd.
Mercury (total)	0.04	0.04		64[1]	610[1]	3/11	No	Conc. < G.V.
Molybdenum	7.7	0.935	27			2/2	No	Conc. < Bkgd.
Nickel (total)	29.5	23.4	32	4300[2]	41000[2]	22/22	No	Conc. < G.V. & Bkgd.
Nitrate	1.32	---				1/1	No	Common soil constituent
Nitrate/Nitrite	9	9	26			6/6	No	Conc. < Bkgd.
Organic Carbon	216670	216670				4/4	No	Common soil constituent
Potassium (total)	3750	1680	1900			11/11	No	Common soil constituent
Silver (total)	8.9	0.56	1.7	1100[2]	10000[2]	4/11	No	Conc. < G.V.
Sodium (total)	2670	2670	240			11/11	No	Common soil constituent
Sulfate	322	322	150			5/6	No	Common soil constituent
Vanadium	30.8	27.9	25	1500[2]	14000[2]	11/11	No	Conc. < G.V.
Zinc (total)	311	311	140	64000[2]	610000[2]	11/11	No	Conc. < G. V.
RADIONUCLIDES (pCi/g)								
Cesium-137	1.9	1.9	0.42	0.46[5]	0.42[5]	9/14	Yes	Conc. > G.V. & Bkgd.
Lead-210	1.42	1.42		1.7[8]	3.2[8]	5/11	No	Conc. < G.V.
Plutonium-238	56	56	0.13	5.5[5]	11[5]	563/573	Yes	Conc. > G.V. & Bkgd.
Plutonium-239/240	0.0328	0.0328	0.18	5.5[5]	10[5]	3/12	No	Conc. < G.V. & Bkgd.
Plutonium-242	0.0143	0.0143				2/5	Yes	F.O.D.[7] = 40%
Potassium-40	45.4	21	37			12/12	Yes	Conc. > Bkgd.
Radium-226	3.15	3.15	2	0.14[5]	0.13[5]	12/14	Yes	Conc. > G.V. & Bkgd.
Strontium-90	0.845	0.384	0.72	3.0[5]	57[5]	2/6	No	Conc. < G.V.
Thorium-228	1.17	0.847	1.5	0.11[5,9]	0.10[5,9]	11/11	No	Conc. < Bkgd.
Thorium-230	1.6	1.6	1.9	44[5]	81[5]	11/11	No	Conc. < Bkgd.
Thorium-232	4.47	2.3	1.4	0.11[5,6]	0.10[5,6]	475/561	Yes[10]	Conc. > G.V. & Bkgd.

Revised Table II.1. Summary Table of All Soil Contaminants Detected in Release Block H

Soil contaminants above detection limit	Maximum concentration Any Depth	Maximum concentration Shallow - only	Soil background	G.V. for construction worker	G.V. for site employee	Detects / Analyses	Carried through RRE?	Reason
Tritium	0.3	---	1.6	23500[5]	45000[5]	1/3	No	Conc. < G.V. & Bkgd.
Uranium-234	1.02	0.851	1.1	37.5[5]	70[5]	10/11	No	Conc. < G.V. & Bkgd.
Uranium-235	0.0659	0.0659	0.11	3.35[5]	3.1[5]	3/11	No	Conc. < G.V. & Bkgd.
Uranium-238	0.962	0.962	1.2	11.0[5]	13.0[5]	10/11	No	Conc. < G.V. & Bkgd.

NOTES: Blanks indicate background or Guideline Value not available. The more restrictive G.V. was used to determine which contaminants were carried through the RRE.

--- No shallow data available.

[1] - Hazard Quotient for both ingestion and inhalation. (Decision made on 0.1 x G.V.)

[2] - Hazard Quotient for ingestion only. (Decision made on 0.1 x G.V.)

[3] - Total Risk 10^{-6} for both ingestion and inhalation.

[4] - Total Risk 10^{-6} for ingestion only.

[5] - Total Risk 10^{-6} for ingestion, inhalation and external.

[6] - Guideline values from thorium-228 + D used to account for Th-228 + D ingrowth.

[7] - F.O.D. = Frequency of detection. Contaminants with a F.O.D. greater than 5% were carried through the RRE.

[8] - Pb-210 guideline value not previously available. G.V. calculations are shown in the Appendix.

[9] - Th-228 guideline values have been revised to reflect updated slope factors. G.V. calculations are shown in the Appendix.

[10] - Th-232 95% upper confidence level was less than background. Therefore, Th-232 was not carried through the risk calculations.

Revised Table II.2. Summary Table of All Current Groundwater Contaminants Detected in BVA Production Wells

Groundwater contaminants above detection limit	Maximum concentration	BVA background	G.V. for construction worker	G.V. for site employee	Carried through RRE?	Reason
ORGANICS (mg/L)						
Acetone	0.012		10[1]	10[2]	No	Conc. < G.V.
Bromodichloromethane	0.0037		0.0045[3]	0.0046[4]	No	Conc. < G.V.
2-Butanone	0.041		53[1]	61[1]	No	Conc. < G.V.
Chloroform	0.0022	0.0005	0.024[3]	0.047[4]	No	Conc. < G.V.
1,1-Dichloroethane	0.0035		9.5[1]	10[2]	No	Conc. < G.V.
1,1-Dichloroethene	0.0017				Yes	No screening values
1,2-Dichloroethene	0.0047		2.0[2]	2.0[2]	No	Conc. < G.V.
1,2-cis-Dichloroethene	0.0021	0.0010	2.0[2]	2.0[2]	No	Conc. < G.V.
1,2-trans-Dichloroethene	0.003		2.0[2]	2.0[2]	No	Conc. < G.V.
Dichloromethane - Methylene chloride	0.0098		0.038[3]	0.038[4]	No	Conc. < G.V.
Isophorone	0.010		0.3[3]	0.3[4]	No	Conc. < G.V.
Tetrachloroethene	0.002		0.46[1]	1.0[2]	No	Conc. < G.V.
1,1,1-Trichloroethane	0.0018	0.0007			Yes	Conc. > Background
Trichloroethene	0.0046		0.024[3]	0.026[4]	No	Conc. < G.V.
Trichlorofluoromethane	0.0025		26[1]	31[2]	No	Conc. < G.V.
1,1,2-Trichloro-1,2,2-Trifluoroethane	0.0087				Yes	No screening values
INORGANICS (mg/L)						
Alkalinity	335				No	Water quality parameter
Aluminum	0.0737	0.0375			No	Water quality parameter
Ammonia	0.58	0.162			No	Water quality parameter
Barium	0.0884	0.3102	7.1[1]	7.2[1]	No	Conc. < G.V.
Cadmium	0.0077		0.051[1]	0.051[2]	Yes	Conc. > G.V.
Calcium	126	111			No	Water quality parameter
Chloride	133	106			No	Water quality parameter
Chromium (total)	0.0249	0.0061	0.51[1]	0.51[2]	No	Conc. < G.V.
Copper	0.593	0.0012			Yes	Conc. > Bkgd.

Revised Table II.2. Summary Table of All Current Groundwater Contaminants Detected in BVA Production Wells

Groundwater contaminants above detection limit	Maximum concentration	BVA background	G.V. for construction worker	G.V. for site employee	Carried through RRE?	Reason
Dissolved Solids	719	603			No	Water quality parameter
Fluoride	0.18	0.419			No	Water quality parameter
Iron	0.780	4.065			No	Conc. < Background
Lead (soluble)	0.040	0.0101			Yes	Conc. > Background
Magnesium	39.6	40.43			No	Conc. < Background
Manganese	0.0248	0.2296	0.51[1]	0.51[2]	No	Conc. < G.V.
Nitrate/Nitrite	4.9	5.349			No	Conc. < Background
Nitrate	2.55				No	Water quality parameter
Nitrite	0.066				No	Water quality parameter
Nitrogen	0.62	0.324			No	Water quality parameter
Organic Carbon	1.1	1.987			No	Conc. < Background
Phosphate	0.22	0.231			No	Conc. < Background
Potassium	3.8	4.461			No	Conc. < Background
Silver	0.0242		0.51[1]	0.51[2]	No	Conc. < G.V.
Sodium	82.4	62.43			No	Water quality parameter
Sulfate	83.0	142.7			No	Conc. < Background
Suspended Solids	8.0	26.44			No	Conc. < Background
Vanadium	0.0244	0.0171	0.71[1]	0.72[2]	No	Conc. < G.V.
Zinc	0.0577	0.1196	31[1]	31[2]	No	Conc. < G.V.
RADIONUCLIDES (pCi/L)						
Actinium-227	0.335		1.34[4]	0.26[4]	Yes	Conc. > Site employee G.V.
Bismuth-210	0.39				Yes	No screening values
Plutonium-239,240	2.0	0.125	2.5[4]	0.51[4]	Yes	Conc. > Site employee G.V.
Radium-226	0.4	0.996	2.74[4]	0.54[4]	No	Conc. < Background
Stronium-85	25				No	Short half-life, single detect
Strontium-90	0.3	0.975	14[4]	2.9[4]	No	Conc. < G.V.
Thorium-228	2.17	0.779	3.5[4]	0.69[4]	Yes	Conc. > Site employee G.V.

Revised Table II.2. Summary Table of All Current Groundwater Contaminants Detected in BVA Production Wells

Groundwater contaminants above detection limit	Maximum concentration	BVA background	G.V. for construction worker	G.V. for site employee	Carried through RRE?	Reason
Thorium-230	1.99	0.289	21[4]	4.3[4]	No	Conc. < G.V.
Thorium-232	0.1		24[4,5]	0.69[4,5]	No	Conc. < G.V.
Tritium	7200	1485	11000[3]	2200[4]	Yes	Conc. > Site employee G.V.
Uranium-234	8.14	0.792	18[4]	3.6[4]	Yes	Conc. > Site employee G.V.
Uranium-238	8.25	0.688	13[4]	2.6[4]	Yes	Conc. > Site employee G.V.

NOTES: Blanks indicate background or guideline values not available. The more restrictive G.V. was used to determine which contaminants were carried through the RRE.

[1] - Hazard Quotient for ingestion, dermal and inhalation. (Decision made on 0.1 x G.V.)

[2] - Hazard Quotient for ingestion only. (Decision made on 0.1 x G.V.)

[3] - Total Risk 10^{-6} for ingestion, dermal and inhalation.

[4] - Total Risk 10^{-6} for ingestion only.

[5] - Guideline values from thorium-228 + D.

Revised Table II.3. Summary Table of All Future Groundwater Contaminants Assumed to be in Production Wells with Input from the Bedrock Aquifer

Groundwater contaminants above detection limit	Maximum concentration	BVA background	G.V. for construction worker	G.V. for site employee	Carried through RRE?	Reason
ORGANICS (mg/L)						
Acetone	0.0129		10[1]	10[2]	No	Conc. < G.V.
Benzene	0.0001		0.0087[3]	0.0099[4]	No	Conc. < G.V.
Benzoic acid	0.071		400[1]	410[2]	No	Conc. < G.V.
Bromodichloromethane	0.0037		0.0045[3]	0.0046[4]	No	Conc. < G.V.
2-Butanone	0.0543		53[1]	61[1]	No	Conc. < G.V.
Carbon tetrachloride	0.0000135		0.002[3]	0.0022[4]	No	Conc. < G.V.
Chloroform	0.0022	0.0005	0.024[3]	0.047[4]	No	Conc. < G.V.
1,1-Dichloroethane	0.0035		9.5[1]	10[2]	No	Conc. < G.V.
1,1-Dichloroethene	0.0017				Yes	No screening values
1,2-Dichloroethene	0.0050		2.0[2]	2.0[2]	No	Conc. < G.V.
1,2-cis-Dichloroethene	0.0023	0.0010	2.0[2]	2.0[2]	No	Conc. < G.V.
1,2-trans-Dichloroethene	0.0032		2.0[2]	2.0[2]	No	Conc. < G.V.
Bis (2-ethylhexyl)phthalate	0.0153	0.0084	0.019[3]	0.02[3]	No	Conc. < G.V.
Isophorone	0.0100		0.3[3]	0.3[4]	No	Conc. < G.V.
4-Methylphenol	0.0004		0.48[1]	0.51[2]	No	Conc. < G.V.
Tetrachloroethene	0.0021		0.46[1]	1.0[2]	No	Conc. < G.V.
1,1,1-Trichloroethane	0.0065	0.0007			Yes	Conc. > Bkgd.
Trichloroethene	0.0050		0.024[3]	0.026[4]	No	Conc. < G.V.
Trichlorofluoromethane	0.0025		26[1]	31[2]	No	Conc. < G.V.
1,1,2-Trichloro-1,2,2-trifluoroethane	0.0087				Yes	No screening values
Toluene	0.0002		16[1]	20[2]	No	Conc. < G.V.
Xylenes (total)	0.000043		200[2]	200[2]	No	Conc. < G.V.
INORGANICS (mg/L)						
Antimony	0.0008	0.0006	0.041[1]	0.041[2]	No	Conc. < G.V.
Barium	0.0884	0.3102	7.1[1]	7.2[2]	No	Conc. < G.V.

Revised Table II.3. Summary Table of All Future Groundwater Contaminants Assumed to be in Production Wells with Input from the Bedrock Aquifer

Groundwater contaminants above detection limit	Maximum concentration	BVA background	G.V. for construction worker	G.V. for site employee	Carried through RRE?	Reason
Beryllium	0.0001		0.000066[3]	0.000067[4]	Yes	Conc. > G.V.
Bismuth	0.0016				Yes	No screening values
Cadmium	0.0077		0.051[1]	0.051[2]	Yes	Conc. > G.V.
Chromium	0.4961	0.0061	0.51[1]	0.51[2]	Yes	Conc. > G.V.
Cobalt	0.0039				Yes	No screening values
Copper	0.5964	0.0012			Yes	Conc. > Bkgd.
Cyanide	0.0001		2.0[1]	2.0[2]	No	Conc. < G.V.
Iron	0.78	4.065			No	Conc. < Bkgd.
Lead (soluble)	0.04	0.0101			Yes	Conc. > Bkgd.
Lithium	0.0036	0.0557			No	Conc. < Bkgd.
Magnesium	43.974	40.428			No	Water quality parameter
Manganese	0.0248	0.2296	0.51[1]	0.51[2]	No	Conc. < G.V.
Molybdenum	0.0096	0.0056			Yes	Conc. > Bkgd.
Nickel	0.1003	0.0350	2.0[1]	2.0[2]	No	Conc. < Bkgd.
Phosphate	0.3664	0.231			No	Water quality parameter
Potassium	6.0034	4.461			No	Water quality parameter
Silver	0.0242		0.51[1]	0.51[2]	No	Conc. < G.V.
Vanadium	0.028	0.0171	0.71[1]	0.72[2]	No	Conc. < G.V.
Zinc	0.0577	0.1196	31[1]	31[2]	No	Conc. < G.V.
RADIONUCLIDES (pCi/L)						
Actinium-227	0.335		1.3[4]	0.26[4]	Yes	Conc. > Site employee G.V.
Bismuth-210	0.39				Yes	No screening values
Plutonium-238	0.0034	0.087	2.7[4]	0.54[4]	No	Conc. < G.V.
Plutonium-239,240	2.0199	0.125	2.5[4]	0.51[4]	Yes	Conc. > Site employee G.V.
Radium-226	0.6402	0.996	2.7[4]	0.54[4]	No	Conc. < Background
Stronium-85	25				No	Short half-life, single detect

Revised Table II.3. Summary Table of All Future Groundwater Contaminants Assumed to be in Production Wells with Input from the Bedrock Aquifer

Groundwater contaminants above detection limit	Maximum concentration	BVA background	G.V. for construction worker	G.V. for site employee	Carried through RRE?	Reason
Strontium-90	0.3121	0.975	14[4]	2.9[4]	No	Conc. < G.V.
Thorium-228	2.17	0.779	3.5[4]	0.69[4]	Yes	Conc. > Site employee G.V.
Thorium-230	2.0645	0.289	21[4]	4.3[4]	No	Conc. < G.V.
Thorium-232	0.1422		24[4,5]	0.69[4,5]	No	Conc. < G.V.
Tritium	10427	1485	11000[4]	2200[4]	Yes	Conc. > Site employee G.V.
Uranium-233	0.0002		18[4]	3.6[4]	No	Conc. < G.V.
Uranium-234	8.14	0.792	18[4]	3.6[4]	Yes	Conc. > Site employee G.V.
Uranium-235	0.0036	0.045	17[4]	3.4[4]	No	Conc. < G.V.
Uranium-235,236	0.0003		17[4]	3.4[4]	No	Conc. < G.V.
Uranium-238	8.25	0.688	13[4]	2.6[4]	Yes	Conc. > Site employee G.V.

NOTES: Blanks indicate background or guideline values not available. The more restrictive G.V. was used to determine which contaminants were carried through the RRE.

[1] - Hazard Quotient for ingestion, dermal and inhalation. (Decision made on 0.1 x G.V.)

[2] - Hazard Quotient for ingestion only. (Decision made on 0.1 x G.V.)

[3] - Total Risk 10^{-6} for ingestion, dermal and inhalation.

[4] - Total Risk 10^{-6} for ingestion only.

[5] - Guideline values from thorium-228+D.

Revised **Table V.1 Characterization of Residual Risks at Release Block H - Construction Worker Soil Pathways - Incremental**

Constituent	Pathway 1 Soil VOC Inhalation	Pathway 2 Soil/Dust Inhalation	Pathway 6 Soil Ingestion	Pathway 7 External Radiation	Pathway 8 Soil Dermal	Construction Worker
Non-carcinogens (HQ)						
Aldrin	NA	***	4.9E-04	NA	1.0E-04	
α-Chlordane	NA	***	9.4E-05	NA	1.6E-04	
γ-Chlordane	NA	***	7.0E-05	NA	1.2E-04	
Heptachlor epoxide	NA	***	7.9E-04	NA	1.7E-04	
Acenaphthene	NA	***	1.4E-05	NA	2.9E-06	
Arsenic	NA	***	3.6E-02	NA	7.5E-04	
Fluorene	NA	***	1.7E-04	NA	3.5E-05	
Naphthalene	NA	***	6.2E-04	NA	5.1E-08	
1,1,2-Trichloro-1,2,2-trifluoroethane	NA	***	3.1E-10	NA	6.5E-11	
Acenaphthylene	NA	***	***	NA	NA	
δ-BHC	NA	***	***	NA	NA	
Bismuth	NA	***	***	NA	NA	
4-Chloro-3-methylphenol	NA	***	***	NA	NA	
Copper	NA	***	***	NA	NA	
Dibenzofuran	NA	***	***	NA	NA	
Lithium	NA	***	***	NA	NA	
2-Methlynaphthalene	NA	***	***	NA	NA	
Phenanthrene	NA	***	***	NA	NA	Total HI =
Total:			3.8E-02		1.3E-03	4.0E-02
Carcinogens (Risk)						
Aldrin	NA	***	1.8E-08	NA	3.7E-09	
Arsenic	NA	***	1.2E-06	NA	2.4E-07	
Benzo(a)pyrene	NA	***	2.7E-06	NA	5.7E-07	
Benzo(g,h,i)perylene	NA	***	***	NA	***	
Carbazole	NA	***	***	NA	***	
α-Chlordane	NA	***	1.2E-09	NA	9.1E-10	
γ-Chlordane	NA	***	8.7E-10	NA	6.7E-10	
Dibenzo(a,h)anthracene	NA	***	***	NA	***	
Heptachlor epoxide	NA	***	6.7E-09	NA	1.4E-09	Total Carcinogenic
Lead	NA	***	***	NA	***	Risk =
Total:			3.9E-06		8.2E-07	4.7E-06
Radionuclides (Risk)						
Cesium-137	NA	1.6E-13	2.8E-08	4.7E-06	NA	
Plutonium-238	NA	1.8E-10	2.0E-07	3.2E-11	NA	Total Radionuclide
Plutonium-242	NA	2.2E-12	2.6E-09	3.3E-13	NA	Risk =
Radium-226	NA	1.8E-11	2.0E-07	1.2E-05	NA	
Total:		2.0E-10	4.3E-07	1.7E-05		1.7E-05

*** - Toxicity values not available.

NA - Not applicable.

Revised **Table V.4 Characterization of Residual Risks at Release Block H - Site Employee**
Soil Pathways - Incremental

Constituent	Pathway 1 Soil VOC Inhalation	Pathway 2 Soil/Dust Inhalation	Pathway 6 Soil Ingestion	Pathway 7 External Radiation	Site Employee
Non-carcinogens (HQ)					
Aldrin	NA	***	5.1E-05	NA	
α-Chlordane	NA	***	9.8E-06	NA	
γ-Chlordane	NA	***	7.2E-06	NA	
Heptachlor epoxide	NA	***	8.3E-05	NA	
Acenaphthene	NA	***	1.5E-06	NA	
Arsenic	NA	***	3.8E-03	NA	
Fluorene	NA	***	1.8E-05	NA	
Naphthalene	NA	***	6.4E-05	NA	
1,1,2-Trichloro-1,2,2-trifluoroethane	NA	***	3.3E-11	NA	
Acenaphthylene	NA	***	***	NA	
δ-BHC	NA	***	***	NA	
Bismuth	NA	***	***	NA	
4-Chloro-3-methylphenol	NA	***	***	NA	
Copper	NA	***	***	NA	
Dibenzofuran	NA	***	***	NA	
Lithium	NA	***	***	NA	
2-Methlynaphthalene	NA	***	***	NA	
Phenanthrene	NA	***	***	NA	Total HI =
Total:			4.0E-03		4.0E-03
Carcinogens (Risk)					
Aldrin	NA	***	9.2E-09	NA	
Arsenic	NA	***	6.0E-07	NA	
Benzo(a)pyrene	NA	***	1.4E-06	NA	
Benzo(g,h,i)perylene	NA	***	***	NA	
Carbazole	NA	***	***	NA	
α-Chlordane	NA	***	6.1E-10	NA	
γ-Chlordane	NA	***	4.5E-10	NA	
Dibenzo(a,h)anthracene	NA	***	***	NA	
Heptachlor epoxide	NA	***	3.5E-09	NA	Total Carcinogenic
Lead	NA	***	***	NA	Risk =
Total:			2.0E-06		2.0E-06
Radionuclides (Risk)					
Cesium-137	NA	8.2E-13	1.5E-08	5.2E-06	
Plutonium-238	NA	9.0E-10	1.1E-07	3.9E-11	Total Radionuclide
Plutonium-242	NA	1.1E-11	1.3E-09	3.7E-13	Risk =
Radium-226	NA	9.2E-11	1.1E-07	1.3E-05	
Total:		1.0E-09	2.4E-07	1.8E-05	1.8E-05

*** - Toxicity values not available.

NA - Not applicable.

Revised **Table F.7 Characterization of Residual Risks at Release Block H - Construction Worker**
Soil Pathways - Background

Constituent	Pathway 1 Soil VOC Inhalation	Pathway 2 Soil/Dust Inhalation	Pathway 6 Soil Ingestion	Pathway 7 External Radiation	Pathway 8 Soil Dermal	Construction Worker
Non-carcinogens (HQ)						
Arsenic	NA	***	1.3E-01	NA	2.8E-03	
Acenaphthalene	NA	***	0.0E+00	NA	0.0E+00	
Acenapthlyene	NA	***	***	NA	***	
Aldrin	NA	***	0.0E+00	NA	0.0E+00	
δ-BHC	NA	***	***	NA	***	
Bismuth	NA	***	***	NA	***	
α-Chlordane	NA	***	0.0E+00	NA	0.0E+00	
γ-Chlordane	NA	***	0.0E+00	NA	0.0E+00	
4-Chloro-3-methylphenol	NA	***	***	NA	***	
Copper	NA	***	***	NA	***	
Dibenzofuran	NA	***	***	NA	***	
Fluorene	NA	***	0.0E+00	NA	0.0E+00	
Heptachlor epoxide	NA	***	0.0E+00	NA	0.0E+00	
Lithium	NA	***	***	NA	***	
2-Methlynaphthalene	NA	***	***	NA	***	
Naphthalene	NA	***	0.0E+00	NA	0.0E+00	
Phenanthrene	NA	***	***	NA	***	
1,1,2-Trichloro-1,2,2-Trifluoroethane	NA	***	0.0E+00	NA	0.0E+00	Total HI =
Total:			1.3E-01		2.8E-03	1.3E-01
Carcinogens (Risk)						
Aldrin	NA	***	0.0E+00	NA	0.0E+00	
Arsenic	NA	***	4.3E-06	NA	9.0E-07	
Benzo(a)pyrene	NA	***	0.0E+00	NA	0.0E+00	
Benzo(g,h,i)perylene	NA	***	***	NA	***	
Carbazole	NA	***	***	NA	***	
α-Chlordane	NA	***	0.0E+00	NA	0.0E+00	
γ-Chlordane	NA	***	0.0E+00	NA	0.0E+00	
Dibenzo(a,h)anthracene	NA	***	***	NA	***	
Heptachlor epoxide	NA	***	0.0E+00	NA	0.0E+00	Total Carcinogenic
Lead	NA	***	***	NA	***	Risk =
Total:			4.3E-06		9.0E-07	5.2E-06
Radionuclides (Risk)						
Cesium-137	NA	4.7E-14	8.1E-09	1.3E-06	NA	
Plutonium-238	NA	2.1E-11	2.3E-08	3.7E-12	NA	Total Radionuclide
Plutonium-242	NA	NA	NA	NA	NA	Risk =
Radium-226	NA	3.1E-11	3.5E-07	2.1E-05	NA	
Total:		5.2E-11	3.8E-07	2.2E-05		2.3E-05

*** - Toxicity values not available.

NA - Not applicable.

Revised **Table F.10 Characterization of Residual Risks at Release Block H - Site Employee Soil Pathways - Background**

Constituent	Pathway 1 Soil VOC Inhalation	Pathway 2 Soil/Dust Inhalation	Pathway 6 Soil Ingestion	Pathway 7 External Radiation	Site Employee
Non-carcinogens (HQ)					
Arsenic	NA	***	1.4E-02	NA	
Acenaphthalene	NA	***	0.0E+00	NA	
Acenapthlyene	NA	***	***	NA	
Aldrin	NA	***	0.0E+00	NA	
δ-BHC	NA	***	***	NA	
Bismuth	NA	***	***	NA	
α-Chlordane	NA	***	0.0E+00	NA	
γ-Chlordane	NA	***	0.0E+00	NA	
4-Chloro-3-methylphenol	NA	***	***	NA	
Copper	NA	***	***	NA	
Dibenzofuran	NA	***	***	NA	
Fluorene	NA	***	0.0E+00	NA	
Heptachlor epoxide	NA	***	0.0E+00	NA	
Lithium	NA	***	***	NA	
2-Methlynaphthalene	NA	***	***	NA	
Naphthalene	NA	***	0.0E+00	NA	
Phenanthrene	NA	***	***	NA	
1,1,2-Trichloro-1,2,2-Trifluoroethane	NA	***	0.0E+00	NA	Total HI =
Total:			1.4E-02		1.4E-02
Carcinogens (Risk)					
Aldrin	NA	***	0.0E+00	NA	
Arsenic	NA	***	2.3E-06	NA	
Benzo(a)pyrene	NA	***	0.0E+00	NA	
Benzo(g,h,i)perylene	NA	***	***	NA	
Carbazole	NA	***	***	NA	
α-Chlordane	NA	***	0.0E+00	NA	
γ-Chlordane	NA	***	0.0E+00	NA	
Dibenzo(a,h)anthracene	NA	***	***	NA	
Heptachlor epoxide	NA	***	0.0E+00	NA	Total Carcinogenic
Lead	NA	***	***	NA	Risk =
Total:			2.3E-06		2.3E-06
Radionuclides (Risk)					
Cesium-137	NA	2.3E-13	4.2E-09	1.5E-06	
Plutonium-238	NA	1.0E-10	1.2E-08	4.1E-12	Total Radionuclide
Plutonium-242	NA	NA	NA	NA	Risk =
Radium-226	NA	1.6E-10	1.9E-07	2.2E-05	
Total:		2.6E-10	2.1E-07	2.4E-05	2.4E-05

*** - Toxicity values not available.

NA - Not applicable.

Revised **Table F.19 Characterization of Residual Risks at Release Block H - Construction Worker Soil Pathways - Total**

Constituent	Pathway 1 Soil VOC Inhalation	Pathway 2 Soil/Dust Inhalation	Pathway 6 Soil Ingestion	Pathway 7 External Radiation	Pathway 8 Soil Dermal	Construction Worker
Non-carcinogens (HQ)						
Aldrin	NA	***	4.9E-04	NA	1.0E-04	
α-Chlordane	NA	***	9.4E-05	NA	1.6E-04	
γ-Chlordane	NA	***	7.0E-05	NA	1.2E-04	
Heptachlor epoxide	NA	***	7.9E-04	NA	1.7E-04	
Acenaphthene	NA	***	1.4E-05	NA	2.9E-06	
Arsenic	NA	***	1.7E-01	NA	3.6E-03	
Fluorene	NA	***	1.7E-04	NA	3.5E-05	
Naphthalene	NA	***	6.2E-04	NA	5.1E-08	
1,1,2-Trichloro-1,2,2-trifluoroethane	NA	***	3.1E-10	NA	6.5E-11	
Acenaphthylene	NA	***	***	NA	NA	
δ-BHC	NA	***	***	NA	NA	
Bismuth	NA	***	***	NA	NA	
4-Chloro-3-methylphenol	NA	***	***	NA	NA	
Copper	NA	***	***	NA	NA	
Dibenzofuran	NA	***	***	NA	NA	
Lithium	NA	***	***	NA	NA	
2-Methlynaphthalene	NA	***	***	NA	NA	
Phenanthrene	NA	***	***	NA	NA	Total HI =
Total:			1.7E-01		4.2E-03	1.7E-01
Carcinogens (Risk)						
Aldrin	NA	***	1.8E-08	NA	3.7E-09	
Arsenic	NA	***	5.5E-06	NA	1.1E-06	
Benzo(a)pyrene	NA	***	2.7E-06	NA	5.7E-07	
Benzo(g,h,i)perylene	NA	***	***	NA	***	
Carbazole	NA	***	***	NA	***	
α-Chlordane	NA	***	1.2E-09	NA	9.1E-10	
γ-Chlordane	NA	***	8.7E-10	NA	6.7E-10	
Dibenzo(a,h)anthracene	NA	***	***	NA	***	
Heptachlor epoxide	NA	***	6.7E-09	NA	1.4E-09	Total Carcinogenic
Lead	NA	***	***	NA	***	Risk =
Total:			8.2E-06		1.7E-06	9.9E-06
Radionuclides (Risk)						
Cesium-137	NA	2.1E-13	3.6E-08	6.0E-06	NA	
Plutonium-238	NA	2.0E-10	2.3E-07	3.6E-11	NA	Total Radionuclide
Plutonium-242	NA	2.2E-12	2.6E-09	3.3E-13	NA	Risk =
Radium-226	NA	4.9E-11	5.5E-07	3.3E-05	NA	
Total:		2.5E-10	8.2E-07	3.9E-05		4.0E-05

*** - Toxicity values not available.

NA - Not applicable.

Revised **Table F22. Characterization of Residual Risks at Release Block H - Site Employee Soil Pathways - Total**

Constituent	Pathway 1 Soil VOC Inhalation	Pathway 2 Soil/Dust Inhalation	Pathway 6 Soil Ingestion	Pathway 7 External Radiation	Site Employee
Non-carcinogens (HQ)					
Aldrin	NA	***	5.1E-05	NA	
α-Chlordane	NA	***	9.8E-06	NA	
γ-Chlordane	NA	***	7.2E-06	NA	
Heptachlor epoxide	NA	***	8.3E-05	NA	
Acenaphthene	NA	***	1.5E-06	NA	
Arsenic	NA	***	1.8E-02	NA	
Fluorene	NA	***	1.8E-05	NA	
Naphthalene	NA	***	6.4E-05	NA	
1,1,2-Trichloro-1,2,2-trifluoroethane	NA	***	3.3E-11	NA	
Acenaphthylene	NA	***	***	NA	
δ-BHC	NA	***	***	NA	
Bismuth	NA	***	***	NA	
4-Chloro-3-methylphenol	NA	***	***	NA	
Copper	NA	***	***	NA	
Dibenzofuran	NA	***	***	NA	
Lithium	NA	***	***	NA	
2-Methlynaphthalene	NA	***	***	NA	
Phenanthrene	NA	***	***	NA	Total HI =
Total:			1.8E-02		1.8E-02
Carcinogens (Risk)					
Aldrin	NA	***	9.2E-09	NA	
Arsenic	NA	***	2.9E-06	NA	
Benzo(a)pyrene	NA	***	1.4E-06	NA	
Benzo(g,h,i)perylene	NA	***	***	NA	
Carbazole	NA	***	***	NA	
α-Chlordane	NA	***	6.1E-10	NA	
γ-Chlordane	NA	***	4.5E-10	NA	
Dibenzo(a,h)anthracene	NA	***	***	NA	
Heptachlor epoxide	NA	***	3.5E-09	NA	Total Carcinogenic
Lead	NA	***	***	NA	Risk =
Total:			4.3E-06		4.3E-06
Radionuclides (Risk)					
Cesium-137	NA	1.1E-12	1.9E-08	6.6E-06	
Plutonium-238	NA	1.1E-09	1.3E-07	4.3E-11	Total Radionuclide
Plutonium-242	NA	1.1E-11	1.3E-09	3.7E-13	Risk =
Radium-226+D	N/A	2.5E-10	3.0E-07	3.5E-05	
Total:		1.4E-09	4.5E-07	4.2E-05	4.2E-05

*** - Toxicity values not available.

NA - Not applicable.

APPENDIX B
Supporting Calculations

Risk and HI Calculations for Arsenic Soil Inhalation and Ingestion

Risk and HI Calculations for α- and γ-Chlordane Soil Inhalation and Ingestion

Risk Calculations for Lead-210 Inhalation, Soil Ingestion and External Exposure

HI Calculations for Naphthalene Soil Ingestion

Risk Calculations for Pu-210 Inhalation, Soil Ingestion and External Exposure

Risk Calculations for Ra-226 Inhalation, Soil Ingestion and External Exposure

Risk Calculations for Th-228 Inhalation, Soil Ingestion and External Exposure

Release Block H
Risk and HI Calculations for Arsenic Soil Inhalation and Ingestion
(Ref: Equation and parameter values from Appendix D, 1997 RRE)

Incremental Soil Concentration
2.3 mg/kg Construction Worker/Site Employee

Oral Slope Factor
1.5E+00 mg/kg-d

Oral Reference Dose
3.0E-04 mg/kg-d

Construction Worker Intake, Carcinogenic [redacted]

Carcinogenic, Ingestion
Intake, mg/kg-d = (CS*EF*ED*10-6 kg/mg*IR)/(AT*BW*365 d/yr)

CS =	2.3	mg/kg (CS = concentration in soil)
EF =	250	days/year (EF = exposure frequency)
ED =	5	years (ED = exposure duration)
IR =	480	mg/day (IR = ingestion rate)
AT =	70	years (AT = averaging time)
BW =	70	kilograms (BW = body weight)

Intake = **7.72E-07** mg/kg-d

Construction Worker Intake, Non-Carcinogenic [redacted]

Non-Carcinogenic, Ingestion
Intake, mg/kg-d = (CS*EF*10-6 kg/mg*IR)/(BW*365 d/yr)

CS =	2.3	mg/kg (CS = concentration in soil)
EF =	250	days/year (EF = exposure frequency)
IR =	480	mg/day (IR = ingestion rate)
BW =	70	kilograms (BW = body weight)

Intake = **1.08E-05** mg/kg-d

Site Employee Intakes, Carcinogenic [redacted]

Carcinogenic, Ingestion
Intake, mg/kg-d = (CS*EF*ED*10-6 kg/mg*IR)/(AT*BW*365 d/yr)

CS =	2.3	mg/kg (CS = concentration in soil)
EF =	250	days/year (EF = exposure frequency)
ED =	25	years (ED = exposure duration)
IR =	50	mg/day (IR = ingestion rate)
AT =	70	years (AT = averaging time)
BW =	70	kilograms (BW = body weight)

Intake = **4.02E-07** mg/kg-d

Non-Carcinogenic, Ingestion
Intake, mg/kg-d = (CS*EF*10-6 kg/mg*IR)/(BW*365 d/yr)

CS =	2.3	mg/kg (CS = concentration in soil)
EF =	250	days/year (EF = exposure frequency)
IR =	50	mg/day (IR = ingestion rate)
BW =	70	kilograms (BW = body weight)

Intake = **1.13E-06** mg/kg-d

Arsenic Risk and Hazard Index (HI) Values
Soil Ingestion and Inhalation

Risk = Intake * Slope Factor
HI = Intake/Reference Dose

Construction Worker	Risk	HI
Soil ingestion	1.2E-06	3.6E-02
Soil inhalation	N/A	N/A

Site Employee	Risk	HI
Soil ingestion	6.0E-07	3.8E-03
Soil inhalation	N/A	N/A

Release Block H
Risk and HI Calculations for α- and γ-Chlordane Soil Inhalation and Ingestion

(Ref: Equation and parameter values from Appendix D, 1997 RRE)

Incremental and Total Soil Concentrations

0.01 mg/kg	α-chlordane: Construction Worker/Site Employee
0.0074 mg/kg	γ-chlordane: Construction Worker/Site Employee

Oral Slope Factor

3.5E-01 mg/kg-d

Oral Reference Dose

5.0E-04 mg/kg-d

Construction Worker Intakes, Carcinogenic [redacted]

α-Chlordane, Carcinogenic, Ingestion

Intake, mg/kg-d = (CS*EF*ED*10-6 kg/mg*IR)/(AT*BW*365 d/yr)

CS =	0.01	mg/kg (CS = concentration in soil)
EF =	250	days/year (EF = exposure frequency)
ED =	5	years (ED = exposure duration)
IR =	480	mg/day (IR = ingestion rate)
AT =	70	years (AT = averaging time)
BW =	70	kilograms (BW = body weight)

Intake = **3.35E-09** mg/kg-d

γ-Chlordane, Carcinogenic, Ingestion

Intake, mg/kg-d = (CS*EF*ED*10-6 kg/mg*IR)/(AT*BW*365 d/yr)

CS =	0.0074	mg/kg (CS = concentration in soil)
EF =	250	days/year (EF = exposure frequency)
ED =	5	years (ED = exposure duration)
IR =	480	mg/day (IR = ingestion rate)
AT =	70	years (AT = averaging time)
BW =	70	kilograms (BW = body weight)

Intake = **2.48E-09** mg/kg-d

Construction Worker Intakes, Non-Carcinogenic [redacted]

α-Chlordane, Non-Carcinogenic, Ingestion

Intake, mg/kg-d = (CS*EF*10-6 kg/mg*IR)/(BW*365 d/yr)

CS =	0.01	mg/kg (CS = concentration in soil)
EF =	250	days/year (EF = exposure frequency)
IR =	480	mg/day (IR = ingestion rate)
BW =	70	kilograms (BW = body weight)

Intake = **4.70E-08** mg/kg-d

γ-Chlordane, Non-Carcinogenic, Ingestion

Intake, mg/kg-d = (CS*EF*10-6 kg/mg*IR)/(BW*365 d/yr)

CS =	0.0074	mg/kg (CS = concentration in soil)
EF =	250	days/year (EF = exposure frequency)
IR =	480	mg/day (IR = ingestion rate)
BW =	70	kilograms (BW = body weight)

Intake = **3.48E-08** mg/kg-d

Construction Worker Intakes, Carcinogenic [redacted]

α-Chlordane, Carcinogenic, Inhalation

Intake, mg/kg-d = ((CS/PEF)*EF*ED*IR)/(BW*AT*365 d/yr)

CS =	0.01	mg/kg (CS = concentration in soil)
PEF =	4.28E+09	m^3/kg (PEF = particulate emission factor)
EF =	250	days/year (EF = exposure frequency)
ED =	5	years (ED = exposure duration)
IR =	20	m^3/day (IR = inhalation rate)
BW =	70	kilograms (BW = body weight)
AT =	70	years (AT = averaging time)

Intake = **3.27E-14** mg/kg-d

γ-Chlordane, Carcinogenic, Inhalation
Intake, mg/kg-d = ((CS/PEF)*EF*ED*IR)/(BW*AT*365 d/yr)

CS =	0.0074	mg/kg (CS = concentration in soil)
PEF =	4.28E+09	m^3/kg (PEF = particulate emission factor)
EF =	250	days/year (EF = exposure frequency)
ED =	5	years (ED = exposure duration)
IR =	20	m^3/day (IR = inhalation rate)
BW =	70	kilograms (BW = body weight)
AT =	70	years (AT = averaging time)

Intake = **2.42E-14** mg/kg-d

Construction Worker Intakes, Non-Carcinogenic [redacted]

α-Chlordane, Non-Carcinogenic, Inhalation
Intake, mg/kg-d = ((CS/PEF)*IR*EF*)/(BW*365 d/yr)

CS =	0.01	mg/kg (CS = concentration in soil)
PEF =	4.28E+09	m^3/kg (PEF = particulate emission factor)
IR =	20	m^3/day (IR = inhalation rate)
EF =	250	days/year (EF = exposure frequency)
BW =	70	kilograms (BW = body weight)

Intake = **4.57E-13** mg/kg-d

γ-Chlordane, Non-Carcinogenic, Inhalation
Intake, mg/kg-d = ((CS/PEF)*IR*EF*)/(BW*365 d/yr)

CS =	0.0074	mg/kg (CS = concentration in soil)
PEF =	4.28E+09	m^3/kg (PEF = particulate emission factor)
IR =	20	m^3/day (IR = inhalation rate)
EF =	250	days/year (EF = exposure frequency)
BW =	70	kilograms (BW = body weight)

Intake = **3.38E-13** mg/kg-d

Site Employee Intakes, Carcinogenic [redacted]

α-Chlordane, Carcinogenic, Ingestion
Intake, mg/kg-d = (CS*EF*ED*10-6 kg/mg*IR)/(AT*BW*365 d/yr)

CS =	0.01	mg/kg (CS = concentration in soil)
EF =	250	days/year (EF = exposure frequency)
ED =	25	years (ED = exposure duration)
IR =	50	mg/day (IR = ingestion rate)
AT =	70	years (AT = averaging time)
BW =	70	kilograms (BW = body weight)

Intake = **1.75E-09** mg/kg-d

γ-Chlordane, Carcinogenic, Ingestion
Intake, mg/kg-d = (CS*EF*ED*10-6 kg/mg*IR)/(AT*BW*365 d/yr)

CS =	0.0074	mg/kg (CS = concentration in soil)
EF =	250	days/year (EF = exposure frequency)
ED =	25	years (ED = exposure duration)
IR =	50	mg/day (IR = ingestion rate)
AT =	70	years (AT = averaging time)
BW =	70	kilograms (BW = body weight)

Intake = **1.29E-09** mg/kg-d

Site Employee Intakes, Non-Carcinogenic [redacted]

α-Chlordane, Non-Carcinogenic, Ingestion
Intake, mg/kg-d = (CS*EF*10-6 kg/mg*IR)/(BW*365 d/yr)

CS =	0.01	mg/kg (CS = concentration in soil)
EF =	250	days/year (EF = exposure frequency)
IR =	50	mg/day (IR = ingestion rate)
BW =	70	kilograms (BW = body weight)

Intake = **4.89E-09** mg/kg-d

γ-Chlordane, Non-Carcinogenic, Ingestion
Intake, mg/kg-d = (CS*EF*10-6 kg/mg*IR)/(BW*365 d/yr)

CS = 0.0074 mg/kg (CS = concentration in soil)
EF = 250 days/year (EF = exposure frequency)
IR = 50 mg/day (IR = ingestion rate)
BW = 70 kilograms (BW = body weight)

Intake = **3.62E-09** mg/kg-d

Site Employee Intakes, Carcinogenic

α-Chlordane, Carcinogenic, Inhalation
Intake, mg/kg-d = ((CS/PEF)*EF*ED*IR)/(BW*AT*365 d/yr)
CS = 0.01 mg/kg (CS = concentration in soil)
PEF = 4.28E+09 m^3/kg (PEF = particulate emission factor)
EF = 250 days/year (EF = exposure frequency)
ED = 25 years (ED = exposure duration)
IR = 20 m^3/day (IR = inhalation rate)
BW = 70 kilograms (BW = body weight)
AT = 70 years (AT = averaging time)

Intake = **1.63E-13** mg/kg-d

γ-Chlordane, Carcinogenic, Inhalation
Intake, mg/kg-d = ((CS/PEF)*EF*ED*IR)/(BW*AT*365 d/yr)
CS = 0.0074 mg/kg (CS = concentration in soil)
PEF = 4.28E+09 m^3/kg (PEF = particulate emission factor)
EF = 250 days/year (EF = exposure frequency)
ED = 25 years (ED = exposure duration)
IR = 20 m^3/day (IR = inhalation rate)
BW = 70 kilograms (BW = body weight)
AT = 70 years (AT = averaging time)

Intake = **1.21E-13** mg/kg-d

Construction Worker Intakes, Non-Carcinogenic

α-Chlordane, Non-Carcinogenic, Inhalation
Intake, mg/kg-d = ((CS/PEF)*IR*EF*)/(BW*365 d/yr)
CS = 0.01 mg/kg (CS = concentration in soil)
PEF = 4.28E+09 m^3/kg (PEF = particulate emission factor)
IR = 20 m^3/day (IR = inhalation rate)
EF = 250 days/year (EF = exposure frequency)
BW = 70 kilograms (BW = body weight)

Intake = **4.57E-13** mg/kg-d

γ-Chlordane, Non-Carcinogenic, Inhalation
Intake, mg/kg-d = ((CS/PEF)*IR*EF*)/(BW*365 d/yr)
CS = 0.0074 mg/kg (CS = concentration in soil)
PEF = 4.28E+09 m^3/kg (PEF = particulate emission factor)
IR = 20 m^3/day (IR = inhalation rate)
EF = 250 days/year (EF = exposure frequency)
BW = 70 kilograms (BW = body weight)

Intake = **3.38E-13** mg/kg-d

Chlordane Risk and Hazard Index (HI) Values
Soil Ingestion and Inhalation

Risk = Intake * Slope Factor
HI = Intake/Reference Dose

	α-Chlordane		γ-Chlordane	
Construction Worker	Risk	HI	Risk	HI
Soil ingestion	1.2E-09	9.4E-05	8.7E-10	7.0E-05
Soil inhalation	N/A	N/A	N/A	N/A

	α-Chlordane		γ-Chlordane	
Site Employee	Risk	HI	Risk	HI
Soil ingestion	6.1E-10	9.8E-06	4.5E-10	7.2E-06
Soil inhalation	N/A	N/A	N/A	N/A

Risk Calculations for Lead-210 Soil Inhalation, Soil Ingestion and External Exposure
For use in establishing risk-based guideline values for Pb-210.
(Ref: Equation and parameter values from Appendix D, 1997 RRE)

Pb-210 Soil Concentration

1.7 pCi/g	Construction worker
3.2 pCi/g	Site employee

Pb-210+D Slope Factors

1.01E-09 risk/pCi ingested
3.86E-09 risk/pCi inhaled
1.45E-10 risk/yr/pCi/g

Construction Worker Ingestion

Intake, pCi = CS*ED*EF*0.001*IR

CS =	1.7	pCi/g (CS = concentration in soil)
ED =	5	years (ED = exposure duration)
EF =	250	days/year (EF = exposure frequency)
IR =	480	mg/day (IR = ingestion rate)

Intake = **1.02E+03** pCi

Construction Worker Inhalation

Intake, mg/kg-d = ((CS*1000/PEF)*ED*EF*IR

CS =	1.7	pCi/g (CS = concentration in soil)
PEF =	4.28E+09	m^3/kg (PEF = particulate emission factor)
ED =	5	years (ED = exposure duration)
EF =	250	days/year (EF = exposure frequency)
IR =	20	m^3/day (IR = inhalation rate)

Intake = **9.93E-03** pCi

Construction Worker External Exposure

Exposure = CS*TE*(1-SE)*ED

CS =	1.7	pCi/g
TE =	3.33E-01	TE = gamma shielding factor, dimensionless
SE =	1.00E-01	SE =gamma exposure time factor, dimensionless
ED =	5.00E+00	yr (ED = exposure duration)

Exposure = 2.55E+00 pCi-yr/g

Site Employee Ingestion

Intake, pCi = CS*ED*EF*0.001*IR

CS =	3.2	mg/kg (CS = concentration in soil)
ED =	25	years (ED = exposure duration)

EF = 250 days/year (EF = exposure frequency)
IR = 50 mg/day (IR = ingestion rate)

Intake = **1.00E+03** pCi

Site Employee Inhalation
Intake, mg/kg-d = ((CS*1000/PEF)*ED*EF*IR
CS = 3.2 mg/kg (CS = concentration in soil)
PEF = 4.28E+09 m^3/kg (PEF = particulate emission factor)
ED = 25 years (ED = exposure duration)
EF = 250 days/year (EF = exposure frequency)
IR = 20 m^3/day (IR = inhalation rate)

Intake = **9.35E-02** pCi

Site Employee External Exposure
Exposure = CS*TE*(1-SE)*ED
CS = 3.2 pCi/g
TE = 8.30E-02 TE = gamma shielding factor, dimensionless
SE = 2.00E-01 SE =gamma exposure time factor, dimensionless
ED = 25 yr (ED = exposure duration)

Exposure = 5.31E+00 pCi-yr/g

Pb-210+D Risk Values
Soil Ingestion, Soil Inhalation, and External Exposure

Risk = Intake • Slope Factor

Construction Worker	Risk
Soil ingestion	1.0E-06
Soil inhalation	3.8E-11
Ext Exp	3.7E-10

Site Employee	Risk
Soil ingestion	1.0E-06
Soil inhalation	3.6E-10
Ext Exp	7.70E-10

Release Block H
HI Calculations for Naphthalene Soil Ingestion

(Ref: Equation and parameter values from Appendix D, 1997 RRE)

Incremental and Total Soil Concentrations

2.625 mg/kg Construction Worker/Site Employee

Oral Reference Dose

2.0E-02 mg/kg-d

Construction Worker Intake, Non-Carcinogenic [redacted]

Ingestion

Intake, mg/kg-d = (CS*EF*10-6 kg/mg*IR)/(BW*365 d/yr)

CS =	2.625	mg/kg (CS = concentration in soil)
EF =	250	days/year (EF = exposure frequency)
IR =	480	mg/day (IR = ingestion rate)
BW =	70	kilograms (BW = body weight)

Intake = **1.23E-05** mg/kg-d

Site Employee Intake, Non-Carcinogenic [redacted]

Ingestion

Intake, mg/kg-d = (CS*EF*10-6 kg/mg*IR)/(BW*365 d/yr)

CS =	2.625	mg/kg (CS = concentration in soil)
EF =	250	days/year (EF = exposure frequency)
IR =	50	mg/day (IR = ingestion rate)
BW =	70	kilograms (BW = body weight)

Intake = **1.28E-06** mg/kg-d

Naphthalene Hazard Index (HI) Values
Soil Ingestion

HI = Intake/Reference Dose

Construction Worker	Risk	HI
Soil ingestion	N/A	6.2E-04
Soil inhalation	N/A	N/A

Site Employee	Risk	HI
Soil ingestion	N/A	6.4E-05
Soil inhalation	N/A	N/A

Release Block H

Risk Calculations for Pu-242 Soil Inhalation, Soil Ingestion and External Exposure

(Ref: Equation and parameter values from Appendix D, 1997 RRE)

Incremental and Total Soil Concentrations

0.0143 pCi/g Construction Worker/Site Employee

Slope Factors

3.00E-10 risk/pCi ingested
2.64E-08 risk/pCi inhaled
1.55E-11 risk/yr/pCi/g

Construction Worker Ingestion

Intake, pCi = CS*ED*EF*0.001*IR

CS =	0.0143	pCi/g (CS = concentration in soil)
ED =	5	years (ED = exposure duration)
EF =	250	days/year (EF = exposure frequency)
IR =	480	mg/day (IR = ingestion rate)

Intake = 8.58E+00 pCi

Construction Worker Inhalation

Intake, mg/kg-d = ((CS*1000/PEF)*ED*EF*IR

CS =	0.0143	pCi/g (CS = concentration in soil)
PEF =	4.28E+09	m^3/kg (PEF = particulate emission factor)
ED =	5	years (ED = exposure duration)
EF =	250	days/year (EF = exposure frequency)
IR =	20	m^3/day (IR = inhalation rate)

Intake = 8.35E-05 pCi

Construction Worker External Exposure

Exposure = CS*TE*(1-SE)*ED

CS =	1.43E-02	pCi/g
TE =	3.33E-01	TE = gamma shielding factor, dimensionless
SE =	1.00E-01	SE =gamma exposure time factor, dimensionless
ED =	5.00E+00	yr (ED = exposure duration)

Exposure = 2.14E-02 pCi-yr/g

Site Employee Ingestion

Intake, pCi = CS*ED*EF*0.001*IR

CS =	0.0143	mg/kg (CS = concentration in soil)
ED =	25	years (ED = exposure duration)
EF =	250	days/year (EF = exposure frequency)
IR =	50	mg/day (IR = ingestion rate)

Intake = 4.47E+00 pCi

Site Employee Inhalation

Intake, mg/kg-d = ((CS*1000/PEF)*ED*EF*IR

CS =	0.0143	mg/kg (CS = concentration in soil)
PEF =	4.28E+09	m^3/kg (PEF = particulate emission factor)
ED =	25	years (ED = exposure duration)
EF =	250	days/year (EF = exposure frequency)
IR =	20	m^3/day (IR = inhalation rate)

Intake = 4.18E-04 pCi

Site Employee External Exposure

Exposure = CS*TE*(1-SE)*ED

CS =	1.43E-02	pCi/g
TE =	8.30E-02	TE = gamma shielding factor, dimensionless
SE =	2.00E-01	SE =gamma exposure time factor, dimensionless
ED =	25	yr (ED = exposure duration)

Exposure = 2.37E-02 pCi-yr/g

Pu-242 Risk Values

Soil Ingestion, Soil Inhalation, and External Exposure

Risk = Intake * Slope Factor

Construction Worker	Risk
Soil ingestion	2.6E-09
Soil inhalation	2.2E-12
Ext Exp	3.3E-13

Site Employee	Risk
Soil ingestion	1.3E-09
Soil inhalation	1.1E-11
Ext Exp	3.68E-13

Release Block H

Risk Calculations for Ra-226 Soil Inhalation, Soil Ingestion and External Exposure

(Ref: Equation and parameter values from Appendix D, 1997 RRE)

Incremental Soil Concentration

1.15 pCi/g Construction Worker/Site Employee

Slope Factors

2.96E-10 risk/pCi ingested
2.75E-09 risk/pCi inhaled
6.74E-06 risk/yr/pCi/g

Construction Worker Ingestion

Intake, pCi = CS*ED*EF*0.001*IR

CS =	1.15	pCi/g (CS = concentration in soil)
ED =	5	years (ED = exposure duration)
EF =	250	days/year (EF = exposure frequency)
IR =	480	mg/day (IR = ingestion rate)

Intake = 8.90E+02 pCi

Construction Worker Inhalation

Intake, mg/kg-d = ((CS*1000/PEF)*ED*EF*IR

CS =	1.15	pCi/g (CS = concentration in soil)
PEF =	4.28E+09	m^3/kg (PEF = particulate emission factor)
ED =	5	years (ED = exposure duration)
EF =	250	days/year (EF = exposure frequency)
IR =	20	m^3/day (IR = inhalation rate)

Intake = 6.72E-03 pCi

Construction Worker External Exposure

Exposure = CS*TE*(1-SE)*ED

CS =	1.15E+00	pCi/g
TE =	3.33E-01	TE = gamma shielding factor, dimensionless
SE =	1.00E-01	SE =gamma exposure time factor, dimensionless
ED =	5.00E+00	yr (ED = exposure duration)

Exposure = 1.72E+00 pCi-yr/g

Site Employee Ingestion

Intake, pCi = CS*ED*EF*0.001*IR

CS =	1.15	mg/kg (CS = concentration in soil)
ED =	25	years (ED = exposure duration)
EF =	250	days/year (EF = exposure frequency)
IR =	50	mg/day (IR = ingestion rate)

Intake = 3.59E+02 pCi

Site Employee Inhalation

Intake, mg/kg-d = ((CS*1000/PEF)*ED*EF*IR

CS =	1.15	mg/kg (CS = concentration in soil)
PEF =	4.28E+09	m^3/kg (PEF = particulate emission factor)
ED =	25	years (ED = exposure duration)
EF =	250	days/year (EF = exposure frequency)
IR =	20	m^3/day (IR = inhalation rate)

Intake = 3.36E-02 pCi

Site Employee External Exposure

Exposure = CS*TE*(1-SE)*ED

CS =	1.15E+00	pCi/g
TE =	8.30E-02	TE = gamma shielding factor, dimensionless
SE =	2.00E-01	SE =gamma exposure time factor, dimensionless
ED =	25	yr (ED = exposure duration)

Exposure = 1.91E+00 pCi-yr/g

Ra-226 Risk Values

Soil Ingestion, Soil Inhalation, and External Exposure

Risk = Intake * Slope Factor

Construction Worker	Risk
Soil ingestion	2.0E-07
Soil inhalation	1.8E-11
Ext Exp	1.2E-05

Site Employee	Risk
Soil ingestion	1.1E-07
Soil inhalation	9.2E-11
Ext Exp	1.29E-05

Risk Calculations for Th-228 Soil Inhalation, Soil Ingestion and External Exposure
For use in establishing risk-based guideline values for Th-228.

Th-228 Soil Concentration

0.11 pCi/g	Construction worker
0.10 pCi/g	Site employee

Th-228+D Slope Factors

2.31E-10 risk/pCi ingested
9.68E-08 risk/pCi inhaled
6.20E-06 risk/yr/pCi/g

Construction Worker Ingestion

Intake, pCi = CS*ED*EF*0.001*IR

CS =	0.11	pCi/g (CS = concentration in soil)
ED =	5	years (ED = exposure duration)
EF =	250	days/year (EF = exposure frequency)
IR =	480	mg/day (IR = ingestion rate)

Intake = **6.60E+01** pCi

Construction Worker Inhalation

Intake, mg/kg-d = ((CS*1000/PEF)*ED*EF*IR

CS =	0.11	pCi/g (CS = concentration in soil)
PEF =	4.28E+09	m^3/kg (PEF = particulate emission factor)
ED =	5	years (ED = exposure duration)
EF =	250	days/year (EF = exposure frequency)
IR =	20	m^3/day (IR = inhalation rate)

Intake = **6.43E-04** pCi

Construction Worker External Exposure

Exposure = CS*TE*(1-SE)*ED

CS =	0.11	pCi/g
TE =	3.33E-01	TE = gamma shielding factor, dimensionless
SE =	1.00E-01	SE =gamma exposure time factor, dimensionless
ED =	5.00E+00	yr (ED = exposure duration)

Exposure = 1.65E-01 pCi-yr/g

Site Employee Ingestion [redacted]

Intake, pCi = CS*ED*EF*0.001*IR

CS =	0.1	mg/kg (CS = concentration in soil)
ED =	25	years (ED = exposure duration)
EF =	250	days/year (EF = exposure frequency)
IR =	50	mg/day (IR = ingestion rate)

Intake = **3.13E+01** pCi

Site Employee Inhalation [redacted]

Intake, mg/kg-d = ((CS*1000/PEF)*ED*EF*IR

CS =	0.1	mg/kg (CS = concentration in soil)
PEF =	4.28E+09	m^3/kg (PEF = particulate emission factor)
ED =	25	years (ED = exposure duration)
EF =	250	days/year (EF = exposure frequency)
IR =	20	m^3/day (IR = inhalation rate)

Intake = **2.92E-03** pCi

Site Employee External Exposure [redacted]

Exposure = CS*TE*(1-SE)*ED

CS =	0.1	pCi/g
TE =	8.30E-02	TE = gamma shielding factor, dimensionless
SE =	2.00E-01	SE =gamma exposure time factor, dimensionless
ED =	25	yr (ED = exposure duration)

Exposure = 1.66E-01 pCi-yr/g

Th-228+D Risk Values
Soil Ingestion, Soil Inhalation, and External Exposure

Risk = Intake * Slope Factor

Construction Worker	Risk
Soil ingestion	1.5E-08
Soil inhalation	6.2E-11
Ext Exp	1.0E-06

Site Employee	Risk
Soil ingestion	7.2E-09
Soil inhalation	2.8E-10
Ext Exp	1.0E-06