APPENDIX I-A

DERIVATION OF INHALATION

REFERENCE DOSES

Appendix I-A: Derivation of inhalation reference doses.[a]

CHEMICAL	TOXIC CONCENTRATION USED IN DERIVATION (mg/m^3)	REGULATORY AGENCY REFERENCE FOR SELECTED TOXIC CONCENTRATION	CONVERSION TO CONTINUOUS EXPOSURE (mg/m^3)	UNCERTAINTY FACTOR (UF)[c]	ESTIMATED RfD (mg/kg/d)
Arsenic	1.0E-02	OSHA[10]	4.0E-03	10(H), 10(MF)	1.0E-05
Beryllium	5.0E-04	NIOSH[11]	2.0E-04	10 (H)	6.0E-05
Bis(2-ethylhexyl)phthalate	5.0E+00	OSHA[12]	2.0E+00	10(H), 10(MF)	6.0E-03
Cadmium	7.0E-03	WHO[13]	b	10(H), 10(MF)	2.0E-05
Chromium-III	5.0E-01	ACGIH[14] (TLV-TVA)	2.0E-01	10(H), 10(MF)	6.0E-04
Cyanide	5.0E+00	NIOSH[15]	2.0E+00	10(H), 10(MF)	6.0E-03
Lead	3.2E-03	[16]	b	10(H), 10(MF)	9.0E-06
Silver	1.0E-02	NIOSH[18]	4.0E-03	10(H)	1.0E-04
Zinc	5.0E-01	OSHA[17]	2.0E-01	10(H), 10(MF)	6.0E-04

a. Derivation of reference doses:

- If available toxic concentration was based on occupational data, the value was converted to continuous exposure as follows:

  Toxic concentration for continuous exposure (mg/m3) = Toxic concentration (mg/m3) x (10 m3/20 m3) x (5 d/7 d)

- To estimate the reference dose:

  Estimated RfD (mg/kg/d) = Toxic concentration (mg/m3) x 20 m3/d / 70 kg / UF

b. No conversion was performed because toxic concentration was based on continuous exposure.

c. (H) = Human sensitivity, (MF) = modifying factor (uncertainties related to NOAEL assumptions, less than continuous exposure, toxic value, etc.)

APPENDIX I-B

DATA TABLES USED IN CALCULATION OF RISKS

TRA WARM WASTE POND
INTERIM ACTION
INDUSTRIAL SCENARIO

INHALATION OF SOIL-CONTAMINATED AIR
NONCARCINOGENIC EFFECTS

EPA REGION 10, UPPER-BOUND CASE

CHEMICAL	CONC. MG/M3	INH. RATE M3/D	%EXP.	EF DAYS/YR	ED YEARS	BW KG	AT DAYS	DOSE MG/KG	INTAKE MG/KG/D	RfD, CHR MG/KG/D	HI
As	1.21E-07	79	0.4	365	40	70	27375	7.97E-04	2.91E-08	1.00E-05	2.9E-03
Be	5.06E-08	79	0.4	365	40	70	27375	3.33E-04	1.22E-08	6.00E-06	2.0E-03
BIS	3.42E-08	79	0.4	365	40	70	27375	2.25E-04	8.23E-09	6.00E-03	1.4E-06
Cd	7.17E-08	79	0.4	365	40	70	27375	4.73E-04	1.73E-08	2.00E-05	8.6E-04
Cr-III	7.77E-06	79	0.4	365	40	70	27375	5.12E-02	1.87E-06	6.00E-04	3.1E-03
Cyanide	2.26E-08	79	0.4	365	40	70	27375	1.49E-04	5.44E-09	6.00E-03	9.1E-07
Hg	6.19E-08	79	0.4	365	40	70	27375	4.08E-04	1.49E-08	9.00E-05	1.7E-04
Pb	4.09E-07	79	0.4	365	40	70	27375	2.70E-03	9.85E-08	9.00E-06	1.1E-02
Ag	5.04E-08	79	0.4	365	40	70	27375	3.32E-04	1.21E-08	1.00E-04	1.2E-04
Sulfide	6.36E-07	79	0.4	365	40	70	27375	4.19E-03	1.53E-07		
Zn	3.29E-06	79	0.4	365	40	70	27375	2.17E-02	7.92E-07	6.00E-04	1.3E-03
Total											2.1E-02

TRA WARM WASTE POND
INTERIM ACTION
INDUSTRIAL SCENARIO

INHALATION OF SOIL-CONTAMINATED AIR
NONCARCINOGENIC EFFECTS

EPA REGION 10, AVERAGE CASE

CHEMICAL	CONC. MG/M3	INH. RATE M3/D	%EXP.	EF DAYS/YR	ED YEARS	BW KG	AT DAYS	DOSE MG/KG	INTAKE MG/KG/D	RfD, CHR MG/KG/D	HI
As	1.21E-07	43	0.25	365	10	70	27375	6.78E-05	2.48E-09	1.00E-05	2.5E-04
Be	5.06E-08	43	0.25	365	10	70	27375	2.84E-05	1.04E-09	6.00E-06	1.7E-04
BIS	3.42E-08	43	0.25	365	10	70	27375	1.92E-05	7.00E-10	6.00E-03	1.2E-07
Cd	7.17E-08	43	0.25	365	10	70	27375	4.02E-05	1.47E-09	2.00E-05	7.3E-05
Cr-III	7.77E-06	43	0.25	365	10	70	27375	4.36E-03	1.59E-07	6.00E-04	2.7E-04
Cyanide	2.26E-08	43	0.25	365	10	70	27375	1.27E-05	4.63E-10	6.00E-03	7.7E-08
Hg	6.19E-08	43	0.25	365	10	70	27375	3.47E-05	1.27E-09	9.00E-05	1.4E-05
Pb	4.09E-07	43	0.25	365	10	70	27375	2.29E-04	8.37E-09	9.00E-06	9.3E-04
Ag	5.04E-08	43	0.25	365	10	70	27375	2.83E-05	1.03E-09	1.00E-04	1.0E-05
Sulfide	6.36E-07	43	0.25	365	10	70	27375	3.57E-04	1.30E-08		
Zn	3.29E-06	43	0.25	365	10	70	27375	1.84E-03	6.74E-08	6.00E-04	1.1E-04
Total											1.8E-03

TRA WARM WASTE POND
INTERIM ACTION
INDUSTRIAL SCENARIO

INHALATION OF SOIL-CONTAMINATED AIR
NONCARCINOGENIC EFFECTS

ADJUSTED UPPER-BOUND CASE, 20 M3/D

CHEMICAL	CONC. MG/M3	INH. RATE M3/D	%EXP.	EF DAYS/YR	ED YEARS	BW KG	AT DAYS	DOSE MG/KG	INTAKE MG/KG/D	RfD, CHR MG/KG/D	HI
As	1.21E-07	20	0.4	365	40	70	27375	2.02E-04	7.38E-09	1.00E-05	7.4E-04
Be	5.06E-08	20	0.4	365	40	70	27375	8.44E-05	3.08E-09	6.00E-06	5.1E-04
BIS	3.42E-08	20	0.4	365	40	70	27375	5.71E-05	2.08E-09	6.00E-03	3.5E-07
Cd	7.17E-08	20	0.4	365	40	70	27375	1.20E-04	4.37E-09	2.00E-05	2.2E-04
Cr-III	7.77E-06	20	0.4	365	40	70	27375	1.30E-02	4.74E-07	6.00E-04	7.9E-04
Cyanide	2.26E-08	20	0.4	365	40	70	27375	3.77E-05	1.38E-09	6.00E-03	2.3E-07
Hg	6.19E-08	20	0.4	365	40	70	27375	1.03E-04	3.77E-09	9.00E-05	4.2E-05
Pb	4.09E-07	20	0.4	365	40	70	27375	6.82E-04	2.49E-08	9.00E-06	2.8E-03
Ag	5.04E-08	20	0.4	365	40	70	27375	8.41E-05	3.07E-09	1.00E-04	3.1E-05
Sulfide	6.36E-07	20	0.4	365	40	70	27375	1.06E-03	3.88E-08		
Zn	3.29E-06	20	0.4	365	40	70	27375	5.49E-03	2.01E-07	6.00E-04	3.3E-04
Total											5.4E-03

TRA WARM WASTE POND
INTERIM ACTION
INDUSTRIAL SCENARIO

INHALATION OF SOIL-CONTAMINATED AIR
NONCARCINOGENIC EFFECTS

ADJUSTED AVERAGE CASE, 20 M3/D

CHEMICAL	CONC. MG/M3	INH. RATE M3/D	%EXP.	EF DAYS/YR	ED YEARS	BW KG	AT DAYS	DOSE MG/KG	INTAKE MG/KG/D	RfD, CHR MG/KG/D	HI
As	1.21E-07	20	0.25	365	10	70	27375	3.15E-05	1.15E-09	1.00E-05	1.2E-04
Be	5.06E-08	20	0.25	365	10	70	27375	1.32E-05	4.82E-10	6.00E-06	8.0E-05
BIS	3.42E-08	20	0.25	365	10	70	27375	8.92E-06	3.26E-10	6.00E-03	5.4E-08
Cd	7.17E-08	20	0.25	365	10	70	27375	1.87E-05	6.83E-10	2.00E-05	3.4E-05
Cr-III	7.77E-06	20	0.25	365	10	70	27375	2.03E-03	7.40E-08	6.00E-04	1.2E-04
Cyanide	2.26E-08	20	0.25	365	10	70	27375	5.89E-06	2.15E-10	6.00E-03	3.6E-08
Hg	6.19E-08	20	0.25	365	10	70	27375	1.61E-05	5.90E-10	9.00E-05	6.6E-06
Pb	4.09E-07	20	0.25	365	10	70	27375	1.07E-04	3.90E-09	9.00E-06	4.3E-04
Ag	5.04E-08	20	0.25	365	10	70	27375	1.31E-05	4.80E-10	1.00E-04	4.8E-06
Sulfide	6.36E-07	20	0.25	365	10	70	27375	1.66E-04	6.06E-09		
Zn	3.29E-06	20	0.25	365	10	70	27375	8.58E-04	3.13E-08	6.00E-04	5.2E-05
Total											8.5E-04

TRA WARM WASTE POND
INTERIM ACTION
INDUSTRIAL SCENARIO

INHALATION OF SOIL-CONTAMINATED AIR
NONCARCINOGENIC EFFECTS

EXPOSURE: 40 HRS/WK, 50 WK/YR, 40 YRS

CHEMICAL	CONC. MG/M3	INH. RATE M3/D	%EXP.	EF DAYS/YR	ED YEARS	BW KG	AT DAYS	DOSE MG/KG	INTAKE MG/KG/D	RfD, CHR MG/KG/D	HI
As	1.21E-07	20	1	83.3	40	70	27375	1.15E-04	4.21E-09	1.00E-05	4.2E-04
Be	5.06E-08	20	1	83.3	40	70	27375	4.82E-05	1.76E-09	6.00E-06	2.9E-04
BIS	3.42E-08	20	1	83.3	40	70	27375	3.26E-05	1.19E-09	6.00E-03	2.0E-07
Cd	7.17E-08	20	1	83.3	40	70	27375	6.83E-05	2.49E-09	2.00E-05	1.2E-04
Cr-III	7.77E-06	20	1	83.3	40	70	27375	7.40E-03	2.70E-07	6.00E-04	4.5E-04
Cyanide	2.26E-08	20	1	83.3	40	70	27375	2.15E-05	7.86E-10	6.00E-03	1.3E-07
Hg	6.19E-08	20	1	83.3	40	70	27375	5.89E-05	2.15E-09	9.00E-05	2.4E-05
Pb	4.09E-07	20	1	83.3	40	70	27375	3.89E-04	1.42E-08	9.00E-06	1.6E-03
Ag	5.04E-08	20	1	83.3	40	70	27375	4.80E-05	1.75E-09	1.00E-04	1.8E-05
Sulfide	6.36E-07	20	1	83.3	40	70	27375	6.05E-04	2.21E-08		
Zn	3.29E-06	20	1	83.3	40	70	27375	3.13E-03	1.14E-07	6.00E-04	1.9E-04
Total											3.1E-03

TRA WARM WASTE POND
INTERIM ACTION
INDUSTRIAL SCENARIO

INHALATION OF SOIL-CONTAMINATED AIR
NONCARCINOGENIC EFFECTS

EXPOSURE: 5 HRS/WK, 50 WK/YR, 40 YRS

CHEMICAL	CONC. MG/M3	INH. RATE M3/D	%EXP.	EF DAYS/YR	ED YEARS	BW KG	AT DAYS	DOSE MG/KG	INTAKE MG/KG/D	RfD, CHR MG/KG/D	HI
As	1.21E-07	20	1	10.4	40	70	27375	1.44E-05	5.25E-10	1.00E-05	5.3E-05
Be	5.06E-08	20	1	10.4	40	70	27375	6.01E-06	2.20E-10	6.00E-06	3.7E-05
BIS	3.42E-08	20	1	10.4	40	70	27375	4.06E-06	1.48E-10	6.00E-03	2.5E-08
Cd	7.17E-08	20	1	10.4	40	70	27375	8.52E-06	3.11E-10	2.00E-05	1.6E-05
Cr-III	7.77E-06	20	1	10.4	40	70	27375	9.24E-04	3.37E-08	6.00E-04	5.6E-05
Cyanide	2.26E-08	20	1	10.4	40	70	27375	2.69E-06	9.81E-11	6.00E-03	1.6E-08
Hg	6.19E-08	20	1	10.4	40	70	27375	7.36E-06	2.69E-10	9.00E-05	3.0E-06
Pb	4.09E-07	20	1	10.4	40	70	27375	4.86E-05	1.78E-09	9.00E-06	2.0E-04
Ag	5.04E-08	20	1	10.4	40	70	27375	5.99E-06	2.19E-10	1.00E-04	2.2E-06
Sulfide	6.36E-07	20	1	10.4	40	70	27375	7.56E-05	2.76E-09		
Zn	3.29E-06	20	1	10.4	40	70	27375	3.91E-04	1.43E-08	6.00E-04	2.4E-05
Total											3.9E-04

TRA WARM WASTE POND
INTERIM ACTION
INDUSTRIAL SCENARIO

INHALATION OF SOIL-CONTAMINATED AIR
NONCARCINOGENIC EFFECTS

EXPOSURE: 40 HRS/WK, 50 WK/YR, 10 YRS

CHEMICAL	CONC. MG/M3	INH. RATE M3/D	%EXP.	EF DAYS/YR	ED YEARS	BW KG	AT DAYS	DOSE MG/KG	INTAKE MG/KG/D	RfD, CHR MG/KG/D	HI
As	1.21E-07	20	1	83.3	10	70	27375	2.88E-05	1.05E-09	1.00E-05	1.1E-04
Be	5.06E-08	20	1	83.3	10	70	27375	1.20E-05	4.40E-10	6.00E-06	7.3E-05
BIS	3.42E-08	20	1	83.3	10	70	27375	8.14E-06	2.97E-10	6.00E-03	5.0E-08
Cd	7.17E-08	20	1	83.3	10	70	27375	1.71E-05	6.23E-10	2.00E-05	3.1E-05
Cr-III	7.77E-06	20	1	83.3	10	70	27375	1.85E-03	6.76E-08	6.00E-04	1.1E-04
Cyanide	2.26E-08	20	1	83.3	10	70	27375	5.38E-06	1.96E-10	6.00E-03	3.3E-08
Hg	6.19E-08	20	1	83.3	10	70	27375	1.47E-05	5.38E-10	9.00E-05	6.0E-06
Pb	4.09E-07	20	1	83.3	10	70	27375	9.73E-05	3.56E-09	9.00E-06	4.0E-04
Ag	5.04E-08	20	1	83.3	10	70	27375	1.20E-05	4.38E-10	1.00E-04	4.4E-06
Sulfide	6.36E-07	20	1	83.3	10	70	27375	1.51E-04	5.53E-09		
Zn	3.29E-06	20	1	83.3	10	70	27375	7.83E-04	2.86E-08	6.00E-04	4.8E-05
Total											7.8E-04

TRA WARM WASTE POND
INTERIM ACTION
INDUSTRIAL SCENARIO

INHALATION OF SOIL-CONTAMINATED AIR
NONCARCINOGENIC EFFECTS

EXPOSURE: 5 HRS/WK, 50 WK/YR, 10 YRS

CHEMICAL	CONC. MG/M3	INH. RATE M3/D	%EXP.	EF DAYS/YR	ED YEARS	BW KG	AT DAYS	DOSE MG/KG	INTAKE MG/KG/D	RfD, CHR MG/KG/D	HI
As	1.21E-07	20	1	10.4	10	70	27375	3.60E-06	1.31E-10	1.00E-05	1.3E-05
Be	5.06E-08	20	1	10.4	10	70	27375	1.50E-06	5.49E-11	6.00E-06	9.2E-06
BIS	3.42E-08	20	1	10.4	10	70	27375	1.02E-06	3.71E-11	6.00E-03	6.2E-09
Cd	7.17E-08	20	1	10.4	10	70	27375	2.13E-06	7.78E-11	2.00E-05	3.9E-06
Cr-III	7.77E-06	20	1	10.4	10	70	27375	2.31E-04	8.43E-09	6.00E-04	1.4E-05
Cyanide	2.26E-08	20	1	10.4	10	70	27375	6.72E-07	2.45E-11	6.00E-03	4.1E-09
Hg	6.19E-08	20	1	10.4	10	70	27375	1.84E-06	6.72E-11	9.00E-05	7.5E-07
Pb	4.09E-07	20	1	10.4	10	70	27375	1.22E-05	4.44E-10	9.00E-06	4.9E-05
Ag	5.04E-08	20	1	10.4	10	70	27375	1.50E-06	5.47E-11	1.00E-04	5.5E-07
Sulfide	6.36E-07	20	1	10.4	10	70	27375	1.89E-05	6.90E-10		
Zn	3.29E-06	20	1	10.4	10	70	27375	9.78E-05	3.57E-09	6.00E-04	6.0E-06
Total											9.7E-05

TRA WARM WASTE POND
INTERIM ACTION
INDUSTRIAL SCENARIO

INHALATION OF SOIL-CONTAMINATED AIR
NONCARCINOGENIC EFFECTS

EXPOSURE: 40 HRS/WK, 50 WK/YR, 1 YR

CHEMICAL	CONC. MG/M3	INH. RATE M3/D	%EXP.	EF DAYS/YR	ED YEARS	BW KG	AT DAYS	DOSE MG/KG	INTAKE MG/KG/D	RfD, CHR MG/KG/D	HI
As	1.21E-07	20	1	83.3	1	70	27375	2.88E-06	1.05E-10	1.00E-05	1.1E-05
Be	5.06E-08	20	1	83.3	1	70	27375	1.20E-06	4.40E-11	6.00E-06	7.3E-06
BIS	3.42E-08	20	1	83.3	1	70	27375	8.14E-07	2.97E-11	6.00E-03	5.0E-09
Cd	7.17E-08	20	1	83.3	1	70	27375	1.71E-06	6.23E-11	2.00E-05	3.1E-06
Cr-III	7.77E-06	20	1	83.3	1	70	27375	1.85E-04	6.76E-09	6.00E-04	1.1E-05
Cyanide	2.26E-08	20	1	83.3	1	70	27375	5.38E-07	1.96E-11	6.00E-03	3.3E-09
Hg	6.19E-08	20	1	83.3	1	70	27375	1.47E-06	5.38E-11	9.00E-05	6.0E-07
Pb	4.09E-07	20	1	83.3	1	70	27375	9.73E-06	3.56E-10	9.00E-06	4.0E-05
Ag	5.04E-08	20	1	83.3	1	70	27375	1.20E-06	4.38E-11	1.00E-04	4.4E-07
Sulfide	6.36E-07	20	1	83.3	1	70	27375	1.51E-05	5.53E-10		
Zn	3.29E-06	20	1	83.3	1	70	27375	7.83E-05	2.86E-09	6.00E-04	4.8E-06
Total											7.8E-05

TRA WARM WASTE POND
INTERIM ACTION
INDUSTRIAL SCENARIO

INHALATION OF SOIL-CONTAMINATED AIR
NONCARCINOGENIC EFFECTS

EXPOSURE: 5 HRS/WK, 50 WK/YR, 1 YR

CHEMICAL	CONC. MG/M3	INH. RATE M3/D	%EXP.	EF DAYS/YR	ED YEARS	BW KG	AT DAYS	DOSE MG/KG	INTAKE MG/KG/D	RfD, CHR MG/KG/D	HI
As	1.21E-07	20	1	10.4	1	70	27375	3.60E-07	1.31E-11	1.00E-05	1.3E-06
Be	5.06E-08	20	1	10.4	1	70	27375	1.50E-07	5.49E-12	6.00E-06	9.2E-07
BIS	3.42E-08	20	1	10.4	1	70	27375	1.02E-07	3.71E-12	6.00E-03	6.2E-10
Cd	7.17E-08	20	1	10.4	1	70	27375	2.13E-07	7.78E-12	2.00E-05	3.9E-07
Cr-III	7.77E-06	20	1	10.4	1	70	27375	2.31E-05	8.43E-10	6.00E-04	1.4E-06
Cyanide	2.26E-08	20	1	10.4	1	70	27375	6.72E-08	2.45E-12	6.00E-03	4.1E-10
Hg	6.19E-08	20	1	10.4	1	70	27375	1.84E-07	6.72E-12	9.00E-05	7.5E-08
Pb	4.09E-07	20	1	10.4	1	70	27375	1.22E-06	4.44E-11	9.00E-06	4.9E-06
Ag	5.04E-08	20	1	10.4	1	70	27375	1.50E-07	5.47E-12	1.00E-04	5.5E-08
Sulfide	6.36E-07	20	1	10.4	1	70	27375	1.89E-06	6.90E-11		
Zn	3.29E-06	20	1	10.4	1	70	27375	9.78E-06	3.57E-10	6.00E-04	6.0E-07
Total											9.7E-06

TRA WARM WASTE POND
INTERIM ACTION
INDUSTRIAL SCENARIO

INHALATION OF SOIL-CONTAMINATED AIR
CARCINOGENIC EFFECTS, CHEMICALS

EPA REGION 10, UPPER-BOUND CASE

CHEMICAL	CONC. MG/M3	INH. RATE M3/D	%EXP.	EF DAYS/YR	ED YEARS	BW KG	AT DAYS	DOSE MG/KG	INTAKE MG/KG/D	SF, INH. MG/KG/D -1	CANCER RISK	EPA CLASS
As	1.21E-07	79	0.4	365	40	70	27375	7.97E-04	8.74E-09	5.00E+01	4.4E-07	A
Be	5.06E-08	79	0.4	365	40	70	27375	3.33E-04	1.22E-08	8.40E+00	1.0E-07	B2
BIS	3.42E-08	79	0.4	365	40	70	27375	2.25E-04	8.23E-09	1.40E-02	1.2E-10	B2,INH. (ORAL SF)
Cd	7.17E-08	79	0.4	365	40	70	27375	4.73E-04	1.73E-08	6.10E+00	1.1E-07	B1
Cr-III	7.77E-06	79	0.4	365	40	70	27375	5.12E-02	1.87E-06			
Cyanide	2.26E-08	79	0.4	365	40	70	27375	1.49E-04	5.44E-09			
Hg	6.19E-08	79	0.4	365	40	70	27375	4.08E-04	1.49E-08			
Pb	4.09E-07	79	0.4	365	40	70	27375	2.70E-03	9.85E-08			
Ag	5.04E-08	79	0.4	365	40	70	27375	3.32E-04	1.21E-08			
Sulfide	6.36E-07	79	0.4	365	40	70	27375	4.19E-03	1.53E-07			
Zn	3.29E-06	79	0.4	365	40	70	27375	2.17E-02	7.92E-07			
Total											6.4E-07	

TRA WARM WASTE POND
INTERIM ACTION
INDUSTRIAL SCENARIO

INHALATION OF SOIL-CONTAMINATED AIR
CARCINOGENIC EFFECTS, CHEMICALS

EPA REGION 10, AVERAGE CASE

CHEMICAL	CONC. MG/M3	INH. RATE M3/D	%EXP.	EF DAYS/YR	ED YEARS	BW KG	AT DAYS	DOSE MG/KG	INTAKE MG/KG/D	SF, INH. MG/KG/D -1	CANCER RISK	EPA CLASS
As	1.21E-07	43	0.25	365	10	70	27375	6.78E-05	7.43E-10	5.00E+01	3.7E-08	A
Be	5.06E-08	43	0.25	365	10	70	27375	2.84E-05	1.04E-09	8.40E+00	8.7E-09	B2
BIS	3.42E-08	43	0.25	365	10	70	27375	1.92E-05	7.00E-10	1.40E-02	9.8E-12	B2,INH. (ORAL SF)
Cd	7.17E-08	43	0.25	365	10	70	27375	4.02E-05	1.47E-09	6.10E+00	9.0E-09	B1
Cr-III	7.77E-06	43	0.25	365	10	70	27375	4.36E-03	1.59E-07			
Cyanide	2.26E-08	43	0.25	365	10	70	27375	1.27E-05	4.63E-10			
Hg	6.19E-08	43	0.25	365	10	70	27375	3.47E-05	1.27E-09			
Pb	4.09E-07	43	0.25	365	10	70	27375	2.29E-04	8.37E-09			
Ag	5.04E-08	43	0.25	365	10	70	27375	2.83E-05	1.03E-09			
Sulfide	6.36E-07	43	0.25	365	10	70	27375	3.57E-04	1.30E-08			
Zn	3.29E-06	43	0.25	365	10	70	27375	1.84E-03	6.74E-08			
Total											5.5E-08	

TRA WARM WASTE POND
INTERIM ACTION
INDUSTRIAL SCENARIO

INHALATION OF SOIL-CONTAMINATED AIR
CARCINOGENIC EFFECTS, CHEMICALS

ADJUSTED UPPER-BOUND CASE, 20 M3/D

CHEMICAL	CONC. MG/M3	INH. RATE M3/D	%EXP.	EF DAYS/YR	ED YEARS	BW KG	AT DAYS	DOSE MG/KG	INTAKE MG/KG/D	SF, INH. MG/KG/D -1	CANCER RISK	EPA CLASS
As	1.21E-07	20	0.4	365	40	70	27375	2.02E-04	2.21E-09	5.00E+01	1.1E-07	A
Be	5.06E-08	20	0.4	365	40	70	27375	8.44E-05	3.08E-09	8.40E+00	2.6E-08	B2
BIS	3.42E-08	20	0.4	365	40	70	27375	5.71E-05	2.08E-09	1.40E-02	2.9E-11	B2,INH. (ORAL SF)
Cd	7.17E-08	20	0.4	365	40	70	27375	1.20E-04	4.37E-09	6.10E+00	2.7E-08	B1
Cr-III	7.77E-06	20	0.4	365	40	70	27375	1.30E-02	4.74E-07			
Cyanide	2.26E-08	20	0.4	365	40	70	27375	3.77E-05	1.38E-09			
Hg	6.19E-08	20	0.4	365	40	70	27375	1.03E-04	3.77E-09			
Pb	4.09E-07	20	0.4	365	40	70	27375	6.82E-04	2.49E-08			
Ag	5.04E-08	20	0.4	365	40	70	27375	8.41E-05	3.07E-09			
Sulfide	6.36E-07	20	0.4	365	40	70	27375	1.06E-03	3.88E-08			
Zn	3.29E-06	20	0.4	365	40	70	27375	5.49E-03	2.01E-07			
Total											1.6E-07	

TRA WARM WASTE POND
INTERIM ACTION
INDUSTRIAL SCENARIO

INHALATION OF SOIL-CONTAMINATED AIR
CARCINOGENIC EFFECTS, CHEMICALS

ADJUSTED AVERAGE CASE, 20 M3/D

CHEMICAL	CONC. MG/M3	INH. RATE M3/D	%EXP.	EF DAYS/YR	ED YEARS	BW KG	AT DAYS	DOSE MG/KG	INTAKE MG/KG/D	SF, INH. MG/KG/D -1	CANCER RISK	EPA CLASS
As	1.21E-07	20	0.25	365	10	70	27375	3.15E-05	3.46E-10	5.00E+01	1.7E-08	A
Be	5.06E-08	20	0.25	365	10	70	27375	1.32E-05	4.82E-10	8.40E+00	4.0E-09	B2
BIS	3.42E-08	20	0.25	365	10	70	27375	8.92E-06	3.26E-10	1.40E-02	4.6E-12	B2,INH. (ORAL SF)
Cd	7.17E-08	20	0.25	365	10	70	27375	1.87E-05	6.83E-10	6.10E+00	4.2E-09	B1
Cr-III	7.77E-06	20	0.25	365	10	70	27375	2.03E-03	7.40E-08			
Cyanide	2.26E-08	20	0.25	365	10	70	27375	5.89E-06	2.15E-10			
Hg	6.19E-08	20	0.25	365	10	70	27375	1.61E-05	5.90E-10			
Pb	4.09E-07	20	0.25	365	10	70	27375	1.07E-04	3.90E-09			
Ag	5.04E-08	20	0.25	365	10	70	27375	1.31E-05	4.80E-10			
Sulfide	6.36E-07	20	0.25	365	10	70	27375	1.66E-04	6.06E-09			
Zn	3.29E-06	20	0.25	365	10	70	27375	8.58E-04	3.13E-08			
Total											2.6E-08	

TRA WARM WASTE POND
INTERIM ACTION
INDUSTRIAL SCENARIO

INHALATION OF SOIL-CONTAMINATED AIR
CARCINOGENIC EFFECTS, CHEMICALS

EXPOSURE: 40 HRS/WK, 50 WK/YR, 40 YRS

CHEMICAL	CONC. MG/M3	INH. RATE M3/D	%EXP.	EF DAYS/YR	ED YEARS	BW KG	AT DAYS	DOSE MG/KG	INTAKE MG/KG/D	SF, INH. MG/KG/D -1	CANCER RISK	EPA CLASS
As	1.21E-07	20	1	83.3	40	70	27375	1.15E-04	1.26E-09	5.00E+01	6.3E-08	A
Be	5.06E-08	20	1	83.3	40	70	27375	4.82E-05	1.76E-09	8.40E+00	1.5E-08	B2
BIS	3.42E-08	20	1	83.3	40	70	27375	3.26E-05	1.19E-09	1.40E-02	1.7E-11	B2,INH. (ORAL SF)
Cd	7.17E-08	20	1	83.3	40	70	27375	6.83E-05	2.49E-09	6.10E+00	1.5E-08	B1
Cr-III	7.77E-06	20	1	83.3	40	70	27375	7.40E-03	2.70E-07			
Cyanide	2.26E-08	20	1	83.3	40	70	27375	2.15E-05	7.86E-10			
Hg	6.19E-08	20	1	83.3	40	70	27375	5.89E-05	2.15E-09			
Pb	4.09E-07	20	1	83.3	40	70	27375	3.89E-04	1.42E-08			
Ag	5.04E-08	20	1	83.3	40	70	27375	4.80E-05	1.75E-09			
Sulfide	6.36E-07	20	1	83.3	40	70	27375	6.05E-04	2.21E-08			
Zn	3.29E-06	20	1	83.3	40	70	27375	3.13E-03	1.14E-07			
Total											9.3E-08	

TRA WARM WASTE POND
INTERIM ACTION
INDUSTRIAL SCENARIO

INHALATION OF SOIL-CONTAMINATED AIR
CARCINOGENIC EFFECTS, CHEMICALS

EXPOSURE: 5 HRS/WK, 50 WK/YR, 40 YRS

CHEMICAL	CONC. MG/M3	INH. RATE M3/D	%EXP.	EF DAYS/YR	ED YEARS	BW KG	AT DAYS	DOSE MG/KG	INTAKE MG/KG/D	SF, INH. MG/KG/D -1	CANCER RISK	EPA CLASS
As	1.21E-07	20	1	10.4	40	70	27375	1.44E-05	1.58E-10	5.00E+01	7.9E-09	A
Be	5.06E-08	20	1	10.4	40	70	27375	6.01E-06	2.20E-10	8.40E+00	1.8E-09	B2
BIS	3.42E-08	20	1	10.4	40	70	27375	4.06E-06	1.48E-10	1.40E-02	2.1E-12	B2,INH. (ORAL SF)
Cd	7.17E-08	20	1	10.4	40	70	27375	8.52E-06	3.11E-10	6.10E+00	1.9E-09	B1
Cr-III	7.77E-06	20	1	10.4	40	70	27375	9.24E-04	3.37E-08			
Cyanide	2.26E-08	20	1	10.4	40	70	27375	2.69E-06	9.81E-11			
Hg	6.19E-08	20	1	10.4	40	70	27375	7.36E-06	2.69E-10			
Pb	4.09E-07	20	1	10.4	40	70	27375	4.86E-05	1.78E-09			
Ag	5.04E-08	20	1	10.4	40	70	27375	5.99E-06	2.19E-10			
Sulfide	6.36E-07	20	1	10.4	40	70	27375	7.56E-05	2.76E-09			
Zn	3.29E-06	20	1	10.4	40	70	27375	3.91E-04	1.43E-08			
Total											1.2E-08	

TRA WARM WASTE POND
INTERIM ACTION
INDUSTRIAL SCENARIO

INHALATION OF SOIL-CONTAMINATED AIR
CARCINOGENIC EFFECTS, CHEMICALS

EXPOSURE: 40 HRS/WK, 50 WK/YR, 10 YRS

CHEMICAL	CONC. MG/M3	INH. RATE M3/D	%EXP.	EF DAYS/YR	ED YEARS	BW KG	AT DAYS	DOSE MG/KG	INTAKE MG/KG/D	SF, INH. MG/KG/D -1	CANCER RISK	EPA CLASS
As	1.21E-07	20	1	83.3	10	70	27375	2.88E-05	3.16E-10	5.00E+01	1.6E-08	A
Be	5.06E-08	20	1	83.3	10	70	27375	1.20E-05	4.40E-10	8.40E+00	3.7E-09	B2
BIS	3.42E-08	20	1	83.3	10	70	27375	8.14E-06	2.97E-10	1.40E-02	4.2E-12	B2,INH. (ORAL SF)
Cd	7.17E-08	20	1	83.3	10	70	27375	1.71E-05	6.23E-10	6.10E+00	3.8E-09	B1
Cr-III	7.77E-06	20	1	83.3	10	70	27375	1.85E-03	6.76E-08			
Cyanide	2.26E-08	20	1	83.3	10	70	27375	5.38E-06	1.96E-10			
Hg	6.19E-08	20	1	83.3	10	70	27375	1.47E-05	5.38E-10			
Pb	4.09E-07	20	1	83.3	10	70	27375	9.73E-05	3.56E-09			
Ag	5.04E-08	20	1	83.3	10	70	27375	1.20E-05	4.38E-10			
Sulfide	6.36E-07	20	1	83.3	10	70	27375	1.51E-04	5.53E-09			
Zn	3.29E-06	20	1	83.3	10	70	27375	7.83E-04	2.86E-08			
Total											2.3E-08	

TRA WARM WASTE POND
INTERIM ACTION
INDUSTRIAL SCENARIO

INHALATION OF SOIL-CONTAMINATED AIR
CARCINOGENIC EFFECTS, CHEMICALS

EXPOSURE: 5 HRS/WK, 50 WK/YR, 10 YRS

CHEMICAL	CONC. MG/M3	INH. RATE M3/D	%EXP.	EF DAYS/YR	ED YEARS	BW KG	AT DAYS	DOSE MG/KG	INTAKE MG/KG/D	SF, INH. MG/KG/D -1	CANCER RISK	EPA CLASS
As	1.21E-07	20	1	10.4	10	70	27375	3.60E-06	3.94E-11	5.00E+01	2.0E-09	A
Be	5.06E-08	20	1	10.4	10	70	27375	1.50E-06	5.49E-11	8.40E+00	4.6E-10	B2
BIS	3.42E-08	20	1	10.4	10	70	27375	1.02E-06	3.71E-11	1.40E-02	5.2E-13	B2,INH. (ORAL SF)
Cd	7.17E-08	20	1	10.4	10	70	27375	2.13E-06	7.78E-11	6.10E+00	4.7E-10	B1
Cr-III	7.77E-06	20	1	10.4	10	70	27375	2.31E-04	8.43E-09			
Cyanide	2.26E-08	20	1	10.4	10	70	27375	6.72E-07	2.45E-11			
Hg	6.19E-08	20	1	10.4	10	70	27375	1.84E-06	6.72E-11			
Pb	4.09E-07	20	1	10.4	10	70	27375	1.22E-05	4.44E-10			
Ag	5.04E-08	20	1	10.4	10	70	27375	1.50E-06	5.47E-11			
Sulfide	6.36E-07	20	1	10.4	10	70	27375	1.89E-05	6.90E-10			
Zn	3.29E-06	20	1	10.4	10	70	27375	9.78E-05	3.57E-09			
Total											2.9E-09	

TRA WARM WASTE POND
INTERIM ACTION
INDUSTRIAL SCENARIO

INHALATION OF SOIL-CONTAMINATED AIR
CARCINOGENIC EFFECTS, CHEMICALS

EXPOSURE: 40 HRS/WK, 50 WK/YR, 1 YR

CHEMICAL	CONC. MG/M3	INH. RATE M3/D	%EXP.	EF DAYS/YR	ED YEARS	BW KG	AT DAYS	DOSE MG/KG	INTAKE MG/KG/D	SF, INH. MG/KG/D -1	CANCER RISK	EPA CLASS
As	1.21E-07	20	1	83.3	1	70	27375	2.88E-06	3.16E-11	5.00E+01	1.6E-09	A
Be	5.06E-08	20	1	83.3	1	70	27375	1.20E-06	4.40E-11	8.40E+00	3.7E-10	B2
BIS	3.42E-08	20	1	83.3	1	70	27375	8.14E-07	2.97E-11	1.40E-02	4.2E-13	B2,INH. (ORAL SF)
Cd	7.17E-08	20	1	83.3	1	70	27375	1.71E-06	6.23E-11	6.10E+00	3.8E-10	B1
Cr-III	7.77E-06	20	1	83.3	1	70	27375	1.85E-04	6.76E-09			
Cyanide	2.26E-08	20	1	83.3	1	70	27375	5.38E-07	1.96E-11			
Hg	6.19E-08	20	1	83.3	1	70	27375	1.47E-06	5.38E-11			
Pb	4.09E-07	20	1	83.3	1	70	27375	9.73E-06	3.56E-10			
Ag	5.04E-08	20	1	83.3	1	70	27375	1.20E-06	4.38E-11			
Sulfide	6.36E-07	20	1	83.3	1	70	27375	1.51E-05	5.53E-10			
Zn	3.29E-06	20	1	83.3	1	70	27375	7.83E-05	2.86E-09			
Total											2.3E-09	

TRA WARM WASTE POND
INTERIM ACTION
INDUSTRIAL SCENARIO

INHALATION OF SOIL-CONTAMINATED AIR
CARCINOGENIC EFFECTS, CHEMICALS

EXPOSURE: 5 HRS/WK, 50 WK/YR, 1 YR

CHEMICAL	CONC. MG/M3	INH. RATE M3/D	%EXP.	EF DAYS/YR	ED YEARS	BW KG	AT DAYS	DOSE MG/KG	INTAKE MG/KG/D	SF, INH. MG/KG/D -1	CANCER RISK	EPA CLASS
As	1.21E-07	20	1	10.4	1	70	27375	3.60E-07	3.94E-12	5.00E+01	2.0E-10	A
Be	5.06E-08	20	1	10.4	1	70	27375	1.50E-07	5.49E-12	8.40E+00	4.6E-11	B2
BIS	3.42E-08	20	1	10.4	1	70	27375	1.02E-07	3.71E-12	1.40E-02	5.2E-14	B2,INH. (ORAL SF)
Cd	7.17E-08	20	1	10.4	1	70	27375	2.13E-07	7.78E-12	6.10E+00	4.7E-11	B1
Cr-III	7.77E-06	20	1	10.4	1	70	27375	2.31E-05	8.43E-10			
Cyanide	2.26E-08	20	1	10.4	1	70	27375	6.72E-08	2.45E-12			
Hg	6.19E-08	20	1	10.4	1	70	27375	1.84E-07	6.72E-12			
Pb	4.09E-07	20	1	10.4	1	70	27375	1.22E-06	4.44E-11			
Ag	5.04E-08	20	1	10.4	1	70	27375	1.50E-07	5.47E-12			
Sulfide	6.36E-07	20	1	10.4	1	70	27375	1.89E-06	6.90E-11			
Zn	3.29E-06	20	1	10.4	1	70	27375	9.78E-06	3.57E-10			
Total											2.9E-10	

TRA WARM WASTE POND
INTERIM ACTION
INDUSTRIAL SCENARIO

INHALATION OF SOIL-CONTAMINATED AIR
CARCINOGENIC EFFECTS, RADIONUCLIDES

EPA REGION 10, UPPER-BOUND CASE

NUCLIDE	H-LIFE (Y)	AIR CONC. (pCi/m3)	INH.RATE M3/D	%EXP.	EF D/YR	ED YEARS	BW KG	AT DAYS	INH. SF (pCi)-1	ADJ. UR (pCi/m3)-1	CANCER RISK
Cr-51	7.585E-02	2.22E-03	79.0000	0.4	365	40	70	27375	3.0E-13	1.4E-07	3.1E-10
Co-60	5.271E+00	1.06E-01	79.0000	0.4	365	40	70	27375	1.6E-10	7.4E-05	7.8E-06
Sr-90	2.860E+01	1.32E-02	79.0000	0.4	365	40	70	27375	5.6E-11	2.6E-05	3.4E-07
Ag-108m	1.270E+02	1.47E-03	79.0000	0.4	365	40	70	27375			
Cs-134	2.062E+00	1.03E-03	79.0000	0.4	365	40	70	27375	2.8E-11	1.3E-05	1.3E-08
Cs-137	3.017E+01	2.64E-01	79.0000	0.4	365	40	70	27375	1.9E-11	8.8E-06	2.3E-06
Eu-152	1.333E+01	2.45E-03	79.0000	0.4	365	40	70	27375	1.2E-08	5.5E-03	1.4E-05
Eu-154	8.800E+00	1.13E-03	79.0000	0.4	365	40	70	27375	1.4E-10	6.5E-05	7.3E-08
Eu-155	4.960E+00	2.22E-04	79.0000	0.4	365	40	70	27375			
Th-228	1.913E+00	6.25E-04	79.0000	0.4	365	40	70	27375	7.7E-08	3.6E-02	2.2E-05
Th-230	7.538E+04	3.27E-04	79.0000	0.4	365	40	70	27375	3.1E-08	1.4E-02	4.7E-06
Th-232	1.450E+10	2.98E-05	79.0000	0.4	365	40	70	27375	3.1E-08	1.4E-02	4.3E-07
U-232	6.890E+01	5.30E-04	79.0000	0.4	365	40	70	27375			
U-234	2.450E+05	1.35E-04	79.0000	0.4	365	40	70	27375	2.7E-08	1.2E-02	1.7E-06
U-238	4.468E+09	3.69E-05	79.0000	0.4	365	40	70	27375	2.4E-08	1.1E-02	4.1E-07
Pu-238	8.774E+01	2.35E-04	79.0000	0.4	365	40	70	27375	4.2E-08	1.9E-02	4.6E-06
Pu-239	2.412E+04	4.40E-04	79.0000	0.4	365	40	70	27375	4.1E-08	1.9E-02	8.3E-06
Am-241	4.322E+02	1.88E-04	79.0000	0.4	365	40	70	27375	4.0E-08	1.8E-02	3.5E-06
Cm-244	1.810E+01	1.55E-04	79.0000	0.4	365	40	70	27375	2.7E-08	1.2E-02	1.9E-06
Total											7.2E-05

TRA WARM WASTE POND
INTERIM ACTION
INDUSTRIAL SCENARIO

INHALATION OF SOIL-CONTAMINATED AIR
CARCINOGENIC EFFECTS, RADIONUCLIDES

EPA REGION 10, AVERAGE CASE

NUCLIDE	H-LIFE (Y)	AIR CONC. (pCi/m3)	INH.RATE M3/D	%EXP.	EF D/YR	ED YEARS	BW KG	AT DAYS	INH. SF (pCi)-1	ADJ. UR (pCi/m3)-1	CANCER RISK
Cr-51	7.585E-02	2.22E-03	43.0000	0.25	365	10	70	27375	3.0E-13	1.2E-08	2.6E-11
Co-60	5.271E+00	1.06E-01	43.0000	0.25	365	10	70	27375	1.6E-10	6.3E-06	6.7E-07
Sr-90	2.860E+01	1.32E-02	43.0000	0.25	365	10	70	27375	5.6E-11	2.2E-06	2.9E-08
Ag-108m	1.270E+02	1.47E-03	43.0000	0.25	365	10	70	27375			
Cs-134	2.062E+00	1.03E-03	43.0000	0.25	365	10	70	27375	2.8E-11	1.1E-06	1.1E-09
Cs-137	3.017E+01	2.64E-01	43.0000	0.25	365	10	70	27375	1.9E-11	7.5E-07	2.0E-07
Eu-152	1.333E+01	2.45E-03	43.0000	0.25	365	10	70	27375	1.2E-08	4.7E-04	1.2E-06
Eu-154	8.800E+00	1.13E-03	43.0000	0.25	365	10	70	27375	1.4E-10	5.5E-06	6.2E-09
Eu-155	4.960E+00	2.22E-04	43.0000	0.25	365	10	70	27375			
Th-228	1.913E+00	6.25E-04	43.0000	0.25	365	10	70	27375	7.7E-08	3.0E-03	1.9E-06
Th-230	7.538E+04	3.27E-04	43.0000	0.25	365	10	70	27375	3.1E-08	1.2E-03	4.0E-07
Th-232	1.450E+10	2.98E-05	43.0000	0.25	365	10	70	27375	3.1E-08	1.2E-03	3.6E-08
U-232	6.890E+01	5.30E-04	43.0000	0.25	365	10	70	27375			
U-234	2.450E+05	1.35E-04	43.0000	0.25	365	10	70	27375	2.7E-08	1.1E-03	1.4E-07
U-238	4.468E+09	3.69E-05	43.0000	0.25	365	10	70	27375	2.4E-08	9.4E-04	3.5E-08
Pu-238	8.774E+01	2.35E-04	43.0000	0.25	365	10	70	27375	4.2E-08	1.6E-03	3.9E-07
Pu-239	2.412E+04	4.40E-04	43.0000	0.25	365	10	70	27375	4.1E-08	1.6E-03	7.1E-07
Am-241	4.322E+02	1.88E-04	43.0000	0.25	365	10	70	27375	4.0E-08	1.6E-03	3.0E-07
Cm-244	1.810E+01	1.55E-04	43.0000	0.25	365	10	70	27375	2.7E-08	1.1E-03	1.6E-07
Total											6.1E-06

TRA WARM WASTE POND
INTERIM ACTION
INDUSTRIAL SCENARIO

INHALATION OF SOIL-CONTAMINATED AIR
CARCINOGENIC EFFECTS, RADIONUCLIDES

ADJUSTED UPPER-BOUND CASE, 20 M3/D

NUCLIDE	H-LIFE (Y)	23ug/m3 AIR (pCi/m3)	INH.RATE M3/D	%EXP.	EF D/YR	ED YEARS	BW KG	AT DAYS	INH. SF (pCi)-1	ADJ. UR (pCi/m3)-1	CANCER RISK
Cr-51	7.585E-02	2.22E-03	20.0000	0.4	365	40	70	27375	3.0E-13	3.5E-08	7.8E-11
Co-60	5.271E+00	1.06E-01	20.0000	0.4	365	40	70	27375	1.6E-10	1.9E-05	2.0E-06
Sr-90	2.860E+01	1.32E-02	20.0000	0.4	365	40	70	27375	5.6E-11	6.5E-06	8.6E-08
Ag-108m	1.270E+02	1.47E-03	20.0000	0.4	365	40	70	27375			
Cs-134	2.062E+00	1.03E-03	20.0000	0.4	365	40	70	27375	2.8E-11	3.3E-06	3.4E-09
Cs-137	3.017E+01	2.64E-01	20.0000	0.4	365	40	70	27375	1.9E-11	2.2E-06	5.9E-07
Eu-152	1.333E+01	2.45E-03	20.0000	0.4	365	40	70	27375	1.2E-08	1.4E-03	3.4E-06
Eu-154	8.800E+00	1.13E-03	20.0000	0.4	365	40	70	27375	1.4E-10	1.6E-05	1.8E-08
Eu-155	4.960E+00	2.22E-04	20.0000	0.4	365	40	70	27375			
Th-228	1.913E+00	6.25E-04	20.0000	0.4	365	40	70	27375	7.7E-08	9.0E-03	5.6E-06
Th-230	7.538E+04	3.27E-04	20.0000	0.4	365	40	70	27375	3.1E-08	3.6E-03	1.2E-06
Th-232	1.450E+10	2.98E-05	20.0000	0.4	365	40	70	27375	3.1E-08	3.6E-03	1.1E-07
U-232	6.890E+01	5.30E-04	20.0000	0.4	365	40	70	27375			
U-234	2.450E+05	1.35E-04	20.0000	0.4	365	40	70	27375	2.7E-08	3.2E-03	4.3E-07
U-238	4.468E+09	3.69E-05	20.0000	0.4	365	40	70	27375	2.4E-08	2.8E-03	1.0E-07
Pu-238	8.774E+01	2.35E-04	20.0000	0.4	365	40	70	27375	4.2E-08	4.9E-03	1.2E-06
Pu-239	2.412E+04	4.40E-04	20.0000	0.4	365	40	70	27375	4.1E-08	4.8E-03	2.1E-06
Am-241	4.322E+02	1.88E-04	20.0000	0.4	365	40	70	27375	4.0E-08	4.7E-03	8.8E-07
Cm-244	1.810E+01	1.55E-04	20.0000	0.4	365	40	70	25550	2.7E-08	3.2E-03	4.9E-07
Total											1.8E-05

TRA WARM WASTE POND
INTERIM ACTION
INDUSTRIAL SCENARIO

INHALATION OF SOIL-CONTAMINATED AIR
CARCINOGENIC EFFECTS, RADIONUCLIDES

ADJUSTED AVERAGE CASE, 20 M3/D

NUCLIDE	H-LIFE (Y)	23ug/m3 AIR (pCi/m3)	INH.RATE M3/D	%EXP.	EF D/YR	ED YEARS	BW KG	AT DAYS	INH. SF (pCi)-1	ADJ. UR (pCi/m3)-1	CANCER RISK
Cr-51	7.585E-02	2.22E-03	20.0000	0.25	365	10	70	27375	3.0E-13	5.5E-09	1.2E-11
Co-60	5.271E+00	1.06E-01	20.0000	0.25	365	10	70	27375	1.6E-10	2.9E-06	3.1E-07
Sr-90	2.860E+01	1.32E-02	20.0000	0.25	365	10	70	27375	5.6E-11	1.0E-06	1.3E-08
Ag-108m	1.270E+02	1.47E-03	20.0000	0.25	365	10	70	27375			
Cs-134	2.062E+00	1.03E-03	20.0000	0.25	365	10	70	27375	2.8E-11	5.1E-07	5.3E-10
Cs-137	3.017E+01	2.64E-01	20.0000	0.25	365	10	70	27375	1.9E-11	3.5E-07	9.2E-08
Eu-152	1.333E+01	2.45E-03	20.0000	0.25	365	10	70	27375	1.2E-08	2.2E-04	5.4E-07
Eu-154	8.800E+00	1.13E-03	20.0000	0.25	365	10	70	27375	1.4E-10	2.6E-06	2.9E-09
Eu-155	4.960E+00	2.22E-04	20.0000	0.25	365	10	70	27375			
Th-228	1.913E+00	6.25E-04	20.0000	0.25	365	10	70	27375	7.7E-08	1.4E-03	8.8E-07
Th-230	7.538E+04	3.27E-04	20.0000	0.25	365	10	70	27375	3.1E-08	5.7E-04	1.9E-07
Th-232	1.450E+10	2.98E-05	20.0000	0.25	365	10	70	27375	3.1E-08	5.7E-04	1.7E-08
U-232	6.890E+01	5.30E-04	20.0000	0.25	365	10	70	27375			
U-234	2.450E+05	1.35E-04	20.0000	0.25	365	10	70	27375	2.7E-08	4.9E-04	6.7E-08
U-238	4.468E+09	3.69E-05	20.0000	0.25	365	10	70	27375	2.4E-08	4.4E-04	1.6E-08
Pu-238	8.774E+01	2.35E-04	20.0000	0.25	365	10	70	27375	4.2E-08	7.7E-04	1.8E-07
Pu-239	2.412E+04	4.40E-04	20.0000	0.25	365	10	70	27375	4.1E-08	7.5E-04	3.3E-07
Am-241	4.322E+02	1.88E-04	20.0000	0.25	365	10	70	27375	4.0E-08	7.3E-04	1.4E-07
Cm-244	1.810E+01	1.55E-04	20.0000	0.25	365	10	70	27375	2.7E-08	4.9E-04	7.6E-08
Total											2.8E-06

TRA WARM WASTE POND
INTERIM ACTION
INDUSTRIAL SCENARIO

INHALATION OF SOIL-CONTAMINATED AIR
CARCINOGENIC EFFECTS, RADIONUCLIDES

EXPOSURE: 40 HRS/WK, 50 WK/YR, 40 YRS

NUCLIDE	H-LIFE (Y)	23ug/m3 AIR (pCi/m3)	INH.RATE M3/D	%EXP.	EF D/YR	ED YEARS	BW KG	AT DAYS	INH. SF (pCi)-1	ADJ. UR (pCi/m3)-1	CANCER RISK
Cr-51	7.585E-02	2.22E-03	20.0000	1	83.3	40	70	27375	3.0E-13	2.0E-08	4.4E-11
Co-60	5.271E+00	1.06E-01	20.0000	1	83.3	40	70	27375	1.6E-10	1.1E-05	1.1E-06
Sr-90	2.860E+01	1.32E-02	20.0000	1	83.3	40	70	27375	5.6E-11	3.7E-06	4.9E-08
Ag-108m	1.270E+02	1.47E-03	20.0000	1	83.3	40	70	27375			
Cs-134	2.062E+00	1.03E-03	20.0000	1	83.3	40	70	27375	2.8E-11	1.9E-06	1.9E-09
Cs-137	3.017E+01	2.64E-01	20.0000	1	83.3	40	70	27375	1.9E-11	1.3E-06	3.3E-07
Eu-152	1.333E+01	2.45E-03	20.0000	1	83.3	40	70	27375	1.2E-08	8.0E-04	2.0E-06
Eu-154	8.800E+00	1.13E-03	20.0000	1	83.3	40	70	27375	1.4E-10	9.3E-06	1.1E-08
Eu-155	4.960E+00	2.22E-04	20.0000	1	83.3	40	70	27375			
Th-228	1.913E+00	6.25E-04	20.0000	1	83.3	40	70	27375	7.7E-08	5.1E-03	3.2E-06
Th-230	7.538E+04	3.27E-04	20.0000	1	83.3	40	70	27375	3.1E-08	2.1E-03	6.8E-07
Th-232	1.450E+10	2.98E-05	20.0000	1	83.3	40	70	27375	3.1E-08	2.1E-03	6.2E-08
U-232	6.890E+01	5.30E-04	20.0000	1	83.3	40	70	27375			
U-234	2.450E+05	1.35E-04	20.0000	1	83.3	40	70	27375	2.7E-08	1.8E-03	2.4E-07
U-238	4.468E+09	3.69E-05	20.0000	1	83.3	40	70	27375	2.4E-08	1.6E-03	5.9E-08
Pu-238	8.774E+01	2.35E-04	20.0000	1	83.3	40	70	27375	4.2E-08	2.8E-03	6.6E-07
Pu-239	2.412E+04	4.40E-04	20.0000	1	83.3	40	70	27375	4.1E-08	2.7E-03	1.2E-06
Am-241	4.322E+02	1.88E-04	20.0000	1	83.3	40	70	27375	4.0E-08	2.7E-03	5.0E-07
Cm-244	1.810E+01	1.55E-04	20.0000	1	83.3	40	70	27375	2.7E-08	1.8E-03	2.8E-07
Total											1.0E-05

TRA WARM WASTE POND
INTERIM ACTION
INDUSTRIAL SCENARIO

INHALATION OF SOIL-CONTAMINATED AIR
CARCINOGENIC EFFECTS, RADIONUCLIDES

EXPOSURE: 5 HRS/WK, 50 WK/YR, 40 YRS

NUCLIDE	H-LIFE (Y)	23ug/m3 AIR (pCi/m3)	INH.RATE M3/D	%EXP.	EF D/YR	ED YEARS	BW KG	AT DAYS	INH. SF (pCi)-1	ADJ. UR (pCi/m3)-1	CANCER RISK
Cr-51	7.585E-02	2.22E-03	20.0000	1	10.4	40	70	27375	3.0E-13	2.5E-09	5.5E-12
Co-60	5.271E+00	1.06E-01	20.0000	1	10.4	40	70	27375	1.6E-10	1.3E-06	1.4E-07
Sr-90	2.860E+01	1.32E-02	20.0000	1	10.4	40	70	27375	5.6E-11	4.7E-07	6.2E-09
Ag-108m	1.270E+02	1.47E-03	20.0000	1	10.4	40	70	27375			
Cs-134	2.062E+00	1.03E-03	20.0000	1	10.4	40	70	27375	2.8E-11	2.3E-07	2.4E-10
Cs-137	3.017E+01	2.64E-01	20.0000	1	10.4	40	70	27375	1.9E-11	1.6E-07	4.2E-08
Eu-152	1.333E+01	2.45E-03	20.0000	1	10.4	40	70	27375	1.2E-08	1.0E-04	2.4E-07
Eu-154	8.800E+00	1.13E-03	20.0000	1	10.4	40	70	27375	1.4E-10	1.2E-06	1.3E-09
Eu-155	4.960E+00	2.22E-04	20.0000	1	10.4	40	70	27375			
Th-228	1.913E+00	6.25E-04	20.0000	1	10.4	40	70	27375	7.7E-08	6.4E-04	4.0E-07
Th-230	7.538E+04	3.27E-04	20.0000	1	10.4	40	70	27375	3.1E-08	2.6E-04	8.4E-08
Th-232	1.450E+10	2.98E-05	20.0000	1	10.4	40	70	27375	3.1E-08	2.6E-04	7.7E-09
U-232	6.890E+01	5.30E-04	20.0000	1	10.4	40	70	27375			
U-234	2.450E+05	1.35E-04	20.0000	1	10.4	40	70	27375	2.7E-08	2.2E-04	3.0E-08
U-238	4.468E+09	3.69E-05	20.0000	1	10.4	40	70	27375	2.4E-08	2.0E-04	7.4E-09
Pu-238	8.774E+01	2.35E-04	20.0000	1	10.4	40	70	27375	4.2E-08	3.5E-04	8.2E-08
Pu-239	2.412E+04	4.40E-04	20.0000	1	10.4	40	70	27375	4.1E-08	3.4E-04	1.5E-07
Am-241	4.322E+02	1.88E-04	20.0000	1	10.4	40	70	27375	4.0E-08	3.3E-04	6.3E-08
Cm-244	1.810E+01	1.55E-04	20.0000	1	10.4	40	70	27375	2.7E-08	2.2E-04	3.5E-08
Total											1.3E-06

TRA WARM WASTE POND
INTERIM ACTION
INDUSTRIAL SCENARIO

INHALATION OF SOIL-CONTAMINATED AIR
CARCINOGENIC EFFECTS, RADIONUCLIDES

EXPOSURE: 40 HRS/WK, 50 WK/YR, 10 YRS

NUCLIDE	H-LIFE (Y)	23ug/m3 AIR (pCi/m3)	INH.RATE M3/D	%EXP.	EF D/YR	ED YEARS	BW KG	AT DAYS	INH. SF (pCi)-1	ADJ. UR (pCi/m3)-1	CANCER RISK
Cr-51	7.585E-02	2.22E-03	20.0000	1	83.3	10	70	27375	3.0E-13	5.0E-09	1.1E-11
Co-60	5.271E+00	1.06E-01	20.0000	1	83.3	10	70	27375	1.6E-10	2.7E-06	2.8E-07
Sr-90	2.860E+01	1.32E-02	20.0000	1	83.3	10	70	27375	5.6E-11	9.3E-07	1.2E-08
Ag-108m	1.270E+02	1.47E-03	20.0000	1	83.3	10	70	27375			
Cs-134	2.062E+00	1.03E-03	20.0000	1	83.3	10	70	27375	2.8E-11	4.7E-07	4.8E-10
Cs-137	3.017E+01	2.64E-01	20.0000	1	83.3	10	70	27375	1.9E-11	3.2E-07	8.4E-08
Eu-152	1.333E+01	2.45E-03	20.0000	1	83.3	10	70	27375	1.2E-08	2.0E-04	4.9E-07
Eu-154	8.800E+00	1.13E-03	20.0000	1	83.3	10	70	27375	1.4E-10	2.3E-06	2.6E-09
Eu-155	4.960E+00	2.22E-04	20.0000	1	83.3	10	70	27375			
Th-228	1.913E+00	6.25E-04	20.0000	1	83.3	10	70	27375	7.7E-08	1.3E-03	8.0E-07
Th-230	7.538E+04	3.27E-04	20.0000	1	83.3	10	70	27375	3.1E-08	5.2E-04	1.7E-07
Th-232	1.450E+10	2.98E-05	20.0000	1	83.3	10	70	27375	3.1E-08	5.2E-04	1.5E-08
U-232	6.890E+01	5.30E-04	20.0000	1	83.3	10	70	27375			
U-234	2.450E+05	1.35E-04	20.0000	1	83.3	10	70	27375	2.7E-08	4.5E-04	6.1E-08
U-238	4.468E+09	3.69E-05	20.0000	1	83.3	10	70	27375	2.4E-08	4.0E-04	1.5E-08
Pu-238	8.774E+01	2.35E-04	20.0000	1	83.3	10	70	27375	4.2E-08	7.0E-04	1.6E-07
Pu-239	2.412E+04	4.40E-04	20.0000	1	83.3	10	70	27375	4.1E-08	6.8E-04	3.0E-07
Am-241	4.322E+02	1.88E-04	20.0000	1	83.3	10	70	27375	4.0E-08	6.7E-04	1.3E-07
Cm-244	1.810E+01	1.55E-04	20.0000	1	83.3	10	70	27375	2.7E-08	4.5E-04	7.0E-08
Total											2.6E-06

TRA WARM WASTE POND
INTERIM ACTION
INDUSTRIAL SCENARIO

INHALATION OF SOIL-CONTAMINATED AIR
CARCINOGENIC EFFECTS, RADIONUCLIDES

EXPOSURE: 5 HRS/WK, 50 WK/YR, 10 YRS

NUCLIDE	H-LIFE (Y)	23ug/m3 AIR (pCi/m3)	INH.RATE M3/D	%EXP.	EF D/YR	ED YEARS	BW KG	AT DAYS	INH. SF (pCi)-1	ADJ. UR (pCi/m3)-1	CANCER RISK
Cr-51	7.585E-02	2.22E-03	20.0000	1	10.4	10	70	27375	3.0E-13	6.2E-10	1.4E-12
Co-60	5.271E+00	1.06E-01	20.0000	1	10.4	10	70	27375	1.6E-10	3.3E-07	3.5E-08
Sr-90	2.860E+01	1.32E-02	20.0000	1	10.4	10	70	27375	5.6E-11	1.2E-07	1.5E-09
Ag-108m	1.270E+02	1.47E-03	20.0000	1	10.4	10	70	27375			
Cs-134	2.062E+00	1.03E-03	20.0000	1	10.4	10	70	27375	2.8E-11	5.8E-08	6.0E-11
Cs-137	3.017E+01	2.64E-01	20.0000	1	10.4	10	70	27375	1.9E-11	4.0E-08	1.0E-08
Eu-152	1.333E+01	2.45E-03	20.0000	1	10.4	10	70	27375	1.2E-08	2.5E-05	6.1E-08
Eu-154	8.800E+00	1.13E-03	20.0000	1	10.4	10	70	27375	1.4E-10	2.9E-07	3.3E-10
Eu-155	4.960E+00	2.22E-04	20.0000	1	10.4	10	70	27375			
Th-228	1.913E+00	6.25E-04	20.0000	1	10.4	10	70	27375	7.7E-08	1.6E-04	1.0E-07
Th-230	7.538E+04	3.27E-04	20.0000	1	10.4	10	70	27375	3.1E-08	6.4E-05	2.1E-08
Th-232	1.450E+10	2.98E-05	20.0000	1	10.4	10	70	27375	3.1E-08	6.4E-05	1.9E-09
U-232	6.890E+01	5.30E-04	20.0000	1	10.4	10	70	27375			
U-234	2.450E+05	1.35E-04	20.0000	1	10.4	10	70	27375	2.7E-08	5.6E-05	7.6E-09
U-238	4.468E+09	3.69E-05	20.0000	1	10.4	10	70	27375	2.4E-08	5.0E-05	1.8E-09
Pu-238	8.774E+01	2.35E-04	20.0000	1	10.4	10	70	27375	4.2E-08	8.7E-05	2.1E-08
Pu-239	2.412E+04	4.40E-04	20.0000	1	10.4	10	70	27375	4.1E-08	8.5E-05	3.8E-08
Am-241	4.322E+02	1.88E-04	20.0000	1	10.4	10	70	27375	4.0E-08	8.3E-05	1.6E-08
Cm-244	1.810E+01	1.55E-04	20.0000	1	10.4	10	70	27375	2.7E-08	5.6E-05	8.7E-09
Total											3.2E-07

TRA WARM WASTE POND
INTERIM ACTION
INDUSTRIAL SCENARIO

INHALATION OF SOIL-CONTAMINATED AIR
CARCINOGENIC EFFECTS, RADIONUCLIDES

EXPOSURE: 40 HRS/WK, 50 WK/YR, 1 YR

NUCLIDE	H-LIFE (Y)	23ug/m3 AIR (pCi/m3)	INH.RATE M3/D	%EXP.	EF D/YR	ED YEARS	BW KG	AT DAYS	INH. SF (pCi)-1	ADJ. UR (pCi/m3)-1	CANCER RISK
Cr-51	7.585E-02	2.22E-03	20.0000	1	83.3	1	70	27375	3.0E-13	5.0E-10	1.1E-12
Co-60	5.271E+00	1.06E-01	20.0000	1	83.3	1	70	27375	1.6E-10	2.7E-07	2.8E-08
Sr-90	2.860E+01	1.32E-02	20.0000	1	83.3	1	70	27375	5.6E-11	9.3E-08	1.2E-09
Ag-108m	1.270E+02	1.47E-03	20.0000	1	83.3	1	70	27375			
Cs-134	2.062E+00	1.03E-03	20.0000	1	83.3	1	70	27375	2.8E-11	4.7E-08	4.8E-11
Cs-137	3.017E+01	2.64E-01	20.0000	1	83.3	1	70	27375	1.9E-11	3.2E-08	8.4E-09
Eu-152	1.333E+01	2.45E-03	20.0000	1	83.3	1	70	27375	1.2E-08	2.0E-05	4.9E-08
Eu-154	8.800E+00	1.13E-03	20.0000	1	83.3	1	70	27375	1.4E-10	2.3E-07	2.6E-10
Eu-155	4.960E+00	2.22E-04	20.0000	1	83.3	1	70	27375			
Th-228	1.913E+00	6.25E-04	20.0000	1	83.3	1	70	27375	7.7E-08	1.3E-04	8.0E-08
Th-230	7.538E+04	3.27E-04	20.0000	1	83.3	1	70	27375	3.1E-08	5.2E-05	1.7E-08
Th-232	1.450E+10	2.98E-05	20.0000	1	83.3	1	70	27375	3.1E-08	5.2E-05	1.5E-09
U-232	6.890E+01	5.30E-04	20.0000	1	83.3	1	70	27375			
U-234	2.450E+05	1.35E-04	20.0000	1	83.3	1	70	27375	2.7E-08	4.5E-05	6.1E-09
U-238	4.468E+09	3.69E-05	20.0000	1	83.3	1	70	27375	2.4E-08	4.0E-05	1.5E-09
Pu-238	8.774E+01	2.35E-04	20.0000	1	83.3	1	70	27375	4.2E-08	7.0E-05	1.6E-08
Pu-239	2.412E+04	4.40E-04	20.0000	1	83.3	1	70	27375	4.1E-08	6.8E-05	3.0E-08
Am-241	4.322E+02	1.88E-04	20.0000	1	83.3	1	70	27375	4.0E-08	6.7E-05	1.3E-08
Cm-244	1.810E+01	1.55E-04	20.0000	1	83.3	1	70	27375	2.7E-08	4.5E-05	7.0E-09
Total											2.6E-07

TRA WARM WASTE POND
INTERIM ACTION
INDUSTRIAL SCENARIO

INHALATION OF SOIL-CONTAMINATED AIR
CARCINOGENIC EFFECTS, RADIONUCLIDES

EXPOSURE: 5 HRS/WK, 50 WK/YR, 1 YR

NUCLIDE	H-LIFE (Y)	23ug/m3 AIR (pCi/m3)	INH.RATE M3/D	%EXP.	EF D/YR	ED YEARS	BW KG	AT DAYS	INH. SF (pCi)-1	ADJ. UR (pCi/m3)-1	CANCER RISK
Cr-51	7.585E-02	2.22E-03	20.0000	1	10.4	1	70	27375	3.0E-13	6.2E-11	1.4E-13
Co-60	5.271E+00	1.06E-01	20.0000	1	10.4	1	70	27375	1.6E-10	3.3E-08	3.5E-09
Sr-90	2.860E+01	1.32E-02	20.0000	1	10.4	1	70	27375	5.6E-11	1.2E-08	1.5E-10
Ag-108m	1.270E+02	1.47E-03	20.0000	1	10.4	1	70	27375			
Cs-134	2.062E+00	1.03E-03	20.0000	1	10.4	1	70	27375	2.8E-11	5.8E-09	6.0E-12
Cs-137	3.017E+01	2.64E-01	20.0000	1	10.4	1	70	27375	1.9E-11	4.0E-09	1.0E-09
Eu-152	1.333E+01	2.45E-03	20.0000	1	10.4	1	70	27375	1.2E-08	2.5E-06	6.1E-09
Eu-154	8.800E+00	1.13E-03	20.0000	1	10.4	1	70	27375	1.4E-10	2.9E-08	3.3E-11
Eu-155	4.960E+00	2.22E-04	20.0000	1	10.4	1	70	27375			
Th-228	1.913E+00	6.25E-04	20.0000	1	10.4	1	70	27375	7.7E-08	1.6E-05	1.0E-08
Th-230	7.538E+04	3.27E-04	20.0000	1	10.4	1	70	27375	3.1E-08	6.4E-06	2.1E-09
Th-232	1.450E+10	2.98E-05	20.0000	1	10.4	1	70	27375	3.1E-08	6.4E-06	1.9E-10
U-232	6.890E+01	5.30E-04	20.0000	1	10.4	1	70	27375			
U-234	2.450E+05	1.35E-04	20.0000	1	10.4	1	70	27375	2.7E-08	5.6E-06	7.6E-10
U-238	4.468E+09	3.69E-05	20.0000	1	10.4	1	70	27375	2.4E-08	5.0E-06	1.8E-10
Pu-238	8.774E+01	2.35E-04	20.0000	1	10.4	1	70	27375	4.2E-08	8.7E-06	2.1E-09
Pu-239	2.412E+04	4.40E-04	20.0000	1	10.4	1	70	27375	4.1E-08	8.5E-06	3.8E-09
Am-241	4.322E+02	1.88E-04	20.0000	1	10.4	1	70	27375	4.0E-08	8.3E-06	1.6E-09
Cm-244	1.810E+01	1.55E-04	20.0000	1	10.4	1	70	27375	2.7E-08	5.6E-06	8.7E-10
Total											3.2E-08

TRA WARM WASTE POND
INTERIM ACTION
INDUSTRIAL SCENARIO, 5 MREM/HR

EXTERNAL EXPOSURE, GROUND SURFACE
CARCINOGENIC EFFECTS, RADIONUCLIDES

EPA REGION 10, UPPER-BOUND CASE

NUCLIDE	SOIL CONC. (pCi/G)	SOIL DEPTH (M)	DENSITY G/M3	%EXP	EF D/YR	ED YEARS	EXT. SF	ADJ. UR (pCi/G)-1	CANCER RISK	DCF	SOIL CONC. uCi/M2	MREM/YR	MREM/HR	RATIO IN 5 MREM/HR	MREM/YR	pCi/G ESTIMATED	CANCER RISK
Cr-51	9.65E+01	0.1	1.8E+06	0.4	365	40	1.9E-12	5.5E-06	5.3E-04	3.41E+00	1.74E+01	5.92E+01	0.01	0.00			
Co-60	4.61E+03	0.1	1.8E+06	0.4	365	40	1.3E-10	3.7E-04	8.2E-01	2.27E+02	8.30E+02	1.88E+05	21.50	2.95	2.58E+04	6.32E+02	2.11E-01
Sr-90	5.73E+02	0.1	1.8E+06	0.4	365	40	0.0E+00	0.0E+00	0.0E+00	0.00E+00	1.03E+02	0.00E+00	0.00	0.00			
Ag-108m	6.37E+01	0.1	1.8E+06	0.4	365	40								0.00			
Cs-134	4.48E+01	0.1	1.8E+06	0.4	365	40	8.9E-11	2.6E-04	1.1E-02	1.58E+02	8.06E+00	1.27E+03	0.15	0.02	1.75E+02	6.15E+00	1.58E-03
Cs-137	1.15E+04	0.1	1.8E+06	0.4	365	40	3.4E-11	9.8E-05	6.8E-01	6.11E+01	2.07E+03	1.26E+05	14.44	1.98	1.73E+04	1.58E+03	1.43E-01
Eu-152	1.07E+02	0.1	1.8E+06	0.4	365	40	6.3E-11	1.8E-04	1.9E-02	1.11E+02	1.93E+01	2.14E+03	0.24	0.03	2.93E+02	1.47E+01	2.66E-03
Eu-154	4.92E+01	0.1	1.8E+06	0.4	365	40	6.8E-11	2.0E-04	9.6E-03	1.21E+02	8.86E+00	1.07E+03	0.12	0.02	1.47E+02	6.75E+00	1.32E-03
Eu-155	9.67E+00	0.1	1.8E+06	0.4	365	40								0.00			
Th-228	2.72E+01	0.1	1.8E+06	0.4	365	40	1.6E-13	4.6E-07	1.3E-05	2.77E-01	4.90E+00	1.36E+00	0.00	0.00			
Th-230	1.42E+01	0.1	1.8E+06	0.4	365	40	5.9E-14	1.7E-07	2.4E-06	9.07E-02	2.56E+00	2.32E-01	0.00	0.00			
Th-232	1.30E+00	0.1	1.8E+06	0.4	365	40	4.6E-14	1.3E-07	1.7E-07	6.66E-02	2.34E-01	1.56E-02	0.00	0.00			
U-232	2.30E+01	0.1	1.8E+06	0.4	365	40								0.00			
U-234	5.86E+00	0.1	1.8E+06	0.4	365	40	5.7E-14	1.6E-07	9.6E-07	8.07E-02	1.05E+00	8.51E-02	0.00	0.00			
U-238	1.61E+00	0.1	1.8E+06	0.4	365	40	4.6E-14	1.3E-07	2.1E-07	6.46E-02	2.90E-01	1.87E-02	0.00	0.00			
Pu-238	1.02E+01	0.1	1.8E+06	0.4	365	40	6.1E-14	1.8E-07	1.8E-06	8.58E-02	1.84E+00	1.58E-01	0.00	0.00			
Pu-239	1.91E+01	0.1	1.8E+06	0.4	365	40	2.6E-14	7.5E-08	1.4E-06	3.78E-02	3.44E+00	1.30E-01	0.00	0.00			
Am-241	8.19E+00	0.1	1.8E+06	0.4	365	40	1.6E-12	4.6E-06	3.8E-05	2.99E+00	1.47E+00	4.41E+00	0.00	0.00			
Cm-244	6.75E+00	0.1	1.8E+06	0.4	365	40	5.8E-14	1.7E-07	1.1E-06	8.29E-02	1.22E+00	1.01E-01	0.00	0.00			
Total													36.45				3.3E-01

TRA WARM WASTE POND
INTERIM ACTION
INDUSTRIAL SCENARIO, 5 MREM/HR

EXTERNAL EXPOSURE, GROUND SURFACE
CARCINOGENIC EFFECTS, RADIONUCLIDES

EPA REGION 10, AVERAGE CASE

NUCLIDE	SOIL CONC. (pCi/G)	SOIL DEPTH (M)	DENSITY G/M3	%EXP.	EF D/YR	ED YEARS	EXT. SF	ADJ. UR (pCi/G)-1	CANCER RISK	DCF	SOIL CONC. uCi/M2	MREM/YR	MREM/HR	RATIO IN 5 MREM/HR	MREM/YR	pCi/G ESTIMATED	CANCER RISK
Cr-51	9.65E+01	0.1	1.8E+06	0.25	365	10	1.9E-12	8.6E-07	8.3E-05	3.41E+00	1.74E+01	5.92E+01	0.01	0.00			
Co-60	4.61E+03	0.1	1.8E+06	0.25	365	10	1.3E-10	5.8E-05	2.4E-01	2.27E+02	8.30E+02	1.88E+05	21.50	2.95	2.58E+04	6.32E+02	3.63E-02
Sr-90	5.73E+02	0.1	1.8E+06	0.25	365	10	0.0E+00	0.0E+00	0.0E+00	0.00E+00	1.03E+02	0.00E+00	0.00	0.00			
Ag-108m	6.37E+01	0.1	1.8E+06	0.25	365	10								0.00			
Cs-134	4.48E+01	0.1	1.8E+06	0.25	365	10	8.9E-11	4.0E-05	1.8E-03	1.58E+02	8.06E+00	1.27E+03	0.15	0.02	1.75E+02	6.15E+00	2.46E-04
Cs-137	1.15E+04	0.1	1.8E+06	0.25	365	10	3.4E-11	1.5E-05	1.6E-01	6.11E+01	2.07E+03	1.26E+05	14.44	1.98	1.73E+04	1.58E+03	2.38E-02
Eu-152	1.07E+02	0.1	1.8E+06	0.25	365	10	6.3E-11	2.8E-05	3.0E-03	1.11E+02	1.93E+01	2.14E+03	0.24	0.03	2.93E+02	1.47E+01	4.16E-04
Eu-154	4.92E+01	0.1	1.8E+06	0.25	365	10	6.8E-11	3.1E-05	1.5E-03	1.21E+02	8.86E+00	1.07E+03	0.12	0.02	1.47E+02	6.75E+00	2.07E-04
Eu-155	9.67E+00	0.1	1.8E+06	0.25	365	10								0.00			
Th-228	2.72E+01	0.1	1.8E+06	0.25	365	10	1.6E-13	7.2E-08	2.0E-06	2.77E-01	4.90E+00	1.36E+00	0.00	0.00			
Th-230	1.42E+01	0.1	1.8E+06	0.25	365	10	5.9E-14	2.7E-08	3.8E-07	9.07E-02	2.56E+00	2.32E-01	0.00	0.00			
Th-232	1.30E+00	0.1	1.8E+06	0.25	365	10	4.6E-14	2.1E-08	2.7E-08	6.66E-02	2.34E-01	1.56E-02	0.00	0.00			
U-232	2.30E+01	0.1	1.8E+06	0.25	365	10								0.00			
U-234	5.86E+00	0.1	1.8E+06	0.25	365	10	5.7E-14	2.6E-08	1.5E-07	8.07E-02	1.05E+00	8.51E-02	0.00	0.00			
U-238	1.61E+00	0.1	1.8E+06	0.25	365	10	4.6E-14	2.1E-08	3.3E-08	6.46E-02	2.90E-01	1.87E-02	0.00	0.00			
Pu-238	1.02E+01	0.1	1.8E+06	0.25	365	10	6.1E-14	2.7E-08	2.8E-07	8.58E-02	1.84E+00	1.58E-01	0.00	0.00			
Pu-239	1.91E+01	0.1	1.8E+06	0.25	365	10	2.6E-14	1.2E-08	2.2E-07	3.78E-02	3.44E+00	1.30E-01	0.00	0.00			
Am-241	8.19E+00	0.1	1.8E+06	0.25	365	10	1.6E-12	7.2E-07	5.9E-06	2.99E+00	1.47E+00	4.41E+00	0.00	0.00			
Cm-244	6.75E+00	0.1	1.8E+06	0.25	365	10	5.8E-14	2.6E-08	1.8E-07	8.29E-02	1.22E+00	1.01E-01	0.00	0.00			
Total													36.45				6.1E-02

TRA WARM WASTE POND
INTERIM ACTION
INDUSTRIAL SCENARIO, 5 MREM/HR

EXTERNAL EXPOSURE, GROUND SURFACE
CARCINOGENIC EFFECTS, RADIONUCLIDES

EXPOSURE: 40 HRS/WK, 50 WK/YR, 40 YRS

NUCLIDE	SOIL CONC. (pCi/G)	SOIL DEPTH (M)	DENSITY G/M3	%EXP.	EF D/YR	ED YEARS	EXT. SF	ADJ. UR (pCi/G)-1	CANCER RISK	DCF	SOIL CONC. uCi/M2	MREM/YR	MREM/HR	RATIO IN 5 MREM/HR	MREM/YR	pCi/G ESTIMATED	CANCER RISK
Cr-51	9.65E+01	0.1	1.8E+06	0.23	365	40	1.9E-12	3.1E-06	3.0E-04	3.41E+00	1.74E+01	5.92E+01	0.01	0.00			
Co-60	4.61E+03	0.1	1.8E+06	0.23	365	40	1.3E-10	2.2E-04	6.3E-01	2.27E+02	8.30E+02	1.88E+05	21.50	2.95	2.58E+04	6.32E+02	1.27E-01
Sr-90	5.73E+02	0.1	1.8E+06	0.23	365	40	0.0E+00	0.0E+00	0.0E+00	0.00E+00	1.03E+02	0.00E+00	0.00	0.00			
Ag-108m	6.37E+01	0.1	1.8E+06	0.23	365	40								0.00			
Cs-134	4.48E+01	0.1	1.8E+06	0.23	365	40	8.9E-11	1.5E-04	6.6E-03	1.58E+02	8.06E+00	1.27E+03	0.15	0.02	1.75E+02	6.15E+00	9.06E-04
Cs-137	1.15E+04	0.1	1.8E+06	0.23	365	40	3.4E-11	5.6E-05	4.8E-01	6.11E+01	2.07E+03	1.26E+05	14.44	1.98	1.73E+04	1.58E+03	8.50E-02
Eu-152	1.07E+02	0.1	1.8E+06	0.23	365	40	6.3E-11	1.0E-04	1.1E-02	1.11E+02	1.93E+01	2.14E+03	0.24	0.03	2.93E+02	1.47E+01	1.53E-03
Eu-154	4.92E+01	0.1	1.8E+06	0.23	365	40	6.8E-11	1.1E-04	5.5E-03	1.21E+02	8.86E+00	1.07E+03	0.12	0.02	1.47E+02	6.75E+00	7.60E-04
Eu-155	9.67E+00	0.1	1.8E+06	0.23	365	40								0.00			
Th-228	2.72E+01	0.1	1.8E+06	0.23	365	40	1.6E-13	2.6E-07	7.2E-06	2.77E-01	4.90E+00	1.36E+00	0.00	0.00			
Th-230	1.42E+01	0.1	1.8E+06	0.23	365	40	5.9E-14	9.8E-08	1.4E-06	9.07E-02	2.56E+00	2.32E-01	0.00	0.00			
Th-232	1.30E+00	0.1	1.8E+06	0.23	365	40	4.6E-14	7.6E-08	9.9E-08	6.66E-02	2.34E-01	1.56E-02	0.00	0.00			
U-232	2.30E+01	0.1	1.8E+06	0.23	365	40								0.00			
U-234	5.86E+00	0.1	1.8E+06	0.23	365	40	5.7E-14	9.4E-08	5.5E-07	8.07E-02	1.05E+00	8.51E-02	0.00	0.00			
U-238	1.61E+00	0.1	1.8E+06	0.23	365	40	4.6E-14	7.6E-08	1.2E-07	6.46E-02	2.90E-01	1.87E-02	0.00	0.00			
Pu-238	1.02E+01	0.1	1.8E+06	0.23	365	40	6.1E-14	1.0E-07	1.0E-06	8.58E-02	1.84E+00	1.58E-01	0.00	0.00			
Pu-239	1.91E+01	0.1	1.8E+06	0.23	365	40	2.6E-14	4.3E-08	8.2E-07	3.78E-02	3.44E+00	1.30E-01	0.00	0.00			
Am-241	8.19E+00	0.1	1.8E+06	0.23	365	40	1.6E-12	2.6E-06	2.2E-05	2.99E+00	1.47E+00	4.41E+00	0.00	0.00			
Cm-244	6.75E+00	0.1	1.8E+06	0.23	365	40	5.8E-14	9.6E-08	6.5E-07	8.29E-02	1.22E+00	1.01E-01	0.00	0.00			
Total													36.45				2.2E-01

TRA WARM WASTE POND
INTERIM ACTION
INDUSTRIAL SCENARIO, 5 MREM/HR

EXTERNAL EXPOSURE, GROUND SURFACE
CARCINOGENIC EFFECTS, RADIONUCLIDES

EXPOSURE: 5 HRS/WK, 50 WK/YR, 40 YRS

NUCLIDE	SOIL CONC. (pCi/G)	SOIL DEPTH (M)	DENSITY G/M3	%EXP.	EF D/YR	ED YEARS	EXT. SF	ADJ. UR (pCi/G)-1	CANCER RISK	DCF	SOIL CONC. uCi/M2	MREM/YR	MREM/HR	RATIO IN 5 MREM/HR	MREM/YR	pCi/G ESTIMATED	CANCER RISK
Cr-51	9.65E+01	0.1	1.8E+06	0.03	365	40	1.9E-12	4.1E-07	4.0E-05	3.41E+00	1.74E+01	5.92E+01	0.01	0.00			
Co-60	4.61E+03	0.1	1.8E+06	0.03	365	40	1.3E-10	2.8E-05	1.2E-01	2.27E+02	8.30E+02	1.88E+05	21.50	2.95	2.58E+04	6.32E+02	1.76E-02
Sr-90	5.73E+02	0.1	1.8E+06	0.03	365	40	0.0E+00	0.0E+00	0.0E+00	0.00E+00	1.03E+02	0.00E+00	0.00	0.00			
Ag-108m	6.37E+01	0.1	1.8E+06	0.03	365	40								0.00			
Cs-134	4.48E+01	0.1	1.8E+06	0.03	365	40	8.9E-11	1.9E-05	8.6E-04	1.58E+02	8.06E+00	1.27E+03	0.15	0.02	1.75E+02	6.15E+00	1.18E-04
Cs-137	1.15E+04	0.1	1.8E+06	0.03	365	40	3.4E-11	7.3E-06	8.1E-02	6.11E+01	2.07E+03	1.26E+05	14.44	1.98	1.73E+04	1.58E+03	1.15E-02
Eu-152	1.07E+02	0.1	1.8E+06	0.03	365	40	6.3E-11	1.4E-05	1.5E-03	1.11E+02	1.93E+01	2.14E+03	0.24	0.03	2.93E+02	1.47E+01	2.00E-04
Eu-154	4.92E+01	0.1	1.8E+06	0.03	365	40	6.8E-11	1.5E-05	7.2E-04	1.21E+02	8.86E+00	1.07E+03	0.12	0.02	1.47E+02	6.75E+00	9.91E-05
Eu-155	9.67E+00	0.1	1.8E+06	0.03	365	40								0.00			
Th-228	2.72E+01	0.1	1.8E+06	0.03	365	40	1.6E-13	3.5E-08	9.4E-07	2.77E-01	4.90E+00	1.36E+00	0.00	0.00			
Th-230	1.42E+01	0.1	1.8E+06	0.03	365	40	5.9E-14	1.3E-08	1.8E-07	9.07E-02	2.56E+00	2.32E-01	0.00	0.00			
Th-232	1.30E+00	0.1	1.8E+06	0.03	365	40	4.6E-14	9.9E-09	1.3E-08	6.66E-02	2.34E-01	1.56E-02	0.00	0.00			
U-232	2.30E+01	0.1	1.8E+06	0.03	365	40								0.00			
U-234	5.86E+00	0.1	1.8E+06	0.03	365	40	5.7E-14	1.2E-08	7.2E-08	8.07E-02	1.05E+00	8.51E-02	0.00	0.00			
U-238	1.61E+00	0.1	1.8E+06	0.03	365	40	4.6E-14	9.9E-09	1.6E-08	6.46E-02	2.90E-01	1.87E-02	0.00	0.00			
Pu-238	1.02E+01	0.1	1.8E+06	0.03	365	40	6.1E-14	1.3E-08	1.3E-07	8.58E-02	1.84E+00	1.58E-01	0.00	0.00			
Pu-239	1.91E+01	0.1	1.8E+06	0.03	365	40	2.6E-14	5.6E-09	1.1E-07	3.78E-02	3.44E+00	1.30E-01	0.00	0.00			
Am-241	8.19E+00	0.1	1.8E+06	0.03	365	40	1.6E-12	3.5E-07	2.8E-06	2.99E+00	1.47E+00	4.41E+00	0.00	0.00			
Cm-244	6.75E+00	0.1	1.8E+06	0.03	365	40	5.8E-14	1.3E-08	8.5E-08	8.29E-02	1.22E+00	1.01E-01	0.00	0.00			
Total													36.45				3.0E-02

TRA WARM WASTE POND
INTERIM ACTION
INDUSTRIAL SCENARIO, 5 MREM/HR

EXTERNAL EXPOSURE, GROUND SURFACE
CARCINOGENIC EFFECTS, RADIONUCLIDES

EXPOSURE: 40 HRS/WK, 50 WK/YR, 10 YRS

NUCLIDE	SOIL CONC. (pCi/G)	SOIL DEPTH (M)	DENSITY G/M3	%EXP.	EF D/YR	ED YEARS	EXT. SF	ADJ. UR (pCi/G)-1	CANCER RISK	DCF	SOIL CONC. uCi/M2	MREM/YR	MREM/HR	RATIO IN 5 MREM/HR	MREM/YR	pCi/G ESTIMATED	CANCER RISK
Cr-51	9.65E+01	0.1	1.8E+06	0.23	365	10	1.9E-12	7.9E-07	7.6E-05	3.41E+00	1.74E+01	5.92E+01	0.01	0.00			
Co-60	4.61E+03	0.1	1.8E+06	0.23	365	10	1.3E-10	5.4E-05	2.2E-01	2.27E+02	8.30E+02	1.88E+05	21.50	2.95	2.58E+04	6.32E+02	3.35E-02
Sr-90	5.73E+02	0.1	1.8E+06	0.23	365	10	0.0E+00	0.0E+00	0.0E+00	0.00E+00	1.03E+02	0.00E+00	0.00	0.00			
Ag-108m	6.37E+01	0.1	1.8E+06	0.23	365	10								0.00			
Cs-134	4.48E+01	0.1	1.8E+06	0.23	365	10	8.9E-11	3.7E-05	1.6E-03	1.58E+02	8.06E+00	1.27E+03	0.15	0.02	1.75E+02	6.15E+00	2.26E-04
Cs-137	1.15E+04	0.1	1.8E+06	0.23	365	10	3.4E-11	1.4E-05	1.5E-01	6.11E+01	2.07E+03	1.26E+05	14.44	1.98	1.73E+04	1.58E+03	2.20E-02
Eu-152	1.07E+02	0.1	1.8E+06	0.23	365	10	6.3E-11	2.6E-05	2.8E-03	1.11E+02	1.93E+01	2.14E+03	0.24	0.03	2.93E+02	1.47E+01	3.83E-04
Eu-154	4.92E+01	0.1	1.8E+06	0.23	365	10	6.8E-11	2.8E-05	1.4E-03	1.21E+02	8.86E+00	1.07E+03	0.12	0.02	1.47E+02	6.75E+00	1.90E-04
Eu-155	9.67E+00	0.1	1.8E+06	0.23	365	10								0.00			
Th-228	2.72E+01	0.1	1.8E+06	0.23	365	10	1.6E-13	6.6E-08	1.8E-06	2.77E-01	4.90E+00	1.36E+00	0.00	0.00			
Th-230	1.42E+01	0.1	1.8E+06	0.23	365	10	5.9E-14	2.4E-08	3.5E-07	9.07E-02	2.56E+00	2.32E-01	0.00	0.00			
Th-232	1.30E+00	0.1	1.8E+06	0.23	365	10	4.6E-14	1.9E-08	2.5E-08	6.66E-02	2.34E-01	1.56E-02	0.00	0.00			
U-232	2.30E+01	0.1	1.8E+06	0.23	365	10								0.00			
U-234	5.86E+00	0.1	1.8E+06	0.23	365	10	5.7E-14	2.4E-08	1.4E-07	8.07E-02	1.05E+00	8.51E-02	0.00	0.00			
U-238	1.61E+00	0.1	1.8E+06	0.23	365	10	4.6E-14	1.9E-08	3.1E-08	6.46E-02	2.90E-01	1.87E-02	0.00	0.00			
Pu-238	1.02E+01	0.1	1.8E+06	0.23	365	10	6.1E-14	2.5E-08	2.6E-07	8.58E-02	1.84E+00	1.58E-01	0.00	0.00			
Pu-239	1.91E+01	0.1	1.8E+06	0.23	365	10	2.6E-14	1.1E-08	2.1E-07	3.78E-02	3.44E+00	1.30E-01	0.00	0.00			
Am-241	8.19E+00	0.1	1.8E+06	0.23	365	10	1.6E-12	6.6E-07	5.4E-06	2.99E+00	1.47E+00	4.41E+00	0.00	0.00			
Cm-244	6.75E+00	0.1	1.8E+06	0.23	365	10	5.8E-14	2.4E-08	1.6E-07	8.29E-02	1.22E+00	1.01E-01	0.00	0.00			
Total													36.45				5.6E-02

TRA WARM WASTE POND
INTERIM ACTION
INDUSTRIAL SCENARIO, 5 MREM/HR

EXTERNAL EXPOSURE, GROUND SURFACE
CARCINOGENIC EFFECTS, RADIONUCLIDES

EXPOSURE: 5 HRS/WK, 50 WK/YR, 10 YRS

NUCLIDE	SOIL CONC. (pCi/G)	SOIL DEPTH (M)	DENSITY G/M3	%EXP.	EF D/YR	ED YEARS	EXT. SF	ADJ. UR (pCi/G)-1	CANCER RISK	DCF	SOIL CONC. uCi/M2	MREM/YR	MREM/HR	RATIO IN 5 MREM/HR	MREM/YR	pCi/G ESTIMATED	CANCER RISK
Cr-51	9.65E+01	0.1	1.8E+06	0.03	365	10	1.9E-12	1.0E-07	9.9E-06	3.41E+00	1.74E+01	5.92E+01	0.01	0.00			
Co-60	4.61E+03	0.1	1.8E+06	0.03	365	10	1.3E-10	7.0E-06	3.2E-02	2.27E+02	8.30E+02	1.88E+05	21.50	2.95	2.58E+04	6.32E+02	4.44E-03
Sr-90	5.73E+02	0.1	1.8E+06	0.03	365	10	0.0E+00	0.0E+00	0.0E+00	0.00E+00	1.03E+02	0.00E+00	0.00	0.00			
Ag-108m	6.37E+01	0.1	1.8E+06	0.03	365	10								0.00			
Cs-134	4.48E+01	0.1	1.8E+06	0.03	365	10	8.9E-11	4.8E-06	2.2E-04	1.58E+02	8.06E+00	1.27E+03	0.15	0.02	1.75E+02	6.15E+00	2.95E-05
Cs-137	1.15E+04	0.1	1.8E+06	0.03	365	10	3.4E-11	1.8E-06	2.1E-02	6.11E+01	2.07E+03	1.26E+05	14.44	1.98	1.73E+04	1.58E+03	2.90E-03
Eu-152	1.07E+02	0.1	1.8E+06	0.03	365	10	6.3E-11	3.4E-06	3.6E-04	1.11E+02	1.93E+01	2.14E+03	0.24	0.03	2.93E+02	1.47E+01	4.99E-05
Eu-154	4.92E+01	0.1	1.8E+06	0.03	365	10	6.8E-11	3.7E-06	1.8E-04	1.21E+02	8.86E+00	1.07E+03	0.12	0.02	1.47E+02	6.75E+00	2.48E-05
Eu-155	9.67E+00	0.1	1.8E+06	0.03	365	10								0.00			
Th-228	2.72E+01	0.1	1.8E+06	0.03	365	10	1.6E-13	8.6E-09	2.4E-07	2.77E-01	4.90E+00	1.36E+00	0.00	0.00			
Th-230	1.42E+01	0.1	1.8E+06	0.03	365	10	5.9E-14	3.2E-09	4.5E-08	9.07E-02	2.56E+00	2.32E-01	0.00	0.00			
Th-232	1.30E+00	0.1	1.8E+06	0.03	365	10	4.6E-14	2.5E-09	3.2E-09	6.66E-02	2.34E-01	1.56E-02	0.00	0.00			
U-232	2.30E+01	0.1	1.8E+06	0.03	365	10								0.00			
U-234	5.86E+00	0.1	1.8E+06	0.03	365	10	5.7E-14	3.1E-09	1.8E-08	8.07E-02	1.05E+00	8.51E-02	0.00	0.00			
U-238	1.61E+00	0.1	1.8E+06	0.03	365	10	4.6E-14	2.5E-09	4.0E-09	6.46E-02	2.90E-01	1.87E-02	0.00	0.00			
Pu-238	1.02E+01	0.1	1.8E+06	0.03	365	10	6.1E-14	3.3E-09	3.4E-08	8.58E-02	1.84E+00	1.58E-01	0.00	0.00			
Pu-239	1.91E+01	0.1	1.8E+06	0.03	365	10	2.6E-14	1.4E-09	2.7E-08	3.78E-02	3.44E+00	1.30E-01	0.00	0.00			
Am-241	8.19E+00	0.1	1.8E+06	0.03	365	10	1.6E-12	8.6E-08	7.1E-07	2.99E+00	1.47E+00	4.41E+00	0.00	0.00			
Cm-244	6.75E+00	0.1	1.8E+06	0.03	365	10	5.8E-14	3.1E-09	2.1E-08	8.29E-02	1.22E+00	1.01E-01	0.00	0.00			
Total													36.45				7.4E-03

TRA WARM WASTE POND
INTERIM ACTION
INDUSTRIAL SCENARIO, 5 MREM/HR

EXTERNAL EXPOSURE, GROUND SURFACE
CARCINOGENIC EFFECTS, RADIONUCLIDES

EXPOSURE: 40 HRS/WK, 50 WK/YR, 1 YR

NUCLIDE	SOIL CONC. (pCi/G)	SOIL DEPTH (M)	DENSITY G/M3	%EXP.	EF D/YR	ED YEARS	EXT. SF	ADJ. UR (pCi/G)-1	CANCER RISK	DCF	SOIL CONC. uCi/M2	MREM/YR	MREM/HR	RATIO IN 5 MREM/HR	MREM/YR	pCi/G ESTIMATED	CANCER RISK
Cr-51	9.65E+01	0.1	1.8E+06	0.23	365	1	1.9E-12	7.9E-08	7.6E-06	3.41E+00	1.74E+01	5.92E+01	0.01	0.00			
Co-60	4.61E+03	0.1	1.8E+06	0.23	365	1	1.3E-10	5.4E-06	2.5E-02	2.27E+02	8.30E+02	1.88E+05	21.50	2.95	2.58E+04	6.32E+02	3.40E-03
Sr-90	5.73E+02	0.1	1.8E+06	0.23	365	1	0.0E+00	0.0E+00	0.0E+00	0.00E+00	1.03E+02	0.00E+00	0.00	0.00			
Ag-108m	6.37E+01	0.1	1.8E+06	0.23	365	1								0.00			
Cs-134	4.48E+01	0.1	1.8E+06	0.23	365	1	8.9E-11	3.7E-06	1.7E-04	1.58E+02	8.06E+00	1.27E+03	0.15	0.02	1.75E+02	6.15E+00	2.26E-05
Cs-137	1.15E+04	0.1	1.8E+06	0.23	365	1	3.4E-11	1.4E-06	1.6E-02	6.11E+01	2.07E+03	1.26E+05	14.44	1.98	1.73E+04	1.58E+03	2.22E-03
Eu-152	1.07E+02	0.1	1.8E+06	0.23	365	1	6.3E-11	2.6E-06	2.8E-04	1.11E+02	1.93E+01	2.14E+03	0.24	0.03	2.93E+02	1.47E+01	3.83E-05
Eu-154	4.92E+01	0.1	1.8E+06	0.23	365	1	6.8E-11	2.8E-06	1.4E-04	1.21E+02	8.86E+00	1.07E+03	0.12	0.02	1.47E+02	6.75E+00	1.90E-05
Eu-155	9.67E+00	0.1	1.8E+06	0.23	365	1								0.00			
Th-228	2.72E+01	0.1	1.8E+06	0.23	365	1	1.6E-13	6.6E-09	1.8E-07	2.77E-01	4.90E+00	1.36E+00	0.00	0.00			
Th-230	1.42E+01	0.1	1.8E+06	0.23	365	1	5.9E-14	2.4E-09	3.5E-08	9.07E-02	2.56E+00	2.32E-01	0.00	0.00			
Th-232	1.30E+00	0.1	1.8E+06	0.23	365	1	4.6E-14	1.9E-09	2.5E-09	6.66E-02	2.34E-01	1.56E-02	0.00	0.00			
U-232	2.30E+01	0.1	1.8E+06	0.23	365	1								0.00			
U-234	5.86E+00	0.1	1.8E+06	0.23	365	1	5.7E-14	2.4E-09	1.4E-08	8.07E-02	1.05E+00	8.51E-02	0.00	0.00			
U-238	1.61E+00	0.1	1.8E+06	0.23	365	1	4.6E-14	1.9E-09	3.1E-09	6.46E-02	2.90E-01	1.87E-02	0.00	0.00			
Pu-238	1.02E+01	0.1	1.8E+06	0.23	365	1	6.1E-14	2.5E-09	2.6E-08	8.58E-02	1.84E+00	1.58E-01	0.00	0.00			
Pu-239	1.91E+01	0.1	1.8E+06	0.23	365	1	2.6E-14	1.1E-09	2.1E-08	3.78E-02	3.44E+00	1.30E-01	0.00	0.00			
Am-241	8.19E+00	0.1	1.8E+06	0.23	365	1	1.6E-12	6.6E-08	5.4E-07	2.99E+00	1.47E+00	4.41E+00	0.00	0.00			
Cm-244	6.75E+00	0.1	1.8E+06	0.23	365	1	5.8E-14	2.4E-09	1.6E-08	8.29E-02	1.22E+00	1.01E-01	0.00	0.00			
Total													36.45				5.7E-03

TRA WARM WASTE POND
INTERIM ACTION
INDUSTRIAL SCENARIO, 5 MREM/HR

EXTERNAL EXPOSURE, GROUND SURFACE
CARCINOGENIC EFFECTS, RADIONUCLIDES

EXPOSURE: 5 HRS/WK, 50 WK/YR, 1 YR

NUCLIDE	SOIL CONC. (pCi/G)	SOIL DEPTH (M)	DENSITY G/M3	%EXP.	EF D/YR	ED YEARS	EXT. SF	ADJ. UR (pCi/G)-1	CANCER RISK	DCF	SOIL CONC. uCi/M2	MREM/YR	MREM/HR	RATIO IN 5 MREM/HR	MREM/YR	pCi/G ESTIMATED	CANCER RISK
Cr-51	9.65E+01	0.1	1.8E+06	0.03	365	1	1.9E-12	1.0E-08	9.9E-07	3.41E+00	1.74E+01	5.92E+01	0.01	0.00			
Co-60	4.61E+03	0.1	1.8E+06	0.03	365	1	1.3E-10	7.0E-07	3.2E-03	2.27E+02	8.30E+02	1.88E+05	21.50	2.95	2.58E+04	6.32E+02	4.44E-04
Sr-90	5.73E+02	0.1	1.8E+06	0.03	365	1	0.0E+00	0.0E+00	0.0E+00	0.00E+00	1.03E+02	0.00E+00	0.00	0.00			
Ag-108m	6.37E+01	0.1	1.8E+06	0.03	365	1		0.0E+00						0.00			
Cs-134	4.48E+01	0.1	1.8E+06	0.03	365	1	8.9E-11	4.8E-07	2.2E-05	1.58E+02	8.06E+00	1.27E+03	0.15	0.02	1.75E+02	6.15E+00	2.95E-06
Cs-137	1.15E+04	0.1	1.8E+06	0.03	365	1	3.4E-11	1.8E-07	2.1E-03	6.11E+01	2.07E+03	1.26E+05	14.44	1.98	1.73E+04	1.58E+03	2.90E-04
Eu-152	1.07E+02	0.1	1.8E+06	0.03	365	1	6.3E-11	3.4E-07	3.6E-05	1.11E+02	1.93E+01	2.14E+03	0.24	0.03	2.93E+02	1.47E+01	4.99E-06
Eu-154	4.92E+01	0.1	1.8E+06	0.03	365	1	6.8E-11	3.7E-07	1.8E-05	1.21E+02	8.86E+00	1.07E+03	0.12	0.02	1.47E+02	6.75E+00	2.48E-06
Eu-155	9.67E+00	0.1	1.8E+06	0.03	365	1		0.0E+00						0.00			
Th-228	2.72E+01	0.1	1.8E+06	0.03	365	1	1.6E-13	8.6E-10	2.4E-08	2.77E-01	4.90E+00	1.36E+00	0.00	0.00			
Th-230	1.42E+01	0.1	1.8E+06	0.03	365	1	5.9E-14	3.2E-10	4.5E-09	9.07E-02	2.56E+00	2.32E-01	0.00	0.00			
Th-232	1.30E+00	0.1	1.8E+06	0.03	365	1	4.6E-14	2.5E-10	3.2E-10	6.66E-02	2.34E-01	1.56E-02	0.00	0.00			
U-232	2.30E+01	0.1	1.8E+06	0.03	365	1		0.0E+00						0.00			
U-234	5.86E+00	0.1	1.8E+06	0.03	365	1	5.7E-14	3.1E-10	1.8E-09	8.07E-02	1.05E+00	8.51E-02	0.00	0.00			
U-238	1.61E+00	0.1	1.8E+06	0.03	365	1	4.6E-14	2.5E-10	4.0E-10	6.46E-02	2.90E-01	1.87E-02	0.00	0.00			
Pu-238	1.02E+01	0.1	1.8E+06	0.03	365	1	6.1E-14	3.3E-10	3.4E-09	8.58E-02	1.84E+00	1.58E-01	0.00	0.00			
Pu-239	1.91E+01	0.1	1.8E+06	0.03	365	1	2.6E-14	1.4E-10	2.7E-09	3.78E-02	3.44E+00	1.30E-01	0.00	0.00			
Am-241	8.19E+00	0.1	1.8E+06	0.03	365	1	1.6E-12	8.6E-09	7.1E-08	2.99E+00	1.47E+00	4.41E+00	0.00	0.00			
Cm-244	6.75E+00	0.1	1.8E+06	0.03	365	1	5.8E-14	3.1E-10	2.1E-09	8.29E-02	1.22E+00	1.01E-01	0.00	0.00			
Total													36.45				7.4E-04

APPENDIX I-C

RISK ASSESSMENT EVALUATION OF INGESTION OF SOIL

FOR A FUTURE RESIDENTIAL SCENARIO AT THE

TRA WARM WASTE POND (OU-2-10)

A risk assessment evaluation was conducted to determine the potential risks associated with the ingestion of contaminated soils at the TRA Warm Waste Pond. The potential scenario consisted of a residential receptor which is assumed to reside at the operable unit after 100 years (e.g. after institutional control).

The concentrations of contaminants used in this evaluation were based on previously obtained sampling data which were shown in Table I-1 of this report. The concentrations of radionuclides were corrected for radioactive decay to establish contaminant concentrations after 100 years.

The exposure assessment followed the revised EPA guidelines for default exposure parameters[1]. The toxicity values used in the evaluation of noncarcinogenic and carcinogenic effects were obtained from the HEAST[2] except for lead. The ingestion reference dose for lead was derived from the EPA drinking water maximum contaminant level. The risk assessment procedures used in the evaluation of ingestion of soil followed EPA guidelines[3].

The concentrations of the evaluated contaminants (after 100 years) and the parameters of the risk assessment are shown in Tables C-1 and C-2. All the hazard quotients for the evaluated chemicals were less than one, which indicate that no adverse health effects (noncarcinogenic effects) are expected from the ingestion of soil for the residential receptor. The resulting noncarcinogenic hazard index (combined chemicals) was 4.60E-01, which is also below the level of concern for noncarcinogenic effects. The carcinogenic risks for the chemicals and radionuclides were below 1.0E-04. The combined cancer risk was 2.92E-05 for chemicals and 3.96E-05 for the radionuclides. This means that the cancer risk for ingestion of soil is within the accepted National Contingency Plan (NCP) target risk range of 10-4 to 10-6. Individual and combined risk results are shown in Tables C-1 and C-2.

TABLE C-1. CONCENTRATIONS OF CHEMICALS AND PARAMETERS USED IN THE RISK ASSESSMENT OF INGESTION OF SOIL (RESIDENTIAL SCENARIO) FOR THE TRA WARM WASTE POND.

NONCARCINOGENIC EFFECTS

	ING. RATE G/D	EF DAYS/YR	ED YEARS	BW KG	AT DAYS	INTAKE G/KG/D
CHILD EXPOSURE	0.2	350	6	15	2190	1.28E-02
ADULT EXPOSURE	0.1	350	24	70	8760	1.37E-03
TOTAL EXPOSURE (CHILD AND ADULT)						1.42E-02

CHEMICAL	SOIL CONC. MG/G	TOTAL INTAKE G/KG/D	TOTAL INTAKE MG/KG/D	ING. RfD MG/KG/D	HI
AS	5.25E-03	1.42E-02	7.46E-05	1.00E-03	7.46E-02
BE	2.20E-03	1.42E-02	3.12E-05	5.00E-03	6.25E-03
BIS*	1.49E-03	1.42E-02	2.12E-05	2.00E-02	1.06E-03
CD	3.12E-03	1.42E-02	4.43E-05	1.00E-03	4.43E-02
CR-III	3.38E-01	1.42E-02	4.80E-03	1.00E+00	4.80E-03
CYANIDE	9.83E-04	1.42E-02	1.40E-05	2.00E-02	6.98E-04
HG	2.69E-03	1.42E-02	3.82E-05	3.00E-04	1.27E-01
PB	1.78E-02	1.42E-02	2.53E-04	1.40E-03	1.81E-01
AG	2.19E-03	1.42E-02	3.11E-05	3.00E-03	1.04E-02
ZN	1.43E-01	1.42E-02	2.03E-03	2.00E-01	1.02E-02
TOTAL HI ---------->					4.60E-01

CARCINOGENIC EFFECTS

	ING. RATE G/D	EF DAYS/YR	ED YEARS	BW KG	INTAKE G/KG
CHILD EXPOSURE	0.2	350	6	15	2.80E+01
ADULT EXPOSURE	0.1	350	24	70	1.20E+01
TOTAL EXPOSURE (CHILD AND ADULT)					4.00E+01

CARCINOGENIC EFFECTS

CHEMICAL	SOIL CONC. MG/G	TOTAL INTAKE G/KG	AT DAYS	TOTAL INTAKE MG/KG/D	ING. SF MG/KG/D-1	CANCER RISK
AS	5.25E-03	4.00E+01	25550	8.22E-06	1.75E+00	1.44E-05
BE	2.20E-03	4.00E+01	25550	3.44E-06	4.30E+00	1.48E-05
BIS*	1.49E-03	4.00E+01	25550	2.33E-06	1.40E-02	3.27E-08
TOTAL CANCER RISK (CHEMICALS) ---------->						2.92E-05

*BIS = Bis(2-ethylhexyl)phthalate

TABLE C-2. CONCENTRATIONS OF RADIONUCLIDES AND PARAMETERS USED IN THE RISK ASSESSMENT OF INGESTION OF SOIL (RESIDENTIAL SCENARIO) FOR THE TRA WARM WASTE POND.

CARCINOGENIC EFFECTS

	ING. RATE G/D	EF DAYS/YR	ED YEARS	SOIL INGESTION G
CHILD EXPOSURE	0.2	350	6	4.20E+02
ADULT EXPOSURE	0.1	350	24	8.40E+02
TOTAL EXPOSURE (CHILD AND ADULT)				1.26E+03

RAD.	CONC. pCi/G	TOTAL INTAKE G	GI FACTOR	ING. SF pCi -1	UNIT RISK pCi/G -1	CANCER RISK
CR-51	0.000E+00	1.26E+03	1.00E-01	4.20E-14	5.29E-11	0.00E+00
CO-60	9.000E-03	1.26E+03	3.00E-01	1.50E-11	1.89E-08	5.10E-11
SR-90	5.077E+01	1.26E+03	3.00E-01	3.30E-11	4.16E-08	6.33E-07
CS-134	0.000E+00	1.26E+03	9.50E-01	4.20E-11	5.29E-08	0.00E+00
CS-137	1.156E+03	1.26E+03	9.50E-01	2.80E-11	3.53E-08	3.87E-05
EU-152	6.550E-01	1.26E+03	1.00E-02	2.10E-12	2.65E-09	1.73E-11
EU-154	1.900E-02	1.26E+03	1.00E-02	3.00E-12	3.78E-09	7.18E-13
TH-228	1.032E+01	1.26E+03	2.00E-04	1.50E-11	1.89E-08	3.90E-11
TH-230	1.419E+01	1.26E+03	2.00E-04	2.40E-11	3.02E-08	8.58E-11
TH-232	1.300E+00	1.26E+03	2.00E-04	2.20E-11	2.77E-08	7.21E-12
U-234	5.860E+00	1.26E+03	2.00E-01	1.40E-10	1.76E-07	2.07E-07
U-238	1.610E+00	1.26E+03	2.00E-01	1.30E-10	1.64E-07	5.27E-08
PU-238	4.630E+00	1.26E+03	1.00E-03	2.80E-10	3.53E-07	1.63E-09
PU-239	1.904E+01	1.26E+03	1.00E-04	3.10E-11	3.91E-08	7.44E-11
AM-241	6.976E+00	1.26E+03	1.00E-03	3.10E-10	3.91E-07	2.72E-09
CM-244	1.470E-01	1.26E+03	1.00E-03	2.00E-10	2.52E-07	3.70E-11
TOTAL CANCER RISK (RADIONUCLIDES)				---------->		3.96E-05

REFERENCES FOR APPENDIX I-C

1. U.S. Environmental Protection Agency, "Standard Default Exposure Parameters," Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual, Supplemental Guidance, OSWER Directive 9285.6-03, March 25, 1991.

2. U.S. Environmental Protection Agency, Human Effects Summary Tables, Third Quarter, FY-1990, July 1990.

3. U.S. Environmental Protection Agency, Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual, EPA/540/1-89/002), December 1989.

INTERIM-ACTION RISK ASSESSMENT FOR THE TEST REACTOR AREA (TRA)

WARM WASTE LEACH POND SEDIMENTS

(OU-2-10)

II. ECOLOGICAL ASSESSMENT

INTERIM-ACTION RISK ASSESSMENT FOR
THE TEST REACTOR AREA WARM WASTE LEACH POND
(OU-2-10)

II. ECOLOGICAL ASSESSMENT

1. INTRODUCTION

Ecological assessment is a qualitative and quantitative evaluation of the actual or potential effects of a hazardous waste site on plants and wildlife. The ecological assessment parallels the human health assessment, in that data on exposure and toxicity are combined to estimate the impact to the environment. Ecological risk evaluation will determine risk to populations of organisms. Individual risks will be evaluated only in cases where a species has been categorized as endangered, threatened, rare, sensitive, or where habitat has been designated as sensitive. Relevant toxicity data will be quantified at an individual level. Extrapolation from individual effects will determine the effects to a population of organisms. This ecological evaluation follows the EPA Risk Assessment Guidance for Superfund, Volume 1; Human Health Evaluation Manual,[1] and Volume 2; Environmental Evaluation Manual,[2] and Interagency Agreement.

The purpose of the ecological assessment is to provide an interim-action risk assessment for the TRA Warm Waste Ponds. This ecological section contains five parts: characterization of the operable unit (TRA-WWP 10-2), exposure assessment, toxicity assessment, risk characterization, and uncertainties evaluation. Characterization of the operable unit is an overview of the potential species and habitat that may be impacted by contaminants. The exposure assessment identifies the amount of contaminants organisms are actually or potentially exposed to, and the significant routes of exposure. The toxicity assessment identifies the potential contaminants and the effects of the contaminants. The risk characterization evaluates the risk of contaminants to populations of organisms. Uncertainties of the risk assessment briefly discusses the limitations of this evaluation. Each is an integral part of the assessment process.

2. SITE CHARACTERIZATION

The warm waste ponds are located in a semi-arid desert environment on the eastern end of the predominantly level Snake River Plain. The majority of the soil at the site is poorly sorted gavels, gravelly sands, and sands with some fine-grained materials. The Big Lost River, Little Lost River, and Birch Creek drain the mountain watersheds located north and northwest of the INEL. Flood diversion dams were built to divert flooding of the INEL facilities. The TRA-WWP were originally constructed in 1952 and expanded in 1957 and 1964. The ponds are used primarily to dispose of low-level radioactive waste water from operating reactors. In the past they have also received cooling water blowdown, ion-exchange and water softener regenerated wastes, and other cold and warm wastes from laboratory and support buildings at TRA. For the purposes of this evaluation, the conditions at the waste disposal area are as follows: pond 64 is dry; pond 52 is one-third full, and pond 57 is full.

TRA is characterized as located within a cold-desert region of the Great Basin of the Snake River Plain. The vegetation of the operable unit is typical of a semi-arid desert environment. Big sagebrush (Artemisia tridentata) dominates the INEL vegetation. Bottlebrush squiretail (Sitanion hystrix), winterfat (Eurotia lanata), needle-and-thread (Stipa comata), and bluebunch wheatgrass (Agropyron spicatum) are examples of the more frequently occurring understory species[3].

Small mammals were reported to be the most frequently occurring wildlife inhabiting the INEL[4]. The deer mouse (Peromyscus maniculatus) was reported by Markham (see Reference 4) to be the most abundant small mammal. Other common small mammal species include montane vole (Microtus montanus), Ord's kangaroo rat (Dipodomys ordii), Townsend's ground squirrel (Spermophilus townsendii), and least chipmunk (Eutamias minimus). Small mammal populations are suggested to be an important food source for snakes, predatory mammals, and birds of desert environments. Other mammals reported sighted at the TRA area are coyotes (Canis latrans), pronghorn (Antilocapra americana), mule deer (Odocoioeus hemionus), pygmy rabbit (Sylvilagus idahoensis), and mountain cottontail (Sylvilagus nuttalli)[5].

The INEL area supports a variety of raptor, sport, and passerine birds. Rough legged hawk (Buteo lagopus) is the most frequently observed raptor on site. Bald eagle, golden eagle, and prairie falcon densities have been monitored on site by Radiological & Environmental Science Laboratory (RESL). Raptors have been used as an indicator of the general health of an environment. Markham[6] has listed the mallard duck (Anas platyrhynchos) as a common sports species, and has reported that this species utilizes the ponds for food and for short resting stops. Radionuclide uptake and exposure effects have been evaluated in the following species: sage grouse (Centrocercus urophasianus), wood ducks (Aix sponsa), raptors, and barn swallow (Hirundo rustica).

Arthropods are a major food source for birds near the ponds. The principal aquatic invertebrates utilized by the birds at the TRA ponds are dragonflies, damselflies, mayflies, water boatman, diving beetles, midges and caddisflies[7]. Evaluation of invertebrates is limited by the amount and quality of available information.

3. EXPOSURE ASSESSMENT

This section identifies actual and potential exposure of vegetation and wildlife to contaminants, exposure pathways, and sensitive species that utilize the TRA Warm Waste Ponds. To document the important ecological characteristics of the site and to evaluate the effects on the local ecosystem, previous documents published on the ecology of the operable unit were reviewed. To complement site-published documents, the following agencies were contacted for sagebrush ecosystem and site-specific natural history information: U.S. Fish & Wildlife, U.S. Bureau of Land Management, Natural Heritage List, and U.S. Forest Service. A literature search was performed to identify toxic research information and to identify possible endangered, threatened, or sensitive species located at the TRA Warm Waste Ponds.

3.1 Identification and Quantification of Hazardous Substances

This section describes the identification and quantification of contaminants at the TRA Warm Waste Pond. The estimate of impact will be a qualitative and quantitative evaluation (when data is available). The identification and quantification of potential hazardous substances were based on existing data from reports written by Hull[8] and Frazier et al.[9] The screening was conducted to select the contaminants which present the greatest hazard based on toxicity, mobility, and quantity. The initial screening revealed 14 contaminants requiring further examination. This number was limited by the available toxicological data for specific contaminants.

The human health inventory section (Table I-1 and Table I-2) described the chemicals and radionuclides. The following contaminants were determined to be related to the ecological evaluation:

Soil:	Arsenic, bis(2-ethylhexyl) phthalate, cadmium, chromium, lead, mercury, and zinc
Surface water:	Am-241, Cs-137, I-131, Pu-239, Sr-90, U-234, and U-238.

3.2 Exposure Pathways

Present conditions at the operable unit (TRA-WWP 10-2) create a possibility of exposure to wildlife from both soil and pond water. Food web connections detail the interaction of plant and animal components within the site ecosystem (see Figure II-1). The population most exposed to soil are the burrowing fauna utilizing pond 62. Ponds 52 and 57 (surface water) pose a point of exposure for wildlife consuming the water and consuming arthropods attracted to water. A fence does surround the TRA ponds, but this has not proven to be a deterrent to wildlife utilizing the water source.

This environmental exposure assessment examined the two most significant exposure pathways for which data are available. The pathways considered are as follows: ingestion of water (liquid waste) and ingestion of contaminated soil (sediments). Not all transport pathways were addressed because of the lack of available toxicity values.

No sensitive ecosystems were identified at TRA-WWP. Ecological indicator species were identified for the TRA ponds and evaluated. Radiation dose to wildlife was provided by Radiological and Environmental Science Laboratory (RESL). Previous research for ducks utilizing the pond and for the ecological indicator species were also obtained from RESL. Specific toxicity information is limited for sagebrush ecosystem wildlife and plants. Toxicity values from surrogate laboratory species were used to compare to estimated environmental concentrations (EEC). Extrapolation from these studies to the TRA Warm Waste Ponds is a source of uncertainty, as discussed in Section 6.

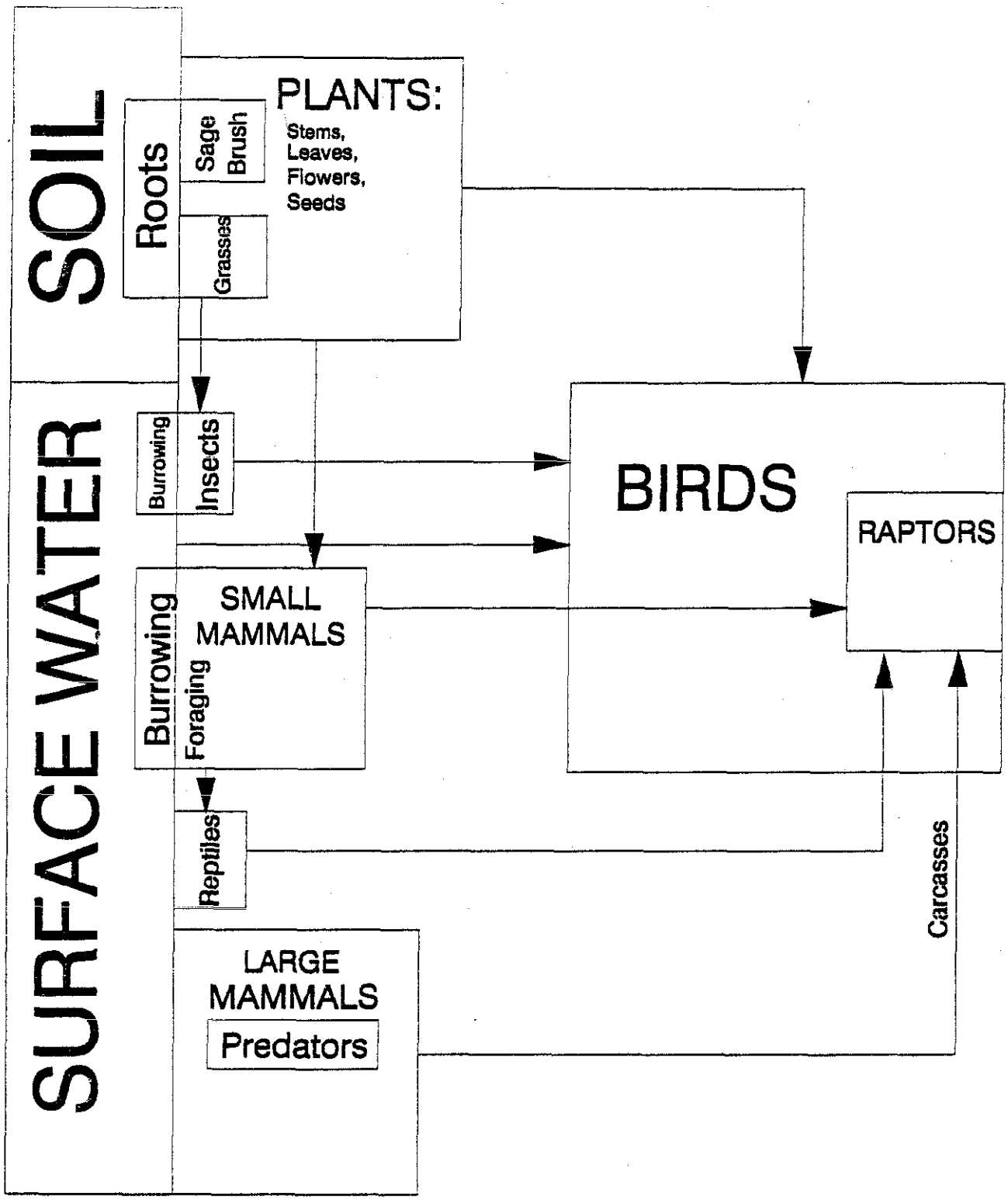

Figure II-1. TRA Warm Waste Ponds Food Web Connections

4. TOXICITY ASSESSMENT

This section gives a brief description of the screening of contaminants and the toxic effects of the site-related contaminants to biota. In addition, any available chemical-specific or radionuclide standards, criteria, methods, and guidance are identified. Appropriate toxicity criteria have not been developed for all terrestrial wildlife. Relevant criteria have been developed and are utilized in this report for most of the chemicals. A more detailed discussion of the toxic effects and criteria is presented below.

4.1 Initial Screening

Surface waters were evaluated for toxicity to wildlife drinking from the pond. Toxic concentrations were estimated from reference doses, using the assumptions and method presented in the Appendix II-A. Reference values used to evaluate toxicity to drinking water were from on-line searches of the Registry of Toxic Effects (RTECS) database, and previous research from RESL. Exposure values for terrestrial organisms to radiation were taken from Oak Ridge National Laboratory (ORNL) Foreign Trip Report[10]. Chemical toxicity to organisms drinking the water could not be evaluated due to lack of sampling data.

Soil concentrations were compared to reference sources, or on-line searches of RTECS and Plant Toxicity Data (PHYTOTOX). To evaluate toxicity to plants, soil concentrations were compared with values derived from "Environmental Profiles Hazard Indices for Constituents of Municipal Sludge" (EPA series produced by the Office of Water, Regulations and Standards; US Environmental Protection Agency, 1985) and "Arsenic Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review"[11]. The following is a description of the toxic values, methods, limits, and effects used to compare to the estimated environmental concentrations.

4.2 Chemicals

Nine chemicals were evaluated for toxicity to wildlife by ingestion of soil. Reference soil concentrations (μg/g dry weight) were obtained for toxicity to: (1) soil biota, (2) plants, (3) predators consuming soil biota, and herbivores (when available). Small mammal were evaluated by taking the lowest toxic dose (LD_{50}) converted to soil concentrations by estimating the amount of soil ingested by each particular organism. These estimates were derived (as explained in detail in Appendix II-A) based on assumptions used in the ecological risk assessment[12].

4.2.1 Arsenic

The toxicity value of arsenic in soil used to compare to environmental concentrations was 3.4 to 9.5 mg/kg. These toxicity values are considered conservative for the protection of vegetation (Eisler, 1988).

Depressed crop yields have been recorded for arsenic levels at 3 to 38 mg/L of water-soluble soil. Arsenic availability to plants is highest in coarse-textured soils having little colloidal material and little ion exchange capacity. To be absorbed by plants, arsenic compounds must be in a mobile form in the soil solution. High concentrations of arsenic are considered toxic to plants. Plants exposed to arsenic exhibit decreased mitosis, photosynthesis, respiration, and interference with nucleic acid and protein synthesis. Kabata-Pandas[13] reported that soil concentrations as low as 15 mg/kg soil are phytotoxic. Soil microorganisms, capable of tolerating and metabolizing relatively high concentrations of arsenic have been reported[14]. To achieve no observable effects in vegetation, the criteria of <1 mg total water-soluble soil As/L and <25 mg total As/kg soil is suggested (see Reference 9). Toxicity information for plants was obtained from PHYTOTOX and Contaminant Hazard Reviews Report No. 12 from the US Fish and Wildlife Service (see Reference 9).

Large mammals may be affected by arsenic levels from soil contamination. In areas where arsenic acid was used to control Johnson grass, white-tailed

deer were killed from feeding in the area where soil contained approximately 2.4 mg/kg (see Reference 9). Small-mammal toxicity values from laboratory research were compared to onsite soil concentrations (Table II-1). Hazard ratios were derived from comparing reference toxicity values obtained from RTECS and Contaminant Hazard Reviews Report No. 12 from the US Fish and Wildlife Service (see Reference 9) to estimated environmental concentration.

The sediment arsenic concentrations at TRA (5.25 mg/kg) are more than twice the toxic soil concentrations for white-tail deer in one area (see above paragraph). The concentration is much less than the phytotoxic value of 15 mg/kg. The concentration of arsenic in soil is above the soil toxicity values for plants derived from the EPA Environmental Profiles and Hazard Indices[15] (45 μg/g).

4.2.2 Bis(2-ethylhexyl) phthalate

Limited data exist on bis(2-ethylhexyl) phthalate. Laboratory studies report bis(2-ethylhexyl) phthalate to be carcinogenic, causing increased incidence of hepatocellular carcinomas or neoplastic nodules following oral administration. Chronic exposures to relatively high concentrations of this chemical in the diet can cause retardation of growth and increased liver and kidney weights. This chemical is not acutely toxic; an oral LD_{50} (lethal dose where 50% of the population dies) of 31,000 mg/kg has been reported in laboratory animals[16] (species not reported).

Concentrations of bis() phthalate (Table I-1) in the soil at TRA are 1.49 mg/kg; this does not approach the oral dose given above. A complete evaluation could not be performed because of lack of information on the chemical.

4.2.3 Cadmium

Crops experience decreased yield when exposed to cadmium. The toxic benchmark ranges have been reported as low as 2.5 μg/g to as high as 640 μg/g. The following toxicity values were taken from EPA Environmental Profiles (see

Table II-1. Ratio of estimated environmental concentrations compared to toxicity reference values at the TRA Warm Waste Pond.

	Ratio of On-Site Concentration Value to Reference Values for Toxicity to: Ingestion of Soil			TRA WWP Soil Summary
Pollutant	Rat	Mouse	Rabbit	Values (mg/kg)
Arsenic	.0000	.0000	.0001	5.25
Beryllium	.0014	.0001		2.20
Bis()phth				1.49
Cadmium	.0001	.0000	.0004	3.12
Chromium	.0406	.0020		338.00
Cyanide	.0002	.0002	.0020	0.98
Lead	.0097	.0001	.0077	17.80
Mercury	.0004	.0001		2.69
Zinc	.0025	.0003	.001	143.00
Am-241				2.4E-6
Cm-244				8.4E-8
Cs-134	.0000	.0000		3.5E-8
Pu-238	.0000		.0003	6.E-7
U-234	.0000	.0000	.5486	9.E-4
U-238	.0001	.00001	.0027	4.78

Reference 12): soil toxicity to plants, 2.5 μg/g soil dry weight (DW); soil toxicity to predators, 0.22 μg/g soil dry weight; soil toxicity to herbivores, 17.9 μg/g soil dry weight (Table II-2).

The estimate of soil toxicity for predators (0.22 μg/g) was reported from a study of chickens feeding on soil biota which exhibit a high rate of uptake of cadmium from soil. This estimate could be considered high for the environment at the TRA Warm Waste Ponds. It is extremely difficult to apply the result of this experiment to the effects on a sagebrush ecosystem.

Concentrations of cadmium (Table I-1) at the operable unit are 3.12 mg/kg. The sediment concentration values exceed the experimental toxicity values given in the previous paragraph for plant and predators. Based on the concentration in soil, cadmium will be toxic to plants (decreased yield) and predators (decreased egg production), but will not be toxic to herbivores.

4.2.4 Chromium

The profile and hazard indices for chromium are as follows: soil toxicity to plants, 200 μg/g soil dry weight (DW); and soil toxicity to predators, 4000 μg/g soil (DW); (Table II-2).

Chromium concentrations in the TRA soil (338 mg/kg) may be of concern for plants but will not be of concern for soil toxicity to predators. Chromium has slow mobility within the plant and accumulates in the lower stems[17]. Wildlife cannot be evaluated because toxicological information on chromium has not been established.

4.2.5 Zinc

Toxicity to predators from soil biota is a function of uptake rates by the biota and food concentrations toxic to predators. Available studies on uptake indicate a toxic range for earthworms of 0.078 to 2.95 μg/g and a toxic

Table II-2. Parameters and toxicity values derived from the EPA Environmental Profiles and Hazard Indices for Constituents of Municipal Sludge.

Metal	Soil Toxicity to Soil Biota (ug/g soil DW)	Soil Toxicity to Plants (ug/g soil DW)	Soil Toxicity to Predators (ug/g soil)	Soil Toxicity to Herbivores (lg/g soil DW)
As		45		962
Be	2	1		0.33
Cd		2.5	17.9	7.9
Cr		200	4000	12346
Zn	1100	224	42.4	211

value of 0.28 μg/g for the woodlouse. Toxic concentrations of contaminated food indicate toxic effects to quail at 125 μg/g and lethal effects at 2000 μg/g. The maximum tolerable level for chickens is given as 1000 μg/g, at which point they begin experiencing decreased growth. These data suggest a possible toxic effect to birds, but doses will not be lethal (see Reference 13).

Concentrations of zinc (Table I-1) in the soil at TRA are calculated at 143 mg/kg. This concentration has been reported to be toxic to certain species. The preliminary screening indicated that zinc exceeds the toxic limit for soil toxicity to predators (soil concentration of 42 μg/g), which suggests a possibility of toxic effects occurring to predators. Zinc does not exceed the concentrations toxic to plants and herbivores; reference values are set at 224 μg/g for plants, and 211 μg/g for herbivores (Table II-2). The above values are for species-specific, limiting the evaluation of a sagebrush environment.

4.3 Radionuclides

The radionuclide evaluation was limited by the lack of exposure standards to compare to onsite values. In the absence of EPA standards, onsite values were compared to a limit suggested to International Atomic Energy Agency (IAEA) by Dr. Gordon Blaylock (see Reference 10) and to reference values when available.

4.3.1 Iodine-131

Iodine-131 concentrations (Table I-2) were compared to a toxic value obtained from RTECS to arrive at a hazard index. Ingestion of pond water was evaluated by comparing the on site environmental concentrations to a derived toxic concentration to determine a hazard quotient. Iodine concentrations (Table II-3) from this evaluation of the pond water indicate concern for coyotes consuming water at the pond.

Table II-3. Ratio of water sample concentrations compared to toxicity reference values at the TRA Warm Waste Pond.

Pollutant	Ratio of On-Site Values to Toxicity Values for Toxicity to: Ingestion of Pond Water				TRA WWP Water
	Rat	Mouse	Rabbit	Dogs	Values (ug/L)
Am-241					3.3E-7
Cm-244					1.2E-9
Cs-137	.0000	.0000			6.4E-6
I-131				1.365	8.2E-4
Pu-239	.0000		.004	.0000	6.8E-6
Sr-90				.0000	1.1E-5
U-234	.2490	.0000	.0000		.51
U-238	.0000	.0000	.004		6.4E-6

__ = Ratio > 1

4.3.2 Cs-137

Coyotes are exposed to radiation by ingestion of pond water and of rodents consumed near the ponds. Arthur et al.[18] reported that coyote fecal concentrations of both Cs-137 (19.9 pCi/g) and Sr-90 (7.6 pCi/g) were significantly greater ($P \leq 0.05$) than those samples collected from the control areas. Alone this study does not establish concern, but this information can support the finding presented in Table II-3.

4.3.3 Strontium-90

The suggested exposure limits were used for strontium-90, due to lack of standards. Markham et al. (see Reference 4) studied ducks maintained on a the TRA leaching pond. The mean dose rate to ducks on the pond from Sr-90 (accounting for 97% of the dose) was 69 mrad per day. The dose received by ducks per day was compared to the suggested limit of .1 to .5 rad/day.

4.3.4 Combined Exposure

RESL has conducted studies on combined radiological exposure to organisms on the INEL. These studies were used to determine the amount of radiation organisms were receiving onsite. As described by EPA guidelines, ecological species that reflect the condition of the environment and possible food chain linkage were identified. Raptors and passerines have been used as indicator species in many studies to reflect the condition of the environment.

Research at the operable unit has addressed radiation to a variety of organisms using the TRA ponds. When evaluating radiation to organisms, the most relevant exposure is to the reproductive organs. Craig et al.[19] calculated radionuclide concentrations in three raptors utilizing small mammals from the TRA area. Assuming a quality factor of one, based on the radionuclide concentrations, doses to raptors from internal gamma-emitting radionuclides ranged from 0 to 0.1 mrad/day. Adult barn swallows ingesting pond arthropods for food and contaminated mud for nest construction received 22 mrad per day (see Reference 5). Concentrations of radionuclides were

measured in the tissues of mallard ducks inhabiting the leaching ponds for 43-145 days. The mean dose rate to experimental ducks was 69 mrad/day (see Reference 4). The dose to organisms from each study can be compared to the suggested dose limit for terrestrial organisms. These studies imply that organisms exposed to radiation are not exceeding the suggested limit of .1 to .5 rad/day (Table II-4).

Table II-4. Comparison of on-site values to IAEA suggested exposure limits for terrestrial organisms at the TRA Warm Waste Pond.

SPECIES	On-Site Exposure Values	Exposure Limits for Terrestrial Organisms
Ducks	69 mrad/d	.1 - .5 Rads/d
Barn swallows	22 mrad/d 45 rad/season*	.1 - .5 Rads/d
Raptors	0 - 0.1 mrad/d	.1 - .5 Rads/d

* Dose rate to thyroid

5. RISK CHARACTERIZATION

Ecological risk assessment evaluates adverse effects to populations as opposed to individual organisms. The extent to which adverse effects on populations are measured is related to changes in rates of mortality, birth, immigration, and emigration. These functions are affected by toxicity, mobility and quantity of contaminant. Adverse effects on individual organisms may be important when endangered species are being considered, where the loss of a few individuals from the population may have a significant effect on the continued existence of the species. Indicator species are used to reflect the general health of the ecosystem.

In this section, impacts on environmental populations are assessed based on the exposure and toxicity estimates presented in this document. According to EPA guidelines[20], noncarcinogenic risk will be based on the ratio of the estimated environmental concentrations to the appropriate toxicological criterion (when available). This ratio is defined as a hazard quotient. For single and multiple chemical assessments, concern levels have been arbitrarily set as follows: no concern, quotient ≤ 0.1; possible concern, $0.1 \leq$ quotient ≤ 10; probable concern, quotient ≥ 10. For multiple contaminant screening, the quotients are summed to calculate a hazard index.

When toxicological criteria were not available, two approaches were taken to evaluate exposure to wildlife and plants. Research from the site was reviewed to establish exposure concentration to an organism; this dose was compared to the radiation limit for terrestrial organisms suggested by the IAEA. When internal exposure concentrations were not known, responses to exposure concentrations were compared with control responses (no exposure) to test the null hypothesis that they are the same as the control responses. Using hypothesis testing procedures that set alpha = 0.05, one avoids declaring that a concentration is toxic when it is not toxic.

5.1 Chemicals

Wildlife in semi-arid desert environment are attracted to surface water. The risk to wildlife and plants appears to be from chemical concentrations in the soil at the 64 dry pond. This area is likely to be used by wildlife and sagebrush biota. Although there appears to be no risk to small mammals from the chemicals (Table II-1 and Table II-2), this does not appear to be the case for other species occurring at the site.

Based on these results and established toxicity values, arsenic concentrations (Table II-1 and Table II-2) in the soil at TRA may pose some concern for plants, large mammals, and predators. These results vary greatly according to the plant species considered for the toxicity testing. The toxicity values are considered to be very conservative for the protection of plants. These concentrations may be toxic to large mammals but have been shown to have been tolerated by small mammals.

Restricted by the assumptions of the toxicity evaluations for cadmium, TRA-WWP exceeds soil toxicity values for predators and plants. The possibility of cadmium being toxic to plants assumes that the uptake of cadmium by plants onsite, and resultant effects, are similar to those of tested vegetation. This may represent a conservative approach due to different uptake factors between species.

Concentrations of chromium may be harmful to plants but does not exceed toxic limits for soil toxicity to predators. This is considered to be a conservative approach because of the limited number of species tested for toxicity to chromium. Wildlife exposure to chromium cannot be evaluated, due to lack of information.

Zinc concentrations in soil exceed the derived toxicity values for soil toxicity by ingestion to predators. There is only a slight possibility of zinc being toxic to predators. This evaluation shows zinc no concern for plants and herbivores.

5.2 Radionuclides

Wildlife has unrestricted access to both water and soil from the contaminated area. Radionuclide effects were evaluated through two pathways: water consumption by wildlife and soil ingestion by mammals. The onsite toxicity values for ingestion of soil did not exceed levels of concern for small mammals. The concentrations of waterfowl exposure to radionuclides are below IAEA suggested limits for terrestrial organisms, with the exception of Iodine-131. Based on the analysis, Iodine-131 could be of possible concern to some species.

5.3 Conclusions

Any continued leaching of chemicals from the TRA ponds into soil could have adverse effects to wildlife and plants. Aerial photographs show no vegetation at the 52 and 57 ponds and sparse vegetation at the dry 64 pond. Leachate may be able to form during wet periods. This leaching could potentially expose vegetation, wildlife, and other biota to toxic concentrations. An evaluation of pond water effects to terrestrial organisms could not be evaluated because chemical sampling data were not available.

After reviewing the research on wildlife exposure to radionuclides, and considering the lack of established radionuclide values, radiation exposure is not likely to exceed the suggested terrestrial limits established by IAEA. The ecological indicator species affected by the radionuclide discharges do not appear to have adverse effects to reproduction.

6. UNCERTAINTIES

The values and procedures used to assess risks in this evaluation are subject to a wide variety of uncertainties. Following is a list of the sources of uncertainties in this evaluation:

- Ecological effects seldom occur in isolation from other stresses
- Quantitative estimates of exposure are lacking
- Environmental parameter measurements are inadequate
- Toxicological data gaps
- Environmental sampling gaps

At the present time, there is not an established standard for exposure to radionuclides by terrestrial organisms. In the absence of this information, this report utilized verbal communications with Dr. Gordon Blaylock, Oak Ridge National Laboratory (ORNL), and a letter report from Dr. Gordon Blaylock to IAEA suggesting a radiation limit to terrestrial organisms (see Reference 10). This limit has not been accepted or peer reviewed. Uncertainty in the radionuclide evaluation may prevent the detection of acute effects occurring to organisms. This flaw may lead to underestimation of the risks in the maximum exposure scenarios.

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APPENDIX II-A

TRA WARM WASTE POND

ECOLOGICAL TOXICITY SCREENING ASSESSMENT METHODS

II-A. APPENDIX

TRA WARM WASTE POND

ECOLOGICAL TOXICITY SCREENING ASSESSMENT METHODS

Soil Ingestion by Wildlife

1. Assumptions

The following assumptions for this ecological assessment were:

Ingestion Rate: Mouse - 5% of body weight; rabbit - 7.5 g/d; mallard - 5 g/d.
Body Weight: mallard - 1 kg; rabbit - 1 kg; mouse - 0.03; rat -0.25.

In addition to soil intake, organisms were assumed to ingest a certain amount of the pollutant concentration in the soil. Rabbits were assumed to ingest 67.5 g of vegetation with a 1% pollutant concentration; mice were assumed to ingest 1.35 g with 1% concentration for vegetation; prey 10% concentration for prey items; and mallards were assumed to ingest 45 g (3/4 of which is vegetation at 1% concentration, and 1/4 insects at 10% concentration).

2. Calculations

Total ingestion rate of a pollutant in soil was then estimated by summing the values for ingestion of soil, vegetation, and prey for each organism (mallards = 8.4875 g; rabbit = 8.175 g; mouse = .224 g; rat = 1.5 g/d). Adding the intake of pollutants from vegetation and prey increased the intake due only to soil ingestion by approximately 10-50%.

Using these assumptions, and standardizing reported units, toxic dosages were converted to soil concentrations using the formula:

$$\text{Soil Concentration (mg/kg soil)} = \frac{[\text{Body weight (kg)} \times \text{Dose (mg/kg/d)}]}{\text{Intake (kg soil/d)}}$$

Wildlife Drinking Surface Water

1. Assumptions

The following assumptions for this ecological assessment were:

Intake: Herbivores drink 10% of their body weight (L/kg/d) and carnivores drink 30% of body weight.

Body Weight: dog - 10 kg; rabbit - 1 kg; rat - 0.25 kg; mouse 0.03.

Additional assumptions made here include:

All organisms have the same relationship between body weight and intake as assumed above.

2. Calculations

Using these assumptions, and standardizing reported units, toxic dosages were converted to water concentrations using the formula:

$$\text{Water Concentration (mL/d)} = \frac{[\text{Body Weight (kg)} \times \text{Dose (mg/kg/d)} \times 1000\ (\mu\text{g/mg})]}{\text{Intake (L/d)}}$$