APPENDIX E

Fate and Transport Modeling Results

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Table E-1. Physical and Chemical Properties of Inorganic SRCs in Surface and Subsurface Soil and Sediment at Load Line 9

Analyte	K_d (L/kg)	Reference	HLC (atm-m^3/mol)	Reference	C_w (mg/L)	SSL Type	Generic SSL	Reference	SSL Type
Inorganic Chemicals									
Aluminum	1.50E+03	a	NA	-	2.00E+01	RSL	3.00E+04	a	Risk
Antimony	4.50E+01	a	NA	-	6.00E-03	MCL	2.70E-01	a	MCL
Arsenic	2.90E+01	a	NA	-	1.00E-02	MCL	2.90E-01	a	MCL
Barium	4.10E+01	a	NA	-	2.00E+00	MCL	8.20E+01	a	MCL
Beryllium	7.90E+02	a	NA	-	4.00E-03	MCL	3.20E+00	a	MCL
Cadmium	7.50E+01	a	NA	-	5.00E-03	MCL	3.80E-01	a	MCL
Chromium	1.90E+01	a	NA	-	1.00E-01	MCL	1.80E+05	a	MCL
Cobalt	4.50E+01	a	NA	-	6.00E-03	RSL	2.70E-01	a	Risk
Copper	3.50E+01	a	NA	-	1.30E+00	MCL	4.60E+01	a	MCL
Lead	9.00E+02	a	NA	-	1.50E-02	MCL	1.40E+01	a	MCL
Manganese	6.50E+01	a	NA	-	4.30E-01	RSL	2.80E+01	a	Risk
Mercury	5.20E+01	a	1.14E-02	a	2.00E-03	MCL	1.00E-01	a	MCL
Nickel	6.50E+01	a	NA	-	3.90E-01	RSL	2.60E+01	a	Risk
Selenium	5.00E+00	a	NA	-	5.00E-02	MCL	2.60E-01	a	MCL
Silver	8.30E+00	a	NA	-	9.40E-02	RSL	8.00E-01	a	Risk
Thallium	7.10E+01	a	NA	-	2.00E-03	MCL	1.40E-01	a	MCL
Zinc	6.20E+01	a	NA	-	6.00E+00	RSL	3.70E+02	a	Risk

[a] USEPA RSL Generic Tables June 2015; found at: http://www2.epa.gov/risk/risk-based-screening-table-generic-tables.
C_w = Target groundwater concentration (either MCL or RSL).
HLC = Henry's Law Constant.
K_d = Distribution coefficient.
L/kg = Liters per Kilogram.
MCL = Clean Water Act Drinking Water Maximum Contaminant Level.
Mg/L = Milligrams per liter.
NA = Not Applicable.
RSL = USEPA Regional Screening Level (USEPA 2015).
SRC = Site-related Contaminant.
SSL = Soil Screening Level.

Table E-2. Physical and Chemical Properties of Organic SRCs in Surface and Subsurface Soil and Sediment at Load Line 9

Analyte	K_{oc} (L/kg)	Reference	HLC (atm-m^3/mol)	Reference	C_w (mg/L)	SSL Type	Generic SSL (mg/kg)	Reference	SSL Type
Explosives									
Nitrocellulose	1.00E+01	d	3.29E-23	d	6.00E+04	RSL	1.30E+04	d	Risk
Nitroguanidine	2.07E+01	d	4.49E-12	d	2.00E+00	RSL	4.80E-01	d	Risk
PETN	6.48E+02	d	1.20E-11	d	1.90E-02	RSL	2.80E-02	d	Risk
Tetryl	4.61E+03	d	2.71E-09	d	3.90E-02	RSL	3.70E-01	d	Risk
Semi-volatile Organic Compounds									
2-Methylnaphthalene	2.48E+03	d	5.18E-04	d	3.60E-02	RSL	1.90E-01	d	Risk
Acenaphthene	5.03E+03	d	1.84E-04	d	5.30E-01	RSL	5.50E+00	d	Risk
Acenaphthylene[a]	7.40E+03	e	1.84E-04	d	1.20E-01	RSL	1.30E+01	d	Risk
Anthracene	1.64E+04	d	5.56E-05	d	1.80E+00	RSL	5.80E+01	d	Risk
Benz(*a*)anthracene	1.77E+05	d	1.20E-05	d	1.20E-05	RSL	4.25E-03	d	Risk
Benzenemethanol	2.15E+01	d	3.37E-07	d	2.00E+00	RSL	4.80E-01	d	Risk
Benzo(*a*)pyrene	5.87E+05	d	4.57E-07	d	2.00E-04	MCL	2.40E-01	d	MCL
Benzo(*b*)fluoranthene	5.99E+05	d	6.57E-07	d	3.40E-05	RSL	4.10E-02	d	Risk
Benzo(*ghi*)perylene[b]	1.07E+07	e	1.40E-07	e	1.20E-01	RSL	1.30E+01	d	Risk
Benzo(*k*)fluoranthene	5.87E+05	d	5.84E-07	d	3.40E-04	RSL	4.00E-01	d	Risk
Bis(2-ethylhexyl)phthalate	1.20E+05	d	2.70E-07	d	6.00E-03	MCL	1.40E+00	d	MCL
Chrysene	1.81E+05	d	5.23E-06	d	3.40E-03	RSL	1.20E+00	d	Risk
Di-n-butyl phthalate	1.16E+03	d	1.81E-06	d	9.00E-01	RSL	2.30E+00	d	Risk
Dibenz(*a*,*h*)anthracene	1.91E+06	d	1.41E-07	d	3.40E-06	RSL	1.30E-02	d	Risk
Dibenzofuran	9.16E+03	d	2.13E-04	d	7.90E-03	RSL	1.50E-01	d	Risk
Fluoranthene	5.55E+04	d	8.86E-06	d	8.00E-01	RSL	8.90E+01	d	Risk
Fluorene	9.16E+03	d	9.62E-05	d	2.90E-01	RSL	5.40E+00	d	Risk
Indeno(1,2,3-*cd*)pyrene	1.95E+06	d	3.48E-07	d	3.40E-05	RSL	1.30E-01	d	Risk
Naphthalene	1.54E+03	d	4.40E-04	d	1.70E-04	RSL	5.40E-04	d	Risk
Phenanthrene[c]	1.82E+04	e	3.93E-05	e	1.20E-01	RSL	1.30E+01	d	Risk
Pyrene	5.43E+04	d	1.19E-05	d	1.20E-01	RSL	1.30E+01	d	Risk

Table E-2. Physical and Chemical Properties of Organic SRCs in Surface and Subsurface Soil at Load Line 9 (continued)

Analyte	K_{oc} (L/kg)	Reference	HLC (atm-m^3/mol)	Reference	C_w (mg/L)	SSL Type	Generic SSL (mg/kg)	Reference	SSL Type
Volatile Organic Compounds									
Toluene	2.34E+02	d	6.64E-03	d	1.00E+00	MCL	6.90E-01	d	MCL

[a] Acenaphthene C_w and Generic SSL was used as a surrogate for acenaphthylene.
[b] Pyrene C_w and Generic SSL was used as a surrogate for benzo(*ghi*)perylene.
[c] Pyrene C_w and Generic SSL was used as a surrogate for phenanthrene.
[d] USEPA RSL Generic Tables June 2015; found at: http://www2.epa.gov/risk/risk-based-screening-table-generic-tables.
[e] USEPA 1994. Risk Reduction Engineering Laboratory Treatability Database, Ver. 5.0, Office of Research and Development, Cincinnati, Ohio.
C_w = Target groundwater concentration (either MCL or RSL).
HLC = Henry's Law Constant.
K_{oc} = Organic carbon partition coefficient.
L/kg = Liters per kilogram.
MCL = Clean Water Act Drinking Water Maximum Contaminant Level.
mg/kg = Milligrams per kilogram.
mg/L = Milligram per kilogram.
PETN = Pentaerythritol tetranitrate.
RSL = USEPA Regional Screening Level (USEPA 2015).
SRC = Site-related Contaminant.
SSL = Soil Screening Level.

Table E-3. HELP Model Parameters for Developing Water Balance Estimates

Layer	Layer Type	Thickness (inch)	Effective K (cm/sec)
1	1--Vertical Percolation Layer	60	2.50E-05
2	3--Barrier Soil Liner	84	8.20E-06

Evapotranspiration and Weather Data	
Station Latitude =	41.24
Maximum Leaf Area Index =	3.5
Start of Growing Season (Julian Date) =	120
End of Growing Season (Julian Date) =	290
Evaporative Zone Depth (inch) =	20 (Fair)

General Design and Evaporative Zone Data	
Fraction of Area Allowing Runoff (%) =	100
Default Soil Database Texture =	Silty Clay
Vegetative Cover =	Poor Stand of Grass
Surface Slope (%) =	4
Slope Length (ft) =	500
SCS Runoff Curve Number =	93

Precipitation Data
Synthetically Generated Using Cleveland, Ohio, Coefficients

Temperature Data
Synthetically Generated Using Cleveland, Ohio, Coefficients

Solar Radiation Data
Synthetically Generated Using Cleveland, Ohio, Coefficients

cm/sec = Centimeters per second.
ft = Feet.
HELP = Hydrologic Evaluation of Landfill Performance.
K = Hydraulic conductivity.
SCS = Soil Conservation Service.

Table E-4. Initial CMCOPCs Based on Maximum Concentration of SRCs Compared to GSSL for Load Line 9

Analyte	CAS Number	Maximum Concentration (mg/kg)	GSSL (mg/kg)	GSSL Type (mg/kg)	Initial CMCOPC (Yes/No)	CMCOPC Justification	Samples >SSL/ Total Samples	Sample ID at Maximum Concentration	Date Collected
Former Production Area									
Inorganic Chemicals									
Aluminum	7429-90-5	2.00E+04	3.00E+04	Risk	No	Below SSL	0/ 91	LL9ss-023-0001-SO	12/8/2003
Antimony	**7440-36-0**	**1.20E+00**	**2.70E-01**	**MCL**	**Yes**	**Exceeds SSL**	**17/ 91**	**LL9ss-026-0001-SO**	**12/10/2003**
Arsenic	**7440-38-2**	**3.20E+01**	**2.90E-01**	**MCL**	**Yes**	**Exceeds SSL**	**91/ 91**	**LL9sb-019-0001-SO**	**12/11/2003**
Barium	**7440-39-3**	**1.80E+02**	**8.20E+01**	**MCL**	**Yes**	**Exceeds SSL**	**14/ 91**	**LL9ss-096-5474-SO**	**3/1/2010**
Beryllium	7440-41-7	1.90E+00	3.20E+00	MCL	No	Below SSL	0/ 91	LL9ss-097-5475-SO	3/1/2010
Cadmium	**7440-43-9**	**2.90E+00**	**3.80E-01**	**MCL**	**Yes**	**Exceeds SSL**	**8/ 91**	**LL9ss-006-0001-SO**	**12/11/2003**
Chromium	7440-47-3	1.10E+02	1.80E+05	MCL	No	Below SSL	0/ 91	LL9ss-024-0001-SO	12/10/2003
Cobalt	**7440-48-4**	**1.90E+01**	**2.70E-01**	**Risk**	**Yes**	**Exceeds SSL**	**91/ 91**	**LL9sb-041-0001-SO**	**10/27/2003**
Copper	7440-50-8	3.10E+01	4.60E+01	MCL	No	Below SSL	0/ 91	LL9ss-020-0001-SO	12/8/2003
Lead	**7439-92-1**	**3.20E+02**	**1.40E+01**	**MCL**	**Yes**	**Exceeds SSL**	**54/ 91**	**LL9ss-024-0001-SO**	**12/10/2003**
Manganese	**7439-96-5**	**3.24E+03**	**2.80E+01**	**Risk**	**Yes**	**Exceeds SSL**	**91/ 91**	**LL9ss-097-5475-SO**	**3/1/2010**
Mercury	**7439-97-6**	**1.50E+00**	**1.00E-01**	**MCL**	**Yes**	**Exceeds SSL**	**19/ 91**	**LL9sb-091-5455-SO**	**3/9/2010**
Nickel	**7440-02-0**	**3.70E+01**	**2.60E+01**	**Risk**	**Yes**	**Exceeds SSL**	**7/ 91**	**LL9sb-041-0001-SO**	**10/27/2003**
Selenium	**7782-49-2**	**1.40E+00**	**2.60E-01**	**MCL**	**Yes**	**Exceeds SSL**	**51/ 91**	**LL9ss-097-5475-SO**	**3/1/2010**
Silver	7440-22-4	3.20E-02	8.00E-01	Risk	No	Below SSL	0/ 91	LL9ss-103-5481-SO	3/2/2010
Thallium	**7440-28-0**	**1.00E+00**	**1.40E-01**	**MCL**	**Yes**	**Exceeds SSL**	**10/ 91**	**LL9sb-043-0001-SO**	**11/6/2003**
Zinc	7440-66-6	2.28E+02	3.70E+02	Risk	No	Below SSL	0/ 91	LL9ss-003-0001-SO	3/11/2002
Explosives									
Nitrocellulose	9004-70-0	1.80E+00	1.30E+04	Risk	No	Below SSL	0/ 8	LL9ss-019-0001-SO	12/11/2003
Tetryl	479-45-8	1.10E-02	3.70E-01	Risk	No	Below SSL	0/ 42	LL9sb-089-5446-SO	3/8/2010
Semi-volatile Organic Compounds									
2-Methylnaphthalene	91-57-6	2.00E-02	1.90E-01	Risk	No	Below SSL	0/ 9	LL9ss-098-5476-SO	3/1/2010
Acenaphthene	83-32-9	4.10E+00	5.50E+00	Risk	No	Below SSL	0/ 34	LL9ss-096-5474-SO	3/1/2010
Acenaphthylene	208-96-8	5.50E-01	1.30E+01	Risk	No	Below SSL	0/ 34	LL9ss-096-5474-SO	3/1/2010
Anthracene	120-12-7	1.20E+01	5.80E+01	Risk	No	Below SSL	0/ 34	LL9ss-096-5474-SO	3/1/2010
Benz(a)anthracene	**56-55-3**	**1.70E+01**	**4.25E-03**	**Risk**	**Yes**	**Exceeds SSL**	**18/ 34**	**LL9ss-096-5474-SO**	**3/1/2010**
Benzo(a)pyrene	**50-32-8**	**1.50E+01**	**2.40E-01**	**MCL**	**Yes**	**Exceeds SSL**	**2/ 34**	**LL9ss-096-5474-SO**	**3/1/2010**

Table E-4. Initial CMCOPCs Based on Maximum Concentration of SRCs Compared to GSSL for Load Line 9 (continued)

Analyte	CAS Number	Maximum Concentration (mg/kg)	GSSL (mg/kg)	GSSL Type (mg/kg)	Initial CMCOPC (Yes/No)	CMCOPC Justification	Samples >SSL/ Total Samples	Sample ID at Maximum Concentration	Date Collected
Benzo(b)fluoranthene	**205-99-2**	**2.00E+01**	**4.10E-02**	**Risk**	**Yes**	**Exceeds SSL**	**11/ 34**	**LL9ss-096-5474-SO**	**3/1/2010**
Benzo(ghi)perylene	191-24-2	9.20E+00	1.30E+01	Risk	No	Below SSL	0/ 34	LL9ss-096-5474-SO	3/1/2010
Benzo(k)fluoranthene	**207-08-9**	**7.10E+00**	**4.00E-01**	**Risk**	**Yes**	**Exceeds SSL**	**2/ 34**	**LL9ss-096-5474-SO**	**3/1/2010**
Bis(2-ethylhexyl)phthalate	117-81-7	1.50E-01	1.40E+00	MCL	No	Below SSL	0/ 9	LL9ss-014-0001-SO	12/11/2003
Chrysene	**218-01-9**	**1.70E+01**	**1.20E+00**	**Risk**	**Yes**	**Exceeds SSL**	**2/ 34**	**LL9ss-096-5474-SO**	**3/1/2010**
Di-n-butyl phthalate	84-74-2	1.40E-01	2.30E+00	Risk	No	Below SSL	0/ 9	LL9sb-040-0001-SO	10/27/2003
Dibenz(a,h)anthracene	**53-70-3**	**2.20E+00**	**1.30E-02**	**Risk**	**Yes**	**Exceeds SSL**	**7/ 34**	**LL9ss-096-5474-SO**	**3/1/2010**
Fluoranthene	206-44-0	4.80E+01	8.90E+01	Risk	No	Below SSL	0/ 34	LL9ss-096-5474-SO	3/1/2010
Fluorene	86-73-7	5.30E+00	5.40E+00	Risk	No	Below SSL	0/ 34	LL9ss-096-5474-SO	3/1/2010
Indeno(1,2,3-cd)pyrene	**193-39-5**	**8.50E+00**	**1.30E-01**	**Risk**	**Yes**	**Exceeds SSL**	**2/ 34**	**LL9ss-096-5474-SO**	**3/1/2010**
Naphthalene	**91-20-3**	**9.20E-01**	**5.40E-04**	**Risk**	**Yes**	**Exceeds SSL**	**5/ 34**	**LL9ss-096-5474-SO**	**3/1/2010**
Phenanthrene	**85-01-8**	**4.30E+01**	**1.30E+01**	**Risk**	**Yes**	**Exceeds SSL**	**1/ 34**	**LL9ss-096-5474-SO**	**3/1/2010**
Pyrene	**129-00-0**	**3.40E+01**	**1.30E+01**	**Risk**	**Yes**	**Exceeds SSL**	**1/ 34**	**LL9ss-096-5474-SO**	**3/1/2010**
Volatile Organic Compounds									
Toluene	108-88-3	3.70E-04	6.90E-01	MCL	No	Below SSL	0/ 8	LL9ss-104-5482-SO	3/2/2010
Non-production Area									
Inorganic Chemicals									
Antimony	**7440-36-0**	**1.40E+00**	**2.70E-01**	**MCL**	**Yes**	**Exceeds SSL**	**4/ 26**	**LL9ss-011-0001-SO**	**3/11/2002**
Arsenic	**7440-38-2**	**1.80E+01**	**2.90E-01**	**MCL**	**Yes**	**Exceeds SSL**	**26/ 26**	**LL9sb-027-0001-SO**	**12/4/2003**
Barium	**7440-39-3**	**1.10E+02**	**8.20E+01**	**MCL**	**Yes**	**Exceeds SSL**	**2/ 26**	**LL9ss-068-0001-SO**	**12/12/2003**
Cadmium	**7440-43-9**	**2.70E+00**	**3.80E-01**	**MCL**	**Yes**	**Exceeds SSL**	**1/ 26**	**LL9ss-068-0001-SO**	**12/12/2003**
Cobalt	**7440-48-4**	**1.80E+01**	**2.70E-01**	**Risk**	**Yes**	**Exceeds SSL**	**26/ 26**	**LL9ss-027-0001-SO**	**12/4/2003**
Copper	**7440-50-8**	**1.24E+03**	**4.60E+01**	**MCL**	**Yes**	**Exceeds SSL**	**2/ 26**	**LL9ss-011-0001-SO**	**3/11/2002**
Lead	**7439-92-1**	**1.33E+03**	**1.40E+01**	**MCL**	**Yes**	**Exceeds SSL**	**13/ 26**	**LL9ss-011-0001-SO**	**3/11/2002**
Manganese	**7439-96-5**	**3.80E+03**	**2.80E+01**	**Risk**	**Yes**	**Exceeds SSL**	**26/ 26**	**LL9ss-027-0001-SO**	**12/4/2003**
Mercury	**7439-97-6**	**8.82E+02**	**1.00E-01**	**MCL**	**Yes**	**Exceeds SSL**	**11/ 31**	**LL9ss-011-0001-SO**	**3/11/2002**
Nickel	7440-02-0	2.50E+01	2.60E+01	Risk	No	Below SSL	0/ 26	LL9sb-025-0001-SO	12/10/2003
Selenium	**7782-49-2**	**1.80E+00**	**2.60E-01**	**MCL**	**Yes**	**Exceeds SSL**	**16/ 26**	**LL9ss-068-0001-SO**	**12/12/2003**
Silver	7440-22-4	3.40E-02	8.00E-01	Risk	No	Below SSL	0/ 26	LL9sb-090-5449-SO	3/9/2010
Thallium	7440-28-0	1.40E-01	1.40E-01	MCL	No	Below SSL	0/ 26	LL9sb-094-5465-SO	3/9/2010

Table E-4. Initial CMCOPCs Based on Maximum Concentration of SRCs Compared to GSSL for Load Line 9 (continued)

Analyte	CAS Number	Maximum Concentration (mg/kg)	GSSL (mg/kg)	GSSL Type (mg/kg)	Initial CMCOPC (Yes/No)	CMCOPC Justification	Samples >SSL/ Total Samples	Sample ID at Maximum Concentration	Date Collected
Zinc	**7440-66-6**	**7.80E+02**	**3.70E+02**	**Risk**	**Yes**	**Exceeds SSL**	**2/ 26**	**LL9ss-068-0001-SO**	**12/12/2003**
Explosives									
Nitrocellulose	9004-70-0	3.20E+00	1.30E+04	Risk	No	Below SSL	0/ 6	LL9ss-068-0001-SO	12/12/2003
Nitroguanidine	556-88-7	8.90E-02	4.80E-01	Risk	No	Below SSL	0/ 6	LL9ss-034-0001-SO	11/11/2003
Semi-volatile Organic Compounds									
2-Methylnaphthalene	91-57-6	2.10E-02	1.90E-01	Risk	No	Below SSL	0/ 10	LL9sb-090-5449-SO	3/9/2010
Acenaphthene	83-32-9	1.30E-02	5.50E+00	Risk	No	Below SSL	0/ 13	LL9ss-095-5473-SO	3/2/2010
Acenaphthylene	208-96-8	5.00E-02	1.30E+01	Risk	No	Below SSL	0/ 13	LL9ss-068-0001-SO	12/12/2003
Anthracene	120-12-7	4.80E-02	5.80E+01	Risk	No	Below SSL	0/ 13	LL9ss-068-0001-SO	12/12/2003
Benz(a)anthracene	**56-55-3**	**2.30E-01**	**4.25E-03**	**Risk**	**Yes**	**Exceeds SSL**	**10/ 13**	**LL9ss-068-0001-SO**	**12/12/2003**
Benzo(a)pyrene	50-32-8	2.40E-01	2.40E-01	MCL	No	Below SSL	0/ 13	LL9ss-068-0001-SO	12/12/2003
Benzo(b)fluoranthene	**205-99-2**	**2.40E-01**	**4.10E-02**	**Risk**	**Yes**	**Exceeds SSL**	**3/ 13**	**LL9ss-068-0001-SO**	**12/12/2003**
Benzo(ghi)perylene	191-24-2	1.70E-01	1.30E+01	Risk	No	Below SSL	0/ 13	LL9ss-068-0001-SO	12/12/2003
Benzo(k)fluoranthene	207-08-9	2.00E-01	4.00E-01	Risk	No	Below SSL	0/ 13	LL9ss-068-0001-SO	12/12/2003
Bis(2-ethylhexyl)phthalate	117-81-7	3.00E-02	1.40E+00	MCL	No	Below SSL	0/ 10	LL9ss-068-0001-SO	12/12/2003
Chrysene	218-01-9	2.50E-01	1.20E+00	Risk	No	Below SSL	0/ 13	LL9ss-068-0001-SO	12/12/2003
Dibenz(a,h)anthracene	**53-70-3**	**1.30E-01**	**1.30E-02**	**Risk**	**Yes**	**Exceeds SSL**	**3/ 13**	**LL9ss-068-0001-SO**	**12/12/2003**
Dibenzofuran	132-64-9	1.30E-02	1.50E-01	Risk	No	Below SSL	0/ 10	LL9ss-068-0001-SO	12/12/2003
Fluoranthene	206-44-0	3.60E-01	8.90E+01	Risk	No	Below SSL	0/ 13	LL9ss-068-0001-SO	12/12/2003
Fluorene	86-73-7	2.50E-02	5.40E+00	Risk	No	Below SSL	0/ 13	LL9ss-068-0001-SO	12/12/2003
Indeno(1,2,3-cd)pyrene	**193-39-5**	**1.70E-01**	**1.30E-01**	**Risk**	**Yes**	**Exceeds SSL**	**1/ 13**	**LL9ss-068-0001-SO**	**12/12/2003**
Naphthalene	**91-20-3**	**1.90E-02**	**5.40E-04**	**Risk**	**Yes**	**Exceeds SSL**	**2/ 13**	**LL9ss-068-0001-SO**	**12/12/2003**
Phenanthrene	85-01-8	2.80E-01	1.30E+01	Risk	No	Below SSL	0/ 13	LL9ss-068-0001-SO	12/12/2003
Pyrene	129-00-0	4.00E-01	1.30E+01	Risk	No	Below SSL	0/ 13	LL9ss-068-0001-SO	12/12/2003

Table E-4. Initial CMCOPCs Based on Maximum Concentration of SRCs Compared to GSSL for Load Line 9 (continued)

Analyte	CAS Number	Maximum Concentration (mg/kg)	GSSL (mg/kg)	GSSL Type (mg/kg)	Initial CMCOPC (Yes/No)	CMCOPC Justification	Samples > SSL / Total Samples	Sample ID at Maximum Concentration	Date Collected
Dry Well Area									
Inorganic Chemicals									
Cadmium	7440-43-9	8.30E-02	3.80E-01	MCL	No	Below SSL	0/ 7	LL9sb-093-5463-SO	3/9/2010
Lead	**7439-92-1**	**5.10E+01**	**1.40E+01**	**MCL**	**Yes**	**Exceeds SSL**	**2/ 7**	**LL9sb-065-0001-SO**	**11/6/2003**
Mercury	**7439-97-6**	**9.70E+00**	**1.00E-01**	**MCL**	**Yes**	**Exceeds SSL**	**4/ 7**	**LL9sb-065-0001-SO**	**11/6/2003**
Thallium	7440-28-0	1.40E-01	1.40E-01	MCL	No	Below SSL	0/ 7	LL9sb-093-5461-SO	3/9/2010

CAS = Chemical Abstract Service.
CMCOPC = Contaminant Migration Chemical of Potential Concern.
GSSL = Generic Soil Screening Level.
ID = Identification.
MCL = Maximum Contaminant Level.
mg/kg = Milligrams per kilogram.
SRC = Site-related Contaminant.
SSL = Soil Screening Level.
Bold = SRCs that exceed the GSSL.

Table E-5. DAF Calculations for Load Line 9

$$DAF = 1 + \frac{(K \times i \times d)}{(q \times L)}$$

$$d = \sqrt{0.0112 \times L^2} + d_a \times \left[1 - \exp\left(\frac{-L \times q}{K \times i \times d_a}\right)\right]$$

Parameter	Symbol	Value	Unit	Note
Former Production Area				
DAF	DAF	1.93	unitless	Calculated from DAF equation shown above
Aquifer hydraulic conductivity	K	1.26E+02	m/year	Average from Load Line 9 monitoring wells (MKM 2007)
Horizontal hydraulic gradient	i	2.31E-02	m/m	Average hydraulic gradient determined from Figure 3-1
Percolation rate	q	9.40E-02	m/year	Developed from HELP model from Cleveland, Ohio, weather data
Source length parallel to groundwater flow	L	200	m	Based on half-width of Former Production Area within Load Line 9
Mixing zone depth	d	6	m	Determined from the lower value between above equation for "d" (d = 25.12 m) and d_a
Aquifer thickness	d_a	6	m	Facility-wide assumption for the unconsolidated aquifer presented in the Load Line 1 investigation (USACE 2003)
Non-production Area				
DAF	DAF	3.22	unitless	Calculated from DAF equation shown above
Aquifer hydraulic conductivity	K	1.26E+02	m/year	Average from Load Line 9 monitoring wells (MKM 2007)
Horizontal hydraulic gradient	i	2.31E-02	m/m	Average hydraulic gradient determined from Figure 3-1
Percolation rate	q	9.40E-02	m/year	Developed from HELP model from Cleveland, Ohio, weather data
Source length parallel to groundwater flow	L	83.7	m	Based on average width of non-production area exposure unit within Load Line 9
Mixing zone depth	d	6	m	Determined from the lower value between above equation for "d" (d = 11.03 m) and d_a
Aquifer thickness	d_a	6	m	Facility-wide assumption for the unconsolidated aquifer presented in the Load Line 1 investigation (USACE 2003)
Dry Well Area				
DAF	DAF	4.72	unitless	Calculated from DAF equation shown above
Aquifer hydraulic conductivity	K	1.26E+02	m/year	Average from Load Line 9 monitoring wells (MKM 2007)
Horizontal hydraulic gradient	i	2.31E-02	m/m	Average hydraulic gradient determined from Figure 3-1
Percolation rate	q	9.40E-02	m/year	Developed from HELP model from Cleveland, Ohio, weather data
Source length parallel to groundwater flow	L	50	m	Approximate length based on extent of contamination

Table E-5. DAF Calculations for Load Line 9 (continued)

Parameter	Symbol	Value	Unit	Notes
Mixing zone depth	d	6	m	Determined from the lower value between above equation for "d" (d = 6.71 m) and d_a
Aquifer thickness	d_a	6	m	Facility-wide assumption for the unconsolidated aquifer presented in the Load Line 1 investigation (USACE 2003)

MKM (MKM Engineers, Inc.) 2007. *Final Report for the Phase I Remedial Investigation at Load Line 9 (RVAAP 42).* August 2007.

USACE (United States Army Corps of Engineers) 2003. *Phase II Remedial Investigation Report for the Load Line 1 at the Ravenna Army Ammunition Plant, Ravenna, Ohio*. June 2003.

DAF = Dilution Attenuation Factor.

HELP = Hydrologic Evaluation of Landfill Performance.

Table E-6. Initial CMCOPCs Based on Comparison of the SRCs Maximum Concentration to SSSL at Load Line 9

Analyte	CAS Number	Maximum Concentration (mg/kg)	SSSL (mg/kg)	Initial CMCOPC (Yes/No)	CMCOPC Justification	Sample ID at Maximum Concentration	Date Collected
Former Production Area with DAF = 1.93							
Inorganic Chemicals							
Antimony	**7440-36-0**	**1.20E+00**	**5.21E-01**	**Yes**	**Exceeds SSSL**	**LL9ss-026-0001-SO**	**12/10/03**
Arsenic	**7440-38-2**	**3.20E+01**	**5.60E-01**	**Yes**	**Exceeds SSSL**	**LL9sb-019-0001-SO**	**12/11/03**
Barium	**7440-39-3**	**1.80E+02**	**1.58E+02**	**Yes**	**Exceeds SSSL**	**LL9ss-096-5474-SO**	**03/01/10**
Cadmium	**7440-43-9**	**2.90E+00**	**7.33E-01**	**Yes**	**Exceeds SSSL**	**LL9ss-006-0001-SO**	**12/11/03**
Cobalt	**7440-48-4**	**1.90E+01**	**5.21E-01**	**Yes**	**Exceeds SSSL**	**LL9sb-041-0001-SO**	**10/27/03**
Lead	**7439-92-1**	**3.20E+02**	**2.70E+01**	**Yes**	**Exceeds SSSL**	**LL9ss-024-0001-SO**	**12/10/03**
Manganese	**7439-96-5**	**3.24E+03**	**5.40E+01**	**Yes**	**Exceeds SSSL**	**LL9ss-097-5475-SO**	**03/01/10**
Mercury	**7439-97-6**	**1.50E+00**	**1.93E-01**	**Yes**	**Exceeds SSSL**	**LL9sb-091-5455-SO**	**03/09/10**
Nickel	7440-02-0	3.70E+01	5.02E+01	No	Below SSSL	LL9sb-041-0001-SO	10/27/03
Selenium	**7782-49-2**	**1.40E+00**	**5.02E-01**	**Yes**	**Exceeds SSSL**	**LL9ss-097-5475-SO**	**03/01/10**
Thallium	**7440-28-0**	**1.00E+00**	**2.70E-01**	**Yes**	**Exceeds SSSL**	**LL9sb-043-0001-SO**	**11/06/03**
Semi-volatile Organic Compounds							
Benz(*a*)anthracene	**56-55-3**	**1.70E+01**	**8.20E-03**	**Yes**	**Exceeds SSSL**	**LL9ss-096-5474-SO**	**03/01/10**
Benzo(*a*)pyrene	**50-32-8**	**1.50E+01**	**4.63E-01**	**Yes**	**Exceeds SSSL**	**LL9ss-096-5474-SO**	**03/01/10**
Benzo(*b*)fluoranthene	**205-99-2**	**2.00E+01**	**7.91E-02**	**Yes**	**Exceeds SSSL**	**LL9ss-096-5474-SO**	**03/01/10**
Benzo(*k*)fluoranthene	**207-08-9**	**7.10E+00**	**7.72E-01**	**Yes**	**Exceeds SSSL**	**LL9ss-096-5474-SO**	**03/01/10**
Chrysene	**218-01-9**	**1.70E+01**	**2.32E+00**	**Yes**	**Exceeds SSSL**	**LL9ss-096-5474-SO**	**03/01/10**
Dibenz(*a,h*)anthracene	**53-70-3**	**2.20E+00**	**2.51E-02**	**Yes**	**Exceeds SSSL**	**LL9ss-096-5474-SO**	**03/01/10**
Indeno(1,2,3-*cd*)pyrene	**193-39-5**	**8.50E+00**	**2.51E-01**	**Yes**	**Exceeds SSSL**	**LL9ss-096-5474-SO**	**03/01/10**
Naphthalene	**91-20-3**	**9.20E-01**	**1.04E-03**	**Yes**	**Exceeds SSSL**	**LL9ss-096-5474-SO**	**03/01/10**
Phenanthrene	**85-01-8**	**4.30E+01**	**2.51E+01**	**Yes**	**Exceeds SSSL**	**LL9ss-096-5474-SO**	**03/01/10**
Pyrene	**129-00-0**	**3.40E+01**	**2.51E+01**	**Yes**	**Exceeds SSSL**	**LL9ss-096-5474-SO**	**03/01/10**
Non-production Area with DAF = 3.22							
Inorganic Chemicals							
Antimony	**7440-36-0**	**1.40E+00**	**8.69E-01**	**Yes**	**Exceeds SSSL**	**LL9ss-011-0001-SO**	**03/11/02**
Arsenic	**7440-38-2**	**1.80E+01**	**9.34E-01**	**Yes**	**Exceeds SSSL**	**LL9sb-027-0001-SO**	**12/04/03**
Barium	7440-39-3	1.10E+02	2.64E+02	No	Below SSSL	LL9ss-068-0001-SO	12/12/03
Cadmium	**7440-43-9**	**2.70E+00**	**1.22E+00**	**Yes**	**Exceeds SSSL**	**LL9ss-068-0001-SO**	**12/12/03**
Cobalt	**7440-48-4**	**1.80E+01**	**8.69E-01**	**Yes**	**Exceeds SSSL**	**LL9ss-027-0001-SO**	**12/04/03**
Copper	**7440-50-8**	**1.24E+03**	**1.48E+02**	**Yes**	**Exceeds SSSL**	**LL9ss-011-0001-SO**	**03/11/02**

Table E-6. Initial CMCOPCs Based on Comparison of the SRCs Maximum Concentration to SSSL at Load Line 9 (continued)

Analyte	CAS Number	Maximum Concentration (mg/kg)	SSSL (mg/kg)	Initial CMCOPC (Yes/No)	CMCOPC Justification	Sample ID at Maximum Concentration	Date Collected
Lead	**7439-92-1**	**1.33E+03**	**4.51E+01**	**Yes**	**Exceeds SSSL**	**LL9ss-011-0001-SO**	**03/11/02**
Manganese	**7439-96-5**	**3.80E+03**	**9.02E+01**	**Yes**	**Exceeds SSSL**	**LL9ss-027-0001-SO**	**12/04/03**
Mercury	**7439-97-6**	**8.82E+02**	**3.22E-01**	**Yes**	**Exceeds SSSL**	**LL9ss-011-0001-SO**	**03/11/02**
Selenium	**7782-49-2**	**1.80E+00**	**8.37E-01**	**Yes**	**Exceeds SSSL**	**LL9ss-068-0001-SO**	**12/12/03**
Zinc	7440-66-6	7.80E+02	1.19E+03	No	Below SSSL	LL9ss-068-0001-SO	12/12/03
Semi-volatile Organic Compounds							
Benz(*a*)anthracene	**56-55-3**	**2.30E-01**	**1.37E-02**	**Yes**	**Exceeds SSSL**	**LL9ss-068-0001-SO**	**12/12/03**
Benzo(*b*)fluoranthene	**205-99-2**	**2.40E-01**	**1.32E-01**	**Yes**	**Exceeds SSSL**	**LL9ss-068-0001-SO**	**12/12/03**
Dibenz(a,h)anthracene	**53-70-3**	**1.30E-01**	**4.19E-02**	**Yes**	**Exceeds SSSL**	**LL9ss-068-0001-SO**	**12/12/03**
Indeno(1,2,3-*cd*)pyrene	193-39-5	1.70E-01	4.19E-01	No	Below SSSL	LL9ss-068-0001-SO	12/12/03
Naphthalene	**91-20-3**	**1.90E-02**	**1.74E-03**	**Yes**	**Exceeds SSSL**	**LL9ss-068-0001-SO**	**12/12/03**
Dry Well Area with DAF = 4.72							
Inorganic Chemicals							
Lead	7439-92-1	5.10E+01	6.61E+01	No	Below SSSL	LL9sb-065-0001-SO	11/06/03
Mercury	**7439-97-6**	**9.70E+00**	**4.72E-01**	**Yes**	**Exceeds SSSL**	**LL9sb-065-0001-SO**	**11/06/03**

CAS = Chemical Abstract Service.
CMCOPC = Contaminant Migration Chemical of Potential Concern.
DAF = Dilution Attenuation Factor.
ID = Identification.
mg/kg = Milligrams per kilogram.
SRC = Site-related Contaminant.
SSSL = Site-specific Soil Screening Level = SSL X DAF.
Bold = SRCs that exceed the SSSL.

Table E-7. Initial CMCOPCs Based on Arrival Time to Groundwater Table in Less Than or Equal to 1,000 Years at Load Line 9

$$R = 1 + \frac{\rho_b K_d}{\theta_w}$$

$$T = L_z \theta_w R / q$$

Parameter	Symbol	Value	Unit	Note
Percolation rate	q	0.31	ft/year	Developed from HELP model from Cleveland, Ohio, weather data
Soil-water distribution coefficient	K_d	chemical-specific	L/kg	See footnotes below for references
Organic carbon distribution coefficient	K_{oc}	chemical-specific	L/kg	See footnotes below for references
Fraction organic carbon	f_{oc}	0.0012	unitless	From PBA08 RI geotechnical samples Load Line 7, Load Line 10, and Load Line 11
Water-filled soil porosity	θ_w	0.311	unitless	
Bulk density (dry)	ρ_b	1.70	gm/cm^3	
Leaching zone	Lz	ISM-specific	ft	Distance from last layer of soil contamination greater than background concentration to top of water table
Retardation factor	R	chemical-specific	unitless	Calculated by equation shown above
Arrival time	T	chemical-specific	year	Calculated by equation shown above

Table E-7. Initial CMCOPCs Based on Arrival Time to Groundwater Table in Less Than or Equal to 1,000 Years at Load Line 9 (continued)

Analyte	Initial CMCOPC Sample ID	Sample Depth[a] (ft)	Lz[b] (ft)	K_{oc} (L/kg)	Reference	K_d (L/kg)	Reference	Retardation Factor (R)	Arrival Time (T) from Sample Max Depth to Groundwater (years)	T <1,000? from Sample Depth to Groundwater Table (Yes/No)
Former Production Area										
Inorganic Chemicals										
Antimony	LL9sb-024-0001-SO	3.0	8.0	NA	-	4.50E+01	c	2.47E+02	1,982	No
Arsenic	**LL9sb-089-5448-SO**	**13.0**	**0.0**	**NA**	**-**	**2.90E+01**	**c**	**1.60E+02**	**0**	**Yes**
Barium	LL9sb-040-0001-SO	7.0	8.0	NA	-	4.10E+01	c	2.25E+02	1,807	No
Cadmium	LL9sb-006-0001-SO	2.0	9.0	NA	-	7.50E+01	c	4.11E+02	3,711	No
Cobalt	LL9ss-037-0001-SO	1.0	12.0	NA	-	4.50E+01	c	2.47E+02	2,973	No
Lead	LL9sb-041-0001-SO	7.5	2.5	NA	-	9.00E+02	c	4.92E+03	12,341	No
Manganese	LL9ss-097-5475-SO	1.0	5.0	NA	-	6.50E+01	c	3.56E+02	1,787	No
Mercury	LL9sb-040-0001-SO	7.0	8.0	NA	-	5.20E+01	c	2.85E+02	2,289	No
Selenium	**LL9ss-097-5475-SO**	**1.0**	**5.0**	**NA**	**-**	**5.00E+00**	**c**	**2.83E+01**	**142**	**Yes**
Thallium	**LL9sb-043-0001-SO**	**11.0**	**0.0**	**NA**	**-**	**7.10E+01**	**c**	**3.89E+02**	**0**	**Yes**
Semi-volatile Organic Compounds										
Benz(*a*)anthracene	LL9sb-040-0001-SO	7.0	8.0	1.77E+05	c	2.12E+02	d	1.16E+03	9,321	No
Benzo(*a*)pyrene	LL9ss-096-5474-SO	1.0	5.0	5.87E+05	c	7.05E+02	d	3.85E+03	19,332	No
Benzo(*b*)fluoranthene	LL9sb-040-0001-SO	7.0	8.0	5.99E+05	c	7.19E+02	d	3.93E+03	31,564	No
Benzo(*k*)fluoranthene	LL9ss-096-5474-SO	1.0	5.0	5.87E+05	c	7.05E+02	d	3.85E+03	19,332	No
Chrysene	LL9ss-096-5474-SO	1.0	5.0	1.81E+05	c	2.17E+02	d	1.18E+03	5,944	No
Dibenz(*a*,*h*)anthracene	LL9sb-040-0001-SO	7.0	8.0	1.91E+06	c	2.29E+03	d	1.25E+04	100,666	No
Indeno(1,2,3-*cd*)pyrene	LL9ss-096-5474-SO	1.0	5.0	1.95E+06	c	2.34E+03	d	1.28E+04	64,166	No
Naphthalene	**LL9ss-096-5474-SO**	**1.0**	**5.0**	**1.54E+03**	**c**	**1.85E+00**	**d**	**1.11E+01**	**56**	**Yes**
Phenanthrene	**LL9ss-096-5474-SO**	**1.0**	**5.0**	**1.82E+04**	**e**	**2.18E+01**	**d**	**1.20E+02**	**604**	**Yes**
Pyrene	LL9ss-096-5474-SO	1.0	5.0	5.43E+04	c	6.52E+01	d	3.57E+02	1,793	No
Non-production Area										
Metals										
Antimony	LL9ss-011-0001-SO	1.0	8.0	NA	-	4.50E+01	c	2.47E+02	1,982	No
Arsenic	LL9ss-011-0001-SO	1.0	8.0	NA	-	2.90E+01	c	1.60E+02	1,280	No
Cadmium	**LL9ss-068-0001-SO**	**1.0**	**1.0**	**NA**	**-**	**7.50E+01**	**c**	**4.11E+02**	**412**	**Yes**
Cobalt	**LL9ss-027-0001-SO**	**1.0**	**1.0**	**NA**	**-**	**4.50E+01**	**c**	**2.47E+02**	**248**	**Yes**
Copper	LL9ss-011-0001-SO	1.0	8.0	NA	-	3.50E+01	c	1.92E+02	1,544	No

Table E-7. Initial CMCOPCs Based on Arrival Time to Groundwater Table in Less Than or Equal to 1,000 Years at Load Line 9 (continued)

Analyte	Initial CMCOPC Sample ID	Sample Depth[a] (ft)	Lz[b] (ft)	K_{oc} (L/kg)	Reference	K_d (L/kg)	Reference	Retardation Factor (R)	Arrival Time (T) from Sample Max Depth to Groundwater (years)	T <1,000? from Sample Depth to Groundwater Table (Yes/No)
Lead	LL9ss-011-0001-SO	1.0	8.0	NA	-	9.00E+02	c	4.92E+03	39,492	No
Manganese	**LL9ss-027-0001-SO**	**1.0**	**1.0**	**NA**	**-**	**6.50E+01**	**c**	**3.56E+02**	**357**	**Yes**
Mercury	LL9ss-011-0001-SO	1.0	8.0	NA	-	5.20E+01	c	2.85E+02	2,289	No
Selenium	**LL9ss-068-0001-SO**	**1.0**	**1.0**	**NA**	**-**	**5.00E+00**	**c**	**2.83E+01**	**28**	**Yes**
Semi-volatile Organic Compounds										
Benz(*a*)anthracene	LL9sb-059-0001-SO	5.0	3.0	1.77E+05	c	2.12E+02	d	1.16E+03	3,495	No
Benzo(*b*)fluoranthene	LL9ss-068-0001-SO	1.0	1.0	5.99E+05	c	7.19E+02	d	3.93E+03	3,945	No
Dibenz(*a*,*h*)anthracene	LL9sb-032-0001-SO	3.0	15.0	1.91E+06	c	2.29E+03	d	1.25E+04	188,748	No
Naphthalene	**LL9ss-068-0001-SO**	**1.0**	**1.0**	**1.54E+03**	**c**	**1.85E+00**	**d**	**1.11E+01**	**11**	**Yes**
Dry Well Area										
Inorganic Chemicals										
Mercury	**LL9sb-065-0001-SO**	**5.00E+00**	**0.0**	**NA**	**-**	**5.20E+01**	**c**	**2.85E+02**	**0**	**Yes**

[a] The maximum depth of an initial CMCOPC (based on the maximum depth that an analyte is detected above facility-wide background).
[b] Based on each specific sample ID location and depth to water table shown in Figure 3-1.
[c] USEPA RSL Generic Tables June 2015; found at: < http://www2.epa.gov/risk/risk-based-screening-table-generic-tables>.
[d] K_d value for organic chemicals calculated by multiplying K_{oc} by foc of 0.0012 (average PBA08 RI geotechnical data from Load Line 7, Load Line 10, and Load Line 11).
[e] USEPA 1994. Risk Reduction Engineering Laboratory Treatability Database, Ver. 5.0, Office of Research and Development, Cincinnati, Ohio.
CMCOPC = Contaminant Migration Chemical of Potential Concern.
HELP = Hydrologic Evaluation of Landfill Performance.
ID = Identification.
ft = Feet.
gm/cm3 = Grams per cubic centimeter.
ISM = Incremental Sampling Method
K_{oc} = Organic carbon partition coefficient.
L/kg = Liters per kilogram.
Lz = Leaching zone.
NA = Not Applicable.
PBA08 RI = Performance Based Acquisition 2008 Remedial Investigation.
Bold = Initial CMCOPCs that exceed the 1,000-year travel time screen.

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Table E-8. Results for SRCs in Sediment at Load Line 9

Analyte	CAS Number	Background Criteria (mg/kg)[a]	Maximum Sediment Concentration (mg/kg)	Sediment Sample ID	K_{oc} (L/kg)	Reference	K_d (L/kg)	Reference	Maximum Groundwater Concentration (mg/L)[b]	DAF[c]	Maximum Groundwater Concentration (mg/L)/DAF	MCL or RSL (mg/L)	MCL or RSL?	CMCOPC (Yes/No)
Drainage Ditches														
Inorganic Chemicals														
Antimony	7440-36-0	0.00E+00	1.60E-01	LL9sd-113-5471-SD	NA	-	4.50E+01	f	3.56E-03	2	1.78E-03	6.00E-03	MCL	No
Beryllium	7440-41-7	3.80E-01	8.90E-01	LL9sd-113-5471-SD	NA	-	7.90E+02	f	1.13E-03	9	1.25E-04	4.00E-03	MCL	No
Cadmium	7440-43-9	0.00E+00	7.20E-01	LL9sd-113-5471-SD	NA	-	7.50E+01	f	9.60E-03	140	6.86E-05	5.00E-03	MCL	No
Cobalt	7440-48-4	9.10E+00	1.00E+01	LL9sd-113-5471-SD	NA	-	4.50E+01	f	2.22E-01	317	7.01E-04	6.00E-03	RSL	No
Lead	7439-92-1	2.74E+01	3.11E+01	LL9sd-113-5471-SD	NA	-	9.00E+02	f	3.46E-02	10	3.46E-03	1.50E-02	MCL	No
Mercury	**7439-97-6**	**5.90E-02**	**3.70E-01**	**LL9sd-114-5472-SD**	**NA**	**-**	**5.20E+01**	**f**	**7.12E-03**	**2**	**3.56E-03**	**2.00E-03**	**MCL**	**Yes**
Nickel	7440-02-0	1.77E+01	1.93E+01	LL9sd-113-5471-SD	NA	-	6.50E+01	f	2.97E-01	106	2.80E-03	3.90E-01	RSL	No
Silver	7440-22-4	0.00E+00	6.60E-02	LL9sd-113-5471-SD	NA	-	8.30E+00	f	7.95E-03	2	3.98E-03	9.40E-02	RSL	No
Explosives														
Nitroguanidine	**556-88-7**	**None**	**1.20E+00**	**LL9sd-113-5471-SD**	**2.07E+01**	**f**	**2.48E-02**	**g**	**4.84E+01**	**2**	**2.42E+01**	**2.00E+00**	**RSL**	**Yes**
PETN	**78-11-5**	**None**	**1.30E-01**	**LL9sd-114-5472-SD**	**6.48E+02**	**f**	**7.78E-01**	**g**	**1.67E-01**	**2**	**8.36E-02**	**1.90E-02**	**RSL**	**Yes**
Semi-volatile Organic Compounds														
2-Methylnaphthalene	91-57-6	None	1.40E-02	LL9sd-114-5472-SD	2.48E+03	f	2.98E+00	g	4.70E-03	2	2.35E-03	3.60E-02	RSL	No
Benz(*a*)anthracene	**56-55-3**	**None**	**3.60E-02**	**LL9sd-114-5472-SD**	**1.77E+05**	**f**	**2.12E+02**	**g**	**1.69E-04**	**2**	**8.47E-05**	**1.20E-05**	**RSL**	**Yes**
Benzenemethanol	100-51-6	None	3.60E-02	LL9sd-113-5471-SD	2.15E+01	f	2.58E-02	g	1.40E+00	2	6.98E-01	2.00E+00	RSL	No
Benzo(*a*)pyrene	50-32-8	None	3.90E-02	LL9sd-114-5472-SD	5.87E+05	f	7.04E+02	g	5.54E-05	2	2.77E-05	2.00E-04	MCL	No
Benzo(*b*)fluoranthene	**205-99-2**	**None**	**5.80E-02**	**LL9sd-114-5472-SD**	**5.99E+05**	**f**	**7.19E+02**	**g**	**8.07E-05**	**2**	**4.03E-05**	**3.40E-05**	**RSL**	**Yes**
Benzo(*ghi*)perylene[d]	191-24-2	None	2.70E-02	LL9sd-114-5472-SD	1.07E+07	h	1.28E+04	g	2.10E-06	2	1.05E-06	1.20E-01	RSL	No
Benzo(*k*)fluoranthene	207-08-9	None	1.90E-02	LL9sd-114-5472-SD	5.87E+05	f	7.04E+02	g	2.70E-05	2	1.35E-05	3.40E-04	RSL	No
Chrysene	218-01-9	None	4.00E-02	LL9sd-114-5472-SD	1.81E+05	f	2.17E+02	g	1.84E-04	2	9.21E-05	3.40E-03	RSL	No
Fluoranthene	206-44-0	None	9.50E-02	LL9sd-114-5472-SD	5.55E+04	f	6.66E+01	g	1.43E-03	2	7.13E-04	8.00E-01	RSL	No
Indeno(1,2,3-*cd*)pyrene	193-39-5	None	2.40E-02	LL9sd-114-5472-SD	1.95E+06	f	2.34E+03	g	1.03E-05	2	5.13E-06	3.40E-05	RSL	No
Naphthalene	**91-20-3**	**None**	**9.20E-03**	**LL9sd-114-5472-SD**	**1.54E+03**	**f**	**1.85E+00**	**g**	**4.98E-03**	**2**	**2.49E-03**	**1.70E-04**	**RSL**	**Yes**
Phenanthrene[e]	85-01-8	None	3.90E-02	LL9sd-114-5472-SD	1.82E+04	h	2.18E+01	g	1.79E-03	2	8.93E-04	1.20E-01	RSL	No
Pyrene	129-00-0	None	6.70E-02	LL9sd-114-5472-SD	5.43E+04	f	6.52E+01	g	1.03E-03	2	5.14E-04	1.20E-01	RSL	No
Volatile Organic Compounds														
Toluene	108-88-3	None	4.40E-04	LL9sd-113-5471-SD	2.34E+02	f	2.81E-01	g	1.57E-03	2	3.62E-04	1.00E+00	MCL	No

Table E-8. Results for SRCs in Sediment at Load Line 9 (continued)

Analyte	CAS Number	Background Criteria (mg/kg)[a]	Maximum Sediment Concentration (mg/kg)	Sediment Sample ID	K_{oc} (L/kg)	Reference	K_d (L/kg)	Reference	Maximum Groundwater Concentration (mg/L)[b]	DAF[c]	Maximum Groundwater Concentration (mg/L)/DAF	MCL or RSL (mg/L)	MCL or RSL?	CMCOPC (Yes/No)
Dry Well Area														
Inorganic Chemicals														
Beryllium	7440-41-7	3.80E-01	8.60E-01	LL9sd-012-0001-SD	NA	-	7.90E+02	f	1.09E-03	13	8.37E-05	4.00E-03	MCL	No
Mercury	7439-97-6	5.90E-02	2.90E+00	LL9sd-012-0001-SD	NA	-	5.20E+01	f	5.58E-02	186	3.00E-04	2.00E-03	MCL	No
Nickel	7440-02-0	1.77E+01	1.90E+01	LL9sd-012-0001-SD	NA	-	6.50E+01	f	2.92E-01	55	5.31E-03	3.90E-01	RSL	No

[a]Background criteria for sediment from final facility-wide background values for the Ravenna Army Ammunition Plant, published in the Final *Phase II Remedial Investigation Report for Winklepeck Burning Grounds at Ravenna Army Ammunition Plant, Ravenna, Ohio* (USACE 2001).
[b]Maximum groundwater concentration = maximum sediment concentration divided by the distribution coefficient.
[c] An exposure unit-specific DAF was calculated based on the sediment and co-located surface water concentrations (Table 6-2) by dividing the calculated groundwater concentration by the co-located surface water concentration. The lowest calculated DAF for each exposure unit (i.e., 2 for the Load Line 9 Drainage Ditches and 13 for the Dry Well Area) was used for analytes that did not have an exposure unit-specific DAF.
[d]Pyrene RSL was used as a surrogate for benzo(*ghi*)perylene.
[e]Pyrene RSL was used as a surrogate for phenanthrene.
[f]USEPA RSL Generic Tables June 2015; found at: < http://www2.epa.gov/risk/risk-based-screening-table-generic-tables>.
[g]K_d value for organic chemicals calculated by multiplying K_{oc} by foc of 0.0012 (average geotechnical data from Load Line 7, Load Line 10, and Load Line 11).
[h]USEPA 1994. Risk Reduction Engineering Laboratory Treatability Database, Ver. 5.0, Office of Research and Development, Cincinnati, Ohio.
CAS = Chemical Abstract Service.
CMCOPC = Contaminant Migration Chemical of Potential Concern.
DAF = Dilution Attenuation Factor.
ID = Identification.
K_d = Distribution coefficient.
K_{oc} = Organic carbon distribution coefficient.
L/kg = Liters per kilogram.
MCL = Maximum Contaminant Level.
mg/kg = Milligrams per kilogram.
mg/L = Milligrams per liter.
NA = Not Applicable.
RSL = Regional Screening Level (USEPA 2015).
SRC = Site-related Contaminant.
Bold = Final CMCOPC to be modeled with Analytical Transient 1-, 2-, 3-Dimensional model.

Table E-9. Climatic Data from SESOIL for Load Line 9

Month	Air Temp (°C)	Cloud Cover	Humidity	Albedo	Evapotranspiration[a] (cm/day)	Precipitation (cm)	Duration (days)	Storms per Month	Model Days in Month
October	12	0.60	0.70	0.17	0.00	6.46	0.42	5.33	30.4
November	5.22	0.70	0.75	0.24	0.00	7.4	0.53	6.67	30.4
December	-1.06	0.80	0.75	0.31	0.00	7.06	0.57	6.14	30.4
January	-2.94	0.80	0.80	0.3	0.00	7.06	0.61	5.69	30.4
February	-2.33	0.70	0.75	0.32	0.00	5.76	0.53	5.09	30.4
March	2.33	0.70	0.70	0.29	0.00	8.26	0.55	7.14	30.4
April	9.11	0.70	0.70	0.19	0.00	8.83	0.48	7.4	30.4
May	14.61	0.60	0.70	0.16	0.00	8.46	0.45	7.15	30.4
June	19.89	0.60	0.70	0.16	0.00	9.07	0.36	6.57	30.4
July	21.89	0.50	0.70	0.16	0.00	9.8	0.3	6.06	30.4
August	21.11	0.55	0.70	0.16	0.00	8.14	0.3	6.06	30.4
September	17.67	0.55	0.70	0.16	0.00	7.85	0.4	5.44	30.4

[a] Data calculated in SESOIL model; 0.00 indicates evapotranspiration is calculated from other climatic data -1996 data from Youngstown, Ohio, Weather Service Office - Airport Station.

cm/day = Centimeters per day.

SESOIL = Seasonal Soil Compartment.

Table E-10. Physical and Chemical Properties of Initial CMCOPCs Selected for SESOIL Modeling for Load Line 9

Initial CMCOPC	Molecular Weight	Solubility (mg/L)	Reference	K_d (L/kg)[a]	Reference	Diffusion Coefficient in Air (cm^2/sec)	Reference	Biodegradation Rate (1/day)	Sample Location	Application Area (cm^2)
Former Production Area										
Inorganic Chemicals										
Arsenic	78.0	0.00E+00	b	2.90E+01	b	NA	NA	NA	LL9sb-019-0001-SO	4.35E+07
Selenium	81.0	0.00E+00	b	5.00E+00	b	NA	NA	NA	LL9ss-097-5475-SO	9.29E+04
Thallium	204.4	0.00E+00	b	7.10E+01	b	NA	NA	NA	LL9sb-043-0001-SO	9.29E+04
Semi-volatile Organic Compounds										
Naphthalene	128.2	3.10E+01	b	1.85E+00	a	6.0E-02	b	NA	LL9ss-096-5474-SO	2.15E+07
Phenanthrene	178.2	1.40E-01	b	2.18E+01	c	2.80E-02	b	NA	LL9ss-096-5474-SO	2.15E+07
Non-production Area										
Inorganic Chemicals										
Cadmium	112.4	0.00E+00	b	7.50E+01	b	NA	NA	NA	LL9ss-068-0001-SO	9.29E+04
Cobalt	58.9	0.00E+00	b	4.50E+01	b	NA	NA	NA	LL9ss-027-0001-SO	3.72E+05
Manganese	54.9	0.00E+00	b	6.50E+01	b	NA	NA	NA	LL9ss-027-0001-SO	3.72E+05
Selenium	81.0	0.00E+00	b	5.00E+00	b	NA	NA	NA	LL9ss-068-0001-SO	9.29E+04
Semi-volatile Organic Compounds										
Naphthalene	128.2	3.10E+01	b	1.85E+00	a	6.0E-02	b	NA	LL9ss-068-0001-SO	9.29E+04
Dry Well Area										
Inorganic Chemicals										
Mercury	200.6	0.00E+00	b	5.20E+01	b	3.1E-02	b	NA	LL9sb-065-0001-SO	3.72E+05

[a]K_d value for organic chemicals calculated by multiplying K_{oc} by foc of 0.0012 (average geotechnical data from Load Line 7, Load Line 10, and Load Line 11).
[b]USEPA RSL Generic Tables June 2015; found at: < http://www2.epa.gov/risk/risk-based-screening-table-generic-tables>.
[c]USEPA 1994. Risk Reduction Engineering Laboratory Treatability Database, Ver. 5.0, Office of Research and Development, Cincinnati, Ohio.
CMCOPC = Contaminant Migration Chemical of Potential Concern.
cm^2/sec = Centimeters per second.
K_d = Distribution coefficient.
L/kg = Liters per kilogram.
mg/L = Milligrams per liter.
NA = Not Applicable.
SESOIL = Seasonal Soil Compartment.

Table E-11. Load Application Data for SESOIL Model at Load Line 9

9-ft-Thick Vadose Zone for Arsenic in the Former Production Area

Analyte	Number of Layers	Layer Number	Thickness of Layer (ft)	Number of Sublayers	Sublayer Number	Maximum Concentration (mg/kg)	Layer Purpose
Arsenic	4	1	1	1	1	17.0	Contaminant Loading
		2	2	2	1	32.0	
					2	32.0	
		3	5.5	1	1	0.0	Leaching
		4	0.5	1	1	0.0	

6-ft-Thick Vadose Zone for Selenium in the Former Production Area

Analyte	Number of Layers	Layer Number	Thickness of Layer (ft)	Number of Sublayers	Sublayer Number	Maximum Concentration (mg/kg)	Layer Purpose
Selenium	4	1	1	1	1	1.4	Contaminant Loading
		2	2	2	1	0.0	Leaching
					2	0.0	
		3	2.5	1	1	0.0	
		4	0.5	1	1	0.0	

11-ft-Thick Vadose Zone for Thallium in the Former Production Area

Analyte	Number of Layers	Layer Number	Thickness of Layer (ft)	Number of Sublayers	Sublayer Number	Maximum Concentration (mg/kg)	Layer Purpose
Thallium	4	1	1	1	1	0.0	Contaminant Loading
		2	7.75	2	1	0.0	
					2	0.0	
		3	2	1	1	1.0	
		4	0.25	1	1	0.0	Leaching

6-ft-Thick Vadose Zone for Naphthalene in the Former Production Area

Analyte	Number of Layers	Layer Number	Thickness of Layer (ft)	Number of Sublayers	Sublayer Number	Maximum Concentration (mg/kg)	Layer Purpose
Naphthalene	4	1	1	1	1	0.92	Contaminant Loading
		2	2	2	1	0.0	Leaching
					2	0.0	
		3	2.5	1	1	0.0	
		4	0.5	1	1	0.0	

6-ft-Thick Vadose Zone for Phenanthrene in the Former Production Area

Analyte	Number of Layers	Layer Number	Thickness of Layer (ft)	Number of Sublayers	Sublayer Number	Maximum Concentration (mg/kg)	Layer Purpose
Phenanthrene	4	1	1	1	1	43	Contaminant Loading
		2	2	2	1	0.0	Leaching
					2	0.0	
		3	2.5	1	1	0.0	
		4	0.5	1	1	0.0	

Table E-11. Load Application Data for SESOIL Model at Load Line 9 (continued)

2-ft-Thick Vadose Zone for Cadmium in the Non-production Area

Analyte	Number of Layers	Layer Number	Thickness of Layer (ft)	Number of Sublayers	Sublayer Number	Maximum Concentration (mg/kg)	Layer Purpose
Cadmium	4	1	1	1	1	2.7	Contaminant Loading
		2	0.5	2	1	0.0	Leaching
					2	0.0	
		3	0.25	1	1	0.0	
		4	0.25	1	1	0.0	

3-ft-Thick Vadose Zone for Cobalt in the Non-production Area

Analyte	Number of Layers	Layer Number	Thickness of Layer (ft)	Number of Sublayers	Sublayer Number	Maximum Concentration (mg/kg)	Layer Purpose
Cobalt	4	1	1	1	1	18	Contaminant Loading
		2	1	2	1	6.7	
					2	6.7	
		3	0.75	1	1	6.7	
		4	0.25	1	1	0.0	Leaching

3-ft-Thick Vadose Zone for Manganese in the Non-production Area

Analyte	Number of Layers	Layer Number	Thickness of Layer (ft)	Number of Sublayers	Sublayer Number	Maximum Concentration (mg/kg)	Layer Purpose
Manganese	4	1	1	1	1	3800.0	Contaminant Loading
		2	1	2	1	410.0	
					2	410.0	
		3	0.75	1	1	410.0	
		4	0.25	1	1	0.0	Leaching

2-ft-Thick Vadose Zone for Selenium in the Non-production Area

Analyte	Number of Layers	Layer Number	Thickness of Layer (ft)	Number of Sublayers	Sublayer Number	Maximum Concentration (mg/kg)	Layer Purpose
Selenium	4	1	1	1	1	1.8	Contaminant Loading
		2	0.5	2	1	0.0	Leaching
					2	0.0	
		3	0.25	1	1	0.0	
		4	0.25	1	1	0.0	

2-ft-Thick Vadose Zone for Naphthalene in the Non-production Area

Analyte	Number of Layers	Layer Number	Thickness of Layer (ft)	Number of Sublayers	Sublayer Number	Maximum Concentration (mg/kg)	Layer Purpose
Naphthalene	4	1	1	1	1	0.019	Contaminant Loading
		2	0.5	2	1	0.0	Leaching
					2	0.0	
		3	0.25	1	1	0.0	
		4	0.25	1	1	0.0	

Table E-11. Load Application Data for SESOIL Model at Load Line 9 (continued)

5-ft-Thick Vadose Zone for Mercury in the Dry Well Area

Analyte	Number of Layers	Layer Number	Thickness of Layer (ft)	Number of Sublayers	Sublayer Number	Maximum Concentration (mg/kg)	Layer Purpose
Mercury	4	1	1	1	1	0.0	Contaminant Loading
		2	1	2	1	0.0	
					2	0.0	
		3	2.75	1	1	9.7	
		4	0.25	1	1	0.0	Leaching

ft = Feet.
mg/kg = Milligrams per kilogram.
SESOIL = Seasonal Soil Compartment

Table E-12. Physical and Chemical Properties of Final CMCOPCs Selected for AT123D Modeling at Load Line 9

Analyte	K_d (L/kg)[a]	Source	Retardation Factor (R)	Source	Diffusion Coefficient in Water (cm^2/sec)	Source	Biodegradation Rate (1/day)	Source
Final CMCOPCs in Soil at the Former Production Area								
Inorganic Chemicals								
Arsenic	2.90E+01	c	1.60E+02	b	NA	NA	0.00E+00	NA
Selenium	5.00E+00	c	2.83E+01	b	NA	NA	0.00E+00	NA
Thallium	7.10E+01	c	3.89E+02	b	NA	NA	0.00E+00	NA
Semi-volatile Organic Compounds								
Naphthalene	1.85E+00	c	1.11E+01	b	8.38E-06	c	0.00E+00	NA
Phenanthrene[e]	2.18E+01	d	1.20E+02	b	7.25E-06	c	0.00E+00	NA
Final CMCOPCs in Soil at the Non-production Area								
Inorganic Chemicals								
Cadmium	7.50E+01	c	4.11E+02	b	NA	NA	0.00E+00	NA
Cobalt	4.50E+01	c	2.47E+02	b	NA	NA	0.00E+00	NA
Manganese	6.50E+01	c	9.85E+02	b	NA	NA	0.00E+00	NA
Selenium	5.00E+00	c	2.83E+01	b	NA	NA	0.00E+00	NA
Semi-volatile Organic Compounds								
Naphthalene	1.85E+00	c	1.11E+01	b	8.38E-06	c	0.00E+00	NA
Final CMCOPCs in Soil at the Dry Well Area								
Inorganic Chemicals								
Mercury	5.20E+01	c	2.85E+02	b	6.30E-06	c	0.00E+00	NA
Final CMCOPCs in Sediment at the Drainage Ditches								
Inorganic Chemicals								
Mercury	5.20E+01	c	2.85E+02	b	6.30E-06	c	0.00E+00	NA
Explosives								
Nitroguanidine	2.48E-02	c	1.14E+00	b	1.42E-05	c	0.00E+00	NA
PETN	7.78E-01	c	5.25E+00	b	6.77E-06	c	0.00E+00	NA
Semi-volatile Organic Compounds								
Benz(a)anthracene	2.12E+02	c	1.16E+03	b	6.75E-06	c	0.00E+00	NA
Benzo(b)fluoranthene	7.19E+02	c	3.93E+03	b	5.56E-06	c	0.00E+00	NA
Naphthalene	1.85E+00	c	1.11E+01	b	8.38E-06	c	0.00E+00	NA

[a]K_d value for organic chemicals calculated by multiplying K_{oc} by foc of 0.0012 (average geotechnical data from Load Line 7, Load Line 10, and Load Line 11).
[b]R value calculated from equation in Table E-7.
[c]USEPA RSL Generic Tables June 2015; found at: < http://www2.epa.gov/risk/risk-based-screening-table-generic-tables>.
[d]USEPA 1994. Risk Reduction Engineering Laboratory Treatability Database, Ver. 5.0, Office of Research and Development, Cincinnati, Ohio.
[e]Pyrene Diffusion Coefficient in Water was used as a surrogate for phenanthrene.

AT123D = Analytical Transient 1-, 2-, 3-Dimensional model.
cm^2/sec = Square centimeters per second.
CMCOPC = Contaminant Migration Chemical of Potential Concern.
K_d = Distribution coefficient.
L/kg = Liters per kilogram.
NA = Not Applicable.

Figures

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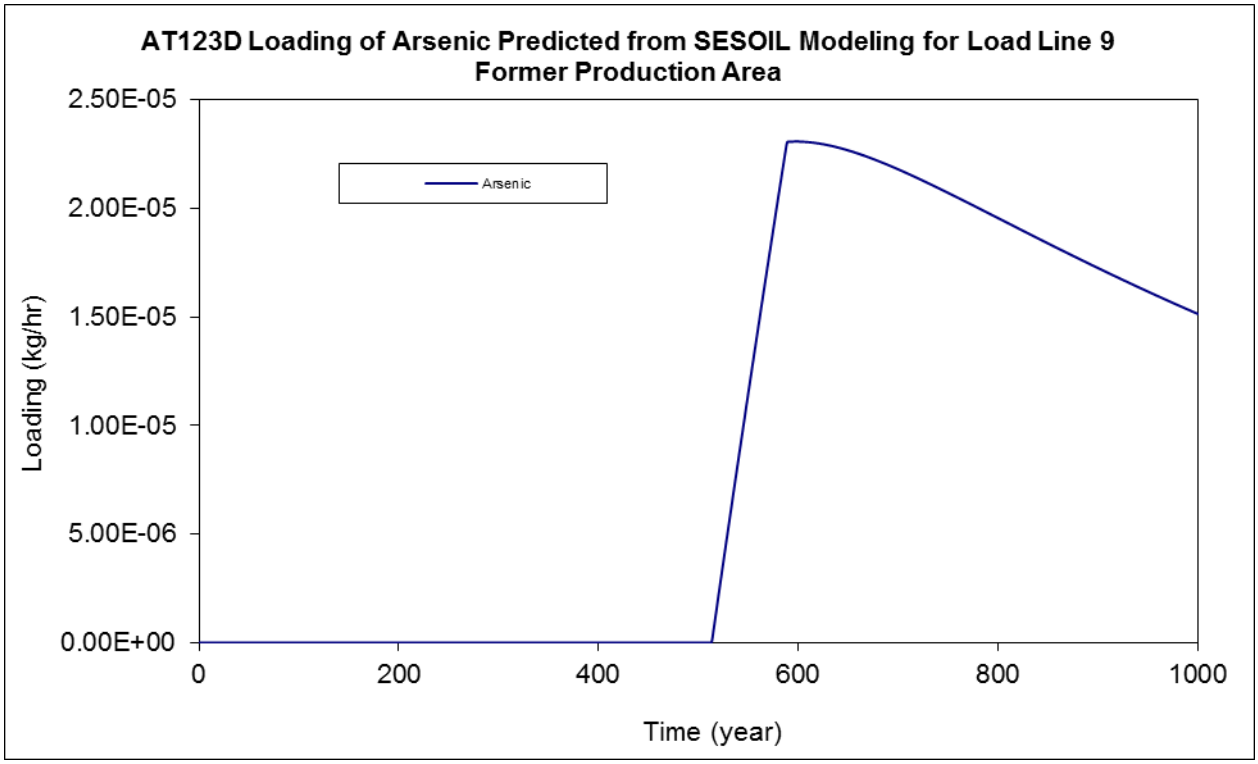

Figure E-1. Predicted Contaminant Mass Loading for AT123D Modeling at Load Line 9, Former Production Area – Arsenic

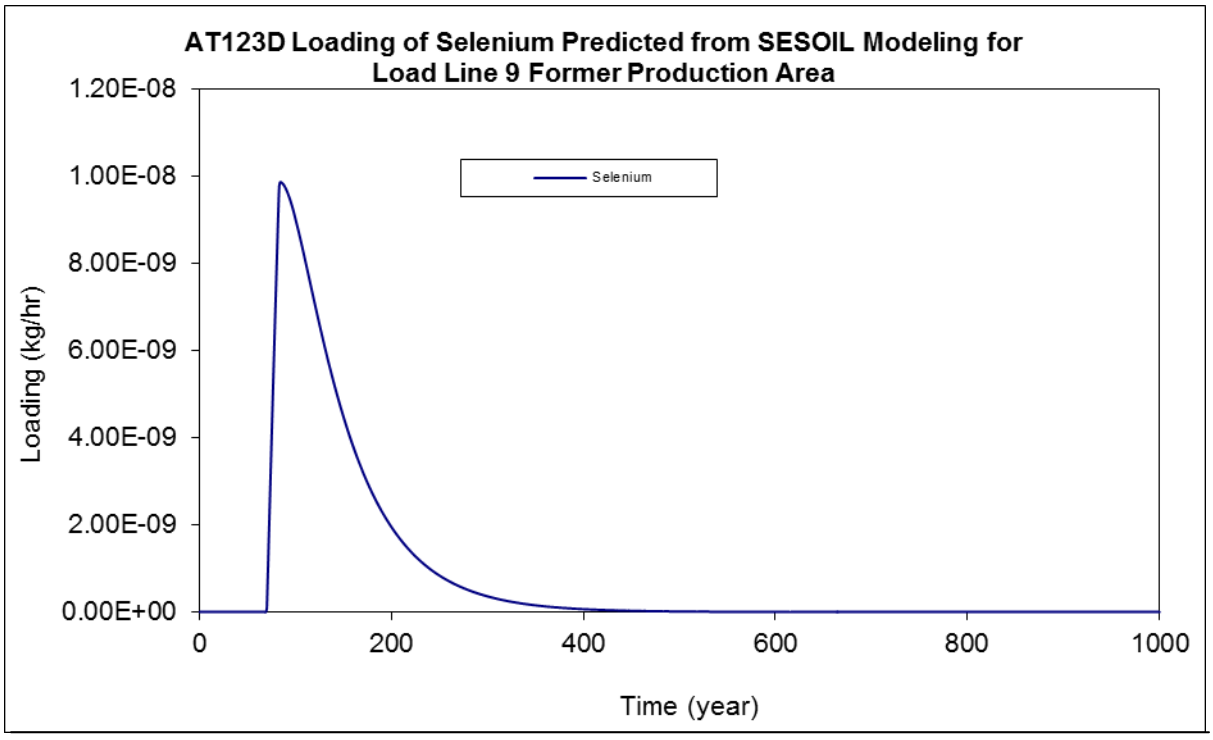

Figure E-2. Predicted Contaminant Mass Loading for AT123D Modeling at Load Line 9, Former Production Area – Selenium

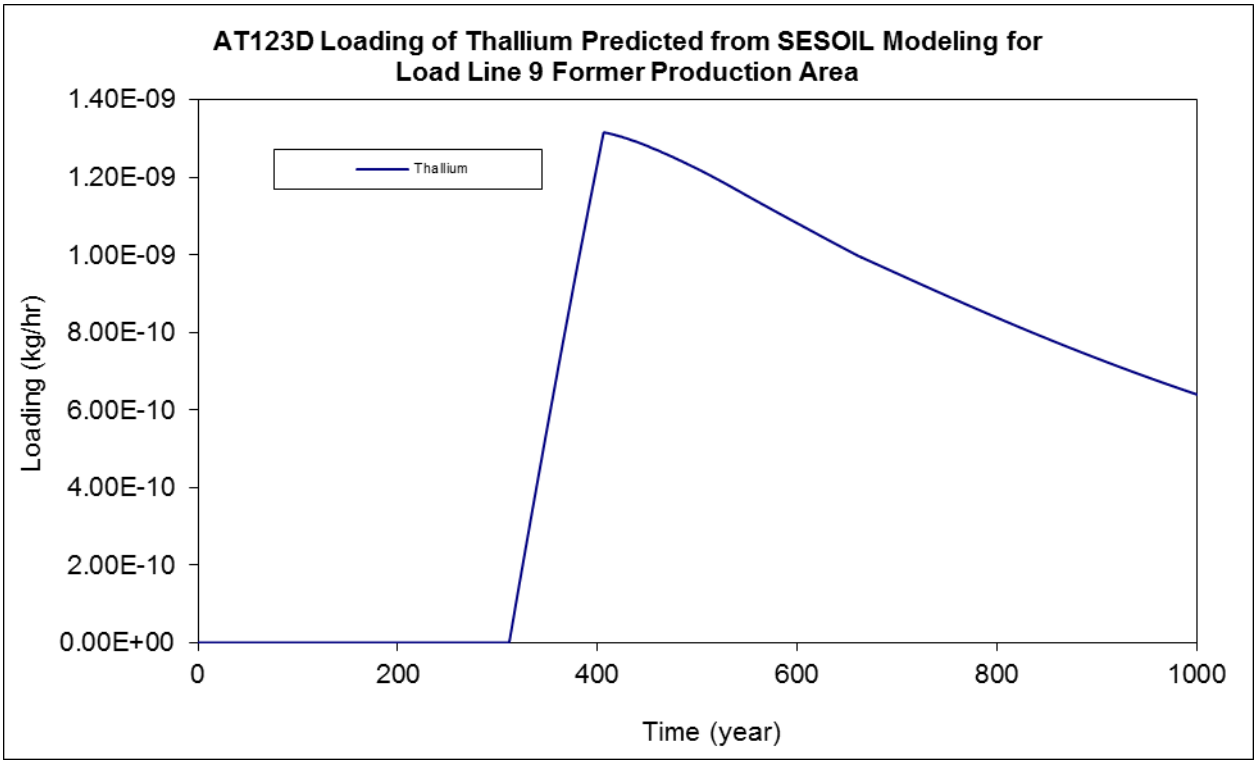

Figure E-3. Predicted Contaminant Mass Loading for AT123D Modeling at Load Line 9, Former Production Area – Thallium

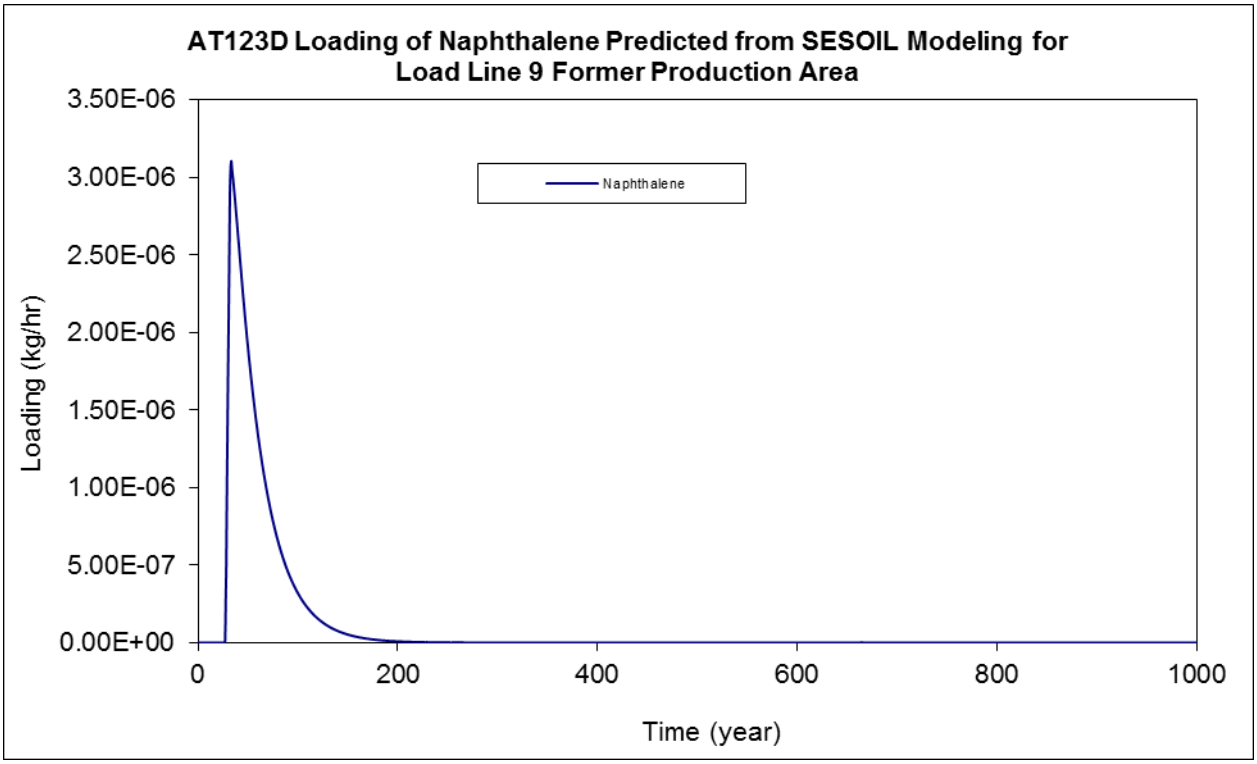

Figure E-4. Predicted Contaminant Mass Loading for AT123D Modeling at Load Line 9, Former Production Area – Naphthalene

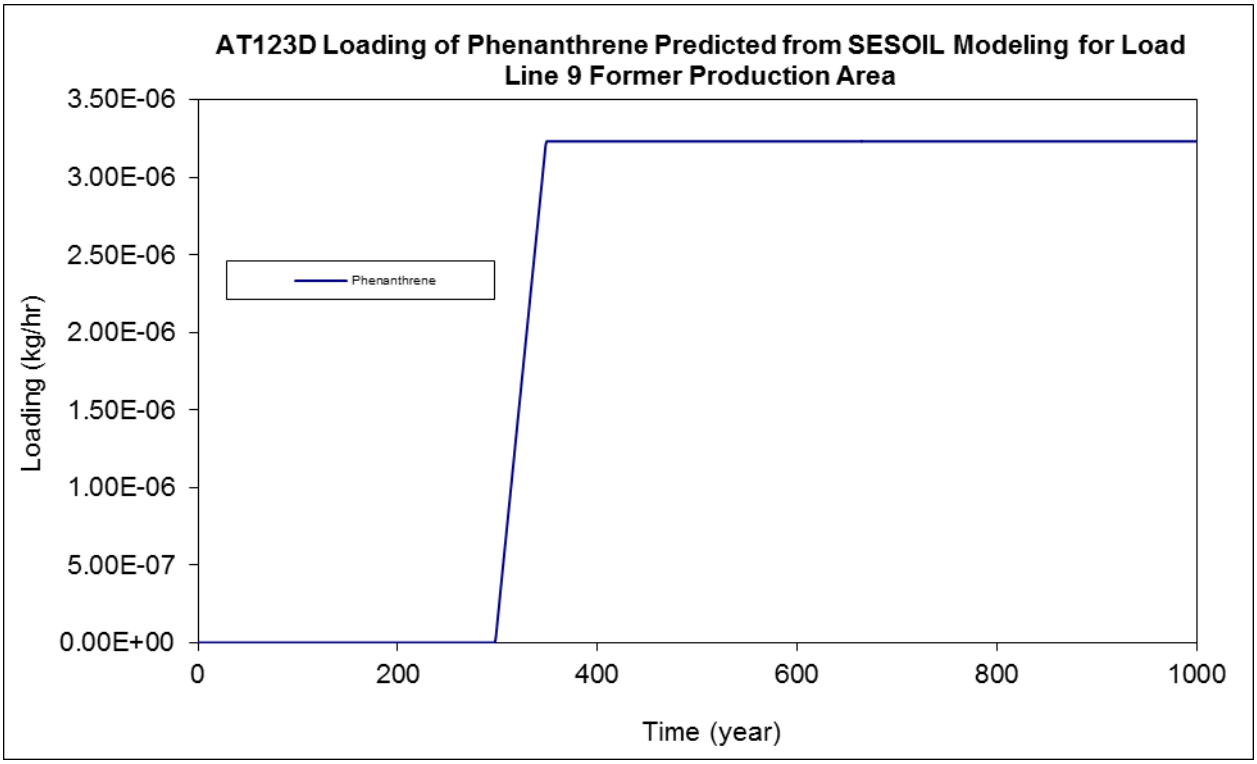

Figure E-5. Predicted Contaminant Mass Loading for AT123D Modeling at Load Line 9, Non-production Area – Phenanthrene

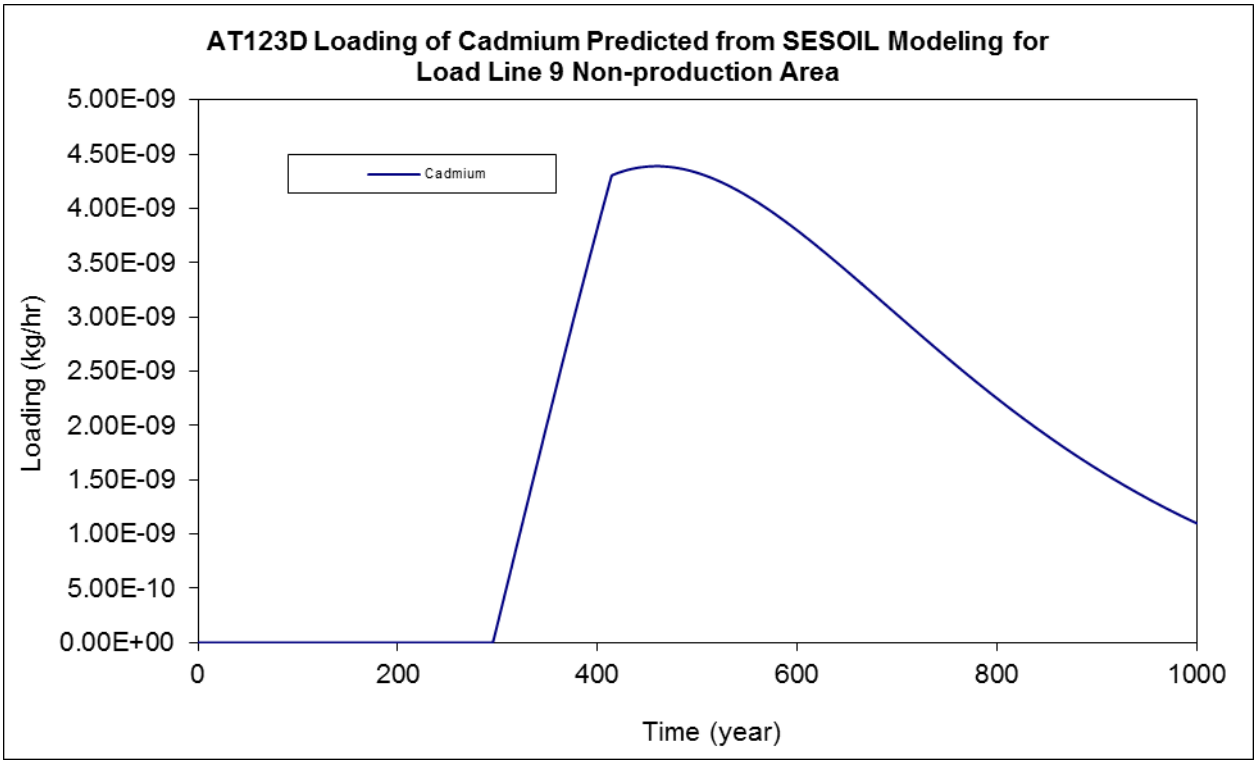

Figure E-6. Predicted Contaminant Mass Loading for AT123D Modeling at Load Line 9, Non-production Area – Cadmium

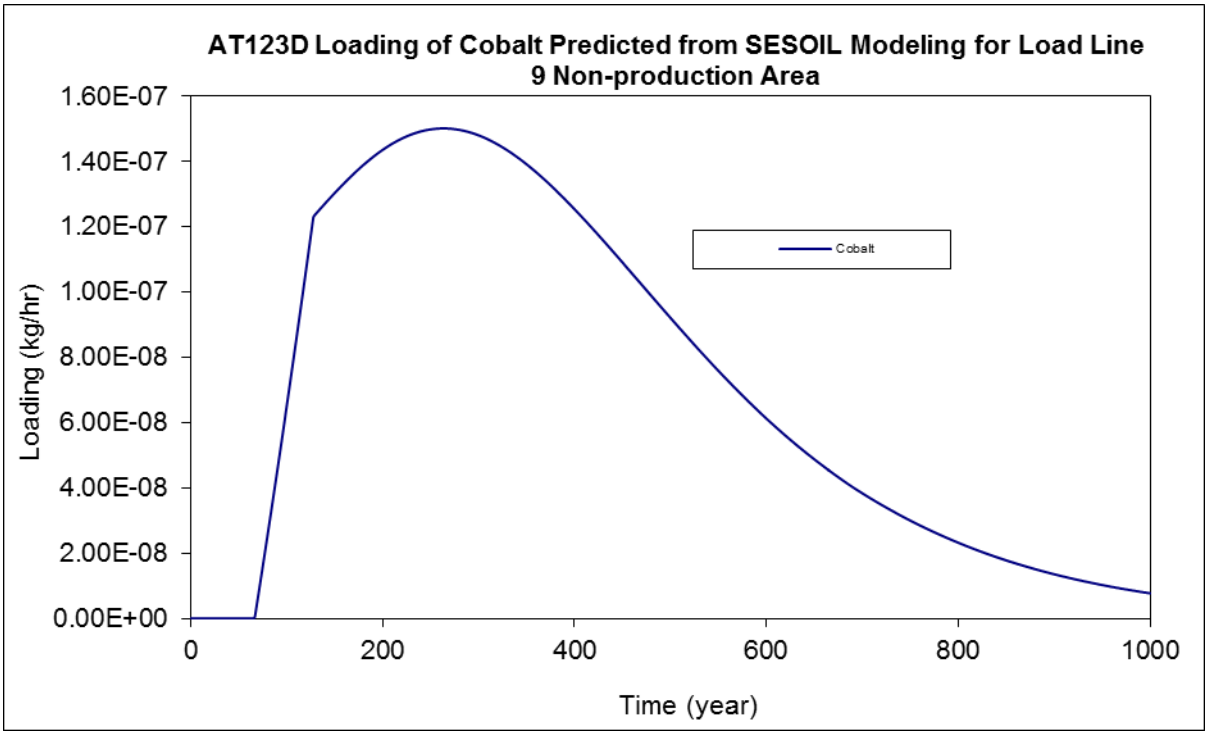

Figure E-7. Predicted Contaminant Mass Loading for AT123D Modeling at Load Line 9, Non-production Area – Cobalt

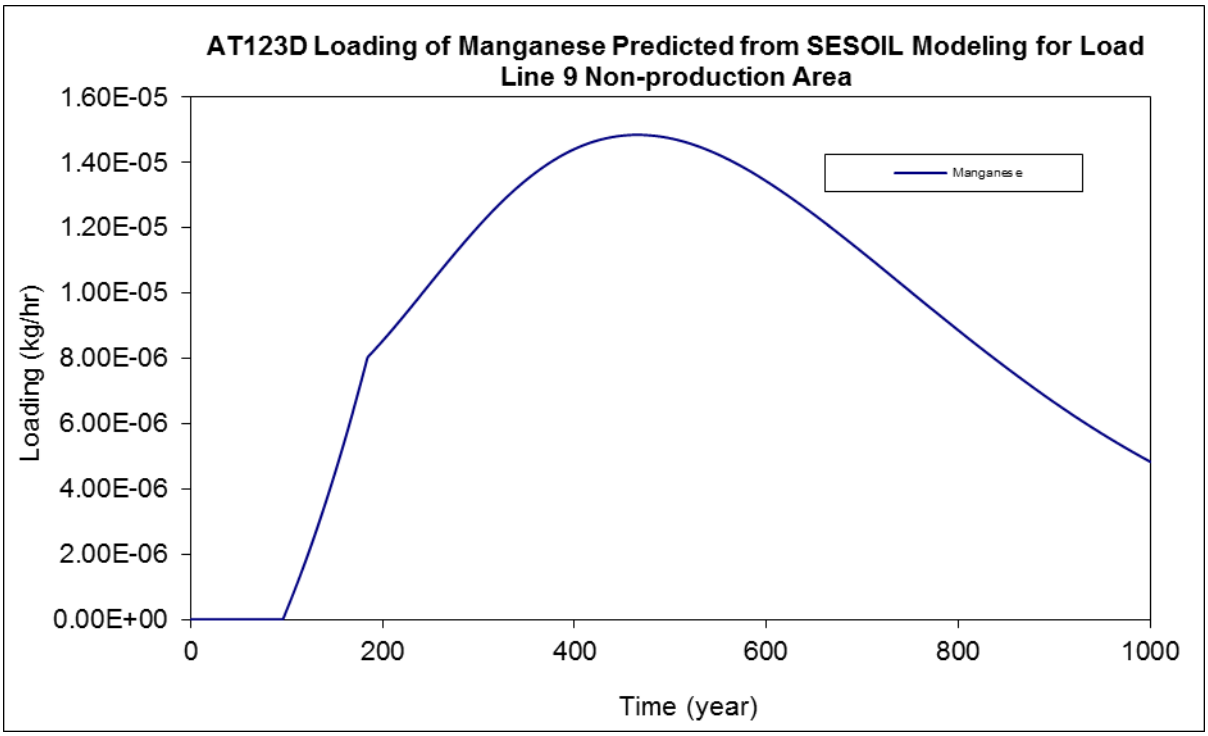

Figure E-8. Predicted Contaminant Mass Loading for AT123D Modeling at Load Line 9, Non-production Area – Manganese

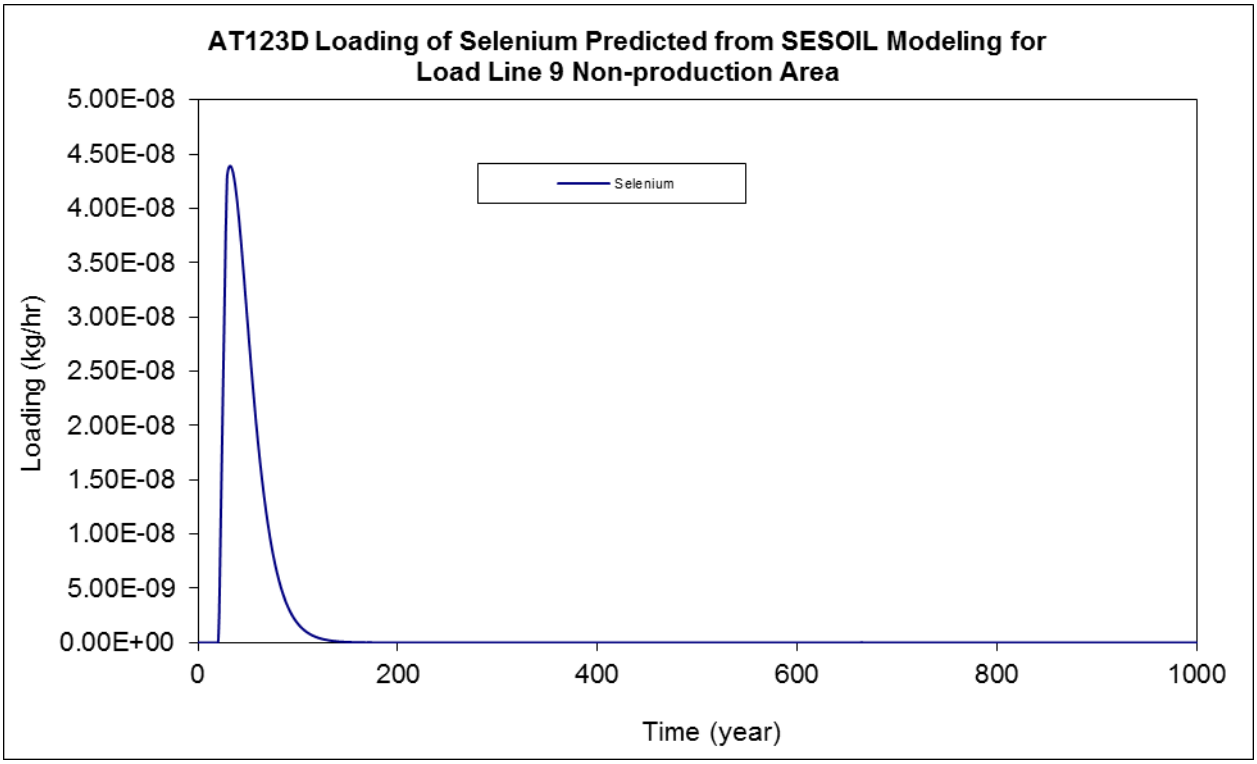

Figure E-9. Predicted Contaminant Mass Loading for AT123D Modeling at Load Line 9, Non-production Area – Selenium

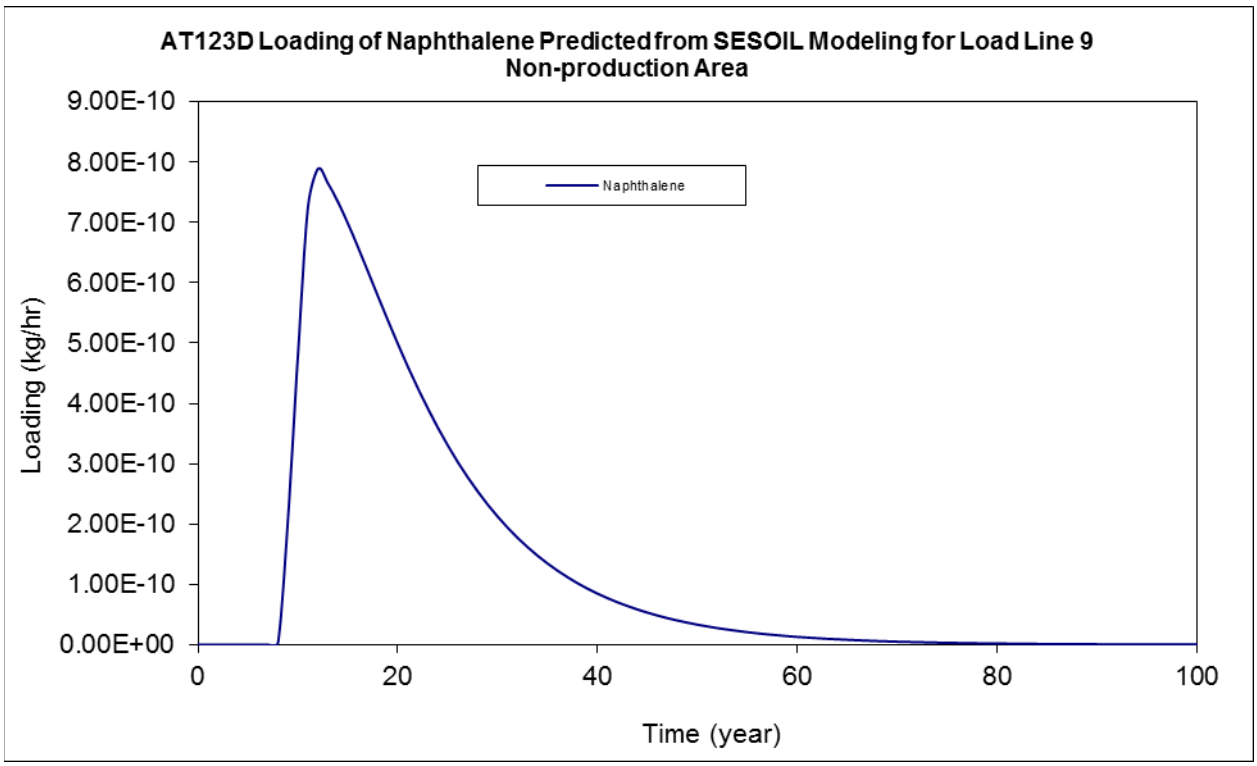

Figure E-10. Predicted Contaminant Mass Loading for AT123D Modeling at Load Line 9, Non-production Area – Naphthalene

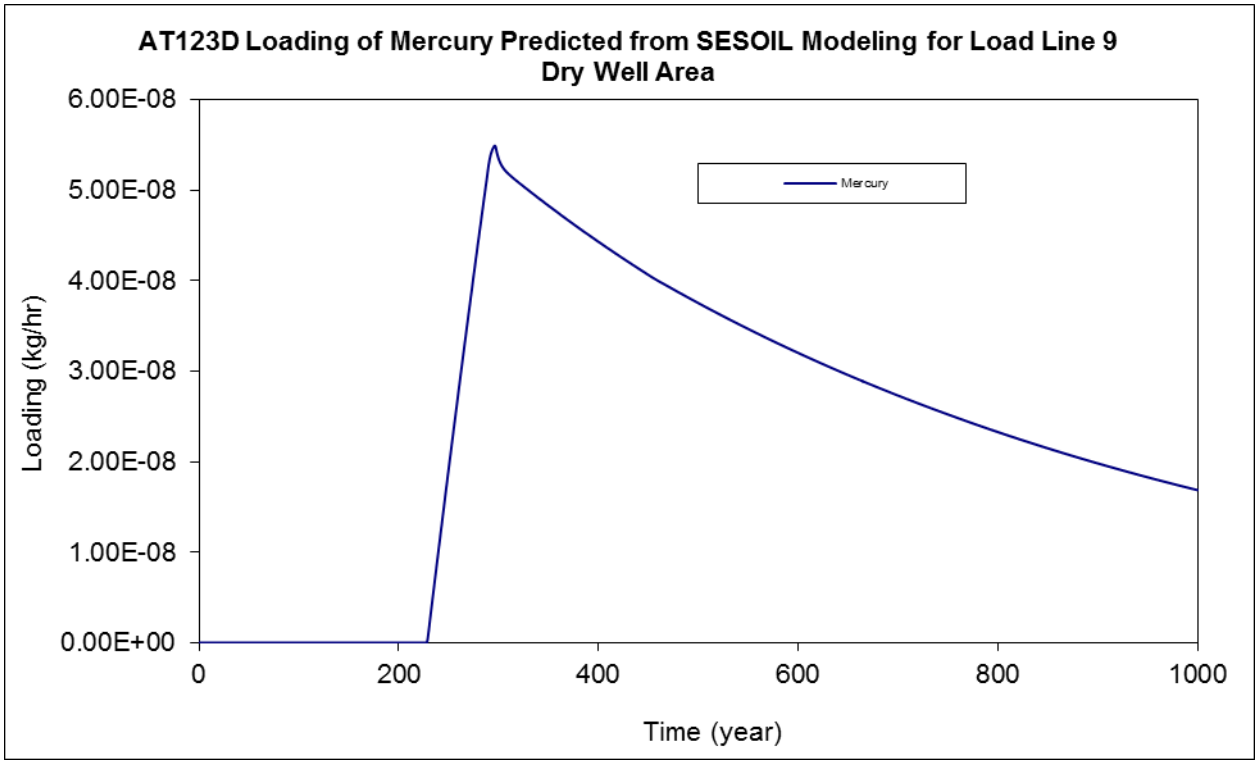

Figure E-11. Predicted Contaminant Mass Loading for AT123D Modeling at Load Line 9, Dry Well Area – Mercury

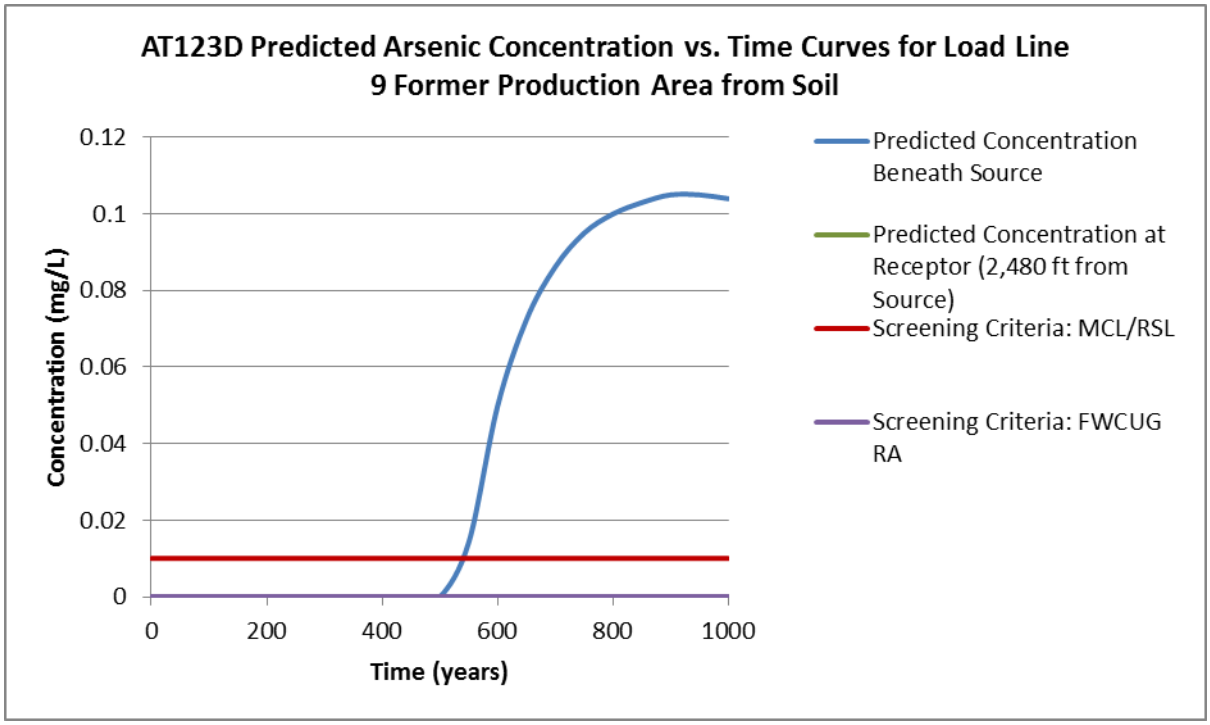

Figure E-12. Predicted Concentration of Arsenic in Groundwater Based on AT123D Modeling at Load Line 9, Former Production Area in Soil

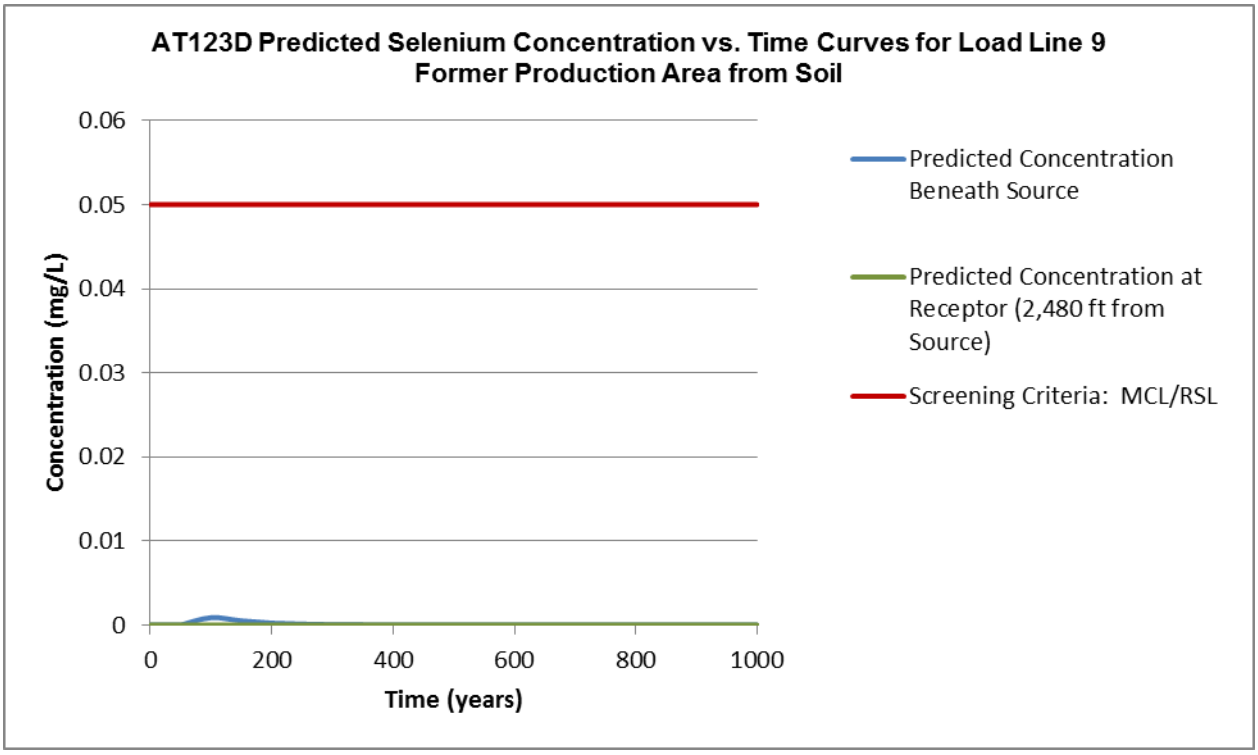

Figure E-13. Predicted Concentration of Selenium in Groundwater Based on AT123D Modeling at Load Line 9, Former Production Area in Soil

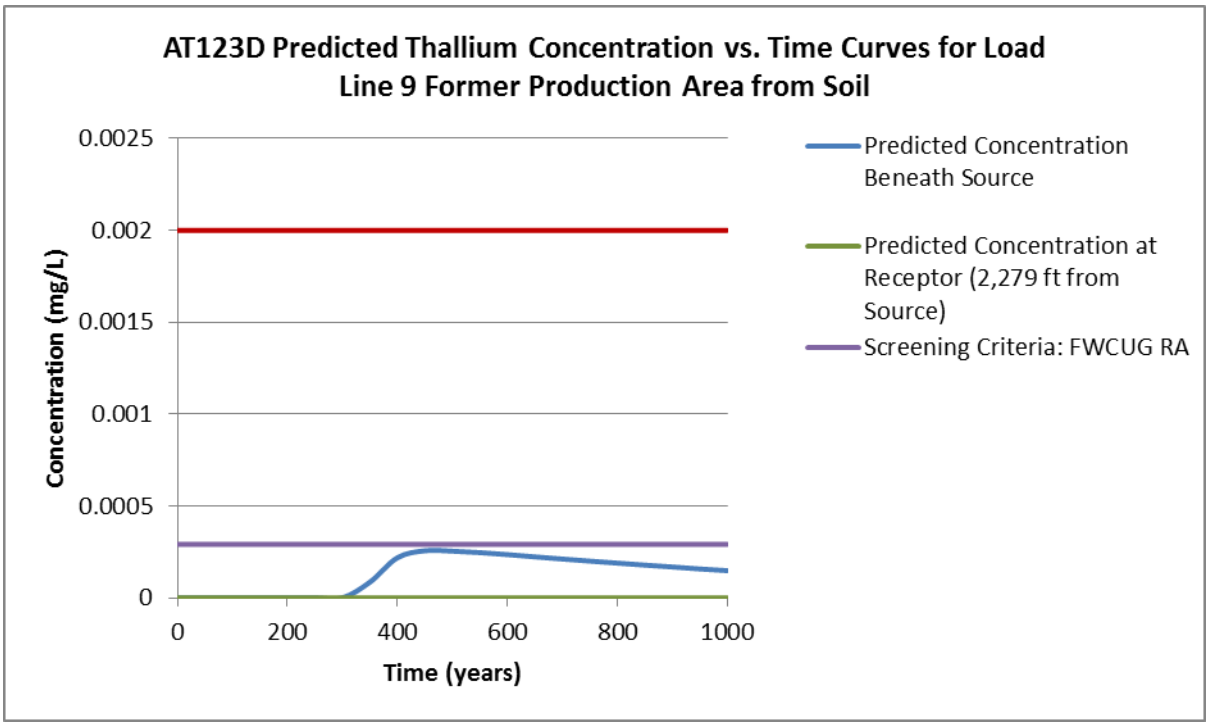

Figure E-14. Predicted Concentration of Thallium in Groundwater Based on AT123D Modeling at Load Line 9, Former Production Area in Soil

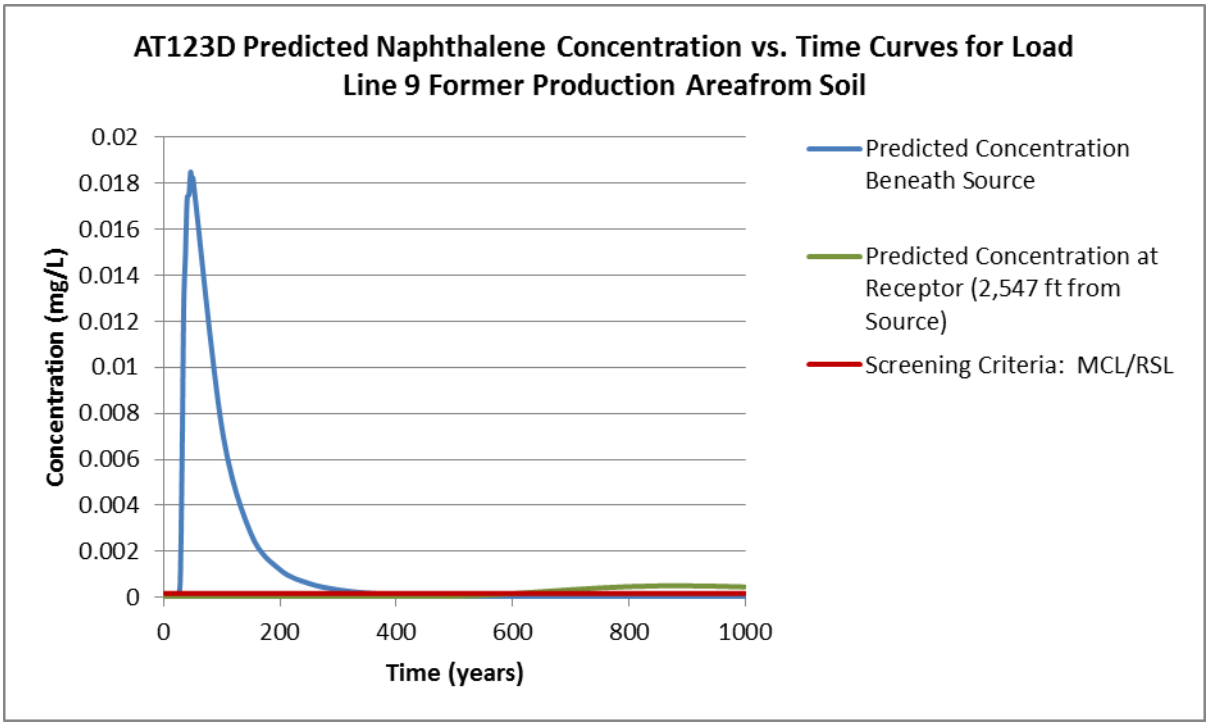

Figure E-15. Predicted Concentration of Naphthalene in Groundwater Based on AT123D Modeling at Load Line 9, Former Production Area in Soil

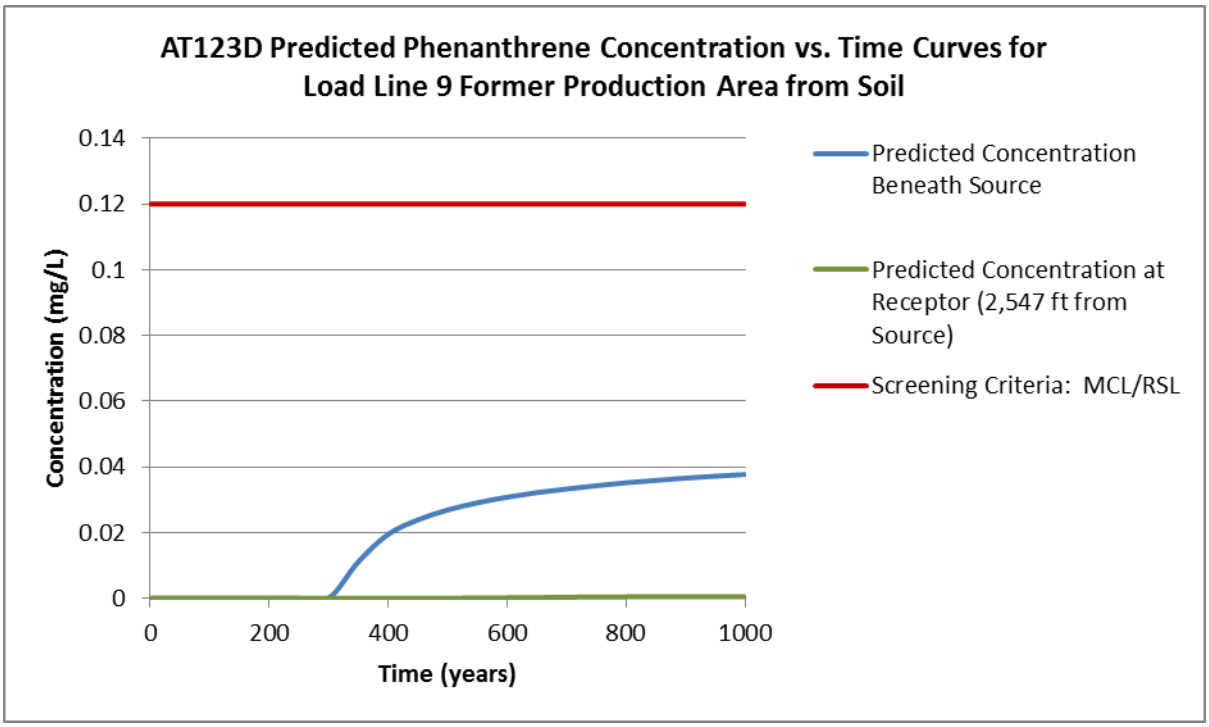

Figure E-16. Predicted Concentration of Phenanthrene in Groundwater Based on AT123D Modeling at Load Line 9, Non-production Area in Soil

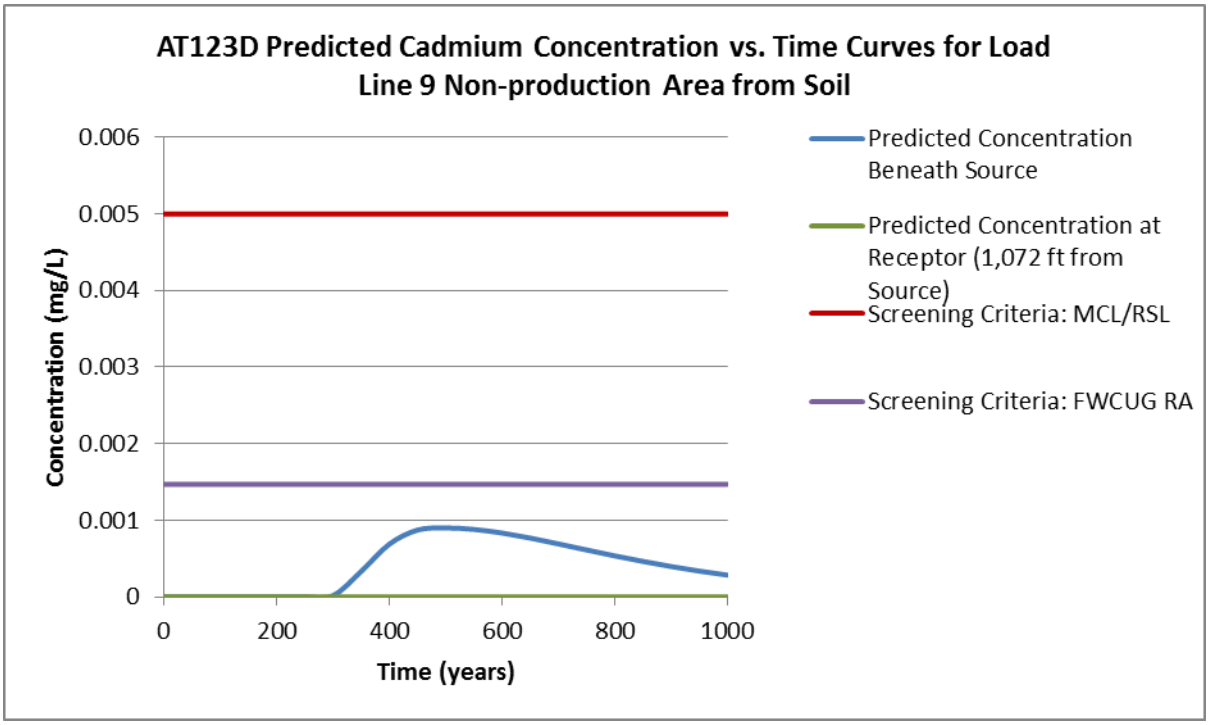

Figure E-17. Predicted Concentration of Cadmium in Groundwater Based on AT123D Modeling at Load Line 9, Non-production Area in Soil

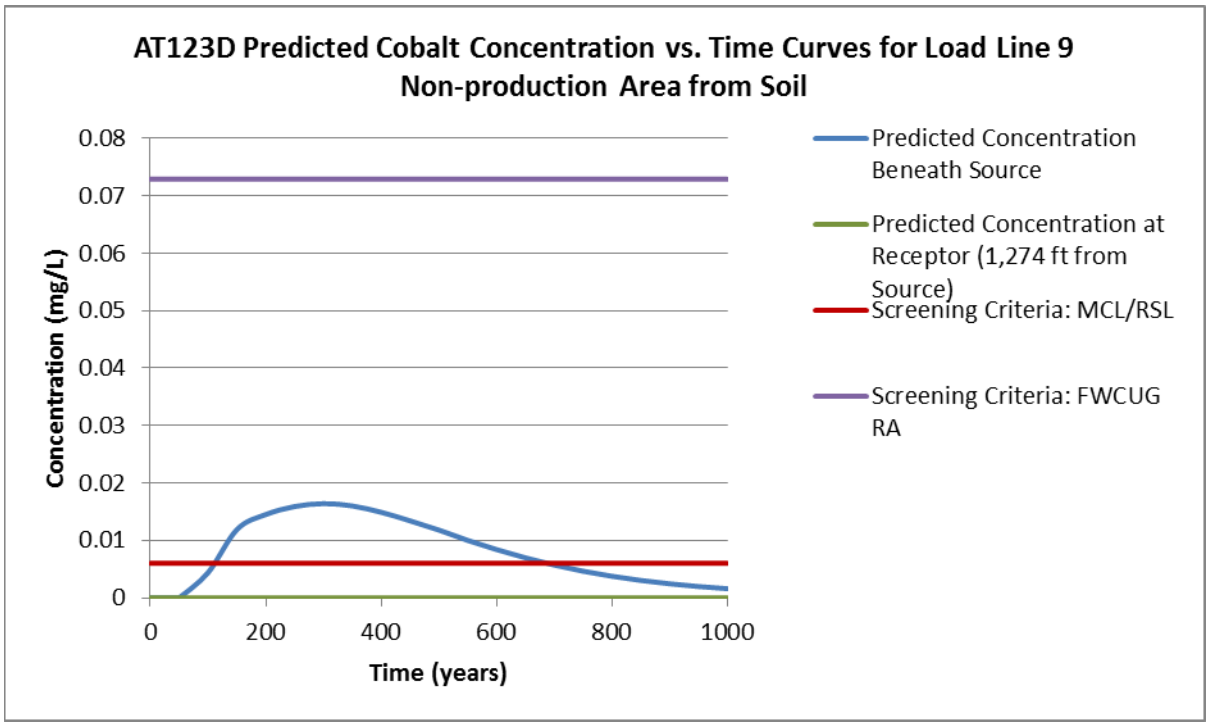

Figure E-18. Predicted Concentration of Cobalt in Groundwater Based on AT123D Modeling at Load Line 9, Non-production Area in Soil

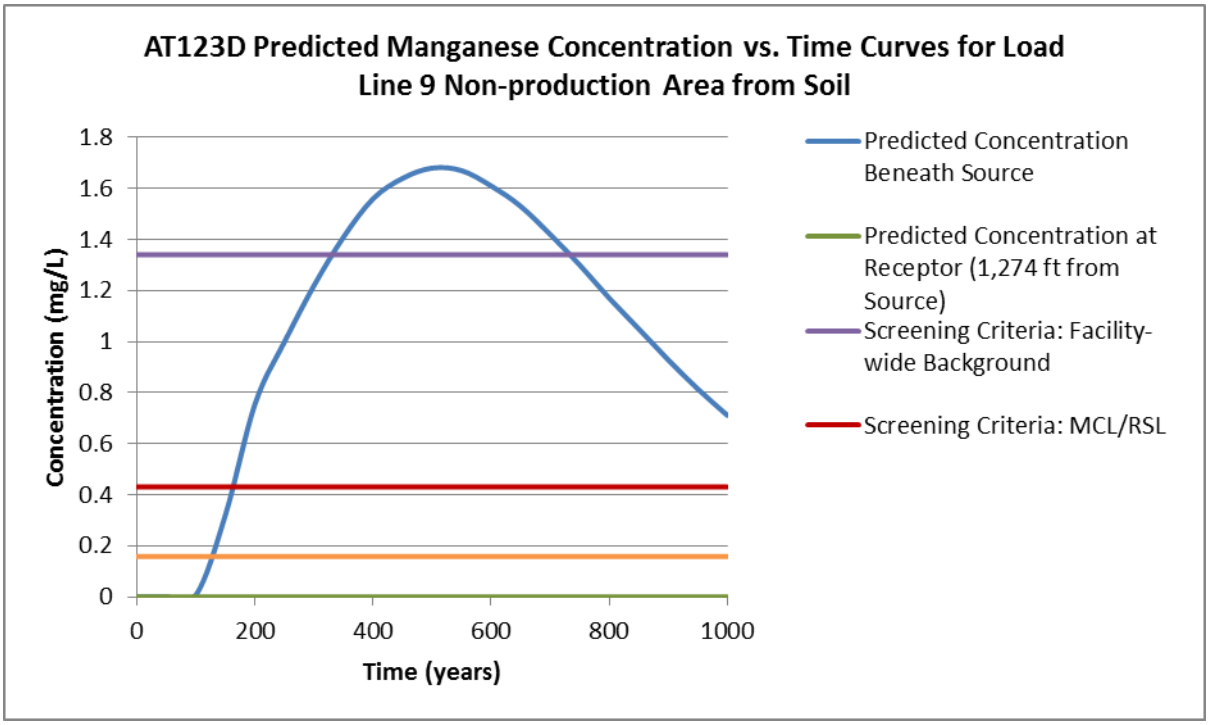

Figure E-19. Predicted Concentration of Manganese in Groundwater Based on AT123D Modeling at Load Line 9, Non-production Area in Soil

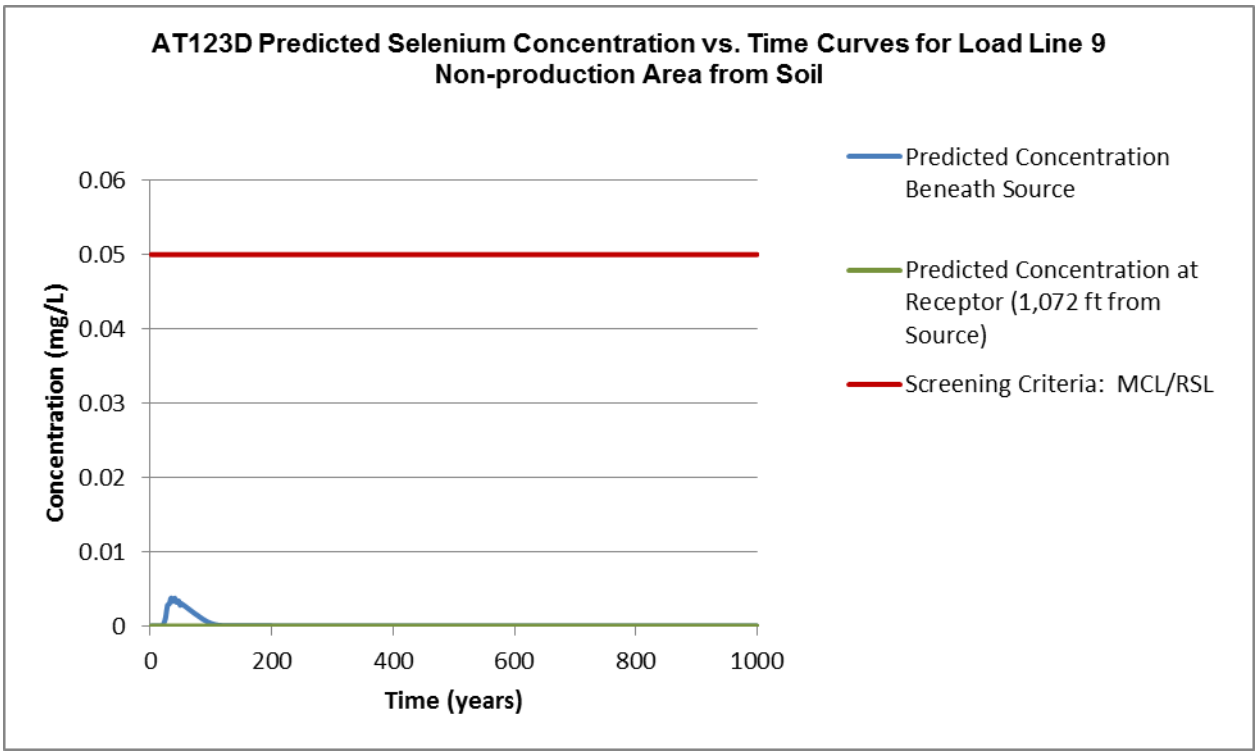

Figure E-20. Predicted Concentration of Selenium in Groundwater Based on AT123D Modeling at Load Line 9, Non-production Area in Soil

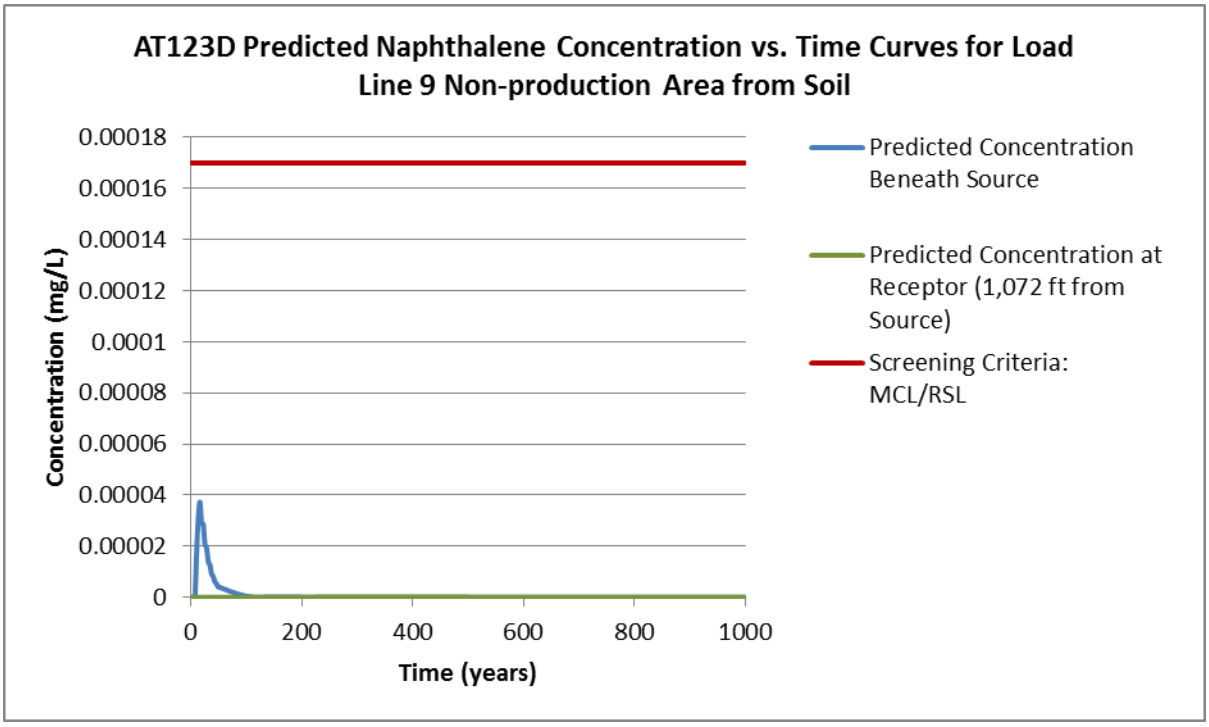

Figure E-21. Predicted Concentration of Naphthalene in Groundwater Based on AT123D Modeling at Load Line 9, Non-production Area in Soil

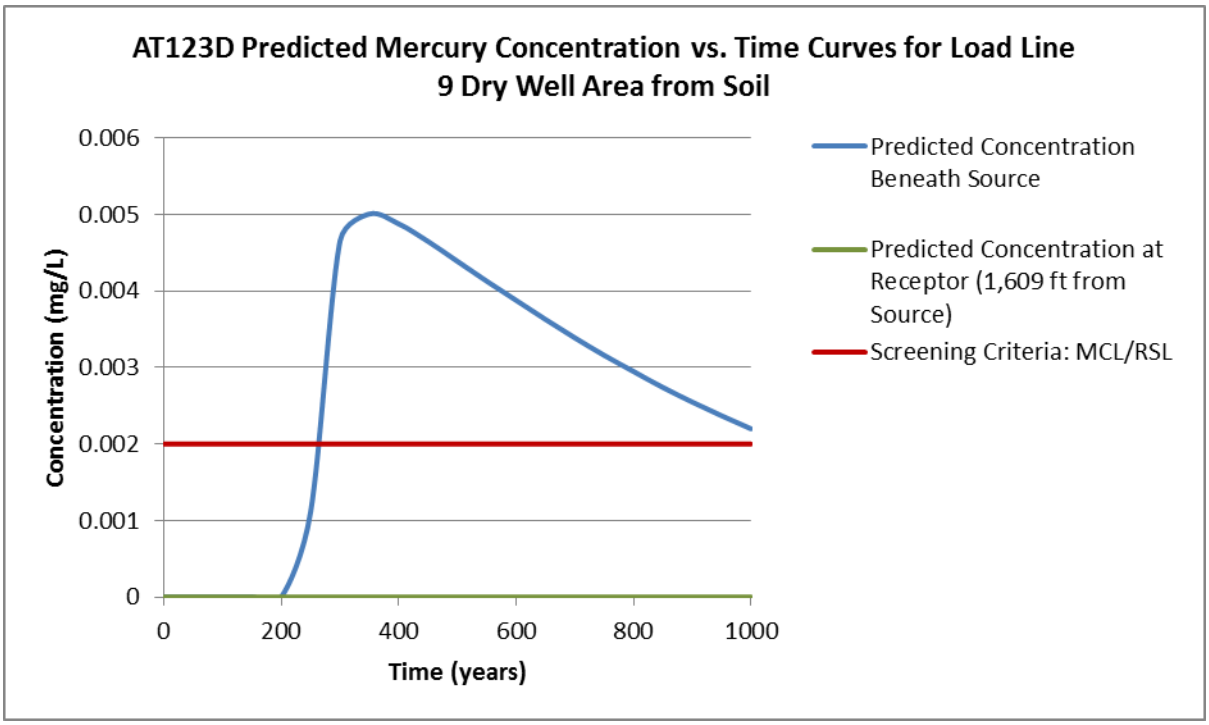

Figure E-22. Predicted Concentration of Mercury in Groundwater Based on AT123D Modeling at Load Line 9, Dry Well Area in Soil

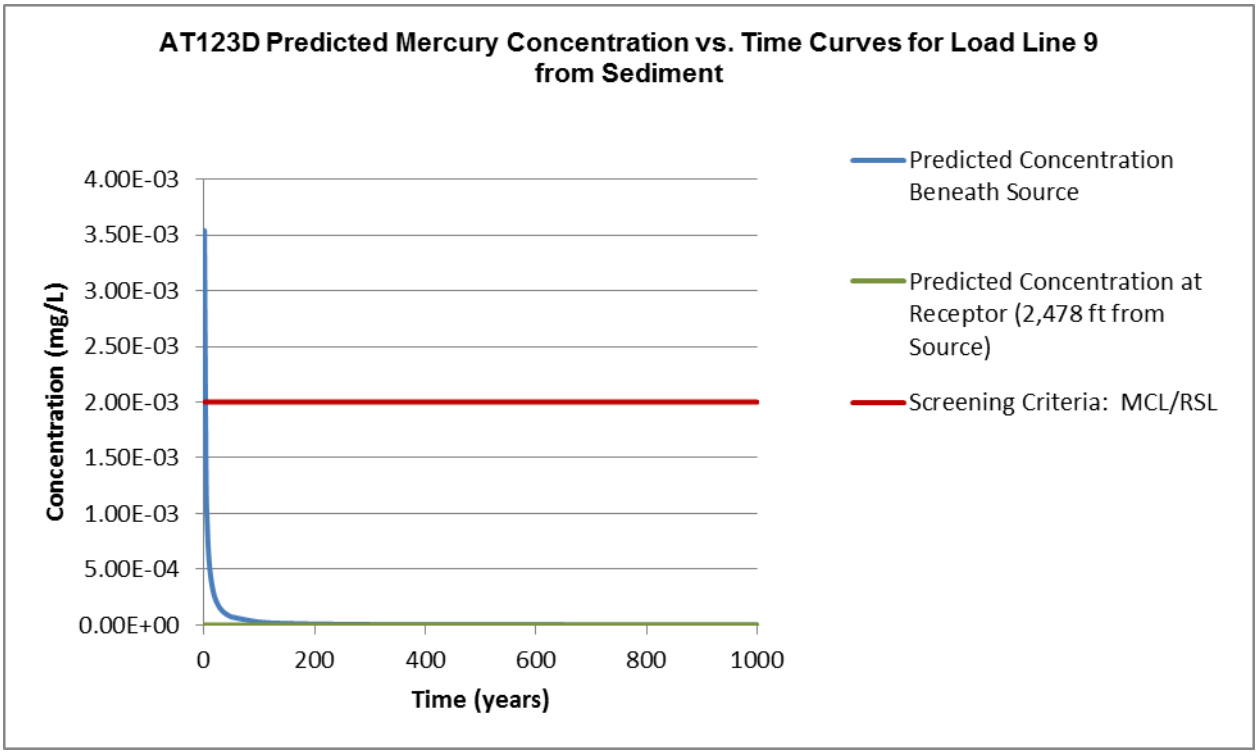

Figure E-23. Predicted Concentration of Mercury in Groundwater Based on AT123D Modeling at Load Line 9 in Sediment

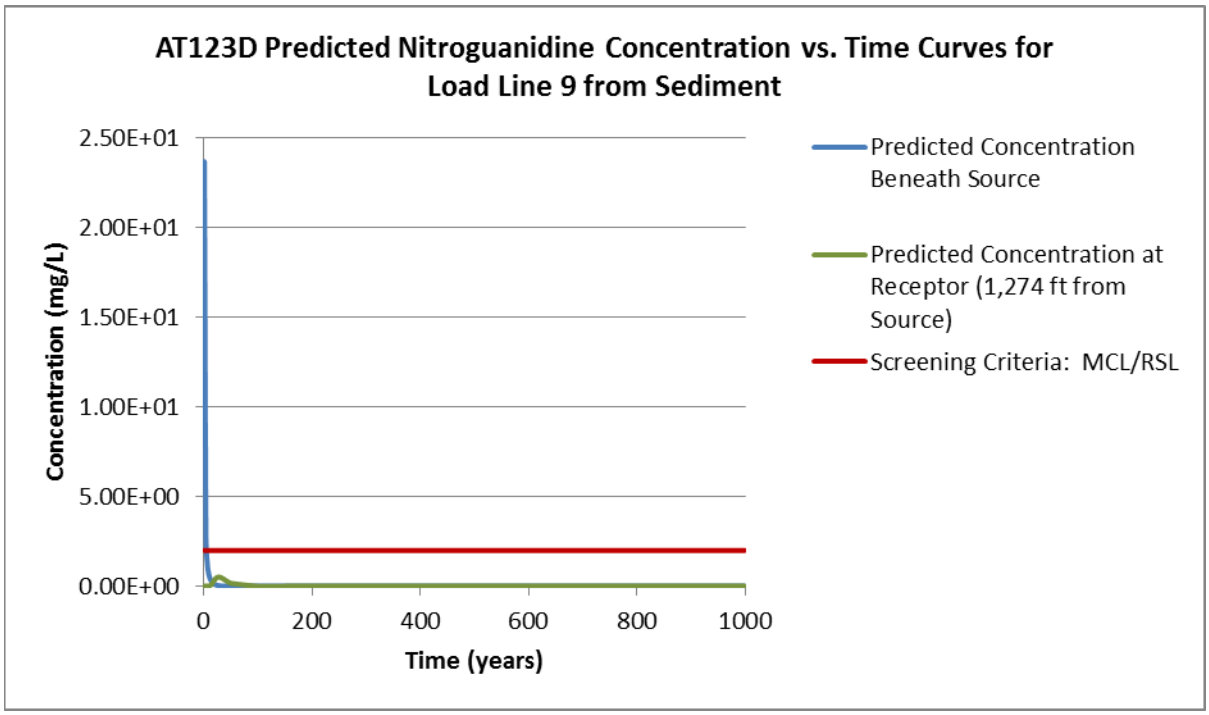

Figure E-24. Predicted Concentration of Nitroguanidine in Groundwater Based on AT123D Modeling at Load Line 9 in Sediment

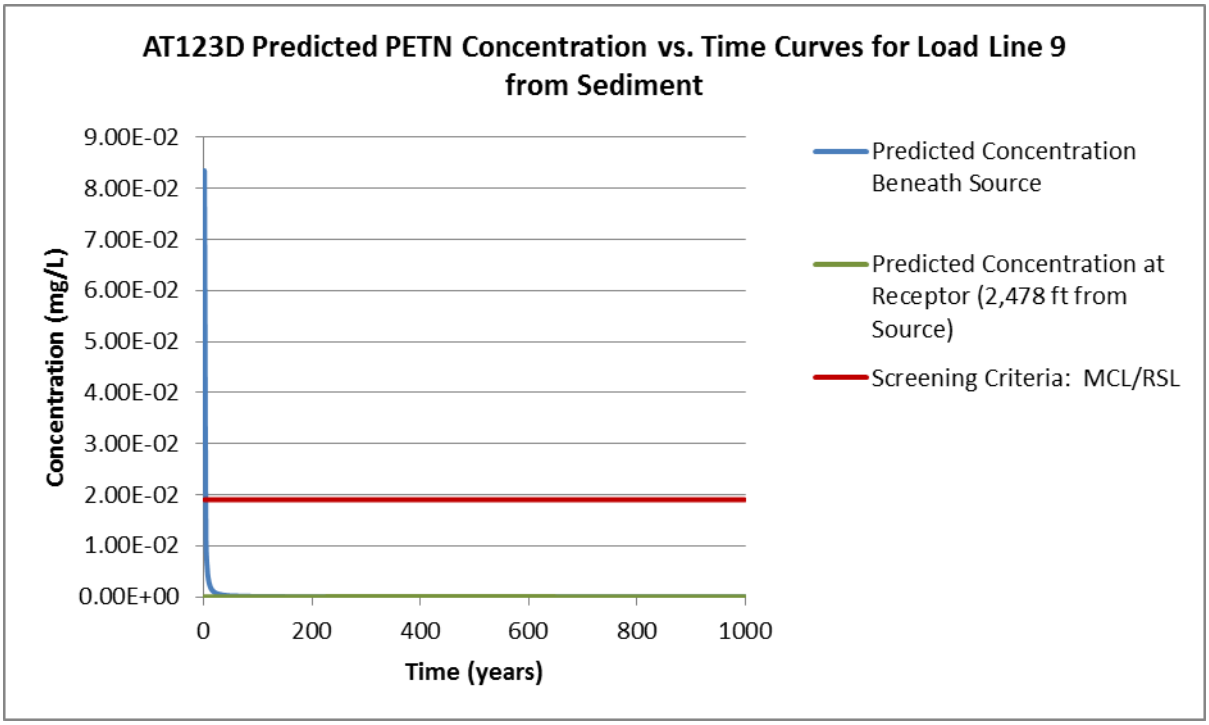

Figure E-25. Predicted Concentration of PETN in Groundwater Based on AT123D Modeling at Load Line 9 in Sediment

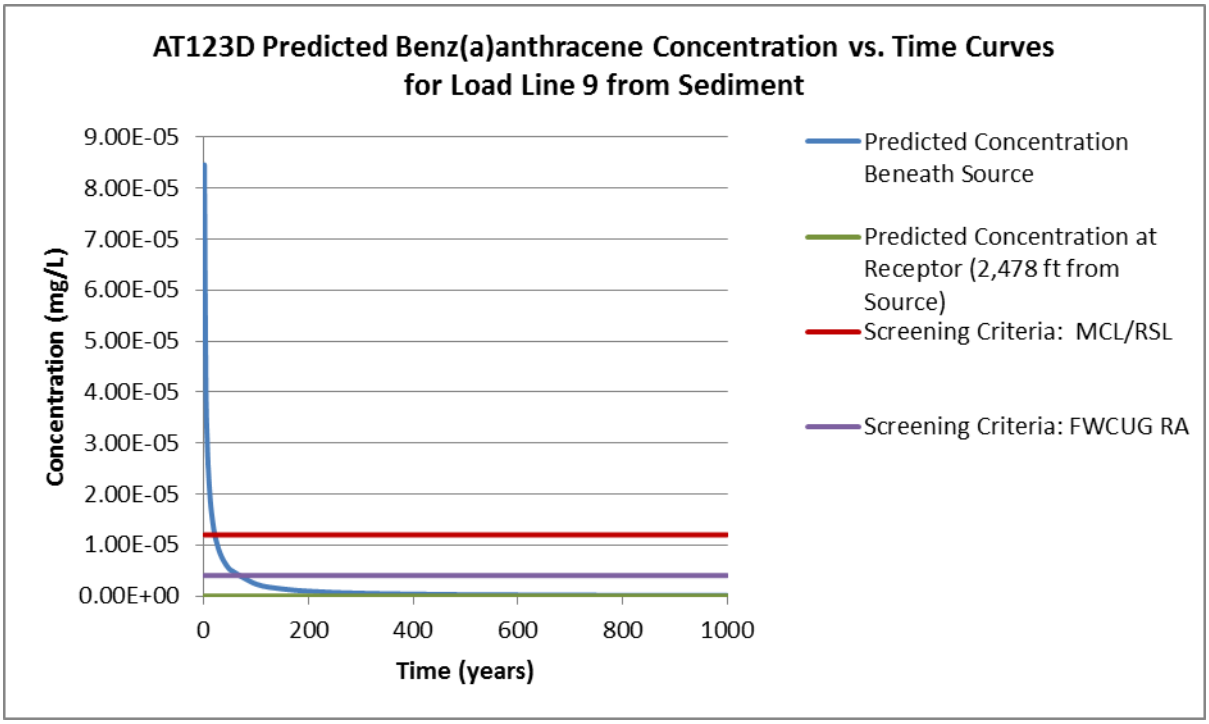

Figure E-26. Predicted Concentration of Benz(a)anthracene in Groundwater Based on AT123D Modeling at Load Line 9 in Sediment

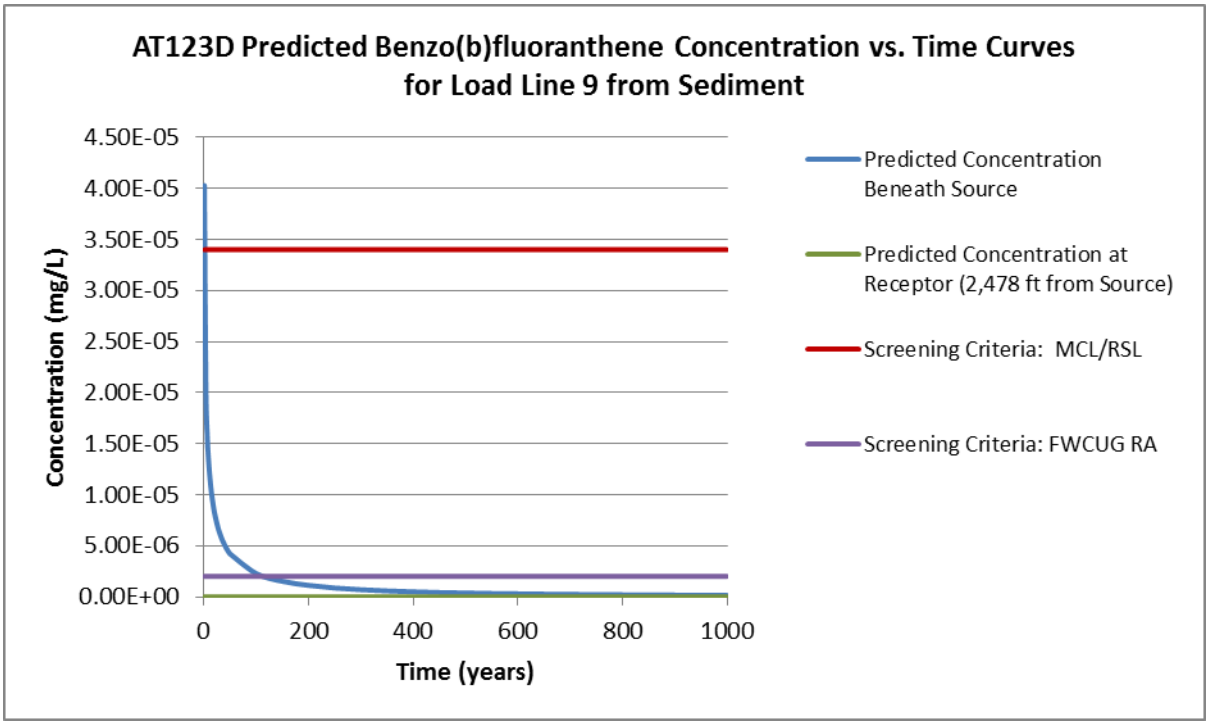

Figure E-27. Predicted Concentration of Benzo(b)fluoranthene in Groundwater Based on AT123D Modeling at Load Line 9 in Sediment

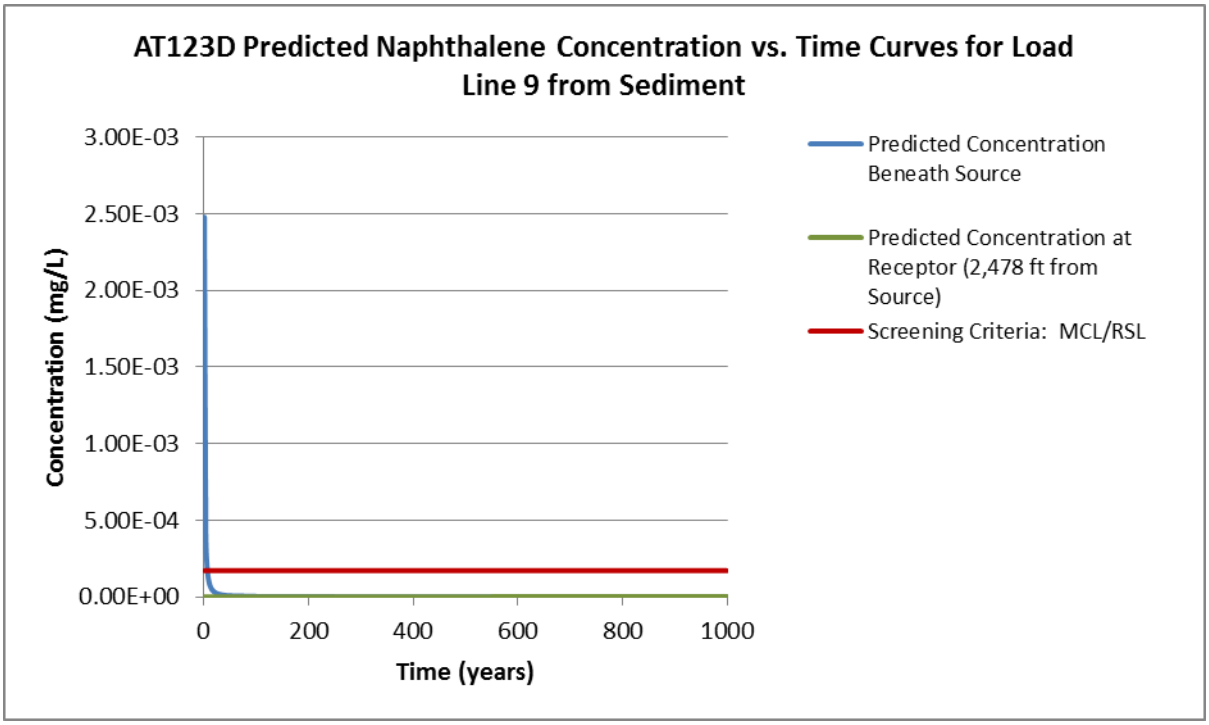

Figure E-28. Predicted Concentration of Naphthalene in Groundwater Based on AT123D Modeling at Load Line 9 in Sediment