Appendix A

Hydrogen Cyanide

Appendix A

Hydrogen Cyanide Production Sector

This appendix provides supporting data for the Hydrogen Cyanide Production industry sector. This industry sector considers four waste stream/waste management scenarios. The data used to model these scenarios and the sensitivity analyses conducted for them are presented in the following sections of this appendix

Tables A-1 through A-6 present the data used to characterize the waste stream and the waste management units and the site-specific data used to model the hydrogen cyanide industry sector.

A.1 Ammonia Recycle Filters Managed in Industrial Landfills

Tables A-7 through A-18 present the results of the sensitivity analysis for the ammonia recycle filters waste stream managed in industrial landfills. Sensitivity analyses have been performed for the following constituents:

- Arsenic

- Antimony
- Nickel.

For each constituent, four sensitivity analysis summaries are presented:

- Summary of Parameters Considered in Sensitivity Analysis
- Summary of Correlated Parameters
- Summary of Cross Pairs Analysis
- Ranking of Parameters According to Percentage of Risk.

A.2 Ammonia Recycle Filters Managed in Municipal Landfills

Tables A-19 through A-34 present the results of modeling carcinogenic risks to the adult resident of the sensitivity analysis for the ammonia recycle filters waste stream managed in municipal landfills. Sensitivity analyses have been performed for the following constituents:

- Arsenic
- Antimony
- Cadmium
- Nickel.

For each constituent, four sensitivity analysis summaries are presented:

- # Summary of Parameters Considered in Sensitivity Analysis
- # Summary of Correlated Parameters
- # Summary of Cross Pairs Analysis
- # Ranking of Parameters According to Percentage of Risk.

Table A-19 Summary of Parameters Considered in Sensitivity Analysis for Antimony

Table A-20 Summary of Correlated Parameters for Antimony

Table A-21 Summary of Cross Pairs Analysis for Antimony

Table A-22. Ranking of Parameters According to Percentage of Risk for Antimony

Table A-23 Summary of Parameters Considered in Sensitivity Analysis for Arsenic

Table A-24 Summary of Correlated Parameters for Arsenic

Table A-25 Summary of Cross Pairs Analysis for Arsenic

Table A-26 Ranking of Parameters According to Percentage of Risk for Arsenic

Table A-27 Summary of Parameters Considered in Sensitivity Analysis for Cadmium

Table A-28 Summary of Correlated Parameters for Cadmium

Table A-29 Summary of Cross Pairs Analysis for Cadmium

Table A-30 Ranking of Parameters According to Percentage of Risk for Cadmium

Table A-31 Summary of Parameters Considered in Sensitivity Analysis for Nickel

Table A-32 Summary of Correlated Parameters for Nickel

Table A-33 Summary of Cross Pairs Analysis for Nickel

Table A-34 Ranking of Parameters According to Percentage of Risk for Arsenic

A.3 Feed Gas Filters Managed in Municipal Landfills

Tables A-35 through A-38 present the results of modeling carcinogenic risks to the adult resident of the sensitivity analysis for the feed gas filters waste stream managed in municipal landfills. Sensitivity analyses have been performed for the following constituents:

Boron.

For this constituent, four sensitivity analysis summaries are presented:

Summary of Parameters Considered in Sensitivity Analysis
Summary of Correlated Parameters
Summary of Cross Pairs Analysis
Ranking of Parameters According to Percentage of Risk.

Table A-35 Summary of Parameters Considered in Sensitivity Analysis for Boron

Table A-36 Summary of Correlated Parameters for Boron

Table A-37 Summary of Cross Pairs Analysis for Boron

Table A-38 Ranking of Parameters According to Percentage of Risk for Boron

A.4 Combined Wastewaters Managed in Onsite Surface Impoundment

Tables A-39 through A-42 present the results of modeling carcinogenic risks to the adult resident of the sensitivity analysis for combined wastewaters managed in an onsite surface impoundment. Sensitivity analyses have been performed for the following constituents:

Acetonitrile.

For this constituent, four sensitivity analysis summaries are presented:

Summary of Parameters Considered in Sensitivity Analysis
Summary of Correlated Parameters
Summary of Cross Pairs Analysis
Ranking of Parameters According to Percentage of Risk.

Table A-39 Summary of Parameters Considered in Sensitivity Analysis for Acetonitrile

Table A-40 Summary of Correlated Parameters for Acetonitrile

Table A-41 Summary of Cross Pairs Analysis for Acetonitrile

Table A-42 Ranking of Parameters According to Percentage of Risk for Acetonitrile

Table A-1. Chemical-Specific Properties for Constituents of Concern for the Ammonia Recycle Filters, Feed Gas Filters, and Combined Wastewaters in the HCN Sector

	Waste Constituent Concentrations				Degradation Rates	
Constituent	**TCLP (MSW landfill) (mg/L)**	**SPLP (Industrial D landfill) (mg/L)**	**Total waste (mg/kg)**	**Finite MSW Source Ratio (L/kg)**	**Overall Hydrolysis rate(1/yr)**	**Biodegrd. Rate(1/yr)**
Antimony	0.55	0.59	81.5	148	0	0
Arsenic	0.045	0.039	5.8	129	0	0
Nickel	0.5	0.61	1460	2920	0	0
Cadmium	*0.025*	NA	2.5	100	0	0
Cadmium	0.087	NA	2.1	24	0	0
Cyanide (total)	0.218	2.4	4	18	8.4	0
Boron	7.4	*0.25*	17900	2419	0	0
Acetonitrle	NA	*NA*	190[(a)] mg/L	NA		

underlined italics indicate values set at 1/2 of detection limit
[(a)] After dilution with other wastes modeled as 5.3 mg/L

Table A-2. Distribution of Offsite Industrial D and Municipal Landfill Areas

	Area Range			
Empirical distribution	**Minimum m^2**		**Maximum m^2**	**Relative Prob.**
	4,000	to	8,090	0.100
	8,090	to	20,200	0.150
	20,200	to	60,700	0.250
	60,700	to	194,000	0.250
	194,000	to	420,000	0.150
	420,000	to	9,350,000	0.100
Total Relative Probability				1.000

Table A-3. Waste Stream Parameters for the Ammonia Recycle Filters and Feed Gas Filters in the HCN Sector

WMU	Location	SWMU Area	Waste Quantity (MT/y)	Waste Density (g/cm^3)	Waste Density (kg/m^3)	Total Waste Vol (m^3)
Municipal Landfill	Millington, TN	LF Distribution	24	1	1000	720
Industrial D Landfill	Anahuac, TX	LF Distribution	21.5	1	1000	645
Municipal Landfill	Millington, TN	LF Distribution	0.2	0.9	900	6.67
Surface Impoundment	Theodore, AS	SI (1,737 m^2)	748,300[(a)]	1	1000	748,300[(a)]

[(a)] after commingling HCN process only WW (20,800 MT/yr) with non-HCN process wastewaters

Table A-4. Site-Specific Climate-Based Parameters for the Ammonia Recycle Filters and Feed Gas Filters in the HCN Sector

WMU	Location	Climate Index	Climate Center	Landfill Infiltartion Rate (m/yr)			Recharge Rate (m/yr)				GWpH		
				SCL	SLT	SNL	SCL	SLT	SNL	GW TempC	SCL	SLT	SNL
Municipal Landfill	Millington, TN	90	Little Rock, AK	0.28	0.35	0.43	0.28	0.35	0.43	17	6.3	5.4	5.5
Industrial D Landfill	Anahuac, TX	96	Lake Charles, LA	0.28	0 .36	0.46	0.28	0.36	0.46	24	6.6	5.7	5.7
Surface Impoundment	Theodore, AL			NA	NA	NA							

Table A-5. Aquifer Types Common Within 100-Mile Radius of Current WMU Managing Ammonia Recycle Filters and Feed Gas Filters in the HCN Sector

Aquifer Types	Aquifer Code	Millington, TN	Anahuac, TX
Sand and Gravel	4	50%	50%
River Valleys/Flood Plains w/ overbank deposits	6	25%	25%
River Valleys/Flood Plains w/o overbank deposits	7	25%	25%

Table A-6. Soil Textures Common Within 100-Mile Radius of Current WMU Managing Ammonia Recycle Filters and Feed Gas Filters in the HCN Sector

		M'lton, TN	Anah., TX
silty clay loam	SCL	38%	56%
silt loam	SIL	58%	32%
sandy loam	SNL	4%	12%

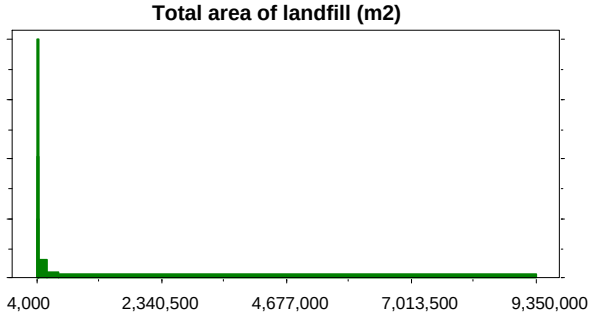

Figure A-1. Distribution of landfill areas.

Table A-7. Summary of Parameters Considered in Sensitivity Analysis for Antimony

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
ACIDCAT	Acid Catalyzed Hydrolysis Rate Constant	C			
ANGLEW	Angle of Well Off Plume Centerline	anglew		Y	Y
ANISORAT	Anisotropy Ratio	C			
AQUTHIK	Aquifer Thickness	log(aquthik-0.8)		Y	Y
AVGPDIAM	Avg. Particle Diameter	log(avgpdiam+0.002)		Y	
BASECAT	Base Catalyzed Hydrolysis Rate Constant	C			
BIODRATA	Biodegradation Rate	C			
BIODRATU	Biodegradation Rate	C			
BULKDENS	Bulk Density	bulkdens**3.5	Y		
CHEMDRU	Chemical Decay Rate	C			
CHEMDRA	Chemical Decay Rate	C			
CONSH2OA	Consump of drinking water	log(consh2oa)			Y
ZDIST	Depth of Well Below Water Table	log(zdist+4)		Y	Y
DISHYD	Dissolved Hydrolysis Rate	C			
YDIST	Distance from Plume Centerline to Well	log(ydist+15)		Y	Y
DURLEACH	Duration of Leaching Period	log(durleach)	Y		
GWAVTIM	Exposure Duration	C			
FRORGCAR	Fraction Organic Carbon	log(frorgcar)		Y	
FRCOEFA	Freundlich Isotherm Coefficient	log(frcoefa)		Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	log(frcoefu)		Y	Y
FREXPA	Freundlich Isotherm Exponent	C			
FREXPU	Freundlich Isotherm Exponent	C			
GWPH	Groundwater pH	gwph	Y		
GWSEEPV	Groundwater Seepage Velocity	log(gwseepv)	Y		
GWTEMP	Groundwater Temperature	C			
HYDGRAD	Hydraulic Gradient	log(hydgrad+0.0003)		Y	Y
INFILRAT	Infiltration Rate	infilrat**1.5		Y	Y
LANDEPTH	Landfill Depth	log(landepth+0.0007)	Y		
LEACHCON	Leachate Concentration	C			
LFFRACT	LF Fraction	C			
LONDISPU	Longitudinal Dispersivity	log(londispu-0.02)	Y		
LONDISPA	Longitudinal Dispersivity	log(londispa+0.3)		Y	Y
XDIST	Longitudinal Distance to Well	log(xdist+250)		Y	Y

Table A-7. Summary of Parameters Considered in Sensitivity Analysis for Antimony

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
LONHYCON	Longitundinal Hydraulic Conductivity	log(lonhycon+100)		Y	Y
MLLA	ml/L	C			
MOISTRPA	Moisture Rention Parameter (a)	log(moistrpa-0.05)	Y		
MOISTRPB	Moisture Rention Parameter (b)	log(moistrpb-0.95)	Y		
MOLDIFF	Molecular Diffusion Coefficient	C			
NEUTHYD	Neutral Hydrolysis Rate Constant	C			
ORGCDIS	Organic Carbon Distribution Coefficient	C			
PERORGM	Percent Organic Matter	log(perorgm)		Y	
POROSITY	Porosity	porosity**1.3		Y	
RADISTW	Radial Distance to Well	log(radistw+250)	Y		
RECHARAT	Recharge Rate	recharat	Y		
RESIDH2O	Residual Water Content	residh2o**2.1		Y	Y
RETCOEF	Retardation Coefficient	log(retcoef-1)	Y		
RFDA	RfD (mg/kg/day)	C			
SATHYCON	Saturated Hydraulic Conductivity	log(sathycon)	Y		
SATURH2O	Saturated Water Content	saturh2o		Y	Y
SOILBDEN	Soil Bulk Density	soilbden	Y		
SORBHYD	Sorbed Hydrolysis Rate	C			
TRANDISP	Transverse Dispersivity	log(trandisp+0.01)	Y		
UNSATHIK	Unsaturated Zone Thickness	log(unsathik)		Y	Y
VERTDISP	Vertical Dispersivity	log(vertdisp+0.001)	Y		
WASTDENS	Waste Density	C			
WASTEVOL	Waste Volume	C			
WMUAREA	WMU Area	log(wmuarea-3900)		Y	Y
WMULEN	WMU Length	log(wmulen-50)	Y		
WMUWIDTH	WMU Width	log(wmuwidth-50)	Y		

Table A-8. Summary of Correlated Parameters for Antimony

Variable 1		Variable 2		Correlation Coefficient
Code	Description	Code	Description	
AVGPDIAM	Avg. Particle Diameter	BULKDENS	Bulk Density	0.9988
LONHYCON	Longitundinal Hydraulic Conductivi	GWSEEPV	Groundwater Seepage Velocity	0.81815
FRCOEFA	Freundlich Isotherm Coefficient	RETCOEF	Retardation Coefficient	0.97469
LONDISPA	Longitudinal Dispersivity	TRANDISP	Transverse Dispersivity	0.99931
LONDISPA	Longitudinal Dispersivity	VERTDISP	Vertical Dispersivity	0.99916
RECHARAT	Recharge Rate	GWPH	Groundwater pH	-0.88331
INFILRAT	Infiltration Rate	GWPH	Groundwater pH	-0.80133
MOISTRPB	Moisture Rention Parameter (b)	GWPH	Groundwater pH	-0.71798
SOILBDEN	Soil Bulk Density	GWPH	Groundwater pH	0.74946
XDIST	Longitudinal Distance to Well	RADISTW	Radial Distance to Well	0.9939
WMUAREA	WMU Area	WMULEN	WMU Length	0.99833
LANDEPTH	Landfill Depth	WMULEN	WMU Length	-0.99043
DURLEACH	Duration of Leaching Period	WMULEN	WMU Length	-0.96305
WMUAREA	WMU Area	WMUWIDTH	WMU Width	0.99833
LANDEPTH	Landfill Depth	WMUWIDTH	WMU Width	-0.99043
DURLEACH	Duration of Leaching Period	WMUWIDTH	WMU Width	-0.96305
INFILRAT	Infiltration Rate	RECHARAT	Recharge Rate	0.90405
SOILBDEN	Soil Bulk Density	RECHARAT	Recharge Rate	-0.97237
WMUAREA	WMU Area	LANDEPTH	Landfill Depth	-0.98363
WMUAREA	WMU Area	DURLEACH	Duration of Leaching Period	-0.96276
LANDEPTH	Landfill Depth	DURLEACH	Duration of Leaching Period	0.95171
RECHARAT	Recharge Rate	SATHYCON	Saturated Hydraulic Conductivity	0.71373
INFILRAT	Infiltration Rate	SATHYCON	Saturated Hydraulic Conductivity	0.80946
RECHARAT	Recharge Rate	MOISTRPA	Moisture Rention Parameter (a)	0.71619
RECHARAT	Recharge Rate	MOISTRPB	Moisture Rention Parameter (b)	0.84927
INFILRAT	Infiltration Rate	MOISTRPB	Moisture Rention Parameter (b)	0.76283
UNSATHIK	Unsaturated Zone Thickness	LONDISPU	Longitudinal Dispersivity	0.99997
RECHARAT	Recharge Rate	SOILBDEN	Soil Bulk Density	-0.97237
INFILRAT	Infiltration Rate	SOILBDEN	Soil Bulk Density	-0.87769
SATHYCON	Saturated Hydraulic Conductivity	SOILBDEN	Soil Bulk Density	-0.70622
MOISTRPA	Moisture Rention Parameter (a)	SOILBDEN	Soil Bulk Density	-0.73096
MOISTRPB	Moisture Rention Parameter (b)	SOILBDEN	Soil Bulk Density	-0.84183

Note: Parameters in the variable 2 column were removed from the analysis.

Table A-9. Summary of Crosspairs Analysis for Antimony

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
AVGPDIAM	Avg. Particle Diameter				
POROSITY	Porosity				
AQUTHIK	Aquifer Thickness			Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity			Y	Y
HYDGRAD	Hydraulic Gradient				
LONDISPA	Longitudinal Dispersivity			Y	Y
FRORGCAR	Fraction Organic Carbon				
ANGLEW	Angle of Well Off Plume Centerline				
XDIST	Longitudinal Distance to Well			Y	Y
YDIST	Distance from Plume Centerline to Well			Y	Y
ZDIST	Depth of Well Below Water Table			Y	
FRCOEFA	Freundlich Isotherm Coefficient			Y	Y
WMUAREA	WMU Area			Y	Y
INFILRAT	Infiltration Rate			Y	Y
RESIDH2O	Residual Water Content				
SATURH2O	Saturated Water Content			Y	Y
UNSATHIK	Unsaturated Zone Thickness			Y	Y
PERORGM	Percent Organic Matter				
FRCOEFU	Freundlich Isotherm Coefficient			Y	Y
AVGPDIAM	Avg. Particle Diameter	AVGPDIAM	Avg. Particle Diameter		
POROSITY	Porosity	AVGPDIAM	Avg. Particle Diameter	Y	
POROSITY	Porosity	POROSITY	Porosity		
AQUTHIK	Aquifer Thickness	AVGPDIAM	Avg. Particle Diameter		
AQUTHIK	Aquifer Thickness	POROSITY	Porosity		
AQUTHIK	Aquifer Thickness	AQUTHIK	Aquifer Thickness	Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity	AVGPDIAM	Avg. Particle Diameter		
LONHYCON	Longitundinal Hydraulic Conductivity	POROSITY	Porosity	Y	
LONHYCON	Longitundinal Hydraulic Conductivity	AQUTHIK	Aquifer Thickness	Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
HYDGRAD	Hydraulic Gradient	AVGPDIAM	Avg. Particle Diameter		
HYDGRAD	Hydraulic Gradient	POROSITY	Porosity		
HYDGRAD	Hydraulic Gradient	AQUTHIK	Aquifer Thickness		
HYDGRAD	Hydraulic Gradient	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
HYDGRAD	Hydraulic Gradient	HYDGRAD	Hydraulic Gradient		
LONDISPA	Longitudinal Dispersivity	AVGPDIAM	Avg. Particle Diameter		
LONDISPA	Longitudinal Dispersivity	POROSITY	Porosity		
LONDISPA	Longitudinal Dispersivity	AQUTHIK	Aquifer Thickness	Y	Y
LONDISPA	Longitudinal Dispersivity	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
LONDISPA	Longitudinal Dispersivity	HYDGRAD	Hydraulic Gradient		
LONDISPA	Longitudinal Dispersivity	LONDISPA	Longitudinal Dispersivity	Y	
FRORGCAR	Fraction Organic Carbon	AVGPDIAM	Avg. Particle Diameter		
FRORGCAR	Fraction Organic Carbon	POROSITY	Porosity		
FRORGCAR	Fraction Organic Carbon	AQUTHIK	Aquifer Thickness	Y	
FRORGCAR	Fraction Organic Carbon	LONHYCON	Longitundinal Hydraulic Conductivity	Y	
FRORGCAR	Fraction Organic Carbon	HYDGRAD	Hydraulic Gradient		
FRORGCAR	Fraction Organic Carbon	LONDISPA	Longitudinal Dispersivity		
FRORGCAR	Fraction Organic Carbon	FRORGCAR	Fraction Organic Carbon		
ANGLEW	Angle of Well Off Plume Centerline	AVGPDIAM	Avg. Particle Diameter		
ANGLEW	Angle of Well Off Plume Centerline	POROSITY	Porosity		

Table A-9. Summary of Crosspairs Analysis for Antimony

Variable 1		Variable 2			
Code	Description	Code	Description	P<0.05	P<0.01
ANGLEW	Angle of Well Off Plume Centerline	AQUTHIK	Aquifer Thickness		
ANGLEW	Angle of Well Off Plume Centerline	LONHYCON	Longitundinal Hydraulic Conductivity		
ANGLEW	Angle of Well Off Plume Centerline	HYDGRAD	Hydraulic Gradient	Y	
ANGLEW	Angle of Well Off Plume Centerline	LONDISPA	Longitudinal Dispersivity		
ANGLEW	Angle of Well Off Plume Centerline	FRORGCAR	Fraction Organic Carbon		
ANGLEW	Angle of Well Off Plume Centerline	ANGLEW	Angle of Well Off Plume Centerline		
XDIST	Longitudinal Distance to Well	AVGPDIAM	Avg. Particle Diameter		
XDIST	Longitudinal Distance to Well	POROSITY	Porosity		
XDIST	Longitudinal Distance to Well	AQUTHIK	Aquifer Thickness	Y	Y
XDIST	Longitudinal Distance to Well	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
XDIST	Longitudinal Distance to Well	HYDGRAD	Hydraulic Gradient	Y	Y
XDIST	Longitudinal Distance to Well	LONDISPA	Longitudinal Dispersivity		
XDIST	Longitudinal Distance to Well	FRORGCAR	Fraction Organic Carbon	Y	
XDIST	Longitudinal Distance to Well	ANGLEW	Angle of Well Off Plume Centerline		
XDIST	Longitudinal Distance to Well	XDIST	Longitudinal Distance to Well		
YDIST	Distance from Plume Centerline to Well	AVGPDIAM	Avg. Particle Diameter		
YDIST	Distance from Plume Centerline to Well	POROSITY	Porosity		
YDIST	Distance from Plume Centerline to Well	AQUTHIK	Aquifer Thickness		
YDIST	Distance from Plume Centerline to Well	LONHYCON	Longitundinal Hydraulic Conductivity		
YDIST	Distance from Plume Centerline to Well	HYDGRAD	Hydraulic Gradient		
YDIST	Distance from Plume Centerline to Well	LONDISPA	Longitudinal Dispersivity	Y	Y
YDIST	Distance from Plume Centerline to Well	FRORGCAR	Fraction Organic Carbon		
YDIST	Distance from Plume Centerline to Well	ANGLEW	Angle of Well Off Plume Centerline		
YDIST	Distance from Plume Centerline to Well	XDIST	Longitudinal Distance to Well	Y	Y
YDIST	Distance from Plume Centerline to Well	YDIST	Distance from Plume Centerline to Well	Y	Y
ZDIST	Depth of Well Below Water Table	AVGPDIAM	Avg. Particle Diameter		
ZDIST	Depth of Well Below Water Table	POROSITY	Porosity		
ZDIST	Depth of Well Below Water Table	AQUTHIK	Aquifer Thickness	Y	Y
ZDIST	Depth of Well Below Water Table	LONHYCON	Longitundinal Hydraulic Conductivity	Y	
ZDIST	Depth of Well Below Water Table	HYDGRAD	Hydraulic Gradient		
ZDIST	Depth of Well Below Water Table	LONDISPA	Longitudinal Dispersivity	Y	Y
ZDIST	Depth of Well Below Water Table	FRORGCAR	Fraction Organic Carbon		
ZDIST	Depth of Well Below Water Table	ANGLEW	Angle of Well Off Plume Centerline		
ZDIST	Depth of Well Below Water Table	XDIST	Longitudinal Distance to Well	Y	
ZDIST	Depth of Well Below Water Table	YDIST	Distance from Plume Centerline to Well		
ZDIST	Depth of Well Below Water Table	ZDIST	Depth of Well Below Water Table	Y	
FRCOEFA	Freundlich Isotherm Coefficient	AVGPDIAM	Avg. Particle Diameter		
FRCOEFA	Freundlich Isotherm Coefficient	POROSITY	Porosity		
FRCOEFA	Freundlich Isotherm Coefficient	AQUTHIK	Aquifer Thickness	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	HYDGRAD	Hydraulic Gradient	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	LONDISPA	Longitudinal Dispersivity	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	FRORGCAR	Fraction Organic Carbon		
FRCOEFA	Freundlich Isotherm Coefficient	ANGLEW	Angle of Well Off Plume Centerline		
FRCOEFA	Freundlich Isotherm Coefficient	XDIST	Longitudinal Distance to Well	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	YDIST	Distance from Plume Centerline to Well		
FRCOEFA	Freundlich Isotherm Coefficient	ZDIST	Depth of Well Below Water Table		
FRCOEFA	Freundlich Isotherm Coefficient	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
WMUAREA	WMU Area	AVGPDIAM	Avg. Particle Diameter		

Table A-9. Summary of Crosspairs Analysis for Antimony

Variable 1		Variable 2			
Code	Description	Code	Description	P<0.05	P<0.01
WMUAREA	WMU Area	POROSITY	Porosity		
WMUAREA	WMU Area	AQUTHIK	Aquifer Thickness		
WMUAREA	WMU Area	LONHYCON	Longitundinal Hydraulic Conductivity		
WMUAREA	WMU Area	HYDGRAD	Hydraulic Gradient	Y	Y
WMUAREA	WMU Area	LONDISPA	Longitudinal Dispersivity	Y	Y
WMUAREA	WMU Area	FRORGCAR	Fraction Organic Carbon		
WMUAREA	WMU Area	ANGLEW	Angle of Well Off Plume Centerline		
WMUAREA	WMU Area	XDIST	Longitudinal Distance to Well		
WMUAREA	WMU Area	YDIST	Distance from Plume Centerline to Well	Y	Y
WMUAREA	WMU Area	ZDIST	Depth of Well Below Water Table		
WMUAREA	WMU Area	FRCOEFA	Freundlich Isotherm Coefficient		
WMUAREA	WMU Area	WMUAREA	WMU Area	Y	Y
INFILRAT	Infiltration Rate	AVGPDIAM	Avg. Particle Diameter		
INFILRAT	Infiltration Rate	POROSITY	Porosity		
INFILRAT	Infiltration Rate	AQUTHIK	Aquifer Thickness		
INFILRAT	Infiltration Rate	LONHYCON	Longitundinal Hydraulic Conductivity	Y	
INFILRAT	Infiltration Rate	HYDGRAD	Hydraulic Gradient	Y	Y
INFILRAT	Infiltration Rate	LONDISPA	Longitudinal Dispersivity		
INFILRAT	Infiltration Rate	FRORGCAR	Fraction Organic Carbon		
INFILRAT	Infiltration Rate	ANGLEW	Angle of Well Off Plume Centerline		
INFILRAT	Infiltration Rate	XDIST	Longitudinal Distance to Well		
INFILRAT	Infiltration Rate	YDIST	Distance from Plume Centerline to Well		
INFILRAT	Infiltration Rate	ZDIST	Depth of Well Below Water Table		
INFILRAT	Infiltration Rate	FRCOEFA	Freundlich Isotherm Coefficient		
INFILRAT	Infiltration Rate	WMUAREA	WMU Area		
INFILRAT	Infiltration Rate	INFILRAT	Infiltration Rate	Y	Y
RESIDH2O	Residual Water Content	AVGPDIAM	Avg. Particle Diameter		
RESIDH2O	Residual Water Content	POROSITY	Porosity		
RESIDH2O	Residual Water Content	AQUTHIK	Aquifer Thickness	Y	Y
RESIDH2O	Residual Water Content	LONHYCON	Longitundinal Hydraulic Conductivity		
RESIDH2O	Residual Water Content	HYDGRAD	Hydraulic Gradient		
RESIDH2O	Residual Water Content	LONDISPA	Longitudinal Dispersivity		
RESIDH2O	Residual Water Content	FRORGCAR	Fraction Organic Carbon		
RESIDH2O	Residual Water Content	ANGLEW	Angle of Well Off Plume Centerline	Y	Y
RESIDH2O	Residual Water Content	XDIST	Longitudinal Distance to Well		
RESIDH2O	Residual Water Content	YDIST	Distance from Plume Centerline to Well		
RESIDH2O	Residual Water Content	ZDIST	Depth of Well Below Water Table		
RESIDH2O	Residual Water Content	FRCOEFA	Freundlich Isotherm Coefficient		
RESIDH2O	Residual Water Content	WMUAREA	WMU Area		
RESIDH2O	Residual Water Content	INFILRAT	Infiltration Rate		
RESIDH2O	Residual Water Content	RESIDH2O	Residual Water Content		
SATURH2O	Saturated Water Content	AVGPDIAM	Avg. Particle Diameter		
SATURH2O	Saturated Water Content	POROSITY	Porosity		
SATURH2O	Saturated Water Content	AQUTHIK	Aquifer Thickness		
SATURH2O	Saturated Water Content	LONHYCON	Longitundinal Hydraulic Conductivity		
SATURH2O	Saturated Water Content	HYDGRAD	Hydraulic Gradient		
SATURH2O	Saturated Water Content	LONDISPA	Longitudinal Dispersivity		
SATURH2O	Saturated Water Content	FRORGCAR	Fraction Organic Carbon		
SATURH2O	Saturated Water Content	ANGLEW	Angle of Well Off Plume Centerline		

Table A-9. Summary of Crosspairs Analysis for Antimony

Variable 1		Variable 2			
Code	Description	Code	Description	P<0.05	P<0.01
SATURH2O	Saturated Water Content	XDIST	Longitudinal Distance to Well		
SATURH2O	Saturated Water Content	YDIST	Distance from Plume Centerline to Well	Y	
SATURH2O	Saturated Water Content	ZDIST	Depth of Well Below Water Table		
SATURH2O	Saturated Water Content	FRCOEFA	Freundlich Isotherm Coefficient		
SATURH2O	Saturated Water Content	WMUAREA	WMU Area	Y	
SATURH2O	Saturated Water Content	INFILRAT	Infiltration Rate	Y	Y
SATURH2O	Saturated Water Content	RESIDH2O	Residual Water Content		
SATURH2O	Saturated Water Content	SATURH2O	Saturated Water Content	Y	Y
UNSATHIK	Unsaturated Zone Thickness	AVGPDIAM	Avg. Particle Diameter		
UNSATHIK	Unsaturated Zone Thickness	POROSITY	Porosity		
UNSATHIK	Unsaturated Zone Thickness	AQUTHIK	Aquifer Thickness	Y	Y
UNSATHIK	Unsaturated Zone Thickness	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
UNSATHIK	Unsaturated Zone Thickness	HYDGRAD	Hydraulic Gradient		
UNSATHIK	Unsaturated Zone Thickness	LONDISPA	Longitudinal Dispersivity		
UNSATHIK	Unsaturated Zone Thickness	FRORGCAR	Fraction Organic Carbon	Y	
UNSATHIK	Unsaturated Zone Thickness	ANGLEW	Angle of Well Off Plume Centerline		
UNSATHIK	Unsaturated Zone Thickness	XDIST	Longitudinal Distance to Well		
UNSATHIK	Unsaturated Zone Thickness	YDIST	Distance from Plume Centerline to Well		
UNSATHIK	Unsaturated Zone Thickness	ZDIST	Depth of Well Below Water Table	Y	Y
UNSATHIK	Unsaturated Zone Thickness	FRCOEFA	Freundlich Isotherm Coefficient		
UNSATHIK	Unsaturated Zone Thickness	WMUAREA	WMU Area		
UNSATHIK	Unsaturated Zone Thickness	INFILRAT	Infiltration Rate	Y	Y
UNSATHIK	Unsaturated Zone Thickness	RESIDH2O	Residual Water Content		
UNSATHIK	Unsaturated Zone Thickness	SATURH2O	Saturated Water Content		
UNSATHIK	Unsaturated Zone Thickness	UNSATHIK	Unsaturated Zone Thickness	Y	Y
PERORGM	Percent Organic Matter	AVGPDIAM	Avg. Particle Diameter		
PERORGM	Percent Organic Matter	POROSITY	Porosity		
PERORGM	Percent Organic Matter	AQUTHIK	Aquifer Thickness		
PERORGM	Percent Organic Matter	LONHYCON	Longitundinal Hydraulic Conductivity		
PERORGM	Percent Organic Matter	HYDGRAD	Hydraulic Gradient		
PERORGM	Percent Organic Matter	LONDISPA	Longitudinal Dispersivity		
PERORGM	Percent Organic Matter	FRORGCAR	Fraction Organic Carbon	Y	
PERORGM	Percent Organic Matter	ANGLEW	Angle of Well Off Plume Centerline		
PERORGM	Percent Organic Matter	XDIST	Longitudinal Distance to Well		
PERORGM	Percent Organic Matter	YDIST	Distance from Plume Centerline to Well		
PERORGM	Percent Organic Matter	ZDIST	Depth of Well Below Water Table		
PERORGM	Percent Organic Matter	FRCOEFA	Freundlich Isotherm Coefficient	Y	
PERORGM	Percent Organic Matter	WMUAREA	WMU Area	Y	
PERORGM	Percent Organic Matter	INFILRAT	Infiltration Rate		
PERORGM	Percent Organic Matter	RESIDH2O	Residual Water Content		
PERORGM	Percent Organic Matter	SATURH2O	Saturated Water Content		
PERORGM	Percent Organic Matter	UNSATHIK	Unsaturated Zone Thickness		
PERORGM	Percent Organic Matter	PERORGM	Percent Organic Matter		
FRCOEFU	Freundlich Isotherm Coefficient	AVGPDIAM	Avg. Particle Diameter		
FRCOEFU	Freundlich Isotherm Coefficient	POROSITY	Porosity		
FRCOEFU	Freundlich Isotherm Coefficient	AQUTHIK	Aquifer Thickness	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	LONHYCON	Longitundinal Hydraulic Conductivity		
FRCOEFU	Freundlich Isotherm Coefficient	HYDGRAD	Hydraulic Gradient		
FRCOEFU	Freundlich Isotherm Coefficient	LONDISPA	Longitudinal Dispersivity		

Table A-9. Summary of Crosspairs Analysis for Antimony

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
FRCOEFU	Freundlich Isotherm Coefficient	FRORGCAR	Fraction Organic Carbon		
FRCOEFU	Freundlich Isotherm Coefficient	ANGLEW	Angle of Well Off Plume Centerline		
FRCOEFU	Freundlich Isotherm Coefficient	XDIST	Longitudinal Distance to Well		
FRCOEFU	Freundlich Isotherm Coefficient	YDIST	Distance from Plume Centerline to Well	Y	
FRCOEFU	Freundlich Isotherm Coefficient	ZDIST	Depth of Well Below Water Table		
FRCOEFU	Freundlich Isotherm Coefficient	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	WMUAREA	WMU Area	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	INFILRAT	Infiltration Rate	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	RESIDH2O	Residual Water Content	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	SATURH2O	Saturated Water Content	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	UNSATHIK	Unsaturated Zone Thickness	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	PERORGM	Percent Organic Matter		
FRCOEFU	Freundlich Isotherm Coefficient	FRCOEFU	Freundlich Isotherm Coefficient	Y	Y

Table A-10. Ranking of Parameters According to Percentage of Risk for Antimony

Variable Description	Reduced Sums of Square	Variable Sums of Square	Variable Degrees of Freedom	% Risk Variation	Mean Square Variable	F VALUE	P VALUE
Freundlich Isotherm Coefficient {Unsaturated} (cm3/g)	128512.0	214679.36	59	8616740.0%	193650.11	9574.16	1.95E+01
Unsaturated Zone Thickness (m)	158541.3	214679.36	59	5613809.0%	193650.11	8019.73	1.95E+01
Freundlich Isotherm Coefficient {Aquifer} (cm3/g)	182555.3	214679.36	59	3212411.0%	193650.11	4015.51	1.95E+01
Aquifer Thickness (m)	187542.7	214679.36	59	2713665.0%	193650.11	2713.67	1.95E+01
Distance from Plume Centerline to Well (m)	197003.7	214679.36	59	1767569.0%	193650.11	3535.14	1.95E+01
Infiltration Rate (m/yr)	202022.6	214679.36	59	1265680.0%	193650.11	2109.47	1.95E+01
Longitudinal Dispersivity {Aquifer} (m)	207014.1	214679.36	59	766524.0%	193650.11	1095.03	1.95E+01
Longitudinal Hydraulic Conductivity (m/yr)	207651.5	214679.36	59	702783.0%	193650.11	878.48	1.95E+01
WMU Area (m2)	209198.9	214679.36	59	548048.0%	193650.11	913.41	1.95E+01
Longitudinal Distance to Well (m)	210507.9	214679.36	59	417142.0%	193650.11	695.24	1.95E+01
Consumption of Drinking Water (ml/kg-day)	212446.7	214679.36	59	223270.0%	193650.11	2232.70	1.95E+01
Hydraulic Gradient (m/m)	213194.4	214679.36	59	148495.0%	193650.11	247.49	1.95E+01
Saturated Water Content	213506.5	214679.36	59	117287.0%	193650.11	293.22	1.95E+01
Depth of Well Below Water Table (m)	213982.7	214679.36	59	69666.0%	193650.11	174.16	1.95E+01
Residual Water Content	214120.0	214679.36	59	55941.0%	193650.11	139.85	1.95E+01
Angle of Well Off Plume Centerline (degrees)	214523.2	214679.36	59	15616.0%	193650.11	78.08	1.95E+01

Constants

Full Model SS	50
Error SS	9
Error DF	0
MS Error	9940

Table A-11. Summary of Parameters Considered in Sensitivity Analysis for Arsenic

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
EXPDURA					
CANSLOPE		C			
ACIDCAT	Acid Catalyzed Hydrolysis Rate Constant	C			
ANGLEW	Angle of Well Off Plume Centerline	anglew		Y	
ANISORAT	Anisotropy Ratio	C			
AQUTHIK	Aquifer Thickness	log(aquthik-0.8)		Y	Y
AVGPDIAM	Avg. Particle Diameter	log(avgpdiam+0.002)		Y	Y
BASECAT	Base Catalyzed Hydrolysis Rate Constant	C			
BIODRATA	Biodegradation Rate	C			
BIODRATU	Biodegradation Rate	C			
BULKDENS	Bulk Density	bulkdens**3.5	Y		
CHEMDRU	Chemical Decay Rate	C			
CHEMDRA	Chemical Decay Rate	C			
CONSH2OA	Consump of drinking water	log(consh2oa)			
ZDIST	Depth of Well Below Water Table	log(zdist+4)		Y	Y
DISHYD	Dissolved Hydrolysis Rate	C			
YDIST	Distance from Plume Centerline to Well	log(ydist+15)		Y	Y
DURLEACH	Duration of Leaching Period	log(durleach)	Y		
GWAVTIM	Exposure Duration	gwavtim		Y	
FRORGCAR	Fraction Organic Carbon	log(frorgcar)			
FRCOEFA	Freundlich Isotherm Coefficient	log(frcoefa+3)		Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	log(frcoefu+3)		Y	Y
FREXPA	Freundlich Isotherm Exponent	C			
FREXPU	Freundlich Isotherm Exponent	C			
GWPH	Groundwater pH	gwph	Y		
GWSEEPV	Groundwater Seepage Velocity	log(gwseepv)	Y		
GWTEMP	Groundwater Temperature	C			
HYDGRAD	Hydraulic Gradient	log(hydgrad+0.0003)		Y	Y
INFILRAT	Infiltration Rate	infilrat**1.5		Y	Y
LANDEPTH	Landfill Depth	log(landepth+0.0007)	Y		
LEACHCON	Leachate Concentration	C			
LFFRACT	LF Fraction	C			
LONDISPA	Longitudinal Dispersivity	log(londispa+0.3)		Y	Y

Table A-11. Summary of Parameters Considered in Sensitivity Analysis for Arsenic

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
LONDISPU	Longitudinal Dispersivity	log(londispu-0.02)	Y		
XDIST	Longitudinal Distance to Well	log(xdist+250)		Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity	log(lonhycon+100)		Y	Y
MOISTRPA	Moisture Rention Parameter (a)	log(moistrpa-0.05)	Y		
MOISTRPB	Moisture Rention Parameter (b)	log(moistrpb-0.95)	Y		
MOLDIFF	Molecular Diffusion Coefficient	C			
NEUTHYD	Neutral Hydrolysis Rate Constant	C			
ORGCDIS	Organic Carbon Distribution Coefficient	C			
PERORGM	Percent Organic Matter	log(perorgm)		Y	
POROSITY	Porosity	porosity**1.3			
RADISTW	Radial Distance to Well	log(radistw+250)	Y		
RECHARAT	Recharge Rate	recharat	Y		
RESIDH2O	Residual Water Content	residh2o**1.9		Y	Y
RETCOEF	Retardation Coefficient	log(retcoef+10)	Y		
SATHYCON	Saturated Hydraulic Conductivity	log(sathycon)	Y		
SATURH2O	Saturated Water Content	saturh2o		Y	
SOILBDEN	Soil Bulk Density	soilbden	Y		
SORBHYD	Sorbed Hydrolysis Rate	C			
TRANDISP	Transverse Dispersivity	log(trandisp+0.01)	Y		
UNSATHIK	Unsaturated Zone Thickness	log(unsathik)		Y	Y
VERTDISP	Vertical Dispersivity	log(vertdisp+0.001)	Y		
WASTDENS	Waste Density	C			
WASTEVOL	Waste Volume	C			
WMUAREA	WMU Area	log(wmuarea-3900)		Y	Y
WMULEN	WMU Length	log(wmulen-50)	Y		
WMUWIDTH	WMU Width	log(wmuwidth-50)	Y		

Table A-12. Summary of Correlated Parameters for Arsenic

Variable 1		Variable 2		Correlation Coefficient
Code	Description	Code	Description	
AVGPDIAM	Avg. Particle Diameter	BULKDENS	Bulk Density	0.9988
LONHYCON	Longitundinal Hydraulic Conductivi	GWSEEPV	Groundwater Seepage Velocity	0.81815
FRCOEFA	Freundlich Isotherm Coefficient	RETCOEF	Retardation Coefficient	0.9877
LONDISPA	Longitudinal Dispersivity	TRANDISP	Transverse Dispersivity	0.99931
LONDISPA	Longitudinal Dispersivity	VERTDISP	Vertical Dispersivity	0.99916
RECHARAT	Recharge Rate	GWPH	Groundwater pH	-0.88331
INFILRAT	Infiltration Rate	GWPH	Groundwater pH	-0.80133
MOISTRPB	Moisture Rention Parameter (b)	GWPH	Groundwater pH	-0.71798
SOILBDEN	Soil Bulk Density	GWPH	Groundwater pH	0.74946
XDIST	Longitudinal Distance to Well	RADISTW	Radial Distance to Well	0.9939
WMUAREA	WMU Area	WMULEN	WMU Length	0.99833
LANDEPTH	Landfill Depth	WMULEN	WMU Length	-0.99043
DURLEACH	Duration of Leaching Period	WMULEN	WMU Length	-0.96305
WMUAREA	WMU Area	WMUWIDTH	WMU Width	0.99833
LANDEPTH	Landfill Depth	WMUWIDTH	WMU Width	-0.99043
DURLEACH	Duration of Leaching Period	WMUWIDTH	WMU Width	-0.96305
INFILRAT	Infiltration Rate	RECHARAT	Recharge Rate	0.90405
SOILBDEN	Soil Bulk Density	RECHARAT	Recharge Rate	-0.97237
WMUAREA	WMU Area	LANDEPTH	Landfill Depth	-0.98363
WMUAREA	WMU Area	DURLEACH	Duration of Leaching Period	-0.96276
LANDEPTH	Landfill Depth	DURLEACH	Duration of Leaching Period	0.95171
RECHARAT	Recharge Rate	SATHYCON	Saturated Hydraulic Conductivity	0.71373
INFILRAT	Infiltration Rate	SATHYCON	Saturated Hydraulic Conductivity	0.80946
RECHARAT	Recharge Rate	MOISTRPA	Moisture Rention Parameter (a)	0.71619
RECHARAT	Recharge Rate	MOISTRPB	Moisture Rention Parameter (b)	0.84927
INFILRAT	Infiltration Rate	MOISTRPB	Moisture Rention Parameter (b)	0.76283
UNSATHIK	Unsaturated Zone Thickness	LONDISPU	Longitudinal Dispersivity	0.99997
RECHARAT	Recharge Rate	SOILBDEN	Soil Bulk Density	-0.97237
INFILRAT	Infiltration Rate	SOILBDEN	Soil Bulk Density	-0.87769
SATHYCON	Saturated Hydraulic Conductivity	SOILBDEN	Soil Bulk Density	-0.70622
MOISTRPA	Moisture Rention Parameter (a)	SOILBDEN	Soil Bulk Density	-0.73096
MOISTRPB	Moisture Rention Parameter (b)	SOILBDEN	Soil Bulk Density	-0.84183
FRCOEFU	Freundlich Isotherm Coefficient	AVRECWF	Average Receptor Well Concentr	-0.70441
FRCOEFU	Freundlich Isotherm Coefficient	DRH2OCNA	drinking water well conc	-0.70441

Note: Parameters in the variable 2 column were removed from the analysis.

Table A-13. Summary of Crosspairs Analysis for Arsenic

Variable 1		Variable 2			
Code	Description	Code	Description	P<0.05	P<0.01
AVGPDIAM	Avg. Particle Diameter				
POROSITY	Porosity				
AQUTHIK	Aquifer Thickness			Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity			Y	Y
HYDGRAD	Hydraulic Gradient			Y	Y
LONDISPA	Longitudinal Dispersivity			Y	Y
FRORGCAR	Fraction Organic Carbon				
ANGLEW	Angle of Well Off Plume Centerline				
XDIST	Longitudinal Distance to Well			Y	Y
YDIST	Distance from Plume Centerline to Well			Y	Y
ZDIST	Depth of Well Below Water Table			Y	
FRCOEFA	Freundlich Isotherm Coefficient			Y	Y
GWAVTIM	Exposure Duration				
WMUAREA	WMU Area			Y	Y
INFILRAT	Infiltration Rate				Y
RESIDH2O	Residual Water Content				
SATURH2O	Saturated Water Content				
UNSATHIK	Unsaturated Zone Thickness			Y	Y
PERORGM	Percent Organic Matter			Y	
FRCOEFU	Freundlich Isotherm Coefficient			Y	Y
AVGPDIAM	Avg. Particle Diameter	AVGPDIAM	Avg. Particle Diameter		
POROSITY	Porosity	AVGPDIAM	Avg. Particle Diameter		
POROSITY	Porosity	POROSITY	Porosity		
AQUTHIK	Aquifer Thickness	AVGPDIAM	Avg. Particle Diameter		
AQUTHIK	Aquifer Thickness	POROSITY	Porosity		
AQUTHIK	Aquifer Thickness	AQUTHIK	Aquifer Thickness		
LONHYCON	Longitundinal Hydraulic Conductivity	AVGPDIAM	Avg. Particle Diameter		
LONHYCON	Longitundinal Hydraulic Conductivity	POROSITY	Porosity		
LONHYCON	Longitundinal Hydraulic Conductivity	AQUTHIK	Aquifer Thickness	Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity	LONHYCON	Longitundinal Hydraulic Conductivity		
HYDGRAD	Hydraulic Gradient	AVGPDIAM	Avg. Particle Diameter		
HYDGRAD	Hydraulic Gradient	POROSITY	Porosity		
HYDGRAD	Hydraulic Gradient	AQUTHIK	Aquifer Thickness		
HYDGRAD	Hydraulic Gradient	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
HYDGRAD	Hydraulic Gradient	HYDGRAD	Hydraulic Gradient		
LONDISPA	Longitudinal Dispersivity	AVGPDIAM	Avg. Particle Diameter		
LONDISPA	Longitudinal Dispersivity	POROSITY	Porosity		
LONDISPA	Longitudinal Dispersivity	AQUTHIK	Aquifer Thickness		
LONDISPA	Longitudinal Dispersivity	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
LONDISPA	Longitudinal Dispersivity	HYDGRAD	Hydraulic Gradient		
LONDISPA	Longitudinal Dispersivity	LONDISPA	Longitudinal Dispersivity		
FRORGCAR	Fraction Organic Carbon	AVGPDIAM	Avg. Particle Diameter		
FRORGCAR	Fraction Organic Carbon	POROSITY	Porosity		
FRORGCAR	Fraction Organic Carbon	AQUTHIK	Aquifer Thickness		
FRORGCAR	Fraction Organic Carbon	LONHYCON	Longitundinal Hydraulic Conductivity		
FRORGCAR	Fraction Organic Carbon	HYDGRAD	Hydraulic Gradient		
FRORGCAR	Fraction Organic Carbon	LONDISPA	Longitudinal Dispersivity		
FRORGCAR	Fraction Organic Carbon	FRORGCAR	Fraction Organic Carbon		
ANGLEW	Angle of Well Off Plume Centerline	AVGPDIAM	Avg. Particle Diameter		

Table A-13. Summary of Crosspairs Analysis for Arsenic

Variable 1		Variable 2			
Code	Description	Code	Description	P<0.05	P<0.01
ANGLEW	Angle of Well Off Plume Centerline	POROSITY	Porosity		
ANGLEW	Angle of Well Off Plume Centerline	AQUTHIK	Aquifer Thickness		
ANGLEW	Angle of Well Off Plume Centerline	LONHYCON	Longitundinal Hydraulic Conductivity		
ANGLEW	Angle of Well Off Plume Centerline	HYDGRAD	Hydraulic Gradient	Y	
ANGLEW	Angle of Well Off Plume Centerline	LONDISPA	Longitudinal Dispersivity		
ANGLEW	Angle of Well Off Plume Centerline	FRORGCAR	Fraction Organic Carbon		
ANGLEW	Angle of Well Off Plume Centerline	ANGLEW	Angle of Well Off Plume Centerline		
XDIST	Longitudinal Distance to Well	AVGPDIAM	Avg. Particle Diameter		
XDIST	Longitudinal Distance to Well	POROSITY	Porosity		
XDIST	Longitudinal Distance to Well	AQUTHIK	Aquifer Thickness		
XDIST	Longitudinal Distance to Well	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
XDIST	Longitudinal Distance to Well	HYDGRAD	Hydraulic Gradient	Y	Y
XDIST	Longitudinal Distance to Well	LONDISPA	Longitudinal Dispersivity	Y	Y
XDIST	Longitudinal Distance to Well	FRORGCAR	Fraction Organic Carbon		
XDIST	Longitudinal Distance to Well	ANGLEW	Angle of Well Off Plume Centerline		
XDIST	Longitudinal Distance to Well	XDIST	Longitudinal Distance to Well		
YDIST	Distance from Plume Centerline to Well	AVGPDIAM	Avg. Particle Diameter		
YDIST	Distance from Plume Centerline to Well	POROSITY	Porosity		
YDIST	Distance from Plume Centerline to Well	AQUTHIK	Aquifer Thickness		
YDIST	Distance from Plume Centerline to Well	LONHYCON	Longitundinal Hydraulic Conductivity		
YDIST	Distance from Plume Centerline to Well	HYDGRAD	Hydraulic Gradient		
YDIST	Distance from Plume Centerline to Well	LONDISPA	Longitudinal Dispersivity		
YDIST	Distance from Plume Centerline to Well	FRORGCAR	Fraction Organic Carbon		
YDIST	Distance from Plume Centerline to Well	ANGLEW	Angle of Well Off Plume Centerline		
YDIST	Distance from Plume Centerline to Well	XDIST	Longitudinal Distance to Well		
YDIST	Distance from Plume Centerline to Well	YDIST	Distance from Plume Centerline to Well	Y	Y
ZDIST	Depth of Well Below Water Table	AVGPDIAM	Avg. Particle Diameter		
ZDIST	Depth of Well Below Water Table	POROSITY	Porosity		
ZDIST	Depth of Well Below Water Table	AQUTHIK	Aquifer Thickness		
ZDIST	Depth of Well Below Water Table	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
ZDIST	Depth of Well Below Water Table	HYDGRAD	Hydraulic Gradient	Y	
ZDIST	Depth of Well Below Water Table	LONDISPA	Longitudinal Dispersivity		
ZDIST	Depth of Well Below Water Table	FRORGCAR	Fraction Organic Carbon		
ZDIST	Depth of Well Below Water Table	ANGLEW	Angle of Well Off Plume Centerline		
ZDIST	Depth of Well Below Water Table	XDIST	Longitudinal Distance to Well		
ZDIST	Depth of Well Below Water Table	YDIST	Distance from Plume Centerline to Well		
ZDIST	Depth of Well Below Water Table	ZDIST	Depth of Well Below Water Table		
FRCOEFA	Freundlich Isotherm Coefficient	AVGPDIAM	Avg. Particle Diameter		
FRCOEFA	Freundlich Isotherm Coefficient	POROSITY	Porosity		
FRCOEFA	Freundlich Isotherm Coefficient	AQUTHIK	Aquifer Thickness		
FRCOEFA	Freundlich Isotherm Coefficient	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	HYDGRAD	Hydraulic Gradient	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	LONDISPA	Longitudinal Dispersivity	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	FRORGCAR	Fraction Organic Carbon		
FRCOEFA	Freundlich Isotherm Coefficient	ANGLEW	Angle of Well Off Plume Centerline		
FRCOEFA	Freundlich Isotherm Coefficient	XDIST	Longitudinal Distance to Well	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	YDIST	Distance from Plume Centerline to Well	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	ZDIST	Depth of Well Below Water Table	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y

Table A-13. Summary of Crosspairs Analysis for Arsenic

Variable 1		Variable 2			
Code	Description	Code	Description	P<0.05	P<0.01
GWAVTIM	Exposure Duration	AVGPDIAM	Avg. Particle Diameter		
GWAVTIM	Exposure Duration	POROSITY	Porosity		
GWAVTIM	Exposure Duration	AQUTHIK	Aquifer Thickness		
GWAVTIM	Exposure Duration	LONHYCON	Longitundinal Hydraulic Conductivity		
GWAVTIM	Exposure Duration	HYDGRAD	Hydraulic Gradient		
GWAVTIM	Exposure Duration	LONDISPA	Longitudinal Dispersivity		
GWAVTIM	Exposure Duration	FRORGCAR	Fraction Organic Carbon		
GWAVTIM	Exposure Duration	ANGLEW	Angle of Well Off Plume Centerline		
GWAVTIM	Exposure Duration	XDIST	Longitudinal Distance to Well		
GWAVTIM	Exposure Duration	YDIST	Distance from Plume Centerline to Well		
GWAVTIM	Exposure Duration	ZDIST	Depth of Well Below Water Table		
GWAVTIM	Exposure Duration	FRCOEFA	Freundlich Isotherm Coefficient		
GWAVTIM	Exposure Duration	GWAVTIM	Exposure Duration		
WMUAREA	WMU Area	AVGPDIAM	Avg. Particle Diameter		
WMUAREA	WMU Area	POROSITY	Porosity		
WMUAREA	WMU Area	AQUTHIK	Aquifer Thickness		
WMUAREA	WMU Area	LONHYCON	Longitundinal Hydraulic Conductivity	Y	
WMUAREA	WMU Area	HYDGRAD	Hydraulic Gradient		
WMUAREA	WMU Area	LONDISPA	Longitudinal Dispersivity	Y	Y
WMUAREA	WMU Area	FRORGCAR	Fraction Organic Carbon		
WMUAREA	WMU Area	ANGLEW	Angle of Well Off Plume Centerline		
WMUAREA	WMU Area	XDIST	Longitudinal Distance to Well		
WMUAREA	WMU Area	YDIST	Distance from Plume Centerline to Well	Y	Y
WMUAREA	WMU Area	ZDIST	Depth of Well Below Water Table		
WMUAREA	WMU Area	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
WMUAREA	WMU Area	GWAVTIM	Exposure Duration		
WMUAREA	WMU Area	WMUAREA	WMU Area		
INFILRAT	Infiltration Rate	AVGPDIAM	Avg. Particle Diameter		
INFILRAT	Infiltration Rate	POROSITY	Porosity		
INFILRAT	Infiltration Rate	AQUTHIK	Aquifer Thickness		
INFILRAT	Infiltration Rate	LONHYCON	Longitundinal Hydraulic Conductivity		
INFILRAT	Infiltration Rate	HYDGRAD	Hydraulic Gradient		
INFILRAT	Infiltration Rate	LONDISPA	Longitudinal Dispersivity		
INFILRAT	Infiltration Rate	FRORGCAR	Fraction Organic Carbon		
INFILRAT	Infiltration Rate	ANGLEW	Angle of Well Off Plume Centerline		
INFILRAT	Infiltration Rate	XDIST	Longitudinal Distance to Well		
INFILRAT	Infiltration Rate	YDIST	Distance from Plume Centerline to Well		
INFILRAT	Infiltration Rate	ZDIST	Depth of Well Below Water Table		
INFILRAT	Infiltration Rate	FRCOEFA	Freundlich Isotherm Coefficient		
INFILRAT	Infiltration Rate	GWAVTIM	Exposure Duration		
INFILRAT	Infiltration Rate	WMUAREA	WMU Area		
INFILRAT	Infiltration Rate	INFILRAT	Infiltration Rate	Y	Y
RESIDH2O	Residual Water Content	AVGPDIAM	Avg. Particle Diameter		
RESIDH2O	Residual Water Content	POROSITY	Porosity		
RESIDH2O	Residual Water Content	AQUTHIK	Aquifer Thickness		
RESIDH2O	Residual Water Content	LONHYCON	Longitundinal Hydraulic Conductivity		
RESIDH2O	Residual Water Content	HYDGRAD	Hydraulic Gradient		
RESIDH2O	Residual Water Content	LONDISPA	Longitudinal Dispersivity		
RESIDH2O	Residual Water Content	FRORGCAR	Fraction Organic Carbon		

Table A-13. Summary of Crosspairs Analysis for Arsenic

Variable 1		Variable 2			
Code	Description	Code	Description	P<0.05	P<0.01
RESIDH2O	Residual Water Content	ANGLEW	Angle of Well Off Plume Centerline		
RESIDH2O	Residual Water Content	XDIST	Longitudinal Distance to Well		
RESIDH2O	Residual Water Content	YDIST	Distance from Plume Centerline to Well		
RESIDH2O	Residual Water Content	ZDIST	Depth of Well Below Water Table		
RESIDH2O	Residual Water Content	FRCOEFA	Freundlich Isotherm Coefficient		
RESIDH2O	Residual Water Content	GWAVTIM	Exposure Duration		
RESIDH2O	Residual Water Content	WMUAREA	WMU Area		
RESIDH2O	Residual Water Content	INFILRAT	Infiltration Rate		
RESIDH2O	Residual Water Content	RESIDH2O	Residual Water Content		
SATURH2O	Saturated Water Content	AVGPDIAM	Avg. Particle Diameter		
SATURH2O	Saturated Water Content	POROSITY	Porosity		
SATURH2O	Saturated Water Content	AQUTHIK	Aquifer Thickness		
SATURH2O	Saturated Water Content	LONHYCON	Longitundinal Hydraulic Conductivity		
SATURH2O	Saturated Water Content	HYDGRAD	Hydraulic Gradient		
SATURH2O	Saturated Water Content	LONDISPA	Longitudinal Dispersivity		
SATURH2O	Saturated Water Content	FRORGCAR	Fraction Organic Carbon		
SATURH2O	Saturated Water Content	ANGLEW	Angle of Well Off Plume Centerline		
SATURH2O	Saturated Water Content	XDIST	Longitudinal Distance to Well		
SATURH2O	Saturated Water Content	YDIST	Distance from Plume Centerline to Well		
SATURH2O	Saturated Water Content	ZDIST	Depth of Well Below Water Table		
SATURH2O	Saturated Water Content	FRCOEFA	Freundlich Isotherm Coefficient		
SATURH2O	Saturated Water Content	GWAVTIM	Exposure Duration		
SATURH2O	Saturated Water Content	WMUAREA	WMU Area		
SATURH2O	Saturated Water Content	INFILRAT	Infiltration Rate		
SATURH2O	Saturated Water Content	RESIDH2O	Residual Water Content	Y	
SATURH2O	Saturated Water Content	SATURH2O	Saturated Water Content		
UNSATHIK	Unsaturated Zone Thickness	AVGPDIAM	Avg. Particle Diameter		
UNSATHIK	Unsaturated Zone Thickness	POROSITY	Porosity		
UNSATHIK	Unsaturated Zone Thickness	AQUTHIK	Aquifer Thickness		
UNSATHIK	Unsaturated Zone Thickness	LONHYCON	Longitundinal Hydraulic Conductivity		
UNSATHIK	Unsaturated Zone Thickness	HYDGRAD	Hydraulic Gradient	Y	Y
UNSATHIK	Unsaturated Zone Thickness	LONDISPA	Longitudinal Dispersivity	Y	Y
UNSATHIK	Unsaturated Zone Thickness	FRORGCAR	Fraction Organic Carbon		
UNSATHIK	Unsaturated Zone Thickness	ANGLEW	Angle of Well Off Plume Centerline		
UNSATHIK	Unsaturated Zone Thickness	XDIST	Longitudinal Distance to Well	Y	Y
UNSATHIK	Unsaturated Zone Thickness	YDIST	Distance from Plume Centerline to Well		
UNSATHIK	Unsaturated Zone Thickness	ZDIST	Depth of Well Below Water Table		
UNSATHIK	Unsaturated Zone Thickness	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
UNSATHIK	Unsaturated Zone Thickness	GWAVTIM	Exposure Duration	Y	
UNSATHIK	Unsaturated Zone Thickness	WMUAREA	WMU Area		
UNSATHIK	Unsaturated Zone Thickness	INFILRAT	Infiltration Rate		
UNSATHIK	Unsaturated Zone Thickness	RESIDH2O	Residual Water Content	Y	Y
UNSATHIK	Unsaturated Zone Thickness	SATURH2O	Saturated Water Content		
UNSATHIK	Unsaturated Zone Thickness	UNSATHIK	Unsaturated Zone Thickness	Y	Y
PERORGM	Percent Organic Matter	AVGPDIAM	Avg. Particle Diameter		
PERORGM	Percent Organic Matter	POROSITY	Porosity		
PERORGM	Percent Organic Matter	AQUTHIK	Aquifer Thickness		
PERORGM	Percent Organic Matter	LONHYCON	Longitundinal Hydraulic Conductivity		
PERORGM	Percent Organic Matter	HYDGRAD	Hydraulic Gradient		

Table A-13. Summary of Crosspairs Analysis for Arsenic

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
PERORGM	Percent Organic Matter	LONDISPA	Longitudinal Dispersivity		
PERORGM	Percent Organic Matter	FRORGCAR	Fraction Organic Carbon		
PERORGM	Percent Organic Matter	ANGLEW	Angle of Well Off Plume Centerline		
PERORGM	Percent Organic Matter	XDIST	Longitudinal Distance to Well		
PERORGM	Percent Organic Matter	YDIST	Distance from Plume Centerline to Well		
PERORGM	Percent Organic Matter	ZDIST	Depth of Well Below Water Table		
PERORGM	Percent Organic Matter	FRCOEFA	Freundlich Isotherm Coefficient		
PERORGM	Percent Organic Matter	GWAVTIM	Exposure Duration		
PERORGM	Percent Organic Matter	WMUAREA	WMU Area		
PERORGM	Percent Organic Matter	INFILRAT	Infiltration Rate		
PERORGM	Percent Organic Matter	RESIDH2O	Residual Water Content		
PERORGM	Percent Organic Matter	SATURH2O	Saturated Water Content	Y	
PERORGM	Percent Organic Matter	UNSATHIK	Unsaturated Zone Thickness		
PERORGM	Percent Organic Matter	PERORGM	Percent Organic Matter		
FRCOEFU	Freundlich Isotherm Coefficient	AVGPDIAM	Avg. Particle Diameter	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	POROSITY	Porosity		
FRCOEFU	Freundlich Isotherm Coefficient	AQUTHIK	Aquifer Thickness	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	HYDGRAD	Hydraulic Gradient	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	LONDISPA	Longitudinal Dispersivity	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	FRORGCAR	Fraction Organic Carbon		
FRCOEFU	Freundlich Isotherm Coefficient	ANGLEW	Angle of Well Off Plume Centerline		
FRCOEFU	Freundlich Isotherm Coefficient	XDIST	Longitudinal Distance to Well	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	YDIST	Distance from Plume Centerline to Well	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	ZDIST	Depth of Well Below Water Table		
FRCOEFU	Freundlich Isotherm Coefficient	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	GWAVTIM	Exposure Duration		
FRCOEFU	Freundlich Isotherm Coefficient	WMUAREA	WMU Area	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	INFILRAT	Infiltration Rate		
FRCOEFU	Freundlich Isotherm Coefficient	RESIDH2O	Residual Water Content		
FRCOEFU	Freundlich Isotherm Coefficient	SATURH2O	Saturated Water Content		
FRCOEFU	Freundlich Isotherm Coefficient	UNSATHIK	Unsaturated Zone Thickness	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	PERORGM	Percent Organic Matter		
FRCOEFU	Freundlich Isotherm Coefficient	FRCOEFU	Freundlich Isotherm Coefficient	Y	Y

Table A-14. Ranking of Parameters According to Percentage of Risk for Arsenic

Variable Description	Reduced Sums of Square	Variable Sums of Square	Variable Degrees of Freedom	% Risk Variation	Mean Square Variable	F VALUE	P VALUE
Freundlich Isotherm Coefficient {Unsaturated} (cm3/g)	644888.8	2532541.56	52	88765277.0%	718889.17	157304.40	7.23E+01
Freundlich Isotherm Coefficient {Aquifer} (cm3/g)	2065450.1	2532541.56	52	46709149.0%	718889.17	42462.86	7.23E+01
Unsaturated Zone Thickness (m)	2333907.0	2532541.56	52	19863451.0%	718889.17	24829.31	7.23E+01
Longitudinal Distance to Well (m)	2448746.0	2532541.56	52	8379552.0%	718889.17	11970.79	7.23E+01
Longitudinal Hydraulic Conductivity (m/yr)	2478245.6	2532541.56	52	5429598.0%	718889.17	6787.00	7.23E+01
Longitudinal Dispersivity {Aquifer} (m)	2491087.6	2532541.56	52	4145399.0%	718889.17	5922.00	7.23E+01
Hydraulic Gradient (m/m)	2508926.7	2532541.56	52	2361486.0%	718889.17	3935.81	7.23E+01
Aquifer Thickness (m)	2513555.6	2532541.56	52	1898598.0%	718889.17	6328.66	7.23E+01
Distance from Plume Centerline to Well (m)	2516760.7	2532541.56	52	1578084.0%	718889.17	3156.17	7.23E+01
Infiltration Rate (m/yr)	2520165.3	2532541.56	52	1237628.0%	718889.17	6188.14	7.23E+01
WMU Area (m2)	2523208.2	2532541.56	52	933333.0%	718889.17	1866.67	7.23E+01
Depth of Well Below Water Table (m)	2530797.6	2532541.56	52	174394.0%	718889.17	581.31	7.23E+01
Average Particle Diameter (cm)	2531780.0	2532541.56	52	76159.0%	718889.17	380.80	7.23E+01
Residual Water Content	2531852.7	2532541.56	52	68883.0%	718889.17	344.42	7.23E+01
Exposure Duration (yr)	2531945.3	2532541.56	52	59623.0%	718889.17	596.23	7.23E+01
Consumption of Drinking Water (ml/kg-day)	2532145.6	2532541.56	52	39591.0%	718889.17	395.91	7.23E+01

Constants

Full Model SS	40
Error SS	12
Error DF	1
MS Error	9947

Table A-15. Summary of Parameters Considered in Sensitivity Analysis for Nickel

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
ACIDCAT	Acid Catalyzed Hydrolysis Rate Constant	C			
ANGLEW	Angle of Well Off Plume Centerline	anglew			
ANISORAT	Anisotropy Ratio	C			
AQUTHIK	Aquifer Thickness	log(aquthik-0.8)		Y	Y
AVGPDIAM	Avg. Particle Diameter	log(avgpdiam+0.002)		Y	Y
BASECAT	Base Catalyzed Hydrolysis Rate Constant	C			
BIODRATA	Biodegradation Rate	C			
BIODRATU	Biodegradation Rate	C			
BULKDENS	Bulk Density	bulkdens**3.5	Y		
CHEMDRU	Chemical Decay Rate	C			
CHEMDRA	Chemical Decay Rate	C			
CONSH2OA	Consump of drinking water	log(consh2oa)			Y
ZDIST	Depth of Well Below Water Table	log(zdist+4)		Y	Y
DISHYD	Dissolved Hydrolysis Rate	C			
YDIST	Distance from Plume Centerline to Well	log(ydist+15)		Y	Y
DURLEACH	Duration of Leaching Period	log(durleach)	Y		
GWAVTIM	Exposure Duration	C			
FRORGCAR	Fraction Organic Carbon	log(frorgcar)		Y	
FRCOEFA	Freundlich Isotherm Coefficient	log(frcoefa+15)		Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	log(frcoefu+15)		Y	Y
FREXPA	Freundlich Isotherm Exponent	C			
FREXPU	Freundlich Isotherm Exponent	C			
GWPH	Groundwater pH	gwph	Y		
GWSEEPV	Groundwater Seepage Velocity	log(gwseepv)	Y		
GWTEMP	Groundwater Temperature	C			
HYDGRAD	Hydraulic Gradient	log(hydgrad+0.0003)		Y	Y
INFILRAT	Infiltration Rate	infilrat**1.5		Y	Y
LANDEPTH	Landfill Depth	log(landepth+0.0007)	Y		
LEACHCON	Leachate Concentration	C			
LFFRACT	LF Fraction	C			
LONDISPU	Longitudinal Dispersivity	log(londispu-0.02)	Y		
LONDISPA	Longitudinal Dispersivity	log(londispa+0.3)		Y	Y
XDIST	Longitudinal Distance to Well	log(xdist+250)		Y	Y

Table A-15. Summary of Parameters Considered in Sensitivity Analysis for Nickel

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
LONHYCON	Longitundinal Hydraulic Conductivity	log(lonhycon+100)		Y	Y
MLLA	ml/L	C			
MOISTRPA	Moisture Rention Parameter (a)	log(moistrpa-0.05)	Y		
MOISTRPB	Moisture Rention Parameter (b)	log(moistrpb-0.95)	Y		
MOLDIFF	Molecular Diffusion Coefficient	C			
NEUTHYD	Neutral Hydrolysis Rate Constant	C			
ORGCDIS	Organic Carbon Distribution Coefficient	C			
PERORGM	Percent Organic Matter	log(perorgm)		Y	
POROSITY	Porosity	porosity**1.3		Y	
RADISTW	Radial Distance to Well	log(radistw+250)	Y		
RECHARAT	Recharge Rate	recharat	Y		
RESIDH2O	Residual Water Content	residh2o**2.1			
RETCOEF	Retardation Coefficient	log(retcoef+50)	Y		
RFDA	RfD (mg/kg/day)	C			
SATHYCON	Saturated Hydraulic Conductivity	log(sathycon)	Y		
SATURH2O	Saturated Water Content	saturh2o		Y	Y
SOILBDEN	Soil Bulk Density	soilbden	Y		
SORBHYD	Sorbed Hydrolysis Rate	C			
TRANDISP	Transverse Dispersivity	log(trandisp+0.01)	Y		
UNSATHIK	Unsaturated Zone Thickness	log(unsathik)		Y	Y
VERTDISP	Vertical Dispersivity	log(vertdisp+0.001)	Y		
WASTDENS	Waste Density	C			
WASTEVOL	Waste Volume	C			
WMUAREA	WMU Area	log(wmuarea-3900)		Y	Y
WMULEN	WMU Length	log(wmulen-50)	Y		
WMUWIDTH	WMU Width	log(wmuwidth-50)	Y		

Table A-16. Summary of Correlated Parameters for Nickel

Variable 1		Variable 2		Correlation Coefficient
Code	Description	Code	Description	
AVGPDIAM	Avg. Particle Diameter	BULKDENS	Bulk Density	0.9988
LONHYCON	Longitundinal Hydraulic Conductivi	GWSEEPV	Groundwater Seepage Velocity	0.81815
FRCOEFA	Freundlich Isotherm Coefficient	RETCOEF	Retardation Coefficient	0.97321
LONDISPA	Longitudinal Dispersivity	TRANDISP	Transverse Dispersivity	0.99931
LONDISPA	Longitudinal Dispersivity	VERTDISP	Vertical Dispersivity	0.99916
RECHARAT	Recharge Rate	GWPH	Groundwater pH	-0.88331
INFILRAT	Infiltration Rate	GWPH	Groundwater pH	-0.80133
MOISTRPB	Moisture Rention Parameter (b)	GWPH	Groundwater pH	-0.71798
SOILBDEN	Soil Bulk Density	GWPH	Groundwater pH	0.74946
XDIST	Longitudinal Distance to Well	RADISTW	Radial Distance to Well	0.9939
WMUAREA	WMU Area	WMULEN	WMU Length	0.99833
LANDEPTH	Landfill Depth	WMULEN	WMU Length	-0.99043
DURLEACH	Duration of Leaching Period	WMULEN	WMU Length	-0.96305
WMUAREA	WMU Area	WMUWIDTH	WMU Width	0.99833
LANDEPTH	Landfill Depth	WMUWIDTH	WMU Width	-0.99043
DURLEACH	Duration of Leaching Period	WMUWIDTH	WMU Width	-0.96305
INFILRAT	Infiltration Rate	RECHARAT	Recharge Rate	0.90405
SOILBDEN	Soil Bulk Density	RECHARAT	Recharge Rate	-0.97237
WMUAREA	WMU Area	LANDEPTH	Landfill Depth	-0.98363
WMUAREA	WMU Area	DURLEACH	Duration of Leaching Period	-0.96277
LANDEPTH	Landfill Depth	DURLEACH	Duration of Leaching Period	0.95171
RECHARAT	Recharge Rate	SATHYCON	Saturated Hydraulic Conductivity	0.71373
INFILRAT	Infiltration Rate	SATHYCON	Saturated Hydraulic Conductivity	0.80946
RECHARAT	Recharge Rate	MOISTRPA	Moisture Rention Parameter (a)	0.71619
RECHARAT	Recharge Rate	MOISTRPB	Moisture Rention Parameter (b)	0.84927
INFILRAT	Infiltration Rate	MOISTRPB	Moisture Rention Parameter (b)	0.76283
UNSATHIK	Unsaturated Zone Thickness	LONDISPU	Longitudinal Dispersivity	0.99997
RECHARAT	Recharge Rate	SOILBDEN	Soil Bulk Density	-0.97237
INFILRAT	Infiltration Rate	SOILBDEN	Soil Bulk Density	-0.87769
SATHYCON	Saturated Hydraulic Conductivity	SOILBDEN	Soil Bulk Density	-0.70622
MOISTRPA	Moisture Rention Parameter (a)	SOILBDEN	Soil Bulk Density	-0.73096
MOISTRPB	Moisture Rention Parameter (b)	SOILBDEN	Soil Bulk Density	-0.84183

Note: Parameters in the variable 2 column were removed from the analysis.

Table A-17. Summary of Crosspairs Analysis for Nickel

Variable 1		Variable 2			
Code	Description	Code	Description	P<0.05	P<0.01
AVGPDIAM	Avg. Particle Diameter			Y	Y
POROSITY	Porosity				
AQUTHIK	Aquifer Thickness			Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity			Y	Y
HYDGRAD	Hydraulic Gradient			Y	Y
LONDISPA	Longitudinal Dispersivity			Y	Y
FRORGCAR	Fraction Organic Carbon				
ANGLEW	Angle of Well Off Plume Centerline				
XDIST	Longitudinal Distance to Well			Y	Y
YDIST	Distance from Plume Centerline to Well			Y	Y
ZDIST	Depth of Well Below Water Table			Y	
FRCOEFA	Freundlich Isotherm Coefficient			Y	Y
WMUAREA	WMU Area			Y	Y
INFILRAT	Infiltration Rate				Y
RESIDH2O	Residual Water Content				
SATURH2O	Saturated Water Content				Y
UNSATHIK	Unsaturated Zone Thickness			Y	Y
PERORGM	Percent Organic Matter				
FRCOEFU	Freundlich Isotherm Coefficient			Y	Y
AVGPDIAM	Avg. Particle Diameter	AVGPDIAM	Avg. Particle Diameter		
POROSITY	Porosity	AVGPDIAM	Avg. Particle Diameter		
POROSITY	Porosity	POROSITY	Porosity		
AQUTHIK	Aquifer Thickness	AVGPDIAM	Avg. Particle Diameter		
AQUTHIK	Aquifer Thickness	POROSITY	Porosity		
AQUTHIK	Aquifer Thickness	AQUTHIK	Aquifer Thickness		
LONHYCON	Longitundinal Hydraulic Conductivity	AVGPDIAM	Avg. Particle Diameter		
LONHYCON	Longitundinal Hydraulic Conductivity	POROSITY	Porosity		
LONHYCON	Longitundinal Hydraulic Conductivity	AQUTHIK	Aquifer Thickness	Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity	LONHYCON	Longitundinal Hydraulic Conductivity		
HYDGRAD	Hydraulic Gradient	AVGPDIAM	Avg. Particle Diameter		
HYDGRAD	Hydraulic Gradient	POROSITY	Porosity		
HYDGRAD	Hydraulic Gradient	AQUTHIK	Aquifer Thickness	Y	Y
HYDGRAD	Hydraulic Gradient	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
HYDGRAD	Hydraulic Gradient	HYDGRAD	Hydraulic Gradient		
LONDISPA	Longitudinal Dispersivity	AVGPDIAM	Avg. Particle Diameter		
LONDISPA	Longitudinal Dispersivity	POROSITY	Porosity		
LONDISPA	Longitudinal Dispersivity	AQUTHIK	Aquifer Thickness	Y	Y
LONDISPA	Longitudinal Dispersivity	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
LONDISPA	Longitudinal Dispersivity	HYDGRAD	Hydraulic Gradient	Y	Y
LONDISPA	Longitudinal Dispersivity	LONDISPA	Longitudinal Dispersivity		
FRORGCAR	Fraction Organic Carbon	AVGPDIAM	Avg. Particle Diameter		
FRORGCAR	Fraction Organic Carbon	POROSITY	Porosity	Y	
FRORGCAR	Fraction Organic Carbon	AQUTHIK	Aquifer Thickness		
FRORGCAR	Fraction Organic Carbon	LONHYCON	Longitundinal Hydraulic Conductivity		
FRORGCAR	Fraction Organic Carbon	HYDGRAD	Hydraulic Gradient		
FRORGCAR	Fraction Organic Carbon	LONDISPA	Longitudinal Dispersivity		
FRORGCAR	Fraction Organic Carbon	FRORGCAR	Fraction Organic Carbon		
ANGLEW	Angle of Well Off Plume Centerline	AVGPDIAM	Avg. Particle Diameter		
ANGLEW	Angle of Well Off Plume Centerline	POROSITY	Porosity		

Table A-17. Summary of Crosspairs Analysis for Nickel

Variable 1		Variable 2			
Code	Description	Code	Description	P<0.05	P<0.01
ANGLEW	Angle of Well Off Plume Centerline	AQUTHIK	Aquifer Thickness		
ANGLEW	Angle of Well Off Plume Centerline	LONHYCON	Longitundinal Hydraulic Conductivity		
ANGLEW	Angle of Well Off Plume Centerline	HYDGRAD	Hydraulic Gradient		
ANGLEW	Angle of Well Off Plume Centerline	LONDISPA	Longitudinal Dispersivity		
ANGLEW	Angle of Well Off Plume Centerline	FRORGCAR	Fraction Organic Carbon		
ANGLEW	Angle of Well Off Plume Centerline	ANGLEW	Angle of Well Off Plume Centerline		
XDIST	Longitudinal Distance to Well	AVGPDIAM	Avg. Particle Diameter		
XDIST	Longitudinal Distance to Well	POROSITY	Porosity		
XDIST	Longitudinal Distance to Well	AQUTHIK	Aquifer Thickness	Y	Y
XDIST	Longitudinal Distance to Well	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
XDIST	Longitudinal Distance to Well	HYDGRAD	Hydraulic Gradient	Y	Y
XDIST	Longitudinal Distance to Well	LONDISPA	Longitudinal Dispersivity	Y	Y
XDIST	Longitudinal Distance to Well	FRORGCAR	Fraction Organic Carbon		
XDIST	Longitudinal Distance to Well	ANGLEW	Angle of Well Off Plume Centerline		
XDIST	Longitudinal Distance to Well	XDIST	Longitudinal Distance to Well		
YDIST	Distance from Plume Centerline to Well	AVGPDIAM	Avg. Particle Diameter		
YDIST	Distance from Plume Centerline to Well	POROSITY	Porosity		
YDIST	Distance from Plume Centerline to Well	AQUTHIK	Aquifer Thickness		
YDIST	Distance from Plume Centerline to Well	LONHYCON	Longitundinal Hydraulic Conductivity		
YDIST	Distance from Plume Centerline to Well	HYDGRAD	Hydraulic Gradient		
YDIST	Distance from Plume Centerline to Well	LONDISPA	Longitudinal Dispersivity		
YDIST	Distance from Plume Centerline to Well	FRORGCAR	Fraction Organic Carbon		
YDIST	Distance from Plume Centerline to Well	ANGLEW	Angle of Well Off Plume Centerline		
YDIST	Distance from Plume Centerline to Well	XDIST	Longitudinal Distance to Well	Y	Y
YDIST	Distance from Plume Centerline to Well	YDIST	Distance from Plume Centerline to Well	Y	Y
ZDIST	Depth of Well Below Water Table	AVGPDIAM	Avg. Particle Diameter		
ZDIST	Depth of Well Below Water Table	POROSITY	Porosity		
ZDIST	Depth of Well Below Water Table	AQUTHIK	Aquifer Thickness		
ZDIST	Depth of Well Below Water Table	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
ZDIST	Depth of Well Below Water Table	HYDGRAD	Hydraulic Gradient		
ZDIST	Depth of Well Below Water Table	LONDISPA	Longitudinal Dispersivity		
ZDIST	Depth of Well Below Water Table	FRORGCAR	Fraction Organic Carbon		
ZDIST	Depth of Well Below Water Table	ANGLEW	Angle of Well Off Plume Centerline		
ZDIST	Depth of Well Below Water Table	XDIST	Longitudinal Distance to Well		
ZDIST	Depth of Well Below Water Table	YDIST	Distance from Plume Centerline to Well		
ZDIST	Depth of Well Below Water Table	ZDIST	Depth of Well Below Water Table		
FRCOEFA	Freundlich Isotherm Coefficient	AVGPDIAM	Avg. Particle Diameter		
FRCOEFA	Freundlich Isotherm Coefficient	POROSITY	Porosity		
FRCOEFA	Freundlich Isotherm Coefficient	AQUTHIK	Aquifer Thickness	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	HYDGRAD	Hydraulic Gradient	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	LONDISPA	Longitudinal Dispersivity	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	FRORGCAR	Fraction Organic Carbon		
FRCOEFA	Freundlich Isotherm Coefficient	ANGLEW	Angle of Well Off Plume Centerline		
FRCOEFA	Freundlich Isotherm Coefficient	XDIST	Longitudinal Distance to Well	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	YDIST	Distance from Plume Centerline to Well		
FRCOEFA	Freundlich Isotherm Coefficient	ZDIST	Depth of Well Below Water Table		
FRCOEFA	Freundlich Isotherm Coefficient	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
WMUAREA	WMU Area	AVGPDIAM	Avg. Particle Diameter		

Table A-17. Summary of Crosspairs Analysis for Nickel

Variable 1		Variable 2			
Code	Description	Code	Description	P<0.05	P<0.01
WMUAREA	WMU Area	POROSITY	Porosity		
WMUAREA	WMU Area	AQUTHIK	Aquifer Thickness		
WMUAREA	WMU Area	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
WMUAREA	WMU Area	HYDGRAD	Hydraulic Gradient		
WMUAREA	WMU Area	LONDISPA	Longitudinal Dispersivity	Y	Y
WMUAREA	WMU Area	FRORGCAR	Fraction Organic Carbon		
WMUAREA	WMU Area	ANGLEW	Angle of Well Off Plume Centerline		
WMUAREA	WMU Area	XDIST	Longitudinal Distance to Well		
WMUAREA	WMU Area	YDIST	Distance from Plume Centerline to Well	Y	Y
WMUAREA	WMU Area	ZDIST	Depth of Well Below Water Table		
WMUAREA	WMU Area	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
WMUAREA	WMU Area	WMUAREA	WMU Area		
INFILRAT	Infiltration Rate	AVGPDIAM	Avg. Particle Diameter		
INFILRAT	Infiltration Rate	POROSITY	Porosity		
INFILRAT	Infiltration Rate	AQUTHIK	Aquifer Thickness		
INFILRAT	Infiltration Rate	LONHYCON	Longitundinal Hydraulic Conductivity	Y	
INFILRAT	Infiltration Rate	HYDGRAD	Hydraulic Gradient		
INFILRAT	Infiltration Rate	LONDISPA	Longitudinal Dispersivity		
INFILRAT	Infiltration Rate	FRORGCAR	Fraction Organic Carbon		
INFILRAT	Infiltration Rate	ANGLEW	Angle of Well Off Plume Centerline		
INFILRAT	Infiltration Rate	XDIST	Longitudinal Distance to Well		
INFILRAT	Infiltration Rate	YDIST	Distance from Plume Centerline to Well		
INFILRAT	Infiltration Rate	ZDIST	Depth of Well Below Water Table		
INFILRAT	Infiltration Rate	FRCOEFA	Freundlich Isotherm Coefficient	Y	
INFILRAT	Infiltration Rate	WMUAREA	WMU Area		
INFILRAT	Infiltration Rate	INFILRAT	Infiltration Rate	Y	Y
RESIDH2O	Residual Water Content	AVGPDIAM	Avg. Particle Diameter		
RESIDH2O	Residual Water Content	POROSITY	Porosity		
RESIDH2O	Residual Water Content	AQUTHIK	Aquifer Thickness		
RESIDH2O	Residual Water Content	LONHYCON	Longitundinal Hydraulic Conductivity		
RESIDH2O	Residual Water Content	HYDGRAD	Hydraulic Gradient		
RESIDH2O	Residual Water Content	LONDISPA	Longitudinal Dispersivity		
RESIDH2O	Residual Water Content	FRORGCAR	Fraction Organic Carbon		
RESIDH2O	Residual Water Content	ANGLEW	Angle of Well Off Plume Centerline		
RESIDH2O	Residual Water Content	XDIST	Longitudinal Distance to Well		
RESIDH2O	Residual Water Content	YDIST	Distance from Plume Centerline to Well		
RESIDH2O	Residual Water Content	ZDIST	Depth of Well Below Water Table		
RESIDH2O	Residual Water Content	FRCOEFA	Freundlich Isotherm Coefficient		
RESIDH2O	Residual Water Content	WMUAREA	WMU Area		
RESIDH2O	Residual Water Content	INFILRAT	Infiltration Rate		
RESIDH2O	Residual Water Content	RESIDH2O	Residual Water Content		
SATURH2O	Saturated Water Content	AVGPDIAM	Avg. Particle Diameter		
SATURH2O	Saturated Water Content	POROSITY	Porosity		
SATURH2O	Saturated Water Content	AQUTHIK	Aquifer Thickness		
SATURH2O	Saturated Water Content	LONHYCON	Longitundinal Hydraulic Conductivity		
SATURH2O	Saturated Water Content	HYDGRAD	Hydraulic Gradient		
SATURH2O	Saturated Water Content	LONDISPA	Longitudinal Dispersivity		
SATURH2O	Saturated Water Content	FRORGCAR	Fraction Organic Carbon		
SATURH2O	Saturated Water Content	ANGLEW	Angle of Well Off Plume Centerline		

Table A-17. Summary of Crosspairs Analysis for Nickel

Variable 1		Variable 2			
Code	Description	Code	Description	P<0.05	P<0.01
SATURH2O	Saturated Water Content	XDIST	Longitudinal Distance to Well	Y	Y
SATURH2O	Saturated Water Content	YDIST	Distance from Plume Centerline to Well		
SATURH2O	Saturated Water Content	ZDIST	Depth of Well Below Water Table		
SATURH2O	Saturated Water Content	FRCOEFA	Freundlich Isotherm Coefficient		
SATURH2O	Saturated Water Content	WMUAREA	WMU Area		
SATURH2O	Saturated Water Content	INFILRAT	Infiltration Rate		
SATURH2O	Saturated Water Content	RESIDH2O	Residual Water Content		
SATURH2O	Saturated Water Content	SATURH2O	Saturated Water Content	Y	Y
UNSATHIK	Unsaturated Zone Thickness	AVGPDIAM	Avg. Particle Diameter	Y	Y
UNSATHIK	Unsaturated Zone Thickness	POROSITY	Porosity		
UNSATHIK	Unsaturated Zone Thickness	AQUTHIK	Aquifer Thickness	Y	Y
UNSATHIK	Unsaturated Zone Thickness	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
UNSATHIK	Unsaturated Zone Thickness	HYDGRAD	Hydraulic Gradient	Y	Y
UNSATHIK	Unsaturated Zone Thickness	LONDISPA	Longitudinal Dispersivity	Y	Y
UNSATHIK	Unsaturated Zone Thickness	FRORGCAR	Fraction Organic Carbon		
UNSATHIK	Unsaturated Zone Thickness	ANGLEW	Angle of Well Off Plume Centerline		
UNSATHIK	Unsaturated Zone Thickness	XDIST	Longitudinal Distance to Well	Y	Y
UNSATHIK	Unsaturated Zone Thickness	YDIST	Distance from Plume Centerline to Well		
UNSATHIK	Unsaturated Zone Thickness	ZDIST	Depth of Well Below Water Table		
UNSATHIK	Unsaturated Zone Thickness	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
UNSATHIK	Unsaturated Zone Thickness	WMUAREA	WMU Area		
UNSATHIK	Unsaturated Zone Thickness	INFILRAT	Infiltration Rate		
UNSATHIK	Unsaturated Zone Thickness	RESIDH2O	Residual Water Content		
UNSATHIK	Unsaturated Zone Thickness	SATURH2O	Saturated Water Content		
UNSATHIK	Unsaturated Zone Thickness	UNSATHIK	Unsaturated Zone Thickness		
PERORGM	Percent Organic Matter	AVGPDIAM	Avg. Particle Diameter		
PERORGM	Percent Organic Matter	POROSITY	Porosity		
PERORGM	Percent Organic Matter	AQUTHIK	Aquifer Thickness		
PERORGM	Percent Organic Matter	LONHYCON	Longitundinal Hydraulic Conductivity		
PERORGM	Percent Organic Matter	HYDGRAD	Hydraulic Gradient		
PERORGM	Percent Organic Matter	LONDISPA	Longitudinal Dispersivity		
PERORGM	Percent Organic Matter	FRORGCAR	Fraction Organic Carbon		
PERORGM	Percent Organic Matter	ANGLEW	Angle of Well Off Plume Centerline		
PERORGM	Percent Organic Matter	XDIST	Longitudinal Distance to Well		
PERORGM	Percent Organic Matter	YDIST	Distance from Plume Centerline to Well	Y	
PERORGM	Percent Organic Matter	ZDIST	Depth of Well Below Water Table		
PERORGM	Percent Organic Matter	FRCOEFA	Freundlich Isotherm Coefficient		
PERORGM	Percent Organic Matter	WMUAREA	WMU Area		
PERORGM	Percent Organic Matter	INFILRAT	Infiltration Rate		
PERORGM	Percent Organic Matter	RESIDH2O	Residual Water Content		
PERORGM	Percent Organic Matter	SATURH2O	Saturated Water Content		
PERORGM	Percent Organic Matter	UNSATHIK	Unsaturated Zone Thickness		
PERORGM	Percent Organic Matter	PERORGM	Percent Organic Matter		
FRCOEFU	Freundlich Isotherm Coefficient	AVGPDIAM	Avg. Particle Diameter		
FRCOEFU	Freundlich Isotherm Coefficient	POROSITY	Porosity		
FRCOEFU	Freundlich Isotherm Coefficient	AQUTHIK	Aquifer Thickness	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	HYDGRAD	Hydraulic Gradient	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	LONDISPA	Longitudinal Dispersivity	Y	Y

Table A-17. Summary of Crosspairs Analysis for Nickel

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
FRCOEFU	Freundlich Isotherm Coefficient	FRORGCAR	Fraction Organic Carbon		
FRCOEFU	Freundlich Isotherm Coefficient	ANGLEW	Angle of Well Off Plume Centerline		
FRCOEFU	Freundlich Isotherm Coefficient	XDIST	Longitudinal Distance to Well	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	YDIST	Distance from Plume Centerline to Well	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	ZDIST	Depth of Well Below Water Table		
FRCOEFU	Freundlich Isotherm Coefficient	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	WMUAREA	WMU Area	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	INFILRAT	Infiltration Rate		
FRCOEFU	Freundlich Isotherm Coefficient	RESIDH2O	Residual Water Content		
FRCOEFU	Freundlich Isotherm Coefficient	SATURH2O	Saturated Water Content		
FRCOEFU	Freundlich Isotherm Coefficient	UNSATHIK	Unsaturated Zone Thickness	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	PERORGM	Percent Organic Matter		
FRCOEFU	Freundlich Isotherm Coefficient	FRCOEFU	Freundlich Isotherm Coefficient	Y	Y

Table A-18. Ranking of Parameters According to Percentage of Risk for Nickel

Variable Description	Reduced Sums of Square	Variable Sums of Square	Variable Degrees of Freedom	% Risk Variation	Mean Square Variable	F VALUE	P VALUE
Freundlich Isotherm Coefficient {Unsaturated} (cm3/g)	1180576.1	3144575.98	58	96399993.0%	1029460.79	178545.45	1.04E+02
Unsaturated Zone Thickness (m)	2419816.0	3144575.98	58	72475996.0%	1029460.79	80528.88	1.04E+02
Freundlich Isotherm Coefficient {Aquifer} (cm3/g)	2816096.2	3144575.98	58	32847982.0%	1029460.79	32847.98	1.04E+02
Longitudinal Distance to Well (m)	3037776.5	3144575.98	58	10679946.0%	1029460.79	10679.95	1.04E+02
Longitudinal Hydraulic Conductivity (m/yr)	3073240.7	3144575.98	58	7133525.0%	1029460.79	7133.52	1.04E+02
Longitudinal Dispersivity {Aquifer} (m)	3088427.7	3144575.98	58	5614830.0%	1029460.79	6238.70	1.04E+02
Aquifer Thickness (m)	3101774.2	3144575.98	58	4280178.0%	1029460.79	5350.22	1.04E+02
Hydraulic Gradient (m/m)	3110537.9	3144575.98	58	3403812.0%	1029460.79	4254.77	1.04E+02
Infiltration Rate (m/yr)	3111257.3	3144575.98	58	3331872.0%	1029460.79	16659.36	1.04E+02
Distance from Plume Centerline to Well (m)	3122991.5	3144575.98	58	2158446.0%	1029460.79	4316.89	1.04E+02
WMU Area (m2)	3130232.9	3144575.98	58	1434311.0%	1029460.79	2390.52	1.04E+02
Saturated Water Content	3140504.3	3144575.98	58	407172.0%	1029460.79	1357.24	1.04E+02
Average Particle Diameter (cm)	3142642.6	3144575.98	58	193338.0%	1029460.79	966.69	1.04E+02
Depth of Well Below Water Table (m)	3143077.2	3144575.98	58	149881.0%	1029460.79	749.40	1.04E+02
Consumption of Drinking Water (ml/kg-day)	3143727.3	3144575.98	58	84873.0%	1029460.79	848.73	1.04E+02

Constants

Full Model SS	47
Error SS	11
Error DF	0
MS Error	9941

Table A-19. Summary of Parameters Considered in Sensitivity Analysis for Antimony

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
ACIDCAT	Acid Catalyzed Hydrolysis Rate Constant	C			
ANGLEW	Angle of Well Off Plume Centerline	anglew		Y	Y
ANISORAT	Anisotropy Ratio	C			
AQUTHIK	Aquifer Thickness	aquthik**-.1		Y	Y
AVGPDIAM	Avg. Particle Diameter	log(avgpdiam+.002)		Y	Y
BASECAT	Base Catalyzed Hydrolysis Rate Constant	C			
BIODRATA	Biodegradation Rate	C			
BIODRATU	Biodegradation Rate	C			
BULKDENS	Bulk Density	bulkdens**3.5	Y		
CHEMDRU	Chemical Decay Rate	C			
CHEMDRA	Chemical Decay Rate	C			
CONSH2OA	Consump of drinking water	log(consh2oa)			Y
ZDIST	Depth of Well Below Water Table	log(zdist+4)		Y	Y
DISHYD	Dissolved Hydrolysis Rate	C			
YDIST	Distance from Plume Centerline to Well	log(ydist+10)		Y	Y
DURLEACH	Duration of Leaching Period	log(durleach)	Y		
GWAVTIM	Exposure Duration	C			
FRORGCAR	Fraction Organic Carbon	log(frorgcar)		Y	
FRCOEFA	Freundlich Isotherm Coefficient	log(frcoefa)		Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	log(frcoefu)		Y	Y
FREXPA	Freundlich Isotherm Exponent	C			
FREXPU	Freundlich Isotherm Exponent	C			
GWPH	Groundwater pH	gwph	Y		
GWSEEPV	Groundwater Seepage Velocity	log(gwseepv)	Y		
GWTEMP	Groundwater Temperature	C			
HYDGRAD	Hydraulic Gradient	log(hydgrad+.0001)		Y	Y
INFILRAT	Infiltration Rate	infilrat**1.5		Y	Y
LANDEPTH	Landfill Depth	log(landepth+.0007)	Y		
LEACHCON	Leachate Concentration	C			
LFFRACT	LF Fraction	C			
LONDISPU	Longitudinal Dispersivity	log(londispu-.02)	Y		
LONDISPA	Longitudinal Dispersivity	log(londispa+.3)		Y	Y
XDIST	Longitudinal Distance to Well	log(xdist+250)		Y	Y

Table A-19. Summary of Parameters Considered in Sensitivity Analysis for Antimony

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
LONHYCON	Longitundinal Hydraulic Conductivity	log(lonhycon+10)		Y	Y
MLLA	ml/L	C			
MOISTRPA	Moisture Rention Parameter (a)	log(moistrpa-.09)	Y		
MOISTRPB	Moisture Rention Parameter (b)	moistrpb**-2.5	Y		
MOLDIFF	Molecular Diffusion Coefficient	C			
NEUTHYD	Neutral Hydrolysis Rate Constant	C			
ORGCDIS	Organic Carbon Distribution Coefficient	C			
PERORGM	Percent Organic Matter	log(perorgm)		Y	
POROSITY	Porosity	porosity**1.3		Y	Y
RADISTW	Radial Distance to Well	log(radistw+250)	Y		
RECHARAT	Recharge Rate	recharat	Y		
RESIDH2O	Residual Water Content	residh2o**1.7		Y	Y
RETCOEF	Retardation Coefficient	log(retcoef-1)	Y		
RFDA	RfD (mg/kg/day)	C			
SATHYCON	Saturated Hydraulic Conductivity	log(sathycon)	Y		
SATURH2O	Saturated Water Content	saturh2o		Y	Y
SOILBDEN	Soil Bulk Density	soilbden	Y		
SORBHYD	Sorbed Hydrolysis Rate	C			
TRANDISP	Transverse Dispersivity	log(trandisp+.1)	Y		
UNSATHIK	Unsaturated Zone Thickness	unsathik**-.006		Y	Y
VERTDISP	Vertical Dispersivity	log(vertdisp+.001)	Y		
WASTDENS	Waste Density	C			
WASTEVOL	Waste Volume	C			
WMUAREA	WMU Area	log(wmuarea-3900)		Y	Y
WMULEN	WMU Length	log(wmulen-50)	Y		
WMUWIDTH	WMU Width	log(wmuwidth-50)	Y		

Table A-20. Summary of Correlated Parameters for Antimony

Variable 1		Variable 2		Correlation Coefficient
Code	Description	Code	Description	
AVGPDIAM	Avg. Particle Diameter	BULKDENS	Bulk Density	0.9988
LONHYCON	Longitundinal Hydraulic Conductivi	GWSEEPV	Groundwater Seepage Velocity	0.8151
FRCOEFA	Freundlich Isotherm Coefficient	RETCOEF	Retardation Coefficient	0.97469
LONDISPA	Longitudinal Dispersivity	TRANDISP	Transverse Dispersivity	0.99866
LONDISPA	Longitudinal Dispersivity	VERTDISP	Vertical Dispersivity	0.99916
RECHARAT	Recharge Rate	GWPH	Groundwater pH	-0.88331
INFILRAT	Infiltration Rate	GWPH	Groundwater pH	-0.80133
MOISTRPB	Moisture Rention Parameter (b)	GWPH	Groundwater pH	0.72897
SOILBDEN	Soil Bulk Density	GWPH	Groundwater pH	0.74946
XDIST	Longitudinal Distance to Well	RADISTW	Radial Distance to Well	0.9939
WMUAREA	WMU Area	WMULEN	WMU Length	0.99833
LANDEPTH	Landfill Depth	WMULEN	WMU Length	-0.99121
DURLEACH	Duration of Leaching Period	WMULEN	WMU Length	-0.96305
WMUAREA	WMU Area	WMUWIDTH	WMU Width	0.99833
LANDEPTH	Landfill Depth	WMUWIDTH	WMU Width	-0.99121
DURLEACH	Duration of Leaching Period	WMUWIDTH	WMU Width	-0.96305
INFILRAT	Infiltration Rate	RECHARAT	Recharge Rate	0.90405
SOILBDEN	Soil Bulk Density	RECHARAT	Recharge Rate	-0.97237
WMUAREA	WMU Area	LANDEPTH	Landfill Depth	-0.98471
WMUAREA	WMU Area	DURLEACH	Duration of Leaching Period	-0.96276
LANDEPTH	Landfill Depth	DURLEACH	Duration of Leaching Period	0.95387
RECHARAT	Recharge Rate	SATHYCON	Saturated Hydraulic Conductivity	0.71373
INFILRAT	Infiltration Rate	SATHYCON	Saturated Hydraulic Conductivity	0.80946
RECHARAT	Recharge Rate	MOISTRPA	Moisture Rention Parameter (a)	0.70898
RECHARAT	Recharge Rate	MOISTRPB	Moisture Rention Parameter (b)	-0.84728
INFILRAT	Infiltration Rate	MOISTRPB	Moisture Rention Parameter (b)	-0.76111
UNSATHIK	Unsaturated Zone Thickness	LONDISPU	Longitudinal Dispersivity	-0.99997
RECHARAT	Recharge Rate	SOILBDEN	Soil Bulk Density	-0.97237
INFILRAT	Infiltration Rate	SOILBDEN	Soil Bulk Density	-0.87769
SATHYCON	Saturated Hydraulic Conductivity	SOILBDEN	Soil Bulk Density	-0.70622
MOISTRPA	Moisture Rention Parameter (a)	SOILBDEN	Soil Bulk Density	-0.72206
MOISTRPB	Moisture Rention Parameter (b)	SOILBDEN	Soil Bulk Density	0.83355

Note: Parameters in the variable 2 column were removed from the analysis.

Table A-21. Summary of Crosspairs Analysis for Antimony

Variable 1		Variable 2			
Code	Description	Code	Description	P<0.05	P<0.01
AVGPDIAM	Avg. Particle Diameter				
POROSITY	Porosity				
AQUTHIK	Aquifer Thickness			Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity			Y	Y
HYDGRAD	Hydraulic Gradient				
LONDISPA	Longitudinal Dispersivity			Y	Y
FRORGCAR	Fraction Organic Carbon				
ANGLEW	Angle of Well Off Plume Centerline				
XDIST	Longitudinal Distance to Well			Y	Y
YDIST	Distance from Plume Centerline to Well			Y	Y
ZDIST	Depth of Well Below Water Table			Y	
FRCOEFA	Freundlich Isotherm Coefficient			Y	Y
WMUAREA	WMU Area			Y	Y
INFILRAT	Infiltration Rate			Y	Y
RESIDH2O	Residual Water Content				
SATURH2O	Saturated Water Content			Y	Y
UNSATHIK	Unsaturated Zone Thickness			Y	Y
PERORGM	Percent Organic Matter				
FRCOEFU	Freundlich Isotherm Coefficient			Y	Y
AVGPDIAM	Avg. Particle Diameter	AVGPDIAM	Avg. Particle Diameter		
POROSITY	Porosity	AVGPDIAM	Avg. Particle Diameter	Y	Y
POROSITY	Porosity	POROSITY	Porosity		
AQUTHIK	Aquifer Thickness	AVGPDIAM	Avg. Particle Diameter		
AQUTHIK	Aquifer Thickness	POROSITY	Porosity		
AQUTHIK	Aquifer Thickness	AQUTHIK	Aquifer Thickness	Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity	AVGPDIAM	Avg. Particle Diameter		
LONHYCON	Longitundinal Hydraulic Conductivity	POROSITY	Porosity	Y	
LONHYCON	Longitundinal Hydraulic Conductivity	AQUTHIK	Aquifer Thickness	Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity	LONHYCON	Longitundinal Hydraulic Conductivity		
HYDGRAD	Hydraulic Gradient	AVGPDIAM	Avg. Particle Diameter		
HYDGRAD	Hydraulic Gradient	POROSITY	Porosity		
HYDGRAD	Hydraulic Gradient	AQUTHIK	Aquifer Thickness		
HYDGRAD	Hydraulic Gradient	LONHYCON	Longitundinal Hydraulic Conductivity	Y	
HYDGRAD	Hydraulic Gradient	HYDGRAD	Hydraulic Gradient		
LONDISPA	Longitudinal Dispersivity	AVGPDIAM	Avg. Particle Diameter		
LONDISPA	Longitudinal Dispersivity	POROSITY	Porosity		
LONDISPA	Longitudinal Dispersivity	AQUTHIK	Aquifer Thickness	Y	Y
LONDISPA	Longitudinal Dispersivity	LONHYCON	Longitundinal Hydraulic Conductivity		
LONDISPA	Longitudinal Dispersivity	HYDGRAD	Hydraulic Gradient		
LONDISPA	Longitudinal Dispersivity	LONDISPA	Longitudinal Dispersivity	Y	Y
FRORGCAR	Fraction Organic Carbon	AVGPDIAM	Avg. Particle Diameter		
FRORGCAR	Fraction Organic Carbon	POROSITY	Porosity		
FRORGCAR	Fraction Organic Carbon	AQUTHIK	Aquifer Thickness	Y	
FRORGCAR	Fraction Organic Carbon	LONHYCON	Longitundinal Hydraulic Conductivity	Y	
FRORGCAR	Fraction Organic Carbon	HYDGRAD	Hydraulic Gradient		
FRORGCAR	Fraction Organic Carbon	LONDISPA	Longitudinal Dispersivity		
FRORGCAR	Fraction Organic Carbon	FRORGCAR	Fraction Organic Carbon		
ANGLEW	Angle of Well Off Plume Centerline	AVGPDIAM	Avg. Particle Diameter		
ANGLEW	Angle of Well Off Plume Centerline	POROSITY	Porosity		

Table A-21. Summary of Crosspairs Analysis for Antimony

Variable 1		Variable 2			
Code	Description	Code	Description	P<0.05	P<0.01
ANGLEW	Angle of Well Off Plume Centerline	AQUTHIK	Aquifer Thickness		
ANGLEW	Angle of Well Off Plume Centerline	LONHYCON	Longitundinal Hydraulic Conductivity		
ANGLEW	Angle of Well Off Plume Centerline	HYDGRAD	Hydraulic Gradient	Y	
ANGLEW	Angle of Well Off Plume Centerline	LONDISPA	Longitudinal Dispersivity		
ANGLEW	Angle of Well Off Plume Centerline	FRORGCAR	Fraction Organic Carbon		
ANGLEW	Angle of Well Off Plume Centerline	ANGLEW	Angle of Well Off Plume Centerline		
XDIST	Longitudinal Distance to Well	AVGPDIAM	Avg. Particle Diameter		
XDIST	Longitudinal Distance to Well	POROSITY	Porosity		
XDIST	Longitudinal Distance to Well	AQUTHIK	Aquifer Thickness	Y	Y
XDIST	Longitudinal Distance to Well	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
XDIST	Longitudinal Distance to Well	HYDGRAD	Hydraulic Gradient	Y	
XDIST	Longitudinal Distance to Well	LONDISPA	Longitudinal Dispersivity		
XDIST	Longitudinal Distance to Well	FRORGCAR	Fraction Organic Carbon	Y	
XDIST	Longitudinal Distance to Well	ANGLEW	Angle of Well Off Plume Centerline		
XDIST	Longitudinal Distance to Well	XDIST	Longitudinal Distance to Well		
YDIST	Distance from Plume Centerline to Well	AVGPDIAM	Avg. Particle Diameter		
YDIST	Distance from Plume Centerline to Well	POROSITY	Porosity		
YDIST	Distance from Plume Centerline to Well	AQUTHIK	Aquifer Thickness		
YDIST	Distance from Plume Centerline to Well	LONHYCON	Longitundinal Hydraulic Conductivity		
YDIST	Distance from Plume Centerline to Well	HYDGRAD	Hydraulic Gradient		
YDIST	Distance from Plume Centerline to Well	LONDISPA	Longitudinal Dispersivity	Y	Y
YDIST	Distance from Plume Centerline to Well	FRORGCAR	Fraction Organic Carbon		
YDIST	Distance from Plume Centerline to Well	ANGLEW	Angle of Well Off Plume Centerline		
YDIST	Distance from Plume Centerline to Well	XDIST	Longitudinal Distance to Well	Y	Y
YDIST	Distance from Plume Centerline to Well	YDIST	Distance from Plume Centerline to Well	Y	Y
ZDIST	Depth of Well Below Water Table	AVGPDIAM	Avg. Particle Diameter		
ZDIST	Depth of Well Below Water Table	POROSITY	Porosity		
ZDIST	Depth of Well Below Water Table	AQUTHIK	Aquifer Thickness	Y	Y
ZDIST	Depth of Well Below Water Table	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
ZDIST	Depth of Well Below Water Table	HYDGRAD	Hydraulic Gradient		
ZDIST	Depth of Well Below Water Table	LONDISPA	Longitudinal Dispersivity	Y	Y
ZDIST	Depth of Well Below Water Table	FRORGCAR	Fraction Organic Carbon		
ZDIST	Depth of Well Below Water Table	ANGLEW	Angle of Well Off Plume Centerline		
ZDIST	Depth of Well Below Water Table	XDIST	Longitudinal Distance to Well	Y	
ZDIST	Depth of Well Below Water Table	YDIST	Distance from Plume Centerline to Well		
ZDIST	Depth of Well Below Water Table	ZDIST	Depth of Well Below Water Table	Y	
FRCOEFA	Freundlich Isotherm Coefficient	AVGPDIAM	Avg. Particle Diameter		
FRCOEFA	Freundlich Isotherm Coefficient	POROSITY	Porosity		
FRCOEFA	Freundlich Isotherm Coefficient	AQUTHIK	Aquifer Thickness	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	HYDGRAD	Hydraulic Gradient	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	LONDISPA	Longitudinal Dispersivity	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	FRORGCAR	Fraction Organic Carbon		
FRCOEFA	Freundlich Isotherm Coefficient	ANGLEW	Angle of Well Off Plume Centerline		
FRCOEFA	Freundlich Isotherm Coefficient	XDIST	Longitudinal Distance to Well	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	YDIST	Distance from Plume Centerline to Well		
FRCOEFA	Freundlich Isotherm Coefficient	ZDIST	Depth of Well Below Water Table		
FRCOEFA	Freundlich Isotherm Coefficient	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
WMUAREA	WMU Area	AVGPDIAM	Avg. Particle Diameter		

Table A-21. Summary of Crosspairs Analysis for Antimony

Variable 1		Variable 2			
Code	Description	Code	Description	P<0.05	P<0.01
WMUAREA	WMU Area	POROSITY	Porosity		
WMUAREA	WMU Area	AQUTHIK	Aquifer Thickness		
WMUAREA	WMU Area	LONHYCON	Longitundinal Hydraulic Conductivity		
WMUAREA	WMU Area	HYDGRAD	Hydraulic Gradient	Y	
WMUAREA	WMU Area	LONDISPA	Longitudinal Dispersivity	Y	Y
WMUAREA	WMU Area	FRORGCAR	Fraction Organic Carbon		
WMUAREA	WMU Area	ANGLEW	Angle of Well Off Plume Centerline		
WMUAREA	WMU Area	XDIST	Longitudinal Distance to Well		
WMUAREA	WMU Area	YDIST	Distance from Plume Centerline to Well	Y	Y
WMUAREA	WMU Area	ZDIST	Depth of Well Below Water Table		
WMUAREA	WMU Area	FRCOEFA	Freundlich Isotherm Coefficient		
WMUAREA	WMU Area	WMUAREA	WMU Area	Y	Y
INFILRAT	Infiltration Rate	AVGPDIAM	Avg. Particle Diameter		
INFILRAT	Infiltration Rate	POROSITY	Porosity		
INFILRAT	Infiltration Rate	AQUTHIK	Aquifer Thickness	Y	
INFILRAT	Infiltration Rate	LONHYCON	Longitundinal Hydraulic Conductivity	Y	
INFILRAT	Infiltration Rate	HYDGRAD	Hydraulic Gradient	Y	Y
INFILRAT	Infiltration Rate	LONDISPA	Longitudinal Dispersivity		
INFILRAT	Infiltration Rate	FRORGCAR	Fraction Organic Carbon		
INFILRAT	Infiltration Rate	ANGLEW	Angle of Well Off Plume Centerline		
INFILRAT	Infiltration Rate	XDIST	Longitudinal Distance to Well		
INFILRAT	Infiltration Rate	YDIST	Distance from Plume Centerline to Well		
INFILRAT	Infiltration Rate	ZDIST	Depth of Well Below Water Table		
INFILRAT	Infiltration Rate	FRCOEFA	Freundlich Isotherm Coefficient		
INFILRAT	Infiltration Rate	WMUAREA	WMU Area		
INFILRAT	Infiltration Rate	INFILRAT	Infiltration Rate	Y	Y
RESIDH2O	Residual Water Content	AVGPDIAM	Avg. Particle Diameter		
RESIDH2O	Residual Water Content	POROSITY	Porosity		
RESIDH2O	Residual Water Content	AQUTHIK	Aquifer Thickness	Y	Y
RESIDH2O	Residual Water Content	LONHYCON	Longitundinal Hydraulic Conductivity		
RESIDH2O	Residual Water Content	HYDGRAD	Hydraulic Gradient		
RESIDH2O	Residual Water Content	LONDISPA	Longitudinal Dispersivity		
RESIDH2O	Residual Water Content	FRORGCAR	Fraction Organic Carbon		
RESIDH2O	Residual Water Content	ANGLEW	Angle of Well Off Plume Centerline	Y	Y
RESIDH2O	Residual Water Content	XDIST	Longitudinal Distance to Well		
RESIDH2O	Residual Water Content	YDIST	Distance from Plume Centerline to Well		
RESIDH2O	Residual Water Content	ZDIST	Depth of Well Below Water Table		
RESIDH2O	Residual Water Content	FRCOEFA	Freundlich Isotherm Coefficient		
RESIDH2O	Residual Water Content	WMUAREA	WMU Area		
RESIDH2O	Residual Water Content	INFILRAT	Infiltration Rate		
RESIDH2O	Residual Water Content	RESIDH2O	Residual Water Content		
SATURH2O	Saturated Water Content	AVGPDIAM	Avg. Particle Diameter		
SATURH2O	Saturated Water Content	POROSITY	Porosity		
SATURH2O	Saturated Water Content	AQUTHIK	Aquifer Thickness		
SATURH2O	Saturated Water Content	LONHYCON	Longitundinal Hydraulic Conductivity		
SATURH2O	Saturated Water Content	HYDGRAD	Hydraulic Gradient		
SATURH2O	Saturated Water Content	LONDISPA	Longitudinal Dispersivity		
SATURH2O	Saturated Water Content	FRORGCAR	Fraction Organic Carbon		
SATURH2O	Saturated Water Content	ANGLEW	Angle of Well Off Plume Centerline		

Table A-21. Summary of Crosspairs Analysis for Antimony

Variable 1		Variable 2			
Code	Description	Code	Description	P<0.05	P<0.01
SATURH2O	Saturated Water Content	XDIST	Longitudinal Distance to Well		
SATURH2O	Saturated Water Content	YDIST	Distance from Plume Centerline to Well	Y	
SATURH2O	Saturated Water Content	ZDIST	Depth of Well Below Water Table		
SATURH2O	Saturated Water Content	FRCOEFA	Freundlich Isotherm Coefficient		
SATURH2O	Saturated Water Content	WMUAREA	WMU Area	Y	
SATURH2O	Saturated Water Content	INFILRAT	Infiltration Rate	Y	Y
SATURH2O	Saturated Water Content	RESIDH2O	Residual Water Content		
SATURH2O	Saturated Water Content	SATURH2O	Saturated Water Content	Y	Y
UNSATHIK	Unsaturated Zone Thickness	AVGPDIAM	Avg. Particle Diameter		
UNSATHIK	Unsaturated Zone Thickness	POROSITY	Porosity		
UNSATHIK	Unsaturated Zone Thickness	AQUTHIK	Aquifer Thickness	Y	Y
UNSATHIK	Unsaturated Zone Thickness	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
UNSATHIK	Unsaturated Zone Thickness	HYDGRAD	Hydraulic Gradient		
UNSATHIK	Unsaturated Zone Thickness	LONDISPA	Longitudinal Dispersivity		
UNSATHIK	Unsaturated Zone Thickness	FRORGCAR	Fraction Organic Carbon	Y	
UNSATHIK	Unsaturated Zone Thickness	ANGLEW	Angle of Well Off Plume Centerline		
UNSATHIK	Unsaturated Zone Thickness	XDIST	Longitudinal Distance to Well		
UNSATHIK	Unsaturated Zone Thickness	YDIST	Distance from Plume Centerline to Well		
UNSATHIK	Unsaturated Zone Thickness	ZDIST	Depth of Well Below Water Table	Y	Y
UNSATHIK	Unsaturated Zone Thickness	FRCOEFA	Freundlich Isotherm Coefficient		
UNSATHIK	Unsaturated Zone Thickness	WMUAREA	WMU Area		
UNSATHIK	Unsaturated Zone Thickness	INFILRAT	Infiltration Rate	Y	Y
UNSATHIK	Unsaturated Zone Thickness	RESIDH2O	Residual Water Content		
UNSATHIK	Unsaturated Zone Thickness	SATURH2O	Saturated Water Content		
UNSATHIK	Unsaturated Zone Thickness	UNSATHIK	Unsaturated Zone Thickness	Y	Y
PERORGM	Percent Organic Matter	AVGPDIAM	Avg. Particle Diameter		
PERORGM	Percent Organic Matter	POROSITY	Porosity		
PERORGM	Percent Organic Matter	AQUTHIK	Aquifer Thickness		
PERORGM	Percent Organic Matter	LONHYCON	Longitundinal Hydraulic Conductivity		
PERORGM	Percent Organic Matter	HYDGRAD	Hydraulic Gradient		
PERORGM	Percent Organic Matter	LONDISPA	Longitudinal Dispersivity		
PERORGM	Percent Organic Matter	FRORGCAR	Fraction Organic Carbon	Y	
PERORGM	Percent Organic Matter	ANGLEW	Angle of Well Off Plume Centerline		
PERORGM	Percent Organic Matter	XDIST	Longitudinal Distance to Well		
PERORGM	Percent Organic Matter	YDIST	Distance from Plume Centerline to Well		
PERORGM	Percent Organic Matter	ZDIST	Depth of Well Below Water Table		
PERORGM	Percent Organic Matter	FRCOEFA	Freundlich Isotherm Coefficient	Y	
PERORGM	Percent Organic Matter	WMUAREA	WMU Area	Y	
PERORGM	Percent Organic Matter	INFILRAT	Infiltration Rate		
PERORGM	Percent Organic Matter	RESIDH2O	Residual Water Content		
PERORGM	Percent Organic Matter	SATURH2O	Saturated Water Content		
PERORGM	Percent Organic Matter	UNSATHIK	Unsaturated Zone Thickness		
PERORGM	Percent Organic Matter	PERORGM	Percent Organic Matter		
FRCOEFU	Freundlich Isotherm Coefficient	AVGPDIAM	Avg. Particle Diameter		
FRCOEFU	Freundlich Isotherm Coefficient	POROSITY	Porosity	Y	
FRCOEFU	Freundlich Isotherm Coefficient	AQUTHIK	Aquifer Thickness	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	LONHYCON	Longitundinal Hydraulic Conductivity		
FRCOEFU	Freundlich Isotherm Coefficient	HYDGRAD	Hydraulic Gradient		
FRCOEFU	Freundlich Isotherm Coefficient	LONDISPA	Longitudinal Dispersivity		

Table A-21. Summary of Crosspairs Analysis for Antimony

Variable 1		Variable 2			
Code	Description	Code	Description	P<0.05	P<0.01
FRCOEFU	Freundlich Isotherm Coefficient	FRORGCAR	Fraction Organic Carbon		
FRCOEFU	Freundlich Isotherm Coefficient	ANGLEW	Angle of Well Off Plume Centerline		
FRCOEFU	Freundlich Isotherm Coefficient	XDIST	Longitudinal Distance to Well		
FRCOEFU	Freundlich Isotherm Coefficient	YDIST	Distance from Plume Centerline to Well	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	ZDIST	Depth of Well Below Water Table		
FRCOEFU	Freundlich Isotherm Coefficient	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	WMUAREA	WMU Area	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	INFILRAT	Infiltration Rate	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	RESIDH2O	Residual Water Content	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	SATURH2O	Saturated Water Content	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	UNSATHIK	Unsaturated Zone Thickness	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	PERORGM	Percent Organic Matter		
FRCOEFU	Freundlich Isotherm Coefficient	FRCOEFU	Freundlich Isotherm Coefficient	Y	Y

Table A-22. Ranking of Parameters According to Percentage of Risk for Antimony

Variable Description	Reduced Sums of Square	Variable Sums of Square	Variable Degrees of Freedom	% Risk Variation	Mean Square Variable	F VALUE	P VALUE
Freundlich Isotherm Coefficient {Unsaturated} (cm3/g)	125816.0	211259.99	60	8544396.0%	193977.58	8544.40	1.95E+01
Unsaturated Zone Thickness (m)	154458.3	211259.99	60	5680174.0%	193977.58	8114.53	1.95E+01
Freundlich Isotherm Coefficient {Aquifer} (cm3/g)	180005.0	211259.99	60	3125496.0%	193977.58	3906.87	1.95E+01
Aquifer Thickness (m)	185795.2	211259.99	60	2546478.0%	193977.58	2546.48	1.95E+01
Distance from Plume Centerline to Well (m)	193336.0	211259.99	60	1792399.0%	193977.58	2987.33	1.95E+01
Infiltration Rate (m/yr)	198478.3	211259.99	60	1278171.0%	193977.58	2130.28	1.95E+01
Longitudinal Dispersivity {Aquifer} (m)	203643.1	211259.99	60	761685.0%	193977.58	1088.12	1.95E+01
Longitudinal Hydraulic Conductivity (m/yr)	204617.7	211259.99	60	664227.0%	193977.58	1107.05	1.95E+01
WMU Area (m2)	205538.5	211259.99	60	572153.0%	193977.58	1144.31	1.95E+01
Longitudinal Distance to Well (m)	207310.0	211259.99	60	395002.0%	193977.58	790.00	1.95E+01
Consumption of Drinking Water (ml/kg-day)	208872.9	211259.99	60	238705.0%	193977.58	2387.05	1.95E+01
Hydraulic Gradient (m/m)	210011.8	211259.99	60	124817.0%	193977.58	416.06	1.95E+01
Saturated Water Content	210124.3	211259.99	60	113568.0%	193977.58	283.92	1.95E+01
Depth of Well Below Water Table (m)	210399.7	211259.99	60	86031.0%	193977.58	172.06	1.95E+01
Residual Water Content	210692.1	211259.99	60	56793.0%	193977.58	141.98	1.95E+01
Average Particle Diameter (cm)	211062.8	211259.99	60	19721.0%	193977.58	98.61	1.95E+01
Angle of Well Off Plume Centerline (degrees)	211095.1	211259.99	60	16491.0%	193977.58	82.45	1.95E+01
Porosity	211119.4	211259.99	60	14062.0%	193977.58	70.31	1.95E+01

Constants

Full Model SS	50
Error SS	10
Error DF	0
MS Error	9939

Table A-23. Summary of Parameters Considered in Sensitivity Analysis for Arsenic

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
EXPDURA					
CANSLOPE		C			
ACIDCAT	Acid Catalyzed Hydrolysis Rate Constant	C			
ANGLEW	Angle of Well Off Plume Centerline	anglew			
ANISORAT	Anisotropy Ratio	C			
AQUTHIK	Aquifer Thickness	aquthik**-.1		Y	Y
AVGPDIAM	Avg. Particle Diameter	log(avgpdiam+.002)		Y	Y
BASECAT	Base Catalyzed Hydrolysis Rate Constant	C			
BIODRATA	Biodegradation Rate	C			
BIODRATU	Biodegradation Rate	C			
BULKDENS	Bulk Density	bulkdens**3.5	Y		
CHEMDRU	Chemical Decay Rate	C			
CHEMDRA	Chemical Decay Rate	C			
CONSH2OA	Consump of drinking water	log(consh2oa)			
ZDIST	Depth of Well Below Water Table	log(zdist+4)		Y	Y
DISHYD	Dissolved Hydrolysis Rate	C			
YDIST	Distance from Plume Centerline to Well	log(ydist+10)		Y	Y
DURLEACH	Duration of Leaching Period	log(durleach)	Y		
GWAVTIM	Exposure Duration	gwavtim		Y	
FRORGCAR	Fraction Organic Carbon	log(frorgcar)			
FRCOEFA	Freundlich Isotherm Coefficient	log(frcoefa+3)		Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	log(frcoefu+3)		Y	Y
FREXPA	Freundlich Isotherm Exponent	C			
FREXPU	Freundlich Isotherm Exponent	C			
GWPH	Groundwater pH	gwph	Y		
GWSEEPV	Groundwater Seepage Velocity	log(gwseepv)	Y		
GWTEMP	Groundwater Temperature	C			
HYDGRAD	Hydraulic Gradient	log(hydgrad+.0001)		Y	Y
INFILRAT	Infiltration Rate	infilrat**1.5		Y	Y
LANDEPTH	Landfill Depth	log(landepth+.0007)	Y		
LEACHCON	Leachate Concentration	C			
LFFRACT	LF Fraction	C			
LONDISPA	Longitudinal Dispersivity	log(londispa+.3)		Y	Y

Table A-23. Summary of Parameters Considered in Sensitivity Analysis for Arsenic

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
LONDISPU	Longitudinal Dispersivity	log(londispu-.02)	Y		
XDIST	Longitudinal Distance to Well	log(xdist+250)		Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity	log(lonhycon+40)		Y	Y
MOISTRPA	Moisture Rention Parameter (a)	log(moistrpa-.09)	Y		
MOISTRPB	Moisture Rention Parameter (b)	moistrpb**-2.5	Y		
MOLDIFF	Molecular Diffusion Coefficient	C			
NEUTHYD	Neutral Hydrolysis Rate Constant	C			
ORGCDIS	Organic Carbon Distribution Coefficient	C			
PERORGM	Percent Organic Matter	log(perorgm)		Y	
POROSITY	Porosity	porosity			
RADISTW	Radial Distance to Well	log(radistw+250)	Y		
RECHARAT	Recharge Rate	recharat	Y		
RESIDH2O	Residual Water Content	residh2o**2.1		Y	Y
RETCOEF	Retardation Coefficient	log(retcoef+10)	Y		
SATHYCON	Saturated Hydraulic Conductivity	log(sathycon)	Y		
SATURH2O	Saturated Water Content	saturh2o		Y	
SOILBDEN	Soil Bulk Density	soilbden	Y		
SORBHYD	Sorbed Hydrolysis Rate	C			
TRANDISP	Transverse Dispersivity	log(trandisp+.07)	Y		
UNSATHIK	Unsaturated Zone Thickness	unsathik**-.006		Y	Y
VERTDISP	Vertical Dispersivity	log(vertdisp+.001)	Y		
WASTDENS	Waste Density	C			
WASTEVOL	Waste Volume	C			
WMUAREA	WMU Area	log(wmuarea-3900)		Y	Y
WMULEN	WMU Length	log(wmulen-50)	Y		
WMUWIDTH	WMU Width	log(wmuwidth-50)	Y		

Table A-24. Summary of Correlated Parameters for Arsenic

Variable 1		Variable 2		Correlation Coefficient
Code	Description	Code	Description	
AVGPDIAM	Avg. Particle Diameter	BULKDENS	Bulk Density	0.9988
LONHYCON	Longitundinal Hydraulic Conductivi	GWSEEPV	Groundwater Seepage Velocity	0.81845
FRCOEFA	Freundlich Isotherm Coefficient	RETCOEF	Retardation Coefficient	0.9877
LONDISPA	Longitudinal Dispersivity	TRANDISP	Transverse Dispersivity	0.99954
LONDISPA	Longitudinal Dispersivity	VERTDISP	Vertical Dispersivity	0.99916
RECHARAT	Recharge Rate	GWPH	Groundwater pH	-0.88331
INFILRAT	Infiltration Rate	GWPH	Groundwater pH	-0.80133
MOISTRPB	Moisture Rention Parameter (b)	GWPH	Groundwater pH	0.72897
SOILBDEN	Soil Bulk Density	GWPH	Groundwater pH	0.74946
XDIST	Longitudinal Distance to Well	RADISTW	Radial Distance to Well	0.9939
WMUAREA	WMU Area	WMULEN	WMU Length	0.99833
LANDEPTH	Landfill Depth	WMULEN	WMU Length	-0.99121
DURLEACH	Duration of Leaching Period	WMULEN	WMU Length	-0.96305
WMUAREA	WMU Area	WMUWIDTH	WMU Width	0.99833
LANDEPTH	Landfill Depth	WMUWIDTH	WMU Width	-0.99121
DURLEACH	Duration of Leaching Period	WMUWIDTH	WMU Width	-0.96305
INFILRAT	Infiltration Rate	RECHARAT	Recharge Rate	0.90405
SOILBDEN	Soil Bulk Density	RECHARAT	Recharge Rate	-0.97237
WMUAREA	WMU Area	LANDEPTH	Landfill Depth	-0.98471
WMUAREA	WMU Area	DURLEACH	Duration of Leaching Period	-0.96276
LANDEPTH	Landfill Depth	DURLEACH	Duration of Leaching Period	0.95387
RECHARAT	Recharge Rate	SATHYCON	Saturated Hydraulic Conductivity	0.71373
INFILRAT	Infiltration Rate	SATHYCON	Saturated Hydraulic Conductivity	0.80946
RECHARAT	Recharge Rate	MOISTRPA	Moisture Rention Parameter (a)	0.70898
RECHARAT	Recharge Rate	MOISTRPB	Moisture Rention Parameter (b)	-0.84728
INFILRAT	Infiltration Rate	MOISTRPB	Moisture Rention Parameter (b)	-0.76111
UNSATHIK	Unsaturated Zone Thickness	LONDISPU	Longitudinal Dispersivity	-0.99997
RECHARAT	Recharge Rate	SOILBDEN	Soil Bulk Density	-0.97237
INFILRAT	Infiltration Rate	SOILBDEN	Soil Bulk Density	-0.87769
SATHYCON	Saturated Hydraulic Conductivity	SOILBDEN	Soil Bulk Density	-0.70622
MOISTRPA	Moisture Rention Parameter (a)	SOILBDEN	Soil Bulk Density	-0.72206
MOISTRPB	Moisture Rention Parameter (b)	SOILBDEN	Soil Bulk Density	0.83355
FRCOEFU	Freundlich Isotherm Coefficient	AVRECWF	Average Receptor Well Concentr	-0.70507
FRCOEFU	Freundlich Isotherm Coefficient	DRH2OCNA	drinking water well conc	-0.70507

Note: Parameters in the variable 2 column were removed from the analysis.

Table A-25. Summary of Crosspairs Analysis for Arsenic

Variable 1		Variable 2			
Code	Description	Code	Description	P<0.05	P<0.01
AVGPDIAM	Avg. Particle Diameter			Y	
POROSITY	Porosity				
AQUTHIK	Aquifer Thickness			Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity			Y	Y
HYDGRAD	Hydraulic Gradient			Y	Y
LONDISPA	Longitudinal Dispersivity			Y	Y
FRORGCAR	Fraction Organic Carbon				
ANGLEW	Angle of Well Off Plume Centerline				
XDIST	Longitudinal Distance to Well			Y	Y
YDIST	Distance from Plume Centerline to Well			Y	Y
ZDIST	Depth of Well Below Water Table			Y	
FRCOEFA	Freundlich Isotherm Coefficient			Y	Y
GWAVTIM	Exposure Duration				
WMUAREA	WMU Area			Y	Y
INFILRAT	Infiltration Rate				Y
RESIDH2O	Residual Water Content				
SATURH2O	Saturated Water Content				
UNSATHIK	Unsaturated Zone Thickness			Y	Y
PERORGM	Percent Organic Matter			Y	
FRCOEFU	Freundlich Isotherm Coefficient			Y	Y
AVGPDIAM	Avg. Particle Diameter	AVGPDIAM	Avg. Particle Diameter		
POROSITY	Porosity	AVGPDIAM	Avg. Particle Diameter		
POROSITY	Porosity	POROSITY	Porosity		
AQUTHIK	Aquifer Thickness	AVGPDIAM	Avg. Particle Diameter		
AQUTHIK	Aquifer Thickness	POROSITY	Porosity		
AQUTHIK	Aquifer Thickness	AQUTHIK	Aquifer Thickness		
LONHYCON	Longitundinal Hydraulic Conductivity	AVGPDIAM	Avg. Particle Diameter		
LONHYCON	Longitundinal Hydraulic Conductivity	POROSITY	Porosity		
LONHYCON	Longitundinal Hydraulic Conductivity	AQUTHIK	Aquifer Thickness	Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity	LONHYCON	Longitundinal Hydraulic Conductivity		
HYDGRAD	Hydraulic Gradient	AVGPDIAM	Avg. Particle Diameter		
HYDGRAD	Hydraulic Gradient	POROSITY	Porosity		
HYDGRAD	Hydraulic Gradient	AQUTHIK	Aquifer Thickness		
HYDGRAD	Hydraulic Gradient	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
HYDGRAD	Hydraulic Gradient	HYDGRAD	Hydraulic Gradient		
LONDISPA	Longitudinal Dispersivity	AVGPDIAM	Avg. Particle Diameter		
LONDISPA	Longitudinal Dispersivity	POROSITY	Porosity		
LONDISPA	Longitudinal Dispersivity	AQUTHIK	Aquifer Thickness		
LONDISPA	Longitudinal Dispersivity	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
LONDISPA	Longitudinal Dispersivity	HYDGRAD	Hydraulic Gradient		
LONDISPA	Longitudinal Dispersivity	LONDISPA	Longitudinal Dispersivity		
FRORGCAR	Fraction Organic Carbon	AVGPDIAM	Avg. Particle Diameter		
FRORGCAR	Fraction Organic Carbon	POROSITY	Porosity		
FRORGCAR	Fraction Organic Carbon	AQUTHIK	Aquifer Thickness		
FRORGCAR	Fraction Organic Carbon	LONHYCON	Longitundinal Hydraulic Conductivity		
FRORGCAR	Fraction Organic Carbon	HYDGRAD	Hydraulic Gradient		
FRORGCAR	Fraction Organic Carbon	LONDISPA	Longitudinal Dispersivity		
FRORGCAR	Fraction Organic Carbon	FRORGCAR	Fraction Organic Carbon		
ANGLEW	Angle of Well Off Plume Centerline	AVGPDIAM	Avg. Particle Diameter		

Table A-25. Summary of Crosspairs Analysis for Arsenic

Variable 1		Variable 2			
Code	Description	Code	Description	P<0.05	P<0.01
ANGLEW	Angle of Well Off Plume Centerline	POROSITY	Porosity		
ANGLEW	Angle of Well Off Plume Centerline	AQUTHIK	Aquifer Thickness		
ANGLEW	Angle of Well Off Plume Centerline	LONHYCON	Longitundinal Hydraulic Conductivity		
ANGLEW	Angle of Well Off Plume Centerline	HYDGRAD	Hydraulic Gradient		
ANGLEW	Angle of Well Off Plume Centerline	LONDISPA	Longitudinal Dispersivity		
ANGLEW	Angle of Well Off Plume Centerline	FRORGCAR	Fraction Organic Carbon		
ANGLEW	Angle of Well Off Plume Centerline	ANGLEW	Angle of Well Off Plume Centerline		
XDIST	Longitudinal Distance to Well	AVGPDIAM	Avg. Particle Diameter		
XDIST	Longitudinal Distance to Well	POROSITY	Porosity		
XDIST	Longitudinal Distance to Well	AQUTHIK	Aquifer Thickness		
XDIST	Longitudinal Distance to Well	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
XDIST	Longitudinal Distance to Well	HYDGRAD	Hydraulic Gradient	Y	Y
XDIST	Longitudinal Distance to Well	LONDISPA	Longitudinal Dispersivity	Y	Y
XDIST	Longitudinal Distance to Well	FRORGCAR	Fraction Organic Carbon		
XDIST	Longitudinal Distance to Well	ANGLEW	Angle of Well Off Plume Centerline		
XDIST	Longitudinal Distance to Well	XDIST	Longitudinal Distance to Well		
YDIST	Distance from Plume Centerline to Well	AVGPDIAM	Avg. Particle Diameter		
YDIST	Distance from Plume Centerline to Well	POROSITY	Porosity		
YDIST	Distance from Plume Centerline to Well	AQUTHIK	Aquifer Thickness		
YDIST	Distance from Plume Centerline to Well	LONHYCON	Longitundinal Hydraulic Conductivity		
YDIST	Distance from Plume Centerline to Well	HYDGRAD	Hydraulic Gradient		
YDIST	Distance from Plume Centerline to Well	LONDISPA	Longitudinal Dispersivity		
YDIST	Distance from Plume Centerline to Well	FRORGCAR	Fraction Organic Carbon		
YDIST	Distance from Plume Centerline to Well	ANGLEW	Angle of Well Off Plume Centerline		
YDIST	Distance from Plume Centerline to Well	XDIST	Longitudinal Distance to Well		
YDIST	Distance from Plume Centerline to Well	YDIST	Distance from Plume Centerline to Well	Y	Y
ZDIST	Depth of Well Below Water Table	AVGPDIAM	Avg. Particle Diameter		
ZDIST	Depth of Well Below Water Table	POROSITY	Porosity		
ZDIST	Depth of Well Below Water Table	AQUTHIK	Aquifer Thickness		
ZDIST	Depth of Well Below Water Table	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
ZDIST	Depth of Well Below Water Table	HYDGRAD	Hydraulic Gradient	Y	
ZDIST	Depth of Well Below Water Table	LONDISPA	Longitudinal Dispersivity		
ZDIST	Depth of Well Below Water Table	FRORGCAR	Fraction Organic Carbon		
ZDIST	Depth of Well Below Water Table	ANGLEW	Angle of Well Off Plume Centerline		
ZDIST	Depth of Well Below Water Table	XDIST	Longitudinal Distance to Well		
ZDIST	Depth of Well Below Water Table	YDIST	Distance from Plume Centerline to Well		
ZDIST	Depth of Well Below Water Table	ZDIST	Depth of Well Below Water Table		
FRCOEFA	Freundlich Isotherm Coefficient	AVGPDIAM	Avg. Particle Diameter		
FRCOEFA	Freundlich Isotherm Coefficient	POROSITY	Porosity		
FRCOEFA	Freundlich Isotherm Coefficient	AQUTHIK	Aquifer Thickness		
FRCOEFA	Freundlich Isotherm Coefficient	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	HYDGRAD	Hydraulic Gradient	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	LONDISPA	Longitudinal Dispersivity	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	FRORGCAR	Fraction Organic Carbon		
FRCOEFA	Freundlich Isotherm Coefficient	ANGLEW	Angle of Well Off Plume Centerline		
FRCOEFA	Freundlich Isotherm Coefficient	XDIST	Longitudinal Distance to Well	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	YDIST	Distance from Plume Centerline to Well	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	ZDIST	Depth of Well Below Water Table		
FRCOEFA	Freundlich Isotherm Coefficient	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y

Table A-25. Summary of Crosspairs Analysis for Arsenic

Variable 1		Variable 2			
Code	Description	Code	Description	P<0.05	P<0.01
GWAVTIM	Exposure Duration	AVGPDIAM	Avg. Particle Diameter		
GWAVTIM	Exposure Duration	POROSITY	Porosity		
GWAVTIM	Exposure Duration	AQUTHIK	Aquifer Thickness		
GWAVTIM	Exposure Duration	LONHYCON	Longitundinal Hydraulic Conductivity		
GWAVTIM	Exposure Duration	HYDGRAD	Hydraulic Gradient		
GWAVTIM	Exposure Duration	LONDISPA	Longitudinal Dispersivity		
GWAVTIM	Exposure Duration	FRORGCAR	Fraction Organic Carbon		
GWAVTIM	Exposure Duration	ANGLEW	Angle of Well Off Plume Centerline		
GWAVTIM	Exposure Duration	XDIST	Longitudinal Distance to Well		
GWAVTIM	Exposure Duration	YDIST	Distance from Plume Centerline to Well		
GWAVTIM	Exposure Duration	ZDIST	Depth of Well Below Water Table		
GWAVTIM	Exposure Duration	FRCOEFA	Freundlich Isotherm Coefficient		
GWAVTIM	Exposure Duration	GWAVTIM	Exposure Duration		
WMUAREA	WMU Area	AVGPDIAM	Avg. Particle Diameter		
WMUAREA	WMU Area	POROSITY	Porosity		
WMUAREA	WMU Area	AQUTHIK	Aquifer Thickness		
WMUAREA	WMU Area	LONHYCON	Longitundinal Hydraulic Conductivity	Y	
WMUAREA	WMU Area	HYDGRAD	Hydraulic Gradient		
WMUAREA	WMU Area	LONDISPA	Longitudinal Dispersivity	Y	Y
WMUAREA	WMU Area	FRORGCAR	Fraction Organic Carbon		
WMUAREA	WMU Area	ANGLEW	Angle of Well Off Plume Centerline		
WMUAREA	WMU Area	XDIST	Longitudinal Distance to Well		
WMUAREA	WMU Area	YDIST	Distance from Plume Centerline to Well	Y	Y
WMUAREA	WMU Area	ZDIST	Depth of Well Below Water Table		
WMUAREA	WMU Area	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
WMUAREA	WMU Area	GWAVTIM	Exposure Duration		
WMUAREA	WMU Area	WMUAREA	WMU Area		
INFILRAT	Infiltration Rate	AVGPDIAM	Avg. Particle Diameter		
INFILRAT	Infiltration Rate	POROSITY	Porosity		
INFILRAT	Infiltration Rate	AQUTHIK	Aquifer Thickness		
INFILRAT	Infiltration Rate	LONHYCON	Longitundinal Hydraulic Conductivity		
INFILRAT	Infiltration Rate	HYDGRAD	Hydraulic Gradient		
INFILRAT	Infiltration Rate	LONDISPA	Longitudinal Dispersivity		
INFILRAT	Infiltration Rate	FRORGCAR	Fraction Organic Carbon		
INFILRAT	Infiltration Rate	ANGLEW	Angle of Well Off Plume Centerline		
INFILRAT	Infiltration Rate	XDIST	Longitudinal Distance to Well		
INFILRAT	Infiltration Rate	YDIST	Distance from Plume Centerline to Well		
INFILRAT	Infiltration Rate	ZDIST	Depth of Well Below Water Table		
INFILRAT	Infiltration Rate	FRCOEFA	Freundlich Isotherm Coefficient		
INFILRAT	Infiltration Rate	GWAVTIM	Exposure Duration		
INFILRAT	Infiltration Rate	WMUAREA	WMU Area		
INFILRAT	Infiltration Rate	INFILRAT	Infiltration Rate	Y	Y
RESIDH2O	Residual Water Content	AVGPDIAM	Avg. Particle Diameter		
RESIDH2O	Residual Water Content	POROSITY	Porosity		
RESIDH2O	Residual Water Content	AQUTHIK	Aquifer Thickness		
RESIDH2O	Residual Water Content	LONHYCON	Longitundinal Hydraulic Conductivity		
RESIDH2O	Residual Water Content	HYDGRAD	Hydraulic Gradient		
RESIDH2O	Residual Water Content	LONDISPA	Longitudinal Dispersivity		
RESIDH2O	Residual Water Content	FRORGCAR	Fraction Organic Carbon		

Table A-25. Summary of Crosspairs Analysis for Arsenic

Variable 1		Variable 2			
Code	Description	Code	Description	P<0.05	P<0.01
RESIDH2O	Residual Water Content	ANGLEW	Angle of Well Off Plume Centerline		
RESIDH2O	Residual Water Content	XDIST	Longitudinal Distance to Well		
RESIDH2O	Residual Water Content	YDIST	Distance from Plume Centerline to Well		
RESIDH2O	Residual Water Content	ZDIST	Depth of Well Below Water Table		
RESIDH2O	Residual Water Content	FRCOEFA	Freundlich Isotherm Coefficient		
RESIDH2O	Residual Water Content	GWAVTIM	Exposure Duration		
RESIDH2O	Residual Water Content	WMUAREA	WMU Area		
RESIDH2O	Residual Water Content	INFILRAT	Infiltration Rate		
RESIDH2O	Residual Water Content	RESIDH2O	Residual Water Content		
SATURH2O	Saturated Water Content	AVGPDIAM	Avg. Particle Diameter		
SATURH2O	Saturated Water Content	POROSITY	Porosity		
SATURH2O	Saturated Water Content	AQUTHIK	Aquifer Thickness		
SATURH2O	Saturated Water Content	LONHYCON	Longitundinal Hydraulic Conductivity		
SATURH2O	Saturated Water Content	HYDGRAD	Hydraulic Gradient		
SATURH2O	Saturated Water Content	LONDISPA	Longitudinal Dispersivity		
SATURH2O	Saturated Water Content	FRORGCAR	Fraction Organic Carbon		
SATURH2O	Saturated Water Content	ANGLEW	Angle of Well Off Plume Centerline		
SATURH2O	Saturated Water Content	XDIST	Longitudinal Distance to Well		
SATURH2O	Saturated Water Content	YDIST	Distance from Plume Centerline to Well		
SATURH2O	Saturated Water Content	ZDIST	Depth of Well Below Water Table		
SATURH2O	Saturated Water Content	FRCOEFA	Freundlich Isotherm Coefficient		
SATURH2O	Saturated Water Content	GWAVTIM	Exposure Duration		
SATURH2O	Saturated Water Content	WMUAREA	WMU Area		
SATURH2O	Saturated Water Content	INFILRAT	Infiltration Rate		
SATURH2O	Saturated Water Content	RESIDH2O	Residual Water Content		
SATURH2O	Saturated Water Content	SATURH2O	Saturated Water Content		
UNSATHIK	Unsaturated Zone Thickness	AVGPDIAM	Avg. Particle Diameter		
UNSATHIK	Unsaturated Zone Thickness	POROSITY	Porosity		
UNSATHIK	Unsaturated Zone Thickness	AQUTHIK	Aquifer Thickness	Y	Y
UNSATHIK	Unsaturated Zone Thickness	LONHYCON	Longitundinal Hydraulic Conductivity		
UNSATHIK	Unsaturated Zone Thickness	HYDGRAD	Hydraulic Gradient	Y	Y
UNSATHIK	Unsaturated Zone Thickness	LONDISPA	Longitudinal Dispersivity	Y	Y
UNSATHIK	Unsaturated Zone Thickness	FRORGCAR	Fraction Organic Carbon		
UNSATHIK	Unsaturated Zone Thickness	ANGLEW	Angle of Well Off Plume Centerline		
UNSATHIK	Unsaturated Zone Thickness	XDIST	Longitudinal Distance to Well	Y	Y
UNSATHIK	Unsaturated Zone Thickness	YDIST	Distance from Plume Centerline to Well		
UNSATHIK	Unsaturated Zone Thickness	ZDIST	Depth of Well Below Water Table		
UNSATHIK	Unsaturated Zone Thickness	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
UNSATHIK	Unsaturated Zone Thickness	GWAVTIM	Exposure Duration	Y	
UNSATHIK	Unsaturated Zone Thickness	WMUAREA	WMU Area		
UNSATHIK	Unsaturated Zone Thickness	INFILRAT	Infiltration Rate		
UNSATHIK	Unsaturated Zone Thickness	RESIDH2O	Residual Water Content	Y	Y
UNSATHIK	Unsaturated Zone Thickness	SATURH2O	Saturated Water Content		
UNSATHIK	Unsaturated Zone Thickness	UNSATHIK	Unsaturated Zone Thickness	Y	Y
PERORGM	Percent Organic Matter	AVGPDIAM	Avg. Particle Diameter		
PERORGM	Percent Organic Matter	POROSITY	Porosity		
PERORGM	Percent Organic Matter	AQUTHIK	Aquifer Thickness		
PERORGM	Percent Organic Matter	LONHYCON	Longitundinal Hydraulic Conductivity		
PERORGM	Percent Organic Matter	HYDGRAD	Hydraulic Gradient		

Table A-25. Summary of Crosspairs Analysis for Arsenic

Variable 1		Variable 2			
Code	Description	Code	Description	P<0.05	P<0.01
PERORGM	Percent Organic Matter	LONDISPA	Longitudinal Dispersivity		
PERORGM	Percent Organic Matter	FRORGCAR	Fraction Organic Carbon		
PERORGM	Percent Organic Matter	ANGLEW	Angle of Well Off Plume Centerline		
PERORGM	Percent Organic Matter	XDIST	Longitudinal Distance to Well		
PERORGM	Percent Organic Matter	YDIST	Distance from Plume Centerline to Well		
PERORGM	Percent Organic Matter	ZDIST	Depth of Well Below Water Table		
PERORGM	Percent Organic Matter	FRCOEFA	Freundlich Isotherm Coefficient		
PERORGM	Percent Organic Matter	GWAVTIM	Exposure Duration		
PERORGM	Percent Organic Matter	WMUAREA	WMU Area		
PERORGM	Percent Organic Matter	INFILRAT	Infiltration Rate		
PERORGM	Percent Organic Matter	RESIDH2O	Residual Water Content		
PERORGM	Percent Organic Matter	SATURH2O	Saturated Water Content	Y	
PERORGM	Percent Organic Matter	UNSATHIK	Unsaturated Zone Thickness		
PERORGM	Percent Organic Matter	PERORGM	Percent Organic Matter		
FRCOEFU	Freundlich Isotherm Coefficient	AVGPDIAM	Avg. Particle Diameter	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	POROSITY	Porosity		
FRCOEFU	Freundlich Isotherm Coefficient	AQUTHIK	Aquifer Thickness	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	HYDGRAD	Hydraulic Gradient	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	LONDISPA	Longitudinal Dispersivity	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	FRORGCAR	Fraction Organic Carbon		
FRCOEFU	Freundlich Isotherm Coefficient	ANGLEW	Angle of Well Off Plume Centerline		
FRCOEFU	Freundlich Isotherm Coefficient	XDIST	Longitudinal Distance to Well	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	YDIST	Distance from Plume Centerline to Well	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	ZDIST	Depth of Well Below Water Table		
FRCOEFU	Freundlich Isotherm Coefficient	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	GWAVTIM	Exposure Duration		
FRCOEFU	Freundlich Isotherm Coefficient	WMUAREA	WMU Area	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	INFILRAT	Infiltration Rate		
FRCOEFU	Freundlich Isotherm Coefficient	RESIDH2O	Residual Water Content		
FRCOEFU	Freundlich Isotherm Coefficient	SATURH2O	Saturated Water Content		
FRCOEFU	Freundlich Isotherm Coefficient	UNSATHIK	Unsaturated Zone Thickness	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	PERORGM	Percent Organic Matter		
FRCOEFU	Freundlich Isotherm Coefficient	FRCOEFU	Freundlich Isotherm Coefficient	Y	Y

Table A-26. Ranking of Parameters According to Percentage of Risk for Arsenic

Variable Description	Reduced Sums of Square	Variable Sums of Square	Variable Degrees of Freedom	% Risk Variation	Mean Square Variable	F VALUE	P VALUE
Freundlich Isotherm Coefficient {Unsaturated} (cm3/g)	647481.0	2537416.45	52	88993546.0%	715544.78	157494.62	7.19E+01
Freundlich Isotherm Coefficient {Aquifer} (cm3/g)	2070202.4	2537416.45	52	46721408.0%	715544.78	46721.41	7.19E+01
Unsaturated Zone Thickness (m)	2337035.1	2537416.45	52	20038138.0%	715544.78	22264.60	7.19E+01
Longitudinal Distance to Well (m)	2453920.5	2537416.45	52	8349594.0%	715544.78	11927.99	7.19E+01
Longitudinal Hydraulic Conductivity (m/yr)	2484250.8	2537416.45	52	5316569.0%	715544.78	6645.71	7.19E+01
Longitudinal Dispersivity {Aquifer} (m)	2496530.7	2537416.45	52	4088576.0%	715544.78	5840.82	7.19E+01
Hydraulic Gradient (m/m)	2513086.9	2537416.45	52	2432953.0%	715544.78	4054.92	7.19E+01
Aquifer Thickness (m)	2518597.4	2537416.45	52	1881908.0%	715544.78	4704.77	7.19E+01
Distance from Plume Centerline to Well (m)	2522056.0	2537416.45	52	1536048.0%	715544.78	3072.10	7.19E+01
Infiltration Rate (m/yr)	2524906.6	2537416.45	52	1250985.0%	715544.78	6254.93	7.19E+01
WMU Area (m2)	2528262.1	2537416.45	52	915433.0%	715544.78	1830.87	7.19E+01
Depth of Well Below Water Table (m)	2536371.7	2537416.45	52	104477.0%	715544.78	522.38	7.19E+01
Average Particle Diameter (cm)	2536627.6	2537416.45	52	78884.0%	715544.78	394.42	7.19E+01
Residual Water Content	2536682.0	2537416.45	52	73450.0%	715544.78	367.25	7.19E+01
Exposure Duration (yr)	2536756.8	2537416.45	52	65966.0%	715544.78	659.66	7.19E+01
Consumption of Drinking Water (ml/kg-day)	2537020.3	2537416.45	52	39613.0%	715544.78	396.13	7.19E+01

Constants

Full Model SS	40
Error SS	12
Error DF	1
MS Error	9947

Table A-27. Summary of Parameters Considered in Sensitivity Analysis for Cadmium

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
ACIDCAT	Acid Catalyzed Hydrolysis Rate Constant	C			
ANGLEW	Angle of Well Off Plume Centerline	anglew			
ANISORAT	Anisotropy Ratio	C			
AQUTHIK	Aquifer Thickness	aquthik**-0.1		Y	Y
AVGPDIAM	Avg. Particle Diameter	log(avgpdiam+0.002)		Y	Y
BASECAT	Base Catalyzed Hydrolysis Rate Constant	C			
BIODRATA	Biodegradation Rate	C			
BIODRATU	Biodegradation Rate	C			
BULKDENS	Bulk Density	bulkdens**3.5	Y		
CHEMDRU	Chemical Decay Rate	C			
CHEMDRA	Chemical Decay Rate	C			
CONSH2OA	Consump of drinking water	log(consh2oa)			Y
ZDIST	Depth of Well Below Water Table	log(zdist+2.5)		Y	Y
DISHYD	Dissolved Hydrolysis Rate	C			
YDIST	Distance from Plume Centerline to Well	log(ydist+20)		Y	Y
DURLEACH	Duration of Leaching Period	log(durleach+0.01)	Y		
GWAVTIM	Exposure Duration	C			
FRORGCAR	Fraction Organic Carbon	log(frorgcar)		Y	
FRCOEFA	Freundlich Isotherm Coefficient	log(frcoefa-0.5)		Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	log(frcoefu+2)		Y	Y
FREXPA	Freundlich Isotherm Exponent	C			
FREXPU	Freundlich Isotherm Exponent	C			
GWPH	Groundwater pH	gwph	Y		
GWSEEPV	Groundwater Seepage Velocity	log(gwseepv)	Y		
GWTEMP	Groundwater Temperature	C			
HYDGRAD	Hydraulic Gradient	log(hydgrad+0.0003)		Y	Y
INFILRAT	Infiltration Rate	infilrat**1.5		Y	Y
LANDEPTH	Landfill Depth	log(landepth+0.0007)	Y		
LEACHCON	Leachate Concentration	leachcon		Y	Y
LFFRACT	LF Fraction	C			
LONDISPU	Longitudinal Dispersivity	log(londispu-0.022)	Y		
LONDISPA	Longitudinal Dispersivity	log(londispa+1)		Y	Y
XDIST	Longitudinal Distance to Well	log(xdist+250)		Y	Y

Table A-27. Summary of Parameters Considered in Sensitivity Analysis for Cadmium

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
LONHYCON	Longitundinal Hydraulic Conductivity	log(lonhycon+50)		Y	Y
MLLA	ml/L	C			
MOISTRPA	Moisture Rention Parameter (a)	log(moistrpa)		Y	
MOISTRPB	Moisture Rention Parameter (b)	log(moistrpb-0.9)	Y		
MOLDIFF	Molecular Diffusion Coefficient	C			
NEUTHYD	Neutral Hydrolysis Rate Constant	C			
ORGCDIS	Organic Carbon Distribution Coefficient	C			
PERORGM	Percent Organic Matter	log(perorgm)		Y	
POROSITY	Porosity	porosity**1.3		Y	
RADISTW	Radial Distance to Well	log(radistw+250)	Y		
RECHARAT	Recharge Rate	recharat	Y		
RESIDH2O	Residual Water Content	residh2o**1.7			
RETCOEF	Retardation Coefficient	log(retcoef-2)	Y		
RFDA	RfD (mg/kg/day)	C			
SATHYCON	Saturated Hydraulic Conductivity	log(sathycon)		Y	
SATURH2O	Saturated Water Content	saturh2o		Y	
SOILBDEN	Soil Bulk Density	soilbden	Y		
SORBHYD	Sorbed Hydrolysis Rate	C			
TRANDISP	Transverse Dispersivity	log(trandisp+0.1)	Y		
UNSATHIK	Unsaturated Zone Thickness	log(unsathik-0.1)		Y	Y
VERTDISP	Vertical Dispersivity	log(vertdisp+0.005)	Y		
WASTDENS	Waste Density	C			
WASTEVOL	Waste Volume	C			
WMUAREA	WMU Area	log(wmuarea-3700)		Y	Y
WMULEN	WMU Length	log(wmulen-50)	Y		
WMUWIDTH	WMU Width	log(wmuwidth-50)	Y		

Table A-28. Summary of Correlated Parameters for Cadmium

Variable 1		Variable 2		Correlation Coefficient
Code	Description	Code	Description	
AVGPDIAM	Avg. Particle Diameter	BULKDENS	Bulk Density	0.99878
LONHYCON	Longitundinal Hydraulic Conductivi	GWSEEPV	Groundwater Seepage Velocity	0.86093
FRCOEFA	Freundlich Isotherm Coefficient	RETCOEF	Retardation Coefficient	0.96416
LONDISPA	Longitudinal Dispersivity	TRANDISP	Transverse Dispersivity	0.99989
LONDISPA	Longitudinal Dispersivity	VERTDISP	Vertical Dispersivity	0.99976
RECHARAT	Recharge Rate	GWPH	Groundwater pH	-0.8876
INFILRAT	Infiltration Rate	GWPH	Groundwater pH	-0.79337
SATURH2O	Saturated Water Content	GWPH	Groundwater pH	-0.73571
SOILBDEN	Soil Bulk Density	GWPH	Groundwater pH	0.70128
XDIST	Longitudinal Distance to Well	RADISTW	Radial Distance to Well	0.99506
WMUAREA	WMU Area	WMULEN	WMU Length	0.99885
LANDEPTH	Landfill Depth	WMULEN	WMU Length	-0.99202
DURLEACH	Duration of Leaching Period	WMULEN	WMU Length	-0.9077
WMUAREA	WMU Area	WMUWIDTH	WMU Width	0.99885
LANDEPTH	Landfill Depth	WMUWIDTH	WMU Width	-0.99202
DURLEACH	Duration of Leaching Period	WMUWIDTH	WMU Width	-0.9077
INFILRAT	Infiltration Rate	RECHARAT	Recharge Rate	0.8914
SOILBDEN	Soil Bulk Density	RECHARAT	Recharge Rate	-0.95082
WMUAREA	WMU Area	LANDEPTH	Landfill Depth	-0.9878
WMUAREA	WMU Area	DURLEACH	Duration of Leaching Period	-0.90931
LANDEPTH	Landfill Depth	DURLEACH	Duration of Leaching Period	0.90455
RECHARAT	Recharge Rate	MOISTRPB	Moisture Rention Parameter (b)	0.74587
UNSATHIK	Unsaturated Zone Thickness	LONDISPU	Longitudinal Dispersivity	0.99997
RECHARAT	Recharge Rate	SOILBDEN	Soil Bulk Density	-0.95082
INFILRAT	Infiltration Rate	SOILBDEN	Soil Bulk Density	-0.84612
MOISTRPB	Moisture Rention Parameter (b)	SOILBDEN	Soil Bulk Density	-0.7381

Note: Parameters in the variable 2 column were removed from the analysis.

Table A-29. Summary of Crosspairs Analysis for Cadmium

Variable 1		Variable 2			
Code	Description	Code	Description	P<0.05	P<0.01
AVGPDIAM	Avg. Particle Diameter			Y	Y
POROSITY	Porosity				
AQUTHIK	Aquifer Thickness			Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity			Y	Y
HYDGRAD	Hydraulic Gradient			Y	Y
LONDISPA	Longitudinal Dispersivity			Y	Y
FRORGCAR	Fraction Organic Carbon				
ANGLEW	Angle of Well Off Plume Centerline				
XDIST	Longitudinal Distance to Well			Y	Y
YDIST	Distance from Plume Centerline to Well			Y	Y
ZDIST	Depth of Well Below Water Table			Y	Y
FRCOEFA	Freundlich Isotherm Coefficient			Y	Y
WMUAREA	WMU Area			Y	Y
LEACHCON	Leachate Concentration			Y	Y
INFILRAT	Infiltration Rate				Y
SATHYCON	Saturated Hydraulic Conductivity				
MOISTRPA	Moisture Rention Parameter (a)				
RESIDH2O	Residual Water Content				
SATURH2O	Saturated Water Content				
UNSATHIK	Unsaturated Zone Thickness			Y	Y
PERORGM	Percent Organic Matter				
FRCOEFU	Freundlich Isotherm Coefficient			Y	Y
AVGPDIAM	Avg. Particle Diameter	AVGPDIAM	Avg. Particle Diameter	Y	Y
POROSITY	Porosity	AVGPDIAM	Avg. Particle Diameter	Y	
POROSITY	Porosity	POROSITY	Porosity		
AQUTHIK	Aquifer Thickness	AVGPDIAM	Avg. Particle Diameter		
AQUTHIK	Aquifer Thickness	POROSITY	Porosity		
AQUTHIK	Aquifer Thickness	AQUTHIK	Aquifer Thickness	Y	
LONHYCON	Longitundinal Hydraulic Conductivity	AVGPDIAM	Avg. Particle Diameter		
LONHYCON	Longitundinal Hydraulic Conductivity	POROSITY	Porosity		
LONHYCON	Longitundinal Hydraulic Conductivity	AQUTHIK	Aquifer Thickness	Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
HYDGRAD	Hydraulic Gradient	AVGPDIAM	Avg. Particle Diameter		
HYDGRAD	Hydraulic Gradient	POROSITY	Porosity		
HYDGRAD	Hydraulic Gradient	AQUTHIK	Aquifer Thickness		
HYDGRAD	Hydraulic Gradient	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
HYDGRAD	Hydraulic Gradient	HYDGRAD	Hydraulic Gradient	Y	Y
LONDISPA	Longitudinal Dispersivity	AVGPDIAM	Avg. Particle Diameter	Y	
LONDISPA	Longitudinal Dispersivity	POROSITY	Porosity		
LONDISPA	Longitudinal Dispersivity	AQUTHIK	Aquifer Thickness	Y	Y
LONDISPA	Longitudinal Dispersivity	LONHYCON	Longitundinal Hydraulic Conductivity		
LONDISPA	Longitudinal Dispersivity	HYDGRAD	Hydraulic Gradient		
LONDISPA	Longitudinal Dispersivity	LONDISPA	Longitudinal Dispersivity		
FRORGCAR	Fraction Organic Carbon	AVGPDIAM	Avg. Particle Diameter		
FRORGCAR	Fraction Organic Carbon	POROSITY	Porosity		
FRORGCAR	Fraction Organic Carbon	AQUTHIK	Aquifer Thickness		
FRORGCAR	Fraction Organic Carbon	LONHYCON	Longitundinal Hydraulic Conductivity		
FRORGCAR	Fraction Organic Carbon	HYDGRAD	Hydraulic Gradient		
FRORGCAR	Fraction Organic Carbon	LONDISPA	Longitudinal Dispersivity		

Table A-29. Summary of Crosspairs Analysis for Cadmium

Variable 1		Variable 2			
Code	Description	Code	Description	P<0.05	P<0.01
FRORGCAR	Fraction Organic Carbon	FRORGCAR	Fraction Organic Carbon		
ANGLEW	Angle of Well Off Plume Centerline	AVGPDIAM	Avg. Particle Diameter		
ANGLEW	Angle of Well Off Plume Centerline	POROSITY	Porosity		
ANGLEW	Angle of Well Off Plume Centerline	AQUTHIK	Aquifer Thickness		
ANGLEW	Angle of Well Off Plume Centerline	LONHYCON	Longitundinal Hydraulic Conductivity		
ANGLEW	Angle of Well Off Plume Centerline	HYDGRAD	Hydraulic Gradient		
ANGLEW	Angle of Well Off Plume Centerline	LONDISPA	Longitudinal Dispersivity		
ANGLEW	Angle of Well Off Plume Centerline	FRORGCAR	Fraction Organic Carbon		
ANGLEW	Angle of Well Off Plume Centerline	ANGLEW	Angle of Well Off Plume Centerline		
XDIST	Longitudinal Distance to Well	AVGPDIAM	Avg. Particle Diameter		
XDIST	Longitudinal Distance to Well	POROSITY	Porosity		
XDIST	Longitudinal Distance to Well	AQUTHIK	Aquifer Thickness	Y	Y
XDIST	Longitudinal Distance to Well	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
XDIST	Longitudinal Distance to Well	HYDGRAD	Hydraulic Gradient	Y	Y
XDIST	Longitudinal Distance to Well	LONDISPA	Longitudinal Dispersivity	Y	Y
XDIST	Longitudinal Distance to Well	FRORGCAR	Fraction Organic Carbon		
XDIST	Longitudinal Distance to Well	ANGLEW	Angle of Well Off Plume Centerline		
XDIST	Longitudinal Distance to Well	XDIST	Longitudinal Distance to Well	Y	Y
YDIST	Distance from Plume Centerline to Well	AVGPDIAM	Avg. Particle Diameter		
YDIST	Distance from Plume Centerline to Well	POROSITY	Porosity		
YDIST	Distance from Plume Centerline to Well	AQUTHIK	Aquifer Thickness		
YDIST	Distance from Plume Centerline to Well	LONHYCON	Longitundinal Hydraulic Conductivity	Y	
YDIST	Distance from Plume Centerline to Well	HYDGRAD	Hydraulic Gradient		
YDIST	Distance from Plume Centerline to Well	LONDISPA	Longitudinal Dispersivity	Y	Y
YDIST	Distance from Plume Centerline to Well	FRORGCAR	Fraction Organic Carbon		
YDIST	Distance from Plume Centerline to Well	ANGLEW	Angle of Well Off Plume Centerline		
YDIST	Distance from Plume Centerline to Well	XDIST	Longitudinal Distance to Well	Y	Y
YDIST	Distance from Plume Centerline to Well	YDIST	Distance from Plume Centerline to Well	Y	Y
ZDIST	Depth of Well Below Water Table	AVGPDIAM	Avg. Particle Diameter	Y	
ZDIST	Depth of Well Below Water Table	POROSITY	Porosity		
ZDIST	Depth of Well Below Water Table	AQUTHIK	Aquifer Thickness	Y	
ZDIST	Depth of Well Below Water Table	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
ZDIST	Depth of Well Below Water Table	HYDGRAD	Hydraulic Gradient	Y	Y
ZDIST	Depth of Well Below Water Table	LONDISPA	Longitudinal Dispersivity		
ZDIST	Depth of Well Below Water Table	FRORGCAR	Fraction Organic Carbon		
ZDIST	Depth of Well Below Water Table	ANGLEW	Angle of Well Off Plume Centerline		
ZDIST	Depth of Well Below Water Table	XDIST	Longitudinal Distance to Well	Y	Y
ZDIST	Depth of Well Below Water Table	YDIST	Distance from Plume Centerline to Well		
ZDIST	Depth of Well Below Water Table	ZDIST	Depth of Well Below Water Table	Y	
FRCOEFA	Freundlich Isotherm Coefficient	AVGPDIAM	Avg. Particle Diameter		
FRCOEFA	Freundlich Isotherm Coefficient	POROSITY	Porosity		
FRCOEFA	Freundlich Isotherm Coefficient	AQUTHIK	Aquifer Thickness	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	HYDGRAD	Hydraulic Gradient	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	LONDISPA	Longitudinal Dispersivity		
FRCOEFA	Freundlich Isotherm Coefficient	FRORGCAR	Fraction Organic Carbon		
FRCOEFA	Freundlich Isotherm Coefficient	ANGLEW	Angle of Well Off Plume Centerline		
FRCOEFA	Freundlich Isotherm Coefficient	XDIST	Longitudinal Distance to Well	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	YDIST	Distance from Plume Centerline to Well	Y	Y

Table A-29. Summary of Crosspairs Analysis for Cadmium

Variable 1		Variable 2			
Code	Description	Code	Description	P<0.05	P<0.01
FRCOEFA	Freundlich Isotherm Coefficient	ZDIST	Depth of Well Below Water Table	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
WMUAREA	WMU Area	AVGPDIAM	Avg. Particle Diameter		
WMUAREA	WMU Area	POROSITY	Porosity		
WMUAREA	WMU Area	AQUTHIK	Aquifer Thickness		
WMUAREA	WMU Area	LONHYCON	Longitundinal Hydraulic Conductivity		
WMUAREA	WMU Area	HYDGRAD	Hydraulic Gradient	Y	
WMUAREA	WMU Area	LONDISPA	Longitudinal Dispersivity	Y	Y
WMUAREA	WMU Area	FRORGCAR	Fraction Organic Carbon		
WMUAREA	WMU Area	ANGLEW	Angle of Well Off Plume Centerline		
WMUAREA	WMU Area	XDIST	Longitudinal Distance to Well	Y	
WMUAREA	WMU Area	YDIST	Distance from Plume Centerline to Well	Y	Y
WMUAREA	WMU Area	ZDIST	Depth of Well Below Water Table		
WMUAREA	WMU Area	FRCOEFA	Freundlich Isotherm Coefficient		
WMUAREA	WMU Area	WMUAREA	WMU Area	Y	Y
LEACHCON	Leachate Concentration	AVGPDIAM	Avg. Particle Diameter		
LEACHCON	Leachate Concentration	POROSITY	Porosity		
LEACHCON	Leachate Concentration	AQUTHIK	Aquifer Thickness		
LEACHCON	Leachate Concentration	LONHYCON	Longitundinal Hydraulic Conductivity		
LEACHCON	Leachate Concentration	HYDGRAD	Hydraulic Gradient		
LEACHCON	Leachate Concentration	LONDISPA	Longitudinal Dispersivity		
LEACHCON	Leachate Concentration	FRORGCAR	Fraction Organic Carbon		
LEACHCON	Leachate Concentration	ANGLEW	Angle of Well Off Plume Centerline		
LEACHCON	Leachate Concentration	XDIST	Longitudinal Distance to Well		
LEACHCON	Leachate Concentration	YDIST	Distance from Plume Centerline to Well		
LEACHCON	Leachate Concentration	ZDIST	Depth of Well Below Water Table		
LEACHCON	Leachate Concentration	FRCOEFA	Freundlich Isotherm Coefficient		
LEACHCON	Leachate Concentration	WMUAREA	WMU Area		
LEACHCON	Leachate Concentration	LEACHCON	Leachate Concentration		
INFILRAT	Infiltration Rate	AVGPDIAM	Avg. Particle Diameter		
INFILRAT	Infiltration Rate	POROSITY	Porosity		
INFILRAT	Infiltration Rate	AQUTHIK	Aquifer Thickness		
INFILRAT	Infiltration Rate	LONHYCON	Longitundinal Hydraulic Conductivity		
INFILRAT	Infiltration Rate	HYDGRAD	Hydraulic Gradient		
INFILRAT	Infiltration Rate	LONDISPA	Longitudinal Dispersivity		
INFILRAT	Infiltration Rate	FRORGCAR	Fraction Organic Carbon		
INFILRAT	Infiltration Rate	ANGLEW	Angle of Well Off Plume Centerline		
INFILRAT	Infiltration Rate	XDIST	Longitudinal Distance to Well		
INFILRAT	Infiltration Rate	YDIST	Distance from Plume Centerline to Well		
INFILRAT	Infiltration Rate	ZDIST	Depth of Well Below Water Table		
INFILRAT	Infiltration Rate	FRCOEFA	Freundlich Isotherm Coefficient		
INFILRAT	Infiltration Rate	WMUAREA	WMU Area		
INFILRAT	Infiltration Rate	LEACHCON	Leachate Concentration		
INFILRAT	Infiltration Rate	INFILRAT	Infiltration Rate	Y	Y
SATHYCON	Saturated Hydraulic Conductivity	AVGPDIAM	Avg. Particle Diameter		
SATHYCON	Saturated Hydraulic Conductivity	POROSITY	Porosity		
SATHYCON	Saturated Hydraulic Conductivity	AQUTHIK	Aquifer Thickness		
SATHYCON	Saturated Hydraulic Conductivity	LONHYCON	Longitundinal Hydraulic Conductivity		
SATHYCON	Saturated Hydraulic Conductivity	HYDGRAD	Hydraulic Gradient		

Table A-29. Summary of Crosspairs Analysis for Cadmium

Variable 1		Variable 2			
Code	Description	Code	Description	P<0.05	P<0.01
SATHYCON	Saturated Hydraulic Conductivity	LONDISPA	Longitudinal Dispersivity		
SATHYCON	Saturated Hydraulic Conductivity	FRORGCAR	Fraction Organic Carbon		
SATHYCON	Saturated Hydraulic Conductivity	ANGLEW	Angle of Well Off Plume Centerline		
SATHYCON	Saturated Hydraulic Conductivity	XDIST	Longitudinal Distance to Well		
SATHYCON	Saturated Hydraulic Conductivity	YDIST	Distance from Plume Centerline to Well		
SATHYCON	Saturated Hydraulic Conductivity	ZDIST	Depth of Well Below Water Table		
SATHYCON	Saturated Hydraulic Conductivity	FRCOEFA	Freundlich Isotherm Coefficient		
SATHYCON	Saturated Hydraulic Conductivity	WMUAREA	WMU Area		
SATHYCON	Saturated Hydraulic Conductivity	LEACHCON	Leachate Concentration	Y	
SATHYCON	Saturated Hydraulic Conductivity	INFILRAT	Infiltration Rate		
SATHYCON	Saturated Hydraulic Conductivity	SATHYCON	Saturated Hydraulic Conductivity		
MOISTRPA	Moisture Rention Parameter (a)	AVGPDIAM	Avg. Particle Diameter		
MOISTRPA	Moisture Rention Parameter (a)	POROSITY	Porosity		
MOISTRPA	Moisture Rention Parameter (a)	AQUTHIK	Aquifer Thickness		
MOISTRPA	Moisture Rention Parameter (a)	LONHYCON	Longitundinal Hydraulic Conductivity		
MOISTRPA	Moisture Rention Parameter (a)	HYDGRAD	Hydraulic Gradient		
MOISTRPA	Moisture Rention Parameter (a)	LONDISPA	Longitudinal Dispersivity		
MOISTRPA	Moisture Rention Parameter (a)	FRORGCAR	Fraction Organic Carbon		
MOISTRPA	Moisture Rention Parameter (a)	ANGLEW	Angle of Well Off Plume Centerline		
MOISTRPA	Moisture Rention Parameter (a)	XDIST	Longitudinal Distance to Well		
MOISTRPA	Moisture Rention Parameter (a)	YDIST	Distance from Plume Centerline to Well		
MOISTRPA	Moisture Rention Parameter (a)	ZDIST	Depth of Well Below Water Table	Y	
MOISTRPA	Moisture Rention Parameter (a)	FRCOEFA	Freundlich Isotherm Coefficient		
MOISTRPA	Moisture Rention Parameter (a)	WMUAREA	WMU Area		
MOISTRPA	Moisture Rention Parameter (a)	LEACHCON	Leachate Concentration		
MOISTRPA	Moisture Rention Parameter (a)	INFILRAT	Infiltration Rate		
MOISTRPA	Moisture Rention Parameter (a)	SATHYCON	Saturated Hydraulic Conductivity		
MOISTRPA	Moisture Rention Parameter (a)	MOISTRPA	Moisture Rention Parameter (a)		
RESIDH2O	Residual Water Content	AVGPDIAM	Avg. Particle Diameter		
RESIDH2O	Residual Water Content	POROSITY	Porosity		
RESIDH2O	Residual Water Content	AQUTHIK	Aquifer Thickness		
RESIDH2O	Residual Water Content	LONHYCON	Longitundinal Hydraulic Conductivity		
RESIDH2O	Residual Water Content	HYDGRAD	Hydraulic Gradient		
RESIDH2O	Residual Water Content	LONDISPA	Longitudinal Dispersivity		
RESIDH2O	Residual Water Content	FRORGCAR	Fraction Organic Carbon		
RESIDH2O	Residual Water Content	ANGLEW	Angle of Well Off Plume Centerline		
RESIDH2O	Residual Water Content	XDIST	Longitudinal Distance to Well		
RESIDH2O	Residual Water Content	YDIST	Distance from Plume Centerline to Well		
RESIDH2O	Residual Water Content	ZDIST	Depth of Well Below Water Table		
RESIDH2O	Residual Water Content	FRCOEFA	Freundlich Isotherm Coefficient		
RESIDH2O	Residual Water Content	WMUAREA	WMU Area		
RESIDH2O	Residual Water Content	LEACHCON	Leachate Concentration		
RESIDH2O	Residual Water Content	INFILRAT	Infiltration Rate		
RESIDH2O	Residual Water Content	SATHYCON	Saturated Hydraulic Conductivity		
RESIDH2O	Residual Water Content	MOISTRPA	Moisture Rention Parameter (a)		
RESIDH2O	Residual Water Content	RESIDH2O	Residual Water Content		
SATURH2O	Saturated Water Content	AVGPDIAM	Avg. Particle Diameter		
SATURH2O	Saturated Water Content	POROSITY	Porosity		
SATURH2O	Saturated Water Content	AQUTHIK	Aquifer Thickness		

Table A-29. Summary of Crosspairs Analysis for Cadmium

Variable 1		Variable 2			
Code	Description	Code	Description	P<0.05	P<0.01
SATURH2O	Saturated Water Content	LONHYCON	Longitundinal Hydraulic Conductivity	Y	
SATURH2O	Saturated Water Content	HYDGRAD	Hydraulic Gradient		
SATURH2O	Saturated Water Content	LONDISPA	Longitudinal Dispersivity		
SATURH2O	Saturated Water Content	FRORGCAR	Fraction Organic Carbon		
SATURH2O	Saturated Water Content	ANGLEW	Angle of Well Off Plume Centerline		
SATURH2O	Saturated Water Content	XDIST	Longitudinal Distance to Well		
SATURH2O	Saturated Water Content	YDIST	Distance from Plume Centerline to Well		
SATURH2O	Saturated Water Content	ZDIST	Depth of Well Below Water Table		
SATURH2O	Saturated Water Content	FRCOEFA	Freundlich Isotherm Coefficient		
SATURH2O	Saturated Water Content	WMUAREA	WMU Area		
SATURH2O	Saturated Water Content	LEACHCON	Leachate Concentration		
SATURH2O	Saturated Water Content	INFILRAT	Infiltration Rate		
SATURH2O	Saturated Water Content	SATHYCON	Saturated Hydraulic Conductivity		
SATURH2O	Saturated Water Content	MOISTRPA	Moisture Rention Parameter (a)		
SATURH2O	Saturated Water Content	RESIDH2O	Residual Water Content		
SATURH2O	Saturated Water Content	SATURH2O	Saturated Water Content		
UNSATHIK	Unsaturated Zone Thickness	AVGPDIAM	Avg. Particle Diameter		
UNSATHIK	Unsaturated Zone Thickness	POROSITY	Porosity		
UNSATHIK	Unsaturated Zone Thickness	AQUTHIK	Aquifer Thickness	Y	
UNSATHIK	Unsaturated Zone Thickness	LONHYCON	Longitundinal Hydraulic Conductivity	Y	
UNSATHIK	Unsaturated Zone Thickness	HYDGRAD	Hydraulic Gradient	Y	Y
UNSATHIK	Unsaturated Zone Thickness	LONDISPA	Longitudinal Dispersivity		
UNSATHIK	Unsaturated Zone Thickness	FRORGCAR	Fraction Organic Carbon		
UNSATHIK	Unsaturated Zone Thickness	ANGLEW	Angle of Well Off Plume Centerline		
UNSATHIK	Unsaturated Zone Thickness	XDIST	Longitudinal Distance to Well	Y	Y
UNSATHIK	Unsaturated Zone Thickness	YDIST	Distance from Plume Centerline to Well	Y	Y
UNSATHIK	Unsaturated Zone Thickness	ZDIST	Depth of Well Below Water Table		
UNSATHIK	Unsaturated Zone Thickness	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
UNSATHIK	Unsaturated Zone Thickness	WMUAREA	WMU Area		
UNSATHIK	Unsaturated Zone Thickness	LEACHCON	Leachate Concentration		
UNSATHIK	Unsaturated Zone Thickness	INFILRAT	Infiltration Rate		
UNSATHIK	Unsaturated Zone Thickness	SATHYCON	Saturated Hydraulic Conductivity		
UNSATHIK	Unsaturated Zone Thickness	MOISTRPA	Moisture Rention Parameter (a)		
UNSATHIK	Unsaturated Zone Thickness	RESIDH2O	Residual Water Content		
UNSATHIK	Unsaturated Zone Thickness	SATURH2O	Saturated Water Content		
UNSATHIK	Unsaturated Zone Thickness	UNSATHIK	Unsaturated Zone Thickness	Y	Y
PERORGM	Percent Organic Matter	AVGPDIAM	Avg. Particle Diameter		
PERORGM	Percent Organic Matter	POROSITY	Porosity		
PERORGM	Percent Organic Matter	AQUTHIK	Aquifer Thickness		
PERORGM	Percent Organic Matter	LONHYCON	Longitundinal Hydraulic Conductivity		
PERORGM	Percent Organic Matter	HYDGRAD	Hydraulic Gradient		
PERORGM	Percent Organic Matter	LONDISPA	Longitudinal Dispersivity		
PERORGM	Percent Organic Matter	FRORGCAR	Fraction Organic Carbon		
PERORGM	Percent Organic Matter	ANGLEW	Angle of Well Off Plume Centerline		
PERORGM	Percent Organic Matter	XDIST	Longitudinal Distance to Well		
PERORGM	Percent Organic Matter	YDIST	Distance from Plume Centerline to Well		
PERORGM	Percent Organic Matter	ZDIST	Depth of Well Below Water Table		
PERORGM	Percent Organic Matter	FRCOEFA	Freundlich Isotherm Coefficient		
PERORGM	Percent Organic Matter	WMUAREA	WMU Area		

Table A-29. Summary of Crosspairs Analysis for Cadmium

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
PERORGM	Percent Organic Matter	LEACHCON	Leachate Concentration		
PERORGM	Percent Organic Matter	INFILRAT	Infiltration Rate		
PERORGM	Percent Organic Matter	SATHYCON	Saturated Hydraulic Conductivity		
PERORGM	Percent Organic Matter	MOISTRPA	Moisture Rention Parameter (a)		
PERORGM	Percent Organic Matter	RESIDH2O	Residual Water Content		
PERORGM	Percent Organic Matter	SATURH2O	Saturated Water Content		
PERORGM	Percent Organic Matter	UNSATHIK	Unsaturated Zone Thickness	Y	
PERORGM	Percent Organic Matter	PERORGM	Percent Organic Matter		
FRCOEFU	Freundlich Isotherm Coefficient	AVGPDIAM	Avg. Particle Diameter		
FRCOEFU	Freundlich Isotherm Coefficient	POROSITY	Porosity		
FRCOEFU	Freundlich Isotherm Coefficient	AQUTHIK	Aquifer Thickness	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	HYDGRAD	Hydraulic Gradient	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	LONDISPA	Longitudinal Dispersivity		
FRCOEFU	Freundlich Isotherm Coefficient	FRORGCAR	Fraction Organic Carbon	Y	
FRCOEFU	Freundlich Isotherm Coefficient	ANGLEW	Angle of Well Off Plume Centerline		
FRCOEFU	Freundlich Isotherm Coefficient	XDIST	Longitudinal Distance to Well	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	YDIST	Distance from Plume Centerline to Well	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	ZDIST	Depth of Well Below Water Table		
FRCOEFU	Freundlich Isotherm Coefficient	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	WMUAREA	WMU Area		
FRCOEFU	Freundlich Isotherm Coefficient	LEACHCON	Leachate Concentration		
FRCOEFU	Freundlich Isotherm Coefficient	INFILRAT	Infiltration Rate	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	SATHYCON	Saturated Hydraulic Conductivity		
FRCOEFU	Freundlich Isotherm Coefficient	MOISTRPA	Moisture Rention Parameter (a)		
FRCOEFU	Freundlich Isotherm Coefficient	RESIDH2O	Residual Water Content		
FRCOEFU	Freundlich Isotherm Coefficient	SATURH2O	Saturated Water Content		
FRCOEFU	Freundlich Isotherm Coefficient	UNSATHIK	Unsaturated Zone Thickness	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	PERORGM	Percent Organic Matter		
FRCOEFU	Freundlich Isotherm Coefficient	FRCOEFU	Freundlich Isotherm Coefficient	Y	Y

Table A-30. Ranking of Parameters According to Percentage of Risk for Cadmium

Variable Description	Reduced Sums of Square	Variable Sums of Square	Variable Degrees of Freedom	% Risk Variation	Mean Square Variable	F VALUE	P VALUE
Freundlich Isotherm Coefficient {Aquifer} (cm3/g)	13039.9	21120.28	58	808043.0%	6158.27	808.04	1.25E+00
Distance from Plume Centerline to Well (m)	15949.7	21120.28	58	517057.0%	6158.27	646.32	1.25E+00
Freundlich Isotherm Coefficient {Unsaturated} (cm3/g)	17245.8	21120.28	58	387446.0%	6158.27	387.45	1.25E+00
Longitudinal Distance to Well (m)	19204.1	21120.28	58	191616.0%	6158.27	174.20	1.25E+00
Unsaturated Zone Thickness (m)	19483.8	21120.28	58	163653.0%	6158.27	204.57	1.25E+00
WMU Area (m2)	19861.1	21120.28	58	125921.0%	6158.27	314.80	1.25E+00
Aquifer Thickness (m)	19959.3	21120.28	58	116099.0%	6158.27	165.86	1.25E+00
Consumption of Drinking Water (ml/kg-day)	20130.2	21120.28	58	99006.0%	6158.27	990.06	1.25E+00
Longitudinal Hydraulic Conductivity (m/yr)	20176.4	21120.28	58	94390.0%	6158.27	117.99	1.25E+00
Longitudinal Dispersivity {Aquifer} (m)	20623.3	21120.28	58	49702.0%	6158.27	99.40	1.25E+00
Hydraulic Gradient (m/m)	20625.5	21120.28	58	49476.0%	6158.27	61.84	1.25E+00
Infiltration Rate (m/yr)	21033.9	21120.28	58	8638.0%	6158.27	28.79	1.25E+00
Depth of Well Below Water Table (m)	21051.0	21120.28	58	6932.0%	6158.27	13.86	1.25E+00
Average Particle Diameter (cm)	21088.0	21120.28	58	3232.0%	6158.27	16.16	1.25E+00
Leachate Concentration (mg/l)	21099.0	21120.28	58	2127.0%	6158.27	21.27	1.25E+00

Constants

Full Model SS	48
Error SS	10
Error DF	0
MS Error	4941

Table A-31. Summary of Parameters Considered in Sensitivity Analysis for Nickel

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
ACIDCAT	Acid Catalyzed Hydrolysis Rate Constant	C			
ANGLEW	Angle of Well Off Plume Centerline	anglew			
ANISORAT	Anisotropy Ratio	C			
AQUTHIK	Aquifer Thickness	aquthik**-.1		Y	Y
AVGPDIAM	Avg. Particle Diameter	log(avgpdiam+.002)		Y	Y
BASECAT	Base Catalyzed Hydrolysis Rate Constant	C			
BIODRATA	Biodegradation Rate	C			
BIODRATU	Biodegradation Rate	C			
BULKDENS	Bulk Density	bulkdens**3.5	Y		
CHEMDRU	Chemical Decay Rate	C			
CHEMDRA	Chemical Decay Rate	C			
CONSH2OA	Consump of drinking water	log(consh2oa)			Y
ZDIST	Depth of Well Below Water Table	log(zdist+4)		Y	Y
DISHYD	Dissolved Hydrolysis Rate	C			
YDIST	Distance from Plume Centerline to Well	log(ydist+20)		Y	Y
DURLEACH	Duration of Leaching Period	log(durleach)	Y		
GWAVTIM	Exposure Duration	C			
FRORGCAR	Fraction Organic Carbon	log(frorgcar)		Y	
FRCOEFA	Freundlich Isotherm Coefficient	log(frcoefa+10)		Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	log(frcoefu+10)		Y	Y
FREXPA	Freundlich Isotherm Exponent	C			
FREXPU	Freundlich Isotherm Exponent	C			
GWPH	Groundwater pH	gwph	Y		
GWSEEPV	Groundwater Seepage Velocity	log(gwseepv)	Y		
GWTEMP	Groundwater Temperature	C			
HYDGRAD	Hydraulic Gradient	log(hydgrad+.0003)		Y	Y
INFILRAT	Infiltration Rate	infilrat**1.5		Y	Y
LANDEPTH	Landfill Depth	log(landepth+.0007)	Y		
LEACHCON	Leachate Concentration	C			
LFFRACT	LF Fraction	C			
LONDISPU	Longitudinal Dispersivity	log(londispu-.02)	Y		
LONDISPA	Longitudinal Dispersivity	log(londispa+.3)		Y	Y
XDIST	Longitudinal Distance to Well	log(xdist+250)		Y	Y

Table A-31. Summary of Parameters Considered in Sensitivity Analysis for Nickel

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
LONHYCON	Longitundinal Hydraulic Conductivity	log(lonhycon+10)		Y	Y
MLLA	ml/L	C			
MOISTRPA	Moisture Rention Parameter (a)	log(moistrpa-.05)	Y		
MOISTRPB	Moisture Rention Parameter (b)	moistrpb**-2.5	Y		
MOLDIFF	Molecular Diffusion Coefficient	C			
NEUTHYD	Neutral Hydrolysis Rate Constant	C			
ORGCDIS	Organic Carbon Distribution Coefficient	C			
PERORGM	Percent Organic Matter	log(perorgm)		Y	
POROSITY	Porosity	porosity**1.3		Y	
RADISTW	Radial Distance to Well	log(radistw+250)	Y		
RECHARAT	Recharge Rate	recharat	Y		
RESIDH2O	Residual Water Content	residh2o**1.7			
RETCOEF	Retardation Coefficient	log(retcoef+100)	Y		
RFDA	RfD (mg/kg/day)	C			
SATHYCON	Saturated Hydraulic Conductivity	log(sathycon)	Y		
SATURH2O	Saturated Water Content	saturh2o		Y	Y
SOILBDEN	Soil Bulk Density	soilbden	Y		
SORBHYD	Sorbed Hydrolysis Rate	C			
TRANDISP	Transverse Dispersivity	log(trandisp+.1)	Y		
UNSATHIK	Unsaturated Zone Thickness	unsathik**-.06		Y	Y
VERTDISP	Vertical Dispersivity	log(vertdisp+.001)	Y		
WASTDENS	Waste Density	C			
WASTEVOL	Waste Volume	C			
WMUAREA	WMU Area	log(wmuarea-3900)		Y	Y
WMULEN	WMU Length	log(wmulen-50)	Y		
WMUWIDTH	WMU Width	log(wmuwidth-50)	Y		

Table A-32. Summary of Correlated Parameters for Nickel

Variable 1		Variable 2		Correlation Coefficient
Code	Description	Code	Description	
AVGPDIAM	Avg. Particle Diameter	BULKDENS	Bulk Density	0.9988
LONHYCON	Longitundinal Hydraulic Conductivi	GWSEEPV	Groundwater Seepage Velocity	0.8151
FRCOEFA	Freundlich Isotherm Coefficient	RETCOEF	Retardation Coefficient	0.97262
LONDISPA	Longitudinal Dispersivity	TRANDISP	Transverse Dispersivity	0.99866
LONDISPA	Longitudinal Dispersivity	VERTDISP	Vertical Dispersivity	0.99916
RECHARAT	Recharge Rate	GWPH	Groundwater pH	-0.88331
INFILRAT	Infiltration Rate	GWPH	Groundwater pH	-0.80133
MOISTRPB	Moisture Rention Parameter (b)	GWPH	Groundwater pH	0.72897
SOILBDEN	Soil Bulk Density	GWPH	Groundwater pH	0.74946
XDIST	Longitudinal Distance to Well	RADISTW	Radial Distance to Well	0.9939
WMUAREA	WMU Area	WMULEN	WMU Length	0.99833
LANDEPTH	Landfill Depth	WMULEN	WMU Length	-0.99121
DURLEACH	Duration of Leaching Period	WMULEN	WMU Length	-0.96305
WMUAREA	WMU Area	WMUWIDTH	WMU Width	0.99833
LANDEPTH	Landfill Depth	WMUWIDTH	WMU Width	-0.99121
DURLEACH	Duration of Leaching Period	WMUWIDTH	WMU Width	-0.96305
INFILRAT	Infiltration Rate	RECHARAT	Recharge Rate	0.90405
SOILBDEN	Soil Bulk Density	RECHARAT	Recharge Rate	-0.97237
WMUAREA	WMU Area	LANDEPTH	Landfill Depth	-0.98471
WMUAREA	WMU Area	DURLEACH	Duration of Leaching Period	-0.96276
LANDEPTH	Landfill Depth	DURLEACH	Duration of Leaching Period	0.95387
RECHARAT	Recharge Rate	SATHYCON	Saturated Hydraulic Conductivity	0.71373
INFILRAT	Infiltration Rate	SATHYCON	Saturated Hydraulic Conductivity	0.80946
RECHARAT	Recharge Rate	MOISTRPA	Moisture Rention Parameter (a)	0.71619
RECHARAT	Recharge Rate	MOISTRPB	Moisture Rention Parameter (b)	-0.84728
INFILRAT	Infiltration Rate	MOISTRPB	Moisture Rention Parameter (b)	-0.76111
UNSATHIK	Unsaturated Zone Thickness	LONDISPU	Longitudinal Dispersivity	-0.99919
RECHARAT	Recharge Rate	SOILBDEN	Soil Bulk Density	-0.97237
INFILRAT	Infiltration Rate	SOILBDEN	Soil Bulk Density	-0.87769
SATHYCON	Saturated Hydraulic Conductivity	SOILBDEN	Soil Bulk Density	-0.70622
MOISTRPA	Moisture Rention Parameter (a)	SOILBDEN	Soil Bulk Density	-0.73096
MOISTRPB	Moisture Rention Parameter (b)	SOILBDEN	Soil Bulk Density	0.83355

Note: Parameters in the variable 2 column were removed from the analysis.

Table A-33. Summary of Crosspairs Analysis for Nickel

Variable 1		Variable 2			
Code	Description	Code	Description	P<0.05	P<0.01
AVGPDIAM	Avg. Particle Diameter			Y	Y
POROSITY	Porosity				
AQUTHIK	Aquifer Thickness			Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity			Y	Y
HYDGRAD	Hydraulic Gradient			Y	Y
LONDISPA	Longitudinal Dispersivity			Y	Y
FRORGCAR	Fraction Organic Carbon				
ANGLEW	Angle of Well Off Plume Centerline				
XDIST	Longitudinal Distance to Well			Y	Y
YDIST	Distance from Plume Centerline to Well			Y	Y
ZDIST	Depth of Well Below Water Table			Y	
FRCOEFA	Freundlich Isotherm Coefficient			Y	Y
WMUAREA	WMU Area			Y	Y
INFILRAT	Infiltration Rate				Y
RESIDH2O	Residual Water Content				
SATURH2O	Saturated Water Content				Y
UNSATHIK	Unsaturated Zone Thickness			Y	Y
PERORGM	Percent Organic Matter				
FRCOEFU	Freundlich Isotherm Coefficient			Y	Y
AVGPDIAM	Avg. Particle Diameter	AVGPDIAM	Avg. Particle Diameter		
POROSITY	Porosity	AVGPDIAM	Avg. Particle Diameter		
POROSITY	Porosity	POROSITY	Porosity		
AQUTHIK	Aquifer Thickness	AVGPDIAM	Avg. Particle Diameter		
AQUTHIK	Aquifer Thickness	POROSITY	Porosity		
AQUTHIK	Aquifer Thickness	AQUTHIK	Aquifer Thickness		
LONHYCON	Longitundinal Hydraulic Conductivity	AVGPDIAM	Avg. Particle Diameter		
LONHYCON	Longitundinal Hydraulic Conductivity	POROSITY	Porosity		
LONHYCON	Longitundinal Hydraulic Conductivity	AQUTHIK	Aquifer Thickness	Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
HYDGRAD	Hydraulic Gradient	AVGPDIAM	Avg. Particle Diameter		
HYDGRAD	Hydraulic Gradient	POROSITY	Porosity		
HYDGRAD	Hydraulic Gradient	AQUTHIK	Aquifer Thickness	Y	Y
HYDGRAD	Hydraulic Gradient	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
HYDGRAD	Hydraulic Gradient	HYDGRAD	Hydraulic Gradient		
LONDISPA	Longitudinal Dispersivity	AVGPDIAM	Avg. Particle Diameter		
LONDISPA	Longitudinal Dispersivity	POROSITY	Porosity		
LONDISPA	Longitudinal Dispersivity	AQUTHIK	Aquifer Thickness	Y	Y
LONDISPA	Longitudinal Dispersivity	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
LONDISPA	Longitudinal Dispersivity	HYDGRAD	Hydraulic Gradient	Y	Y
LONDISPA	Longitudinal Dispersivity	LONDISPA	Longitudinal Dispersivity		
FRORGCAR	Fraction Organic Carbon	AVGPDIAM	Avg. Particle Diameter		
FRORGCAR	Fraction Organic Carbon	POROSITY	Porosity	Y	
FRORGCAR	Fraction Organic Carbon	AQUTHIK	Aquifer Thickness		
FRORGCAR	Fraction Organic Carbon	LONHYCON	Longitundinal Hydraulic Conductivity		
FRORGCAR	Fraction Organic Carbon	HYDGRAD	Hydraulic Gradient		
FRORGCAR	Fraction Organic Carbon	LONDISPA	Longitudinal Dispersivity		
FRORGCAR	Fraction Organic Carbon	FRORGCAR	Fraction Organic Carbon		
ANGLEW	Angle of Well Off Plume Centerline	AVGPDIAM	Avg. Particle Diameter		
ANGLEW	Angle of Well Off Plume Centerline	POROSITY	Porosity		

Table A-33. Summary of Crosspairs Analysis for Nickel

Variable 1		Variable 2			
Code	Description	Code	Description	P<0.05	P<0.01
ANGLEW	Angle of Well Off Plume Centerline	AQUTHIK	Aquifer Thickness		
ANGLEW	Angle of Well Off Plume Centerline	LONHYCON	Longitundinal Hydraulic Conductivity		
ANGLEW	Angle of Well Off Plume Centerline	HYDGRAD	Hydraulic Gradient		
ANGLEW	Angle of Well Off Plume Centerline	LONDISPA	Longitudinal Dispersivity		
ANGLEW	Angle of Well Off Plume Centerline	FRORGCAR	Fraction Organic Carbon		
ANGLEW	Angle of Well Off Plume Centerline	ANGLEW	Angle of Well Off Plume Centerline		
XDIST	Longitudinal Distance to Well	AVGPDIAM	Avg. Particle Diameter		
XDIST	Longitudinal Distance to Well	POROSITY	Porosity		
XDIST	Longitudinal Distance to Well	AQUTHIK	Aquifer Thickness	Y	Y
XDIST	Longitudinal Distance to Well	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
XDIST	Longitudinal Distance to Well	HYDGRAD	Hydraulic Gradient	Y	Y
XDIST	Longitudinal Distance to Well	LONDISPA	Longitudinal Dispersivity	Y	Y
XDIST	Longitudinal Distance to Well	FRORGCAR	Fraction Organic Carbon		
XDIST	Longitudinal Distance to Well	ANGLEW	Angle of Well Off Plume Centerline		
XDIST	Longitudinal Distance to Well	XDIST	Longitudinal Distance to Well		
YDIST	Distance from Plume Centerline to Well	AVGPDIAM	Avg. Particle Diameter		
YDIST	Distance from Plume Centerline to Well	POROSITY	Porosity	Y	
YDIST	Distance from Plume Centerline to Well	AQUTHIK	Aquifer Thickness		
YDIST	Distance from Plume Centerline to Well	LONHYCON	Longitundinal Hydraulic Conductivity		
YDIST	Distance from Plume Centerline to Well	HYDGRAD	Hydraulic Gradient		
YDIST	Distance from Plume Centerline to Well	LONDISPA	Longitudinal Dispersivity		
YDIST	Distance from Plume Centerline to Well	FRORGCAR	Fraction Organic Carbon		
YDIST	Distance from Plume Centerline to Well	ANGLEW	Angle of Well Off Plume Centerline		
YDIST	Distance from Plume Centerline to Well	XDIST	Longitudinal Distance to Well	Y	Y
YDIST	Distance from Plume Centerline to Well	YDIST	Distance from Plume Centerline to Well	Y	Y
ZDIST	Depth of Well Below Water Table	AVGPDIAM	Avg. Particle Diameter		
ZDIST	Depth of Well Below Water Table	POROSITY	Porosity		
ZDIST	Depth of Well Below Water Table	AQUTHIK	Aquifer Thickness		
ZDIST	Depth of Well Below Water Table	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
ZDIST	Depth of Well Below Water Table	HYDGRAD	Hydraulic Gradient	Y	
ZDIST	Depth of Well Below Water Table	LONDISPA	Longitudinal Dispersivity		
ZDIST	Depth of Well Below Water Table	FRORGCAR	Fraction Organic Carbon		
ZDIST	Depth of Well Below Water Table	ANGLEW	Angle of Well Off Plume Centerline		
ZDIST	Depth of Well Below Water Table	XDIST	Longitudinal Distance to Well		
ZDIST	Depth of Well Below Water Table	YDIST	Distance from Plume Centerline to Well		
ZDIST	Depth of Well Below Water Table	ZDIST	Depth of Well Below Water Table		
FRCOEFA	Freundlich Isotherm Coefficient	AVGPDIAM	Avg. Particle Diameter		
FRCOEFA	Freundlich Isotherm Coefficient	POROSITY	Porosity		
FRCOEFA	Freundlich Isotherm Coefficient	AQUTHIK	Aquifer Thickness	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	HYDGRAD	Hydraulic Gradient	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	LONDISPA	Longitudinal Dispersivity	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	FRORGCAR	Fraction Organic Carbon		
FRCOEFA	Freundlich Isotherm Coefficient	ANGLEW	Angle of Well Off Plume Centerline		
FRCOEFA	Freundlich Isotherm Coefficient	XDIST	Longitudinal Distance to Well	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	YDIST	Distance from Plume Centerline to Well		
FRCOEFA	Freundlich Isotherm Coefficient	ZDIST	Depth of Well Below Water Table	Y	
FRCOEFA	Freundlich Isotherm Coefficient	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
WMUAREA	WMU Area	AVGPDIAM	Avg. Particle Diameter		

Table A-33. Summary of Crosspairs Analysis for Nickel

Variable 1		Variable 2			
Code	Description	Code	Description	P<0.05	P<0.01
WMUAREA	WMU Area	POROSITY	Porosity		
WMUAREA	WMU Area	AQUTHIK	Aquifer Thickness		
WMUAREA	WMU Area	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
WMUAREA	WMU Area	HYDGRAD	Hydraulic Gradient		
WMUAREA	WMU Area	LONDISPA	Longitudinal Dispersivity	Y	Y
WMUAREA	WMU Area	FRORGCAR	Fraction Organic Carbon		
WMUAREA	WMU Area	ANGLEW	Angle of Well Off Plume Centerline		
WMUAREA	WMU Area	XDIST	Longitudinal Distance to Well		
WMUAREA	WMU Area	YDIST	Distance from Plume Centerline to Well	Y	Y
WMUAREA	WMU Area	ZDIST	Depth of Well Below Water Table		
WMUAREA	WMU Area	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
WMUAREA	WMU Area	WMUAREA	WMU Area		
INFILRAT	Infiltration Rate	AVGPDIAM	Avg. Particle Diameter		
INFILRAT	Infiltration Rate	POROSITY	Porosity		
INFILRAT	Infiltration Rate	AQUTHIK	Aquifer Thickness		
INFILRAT	Infiltration Rate	LONHYCON	Longitundinal Hydraulic Conductivity		
INFILRAT	Infiltration Rate	HYDGRAD	Hydraulic Gradient		
INFILRAT	Infiltration Rate	LONDISPA	Longitudinal Dispersivity		
INFILRAT	Infiltration Rate	FRORGCAR	Fraction Organic Carbon		
INFILRAT	Infiltration Rate	ANGLEW	Angle of Well Off Plume Centerline		
INFILRAT	Infiltration Rate	XDIST	Longitudinal Distance to Well		
INFILRAT	Infiltration Rate	YDIST	Distance from Plume Centerline to Well		
INFILRAT	Infiltration Rate	ZDIST	Depth of Well Below Water Table		
INFILRAT	Infiltration Rate	FRCOEFA	Freundlich Isotherm Coefficient	Y	
INFILRAT	Infiltration Rate	WMUAREA	WMU Area		
INFILRAT	Infiltration Rate	INFILRAT	Infiltration Rate	Y	Y
RESIDH2O	Residual Water Content	AVGPDIAM	Avg. Particle Diameter		
RESIDH2O	Residual Water Content	POROSITY	Porosity		
RESIDH2O	Residual Water Content	AQUTHIK	Aquifer Thickness		
RESIDH2O	Residual Water Content	LONHYCON	Longitundinal Hydraulic Conductivity		
RESIDH2O	Residual Water Content	HYDGRAD	Hydraulic Gradient		
RESIDH2O	Residual Water Content	LONDISPA	Longitudinal Dispersivity		
RESIDH2O	Residual Water Content	FRORGCAR	Fraction Organic Carbon		
RESIDH2O	Residual Water Content	ANGLEW	Angle of Well Off Plume Centerline		
RESIDH2O	Residual Water Content	XDIST	Longitudinal Distance to Well		
RESIDH2O	Residual Water Content	YDIST	Distance from Plume Centerline to Well		
RESIDH2O	Residual Water Content	ZDIST	Depth of Well Below Water Table		
RESIDH2O	Residual Water Content	FRCOEFA	Freundlich Isotherm Coefficient		
RESIDH2O	Residual Water Content	WMUAREA	WMU Area		
RESIDH2O	Residual Water Content	INFILRAT	Infiltration Rate		
RESIDH2O	Residual Water Content	RESIDH2O	Residual Water Content		
SATURH2O	Saturated Water Content	AVGPDIAM	Avg. Particle Diameter		
SATURH2O	Saturated Water Content	POROSITY	Porosity		
SATURH2O	Saturated Water Content	AQUTHIK	Aquifer Thickness		
SATURH2O	Saturated Water Content	LONHYCON	Longitundinal Hydraulic Conductivity		
SATURH2O	Saturated Water Content	HYDGRAD	Hydraulic Gradient		
SATURH2O	Saturated Water Content	LONDISPA	Longitudinal Dispersivity		
SATURH2O	Saturated Water Content	FRORGCAR	Fraction Organic Carbon		
SATURH2O	Saturated Water Content	ANGLEW	Angle of Well Off Plume Centerline		

Table A-33. Summary of Crosspairs Analysis for Nickel

Variable 1		Variable 2			
Code	Description	Code	Description	P<0.05	P<0.01
SATURH2O	Saturated Water Content	XDIST	Longitudinal Distance to Well	Y	Y
SATURH2O	Saturated Water Content	YDIST	Distance from Plume Centerline to Well		
SATURH2O	Saturated Water Content	ZDIST	Depth of Well Below Water Table		
SATURH2O	Saturated Water Content	FRCOEFA	Freundlich Isotherm Coefficient		
SATURH2O	Saturated Water Content	WMUAREA	WMU Area		
SATURH2O	Saturated Water Content	INFILRAT	Infiltration Rate		
SATURH2O	Saturated Water Content	RESIDH2O	Residual Water Content		
SATURH2O	Saturated Water Content	SATURH2O	Saturated Water Content	Y	Y
UNSATHIK	Unsaturated Zone Thickness	AVGPDIAM	Avg. Particle Diameter	Y	Y
UNSATHIK	Unsaturated Zone Thickness	POROSITY	Porosity		
UNSATHIK	Unsaturated Zone Thickness	AQUTHIK	Aquifer Thickness	Y	Y
UNSATHIK	Unsaturated Zone Thickness	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
UNSATHIK	Unsaturated Zone Thickness	HYDGRAD	Hydraulic Gradient	Y	Y
UNSATHIK	Unsaturated Zone Thickness	LONDISPA	Longitudinal Dispersivity	Y	Y
UNSATHIK	Unsaturated Zone Thickness	FRORGCAR	Fraction Organic Carbon		
UNSATHIK	Unsaturated Zone Thickness	ANGLEW	Angle of Well Off Plume Centerline		
UNSATHIK	Unsaturated Zone Thickness	XDIST	Longitudinal Distance to Well	Y	Y
UNSATHIK	Unsaturated Zone Thickness	YDIST	Distance from Plume Centerline to Well		
UNSATHIK	Unsaturated Zone Thickness	ZDIST	Depth of Well Below Water Table		
UNSATHIK	Unsaturated Zone Thickness	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
UNSATHIK	Unsaturated Zone Thickness	WMUAREA	WMU Area	Y	
UNSATHIK	Unsaturated Zone Thickness	INFILRAT	Infiltration Rate		
UNSATHIK	Unsaturated Zone Thickness	RESIDH2O	Residual Water Content		
UNSATHIK	Unsaturated Zone Thickness	SATURH2O	Saturated Water Content		
UNSATHIK	Unsaturated Zone Thickness	UNSATHIK	Unsaturated Zone Thickness	Y	Y
PERORGM	Percent Organic Matter	AVGPDIAM	Avg. Particle Diameter		
PERORGM	Percent Organic Matter	POROSITY	Porosity		
PERORGM	Percent Organic Matter	AQUTHIK	Aquifer Thickness	Y	
PERORGM	Percent Organic Matter	LONHYCON	Longitundinal Hydraulic Conductivity		
PERORGM	Percent Organic Matter	HYDGRAD	Hydraulic Gradient		
PERORGM	Percent Organic Matter	LONDISPA	Longitudinal Dispersivity		
PERORGM	Percent Organic Matter	FRORGCAR	Fraction Organic Carbon		
PERORGM	Percent Organic Matter	ANGLEW	Angle of Well Off Plume Centerline		
PERORGM	Percent Organic Matter	XDIST	Longitudinal Distance to Well		
PERORGM	Percent Organic Matter	YDIST	Distance from Plume Centerline to Well	Y	
PERORGM	Percent Organic Matter	ZDIST	Depth of Well Below Water Table		
PERORGM	Percent Organic Matter	FRCOEFA	Freundlich Isotherm Coefficient		
PERORGM	Percent Organic Matter	WMUAREA	WMU Area		
PERORGM	Percent Organic Matter	INFILRAT	Infiltration Rate		
PERORGM	Percent Organic Matter	RESIDH2O	Residual Water Content		
PERORGM	Percent Organic Matter	SATURH2O	Saturated Water Content		
PERORGM	Percent Organic Matter	UNSATHIK	Unsaturated Zone Thickness		
PERORGM	Percent Organic Matter	PERORGM	Percent Organic Matter		
FRCOEFU	Freundlich Isotherm Coefficient	AVGPDIAM	Avg. Particle Diameter		
FRCOEFU	Freundlich Isotherm Coefficient	POROSITY	Porosity		
FRCOEFU	Freundlich Isotherm Coefficient	AQUTHIK	Aquifer Thickness	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	HYDGRAD	Hydraulic Gradient	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	LONDISPA	Longitudinal Dispersivity	Y	Y

Table A-33. Summary of Crosspairs Analysis for Nickel

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
FRCOEFU	Freundlich Isotherm Coefficient	FRORGCAR	Fraction Organic Carbon		
FRCOEFU	Freundlich Isotherm Coefficient	ANGLEW	Angle of Well Off Plume Centerline		
FRCOEFU	Freundlich Isotherm Coefficient	XDIST	Longitudinal Distance to Well	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	YDIST	Distance from Plume Centerline to Well	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	ZDIST	Depth of Well Below Water Table		
FRCOEFU	Freundlich Isotherm Coefficient	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	WMUAREA	WMU Area	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	INFILRAT	Infiltration Rate		
FRCOEFU	Freundlich Isotherm Coefficient	RESIDH2O	Residual Water Content		
FRCOEFU	Freundlich Isotherm Coefficient	SATURH2O	Saturated Water Content		
FRCOEFU	Freundlich Isotherm Coefficient	UNSATHIK	Unsaturated Zone Thickness	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	PERORGM	Percent Organic Matter		
FRCOEFU	Freundlich Isotherm Coefficient	FRCOEFU	Freundlich Isotherm Coefficient	Y	Y

Table A-34. Ranking of Parameters According to Percentage of Risk for Nickel

Variable Description	Reduced Sums of Square	Variable Sums of Square	Variable Degrees of Freedom	% Risk Variation	Mean Square Variable	F VALUE	P VALUE
Freundlich Isotherm Coefficient {Unsaturated} (cm3/g)	1190846.5	3142699.58	60	95185311.0%	1002947.63	177441.19	1.01E+02
Unsaturated Zone Thickness (m)	2407527.5	3142699.58	60	73517211.0%	1002947.63	73517.21	1.01E+02
Freundlich Isotherm Coefficient {Aquifer} (cm3/g)	2813217.3	3142699.58	60	32948231.0%	1002947.63	32948.23	1.01E+02
Longitudinal Distance to Well (m)	3034843.8	3142699.58	60	10785581.0%	1002947.63	10785.58	1.01E+02
Longitudinal Hydraulic Conductivity (m/yr)	3070085.3	3142699.58	60	7261433.0%	1002947.63	6601.30	1.01E+02
Longitudinal Dispersivity {Aquifer} (m)	3086931.7	3142699.58	60	5576788.0%	1002947.63	6196.43	1.01E+02
Aquifer Thickness (m)	3101220.9	3142699.58	60	4147865.0%	1002947.63	5184.83	1.01E+02
Hydraulic Gradient (m/m)	3108071.8	3142699.58	60	3462774.0%	1002947.63	4328.47	1.01E+02
Infiltration Rate (m/yr)	3110400.0	3142699.58	60	3229963.0%	1002947.63	16149.82	1.01E+02
Distance from Plume Centerline to Well (m)	3120233.5	3142699.58	60	2246610.0%	1002947.63	4493.22	1.01E+02
WMU Area (m2)	3127973.9	3142699.58	60	1472565.0%	1002947.63	2454.28	1.01E+02
Saturated Water Content	3138695.7	3142699.58	60	400386.0%	1002947.63	1334.62	1.01E+02
Average Particle Diameter (cm)	3140848.9	3142699.58	60	185064.0%	1002947.63	925.32	1.01E+02
Depth of Well Below Water Table (m)	3141345.1	3142699.58	60	135443.0%	1002947.63	677.22	1.01E+02
Consumption of Drinking Water (ml/kg-day)	3141916.9	3142699.58	60	78273.0%	1002947.63	782.73	1.01E+02

Constants

Full Model SS	49
Error SS	11
Error DF	0
MS Error	9939

Table A-35. Summary of Parameters Considered in Sensitivity Analysis for Boron

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
ACIDCAT	Acid Catalyzed Hydrolysis Rate Constant	C			
ANGLEW	Angle of Well Off Plume Centerline	anglew		Y	Y
ANISORAT	Anisotropy Ratio	C			
AQUTHIK	Aquifer Thickness	log(aquthik-0.2)		Y	Y
AVGPDIAM	Avg. Particle Diameter	log(avgpdiam+0.001)		Y	Y
BASECAT	Base Catalyzed Hydrolysis Rate Constant	C			
BIODRATA	Biodegradation Rate	C			
BIODRATU	Biodegradation Rate	C			
BULKDENS	Bulk Density	bulkdens**3.5	Y		
CHEMDRU	Chemical Decay Rate	C			
CHEMDRA	Chemical Decay Rate	C			
CONSH2OA	Consump of drinking water	log(consh2oa)			Y
ZDIST	Depth of Well Below Water Table	log(zdist+2)		Y	Y
DISHYD	Dissolved Hydrolysis Rate	C			
YDIST	Distance from Plume Centerline to Well	log(ydist+5)		Y	Y
DURLEACH	Duration of Leaching Period	log(durleach)	Y		
GWAVTIM	Exposure Duration	C			
FRORGCAR	Fraction Organic Carbon	log(frorgcar)		Y	
FRCOEFA	Freundlich Isotherm Coefficient	log(frcoefa+0.8)		Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	log(frcoefu+1)		Y	Y
FREXPA	Freundlich Isotherm Exponent	C			
FREXPU	Freundlich Isotherm Exponent	C			
GWPH	Groundwater pH	gwph	Y		
GWSEEPV	Groundwater Seepage Velocity	log(gwseepv)	Y		
GWTEMP	Groundwater Temperature	C			
HYDGRAD	Hydraulic Gradient	log(hydgrad+.0003)		Y	Y
INFILRAT	Infiltration Rate	infilrat**1.5		Y	Y
LANDEPTH	Landfill Depth	log(landepth+0.00001)	Y		
LEACHCON	Leachate Concentration	C			
LFFRACT	LF Fraction	C			
LONDISPU	Longitudinal Dispersivity	log(londispu-0.025)	Y		
LONDISPA	Longitudinal Dispersivity	log(londispa+0.3)		Y	Y
XDIST	Longitudinal Distance to Well	log(xdist+100)		Y	Y

Table A-35. Summary of Parameters Considered in Sensitivity Analysis for Boron

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
LONHYCON	Longitundinal Hydraulic Conductivity	log(lonhycon+10)		Y	Y
MLLA	ml/L	C			
MOISTRPA	Moisture Rention Parameter (a)	log(moistrpa-0.05)			
MOISTRPB	Moisture Rention Parameter (b)	log(moistrpb-1)		Y	
MOLDIFF	Molecular Diffusion Coefficient	C			
NEUTHYD	Neutral Hydrolysis Rate Constant	C			
ORGCDIS	Organic Carbon Distribution Coefficient	C			
PERORGM	Percent Organic Matter	log(perorgm)		Y	
POROSITY	Porosity	porosity**1.1		Y	Y
RADISTW	Radial Distance to Well	log(radistw+100)	Y		
RECHARAT	Recharge Rate	recharat	Y		
RESIDH2O	Residual Water Content	residh2o**1.45			
RETCOEF	Retardation Coefficient	log(retcoef-0.5)	Y		
RFDA	RfD (mg/kg/day)	C			
SATHYCON	Saturated Hydraulic Conductivity	log(sathycon)			
SATURH2O	Saturated Water Content	saturh2o		Y	
SOILBDEN	Soil Bulk Density	soilbden	Y		
SORBHYD	Sorbed Hydrolysis Rate	C			
TRANDISP	Transverse Dispersivity	log(trandisp+0.01)	Y		
UNSATHIK	Unsaturated Zone Thickness	unsathik**-0.1		Y	Y
VERTDISP	Vertical Dispersivity	log(vertdisp+0.001)	Y		
WASTDENS	Waste Density	C			
WASTEVOL	Waste Volume	C			
WMUAREA	WMU Area	log(wmuarea-3900)		Y	Y
WMULEN	WMU Length	log(wmulen-50)	Y		
WMUWIDTH	WMU Width	log(wmuwidth-50)	Y		

Table A-36. Summary of Correlated Parameters for Boron

Variable 1		Variable 2		Correlation Coefficient
Code	Description	Code	Description	
AVGPDIAM	Avg. Particle Diameter	BULKDENS	Bulk Density	0.99828
LONHYCON	Longitundinal Hydraulic Conductivi	GWSEEPV	Groundwater Seepage Velocity	0.84188
FRCOEFA	Freundlich Isotherm Coefficient	RETCOEF	Retardation Coefficient	0.88787
LONDISPA	Longitudinal Dispersivity	TRANDISP	Transverse Dispersivity	0.9991
LONDISPA	Longitudinal Dispersivity	VERTDISP	Vertical Dispersivity	0.99895
RECHARAT	Recharge Rate	GWPH	Groundwater pH	-0.898
INFILRAT	Infiltration Rate	GWPH	Groundwater pH	-0.79241
SATURH2O	Saturated Water Content	GWPH	Groundwater pH	-0.75722
SOILBDEN	Soil Bulk Density	GWPH	Groundwater pH	0.72055
XDIST	Longitudinal Distance to Well	RADISTW	Radial Distance to Well	0.99861
WMUAREA	WMU Area	WMULEN	WMU Length	0.99787
LANDEPTH	Landfill Depth	WMULEN	WMU Length	-0.99252
DURLEACH	Duration of Leaching Period	WMULEN	WMU Length	-0.96904
WMUAREA	WMU Area	WMUWIDTH	WMU Width	0.99787
LANDEPTH	Landfill Depth	WMUWIDTH	WMU Width	-0.99252
DURLEACH	Duration of Leaching Period	WMUWIDTH	WMU Width	-0.96904
INFILRAT	Infiltration Rate	RECHARAT	Recharge Rate	0.87828
MOISTRPB	Moisture Rention Parameter (b)	RECHARAT	Recharge Rate	0.73118
SOILBDEN	Soil Bulk Density	RECHARAT	Recharge Rate	-0.95214
WMUAREA	WMU Area	LANDEPTH	Landfill Depth	-0.98589
WMUAREA	WMU Area	DURLEACH	Duration of Leaching Period	-0.96478
LANDEPTH	Landfill Depth	DURLEACH	Duration of Leaching Period	0.97231
RECHARAT	Recharge Rate	MOISTRPB	Moisture Rention Parameter (b)	0.73118
UNSATHIK	Unsaturated Zone Thickness	LONDISPU	Longitudinal Dispersivity	-0.99715
RECHARAT	Recharge Rate	SOILBDEN	Soil Bulk Density	-0.95214
INFILRAT	Infiltration Rate	SOILBDEN	Soil Bulk Density	-0.83367
MOISTRPB	Moisture Rention Parameter (b)	SOILBDEN	Soil Bulk Density	-0.71306

Note: Parameters in the variable 2 column were removed from the analysis.

Table A-37. Summary of Crosspairs Analysis for Boron

Variable 1		Variable 2			
Code	Description	Code	Description	P<0.05	P<0.01
AVGPDIAM	Avg. Particle Diameter			Y	Y
POROSITY	Porosity			Y	Y
AQUTHIK	Aquifer Thickness			Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity				
HYDGRAD	Hydraulic Gradient				
LONDISPA	Longitudinal Dispersivity			Y	Y
FRORGCAR	Fraction Organic Carbon				
ANGLEW	Angle of Well Off Plume Centerline				
XDIST	Longitudinal Distance to Well			Y	Y
YDIST	Distance from Plume Centerline to Well			Y	Y
ZDIST	Depth of Well Below Water Table			Y	Y
FRCOEFA	Freundlich Isotherm Coefficient			Y	Y
WMUAREA	WMU Area			Y	Y
INFILRAT	Infiltration Rate			Y	
SATHYCON	Saturated Hydraulic Conductivity				
MOISTRPA	Moisture Rention Parameter (a)				
MOISTRPB	Moisture Rention Parameter (b)				
RESIDH2O	Residual Water Content				
SATURH2O	Saturated Water Content			Y	
UNSATHIK	Unsaturated Zone Thickness			Y	Y
PERORGM	Percent Organic Matter				
FRCOEFU	Freundlich Isotherm Coefficient			Y	Y
AVGPDIAM	Avg. Particle Diameter	AVGPDIAM	Avg. Particle Diameter		
POROSITY	Porosity	AVGPDIAM	Avg. Particle Diameter		
POROSITY	Porosity	POROSITY	Porosity	Y	
AQUTHIK	Aquifer Thickness	AVGPDIAM	Avg. Particle Diameter		
AQUTHIK	Aquifer Thickness	POROSITY	Porosity		
AQUTHIK	Aquifer Thickness	AQUTHIK	Aquifer Thickness	Y	
LONHYCON	Longitundinal Hydraulic Conductivity	AVGPDIAM	Avg. Particle Diameter	Y	
LONHYCON	Longitundinal Hydraulic Conductivity	POROSITY	Porosity		
LONHYCON	Longitundinal Hydraulic Conductivity	AQUTHIK	Aquifer Thickness	Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
HYDGRAD	Hydraulic Gradient	AVGPDIAM	Avg. Particle Diameter	Y	
HYDGRAD	Hydraulic Gradient	POROSITY	Porosity		
HYDGRAD	Hydraulic Gradient	AQUTHIK	Aquifer Thickness	Y	Y
HYDGRAD	Hydraulic Gradient	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
HYDGRAD	Hydraulic Gradient	HYDGRAD	Hydraulic Gradient	Y	Y
LONDISPA	Longitudinal Dispersivity	AVGPDIAM	Avg. Particle Diameter		
LONDISPA	Longitudinal Dispersivity	POROSITY	Porosity		
LONDISPA	Longitudinal Dispersivity	AQUTHIK	Aquifer Thickness	Y	Y
LONDISPA	Longitudinal Dispersivity	LONHYCON	Longitundinal Hydraulic Conductivity		
LONDISPA	Longitudinal Dispersivity	HYDGRAD	Hydraulic Gradient		
LONDISPA	Longitudinal Dispersivity	LONDISPA	Longitudinal Dispersivity		
FRORGCAR	Fraction Organic Carbon	AVGPDIAM	Avg. Particle Diameter		
FRORGCAR	Fraction Organic Carbon	POROSITY	Porosity	Y	
FRORGCAR	Fraction Organic Carbon	AQUTHIK	Aquifer Thickness		
FRORGCAR	Fraction Organic Carbon	LONHYCON	Longitundinal Hydraulic Conductivity		
FRORGCAR	Fraction Organic Carbon	HYDGRAD	Hydraulic Gradient		
FRORGCAR	Fraction Organic Carbon	LONDISPA	Longitudinal Dispersivity		

Table A-37. Summary of Crosspairs Analysis for Boron

Variable 1		Variable 2			
Code	Description	Code	Description	P<0.05	P<0.01
FRORGCAR	Fraction Organic Carbon	FRORGCAR	Fraction Organic Carbon		
ANGLEW	Angle of Well Off Plume Centerline	AVGPDIAM	Avg. Particle Diameter		
ANGLEW	Angle of Well Off Plume Centerline	POROSITY	Porosity		
ANGLEW	Angle of Well Off Plume Centerline	AQUTHIK	Aquifer Thickness		
ANGLEW	Angle of Well Off Plume Centerline	LONHYCON	Longitundinal Hydraulic Conductivity		
ANGLEW	Angle of Well Off Plume Centerline	HYDGRAD	Hydraulic Gradient		
ANGLEW	Angle of Well Off Plume Centerline	LONDISPA	Longitudinal Dispersivity		
ANGLEW	Angle of Well Off Plume Centerline	FRORGCAR	Fraction Organic Carbon		
ANGLEW	Angle of Well Off Plume Centerline	ANGLEW	Angle of Well Off Plume Centerline	Y	Y
XDIST	Longitudinal Distance to Well	AVGPDIAM	Avg. Particle Diameter		
XDIST	Longitudinal Distance to Well	POROSITY	Porosity		
XDIST	Longitudinal Distance to Well	AQUTHIK	Aquifer Thickness	Y	Y
XDIST	Longitudinal Distance to Well	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
XDIST	Longitudinal Distance to Well	HYDGRAD	Hydraulic Gradient	Y	Y
XDIST	Longitudinal Distance to Well	LONDISPA	Longitudinal Dispersivity	Y	
XDIST	Longitudinal Distance to Well	FRORGCAR	Fraction Organic Carbon		
XDIST	Longitudinal Distance to Well	ANGLEW	Angle of Well Off Plume Centerline		
XDIST	Longitudinal Distance to Well	XDIST	Longitudinal Distance to Well		
YDIST	Distance from Plume Centerline to Well	AVGPDIAM	Avg. Particle Diameter		
YDIST	Distance from Plume Centerline to Well	POROSITY	Porosity		
YDIST	Distance from Plume Centerline to Well	AQUTHIK	Aquifer Thickness	Y	Y
YDIST	Distance from Plume Centerline to Well	LONHYCON	Longitundinal Hydraulic Conductivity		
YDIST	Distance from Plume Centerline to Well	HYDGRAD	Hydraulic Gradient		
YDIST	Distance from Plume Centerline to Well	LONDISPA	Longitudinal Dispersivity	Y	Y
YDIST	Distance from Plume Centerline to Well	FRORGCAR	Fraction Organic Carbon		
YDIST	Distance from Plume Centerline to Well	ANGLEW	Angle of Well Off Plume Centerline		
YDIST	Distance from Plume Centerline to Well	XDIST	Longitudinal Distance to Well	Y	Y
YDIST	Distance from Plume Centerline to Well	YDIST	Distance from Plume Centerline to Well	Y	Y
ZDIST	Depth of Well Below Water Table	AVGPDIAM	Avg. Particle Diameter		
ZDIST	Depth of Well Below Water Table	POROSITY	Porosity		
ZDIST	Depth of Well Below Water Table	AQUTHIK	Aquifer Thickness	Y	
ZDIST	Depth of Well Below Water Table	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
ZDIST	Depth of Well Below Water Table	HYDGRAD	Hydraulic Gradient	Y	Y
ZDIST	Depth of Well Below Water Table	LONDISPA	Longitudinal Dispersivity	Y	Y
ZDIST	Depth of Well Below Water Table	FRORGCAR	Fraction Organic Carbon		
ZDIST	Depth of Well Below Water Table	ANGLEW	Angle of Well Off Plume Centerline		
ZDIST	Depth of Well Below Water Table	XDIST	Longitudinal Distance to Well	Y	Y
ZDIST	Depth of Well Below Water Table	YDIST	Distance from Plume Centerline to Well		
ZDIST	Depth of Well Below Water Table	ZDIST	Depth of Well Below Water Table	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	AVGPDIAM	Avg. Particle Diameter	Y	
FRCOEFA	Freundlich Isotherm Coefficient	POROSITY	Porosity		
FRCOEFA	Freundlich Isotherm Coefficient	AQUTHIK	Aquifer Thickness	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	HYDGRAD	Hydraulic Gradient	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	LONDISPA	Longitudinal Dispersivity	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	FRORGCAR	Fraction Organic Carbon		
FRCOEFA	Freundlich Isotherm Coefficient	ANGLEW	Angle of Well Off Plume Centerline		
FRCOEFA	Freundlich Isotherm Coefficient	XDIST	Longitudinal Distance to Well	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	YDIST	Distance from Plume Centerline to Well	Y	Y

Table A-37. Summary of Crosspairs Analysis for Boron

Variable 1		Variable 2			
Code	Description	Code	Description	P<0.05	P<0.01
FRCOEFA	Freundlich Isotherm Coefficient	ZDIST	Depth of Well Below Water Table		
FRCOEFA	Freundlich Isotherm Coefficient	FRCOEFA	Freundlich Isotherm Coefficient		
WMUAREA	WMU Area	AVGPDIAM	Avg. Particle Diameter		
WMUAREA	WMU Area	POROSITY	Porosity		
WMUAREA	WMU Area	AQUTHIK	Aquifer Thickness	Y	Y
WMUAREA	WMU Area	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
WMUAREA	WMU Area	HYDGRAD	Hydraulic Gradient	Y	Y
WMUAREA	WMU Area	LONDISPA	Longitudinal Dispersivity	Y	Y
WMUAREA	WMU Area	FRORGCAR	Fraction Organic Carbon		
WMUAREA	WMU Area	ANGLEW	Angle of Well Off Plume Centerline		
WMUAREA	WMU Area	XDIST	Longitudinal Distance to Well	Y	Y
WMUAREA	WMU Area	YDIST	Distance from Plume Centerline to Well	Y	Y
WMUAREA	WMU Area	ZDIST	Depth of Well Below Water Table		
WMUAREA	WMU Area	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
WMUAREA	WMU Area	WMUAREA	WMU Area	Y	Y
INFILRAT	Infiltration Rate	AVGPDIAM	Avg. Particle Diameter		
INFILRAT	Infiltration Rate	POROSITY	Porosity		
INFILRAT	Infiltration Rate	AQUTHIK	Aquifer Thickness	Y	
INFILRAT	Infiltration Rate	LONHYCON	Longitundinal Hydraulic Conductivity	Y	
INFILRAT	Infiltration Rate	HYDGRAD	Hydraulic Gradient		
INFILRAT	Infiltration Rate	LONDISPA	Longitudinal Dispersivity		
INFILRAT	Infiltration Rate	FRORGCAR	Fraction Organic Carbon		
INFILRAT	Infiltration Rate	ANGLEW	Angle of Well Off Plume Centerline		
INFILRAT	Infiltration Rate	XDIST	Longitudinal Distance to Well		
INFILRAT	Infiltration Rate	YDIST	Distance from Plume Centerline to Well		
INFILRAT	Infiltration Rate	ZDIST	Depth of Well Below Water Table		
INFILRAT	Infiltration Rate	FRCOEFA	Freundlich Isotherm Coefficient		
INFILRAT	Infiltration Rate	WMUAREA	WMU Area		
INFILRAT	Infiltration Rate	INFILRAT	Infiltration Rate	Y	Y
SATHYCON	Saturated Hydraulic Conductivity	AVGPDIAM	Avg. Particle Diameter		
SATHYCON	Saturated Hydraulic Conductivity	POROSITY	Porosity		
SATHYCON	Saturated Hydraulic Conductivity	AQUTHIK	Aquifer Thickness		
SATHYCON	Saturated Hydraulic Conductivity	LONHYCON	Longitundinal Hydraulic Conductivity		
SATHYCON	Saturated Hydraulic Conductivity	HYDGRAD	Hydraulic Gradient		
SATHYCON	Saturated Hydraulic Conductivity	LONDISPA	Longitudinal Dispersivity		
SATHYCON	Saturated Hydraulic Conductivity	FRORGCAR	Fraction Organic Carbon		
SATHYCON	Saturated Hydraulic Conductivity	ANGLEW	Angle of Well Off Plume Centerline		
SATHYCON	Saturated Hydraulic Conductivity	XDIST	Longitudinal Distance to Well		
SATHYCON	Saturated Hydraulic Conductivity	YDIST	Distance from Plume Centerline to Well		
SATHYCON	Saturated Hydraulic Conductivity	ZDIST	Depth of Well Below Water Table		
SATHYCON	Saturated Hydraulic Conductivity	FRCOEFA	Freundlich Isotherm Coefficient		
SATHYCON	Saturated Hydraulic Conductivity	WMUAREA	WMU Area		
SATHYCON	Saturated Hydraulic Conductivity	INFILRAT	Infiltration Rate		
SATHYCON	Saturated Hydraulic Conductivity	SATHYCON	Saturated Hydraulic Conductivity		
MOISTRPA	Moisture Rention Parameter (a)	AVGPDIAM	Avg. Particle Diameter		
MOISTRPA	Moisture Rention Parameter (a)	POROSITY	Porosity		
MOISTRPA	Moisture Rention Parameter (a)	AQUTHIK	Aquifer Thickness		
MOISTRPA	Moisture Rention Parameter (a)	LONHYCON	Longitundinal Hydraulic Conductivity		
MOISTRPA	Moisture Rention Parameter (a)	HYDGRAD	Hydraulic Gradient		

Table A-37. Summary of Crosspairs Analysis for Boron

Variable 1		Variable 2			
Code	Description	Code	Description	P<0.05	P<0.01
MOISTRPA	Moisture Rention Parameter (a)	LONDISPA	Longitudinal Dispersivity		
MOISTRPA	Moisture Rention Parameter (a)	FRORGCAR	Fraction Organic Carbon		
MOISTRPA	Moisture Rention Parameter (a)	ANGLEW	Angle of Well Off Plume Centerline		
MOISTRPA	Moisture Rention Parameter (a)	XDIST	Longitudinal Distance to Well		
MOISTRPA	Moisture Rention Parameter (a)	YDIST	Distance from Plume Centerline to Well		
MOISTRPA	Moisture Rention Parameter (a)	ZDIST	Depth of Well Below Water Table		
MOISTRPA	Moisture Rention Parameter (a)	FRCOEFA	Freundlich Isotherm Coefficient		
MOISTRPA	Moisture Rention Parameter (a)	WMUAREA	WMU Area		
MOISTRPA	Moisture Rention Parameter (a)	INFILRAT	Infiltration Rate		
MOISTRPA	Moisture Rention Parameter (a)	SATHYCON	Saturated Hydraulic Conductivity		
MOISTRPA	Moisture Rention Parameter (a)	MOISTRPA	Moisture Rention Parameter (a)		
MOISTRPB	Moisture Rention Parameter (b)	AVGPDIAM	Avg. Particle Diameter	Y	
MOISTRPB	Moisture Rention Parameter (b)	POROSITY	Porosity		
MOISTRPB	Moisture Rention Parameter (b)	AQUTHIK	Aquifer Thickness		
MOISTRPB	Moisture Rention Parameter (b)	LONHYCON	Longitundinal Hydraulic Conductivity		
MOISTRPB	Moisture Rention Parameter (b)	HYDGRAD	Hydraulic Gradient		
MOISTRPB	Moisture Rention Parameter (b)	LONDISPA	Longitudinal Dispersivity		
MOISTRPB	Moisture Rention Parameter (b)	FRORGCAR	Fraction Organic Carbon		
MOISTRPB	Moisture Rention Parameter (b)	ANGLEW	Angle of Well Off Plume Centerline	Y	
MOISTRPB	Moisture Rention Parameter (b)	XDIST	Longitudinal Distance to Well		
MOISTRPB	Moisture Rention Parameter (b)	YDIST	Distance from Plume Centerline to Well		
MOISTRPB	Moisture Rention Parameter (b)	ZDIST	Depth of Well Below Water Table		
MOISTRPB	Moisture Rention Parameter (b)	FRCOEFA	Freundlich Isotherm Coefficient		
MOISTRPB	Moisture Rention Parameter (b)	WMUAREA	WMU Area		
MOISTRPB	Moisture Rention Parameter (b)	INFILRAT	Infiltration Rate		
MOISTRPB	Moisture Rention Parameter (b)	SATHYCON	Saturated Hydraulic Conductivity		
MOISTRPB	Moisture Rention Parameter (b)	MOISTRPA	Moisture Rention Parameter (a)		
MOISTRPB	Moisture Rention Parameter (b)	MOISTRPB	Moisture Rention Parameter (b)		
RESIDH2O	Residual Water Content	AVGPDIAM	Avg. Particle Diameter		
RESIDH2O	Residual Water Content	POROSITY	Porosity		
RESIDH2O	Residual Water Content	AQUTHIK	Aquifer Thickness		
RESIDH2O	Residual Water Content	LONHYCON	Longitundinal Hydraulic Conductivity		
RESIDH2O	Residual Water Content	HYDGRAD	Hydraulic Gradient		
RESIDH2O	Residual Water Content	LONDISPA	Longitudinal Dispersivity		
RESIDH2O	Residual Water Content	FRORGCAR	Fraction Organic Carbon		
RESIDH2O	Residual Water Content	ANGLEW	Angle of Well Off Plume Centerline		
RESIDH2O	Residual Water Content	XDIST	Longitudinal Distance to Well		
RESIDH2O	Residual Water Content	YDIST	Distance from Plume Centerline to Well		
RESIDH2O	Residual Water Content	ZDIST	Depth of Well Below Water Table		
RESIDH2O	Residual Water Content	FRCOEFA	Freundlich Isotherm Coefficient		
RESIDH2O	Residual Water Content	WMUAREA	WMU Area		
RESIDH2O	Residual Water Content	INFILRAT	Infiltration Rate		
RESIDH2O	Residual Water Content	SATHYCON	Saturated Hydraulic Conductivity		
RESIDH2O	Residual Water Content	MOISTRPA	Moisture Rention Parameter (a)		
RESIDH2O	Residual Water Content	MOISTRPB	Moisture Rention Parameter (b)		
RESIDH2O	Residual Water Content	RESIDH2O	Residual Water Content		
SATURH2O	Saturated Water Content	AVGPDIAM	Avg. Particle Diameter		
SATURH2O	Saturated Water Content	POROSITY	Porosity		
SATURH2O	Saturated Water Content	AQUTHIK	Aquifer Thickness		

Table A-37. Summary of Crosspairs Analysis for Boron

Variable 1		Variable 2			
Code	Description	Code	Description	P<0.05	P<0.01
SATURH2O	Saturated Water Content	LONHYCON	Longitundinal Hydraulic Conductivity		
SATURH2O	Saturated Water Content	HYDGRAD	Hydraulic Gradient		
SATURH2O	Saturated Water Content	LONDISPA	Longitudinal Dispersivity	Y	
SATURH2O	Saturated Water Content	FRORGCAR	Fraction Organic Carbon		
SATURH2O	Saturated Water Content	ANGLEW	Angle of Well Off Plume Centerline		
SATURH2O	Saturated Water Content	XDIST	Longitudinal Distance to Well		
SATURH2O	Saturated Water Content	YDIST	Distance from Plume Centerline to Well		
SATURH2O	Saturated Water Content	ZDIST	Depth of Well Below Water Table		
SATURH2O	Saturated Water Content	FRCOEFA	Freundlich Isotherm Coefficient		
SATURH2O	Saturated Water Content	WMUAREA	WMU Area		
SATURH2O	Saturated Water Content	INFILRAT	Infiltration Rate		
SATURH2O	Saturated Water Content	SATHYCON	Saturated Hydraulic Conductivity		
SATURH2O	Saturated Water Content	MOISTRPA	Moisture Rention Parameter (a)		
SATURH2O	Saturated Water Content	MOISTRPB	Moisture Rention Parameter (b)	Y	
SATURH2O	Saturated Water Content	RESIDH2O	Residual Water Content		
SATURH2O	Saturated Water Content	SATURH2O	Saturated Water Content		
UNSATHIK	Unsaturated Zone Thickness	AVGPDIAM	Avg. Particle Diameter		
UNSATHIK	Unsaturated Zone Thickness	POROSITY	Porosity		
UNSATHIK	Unsaturated Zone Thickness	AQUTHIK	Aquifer Thickness	Y	Y
UNSATHIK	Unsaturated Zone Thickness	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
UNSATHIK	Unsaturated Zone Thickness	HYDGRAD	Hydraulic Gradient	Y	Y
UNSATHIK	Unsaturated Zone Thickness	LONDISPA	Longitudinal Dispersivity		
UNSATHIK	Unsaturated Zone Thickness	FRORGCAR	Fraction Organic Carbon		
UNSATHIK	Unsaturated Zone Thickness	ANGLEW	Angle of Well Off Plume Centerline		
UNSATHIK	Unsaturated Zone Thickness	XDIST	Longitudinal Distance to Well	Y	Y
UNSATHIK	Unsaturated Zone Thickness	YDIST	Distance from Plume Centerline to Well	Y	Y
UNSATHIK	Unsaturated Zone Thickness	ZDIST	Depth of Well Below Water Table		
UNSATHIK	Unsaturated Zone Thickness	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
UNSATHIK	Unsaturated Zone Thickness	WMUAREA	WMU Area	Y	Y
UNSATHIK	Unsaturated Zone Thickness	INFILRAT	Infiltration Rate		
UNSATHIK	Unsaturated Zone Thickness	SATHYCON	Saturated Hydraulic Conductivity		
UNSATHIK	Unsaturated Zone Thickness	MOISTRPA	Moisture Rention Parameter (a)		
UNSATHIK	Unsaturated Zone Thickness	MOISTRPB	Moisture Rention Parameter (b)		
UNSATHIK	Unsaturated Zone Thickness	RESIDH2O	Residual Water Content		
UNSATHIK	Unsaturated Zone Thickness	SATURH2O	Saturated Water Content		
UNSATHIK	Unsaturated Zone Thickness	UNSATHIK	Unsaturated Zone Thickness	Y	Y
PERORGM	Percent Organic Matter	AVGPDIAM	Avg. Particle Diameter		
PERORGM	Percent Organic Matter	POROSITY	Porosity		
PERORGM	Percent Organic Matter	AQUTHIK	Aquifer Thickness		
PERORGM	Percent Organic Matter	LONHYCON	Longitundinal Hydraulic Conductivity	Y	
PERORGM	Percent Organic Matter	HYDGRAD	Hydraulic Gradient		
PERORGM	Percent Organic Matter	LONDISPA	Longitudinal Dispersivity		
PERORGM	Percent Organic Matter	FRORGCAR	Fraction Organic Carbon		
PERORGM	Percent Organic Matter	ANGLEW	Angle of Well Off Plume Centerline		
PERORGM	Percent Organic Matter	XDIST	Longitudinal Distance to Well	Y	
PERORGM	Percent Organic Matter	YDIST	Distance from Plume Centerline to Well		
PERORGM	Percent Organic Matter	ZDIST	Depth of Well Below Water Table		
PERORGM	Percent Organic Matter	FRCOEFA	Freundlich Isotherm Coefficient		
PERORGM	Percent Organic Matter	WMUAREA	WMU Area		

Table A-37. Summary of Crosspairs Analysis for Boron

Variable 1		Variable 2			
Code	Description	Code	Description	P<0.05	P<0.01
PERORGM	Percent Organic Matter	INFILRAT	Infiltration Rate		
PERORGM	Percent Organic Matter	SATHYCON	Saturated Hydraulic Conductivity		
PERORGM	Percent Organic Matter	MOISTRPA	Moisture Rention Parameter (a)		
PERORGM	Percent Organic Matter	MOISTRPB	Moisture Rention Parameter (b)		
PERORGM	Percent Organic Matter	RESIDH2O	Residual Water Content		
PERORGM	Percent Organic Matter	SATURH2O	Saturated Water Content		
PERORGM	Percent Organic Matter	UNSATHIK	Unsaturated Zone Thickness		
PERORGM	Percent Organic Matter	PERORGM	Percent Organic Matter		
FRCOEFU	Freundlich Isotherm Coefficient	AVGPDIAM	Avg. Particle Diameter		
FRCOEFU	Freundlich Isotherm Coefficient	POROSITY	Porosity		
FRCOEFU	Freundlich Isotherm Coefficient	AQUTHIK	Aquifer Thickness	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	HYDGRAD	Hydraulic Gradient		
FRCOEFU	Freundlich Isotherm Coefficient	LONDISPA	Longitudinal Dispersivity		
FRCOEFU	Freundlich Isotherm Coefficient	FRORGCAR	Fraction Organic Carbon		
FRCOEFU	Freundlich Isotherm Coefficient	ANGLEW	Angle of Well Off Plume Centerline		
FRCOEFU	Freundlich Isotherm Coefficient	XDIST	Longitudinal Distance to Well		
FRCOEFU	Freundlich Isotherm Coefficient	YDIST	Distance from Plume Centerline to Well	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	ZDIST	Depth of Well Below Water Table		
FRCOEFU	Freundlich Isotherm Coefficient	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	WMUAREA	WMU Area	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	INFILRAT	Infiltration Rate		
FRCOEFU	Freundlich Isotherm Coefficient	SATHYCON	Saturated Hydraulic Conductivity		
FRCOEFU	Freundlich Isotherm Coefficient	MOISTRPA	Moisture Rention Parameter (a)		
FRCOEFU	Freundlich Isotherm Coefficient	MOISTRPB	Moisture Rention Parameter (b)		
FRCOEFU	Freundlich Isotherm Coefficient	RESIDH2O	Residual Water Content		
FRCOEFU	Freundlich Isotherm Coefficient	SATURH2O	Saturated Water Content		
FRCOEFU	Freundlich Isotherm Coefficient	UNSATHIK	Unsaturated Zone Thickness	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	PERORGM	Percent Organic Matter		
FRCOEFU	Freundlich Isotherm Coefficient	FRCOEFU	Freundlich Isotherm Coefficient	Y	Y

Table A-38. Ranking of Parameters According to Percentage of Risk for Boron

Variable Description	Reduced Sums of Square	Variable Sums of Square	Variable Degrees of Freedom	% Risk Variation	Mean Square Variable	F VALUE	P VALUE
Longitudinal Distance to Well (m)	4014.4	5344.78	65	133038.0%	1482.75	147.82	3.01E-01
Distance from Plume Centerline to Well (m)	4160.8	5344.78	65	118394.0%	1482.75	131.55	3.01E-01
Consumption of Drinking Water (ml/kg-day)	4599.6	5344.78	65	74513.0%	1482.75	745.13	3.01E-01
Freundlich Isotherm Coefficient {Aquifer} (cm3/g)	4643.3	5344.78	65	70146.0%	1482.75	70.15	3.01E-01
WMU Area (m2)	4793.6	5344.78	65	55119.0%	1482.75	50.11	3.01E-01
Longitudinal Hydraulic Conductivity (m/yr)	4950.5	5344.78	65	39431.0%	1482.75	39.43	3.01E-01
Unsaturated Zone Thickness (m)	4976.1	5344.78	65	36870.0%	1482.75	36.87	3.01E-01
Aquifer Thickness (m)	4980.4	5344.78	65	36441.0%	1482.75	36.44	3.01E-01
Hydraulic Gradient (m/m)	5086.6	5344.78	65	25820.0%	1482.75	28.69	3.01E-01
Longitudinal Dispersivity {Aquifer} (m)	5124.3	5344.78	65	22050.0%	1482.75	36.75	3.01E-01
Freundlich Isotherm Coefficient {Unsaturated} (cm3/g)	5163.3	5344.78	65	18150.0%	1482.75	22.69	3.01E-01
Depth of Well Below Water Table (m)	5320.5	5344.78	65	2429.0%	1482.75	4.05	3.01E-01
Infiltration Rate (m/yr)	5330.8	5344.78	65	1400.0%	1482.75	7.00	3.01E-01
Porosity	5337.7	5344.78	65	710.0%	1482.75	7.10	3.01E-01
Average Particle Diameter (cm)	5339.8	5344.78	65	498.0%	1482.75	4.98	3.01E-01
Angle of Well Off Plume Centerline (degrees)	5342.5	5344.78	65	227.0%	1482.75	1.14	3.01E-01

Constants

Full Model SS	56
Error SS	9
Error DF	0
MS Error	4934

Table A-39. Summary of Parameters Considered in Sensitivity Analysis for Acetonitrile

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
TIMBATHA					
INHALRTA					
SHOWTIMA					
ACIDCAT	Acid Catalyzed Hydrolysis Rate Constant	C			
ANGLEW	Angle of Well Off Plume Centerline	anglew		Y	
ANISORAT	Anisotropy Ratio	C			
AQUTHIK	Aquifer Thickness	log(aquthik+100)		Y	Y
AVGPDIAM	Avg. Particle Diameter	log(avgpdiam+0.003)		Y	
BASECAT	Base Catalyzed Hydrolysis Rate Constant	C			
BIODRATA	Biodegradation Rate	C			
BIODRATU	Biodegradation Rate	C			
BULKDENS	Bulk Density	bulkdens**3.5	Y		
CHEMDRU	Chemical Decay Rate	chemdru	Y		
CHEMDRA	Chemical Decay Rate	log(chemdra)	Y		
ZDIST	Depth of Well Below Water Table	log(zdist+70)		Y	Y
DISHYD	Dissolved Hydrolysis Rate				
YDIST	Distance from Plume Centerline to Well	log(ydist+40)		Y	Y
DURLEACH	Duration of Leaching Period	C			
GWAVTIM	Exposure Duration	C			
FRORGCAR	Fraction Organic Carbon	log(frorgcar)	Y		
FRCOEFA	Freundlich Isotherm Coefficient	log(frcoefa)		Y	
FRCOEFU	Freundlich Isotherm Coefficient	log(frcoefu)			
FREXPA	Freundlich Isotherm Exponent	C			
FREXPU	Freundlich Isotherm Exponent	C			
GWPH	Groundwater pH	gwph	Y		
GWSEEPV	Groundwater Seepage Velocity	log(gwseepv-50)		Y	Y
GWTEMP	Groundwater Temperature	C			
HYDGRAD	Hydraulic Gradient	log(hydgrad+0.03)		Y	Y
INFILRAT	Infiltration Rate	infilrat**2.3		Y	Y
LANDEPTH	Landfill Depth	C			
LEACHCON	Leachate Concentration	C			
LFFRACT	LF Fraction	C			
LONDISPA	Longitudinal Dispersivity	log(londispa+3)		Y	Y

Table A-39. Summary of Parameters Considered in Sensitivity Analysis for Acetonitrile

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
LONDISPU	Longitudinal Dispersivity	C			
XDIST	Longitudinal Distance to Well	log(xdist+250)		Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity	log(lonhycon+100000)		Y	Y
MOISTRPA	Moisture Rention Parameter (a)	log(moistrpa+3)		Y	Y
MOISTRPB	Moisture Rention Parameter (b)	log(moistrpb+7)	Y		
MOLDIFF	Molecular Diffusion Coefficient	C			
NEUTHYD	Neutral Hydrolysis Rate Constant	C			
ORGCDIS	Organic Carbon Distribution Coefficient	C			
PERORGM	Percent Organic Matter	log(perorgm)	Y		
POROSITY	Porosity	porosity**1.1		Y	Y
RADISTW	Radial Distance to Well	log(radistw+250)	Y		
RECHARAT	Recharge Rate	recharat		Y	Y
RESIDH2O	Residual Water Content	residh2o**1.5			
RETCOEF	Retardation Coefficient	log(retcoef)		Y	
SATHYCON	Saturated Hydraulic Conductivity	log(sathycon+10)		Y	Y
SATURH2O	Saturated Water Content	saturh2o	Y		
SOILBDEN	Soil Bulk Density	soilbden	Y		
SORBHYD	Sorbed Hydrolysis Rate	C			
TRANDISP	Transverse Dispersivity	log(trandisp+0.3)	Y		
UNSATHIK	Unsaturated Zone Thickness	C			
VERTDISP	Vertical Dispersivity	log(vertdisp+0.01)	Y		
WASTDENS	Waste Density	C			
WASTEVOL	Waste Volume	C			
WMUAREA	WMU Area	C			
WMULEN	WMU Length	C			
WMUWIDTH	WMU Width	C			

Table A-40. Summary of Correlated Parameters for Acetonitrile

Variable 1		Variable 2		Correlation Coefficient
Code	Description	Code	Description	
AVGPDIAM	Avg. Particle Diameter	BULKDENS	Bulk Density	0.99765
LONDISPA	Longitudinal Dispersivity	TRANDISP	Transverse Dispersivity	0.99993
LONDISPA	Longitudinal Dispersivity	VERTDISP	Vertical Dispersivity	0.99958
CHEMDRA	Chemical Decay Rate	GWPH	Groundwater pH	0.99995
RECHARAT	Recharge Rate	GWPH	Groundwater pH	-1
MOISTRPB	Moisture Rention Parameter (b)	GWPH	Groundwater pH	-0.78897
XDIST	Longitudinal Distance to Well	RADISTW	Radial Distance to Well	0.99784
RECHARAT	Recharge Rate	CHEMDRA	Chemical Decay Rate	-0.99995
MOISTRPB	Moisture Rention Parameter (b)	CHEMDRA	Chemical Decay Rate	-0.78893
SATURH2O	Saturated Water Content	CHEMDRA	Chemical Decay Rate	0.99995
SOILBDEN	Soil Bulk Density	CHEMDRA	Chemical Decay Rate	0.99995
CHEMDRU	Chemical Decay Rate	CHEMDRA	Chemical Decay Rate	0.99994
SOILBDEN	Soil Bulk Density	RECHARAT	Recharge Rate	-1
CHEMDRA	Chemical Decay Rate	MOISTRPB	Moisture Rention Parameter (b)	-0.78893
RECHARAT	Recharge Rate	MOISTRPB	Moisture Rention Parameter (b)	0.78897
SATURH2O	Saturated Water Content	MOISTRPB	Moisture Rention Parameter (b)	-0.78897
CHEMDRU	Chemical Decay Rate	MOISTRPB	Moisture Rention Parameter (b)	-0.78898
RECHARAT	Recharge Rate	SATURH2O	Saturated Water Content	-1
MOISTRPB	Moisture Rention Parameter (b)	SATURH2O	Saturated Water Content	-0.78897
CHEMDRA	Chemical Decay Rate	SOILBDEN	Soil Bulk Density	0.99995
RECHARAT	Recharge Rate	SOILBDEN	Soil Bulk Density	-1
MOISTRPB	Moisture Rention Parameter (b)	SOILBDEN	Soil Bulk Density	-0.78897
CHEMDRA	Chemical Decay Rate	CHEMDRU	Chemical Decay Rate	0.99994
RECHARAT	Recharge Rate	CHEMDRU	Chemical Decay Rate	-1
MOISTRPB	Moisture Rention Parameter (b)	CHEMDRU	Chemical Decay Rate	-0.78898

Note: Parameters in the variable 2 column were removed from the analysis.

Table A-41. Summary of Crosspairs Analysis for Acetonitrile

Variable 1		Variable 2			
Code	Description	Code	Description	P<0.05	P<0.01
AVGPDIAM	Avg. Particle Diameter				
POROSITY	Porosity				Y
AQUTHIK	Aquifer Thickness			Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity				
HYDGRAD	Hydraulic Gradient				
GWSEEPV	Groundwater Seepage Velocity				Y
RETCOEF	Retardation Coefficient				
LONDISPA	Longitudinal Dispersivity			Y	Y
ANGLEW	Angle of Well Off Plume Centerline				
XDIST	Longitudinal Distance to Well			Y	Y
YDIST	Distance from Plume Centerline to Well			Y	Y
ZDIST	Depth of Well Below Water Table			Y	Y
FRCOEFA	Freundlich Isotherm Coefficient				
RECHARAT	Recharge Rate			Y	Y
INFILRAT	Infiltration Rate			Y	Y
SATHYCON	Saturated Hydraulic Conductivity			Y	Y
MOISTRPA	Moisture Rention Parameter (a)				Y
RESIDH2O	Residual Water Content				
FRCOEFU	Freundlich Isotherm Coefficient				
AVGPDIAM	Avg. Particle Diameter	AVGPDIAM	Avg. Particle Diameter		
POROSITY	Porosity	AVGPDIAM	Avg. Particle Diameter		
POROSITY	Porosity	POROSITY	Porosity	Y	
AQUTHIK	Aquifer Thickness	AVGPDIAM	Avg. Particle Diameter		
AQUTHIK	Aquifer Thickness	POROSITY	Porosity		
AQUTHIK	Aquifer Thickness	AQUTHIK	Aquifer Thickness	Y	
LONHYCON	Longitundinal Hydraulic Conductivity	AVGPDIAM	Avg. Particle Diameter		
LONHYCON	Longitundinal Hydraulic Conductivity	POROSITY	Porosity	Y	
LONHYCON	Longitundinal Hydraulic Conductivity	AQUTHIK	Aquifer Thickness	Y	
LONHYCON	Longitundinal Hydraulic Conductivity	LONHYCON	Longitundinal Hydraulic Conductivity	Y	
HYDGRAD	Hydraulic Gradient	AVGPDIAM	Avg. Particle Diameter		
HYDGRAD	Hydraulic Gradient	POROSITY	Porosity	Y	
HYDGRAD	Hydraulic Gradient	AQUTHIK	Aquifer Thickness	Y	
HYDGRAD	Hydraulic Gradient	LONHYCON	Longitundinal Hydraulic Conductivity	Y	
HYDGRAD	Hydraulic Gradient	HYDGRAD	Hydraulic Gradient	Y	
GWSEEPV	Groundwater Seepage Velocity	AVGPDIAM	Avg. Particle Diameter		
GWSEEPV	Groundwater Seepage Velocity	POROSITY	Porosity	Y	
GWSEEPV	Groundwater Seepage Velocity	AQUTHIK	Aquifer Thickness		
GWSEEPV	Groundwater Seepage Velocity	LONHYCON	Longitundinal Hydraulic Conductivity	Y	
GWSEEPV	Groundwater Seepage Velocity	HYDGRAD	Hydraulic Gradient	Y	
GWSEEPV	Groundwater Seepage Velocity	GWSEEPV	Groundwater Seepage Velocity	Y	
RETCOEF	Retardation Coefficient	AVGPDIAM	Avg. Particle Diameter		
RETCOEF	Retardation Coefficient	POROSITY	Porosity		
RETCOEF	Retardation Coefficient	AQUTHIK	Aquifer Thickness		
RETCOEF	Retardation Coefficient	LONHYCON	Longitundinal Hydraulic Conductivity		
RETCOEF	Retardation Coefficient	HYDGRAD	Hydraulic Gradient		
RETCOEF	Retardation Coefficient	GWSEEPV	Groundwater Seepage Velocity		
RETCOEF	Retardation Coefficient	RETCOEF	Retardation Coefficient		
LONDISPA	Longitudinal Dispersivity	AVGPDIAM	Avg. Particle Diameter		
LONDISPA	Longitudinal Dispersivity	POROSITY	Porosity		

Table A-41. Summary of Crosspairs Analysis for Acetonitrile

Variable 1		Variable 2			
Code	Description	Code	Description	P<0.05	P<0.01
LONDISPA	Longitudinal Dispersivity	AQUTHIK	Aquifer Thickness	Y	
LONDISPA	Longitudinal Dispersivity	LONHYCON	Longitundinal Hydraulic Conductivity	Y	
LONDISPA	Longitudinal Dispersivity	HYDGRAD	Hydraulic Gradient	Y	
LONDISPA	Longitudinal Dispersivity	GWSEEPV	Groundwater Seepage Velocity		
LONDISPA	Longitudinal Dispersivity	RETCOEF	Retardation Coefficient		
LONDISPA	Longitudinal Dispersivity	LONDISPA	Longitudinal Dispersivity	Y	
ANGLEW	Angle of Well Off Plume Centerline	AVGPDIAM	Avg. Particle Diameter		
ANGLEW	Angle of Well Off Plume Centerline	POROSITY	Porosity		
ANGLEW	Angle of Well Off Plume Centerline	AQUTHIK	Aquifer Thickness		
ANGLEW	Angle of Well Off Plume Centerline	LONHYCON	Longitundinal Hydraulic Conductivity		
ANGLEW	Angle of Well Off Plume Centerline	HYDGRAD	Hydraulic Gradient		
ANGLEW	Angle of Well Off Plume Centerline	GWSEEPV	Groundwater Seepage Velocity		
ANGLEW	Angle of Well Off Plume Centerline	RETCOEF	Retardation Coefficient	Y	
ANGLEW	Angle of Well Off Plume Centerline	LONDISPA	Longitudinal Dispersivity		
ANGLEW	Angle of Well Off Plume Centerline	ANGLEW	Angle of Well Off Plume Centerline		
XDIST	Longitudinal Distance to Well	AVGPDIAM	Avg. Particle Diameter		
XDIST	Longitudinal Distance to Well	POROSITY	Porosity		
XDIST	Longitudinal Distance to Well	AQUTHIK	Aquifer Thickness	Y	
XDIST	Longitudinal Distance to Well	LONHYCON	Longitundinal Hydraulic Conductivity		
XDIST	Longitudinal Distance to Well	HYDGRAD	Hydraulic Gradient		
XDIST	Longitudinal Distance to Well	GWSEEPV	Groundwater Seepage Velocity		
XDIST	Longitudinal Distance to Well	RETCOEF	Retardation Coefficient		
XDIST	Longitudinal Distance to Well	LONDISPA	Longitudinal Dispersivity	Y	
XDIST	Longitudinal Distance to Well	ANGLEW	Angle of Well Off Plume Centerline		
XDIST	Longitudinal Distance to Well	XDIST	Longitudinal Distance to Well		
YDIST	Distance from Plume Centerline to Well	AVGPDIAM	Avg. Particle Diameter		
YDIST	Distance from Plume Centerline to Well	POROSITY	Porosity		
YDIST	Distance from Plume Centerline to Well	AQUTHIK	Aquifer Thickness	Y	
YDIST	Distance from Plume Centerline to Well	LONHYCON	Longitundinal Hydraulic Conductivity		
YDIST	Distance from Plume Centerline to Well	HYDGRAD	Hydraulic Gradient		
YDIST	Distance from Plume Centerline to Well	GWSEEPV	Groundwater Seepage Velocity		
YDIST	Distance from Plume Centerline to Well	RETCOEF	Retardation Coefficient	Y	
YDIST	Distance from Plume Centerline to Well	LONDISPA	Longitudinal Dispersivity	Y	
YDIST	Distance from Plume Centerline to Well	ANGLEW	Angle of Well Off Plume Centerline		
YDIST	Distance from Plume Centerline to Well	XDIST	Longitudinal Distance to Well	Y	
YDIST	Distance from Plume Centerline to Well	YDIST	Distance from Plume Centerline to Well	Y	
ZDIST	Depth of Well Below Water Table	AVGPDIAM	Avg. Particle Diameter	Y	
ZDIST	Depth of Well Below Water Table	POROSITY	Porosity		
ZDIST	Depth of Well Below Water Table	AQUTHIK	Aquifer Thickness	Y	
ZDIST	Depth of Well Below Water Table	LONHYCON	Longitundinal Hydraulic Conductivity		
ZDIST	Depth of Well Below Water Table	HYDGRAD	Hydraulic Gradient		
ZDIST	Depth of Well Below Water Table	GWSEEPV	Groundwater Seepage Velocity		
ZDIST	Depth of Well Below Water Table	RETCOEF	Retardation Coefficient		
ZDIST	Depth of Well Below Water Table	LONDISPA	Longitudinal Dispersivity	Y	
ZDIST	Depth of Well Below Water Table	ANGLEW	Angle of Well Off Plume Centerline		
ZDIST	Depth of Well Below Water Table	XDIST	Longitudinal Distance to Well	Y	
ZDIST	Depth of Well Below Water Table	YDIST	Distance from Plume Centerline to Well	Y	
ZDIST	Depth of Well Below Water Table	ZDIST	Depth of Well Below Water Table		
FRCOEFA	Freundlich Isotherm Coefficient	AVGPDIAM	Avg. Particle Diameter		

Table A-41. Summary of Crosspairs Analysis for Acetonitrile

Variable 1		Variable 2			
Code	Description	Code	Description	P<0.05	P<0.01
FRCOEFA	Freundlich Isotherm Coefficient	POROSITY	Porosity		
FRCOEFA	Freundlich Isotherm Coefficient	AQUTHIK	Aquifer Thickness		
FRCOEFA	Freundlich Isotherm Coefficient	LONHYCON	Longitundinal Hydraulic Conductivity		
FRCOEFA	Freundlich Isotherm Coefficient	HYDGRAD	Hydraulic Gradient		
FRCOEFA	Freundlich Isotherm Coefficient	GWSEEPV	Groundwater Seepage Velocity		
FRCOEFA	Freundlich Isotherm Coefficient	RETCOEF	Retardation Coefficient		
FRCOEFA	Freundlich Isotherm Coefficient	LONDISPA	Longitudinal Dispersivity		
FRCOEFA	Freundlich Isotherm Coefficient	ANGLEW	Angle of Well Off Plume Centerline		
FRCOEFA	Freundlich Isotherm Coefficient	XDIST	Longitudinal Distance to Well		
FRCOEFA	Freundlich Isotherm Coefficient	YDIST	Distance from Plume Centerline to Well		
FRCOEFA	Freundlich Isotherm Coefficient	ZDIST	Depth of Well Below Water Table		
FRCOEFA	Freundlich Isotherm Coefficient	FRCOEFA	Freundlich Isotherm Coefficient		
RECHARAT	Recharge Rate	AVGPDIAM	Avg. Particle Diameter		
RECHARAT	Recharge Rate	POROSITY	Porosity		
RECHARAT	Recharge Rate	AQUTHIK	Aquifer Thickness		
RECHARAT	Recharge Rate	LONHYCON	Longitundinal Hydraulic Conductivity		
RECHARAT	Recharge Rate	HYDGRAD	Hydraulic Gradient		
RECHARAT	Recharge Rate	GWSEEPV	Groundwater Seepage Velocity		
RECHARAT	Recharge Rate	RETCOEF	Retardation Coefficient		
RECHARAT	Recharge Rate	LONDISPA	Longitudinal Dispersivity	Y	
RECHARAT	Recharge Rate	ANGLEW	Angle of Well Off Plume Centerline		
RECHARAT	Recharge Rate	XDIST	Longitudinal Distance to Well		
RECHARAT	Recharge Rate	YDIST	Distance from Plume Centerline to Well		
RECHARAT	Recharge Rate	ZDIST	Depth of Well Below Water Table		
RECHARAT	Recharge Rate	FRCOEFA	Freundlich Isotherm Coefficient	Y	
RECHARAT	Recharge Rate	RECHARAT	Recharge Rate		
INFILRAT	Infiltration Rate	AVGPDIAM	Avg. Particle Diameter		
INFILRAT	Infiltration Rate	POROSITY	Porosity		
INFILRAT	Infiltration Rate	AQUTHIK	Aquifer Thickness	Y	
INFILRAT	Infiltration Rate	LONHYCON	Longitundinal Hydraulic Conductivity		
INFILRAT	Infiltration Rate	HYDGRAD	Hydraulic Gradient		
INFILRAT	Infiltration Rate	GWSEEPV	Groundwater Seepage Velocity		
INFILRAT	Infiltration Rate	RETCOEF	Retardation Coefficient		
INFILRAT	Infiltration Rate	LONDISPA	Longitudinal Dispersivity		
INFILRAT	Infiltration Rate	ANGLEW	Angle of Well Off Plume Centerline		
INFILRAT	Infiltration Rate	XDIST	Longitudinal Distance to Well		
INFILRAT	Infiltration Rate	YDIST	Distance from Plume Centerline to Well	Y	
INFILRAT	Infiltration Rate	ZDIST	Depth of Well Below Water Table		
INFILRAT	Infiltration Rate	FRCOEFA	Freundlich Isotherm Coefficient	Y	
INFILRAT	Infiltration Rate	RECHARAT	Recharge Rate		
INFILRAT	Infiltration Rate	INFILRAT	Infiltration Rate	Y	
SATHYCON	Saturated Hydraulic Conductivity	AVGPDIAM	Avg. Particle Diameter		
SATHYCON	Saturated Hydraulic Conductivity	POROSITY	Porosity		
SATHYCON	Saturated Hydraulic Conductivity	AQUTHIK	Aquifer Thickness	Y	
SATHYCON	Saturated Hydraulic Conductivity	LONHYCON	Longitundinal Hydraulic Conductivity		
SATHYCON	Saturated Hydraulic Conductivity	HYDGRAD	Hydraulic Gradient		
SATHYCON	Saturated Hydraulic Conductivity	GWSEEPV	Groundwater Seepage Velocity		
SATHYCON	Saturated Hydraulic Conductivity	RETCOEF	Retardation Coefficient		
SATHYCON	Saturated Hydraulic Conductivity	LONDISPA	Longitudinal Dispersivity		

Table A-41. Summary of Crosspairs Analysis for Acetonitrile

Variable 1		Variable 2			
Code	Description	Code	Description	P<0.05	P<0.01
SATHYCON	Saturated Hydraulic Conductivity	ANGLEW	Angle of Well Off Plume Centerline		
SATHYCON	Saturated Hydraulic Conductivity	XDIST	Longitudinal Distance to Well		
SATHYCON	Saturated Hydraulic Conductivity	YDIST	Distance from Plume Centerline to Well		
SATHYCON	Saturated Hydraulic Conductivity	ZDIST	Depth of Well Below Water Table		
SATHYCON	Saturated Hydraulic Conductivity	FRCOEFA	Freundlich Isotherm Coefficient		
SATHYCON	Saturated Hydraulic Conductivity	RECHARAT	Recharge Rate		
SATHYCON	Saturated Hydraulic Conductivity	INFILRAT	Infiltration Rate	Y	
SATHYCON	Saturated Hydraulic Conductivity	SATHYCON	Saturated Hydraulic Conductivity		
MOISTRPA	Moisture Rention Parameter (a)	AVGPDIAM	Avg. Particle Diameter		
MOISTRPA	Moisture Rention Parameter (a)	POROSITY	Porosity		
MOISTRPA	Moisture Rention Parameter (a)	AQUTHIK	Aquifer Thickness		
MOISTRPA	Moisture Rention Parameter (a)	LONHYCON	Longitundinal Hydraulic Conductivity		
MOISTRPA	Moisture Rention Parameter (a)	HYDGRAD	Hydraulic Gradient		
MOISTRPA	Moisture Rention Parameter (a)	GWSEEPV	Groundwater Seepage Velocity		
MOISTRPA	Moisture Rention Parameter (a)	RETCOEF	Retardation Coefficient		
MOISTRPA	Moisture Rention Parameter (a)	LONDISPA	Longitudinal Dispersivity		
MOISTRPA	Moisture Rention Parameter (a)	ANGLEW	Angle of Well Off Plume Centerline		
MOISTRPA	Moisture Rention Parameter (a)	XDIST	Longitudinal Distance to Well		
MOISTRPA	Moisture Rention Parameter (a)	YDIST	Distance from Plume Centerline to Well		
MOISTRPA	Moisture Rention Parameter (a)	ZDIST	Depth of Well Below Water Table		
MOISTRPA	Moisture Rention Parameter (a)	FRCOEFA	Freundlich Isotherm Coefficient		
MOISTRPA	Moisture Rention Parameter (a)	RECHARAT	Recharge Rate		
MOISTRPA	Moisture Rention Parameter (a)	INFILRAT	Infiltration Rate	Y	
MOISTRPA	Moisture Rention Parameter (a)	SATHYCON	Saturated Hydraulic Conductivity	Y	
MOISTRPA	Moisture Rention Parameter (a)	MOISTRPA	Moisture Rention Parameter (a)		
RESIDH2O	Residual Water Content	AVGPDIAM	Avg. Particle Diameter		
RESIDH2O	Residual Water Content	POROSITY	Porosity		
RESIDH2O	Residual Water Content	AQUTHIK	Aquifer Thickness		
RESIDH2O	Residual Water Content	LONHYCON	Longitundinal Hydraulic Conductivity		
RESIDH2O	Residual Water Content	HYDGRAD	Hydraulic Gradient		
RESIDH2O	Residual Water Content	GWSEEPV	Groundwater Seepage Velocity		
RESIDH2O	Residual Water Content	RETCOEF	Retardation Coefficient		
RESIDH2O	Residual Water Content	LONDISPA	Longitudinal Dispersivity		
RESIDH2O	Residual Water Content	ANGLEW	Angle of Well Off Plume Centerline		
RESIDH2O	Residual Water Content	XDIST	Longitudinal Distance to Well		
RESIDH2O	Residual Water Content	YDIST	Distance from Plume Centerline to Well		
RESIDH2O	Residual Water Content	ZDIST	Depth of Well Below Water Table		
RESIDH2O	Residual Water Content	FRCOEFA	Freundlich Isotherm Coefficient		
RESIDH2O	Residual Water Content	RECHARAT	Recharge Rate		
RESIDH2O	Residual Water Content	INFILRAT	Infiltration Rate		
RESIDH2O	Residual Water Content	SATHYCON	Saturated Hydraulic Conductivity		
RESIDH2O	Residual Water Content	MOISTRPA	Moisture Rention Parameter (a)		
RESIDH2O	Residual Water Content	RESIDH2O	Residual Water Content		
FRCOEFU	Freundlich Isotherm Coefficient	AVGPDIAM	Avg. Particle Diameter		
FRCOEFU	Freundlich Isotherm Coefficient	POROSITY	Porosity		
FRCOEFU	Freundlich Isotherm Coefficient	AQUTHIK	Aquifer Thickness		
FRCOEFU	Freundlich Isotherm Coefficient	LONHYCON	Longitundinal Hydraulic Conductivity		
FRCOEFU	Freundlich Isotherm Coefficient	HYDGRAD	Hydraulic Gradient		
FRCOEFU	Freundlich Isotherm Coefficient	GWSEEPV	Groundwater Seepage Velocity		

Table A-41. Summary of Crosspairs Analysis for Acetonitrile

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
FRCOEFU	Freundlich Isotherm Coefficient	RETCOEF	Retardation Coefficient		
FRCOEFU	Freundlich Isotherm Coefficient	LONDISPA	Longitudinal Dispersivity		
FRCOEFU	Freundlich Isotherm Coefficient	ANGLEW	Angle of Well Off Plume Centerline		
FRCOEFU	Freundlich Isotherm Coefficient	XDIST	Longitudinal Distance to Well		
FRCOEFU	Freundlich Isotherm Coefficient	YDIST	Distance from Plume Centerline to Well		
FRCOEFU	Freundlich Isotherm Coefficient	ZDIST	Depth of Well Below Water Table		
FRCOEFU	Freundlich Isotherm Coefficient	FRCOEFA	Freundlich Isotherm Coefficient		
FRCOEFU	Freundlich Isotherm Coefficient	RECHARAT	Recharge Rate		
FRCOEFU	Freundlich Isotherm Coefficient	INFILRAT	Infiltration Rate		
FRCOEFU	Freundlich Isotherm Coefficient	SATHYCON	Saturated Hydraulic Conductivity		
FRCOEFU	Freundlich Isotherm Coefficient	MOISTRPA	Moisture Rention Parameter (a)		
FRCOEFU	Freundlich Isotherm Coefficient	RESIDH2O	Residual Water Content		
FRCOEFU	Freundlich Isotherm Coefficient	FRCOEFU	Freundlich Isotherm Coefficient		

Table A-42. Ranking of Parameters According to Percentage of Risk for Acetonitrile

Variable Description	Reduced Sums of Square	Variable Sums of Square	Variable Degrees of Freedom	% Risk Variation	Mean Square Variable	F VALUE	P VALUE
Distance from Plume Centerline to Well (m)	955.6	2069.89	44	111424.0%	360.89	185.71	7.30E-02
Longitudinal Dispersivity {Aquifer} (m)	1530.5	2069.89	44	53938.0%	360.89	59.93	7.30E-02
Aquifer Thickness (m)	1829.7	2069.89	44	24021.0%	360.89	26.69	7.30E-02
Longitudinal Distance to Well (m)	2009.0	2069.89	44	6087.0%	360.89	12.17	7.30E-02
Infiltration Rate (m/yr)	2016.7	2069.89	44	5315.0%	360.89	13.29	7.30E-02
Hydraulic Gradient (m/m)	2017.7	2069.89	44	5221.0%	360.89	10.44	7.30E-02
Depth of Well Below Water Table (m)	2022.0	2069.89	44	4790.0%	360.89	9.58	7.30E-02
Longitudinal Hydraulic Conductivity (m/yr)	2033.7	2069.89	44	3620.0%	360.89	9.05	7.30E-02
Shower Time (min)	2042.7	2069.89	44	2720.0%	360.89	27.20	7.30E-02
Recharge Rate (m/yr)	2065.6	2069.89	44	425.0%	360.89	2.13	7.30E-02
Groundwater Seepage Velocity (m/yr)	2066.6	2069.89	44	327.0%	360.89	0.65	7.30E-02
Porosity	2067.2	2069.89	44	266.0%	360.89	0.67	7.30E-02
Saturated Hydraulic Conductivity (m/yr)	2068.5	2069.89	44	136.0%	360.89	0.45	7.30E-02
Moisture Retention Parameter a (1/m)	2069.0	2069.89	44	86.0%	360.89	0.43	7.30E-02
Time in Bathroom after Shower (min)	2069.3	2069.89	44	56.0%	360.89	0.56	7.30E-02

Constants

Full Model SS	38
Error SS	6
Error DF	0
MS Error	4955

Appendix B

Sodium Phosphate

Appendix B

Sodium Phosphate Production Sector

This appendix provides supporting data for the Sodium Phosphate Production industry sector. This industry sector considers four waste stream/waste management scenarios. The data used to model these scenarios and the sensitivity analyses conducted for them are presented in the following sections of this appendix

B.1 Filter Cake Filters Managed in Industrial Landfills
B.2 Filter Bag Wastes Managed in Industrial Landfills

Tables B1 through B-6 present the data used to characterize the filter cake waste stream and the waste management units and the site-specific data used to model this waste stream in the sodium phosphate industry sector.

Table B-1 Chemical-Specific Properties for Constituents of Concern for the Filter Cake in the $NaPO_4$ Sector

Table B-2 Distribution of Offsite Industrial D and Municipal Landfill Areas

Table B-3 Waste Stream Parameters for the Filter Cake in the $NaPO_4$ Sector

Table B-4 Site-Specific Climate-Related Parameters for Filter Cake in the $NaPO_4$ Sector

Table B-5 Aquifer Types Common Within 100-Mile Radius of Current WMU Managing Filter Cake in the $NaPO_4$ Sector

Table B-6 Soil Textures Common Within 100-Mile Radius of Current WMU Managing Filter Cake in the $NaPO_4$ Sector

Figure B-1 Distribution of landfill areas.

Table B-7 Chemical-Specific Properties for Constituents of Concern for the Filter Bag Waste in the $NaPO_4$ Sector

Table B-8 Distribution of Offsite Industrial D and Municipal Landfill Areas

Table B-9 Waste Stream Parameters for the Filter Bag Waste in the $NaPO_4$ Sector

Table B-10 Site-Specific Climate-Related Parameters for Filter Bag Waste in the $NaPO_4$ Sector

B.1 Filter Cake Managed in Industrial Landfills

Tables B-13 through B-20 present the results of the sensitivity analysis for the ammonia recycle filters waste stream managed in industrial landfills. Sensitivity analyses have been performed for the following constituents:

- Antimony
- Thallium

For each constituent, four sensitivity analysis summaries are presented:

- Summary of Parameters Considered in Sensitivity Analysis
- Summary of Correlated Parameters
- Summary of Cross Pairs Analysis
- Ranking of Parameters According to Percentage of Risk.

B.2 Filter Bag Wastes Managed in Industrial Landfills

Tables A-19 through A-34 present the results of modeling carcinogenic risks to the adult resident of the sensitivity analysis for the ammonia recycle filters waste stream managed in municipal landfills. Sensitivity analyses have been performed for the following constituents:

- Antimony

Four sensitivity analysis summaries are presented:

- Summary of Parameters Considered in Sensitivity Analysis
- Summary of Correlated Parameters
- Summary of Cross Pairs Analysis
- Ranking of Parameters According to Percentage of Risk.

Table B-21 Summary of Parameters Considered in Sensitivity Analysis for Antimony

Table B-22 Summary of Correlated Parameters for Antimony

Table B-23 Summary of Cross Pairs Analysis for Antimony

Table B-24 Ranking of Parameters According to Percentage of Risk for Antimony

Table B-1. Chemical-Specific Properties for Constituents of Concern for Filter Cake in the $NaPO_4$ Sector

	Waste Constituent Concentrations				Degradation Rates	
Constituent	TCLP (MSW landfill) (mg/L)	SPLP (Industrial D landfill) (mg/L)	Total waste (mg/kg)	Finite MSW Source Ratio (L/kg)	Overall Hydrolysis rate(1/yr)	Biodegrd. Rate(1/yr)
Antimony	*0.25*	0.0298	0.5	*2*	0	0
Thallium	*1*	0.0079	*1*	*1*	0	0

underline italics indicate values set at 1/2 of detection limit

Table B-2. Distribution of Industrial D Landfill Areas

	Area Range			
Empirical distribution	Minimum m2		Maximum m2	Relative Prob.
	4,000	to	8,090	0.100
	8,090	to	20,200	0.150
	20,200	to	60,700	0.250
	60,700	to	194,000	0.250
	194,000	to	420,000	0.150
	420,000	to	9,350,000	0.100
Total Relative Probability				1.000

Table B-3. Waste Stream Parameters for Filter Cake Waste Stream in the $NaP0_4$ Sector

WMU	Location	Landfill Area	Waste Quantity (MT/y)	Waste Density (g/cm^3)	Waste Density (kg/m^3)	Total Waste Vol (m^3)
Industrial D Landfill	Chicago, IL	Distribution	108	2	2000	1620

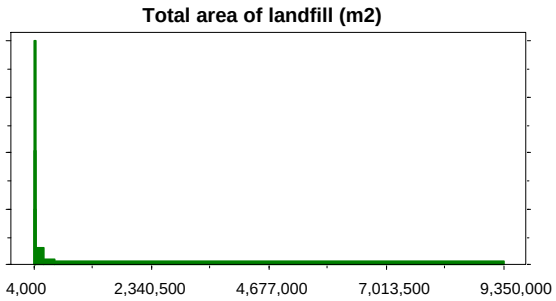

Figure B-1. Distribution of landfill areas.

Table B-4. Site-Specific Climate-Related Parameters for the Filter Cake Waste Stream in the $NaPO_4$ Sector

WMU	Location	Climate Index	Climate Center	Landfill Infiltartion Rate (m/yr)			Recharge Rate (m/yr)			GWpH			
				SCL	SLT	SNL	SCL	SLT	SNL	GW TempC	SCL	SLT	SNL
Ind D LF	Chicago, IL	42	Chicago, IL	0.06	0.08	0.11	0.06	0.08	0.11	12	6.9	6.8	6.5

Table B-5. Aquifer Types Common Within 100-Mile Radius of Current WMU Managing Filter Cake Waste in the $NaPO_4$ Sector

Aquifer Types	Aquifer Code	Chicago Il
Till over Sedimentary Rock	3	33%
Outwash	8	33%
Solution Limestone	12	33%

Table B-6. Soil Textures Common Within 100-Mile Radius of Current WMU Managing Filter Cake Waste in the $NaPO_4$ Sector

		Chicago, IL
silty clay loam	SCL	41%
silt loam	SIL	36%
sandy loam	SNL	23%

Table B-7. Chemical-Specific Properties for Constituents of Concern for Filter Bag Wastes in the $NaPO_4$ Sector

	Waste Constituent Concentrations				*Degradation Rates*	
Constituent	**TCLP (MSW landfill) (mg/L)**	**SPLP (Industrial D landfill) (mg/L)**	**Total waste (mg/kg)**	**Finite MSW Source Ratio (L/kg)**	**Overall Hydrolysis rate(1/yr)**	**Biodegrd. Rate(1/yr)**
Antimony	*0.25*	0.31	48.8	195	0	0

underline italics indicate values set at 1/2 of detection limit

Table B-8. Distribution of Industrial D Landfill Areas

Empirical distribution	**Area Range**			**Relative Prob.**
	Minimum m^2		**Maximum m^2**	
	4,000	to	8,090	0.100
	8,090	to	20,200	0.150
	20,200	to	60,700	0.250
	60,700	to	194,000	0.250
	194,000	to	420,000	0.150
	420,000	to	9,350,000	0.100
Total Relative Probability				1.000

Table B- 9. Waste Stream Parameters for Filter Bag Waste in the $NaPO_4$ Sector

WMU	**Location**	**Landfill Area**	**Waste Quantity. (MT/y)**	**Waste Density (g/cm^3)**	**Waste Density (kg/m^3)**	**Total Waste Vol (m^3)**
Industrial D Landfill	Chicago, IL	Distribution	1.35	1.4	1400	28.9
Industrial D Landfill	East St. Louis, IL	Distribution	0.05	1.4	1400	1.071
Industrial D Landfill	Augusta, GA	Distribution	0.7	1.4	1400	15

Table B-10. Site-Specific Climate-Based Parameters for the Filter Bag Wastes in the $NaPO_4$ Sector

WMU	Location	Climate Index	Climate Center	Landfill Infiltration Rate (m/yr)			Recharge Rate (m/yr)				GWpH		
				SCL	SLT	SNL	SCL	SLT	SNL	GW TempC	SCL	SLT	SNL
Industrial D Landfill	Chicago, IL	42	Chicago, IL	0.06	0.08	0.11	0.06	0.08	0.11	12	6.9	6.8	6.5
Industrial D Landfill	East St. Louis, IL	54	East St. Louis, IL	0.07	0.14	0.17	0.07	0.14	0.17	14	5.9	5.7	6.3
Industrial D Landfill	Augusta, GA	95	Atlanta, GA	0.28	0.34	0.40	0.28	0.34	0.40	19	5.3	5.1	5.2

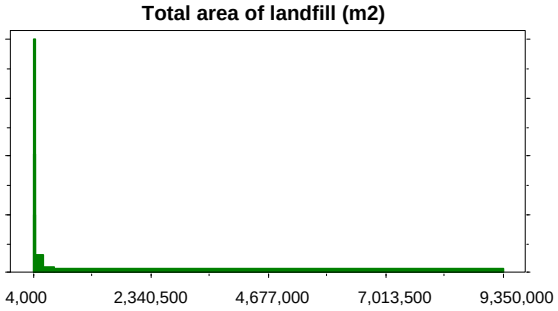

Figure B-1-1. Distribution of Landfill Areas

Table B-11. Aquifer Types Common in 100-Mile Radius of WMU Currently Managing Filter Bag Wastes in the $NaPO_4$ Sector

Aquifer Code	Chicago, Il	E. St. Louis, IL	Aug., GA
1			40%
3	33%		
4		25%	
6		12.5%	
7		12.5%	
8	33%		
9		25%	
10			60%
12	33%	25%	

Table B-12. Soil Textures Common in 100-Mile Radius of WMU Currently Managing Filter Bag Wastes in the $NaPO_4$ Sector

		Chicago, IL	E.St.L. IL	Augusta, GA
silty clay loam	SCL	41%	57%	26%
silt loam	SIL	36%	42%	37%
sandy loam	SNL	23%	1%	37%

Table B-13. Summary of Parameters Considered in Sensitivity Analysis for Antimony

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
ACIDCAT	Acid Catalyzed Hydrolysis Rate Constant	C			
ANGLEW	Angle of Well Off Plume Centerline	anglew		Y	
ANISORAT	Anisotropy Ratio	C			
AQUTHIK	Aquifer Thickness	aquthik**-.1		Y	Y
AVGPDIAM	Avg. Particle Diameter	log(avgpdiam+.004)		Y	
BASECAT	Base Catalyzed Hydrolysis Rate Constant	C			
BIODRATA	Biodegradation Rate	C			
BIODRATU	Biodegradation Rate	C			
BULKDENS	Bulk Density	bulkdens**3.5	Y		
CHEMDRU	Chemical Decay Rate	C			
CHEMDRA	Chemical Decay Rate	C			
CONSH2OA	Consump of drinking water	log(consh2oa)			Y
ZDIST	Depth of Well Below Water Table	log(zdist+4)		Y	Y
DISHYD	Dissolved Hydrolysis Rate	C			
YDIST	Distance from Plume Centerline to Well	log(ydist+20)		Y	Y
DURLEACH	Duration of Leaching Period	log(durleach)	Y		
GWAVTIM	Exposure Duration	C			
FRORGCAR	Fraction Organic Carbon	log(frorgcar)			
FRCOEFA	Freundlich Isotherm Coefficient	log(frcoefa)		Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	log(frcoefu)		Y	Y
FREXPA	Freundlich Isotherm Exponent	C			
FREXPU	Freundlich Isotherm Exponent	C			
GWPH	Groundwater pH	gwph	Y		
GWSEEPV	Groundwater Seepage Velocity	log(gwseepv)	Y		
GWTEMP	Groundwater Temperature	C			
HYDGRAD	Hydraulic Gradient	log(hydgrad+.0005)		Y	Y
INFILRAT	Infiltration Rate	infilrat**1.5		Y	Y
LANDEPTH	Landfill Depth	log(landepth+.0007)	Y		
LEACHCON	Leachate Concentration	leachcon		Y	Y
LFFRACT	LF Fraction	C			
LONDISPU	Longitudinal Dispersivity	log(londispu+.01)	Y		
LONDISPA	Longitudinal Dispersivity	log(londispa+.3)		Y	Y
XDIST	Longitudinal Distance to Well	log(xdist+250)		Y	Y

Table B-13. Summary of Parameters Considered in Sensitivity Analysis for Antimony

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
LONHYCON	Longitundinal Hydraulic Conductivity	log(lonhycon+100)		Y	Y
MLLA	ml/L	C			
MOISTRPA	Moisture Rention Parameter (a)	log(moistrpa-.05)	Y		
MOISTRPB	Moisture Rention Parameter (b)	log(moistrpb-1)	Y		
MOLDIFF	Molecular Diffusion Coefficient	C			
NEUTHYD	Neutral Hydrolysis Rate Constant	C			
ORGCDIS	Organic Carbon Distribution Coefficient	C			
PERORGM	Percent Organic Matter	log(perorgm)		Y	Y
POROSITY	Porosity	porosity**1.3		Y	
RADISTW	Radial Distance to Well	log(radistw+250)	Y		
RECHARAT	Recharge Rate	recharat	Y		
RESIDH2O	Residual Water Content	residh2o**2.1			
RETCOEF	Retardation Coefficient	log(retcoef)	Y		
RFDA	RfD (mg/kg/day)	C			
SATHYCON	Saturated Hydraulic Conductivity	log(sathycon)	Y		
SATURH2O	Saturated Water Content	saturh2o		Y	Y
SOILBDEN	Soil Bulk Density	soilbden	Y		
SORBHYD	Sorbed Hydrolysis Rate	C			
TRANDISP	Transverse Dispersivity	log(trandisp+.01)	Y		
UNSATHIK	Unsaturated Zone Thickness	unsathik**-.1		Y	Y
VERTDISP	Vertical Dispersivity	log(vertdisp+.001)	Y		
WASTDENS	Waste Density	C			
WASTEVOL	Waste Volume	C			
WMUAREA	WMU Area	log(wmuarea-3900)		Y	Y
WMULEN	WMU Length	log(wmulen-50)	Y		
WMUWIDTH	WMU Width	log(wmuwidth-50)	Y		

Table B-14. Summary of Correlated Parameters for Antimony

Variable 1		Variable 2		Correlation Coefficient
Code	Description	Code	Description	
AVGPDIAM	Avg. Particle Diameter	BULKDENS	Bulk Density	0.99625
LONHYCON	Longitundinal Hydraulic Conductivi	GWSEEPV	Groundwater Seepage Velocity	0.75583
FRCOEFA	Freundlich Isotherm Coefficient	RETCOEF	Retardation Coefficient	0.97585
LONDISPA	Longitudinal Dispersivity	TRANDISP	Transverse Dispersivity	0.99938
LONDISPA	Longitudinal Dispersivity	VERTDISP	Vertical Dispersivity	0.99941
RECHARAT	Recharge Rate	GWPH	Groundwater pH	-0.99348
INFILRAT	Infiltration Rate	GWPH	Groundwater pH	-0.99163
SATHYCON	Saturated Hydraulic Conductivity	GWPH	Groundwater pH	-0.75963
MOISTRPA	Moisture Rention Parameter (a)	GWPH	Groundwater pH	-0.80691
MOISTRPB	Moisture Rention Parameter (b)	GWPH	Groundwater pH	-0.86817
SOILBDEN	Soil Bulk Density	GWPH	Groundwater pH	0.99904
XDIST	Longitudinal Distance to Well	RADISTW	Radial Distance to Well	0.99375
WMUAREA	WMU Area	WMULEN	WMU Length	0.99849
LANDEPTH	Landfill Depth	WMULEN	WMU Length	-0.99435
DURLEACH	Duration of Leaching Period	WMULEN	WMU Length	-0.97686
WMUAREA	WMU Area	WMUWIDTH	WMU Width	0.99849
LANDEPTH	Landfill Depth	WMUWIDTH	WMU Width	-0.99435
DURLEACH	Duration of Leaching Period	WMUWIDTH	WMU Width	-0.97686
INFILRAT	Infiltration Rate	RECHARAT	Recharge Rate	0.99416
SOILBDEN	Soil Bulk Density	RECHARAT	Recharge Rate	-0.99753
WMUAREA	WMU Area	LANDEPTH	Landfill Depth	-0.99059
WMUAREA	WMU Area	DURLEACH	Duration of Leaching Period	-0.9772
LANDEPTH	Landfill Depth	DURLEACH	Duration of Leaching Period	0.97992
RECHARAT	Recharge Rate	SATHYCON	Saturated Hydraulic Conductivity	0.77134
INFILRAT	Infiltration Rate	SATHYCON	Saturated Hydraulic Conductivity	0.78104
RECHARAT	Recharge Rate	MOISTRPA	Moisture Rention Parameter (a)	0.8078
INFILRAT	Infiltration Rate	MOISTRPA	Moisture Rention Parameter (a)	0.80423
MOISTRPB	Moisture Rention Parameter (b)	MOISTRPA	Moisture Rention Parameter (a)	0.70875
RECHARAT	Recharge Rate	MOISTRPB	Moisture Rention Parameter (b)	0.88232
INFILRAT	Infiltration Rate	MOISTRPB	Moisture Rention Parameter (b)	0.87399
UNSATHIK	Unsaturated Zone Thickness	LONDISPU	Longitudinal Dispersivity	-0.97786
RECHARAT	Recharge Rate	SOILBDEN	Soil Bulk Density	-0.99753
INFILRAT	Infiltration Rate	SOILBDEN	Soil Bulk Density	-0.99414

Table B-14. Summary of Correlated Parameters for Antimony

Variable 1		Variable 2		Correlation Coefficient
Code	**Description**	**Code**	**Description**	
SATHYCON	Saturated Hydraulic Conductivity	SOILBDEN	Soil Bulk Density	-0.76532
MOISTRPA	Moisture Rention Parameter (a)	SOILBDEN	Soil Bulk Density	-0.8085
MOISTRPB	Moisture Rention Parameter (b)	SOILBDEN	Soil Bulk Density	-0.87496

Note: Parameters in the variable 2 column were removed from the analysis.

Table B-15. Summary of Crosspairs Analysis for Antimony

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
AVGPDIAM	Avg. Particle Diameter				
POROSITY	Porosity				
AQUTHIK	Aquifer Thickness			Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity			Y	Y
HYDGRAD	Hydraulic Gradient			Y	Y
LONDISPA	Longitudinal Dispersivity			Y	Y
FRORGCAR	Fraction Organic Carbon				
ANGLEW	Angle of Well Off Plume Centerline				
XDIST	Longitudinal Distance to Well			Y	Y
YDIST	Distance from Plume Centerline to Well			Y	Y
ZDIST	Depth of Well Below Water Table				
FRCOEFA	Freundlich Isotherm Coefficient			Y	Y
WMUAREA	WMU Area				
LEACHCON	Leachate Concentration			Y	Y
INFILRAT	Infiltration Rate			Y	Y
RESIDH2O	Residual Water Content				
SATURH2O	Saturated Water Content			Y	Y
UNSATHIK	Unsaturated Zone Thickness			Y	Y
PERORGM	Percent Organic Matter				
FRCOEFU	Freundlich Isotherm Coefficient			Y	Y
AVGPDIAM	Avg. Particle Diameter	AVGPDIAM	Avg. Particle Diameter		
POROSITY	Porosity	AVGPDIAM	Avg. Particle Diameter		
POROSITY	Porosity	POROSITY	Porosity		
AQUTHIK	Aquifer Thickness	AVGPDIAM	Avg. Particle Diameter		
AQUTHIK	Aquifer Thickness	POROSITY	Porosity		
AQUTHIK	Aquifer Thickness	AQUTHIK	Aquifer Thickness		
LONHYCON	Longitundinal Hydraulic Conductivity	AVGPDIAM	Avg. Particle Diameter		
LONHYCON	Longitundinal Hydraulic Conductivity	POROSITY	Porosity		
LONHYCON	Longitundinal Hydraulic Conductivity	AQUTHIK	Aquifer Thickness	Y	
LONHYCON	Longitundinal Hydraulic Conductivity	LONHYCON	Longitundinal Hydraulic Conductivity	Y	
HYDGRAD	Hydraulic Gradient	AVGPDIAM	Avg. Particle Diameter		
HYDGRAD	Hydraulic Gradient	POROSITY	Porosity		
HYDGRAD	Hydraulic Gradient	AQUTHIK	Aquifer Thickness	Y	
HYDGRAD	Hydraulic Gradient	LONHYCON	Longitundinal Hydraulic Conductivity	Y	
HYDGRAD	Hydraulic Gradient	HYDGRAD	Hydraulic Gradient		
LONDISPA	Longitudinal Dispersivity	AVGPDIAM	Avg. Particle Diameter		
LONDISPA	Longitudinal Dispersivity	POROSITY	Porosity		
LONDISPA	Longitudinal Dispersivity	AQUTHIK	Aquifer Thickness	Y	
LONDISPA	Longitudinal Dispersivity	LONHYCON	Longitundinal Hydraulic Conductivity	Y	
LONDISPA	Longitudinal Dispersivity	HYDGRAD	Hydraulic Gradient	Y	
LONDISPA	Longitudinal Dispersivity	LONDISPA	Longitudinal Dispersivity	Y	
FRORGCAR	Fraction Organic Carbon	AVGPDIAM	Avg. Particle Diameter		
FRORGCAR	Fraction Organic Carbon	POROSITY	Porosity		
FRORGCAR	Fraction Organic Carbon	AQUTHIK	Aquifer Thickness		
FRORGCAR	Fraction Organic Carbon	LONHYCON	Longitundinal Hydraulic Conductivity		
FRORGCAR	Fraction Organic Carbon	HYDGRAD	Hydraulic Gradient		
FRORGCAR	Fraction Organic Carbon	LONDISPA	Longitudinal Dispersivity		
FRORGCAR	Fraction Organic Carbon	FRORGCAR	Fraction Organic Carbon		
ANGLEW	Angle of Well Off Plume Centerline	AVGPDIAM	Avg. Particle Diameter	Y	

Table B-15. Summary of Crosspairs Analysis for Antimony

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
ANGLEW	Angle of Well Off Plume Centerline	POROSITY	Porosity	Y	
ANGLEW	Angle of Well Off Plume Centerline	AQUTHIK	Aquifer Thickness	Y	
ANGLEW	Angle of Well Off Plume Centerline	LONHYCON	Longitundinal Hydraulic Conductivity		
ANGLEW	Angle of Well Off Plume Centerline	HYDGRAD	Hydraulic Gradient		
ANGLEW	Angle of Well Off Plume Centerline	LONDISPA	Longitudinal Dispersivity		
ANGLEW	Angle of Well Off Plume Centerline	FRORGCAR	Fraction Organic Carbon		
ANGLEW	Angle of Well Off Plume Centerline	ANGLEW	Angle of Well Off Plume Centerline		
XDIST	Longitudinal Distance to Well	AVGPDIAM	Avg. Particle Diameter		
XDIST	Longitudinal Distance to Well	POROSITY	Porosity		
XDIST	Longitudinal Distance to Well	AQUTHIK	Aquifer Thickness	Y	
XDIST	Longitudinal Distance to Well	LONHYCON	Longitundinal Hydraulic Conductivity	Y	
XDIST	Longitudinal Distance to Well	HYDGRAD	Hydraulic Gradient	Y	
XDIST	Longitudinal Distance to Well	LONDISPA	Longitudinal Dispersivity	Y	
XDIST	Longitudinal Distance to Well	FRORGCAR	Fraction Organic Carbon		
XDIST	Longitudinal Distance to Well	ANGLEW	Angle of Well Off Plume Centerline		
XDIST	Longitudinal Distance to Well	XDIST	Longitudinal Distance to Well		
YDIST	Distance from Plume Centerline to Well	AVGPDIAM	Avg. Particle Diameter		
YDIST	Distance from Plume Centerline to Well	POROSITY	Porosity		
YDIST	Distance from Plume Centerline to Well	AQUTHIK	Aquifer Thickness		
YDIST	Distance from Plume Centerline to Well	LONHYCON	Longitundinal Hydraulic Conductivity		
YDIST	Distance from Plume Centerline to Well	HYDGRAD	Hydraulic Gradient		
YDIST	Distance from Plume Centerline to Well	LONDISPA	Longitudinal Dispersivity	Y	
YDIST	Distance from Plume Centerline to Well	FRORGCAR	Fraction Organic Carbon		
YDIST	Distance from Plume Centerline to Well	ANGLEW	Angle of Well Off Plume Centerline		
YDIST	Distance from Plume Centerline to Well	XDIST	Longitudinal Distance to Well		
YDIST	Distance from Plume Centerline to Well	YDIST	Distance from Plume Centerline to Well	Y	
ZDIST	Depth of Well Below Water Table	AVGPDIAM	Avg. Particle Diameter		
ZDIST	Depth of Well Below Water Table	POROSITY	Porosity		
ZDIST	Depth of Well Below Water Table	AQUTHIK	Aquifer Thickness	Y	
ZDIST	Depth of Well Below Water Table	LONHYCON	Longitundinal Hydraulic Conductivity	Y	
ZDIST	Depth of Well Below Water Table	HYDGRAD	Hydraulic Gradient	Y	
ZDIST	Depth of Well Below Water Table	LONDISPA	Longitudinal Dispersivity		
ZDIST	Depth of Well Below Water Table	FRORGCAR	Fraction Organic Carbon		
ZDIST	Depth of Well Below Water Table	ANGLEW	Angle of Well Off Plume Centerline		
ZDIST	Depth of Well Below Water Table	XDIST	Longitudinal Distance to Well	Y	
ZDIST	Depth of Well Below Water Table	YDIST	Distance from Plume Centerline to Well		
ZDIST	Depth of Well Below Water Table	ZDIST	Depth of Well Below Water Table		
FRCOEFA	Freundlich Isotherm Coefficient	AVGPDIAM	Avg. Particle Diameter	Y	
FRCOEFA	Freundlich Isotherm Coefficient	POROSITY	Porosity		
FRCOEFA	Freundlich Isotherm Coefficient	AQUTHIK	Aquifer Thickness		
FRCOEFA	Freundlich Isotherm Coefficient	LONHYCON	Longitundinal Hydraulic Conductivity	Y	
FRCOEFA	Freundlich Isotherm Coefficient	HYDGRAD	Hydraulic Gradient	Y	
FRCOEFA	Freundlich Isotherm Coefficient	LONDISPA	Longitudinal Dispersivity	Y	
FRCOEFA	Freundlich Isotherm Coefficient	FRORGCAR	Fraction Organic Carbon		
FRCOEFA	Freundlich Isotherm Coefficient	ANGLEW	Angle of Well Off Plume Centerline		
FRCOEFA	Freundlich Isotherm Coefficient	XDIST	Longitudinal Distance to Well	Y	
FRCOEFA	Freundlich Isotherm Coefficient	YDIST	Distance from Plume Centerline to Well		
FRCOEFA	Freundlich Isotherm Coefficient	ZDIST	Depth of Well Below Water Table	Y	
FRCOEFA	Freundlich Isotherm Coefficient	FRCOEFA	Freundlich Isotherm Coefficient	Y	

Table B-15. Summary of Crosspairs Analysis for Antimony

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
WMUAREA	WMU Area	AVGPDIAM	Avg. Particle Diameter		
WMUAREA	WMU Area	POROSITY	Porosity		
WMUAREA	WMU Area	AQUTHIK	Aquifer Thickness		
WMUAREA	WMU Area	LONHYCON	Longitundinal Hydraulic Conductivity		
WMUAREA	WMU Area	HYDGRAD	Hydraulic Gradient		
WMUAREA	WMU Area	LONDISPA	Longitudinal Dispersivity	Y	
WMUAREA	WMU Area	FRORGCAR	Fraction Organic Carbon		
WMUAREA	WMU Area	ANGLEW	Angle of Well Off Plume Centerline		
WMUAREA	WMU Area	XDIST	Longitudinal Distance to Well		
WMUAREA	WMU Area	YDIST	Distance from Plume Centerline to Well	Y	
WMUAREA	WMU Area	ZDIST	Depth of Well Below Water Table		
WMUAREA	WMU Area	FRCOEFA	Freundlich Isotherm Coefficient		
WMUAREA	WMU Area	WMUAREA	WMU Area	Y	
LEACHCON	Leachate Concentration	AVGPDIAM	Avg. Particle Diameter		
LEACHCON	Leachate Concentration	POROSITY	Porosity		
LEACHCON	Leachate Concentration	AQUTHIK	Aquifer Thickness		
LEACHCON	Leachate Concentration	LONHYCON	Longitundinal Hydraulic Conductivity		
LEACHCON	Leachate Concentration	HYDGRAD	Hydraulic Gradient		
LEACHCON	Leachate Concentration	LONDISPA	Longitudinal Dispersivity		
LEACHCON	Leachate Concentration	FRORGCAR	Fraction Organic Carbon		
LEACHCON	Leachate Concentration	ANGLEW	Angle of Well Off Plume Centerline		
LEACHCON	Leachate Concentration	XDIST	Longitudinal Distance to Well		
LEACHCON	Leachate Concentration	YDIST	Distance from Plume Centerline to Well		
LEACHCON	Leachate Concentration	ZDIST	Depth of Well Below Water Table		
LEACHCON	Leachate Concentration	FRCOEFA	Freundlich Isotherm Coefficient		
LEACHCON	Leachate Concentration	WMUAREA	WMU Area		
LEACHCON	Leachate Concentration	LEACHCON	Leachate Concentration		
INFILRAT	Infiltration Rate	AVGPDIAM	Avg. Particle Diameter		
INFILRAT	Infiltration Rate	POROSITY	Porosity		
INFILRAT	Infiltration Rate	AQUTHIK	Aquifer Thickness		
INFILRAT	Infiltration Rate	LONHYCON	Longitundinal Hydraulic Conductivity		
INFILRAT	Infiltration Rate	HYDGRAD	Hydraulic Gradient		
INFILRAT	Infiltration Rate	LONDISPA	Longitudinal Dispersivity		
INFILRAT	Infiltration Rate	FRORGCAR	Fraction Organic Carbon		
INFILRAT	Infiltration Rate	ANGLEW	Angle of Well Off Plume Centerline		
INFILRAT	Infiltration Rate	XDIST	Longitudinal Distance to Well		
INFILRAT	Infiltration Rate	YDIST	Distance from Plume Centerline to Well		
INFILRAT	Infiltration Rate	ZDIST	Depth of Well Below Water Table		
INFILRAT	Infiltration Rate	FRCOEFA	Freundlich Isotherm Coefficient		
INFILRAT	Infiltration Rate	WMUAREA	WMU Area		
INFILRAT	Infiltration Rate	LEACHCON	Leachate Concentration		
INFILRAT	Infiltration Rate	INFILRAT	Infiltration Rate	Y	
RESIDH2O	Residual Water Content	AVGPDIAM	Avg. Particle Diameter		
RESIDH2O	Residual Water Content	POROSITY	Porosity		
RESIDH2O	Residual Water Content	AQUTHIK	Aquifer Thickness		
RESIDH2O	Residual Water Content	LONHYCON	Longitundinal Hydraulic Conductivity		
RESIDH2O	Residual Water Content	HYDGRAD	Hydraulic Gradient		
RESIDH2O	Residual Water Content	LONDISPA	Longitudinal Dispersivity		
RESIDH2O	Residual Water Content	FRORGCAR	Fraction Organic Carbon		

Table B-15. Summary of Crosspairs Analysis for Antimony

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
RESIDH2O	Residual Water Content	ANGLEW	Angle of Well Off Plume Centerline		
RESIDH2O	Residual Water Content	XDIST	Longitudinal Distance to Well		
RESIDH2O	Residual Water Content	YDIST	Distance from Plume Centerline to Well		
RESIDH2O	Residual Water Content	ZDIST	Depth of Well Below Water Table		
RESIDH2O	Residual Water Content	FRCOEFA	Freundlich Isotherm Coefficient		
RESIDH2O	Residual Water Content	WMUAREA	WMU Area		
RESIDH2O	Residual Water Content	LEACHCON	Leachate Concentration		
RESIDH2O	Residual Water Content	INFILRAT	Infiltration Rate		
RESIDH2O	Residual Water Content	RESIDH2O	Residual Water Content		
SATURH2O	Saturated Water Content	AVGPDIAM	Avg. Particle Diameter		
SATURH2O	Saturated Water Content	POROSITY	Porosity		
SATURH2O	Saturated Water Content	AQUTHIK	Aquifer Thickness		
SATURH2O	Saturated Water Content	LONHYCON	Longitundinal Hydraulic Conductivity		
SATURH2O	Saturated Water Content	HYDGRAD	Hydraulic Gradient		
SATURH2O	Saturated Water Content	LONDISPA	Longitudinal Dispersivity		
SATURH2O	Saturated Water Content	FRORGCAR	Fraction Organic Carbon		
SATURH2O	Saturated Water Content	ANGLEW	Angle of Well Off Plume Centerline		
SATURH2O	Saturated Water Content	XDIST	Longitudinal Distance to Well		
SATURH2O	Saturated Water Content	YDIST	Distance from Plume Centerline to Well		
SATURH2O	Saturated Water Content	ZDIST	Depth of Well Below Water Table		
SATURH2O	Saturated Water Content	FRCOEFA	Freundlich Isotherm Coefficient		
SATURH2O	Saturated Water Content	WMUAREA	WMU Area		
SATURH2O	Saturated Water Content	LEACHCON	Leachate Concentration		
SATURH2O	Saturated Water Content	INFILRAT	Infiltration Rate		
SATURH2O	Saturated Water Content	RESIDH2O	Residual Water Content		
SATURH2O	Saturated Water Content	SATURH2O	Saturated Water Content	Y	
UNSATHIK	Unsaturated Zone Thickness	AVGPDIAM	Avg. Particle Diameter		
UNSATHIK	Unsaturated Zone Thickness	POROSITY	Porosity		
UNSATHIK	Unsaturated Zone Thickness	AQUTHIK	Aquifer Thickness		
UNSATHIK	Unsaturated Zone Thickness	LONHYCON	Longitundinal Hydraulic Conductivity		
UNSATHIK	Unsaturated Zone Thickness	HYDGRAD	Hydraulic Gradient		
UNSATHIK	Unsaturated Zone Thickness	LONDISPA	Longitudinal Dispersivity		
UNSATHIK	Unsaturated Zone Thickness	FRORGCAR	Fraction Organic Carbon		
UNSATHIK	Unsaturated Zone Thickness	ANGLEW	Angle of Well Off Plume Centerline		
UNSATHIK	Unsaturated Zone Thickness	XDIST	Longitudinal Distance to Well		
UNSATHIK	Unsaturated Zone Thickness	YDIST	Distance from Plume Centerline to Well		
UNSATHIK	Unsaturated Zone Thickness	ZDIST	Depth of Well Below Water Table		
UNSATHIK	Unsaturated Zone Thickness	FRCOEFA	Freundlich Isotherm Coefficient		
UNSATHIK	Unsaturated Zone Thickness	WMUAREA	WMU Area		
UNSATHIK	Unsaturated Zone Thickness	LEACHCON	Leachate Concentration		
UNSATHIK	Unsaturated Zone Thickness	INFILRAT	Infiltration Rate		
UNSATHIK	Unsaturated Zone Thickness	RESIDH2O	Residual Water Content		
UNSATHIK	Unsaturated Zone Thickness	SATURH2O	Saturated Water Content		
UNSATHIK	Unsaturated Zone Thickness	UNSATHIK	Unsaturated Zone Thickness	Y	
PERORGM	Percent Organic Matter	AVGPDIAM	Avg. Particle Diameter		
PERORGM	Percent Organic Matter	POROSITY	Porosity		
PERORGM	Percent Organic Matter	AQUTHIK	Aquifer Thickness		
PERORGM	Percent Organic Matter	LONHYCON	Longitundinal Hydraulic Conductivity		
PERORGM	Percent Organic Matter	HYDGRAD	Hydraulic Gradient		

Table B-15. Summary of Crosspairs Analysis for Antimony

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
PERORGM	Percent Organic Matter	LONDISPA	Longitudinal Dispersivity		
PERORGM	Percent Organic Matter	FRORGCAR	Fraction Organic Carbon		
PERORGM	Percent Organic Matter	ANGLEW	Angle of Well Off Plume Centerline		
PERORGM	Percent Organic Matter	XDIST	Longitudinal Distance to Well		
PERORGM	Percent Organic Matter	YDIST	Distance from Plume Centerline to Well		
PERORGM	Percent Organic Matter	ZDIST	Depth of Well Below Water Table		
PERORGM	Percent Organic Matter	FRCOEFA	Freundlich Isotherm Coefficient		
PERORGM	Percent Organic Matter	WMUAREA	WMU Area		
PERORGM	Percent Organic Matter	LEACHCON	Leachate Concentration		
PERORGM	Percent Organic Matter	INFILRAT	Infiltration Rate		
PERORGM	Percent Organic Matter	RESIDH2O	Residual Water Content		
PERORGM	Percent Organic Matter	SATURH2O	Saturated Water Content		
PERORGM	Percent Organic Matter	UNSATHIK	Unsaturated Zone Thickness		
PERORGM	Percent Organic Matter	PERORGM	Percent Organic Matter	Y	
FRCOEFU	Freundlich Isotherm Coefficient	AVGPDIAM	Avg. Particle Diameter		
FRCOEFU	Freundlich Isotherm Coefficient	POROSITY	Porosity		
FRCOEFU	Freundlich Isotherm Coefficient	AQUTHIK	Aquifer Thickness	Y	
FRCOEFU	Freundlich Isotherm Coefficient	LONHYCON	Longitundinal Hydraulic Conductivity		
FRCOEFU	Freundlich Isotherm Coefficient	HYDGRAD	Hydraulic Gradient		
FRCOEFU	Freundlich Isotherm Coefficient	LONDISPA	Longitudinal Dispersivity		
FRCOEFU	Freundlich Isotherm Coefficient	FRORGCAR	Fraction Organic Carbon		
FRCOEFU	Freundlich Isotherm Coefficient	ANGLEW	Angle of Well Off Plume Centerline		
FRCOEFU	Freundlich Isotherm Coefficient	XDIST	Longitudinal Distance to Well	Y	
FRCOEFU	Freundlich Isotherm Coefficient	YDIST	Distance from Plume Centerline to Well		
FRCOEFU	Freundlich Isotherm Coefficient	ZDIST	Depth of Well Below Water Table		
FRCOEFU	Freundlich Isotherm Coefficient	FRCOEFA	Freundlich Isotherm Coefficient	Y	
FRCOEFU	Freundlich Isotherm Coefficient	WMUAREA	WMU Area	Y	
FRCOEFU	Freundlich Isotherm Coefficient	LEACHCON	Leachate Concentration		
FRCOEFU	Freundlich Isotherm Coefficient	INFILRAT	Infiltration Rate	Y	
FRCOEFU	Freundlich Isotherm Coefficient	RESIDH2O	Residual Water Content		
FRCOEFU	Freundlich Isotherm Coefficient	SATURH2O	Saturated Water Content	Y	
FRCOEFU	Freundlich Isotherm Coefficient	UNSATHIK	Unsaturated Zone Thickness	Y	
FRCOEFU	Freundlich Isotherm Coefficient	PERORGM	Percent Organic Matter	Y	
FRCOEFU	Freundlich Isotherm Coefficient	FRCOEFU	Freundlich Isotherm Coefficient	Y	

Table B-16. Ranking of Parameters According to Percentage of Risk for Antimony

Variable Description	Reduced Sums of Square	Variable Sums of Square	Variable Degrees of Freedom	% Risk Variation	Mean Square Variable	F VALUE	P VALUE
Freundlich Isotherm Coefficient {Unsaturated} (cm3/g)	426035.2	1262307.36	52	33627215.0%	437009.06	83627.21	4.39E+01
Unsaturated Zone Thickness (m)	981818.3	1262307.36	52	28048910.0%	437009.06	93496.37	4.39E+01
Freundlich Isotherm Coefficient {Aquifer} (cm3/g)	1201426.6	1262307.36	52	6088081.0%	437009.06	7610.10	4.39E+01
Longitudinal Hydraulic Conductivity (m/yr)	1234618.6	1262307.36	52	2768872.0%	437009.06	3461.09	4.39E+01
Longitudinal Distance to Well (m)	1244115.7	1262307.36	52	1819167.0%	437009.06	2598.81	4.39E+01
Infiltration Rate (m/yr)	1244609.5	1262307.36	52	1769790.0%	437009.06	5899.30	4.39E+01
Hydraulic Gradient (m/m)	1245154.1	1262307.36	52	1715331.0%	437009.06	2450.47	4.39E+01
Distance from Plume Centerline to Well (m)	1248527.7	1262307.36	52	1377967.0%	437009.06	3444.92	4.39E+01
Aquifer Thickness (m)	1251074.1	1262307.36	52	1123325.0%	437009.06	1872.21	4.39E+01
Longitudinal Dispersivity {Aquifer} (m)	1253841.1	1262307.36	52	846621.0%	437009.06	1058.28	4.39E+01
WMU Area (m2)	1258052.9	1262307.36	52	425448.0%	437009.06	850.90	4.39E+01
Consumption of Drinking Water (ml/kg-day)	1259491.3	1262307.36	52	281608.0%	437009.06	2816.08	4.39E+01
Depth of Well Below Water Table (m)	1260434.8	1262307.36	52	187257.0%	437009.06	374.51	4.39E+01
Saturated Water Content	1261686.7	1262307.36	52	62064.0%	437009.06	310.32	4.39E+01
Leachate Concentration (mg/L)	1261803.5	1262307.36	52	50386.0%	437009.06	503.86	4.39E+01
Percent Organic Matter	1261954.4	1262307.36	52	35299.0%	437009.06	176.50	4.39E+01

Constants

Full Model SS	42
Error SS	10
Error DF	0
MS Error	9947

Table B-17. Summary of Parameters Considered in Sensitivity Analysis for Thallium

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
ACIDCAT	Acid Catalyzed Hydrolysis Rate Constant	C			
ANGLEW	Angle of Well Off Plume Centerline	anglew		Y	
ANISORAT	Anisotropy Ratio	C			
AQUTHIK	Aquifer Thickness	aquthik**-.21		Y	Y
AVGPDIAM	Avg. Particle Diameter	log(avgpdiam+.004)		Y	Y
BASECAT	Base Catalyzed Hydrolysis Rate Constant	C			
BIODRATA	Biodegradation Rate	C			
BIODRATU	Biodegradation Rate	C			
BULKDENS	Bulk Density	bulkdens**3.5	Y		
CHEMDRU	Chemical Decay Rate	C			
CHEMDRA	Chemical Decay Rate	C			
CONSH2OA	Consump of drinking water	log(consh2oa)			Y
ZDIST	Depth of Well Below Water Table	log(zdist+4)		Y	Y
DISHYD	Dissolved Hydrolysis Rate	C			
YDIST	Distance from Plume Centerline to Well	log(ydist+20)		Y	Y
DURLEACH	Duration of Leaching Period	log(durleach)	Y		
GWAVTIM	Exposure Duration	C			
FRORGCAR	Fraction Organic Carbon	log(frorgcar)		Y	
FRCOEFA	Freundlich Isotherm Coefficient	C			
FRCOEFU	Freundlich Isotherm Coefficient	C			
FREXPA	Freundlich Isotherm Exponent	C			
FREXPU	Freundlich Isotherm Exponent	C			
GWPH	Groundwater pH	gwph	Y		
GWSEEPV	Groundwater Seepage Velocity	log(gwseepv)	Y		
GWTEMP	Groundwater Temperature	C			
HYDGRAD	Hydraulic Gradient	log(hydgrad+.0005)		Y	Y
INFILRAT	Infiltration Rate	infilrat**1.3		Y	Y
LANDEPTH	Landfill Depth	log(landepth+.000002)	Y		
LEACHCON	Leachate Concentration	leachcon		Y	
LFFRACT	LF Fraction	C			
LONDISPU	Longitudinal Dispersivity	londispu**-.255	Y		
LONDISPA	Longitudinal Dispersivity	log(londispa+.3)		Y	Y
XDIST	Longitudinal Distance to Well	log(xdist+250)		Y	Y

Table B-17. Summary of Parameters Considered in Sensitivity Analysis for Thallium

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
LONHYCON	Longitundinal Hydraulic Conductivity	log(lonhycon+5)		Y	Y
MLLA	ml/L	C			
MOISTRPA	Moisture Rention Parameter (a)	log(moistrpa-.05)	Y		
MOISTRPB	Moisture Rention Parameter (b)	log(moistrpb-1)	Y		
MOLDIFF	Molecular Diffusion Coefficient	C			
NEUTHYD	Neutral Hydrolysis Rate Constant	C			
ORGCDIS	Organic Carbon Distribution Coefficient	C			
PERORGM	Percent Organic Matter	log(perorgm)			
POROSITY	Porosity	porosity**1.3			
RADISTW	Radial Distance to Well	log(radistw+250)	Y		
RECHARAT	Recharge Rate	recharat	Y		
RESIDH2O	Residual Water Content	residh2o**2.1		Y	
RETCOEF	Retardation Coefficient	C			
RFDA	RfD (mg/kg/day)	C			
SATHYCON	Saturated Hydraulic Conductivity	log(sathycon)	Y		
SATURH2O	Saturated Water Content	saturh2o		Y	Y
SOILBDEN	Soil Bulk Density	soilbden	Y		
SORBHYD	Sorbed Hydrolysis Rate	C			
TRANDISP	Transverse Dispersivity	log(trandisp+.01)	Y		
UNSATHIK	Unsaturated Zone Thickness	unsathik**-.17		Y	Y
VERTDISP	Vertical Dispersivity	log(vertdisp+.001)	Y		
WASTDENS	Waste Density	C			
WASTEVOL	Waste Volume	C			
WMUAREA	WMU Area	log(wmuarea-3900)		Y	Y
WMULEN	WMU Length	log(wmulen-50)	Y		
WMUWIDTH	WMU Width	log(wmuwidth-50)	Y		

Table B-18. Summary of Correlated Parameters for Thallium

Variable 1		Variable 2		Correlation Coefficient
Code	Description	Code	Description	
AVGPDIAM	Avg. Particle Diameter	BULKDENS	Bulk Density	0.99629
LONHYCON	Longitundinal Hydraulic Conductivi	GWSEEPV	Groundwater Seepage Velocity	0.76081
LONDISPA	Longitudinal Dispersivity	TRANDISP	Transverse Dispersivity	0.99938
LONDISPA	Longitudinal Dispersivity	VERTDISP	Vertical Dispersivity	0.99938
RECHARAT	Recharge Rate	GWPH	Groundwater pH	-0.99348
INFILRAT	Infiltration Rate	GWPH	Groundwater pH	-0.98915
SATHYCON	Saturated Hydraulic Conductivity	GWPH	Groundwater pH	-0.76832
MOISTRPA	Moisture Rention Parameter (a)	GWPH	Groundwater pH	-0.7988
MOISTRPB	Moisture Rention Parameter (b)	GWPH	Groundwater pH	-0.86335
SOILBDEN	Soil Bulk Density	GWPH	Groundwater pH	0.99904
XDIST	Longitudinal Distance to Well	RADISTW	Radial Distance to Well	0.99364
WMUAREA	WMU Area	WMULEN	WMU Length	0.99849
LANDEPTH	Landfill Depth	WMULEN	WMU Length	-0.98823
DURLEACH	Duration of Leaching Period	WMULEN	WMU Length	-0.97341
WMUAREA	WMU Area	WMUWIDTH	WMU Width	0.99849
LANDEPTH	Landfill Depth	WMUWIDTH	WMU Width	-0.98823
DURLEACH	Duration of Leaching Period	WMUWIDTH	WMU Width	-0.97341
INFILRAT	Infiltration Rate	RECHARAT	Recharge Rate	0.99361
SOILBDEN	Soil Bulk Density	RECHARAT	Recharge Rate	-0.99753
WMUAREA	WMU Area	LANDEPTH	Landfill Depth	-0.9886
WMUAREA	WMU Area	DURLEACH	Duration of Leaching Period	-0.97381
LANDEPTH	Landfill Depth	DURLEACH	Duration of Leaching Period	0.98555
RECHARAT	Recharge Rate	SATHYCON	Saturated Hydraulic Conductivity	0.77965
INFILRAT	Infiltration Rate	SATHYCON	Saturated Hydraulic Conductivity	0.79052
RECHARAT	Recharge Rate	MOISTRPA	Moisture Rention Parameter (a)	0.79907
INFILRAT	Infiltration Rate	MOISTRPA	Moisture Rention Parameter (a)	0.7945
RECHARAT	Recharge Rate	MOISTRPB	Moisture Rention Parameter (b)	0.87725
INFILRAT	Infiltration Rate	MOISTRPB	Moisture Rention Parameter (b)	0.86911
AVRECWF	Average Receptor Well Concentrati	UNSATHIK	Unsaturated Zone Thickness	0.74661
UNSATHIK	Unsaturated Zone Thickness	LONDISPU	Longitudinal Dispersivity	0.98832
AVRECWF	Average Receptor Well Concentrati	LONDISPU	Longitudinal Dispersivity	0.76862
RECHARAT	Recharge Rate	SOILBDEN	Soil Bulk Density	-0.99753
INFILRAT	Infiltration Rate	SOILBDEN	Soil Bulk Density	-0.9924

Table B-18. Summary of Correlated Parameters for Thallium

Variable 1		Variable 2		Correlation Coefficient
Code	**Description**	**Code**	**Description**	
SATHYCON	Saturated Hydraulic Conductivity	SOILBDEN	Soil Bulk Density	-0.77387
MOISTRPA	Moisture Rention Parameter (a)	SOILBDEN	Soil Bulk Density	-0.80014
MOISTRPB	Moisture Rention Parameter (b)	SOILBDEN	Soil Bulk Density	-0.87004
UNSATHIK	Unsaturated Zone Thickness	AVRECWF	Average Receptor Well Concentr	0.74661
UNSATHIK	Unsaturated Zone Thickness	DRH2OCNA	drinking water well conc	0.74661
UNSATHIK	Unsaturated Zone Thickness			0.74661

Note: Parameters in the variable 2 column were removed from the analysis.

Table B-19. Summary of Crosspairs Analysis for Thallium

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
AVGPDIAM	Avg. Particle Diameter			Y	Y
POROSITY	Porosity				
AQUTHIK	Aquifer Thickness			Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity			Y	Y
HYDGRAD	Hydraulic Gradient			Y	Y
LONDISPA	Longitudinal Dispersivity			Y	Y
FRORGCAR	Fraction Organic Carbon				
ANGLEW	Angle of Well Off Plume Centerline				
XDIST	Longitudinal Distance to Well			Y	Y
YDIST	Distance from Plume Centerline to Well			Y	Y
ZDIST	Depth of Well Below Water Table				
WMUAREA	WMU Area				
LEACHCON	Leachate Concentration				
INFILRAT	Infiltration Rate				Y
RESIDH2O	Residual Water Content				
SATURH2O	Saturated Water Content				Y
UNSATHIK	Unsaturated Zone Thickness			Y	Y
PERORGM	Percent Organic Matter				
AVGPDIAM	Avg. Particle Diameter	AVGPDIAM	Avg. Particle Diameter	Y	
POROSITY	Porosity	AVGPDIAM	Avg. Particle Diameter		
POROSITY	Porosity	POROSITY	Porosity		
AQUTHIK	Aquifer Thickness	AVGPDIAM	Avg. Particle Diameter		
AQUTHIK	Aquifer Thickness	POROSITY	Porosity		
AQUTHIK	Aquifer Thickness	AQUTHIK	Aquifer Thickness	Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity	AVGPDIAM	Avg. Particle Diameter		
LONHYCON	Longitundinal Hydraulic Conductivity	POROSITY	Porosity		
LONHYCON	Longitundinal Hydraulic Conductivity	AQUTHIK	Aquifer Thickness	Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity	LONHYCON	Longitundinal Hydraulic Conductivity		
HYDGRAD	Hydraulic Gradient	AVGPDIAM	Avg. Particle Diameter		
HYDGRAD	Hydraulic Gradient	POROSITY	Porosity		
HYDGRAD	Hydraulic Gradient	AQUTHIK	Aquifer Thickness	Y	Y
HYDGRAD	Hydraulic Gradient	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
HYDGRAD	Hydraulic Gradient	HYDGRAD	Hydraulic Gradient	Y	Y
LONDISPA	Longitudinal Dispersivity	AVGPDIAM	Avg. Particle Diameter		
LONDISPA	Longitudinal Dispersivity	POROSITY	Porosity		
LONDISPA	Longitudinal Dispersivity	AQUTHIK	Aquifer Thickness		
LONDISPA	Longitudinal Dispersivity	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
LONDISPA	Longitudinal Dispersivity	HYDGRAD	Hydraulic Gradient	Y	Y
LONDISPA	Longitudinal Dispersivity	LONDISPA	Longitudinal Dispersivity	Y	
FRORGCAR	Fraction Organic Carbon	AVGPDIAM	Avg. Particle Diameter	Y	
FRORGCAR	Fraction Organic Carbon	POROSITY	Porosity		
FRORGCAR	Fraction Organic Carbon	AQUTHIK	Aquifer Thickness		
FRORGCAR	Fraction Organic Carbon	LONHYCON	Longitundinal Hydraulic Conductivity		
FRORGCAR	Fraction Organic Carbon	HYDGRAD	Hydraulic Gradient		
FRORGCAR	Fraction Organic Carbon	LONDISPA	Longitudinal Dispersivity		
FRORGCAR	Fraction Organic Carbon	FRORGCAR	Fraction Organic Carbon		
ANGLEW	Angle of Well Off Plume Centerline	AVGPDIAM	Avg. Particle Diameter		
ANGLEW	Angle of Well Off Plume Centerline	POROSITY	Porosity		
ANGLEW	Angle of Well Off Plume Centerline	AQUTHIK	Aquifer Thickness		

Table B-19. Summary of Crosspairs Analysis for Thallium

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
ANGLEW	Angle of Well Off Plume Centerline	LONHYCON	Longitundinal Hydraulic Conductivity		
ANGLEW	Angle of Well Off Plume Centerline	HYDGRAD	Hydraulic Gradient		
ANGLEW	Angle of Well Off Plume Centerline	LONDISPA	Longitudinal Dispersivity		
ANGLEW	Angle of Well Off Plume Centerline	FRORGCAR	Fraction Organic Carbon	Y	
ANGLEW	Angle of Well Off Plume Centerline	ANGLEW	Angle of Well Off Plume Centerline		
XDIST	Longitudinal Distance to Well	AVGPDIAM	Avg. Particle Diameter		
XDIST	Longitudinal Distance to Well	POROSITY	Porosity		
XDIST	Longitudinal Distance to Well	AQUTHIK	Aquifer Thickness	Y	Y
XDIST	Longitudinal Distance to Well	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
XDIST	Longitudinal Distance to Well	HYDGRAD	Hydraulic Gradient	Y	Y
XDIST	Longitudinal Distance to Well	LONDISPA	Longitudinal Dispersivity	Y	Y
XDIST	Longitudinal Distance to Well	FRORGCAR	Fraction Organic Carbon		
XDIST	Longitudinal Distance to Well	ANGLEW	Angle of Well Off Plume Centerline		
XDIST	Longitudinal Distance to Well	XDIST	Longitudinal Distance to Well	Y	
YDIST	Distance from Plume Centerline to Well	AVGPDIAM	Avg. Particle Diameter	Y	
YDIST	Distance from Plume Centerline to Well	POROSITY	Porosity		
YDIST	Distance from Plume Centerline to Well	AQUTHIK	Aquifer Thickness		
YDIST	Distance from Plume Centerline to Well	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
YDIST	Distance from Plume Centerline to Well	HYDGRAD	Hydraulic Gradient	Y	Y
YDIST	Distance from Plume Centerline to Well	LONDISPA	Longitudinal Dispersivity	Y	Y
YDIST	Distance from Plume Centerline to Well	FRORGCAR	Fraction Organic Carbon		
YDIST	Distance from Plume Centerline to Well	ANGLEW	Angle of Well Off Plume Centerline		
YDIST	Distance from Plume Centerline to Well	XDIST	Longitudinal Distance to Well		
YDIST	Distance from Plume Centerline to Well	YDIST	Distance from Plume Centerline to Well	Y	Y
ZDIST	Depth of Well Below Water Table	AVGPDIAM	Avg. Particle Diameter		
ZDIST	Depth of Well Below Water Table	POROSITY	Porosity		
ZDIST	Depth of Well Below Water Table	AQUTHIK	Aquifer Thickness		
ZDIST	Depth of Well Below Water Table	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
ZDIST	Depth of Well Below Water Table	HYDGRAD	Hydraulic Gradient		
ZDIST	Depth of Well Below Water Table	LONDISPA	Longitudinal Dispersivity		
ZDIST	Depth of Well Below Water Table	FRORGCAR	Fraction Organic Carbon		
ZDIST	Depth of Well Below Water Table	ANGLEW	Angle of Well Off Plume Centerline		
ZDIST	Depth of Well Below Water Table	XDIST	Longitudinal Distance to Well		
ZDIST	Depth of Well Below Water Table	YDIST	Distance from Plume Centerline to Well		
ZDIST	Depth of Well Below Water Table	ZDIST	Depth of Well Below Water Table	Y	Y
WMUAREA	WMU Area	AVGPDIAM	Avg. Particle Diameter	Y	
WMUAREA	WMU Area	POROSITY	Porosity		
WMUAREA	WMU Area	AQUTHIK	Aquifer Thickness	Y	Y
WMUAREA	WMU Area	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
WMUAREA	WMU Area	HYDGRAD	Hydraulic Gradient	Y	Y
WMUAREA	WMU Area	LONDISPA	Longitudinal Dispersivity	Y	Y
WMUAREA	WMU Area	FRORGCAR	Fraction Organic Carbon		
WMUAREA	WMU Area	ANGLEW	Angle of Well Off Plume Centerline		
WMUAREA	WMU Area	XDIST	Longitudinal Distance to Well		
WMUAREA	WMU Area	YDIST	Distance from Plume Centerline to Well	Y	Y
WMUAREA	WMU Area	ZDIST	Depth of Well Below Water Table		
WMUAREA	WMU Area	WMUAREA	WMU Area		
LEACHCON	Leachate Concentration	AVGPDIAM	Avg. Particle Diameter		
LEACHCON	Leachate Concentration	POROSITY	Porosity		

Table B-19. Summary of Crosspairs Analysis for Thallium

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
LEACHCON	Leachate Concentration	AQUTHIK	Aquifer Thickness		
LEACHCON	Leachate Concentration	LONHYCON	Longitundinal Hydraulic Conductivity		
LEACHCON	Leachate Concentration	HYDGRAD	Hydraulic Gradient		
LEACHCON	Leachate Concentration	LONDISPA	Longitudinal Dispersivity		
LEACHCON	Leachate Concentration	FRORGCAR	Fraction Organic Carbon		
LEACHCON	Leachate Concentration	ANGLEW	Angle of Well Off Plume Centerline		
LEACHCON	Leachate Concentration	XDIST	Longitudinal Distance to Well	Y	
LEACHCON	Leachate Concentration	YDIST	Distance from Plume Centerline to Well		
LEACHCON	Leachate Concentration	ZDIST	Depth of Well Below Water Table		
LEACHCON	Leachate Concentration	WMUAREA	WMU Area		
LEACHCON	Leachate Concentration	LEACHCON	Leachate Concentration		
INFILRAT	Infiltration Rate	AVGPDIAM	Avg. Particle Diameter		
INFILRAT	Infiltration Rate	POROSITY	Porosity		
INFILRAT	Infiltration Rate	AQUTHIK	Aquifer Thickness	Y	Y
INFILRAT	Infiltration Rate	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
INFILRAT	Infiltration Rate	HYDGRAD	Hydraulic Gradient		
INFILRAT	Infiltration Rate	LONDISPA	Longitudinal Dispersivity		
INFILRAT	Infiltration Rate	FRORGCAR	Fraction Organic Carbon		
INFILRAT	Infiltration Rate	ANGLEW	Angle of Well Off Plume Centerline		
INFILRAT	Infiltration Rate	XDIST	Longitudinal Distance to Well	Y	Y
INFILRAT	Infiltration Rate	YDIST	Distance from Plume Centerline to Well		
INFILRAT	Infiltration Rate	ZDIST	Depth of Well Below Water Table		
INFILRAT	Infiltration Rate	WMUAREA	WMU Area		
INFILRAT	Infiltration Rate	LEACHCON	Leachate Concentration		
INFILRAT	Infiltration Rate	INFILRAT	Infiltration Rate		
RESIDH2O	Residual Water Content	AVGPDIAM	Avg. Particle Diameter		
RESIDH2O	Residual Water Content	POROSITY	Porosity		
RESIDH2O	Residual Water Content	AQUTHIK	Aquifer Thickness	Y	
RESIDH2O	Residual Water Content	LONHYCON	Longitundinal Hydraulic Conductivity		
RESIDH2O	Residual Water Content	HYDGRAD	Hydraulic Gradient		
RESIDH2O	Residual Water Content	LONDISPA	Longitudinal Dispersivity		
RESIDH2O	Residual Water Content	FRORGCAR	Fraction Organic Carbon		
RESIDH2O	Residual Water Content	ANGLEW	Angle of Well Off Plume Centerline		
RESIDH2O	Residual Water Content	XDIST	Longitudinal Distance to Well		
RESIDH2O	Residual Water Content	YDIST	Distance from Plume Centerline to Well		
RESIDH2O	Residual Water Content	ZDIST	Depth of Well Below Water Table	Y	
RESIDH2O	Residual Water Content	WMUAREA	WMU Area		
RESIDH2O	Residual Water Content	LEACHCON	Leachate Concentration		
RESIDH2O	Residual Water Content	INFILRAT	Infiltration Rate		
RESIDH2O	Residual Water Content	RESIDH2O	Residual Water Content		
SATURH2O	Saturated Water Content	AVGPDIAM	Avg. Particle Diameter		
SATURH2O	Saturated Water Content	POROSITY	Porosity		
SATURH2O	Saturated Water Content	AQUTHIK	Aquifer Thickness		
SATURH2O	Saturated Water Content	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
SATURH2O	Saturated Water Content	HYDGRAD	Hydraulic Gradient	Y	
SATURH2O	Saturated Water Content	LONDISPA	Longitudinal Dispersivity		
SATURH2O	Saturated Water Content	FRORGCAR	Fraction Organic Carbon		
SATURH2O	Saturated Water Content	ANGLEW	Angle of Well Off Plume Centerline		
SATURH2O	Saturated Water Content	XDIST	Longitudinal Distance to Well		

Table B-19. Summary of Crosspairs Analysis for Thallium

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
SATURH2O	Saturated Water Content	YDIST	Distance from Plume Centerline to Well		
SATURH2O	Saturated Water Content	ZDIST	Depth of Well Below Water Table		
SATURH2O	Saturated Water Content	WMUAREA	WMU Area		
SATURH2O	Saturated Water Content	LEACHCON	Leachate Concentration		
SATURH2O	Saturated Water Content	INFILRAT	Infiltration Rate		
SATURH2O	Saturated Water Content	RESIDH2O	Residual Water Content		
SATURH2O	Saturated Water Content	SATURH2O	Saturated Water Content		
UNSATHIK	Unsaturated Zone Thickness	AVGPDIAM	Avg. Particle Diameter		
UNSATHIK	Unsaturated Zone Thickness	POROSITY	Porosity		
UNSATHIK	Unsaturated Zone Thickness	AQUTHIK	Aquifer Thickness	Y	Y
UNSATHIK	Unsaturated Zone Thickness	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
UNSATHIK	Unsaturated Zone Thickness	HYDGRAD	Hydraulic Gradient	Y	
UNSATHIK	Unsaturated Zone Thickness	LONDISPA	Longitudinal Dispersivity		
UNSATHIK	Unsaturated Zone Thickness	FRORGCAR	Fraction Organic Carbon		
UNSATHIK	Unsaturated Zone Thickness	ANGLEW	Angle of Well Off Plume Centerline		
UNSATHIK	Unsaturated Zone Thickness	XDIST	Longitudinal Distance to Well	Y	Y
UNSATHIK	Unsaturated Zone Thickness	YDIST	Distance from Plume Centerline to Well	Y	Y
UNSATHIK	Unsaturated Zone Thickness	ZDIST	Depth of Well Below Water Table	Y	Y
UNSATHIK	Unsaturated Zone Thickness	WMUAREA	WMU Area	Y	Y
UNSATHIK	Unsaturated Zone Thickness	LEACHCON	Leachate Concentration		
UNSATHIK	Unsaturated Zone Thickness	INFILRAT	Infiltration Rate	Y	Y
UNSATHIK	Unsaturated Zone Thickness	RESIDH2O	Residual Water Content		
UNSATHIK	Unsaturated Zone Thickness	SATURH2O	Saturated Water Content		
UNSATHIK	Unsaturated Zone Thickness	UNSATHIK	Unsaturated Zone Thickness	Y	Y
PERORGM	Percent Organic Matter	AVGPDIAM	Avg. Particle Diameter		
PERORGM	Percent Organic Matter	POROSITY	Porosity		
PERORGM	Percent Organic Matter	AQUTHIK	Aquifer Thickness		
PERORGM	Percent Organic Matter	LONHYCON	Longitundinal Hydraulic Conductivity		
PERORGM	Percent Organic Matter	HYDGRAD	Hydraulic Gradient		
PERORGM	Percent Organic Matter	LONDISPA	Longitudinal Dispersivity		
PERORGM	Percent Organic Matter	FRORGCAR	Fraction Organic Carbon		
PERORGM	Percent Organic Matter	ANGLEW	Angle of Well Off Plume Centerline		
PERORGM	Percent Organic Matter	XDIST	Longitudinal Distance to Well		
PERORGM	Percent Organic Matter	YDIST	Distance from Plume Centerline to Well		
PERORGM	Percent Organic Matter	ZDIST	Depth of Well Below Water Table		
PERORGM	Percent Organic Matter	WMUAREA	WMU Area		
PERORGM	Percent Organic Matter	LEACHCON	Leachate Concentration		
PERORGM	Percent Organic Matter	INFILRAT	Infiltration Rate		
PERORGM	Percent Organic Matter	RESIDH2O	Residual Water Content		
PERORGM	Percent Organic Matter	SATURH2O	Saturated Water Content		
PERORGM	Percent Organic Matter	UNSATHIK	Unsaturated Zone Thickness		
PERORGM	Percent Organic Matter	PERORGM	Percent Organic Matter		

Table B-20. Ranking of Parameters According to Percentage of Risk for Thallium

Variable Description	Reduced Sums of Square	Variable Sums of Square	Variable Degrees of Freedom	% Risk Variation	Mean Square Variable	F VALUE	P VALUE
Unsaturated Zone Thickness (m)	882156.7	1461647.86	47	57949118.0%	381167.68	64387.91	3.83E+01
Infiltration Rate (m/yr)	1398789.0	1461647.86	47	6285891.0%	381167.68	12571.78	3.83E+01
Aquifer Thickness (m)	1401887.7	1461647.86	47	5976016.0%	381167.68	7470.02	3.83E+01
Longitudinal Hydraulic Conductivity (m/yr)	1406503.9	1461647.86	47	5514397.0%	381167.68	5013.09	3.83E+01
Longitudinal Distance to Well (m)	1425135.7	1461647.86	47	3651219.0%	381167.68	5216.03	3.83E+01
Hydraulic Gradient (m/m)	1434090.0	1461647.86	47	2755786.0%	381167.68	3444.73	3.83E+01
Distance from Plume Centerline to Well (m)	1442560.5	1461647.86	47	1908740.0%	381167.68	2726.77	3.83E+01
Longitudinal Dispersivity {Aquifer} (m)	1449121.0	1461647.86	47	1252690.0%	381167.68	2087.82	3.83E+01
WMU Area (m2)	1449346.1	1461647.86	47	1230181.0%	381167.68	1757.40	3.83E+01
Depth of Well Below Water Table (m)	1456260.2	1461647.86	47	538767.0%	381167.68	1346.92	3.83E+01
Consumption of Drinking Water (ml/kg-day)	1459692.5	1461647.86	47	195538.0%	381167.68	1955.38	3.83E+01
Saturated Water Content	1460078.4	1461647.86	47	156942.0%	381167.68	784.71	3.83E+01
Average Particle Diameter (cm)	1461322.8	1461647.86	47	32509.0%	381167.68	325.09	3.83E+01

Constants

Full Model SS	38
Error SS	9
Error DF	0
MS Error	9952

Table B-21. Summary of Parameters Considered in Sensitivity Analysis for Antimony

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
ACIDCAT	Acid Catalyzed Hydrolysis Rate Constant	C			
ANGLEW	Angle of Well Off Plume Centerline	anglew			
ANISORAT	Anisotropy Ratio	C			
AQUTHIK	Aquifer Thickness	aquthik**-.21		Y	Y
AVGPDIAM	Avg. Particle Diameter	log(avgpdiam+.004)		Y	Y
BASECAT	Base Catalyzed Hydrolysis Rate Constant	C			
BIODRATA	Biodegradation Rate	C			
BIODRATU	Biodegradation Rate	C			
BULKDENS	Bulk Density	bulkdens**3.5	Y		
CHEMDRU	Chemical Decay Rate	C			
CHEMDRA	Chemical Decay Rate	C			
CONSH2OA	Consump of drinking water	log(consh2oa)			Y
ZDIST	Depth of Well Below Water Table	log(zdist+4)		Y	Y
DISHYD	Dissolved Hydrolysis Rate	C			
YDIST	Distance from Plume Centerline to Well	log(ydist+20)		Y	Y
DURLEACH	Duration of Leaching Period	log(durleach)	Y		
GWAVTIM	Exposure Duration	C			
FRORGCAR	Fraction Organic Carbon	log(frorgcar)		Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	log(frcoefa)		Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	log(frcoefu)		Y	Y
FREXPA	Freundlich Isotherm Exponent	C			
FREXPU	Freundlich Isotherm Exponent	C			
GWPH	Groundwater pH	gwph	Y		
GWSEEPV	Groundwater Seepage Velocity	log(gwseepv)		Y	Y
GWTEMP	Groundwater Temperature	gwtemp	Y		
HYDGRAD	Hydraulic Gradient	log(hydgrad+.0005)		Y	Y
INFILRAT	Infiltration Rate	infilrat**1.3		Y	Y
LANDEPTH	Landfill Depth	log(landepth+.000002)	Y		
LEACHCON	Leachate Concentration	C			
LFFRACT	LF Fraction	C			
LONDISPU	Longitudinal Dispersivity	londispu**-.255	Y		
LONDISPA	Longitudinal Dispersivity	log(londispa+.3)		Y	Y
XDIST	Longitudinal Distance to Well	log(xdist+250)		Y	Y

Table B-21. Summary of Parameters Considered in Sensitivity Analysis for Antimony

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
LONHYCON	Longitundinal Hydraulic Conductivity	log(lonhycon+5)		Y	Y
MLLA	ml/L	C			
MOISTRPA	Moisture Rention Parameter (a)	log(moistrpa-.05)		Y	
MOISTRPB	Moisture Rention Parameter (b)	log(moistrpb-1)		Y	
MOLDIFF	Molecular Diffusion Coefficient	C			
NEUTHYD	Neutral Hydrolysis Rate Constant	C			
ORGCDIS	Organic Carbon Distribution Coefficient	C			
PERORGM	Percent Organic Matter	log(perorgm)		Y	
POROSITY	Porosity	porosity**1.3		Y	Y
RADISTW	Radial Distance to Well	log(radistw+250)	Y		
RECHARAT	Recharge Rate	recharat	Y		
RESIDH2O	Residual Water Content	residh2o**2.1		Y	Y
RETCOEF	Retardation Coefficient	log(retcoef)	Y		
RFDA	RfD (mg/kg/day)	C			
SATHYCON	Saturated Hydraulic Conductivity	log(sathycon)		Y	
SATURH2O	Saturated Water Content	saturh2o		Y	
SOILBDEN	Soil Bulk Density	soilbden	Y		
SORBHYD	Sorbed Hydrolysis Rate	C			
TRANDISP	Transverse Dispersivity	log(trandisp+.01)	Y		
UNSATHIK	Unsaturated Zone Thickness	unsathik**-.17		Y	Y
VERTDISP	Vertical Dispersivity	log(vertdisp+.001)	Y		
WASTDENS	Waste Density	C			
WASTEVOL	Waste Volume	wastevol		Y	Y
WMUAREA	WMU Area	log(wmuarea-3900)		Y	Y
WMULEN	WMU Length	log(wmulen-50)	Y		
WMUWIDTH	WMU Width	log(wmuwidth-50)	Y		

Table B-22. Summary of Correlated Parameters for Antimony

Variable 1		Variable 2		Correlation Coefficient
Code	Description	Code	Description	
AVGPDIAM	Avg. Particle Diameter	BULKDENS	Bulk Density	0.99614
FRCOEFA	Freundlich Isotherm Coefficient	RETCOEF	Retardation Coefficient	0.97512
LONDISPA	Longitudinal Dispersivity	TRANDISP	Transverse Dispersivity	0.99935
LONDISPA	Longitudinal Dispersivity	VERTDISP	Vertical Dispersivity	0.99942
RECHARAT	Recharge Rate	GWTEMP	Groundwater Temperature	0.93863
INFILRAT	Infiltration Rate	GWTEMP	Groundwater Temperature	0.91721
GWTEMP	Groundwater Temperature	GWPH	Groundwater pH	-0.92096
RECHARAT	Recharge Rate	GWPH	Groundwater pH	-0.82545
INFILRAT	Infiltration Rate	GWPH	Groundwater pH	-0.80114
XDIST	Longitudinal Distance to Well	RADISTW	Radial Distance to Well	0.99366
WMUAREA	WMU Area	WMULEN	WMU Length	0.99835
LANDEPTH	Landfill Depth	WMULEN	WMU Length	-0.75732
DURLEACH	Duration of Leaching Period	WMULEN	WMU Length	-0.75883
WMUAREA	WMU Area	WMUWIDTH	WMU Width	0.99835
LANDEPTH	Landfill Depth	WMUWIDTH	WMU Width	-0.75732
DURLEACH	Duration of Leaching Period	WMUWIDTH	WMU Width	-0.75883
GWTEMP	Groundwater Temperature	RECHARAT	Recharge Rate	0.93863
INFILRAT	Infiltration Rate	RECHARAT	Recharge Rate	0.98834
WMUAREA	WMU Area	LANDEPTH	Landfill Depth	-0.75442
WMUAREA	WMU Area	DURLEACH	Duration of Leaching Period	-0.75838
LANDEPTH	Landfill Depth	DURLEACH	Duration of Leaching Period	0.9413
UNSATHIK	Unsaturated Zone Thickness	LONDISPU	Longitudinal Dispersivity	0.9839
SATHYCON	Saturated Hydraulic Conductivity	SOILBDEN	Soil Bulk Density	-0.75136
MOISTRPA	Moisture Rention Parameter (a)	SOILBDEN	Soil Bulk Density	-0.78595
MOISTRPB	Moisture Rention Parameter (b)	SOILBDEN	Soil Bulk Density	-0.86325

Note: Parameters in the variable 2 column were removed from the analysis.

Table B-23. Summary of Crosspairs Analysis for Antimony

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
AVGPDIAM	Avg. Particle Diameter			Y	
POROSITY	Porosity				
AQUTHIK	Aquifer Thickness			Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity				
HYDGRAD	Hydraulic Gradient				
GWSEEPV	Groundwater Seepage Velocity				
LONDISPA	Longitudinal Dispersivity			Y	Y
FRORGCAR	Fraction Organic Carbon				
ANGLEW	Angle of Well Off Plume Centerline				
XDIST	Longitudinal Distance to Well			Y	Y
YDIST	Distance from Plume Centerline to Well			Y	Y
ZDIST	Depth of Well Below Water Table				
FRCOEFA	Freundlich Isotherm Coefficient			Y	Y
WMUAREA	WMU Area			Y	Y
INFILRAT	Infiltration Rate			Y	Y
WASTEVOL	Waste Volume			Y	Y
SATHYCON	Saturated Hydraulic Conductivity			Y	
MOISTRPA	Moisture Rention Parameter (a)				
MOISTRPB	Moisture Rention Parameter (b)				
RESIDH2O	Residual Water Content				
SATURH2O	Saturated Water Content				
UNSATHIK	Unsaturated Zone Thickness			Y	Y
PERORGM	Percent Organic Matter				
FRCOEFU	Freundlich Isotherm Coefficient			Y	Y
AVGPDIAM	Avg. Particle Diameter	AVGPDIAM	Avg. Particle Diameter		
POROSITY	Porosity	AVGPDIAM	Avg. Particle Diameter		
POROSITY	Porosity	POROSITY	Porosity	Y	
AQUTHIK	Aquifer Thickness	AVGPDIAM	Avg. Particle Diameter		
AQUTHIK	Aquifer Thickness	POROSITY	Porosity	Y	
AQUTHIK	Aquifer Thickness	AQUTHIK	Aquifer Thickness	Y	
LONHYCON	Longitundinal Hydraulic Conductivity	AVGPDIAM	Avg. Particle Diameter		
LONHYCON	Longitundinal Hydraulic Conductivity	POROSITY	Porosity		
LONHYCON	Longitundinal Hydraulic Conductivity	AQUTHIK	Aquifer Thickness		
LONHYCON	Longitundinal Hydraulic Conductivity	LONHYCON	Longitundinal Hydraulic Conductivity		
HYDGRAD	Hydraulic Gradient	AVGPDIAM	Avg. Particle Diameter		
HYDGRAD	Hydraulic Gradient	POROSITY	Porosity		
HYDGRAD	Hydraulic Gradient	AQUTHIK	Aquifer Thickness		
HYDGRAD	Hydraulic Gradient	LONHYCON	Longitundinal Hydraulic Conductivity		
HYDGRAD	Hydraulic Gradient	HYDGRAD	Hydraulic Gradient		
GWSEEPV	Groundwater Seepage Velocity	AVGPDIAM	Avg. Particle Diameter		
GWSEEPV	Groundwater Seepage Velocity	POROSITY	Porosity		
GWSEEPV	Groundwater Seepage Velocity	AQUTHIK	Aquifer Thickness	Y	
GWSEEPV	Groundwater Seepage Velocity	LONHYCON	Longitundinal Hydraulic Conductivity		
GWSEEPV	Groundwater Seepage Velocity	HYDGRAD	Hydraulic Gradient		
GWSEEPV	Groundwater Seepage Velocity	GWSEEPV	Groundwater Seepage Velocity		
LONDISPA	Longitudinal Dispersivity	AVGPDIAM	Avg. Particle Diameter		
LONDISPA	Longitudinal Dispersivity	POROSITY	Porosity		
LONDISPA	Longitudinal Dispersivity	AQUTHIK	Aquifer Thickness	Y	
LONDISPA	Longitudinal Dispersivity	LONHYCON	Longitundinal Hydraulic Conductivity		

Table B-23. Summary of Crosspairs Analysis for Antimony

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
LONDISPA	Longitudinal Dispersivity	HYDGRAD	Hydraulic Gradient		
LONDISPA	Longitudinal Dispersivity	GWSEEPV	Groundwater Seepage Velocity		
LONDISPA	Longitudinal Dispersivity	LONDISPA	Longitudinal Dispersivity		
FRORGCAR	Fraction Organic Carbon	AVGPDIAM	Avg. Particle Diameter		
FRORGCAR	Fraction Organic Carbon	POROSITY	Porosity		
FRORGCAR	Fraction Organic Carbon	AQUTHIK	Aquifer Thickness		
FRORGCAR	Fraction Organic Carbon	LONHYCON	Longitundinal Hydraulic Conductivity		
FRORGCAR	Fraction Organic Carbon	HYDGRAD	Hydraulic Gradient		
FRORGCAR	Fraction Organic Carbon	GWSEEPV	Groundwater Seepage Velocity		
FRORGCAR	Fraction Organic Carbon	LONDISPA	Longitudinal Dispersivity		
FRORGCAR	Fraction Organic Carbon	FRORGCAR	Fraction Organic Carbon		
ANGLEW	Angle of Well Off Plume Centerline	AVGPDIAM	Avg. Particle Diameter		
ANGLEW	Angle of Well Off Plume Centerline	POROSITY	Porosity		
ANGLEW	Angle of Well Off Plume Centerline	AQUTHIK	Aquifer Thickness		
ANGLEW	Angle of Well Off Plume Centerline	LONHYCON	Longitundinal Hydraulic Conductivity		
ANGLEW	Angle of Well Off Plume Centerline	HYDGRAD	Hydraulic Gradient		
ANGLEW	Angle of Well Off Plume Centerline	GWSEEPV	Groundwater Seepage Velocity		
ANGLEW	Angle of Well Off Plume Centerline	LONDISPA	Longitudinal Dispersivity		
ANGLEW	Angle of Well Off Plume Centerline	FRORGCAR	Fraction Organic Carbon		
ANGLEW	Angle of Well Off Plume Centerline	ANGLEW	Angle of Well Off Plume Centerline		
XDIST	Longitudinal Distance to Well	AVGPDIAM	Avg. Particle Diameter		
XDIST	Longitudinal Distance to Well	POROSITY	Porosity		
XDIST	Longitudinal Distance to Well	AQUTHIK	Aquifer Thickness	Y	
XDIST	Longitudinal Distance to Well	LONHYCON	Longitundinal Hydraulic Conductivity		
XDIST	Longitudinal Distance to Well	HYDGRAD	Hydraulic Gradient		
XDIST	Longitudinal Distance to Well	GWSEEPV	Groundwater Seepage Velocity		
XDIST	Longitudinal Distance to Well	LONDISPA	Longitudinal Dispersivity		
XDIST	Longitudinal Distance to Well	FRORGCAR	Fraction Organic Carbon	Y	
XDIST	Longitudinal Distance to Well	ANGLEW	Angle of Well Off Plume Centerline		
XDIST	Longitudinal Distance to Well	XDIST	Longitudinal Distance to Well		
YDIST	Distance from Plume Centerline to Well	AVGPDIAM	Avg. Particle Diameter		
YDIST	Distance from Plume Centerline to Well	POROSITY	Porosity		
YDIST	Distance from Plume Centerline to Well	AQUTHIK	Aquifer Thickness		
YDIST	Distance from Plume Centerline to Well	LONHYCON	Longitundinal Hydraulic Conductivity		
YDIST	Distance from Plume Centerline to Well	HYDGRAD	Hydraulic Gradient		
YDIST	Distance from Plume Centerline to Well	GWSEEPV	Groundwater Seepage Velocity		
YDIST	Distance from Plume Centerline to Well	LONDISPA	Longitudinal Dispersivity	Y	
YDIST	Distance from Plume Centerline to Well	FRORGCAR	Fraction Organic Carbon		
YDIST	Distance from Plume Centerline to Well	ANGLEW	Angle of Well Off Plume Centerline		
YDIST	Distance from Plume Centerline to Well	XDIST	Longitudinal Distance to Well	Y	
YDIST	Distance from Plume Centerline to Well	YDIST	Distance from Plume Centerline to Well	Y	
ZDIST	Depth of Well Below Water Table	AVGPDIAM	Avg. Particle Diameter		
ZDIST	Depth of Well Below Water Table	POROSITY	Porosity		
ZDIST	Depth of Well Below Water Table	AQUTHIK	Aquifer Thickness		
ZDIST	Depth of Well Below Water Table	LONHYCON	Longitundinal Hydraulic Conductivity		
ZDIST	Depth of Well Below Water Table	HYDGRAD	Hydraulic Gradient		
ZDIST	Depth of Well Below Water Table	GWSEEPV	Groundwater Seepage Velocity		
ZDIST	Depth of Well Below Water Table	LONDISPA	Longitudinal Dispersivity		
ZDIST	Depth of Well Below Water Table	FRORGCAR	Fraction Organic Carbon		

Table B-23. Summary of Crosspairs Analysis for Antimony

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
ZDIST	Depth of Well Below Water Table	ANGLEW	Angle of Well Off Plume Centerline		
ZDIST	Depth of Well Below Water Table	XDIST	Longitudinal Distance to Well		
ZDIST	Depth of Well Below Water Table	YDIST	Distance from Plume Centerline to Well		
ZDIST	Depth of Well Below Water Table	ZDIST	Depth of Well Below Water Table		
FRCOEFA	Freundlich Isotherm Coefficient	AVGPDIAM	Avg. Particle Diameter		
FRCOEFA	Freundlich Isotherm Coefficient	POROSITY	Porosity		
FRCOEFA	Freundlich Isotherm Coefficient	AQUTHIK	Aquifer Thickness	Y	
FRCOEFA	Freundlich Isotherm Coefficient	LONHYCON	Longitundinal Hydraulic Conductivity	Y	
FRCOEFA	Freundlich Isotherm Coefficient	HYDGRAD	Hydraulic Gradient	Y	
FRCOEFA	Freundlich Isotherm Coefficient	GWSEEPV	Groundwater Seepage Velocity		
FRCOEFA	Freundlich Isotherm Coefficient	LONDISPA	Longitudinal Dispersivity	Y	
FRCOEFA	Freundlich Isotherm Coefficient	FRORGCAR	Fraction Organic Carbon		
FRCOEFA	Freundlich Isotherm Coefficient	ANGLEW	Angle of Well Off Plume Centerline		
FRCOEFA	Freundlich Isotherm Coefficient	XDIST	Longitudinal Distance to Well	Y	
FRCOEFA	Freundlich Isotherm Coefficient	YDIST	Distance from Plume Centerline to Well	Y	
FRCOEFA	Freundlich Isotherm Coefficient	ZDIST	Depth of Well Below Water Table	Y	
FRCOEFA	Freundlich Isotherm Coefficient	FRCOEFA	Freundlich Isotherm Coefficient	Y	
WMUAREA	WMU Area	AVGPDIAM	Avg. Particle Diameter	Y	
WMUAREA	WMU Area	POROSITY	Porosity		
WMUAREA	WMU Area	AQUTHIK	Aquifer Thickness	Y	
WMUAREA	WMU Area	LONHYCON	Longitundinal Hydraulic Conductivity		
WMUAREA	WMU Area	HYDGRAD	Hydraulic Gradient		
WMUAREA	WMU Area	GWSEEPV	Groundwater Seepage Velocity		
WMUAREA	WMU Area	LONDISPA	Longitudinal Dispersivity	Y	
WMUAREA	WMU Area	FRORGCAR	Fraction Organic Carbon	Y	
WMUAREA	WMU Area	ANGLEW	Angle of Well Off Plume Centerline		
WMUAREA	WMU Area	XDIST	Longitudinal Distance to Well		
WMUAREA	WMU Area	YDIST	Distance from Plume Centerline to Well	Y	
WMUAREA	WMU Area	ZDIST	Depth of Well Below Water Table		
WMUAREA	WMU Area	FRCOEFA	Freundlich Isotherm Coefficient	Y	
WMUAREA	WMU Area	WMUAREA	WMU Area	Y	
INFILRAT	Infiltration Rate	AVGPDIAM	Avg. Particle Diameter		
INFILRAT	Infiltration Rate	POROSITY	Porosity		
INFILRAT	Infiltration Rate	AQUTHIK	Aquifer Thickness		
INFILRAT	Infiltration Rate	LONHYCON	Longitundinal Hydraulic Conductivity		
INFILRAT	Infiltration Rate	HYDGRAD	Hydraulic Gradient		
INFILRAT	Infiltration Rate	GWSEEPV	Groundwater Seepage Velocity		
INFILRAT	Infiltration Rate	LONDISPA	Longitudinal Dispersivity		
INFILRAT	Infiltration Rate	FRORGCAR	Fraction Organic Carbon		
INFILRAT	Infiltration Rate	ANGLEW	Angle of Well Off Plume Centerline		
INFILRAT	Infiltration Rate	XDIST	Longitudinal Distance to Well	Y	
INFILRAT	Infiltration Rate	YDIST	Distance from Plume Centerline to Well		
INFILRAT	Infiltration Rate	ZDIST	Depth of Well Below Water Table		
INFILRAT	Infiltration Rate	FRCOEFA	Freundlich Isotherm Coefficient	Y	
INFILRAT	Infiltration Rate	WMUAREA	WMU Area	Y	
INFILRAT	Infiltration Rate	INFILRAT	Infiltration Rate	Y	
WASTEVOL	Waste Volume	AVGPDIAM	Avg. Particle Diameter		
WASTEVOL	Waste Volume	POROSITY	Porosity		
WASTEVOL	Waste Volume	AQUTHIK	Aquifer Thickness		

Table B-23. Summary of Crosspairs Analysis for Antimony

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
WASTEVOL	Waste Volume	LONHYCON	Longitundinal Hydraulic Conductivity		
WASTEVOL	Waste Volume	HYDGRAD	Hydraulic Gradient		
WASTEVOL	Waste Volume	GWSEEPV	Groundwater Seepage Velocity		
WASTEVOL	Waste Volume	LONDISPA	Longitudinal Dispersivity		
WASTEVOL	Waste Volume	FRORGCAR	Fraction Organic Carbon		
WASTEVOL	Waste Volume	ANGLEW	Angle of Well Off Plume Centerline		
WASTEVOL	Waste Volume	XDIST	Longitudinal Distance to Well		
WASTEVOL	Waste Volume	YDIST	Distance from Plume Centerline to Well		
WASTEVOL	Waste Volume	ZDIST	Depth of Well Below Water Table		
WASTEVOL	Waste Volume	FRCOEFA	Freundlich Isotherm Coefficient		
WASTEVOL	Waste Volume	WMUAREA	WMU Area	Y	
WASTEVOL	Waste Volume	INFILRAT	Infiltration Rate		
WASTEVOL	Waste Volume	WASTEVOL	Waste Volume	Y	
SATHYCON	Saturated Hydraulic Conductivity	AVGPDIAM	Avg. Particle Diameter		
SATHYCON	Saturated Hydraulic Conductivity	POROSITY	Porosity		
SATHYCON	Saturated Hydraulic Conductivity	AQUTHIK	Aquifer Thickness		
SATHYCON	Saturated Hydraulic Conductivity	LONHYCON	Longitundinal Hydraulic Conductivity		
SATHYCON	Saturated Hydraulic Conductivity	HYDGRAD	Hydraulic Gradient		
SATHYCON	Saturated Hydraulic Conductivity	GWSEEPV	Groundwater Seepage Velocity		
SATHYCON	Saturated Hydraulic Conductivity	LONDISPA	Longitudinal Dispersivity		
SATHYCON	Saturated Hydraulic Conductivity	FRORGCAR	Fraction Organic Carbon		
SATHYCON	Saturated Hydraulic Conductivity	ANGLEW	Angle of Well Off Plume Centerline		
SATHYCON	Saturated Hydraulic Conductivity	XDIST	Longitudinal Distance to Well		
SATHYCON	Saturated Hydraulic Conductivity	YDIST	Distance from Plume Centerline to Well		
SATHYCON	Saturated Hydraulic Conductivity	ZDIST	Depth of Well Below Water Table		
SATHYCON	Saturated Hydraulic Conductivity	FRCOEFA	Freundlich Isotherm Coefficient		
SATHYCON	Saturated Hydraulic Conductivity	WMUAREA	WMU Area		
SATHYCON	Saturated Hydraulic Conductivity	INFILRAT	Infiltration Rate		
SATHYCON	Saturated Hydraulic Conductivity	WASTEVOL	Waste Volume		
SATHYCON	Saturated Hydraulic Conductivity	SATHYCON	Saturated Hydraulic Conductivity		
MOISTRPA	Moisture Rention Parameter (a)	AVGPDIAM	Avg. Particle Diameter		
MOISTRPA	Moisture Rention Parameter (a)	POROSITY	Porosity		
MOISTRPA	Moisture Rention Parameter (a)	AQUTHIK	Aquifer Thickness		
MOISTRPA	Moisture Rention Parameter (a)	LONHYCON	Longitundinal Hydraulic Conductivity		
MOISTRPA	Moisture Rention Parameter (a)	HYDGRAD	Hydraulic Gradient		
MOISTRPA	Moisture Rention Parameter (a)	GWSEEPV	Groundwater Seepage Velocity		
MOISTRPA	Moisture Rention Parameter (a)	LONDISPA	Longitudinal Dispersivity		
MOISTRPA	Moisture Rention Parameter (a)	FRORGCAR	Fraction Organic Carbon		
MOISTRPA	Moisture Rention Parameter (a)	ANGLEW	Angle of Well Off Plume Centerline		
MOISTRPA	Moisture Rention Parameter (a)	XDIST	Longitudinal Distance to Well		
MOISTRPA	Moisture Rention Parameter (a)	YDIST	Distance from Plume Centerline to Well	Y	
MOISTRPA	Moisture Rention Parameter (a)	ZDIST	Depth of Well Below Water Table		
MOISTRPA	Moisture Rention Parameter (a)	FRCOEFA	Freundlich Isotherm Coefficient		
MOISTRPA	Moisture Rention Parameter (a)	WMUAREA	WMU Area		
MOISTRPA	Moisture Rention Parameter (a)	INFILRAT	Infiltration Rate		
MOISTRPA	Moisture Rention Parameter (a)	WASTEVOL	Waste Volume		
MOISTRPA	Moisture Rention Parameter (a)	SATHYCON	Saturated Hydraulic Conductivity		
MOISTRPA	Moisture Rention Parameter (a)	MOISTRPA	Moisture Rention Parameter (a)		
MOISTRPB	Moisture Rention Parameter (b)	AVGPDIAM	Avg. Particle Diameter		

Table B-23. Summary of Crosspairs Analysis for Antimony

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
MOISTRPB	Moisture Rention Parameter (b)	POROSITY	Porosity		
MOISTRPB	Moisture Rention Parameter (b)	AQUTHIK	Aquifer Thickness		
MOISTRPB	Moisture Rention Parameter (b)	LONHYCON	Longitundinal Hydraulic Conductivity		
MOISTRPB	Moisture Rention Parameter (b)	HYDGRAD	Hydraulic Gradient		
MOISTRPB	Moisture Rention Parameter (b)	GWSEEPV	Groundwater Seepage Velocity		
MOISTRPB	Moisture Rention Parameter (b)	LONDISPA	Longitudinal Dispersivity		
MOISTRPB	Moisture Rention Parameter (b)	FRORGCAR	Fraction Organic Carbon		
MOISTRPB	Moisture Rention Parameter (b)	ANGLEW	Angle of Well Off Plume Centerline		
MOISTRPB	Moisture Rention Parameter (b)	XDIST	Longitudinal Distance to Well		
MOISTRPB	Moisture Rention Parameter (b)	YDIST	Distance from Plume Centerline to Well	Y	
MOISTRPB	Moisture Rention Parameter (b)	ZDIST	Depth of Well Below Water Table		
MOISTRPB	Moisture Rention Parameter (b)	FRCOEFA	Freundlich Isotherm Coefficient		
MOISTRPB	Moisture Rention Parameter (b)	WMUAREA	WMU Area	Y	
MOISTRPB	Moisture Rention Parameter (b)	INFILRAT	Infiltration Rate		
MOISTRPB	Moisture Rention Parameter (b)	WASTEVOL	Waste Volume		
MOISTRPB	Moisture Rention Parameter (b)	SATHYCON	Saturated Hydraulic Conductivity		
MOISTRPB	Moisture Rention Parameter (b)	MOISTRPA	Moisture Rention Parameter (a)		
MOISTRPB	Moisture Rention Parameter (b)	MOISTRPB	Moisture Rention Parameter (b)		
RESIDH2O	Residual Water Content	AVGPDIAM	Avg. Particle Diameter		
RESIDH2O	Residual Water Content	POROSITY	Porosity		
RESIDH2O	Residual Water Content	AQUTHIK	Aquifer Thickness		
RESIDH2O	Residual Water Content	LONHYCON	Longitundinal Hydraulic Conductivity		
RESIDH2O	Residual Water Content	HYDGRAD	Hydraulic Gradient		
RESIDH2O	Residual Water Content	GWSEEPV	Groundwater Seepage Velocity		
RESIDH2O	Residual Water Content	LONDISPA	Longitudinal Dispersivity		
RESIDH2O	Residual Water Content	FRORGCAR	Fraction Organic Carbon		
RESIDH2O	Residual Water Content	ANGLEW	Angle of Well Off Plume Centerline		
RESIDH2O	Residual Water Content	XDIST	Longitudinal Distance to Well		
RESIDH2O	Residual Water Content	YDIST	Distance from Plume Centerline to Well		
RESIDH2O	Residual Water Content	ZDIST	Depth of Well Below Water Table		
RESIDH2O	Residual Water Content	FRCOEFA	Freundlich Isotherm Coefficient		
RESIDH2O	Residual Water Content	WMUAREA	WMU Area	Y	
RESIDH2O	Residual Water Content	INFILRAT	Infiltration Rate		
RESIDH2O	Residual Water Content	WASTEVOL	Waste Volume		
RESIDH2O	Residual Water Content	SATHYCON	Saturated Hydraulic Conductivity		
RESIDH2O	Residual Water Content	MOISTRPA	Moisture Rention Parameter (a)		
RESIDH2O	Residual Water Content	MOISTRPB	Moisture Rention Parameter (b)		
RESIDH2O	Residual Water Content	RESIDH2O	Residual Water Content		
SATURH2O	Saturated Water Content	AVGPDIAM	Avg. Particle Diameter		
SATURH2O	Saturated Water Content	POROSITY	Porosity		
SATURH2O	Saturated Water Content	AQUTHIK	Aquifer Thickness		
SATURH2O	Saturated Water Content	LONHYCON	Longitundinal Hydraulic Conductivity		
SATURH2O	Saturated Water Content	HYDGRAD	Hydraulic Gradient		
SATURH2O	Saturated Water Content	GWSEEPV	Groundwater Seepage Velocity		
SATURH2O	Saturated Water Content	LONDISPA	Longitudinal Dispersivity		
SATURH2O	Saturated Water Content	FRORGCAR	Fraction Organic Carbon		
SATURH2O	Saturated Water Content	ANGLEW	Angle of Well Off Plume Centerline		
SATURH2O	Saturated Water Content	XDIST	Longitudinal Distance to Well		
SATURH2O	Saturated Water Content	YDIST	Distance from Plume Centerline to Well		

Table B-23. Summary of Crosspairs Analysis for Antimony

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
SATURH2O	Saturated Water Content	ZDIST	Depth of Well Below Water Table		
SATURH2O	Saturated Water Content	FRCOEFA	Freundlich Isotherm Coefficient		
SATURH2O	Saturated Water Content	WMUAREA	WMU Area		
SATURH2O	Saturated Water Content	INFILRAT	Infiltration Rate	Y	
SATURH2O	Saturated Water Content	WASTEVOL	Waste Volume	Y	
SATURH2O	Saturated Water Content	SATHYCON	Saturated Hydraulic Conductivity		
SATURH2O	Saturated Water Content	MOISTRPA	Moisture Rention Parameter (a)		
SATURH2O	Saturated Water Content	MOISTRPB	Moisture Rention Parameter (b)		
SATURH2O	Saturated Water Content	RESIDH2O	Residual Water Content		
SATURH2O	Saturated Water Content	SATURH2O	Saturated Water Content		
UNSATHIK	Unsaturated Zone Thickness	AVGPDIAM	Avg. Particle Diameter		
UNSATHIK	Unsaturated Zone Thickness	POROSITY	Porosity	Y	
UNSATHIK	Unsaturated Zone Thickness	AQUTHIK	Aquifer Thickness		
UNSATHIK	Unsaturated Zone Thickness	LONHYCON	Longitundinal Hydraulic Conductivity	Y	
UNSATHIK	Unsaturated Zone Thickness	HYDGRAD	Hydraulic Gradient	Y	
UNSATHIK	Unsaturated Zone Thickness	GWSEEPV	Groundwater Seepage Velocity	Y	
UNSATHIK	Unsaturated Zone Thickness	LONDISPA	Longitudinal Dispersivity		
UNSATHIK	Unsaturated Zone Thickness	FRORGCAR	Fraction Organic Carbon		
UNSATHIK	Unsaturated Zone Thickness	ANGLEW	Angle of Well Off Plume Centerline		
UNSATHIK	Unsaturated Zone Thickness	XDIST	Longitudinal Distance to Well		
UNSATHIK	Unsaturated Zone Thickness	YDIST	Distance from Plume Centerline to Well		
UNSATHIK	Unsaturated Zone Thickness	ZDIST	Depth of Well Below Water Table		
UNSATHIK	Unsaturated Zone Thickness	FRCOEFA	Freundlich Isotherm Coefficient	Y	
UNSATHIK	Unsaturated Zone Thickness	WMUAREA	WMU Area		
UNSATHIK	Unsaturated Zone Thickness	INFILRAT	Infiltration Rate	Y	
UNSATHIK	Unsaturated Zone Thickness	WASTEVOL	Waste Volume		
UNSATHIK	Unsaturated Zone Thickness	SATHYCON	Saturated Hydraulic Conductivity		
UNSATHIK	Unsaturated Zone Thickness	MOISTRPA	Moisture Rention Parameter (a)		
UNSATHIK	Unsaturated Zone Thickness	MOISTRPB	Moisture Rention Parameter (b)		
UNSATHIK	Unsaturated Zone Thickness	RESIDH2O	Residual Water Content		
UNSATHIK	Unsaturated Zone Thickness	SATURH2O	Saturated Water Content		
UNSATHIK	Unsaturated Zone Thickness	UNSATHIK	Unsaturated Zone Thickness	Y	
PERORGM	Percent Organic Matter	AVGPDIAM	Avg. Particle Diameter		
PERORGM	Percent Organic Matter	POROSITY	Porosity		
PERORGM	Percent Organic Matter	AQUTHIK	Aquifer Thickness	Y	
PERORGM	Percent Organic Matter	LONHYCON	Longitundinal Hydraulic Conductivity		
PERORGM	Percent Organic Matter	HYDGRAD	Hydraulic Gradient		
PERORGM	Percent Organic Matter	GWSEEPV	Groundwater Seepage Velocity		
PERORGM	Percent Organic Matter	LONDISPA	Longitudinal Dispersivity		
PERORGM	Percent Organic Matter	FRORGCAR	Fraction Organic Carbon		
PERORGM	Percent Organic Matter	ANGLEW	Angle of Well Off Plume Centerline		
PERORGM	Percent Organic Matter	XDIST	Longitudinal Distance to Well		
PERORGM	Percent Organic Matter	YDIST	Distance from Plume Centerline to Well		
PERORGM	Percent Organic Matter	ZDIST	Depth of Well Below Water Table		
PERORGM	Percent Organic Matter	FRCOEFA	Freundlich Isotherm Coefficient		
PERORGM	Percent Organic Matter	WMUAREA	WMU Area		
PERORGM	Percent Organic Matter	INFILRAT	Infiltration Rate		
PERORGM	Percent Organic Matter	WASTEVOL	Waste Volume		
PERORGM	Percent Organic Matter	SATHYCON	Saturated Hydraulic Conductivity	Y	

Table B-23. Summary of Crosspairs Analysis for Antimony

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
PERORGM	Percent Organic Matter	MOISTRPA	Moisture Rention Parameter (a)		
PERORGM	Percent Organic Matter	MOISTRPB	Moisture Rention Parameter (b)		
PERORGM	Percent Organic Matter	RESIDH2O	Residual Water Content		
PERORGM	Percent Organic Matter	SATURH2O	Saturated Water Content		
PERORGM	Percent Organic Matter	UNSATHIK	Unsaturated Zone Thickness		
PERORGM	Percent Organic Matter	PERORGM	Percent Organic Matter		
FRCOEFU	Freundlich Isotherm Coefficient	AVGPDIAM	Avg. Particle Diameter		
FRCOEFU	Freundlich Isotherm Coefficient	POROSITY	Porosity		
FRCOEFU	Freundlich Isotherm Coefficient	AQUTHIK	Aquifer Thickness	Y	
FRCOEFU	Freundlich Isotherm Coefficient	LONHYCON	Longitundinal Hydraulic Conductivity		
FRCOEFU	Freundlich Isotherm Coefficient	HYDGRAD	Hydraulic Gradient		
FRCOEFU	Freundlich Isotherm Coefficient	GWSEEPV	Groundwater Seepage Velocity		
FRCOEFU	Freundlich Isotherm Coefficient	LONDISPA	Longitudinal Dispersivity		
FRCOEFU	Freundlich Isotherm Coefficient	FRORGCAR	Fraction Organic Carbon		
FRCOEFU	Freundlich Isotherm Coefficient	ANGLEW	Angle of Well Off Plume Centerline		
FRCOEFU	Freundlich Isotherm Coefficient	XDIST	Longitudinal Distance to Well		
FRCOEFU	Freundlich Isotherm Coefficient	YDIST	Distance from Plume Centerline to Well		
FRCOEFU	Freundlich Isotherm Coefficient	ZDIST	Depth of Well Below Water Table		
FRCOEFU	Freundlich Isotherm Coefficient	FRCOEFA	Freundlich Isotherm Coefficient	Y	
FRCOEFU	Freundlich Isotherm Coefficient	WMUAREA	WMU Area	Y	
FRCOEFU	Freundlich Isotherm Coefficient	INFILRAT	Infiltration Rate	Y	
FRCOEFU	Freundlich Isotherm Coefficient	WASTEVOL	Waste Volume		
FRCOEFU	Freundlich Isotherm Coefficient	SATHYCON	Saturated Hydraulic Conductivity		
FRCOEFU	Freundlich Isotherm Coefficient	MOISTRPA	Moisture Rention Parameter (a)		
FRCOEFU	Freundlich Isotherm Coefficient	MOISTRPB	Moisture Rention Parameter (b)		
FRCOEFU	Freundlich Isotherm Coefficient	RESIDH2O	Residual Water Content		
FRCOEFU	Freundlich Isotherm Coefficient	SATURH2O	Saturated Water Content		
FRCOEFU	Freundlich Isotherm Coefficient	UNSATHIK	Unsaturated Zone Thickness	Y	
FRCOEFU	Freundlich Isotherm Coefficient	PERORGM	Percent Organic Matter		
FRCOEFU	Freundlich Isotherm Coefficient	FRCOEFU	Freundlich Isotherm Coefficient	Y	

Table B-24. Ranking of Parameters According to Percentage of Risk for Antimony

Variable Description	Reduced Sums of Square	Variable Sums of Square	Variable Degrees of Freedom	% Risk Variation	Mean Square Variable	F VALUE	P VALUE
Freundlich Isotherm Coefficient {Unsaturated} (cm3/g)	492938.6	1068388.00	53	37544944.0%	491846.76	82207.06	4.95E+01
Unsaturated Zone Thickness (m)	827274.8	1068388.00	53	24111321.0%	491846.76	60278.30	4.95E+01
Infiltration Rate (m/yr)	961983.8	1068388.00	53	10640416.0%	491846.76	17734.03	4.95E+01
Freundlich Isotherm Coefficient {Aquifer} (cm3/g)	1010535.3	1068388.00	53	5785272.0%	491846.76	5785.27	4.95E+01
Saturated Hydraulic Conductivity (m/yr)	1021374.3	1068388.00	53	4701368.0%	491846.76	23506.84	4.95E+01
WMU Area (m2)	1037602.3	1068388.00	53	3078566.0%	491846.76	3078.57	4.95E+01
Distance from Plume Centerline to Well (m)	1053365.7	1068388.00	53	1502230.0%	491846.76	2503.72	4.95E+01
Aquifer Thickness (m)	1057052.7	1068388.00	53	1133530.0%	491846.76	1416.91	4.95E+01
Longitudinal Dispersivity {Aquifer} (m)	1059780.8	1068388.00	53	860717.0%	491846.76	1721.43	4.95E+01
Longitudinal Distance to Well (m)	1060754.8	1068388.00	53	763323.0%	491846.76	1526.65	4.95E+01
Longitudinal Hydraulic Conductivity (m/yr)	1061302.5	1068388.00	53	708546.0%	491846.76	3542.73	4.95E+01
Hydraulic Gradient (m/m)	1064577.1	1068388.00	53	381085.0%	491846.76	1905.43	4.95E+01
Groundwater Seepage Velocity (m/yr)	1066313.9	1068388.00	53	207411.0%	491846.76	1037.06	4.95E+01
Consumption of Drinking Water (ml/kg-day)	1066504.9	1068388.00	53	188314.0%	491846.76	1883.14	4.95E+01
Residual Water Content	1067488.5	1068388.00	53	89955.0%	491846.76	449.77	4.95E+01
Depth of Well Below Water Table (m)	1067654.6	1068388.00	53	73336.0%	491846.76	366.68	4.95E+01
Porosity	1067952.4	1068388.00	53	43563.0%	491846.76	217.82	4.95E+01
Average Particle Diameter (cm)	1067953.2	1068388.00	53	43480.0%	491846.76	217.40	4.95E+01
Fraction Organic Carbon (g/g)	1068018.3	1068388.00	53	36970.0%	491846.76	184.85	4.95E+01

Constants

Full Model SS	46
Error SS	7
Error DF	0
MS Error	9946

Appendix C

Sodium Chlorate

Appendix C

Sodium Chlorate Production Sector

This appendix provides supporting data for the sodium chlorate production industry sector. This industry sector considers three waste stream/waste management scenarios. The data used to model these scenarios and the sensitivity analyses conducted for them are presented in the following sections of this appendix

C.1 Sludge Residues Managed in Municipal Landfills
C.2 Filter Wastes without Chromium Managed in Municipal Landfills
C.3 Filter Wastes without Chromium Managed in Offsite Industrial Landfills

Tables C-1 through C-6 present the data used to characterize the waste stream and the waste management units and the site-specific data used to model the hydrogen cyanide industry sector.

Table C-1 Chemical-Specific Properties for Constituents of Concern for the Sludge Residues in the $NaClO_3$ Sector

Table C-2 Distribution of Municipal Landfill Areas

Table C-3 Waste Stream Parameters for the Sludge Residues in the $NaClO_3$ Sector

Table C-4 Site-Specific Climate-Based Parameters for the Sludge Residues in the $NaClO_3$ Sector

Table C-5 Aquifer Types Common Within 100-Mile Radius of Current WMU Managing Sludge Residues in the $NaClO_3$ Sector

Table C-6 Soil Textures Common Within 100-Mile Radius of Current WMU Managing Sludge Residues in the $NaClO_3$ Sector

Table C-7 Chemical-Specific Properties for Constituents of Concern for the Filter Wastes Without Chromium in the $NaClO_3$ Sector

Table C-8 Waste Stream Parameters for the Filter Wastes Without Chromium in the $NaClO_3$ Sector

Table C-9 Site-Specific Climate-Based Parameters for the Filter Wastes Without Chromium in the $NaClO_3$ Sector

Table C-10 Aquifer Types Common Within 100-Mile Radius of Current WMU Managing Filter Wastes Without Chromium in the $NaClO_3$ Sector

C.1 Sludge Residues without Chromium in the Sodium Chlorate Sector Managed in MunicipalLandfills

Tables C-12 through C-15 present the results of the sensitivity analysis for the lead in the sludge residue managed in municipal landfills. Sensitivity analyses were performed for only this constituent due to very low risks in this waste stream.

Table C-1. Chemical-Specific Properties for Constituents of Concern in the Sludge Waste in the $NaCl0_3$ Sector

	Waste Constituent Concentrations		*Degradation Rates*		
Constituent	**TCLP (MSW landfill) (mg/L)**	**Total waste (mg/kg)**	**Finite MSW Source Ratio (L/kg)**	**Overall Hydrolysis rate(1/yr)**	**Biodegrd. Rate(1/yr)**
Arsenic	0.03	14.3	477	0	0
Arsenic	*0.0025*	*2.5*	1000	0	0
Arsenic	*0.0025*	*2.5*	1000	0	0
Arsenic	*0.0025*	*2.5*	1000	0	0
Lead	0.024	14.8	617	0	0
Lead	*0.015*	139	9267	0	0
Lead	0.12	19.3	161	0	0
Lead	0.05	34.9	698	0	0
Manganese	0.08	69.2	865	0	0
Manganese	4.5	238	53	0	0
Manganese	0.5	125	250	0	0
Manganese	0.7	51.9	74	0	0
Nickel	*0.1*	7.4	74	0	0
Nickel	0.4	12.1	30	0	0
Nickel	0.1	*2.5*	*25*	0	0
Nickel	*0.1*	*2.5*	25	0	0
Zinc	*1*	111	111	0	0
Zinc	10.6	279	26	0	0
Zinc	*1*	*25*	25	0	0
Zinc	*1*	*25*	25	0	0

underline italics indicate values set at 1/2 of detection limit

Table C-2. Distribution of Municipal Landfill Areas

Empirical distribution	Area Range Minimum m2		Maximum m2	Relative Prob.
	4,000	to	8,090	0.100
	8,090	to	20,200	0.150
	20,200	to	60,700	0.250
	60,700	to	194,000	0.250
	194,000	to	420,000	0.150
	420,000	to	9,350,000	0.100
Total Relative Probability				1.000

Table C-3. Waste Stream Parameters for Sludge Waste in the $NaCl0_3$ Sector

WMU	Location	Landfill Area	Waste Quantity (MT/y)	Waste Density (g/cm^3)	Waste Density (kg/m^3)	Total Waste Vol (m^3)
MunicipalLandfill	Elgin, SC	Distribution	135	1.4	1400	all
MunicipalLandfill	Starkville, MS	Distribution	130	1.2	1200	combinations
MunicipalLandfill	Ephrate, WA	Distribution	89	NA	NA	quantity/density

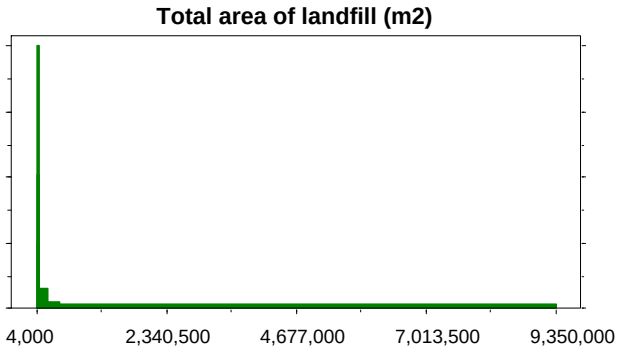

Figure C-1. Distribution of municipal landfill areas.

Table C-4. Site-Specific Climate-Based Parameters for Sludge Waste in the $NaCl0_3$ Sector

WMU	Location	Climate Index	Climate Center	Landfill Infiltartion Rate Recharge Rate (m/yr)				GWpH		
				SCL	SLT	SNL	GW TempC	SCL	SLT	SNL
Municipal Landfill	Elgin, SC	93	Charleston, SC	0.21	0.26	0.33	18	5.2	5.0	5.3
Municipal Landfill	Starkville, MS	90	Little Rock, AK	0.28	0.35	0.43	19	5.7	5.0	5.0
Municipal Landfill	Ephrata, WA	9	Yakima, WA	0.0003	0	0.0023	14	7.3	7.3	6.9

Table C-5. Aquifer Types Common Within 100-Mile Radius of WMU Currently Managing Sludge Waste in the $NaCl0_3$ Sector

Aquifer Types	Aquifer Code	Elgin, SC	Starkville, MS	Ephrata, WA
Metamorphic & igneous	1	70%		
Bedded Sedimentary Rock	2			50%
River Valleys/Flood Plains w/ overbank deposits	6		25%	
River Valleys/Flood Plains w/o overbank deposits	7		25%	50%
Outwash	8			
Till and Till over outwash	9			
Unconsolidated and semiconsolidated shallow aquifers	10	30%	50%	60%
Solution Limestone	12			

Table C-6. Soil Textures Common Within 100-Mile Radius of WMU Currently Managing Sludge Waste in the $NaC10_3$ Sector

		Elgin, SC	Starkville, MS	Ephrata, WA
silty clay loam	SCL	43%	32%	3%
silt loam	SIL	26%	62%	56%
sandy loam	SNL	31%	5%	41%

Table C-7. Chemical-Specific Properties for Constituents of Concern for Filter Wastes in the $NaCl0_3$ Sector

	Waste Constituent Concentrations			*Degradation Rates*	
Constituent	**TCLP (MSW landfill) (mg/L)**	**Total waste (mg/kg)**	**Finite MSW Source Ratio (L/kg)**	**Overall Hydrolysis rate(1/yr)**	**Biodegrd. Rate(1/yr)**
Arsenic	0.014	7.3	521	0	0
Arsenic	*0.0025*	5.3	2120	0	0
Antimony	0.018	34.1	1894	0	0
Antimony	0.012	*2.5*	208	0	0
Cadmium	*0.025*	22.5	900	0	0
Cadmium	*0.025*	*2.5*	100	0	0

underline italics indicate values set at 1/2 of detection limit

Table C-8. Distribution of Industrial D and Municipal Landfills

	Area Range			
Empirical distribution	**Minimum m2**		**Maximum m2**	**Relative Prob.**
	4,000	to	8,090	0.100
	8,090	to	20,200	0.150
	20,200	to	60,700	0.250
	60,700	to	194,000	0.250
	194,000	to	420,000	0.150
	420,000	to	9,350,000	0.100
Total Relative Probability				1.000

Table C-9. Waste Stream Parameters for Filter Wastes in the $NaCl0_3$ Sector

WMU	Location	Landfill Area	Waste Quantity. (MT/y)	Waste Density (g/cm^3)	Waste Density (kg/m^3)	Total Waste Vol (m^3)
Industrial D Landfill	PerdueHill, Al	Distribution	0.6	1.4	1400	all combinations quantity/density
Municipal Landfill	Blythe, GA	Distribution	2.3	1.2	1200	
Municipal Landfill	Ephrata,WA	Distribution	0.5			

Table C-10. Site-Specific Climate-Based Parameters for Filter Wastes in the $NaCl0_3$ Sector

WMU	Location	Climate Index	Climate Center	Landfill Infiltartion Rate Recharge Rate (m/yr)				GWpH		
				SCL	SLT	SNL	GW TempC	SCL	SLT	SNL
Municipal Landfill	Blythe, GA	95	Atlanta, GA	0.28	0.34	0.40	18	5.3	5.1	5.2
Municipal Landfill	Ephrata, WA	9	Yakima, WA	0.0003	0	0.0023	14	7.3	7.3	6.9
Industrial D Landfill	Perdue Hill, AL	95	Atlanta, GA	0.28	0.34	0.40	20	6.0	5.0	5.0

Table C-11. Aquifer Types Common in 100-Mile Radius of WMU Currently Managing Filter Wastes in the $NaCl0_3$ Sector

Aquifer Types	Aquifer Code	Ephrata, WA	Blythe, GA	Perdue Hill, AL
Metamorphic & igneous	1		40%	
Bedded Sedimentary Rock	2	50%		
River Valleys/Flood Plains w/ overbank deposits	6			17%
River Valleys/Flood Plains w/o overbank deposits	7	50%		17%
Unconsolidated and semiconsolidated shallow aquifers	10		60%	33%
Solution Limestone	12			33%

Table C-12. Soil Textures Common Within 100-Mile Radius of WMU Managing Filter Waste in $NaCl0_3$ Sector

		Ephrata, WA	Blythe, GA	Perdue Hill, AL
silty clay loam	SCL	3%	24%	7%
silt loam	SIL	56%	40%	59%
sandy loam	SNL	41%	36%	34%

Aquifer types assigned based on groundwater atlas (Heath, 1984) and GIS maps (approx. 100-mile radius); soils represent 100-mile radius around city centroid from STATSGO database.

Table C-13. Summary of Parameters Considered in Sensitivity Analysis for Lead

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
ACIDCAT	Acid Catalyzed Hydrolysis Rate Constant	C			
ANGLEW	Angle of Well Off Plume Centerline	anglew			
ANISORAT	Anisotropy Ratio	C			
AQUTHIK	Aquifer Thickness	aquthik**-0.1		Y	Y
AVGPDIAM	Avg. Particle Diameter	log(avgpdiam+0.001)		Y	
BASECAT	Base Catalyzed Hydrolysis Rate Constant	C			
BIODRATA	Biodegradation Rate	C			
BIODRATU	Biodegradation Rate	C			
BULKDENS	Bulk Density	bulkdens**3.5	Y		
CHEMDRU	Chemical Decay Rate	C			
CHEMDRA	Chemical Decay Rate	C			
CONSH2OA	Consump of drinking water	C			
ZDIST	Depth of Well Below Water Table	log(zdist+3)		Y	Y
DISHYD	Dissolved Hydrolysis Rate	C			
YDIST	Distance from Plume Centerline to Well	log(ydist+10)		Y	Y
DURLEACH	Duration of Leaching Period	durleach**-0.07	Y		
GWAVTIM	Exposure Duration	C			
FRORGCAR	Fraction Organic Carbon	log(frorgcar)		Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	log(frcoefa+200)		Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	log(frcoefu+100)		Y	Y
FREXPA	Freundlich Isotherm Exponent	C			
FREXPU	Freundlich Isotherm Exponent	C			
GWPH	Groundwater pH	gwph	Y		
GWSEEPV	Groundwater Seepage Velocity	log(gwseepv-0.05)	Y		
GWTEMP	Groundwater Temperature	gwtemp	Y		
HYDGRAD	Hydraulic Gradient	log(hydgrad+0.0003)		Y	Y
INFILRAT	Infiltration Rate	infilrat**1.5		Y	Y
LANDEPTH	Landfill Depth	log(landepth+0.001)	Y		
LEACHCON	Leachate Concentration	leachcon		Y	Y
LFFRACT	LF Fraction	C			
LONDISPU	Longitudinal Dispersivity	log(londispu-0.017)	Y		
LONDISPA	Longitudinal Dispersivity	log(londispa+0.3)		Y	Y
XDIST	Longitudinal Distance to Well	log(xdist+200)		Y	Y

Table C-13. Summary of Parameters Considered in Sensitivity Analysis for Lead

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
LONHYCON	Longitundinal Hydraulic Conductivity	log(lonhycon-3.1)		Y	Y
MLLA	ml/L	C			
MOISTRPA	Moisture Rention Parameter (a)	log(moistrpa-0.05)			
MOISTRPB	Moisture Rention Parameter (b)	log(moistrpb-0.9)		Y	Y
MOLDIFF	Molecular Diffusion Coefficient	C			
NEUTHYD	Neutral Hydrolysis Rate Constant	C			
ORGCDIS	Organic Carbon Distribution Coefficient	C			
PERORGM	Percent Organic Matter	log(perorgm)		Y	
POROSITY	Porosity	porosity**1.3		Y	
RADISTW	Radial Distance to Well	log(radistw+250)	Y		
RECHARAT	Recharge Rate	recharat	Y		
RESIDH2O	Residual Water Content	residh2o**1.7		Y	
RETCOEF	Retardation Coefficient	log(retcoef+1000)	Y		
RFDA	RfD (mg/kg/day)	C			
SATHYCON	Saturated Hydraulic Conductivity	log(sathycon)		Y	Y
SATURH2O	Saturated Water Content	saturh2o		Y	Y
SOILBDEN	Soil Bulk Density	soilbden	Y		
SORBHYD	Sorbed Hydrolysis Rate	C			
TRANDISP	Transverse Dispersivity	log(trandisp+0.01)	Y		
UNSATHIK	Unsaturated Zone Thickness	log(unsathik-0.3)		Y	Y
VERTDISP	Vertical Dispersivity	log(vertdisp+0.001)	Y		
WASTDENS	Waste Density	wastdens			
WASTEVOL	Waste Volume	wastevol	Y		
WMUAREA	WMU Area	log(wmuarea-3900)		Y	Y
WMULEN	WMU Length	log(wmulen-50)	Y		
WMUWIDTH	WMU Width	log(wmuwidth-50)	Y		

Table C-14. Summary of Correlated Parameters for Lead

Variable 1		Variable 2		Correlation Coefficient
Code	Description	Code	Description	
AVGPDIAM	Avg. Particle Diameter	BULKDENS	Bulk Density	0.9981
LONHYCON	Longitundinal Hydraulic Conductivi	GWSEEPV	Groundwater Seepage Velocity	0.70541
FRCOEFA	Freundlich Isotherm Coefficient	RETCOEF	Retardation Coefficient	0.9833
LONDISPA	Longitudinal Dispersivity	TRANDISP	Transverse Dispersivity	0.99936
LONDISPA	Longitudinal Dispersivity	VERTDISP	Vertical Dispersivity	0.99706
RECHARAT	Recharge Rate	GWTEMP	Groundwater Temperature	0.96535
INFILRAT	Infiltration Rate	GWTEMP	Groundwater Temperature	0.90116
WASTEVOL	Waste Volume	GWTEMP	Groundwater Temperature	0.89565
DURLEACH	Duration of Leaching Period	GWTEMP	Groundwater Temperature	0.80226
GWTEMP	Groundwater Temperature	GWPH	Groundwater pH	-0.94775
RECHARAT	Recharge Rate	GWPH	Groundwater pH	-0.93636
INFILRAT	Infiltration Rate	GWPH	Groundwater pH	-0.87629
WASTEVOL	Waste Volume	GWPH	Groundwater pH	-0.90587
DURLEACH	Duration of Leaching Period	GWPH	Groundwater pH	-0.83302
XDIST	Longitudinal Distance to Well	RADISTW	Radial Distance to Well	0.9926
WMUAREA	WMU Area	WMULEN	WMU Length	0.99825
LANDEPTH	Landfill Depth	WMULEN	WMU Length	-0.98741
WMUAREA	WMU Area	WMUWIDTH	WMU Width	0.99825
LANDEPTH	Landfill Depth	WMUWIDTH	WMU Width	-0.98741
GWTEMP	Groundwater Temperature	RECHARAT	Recharge Rate	0.96535
INFILRAT	Infiltration Rate	RECHARAT	Recharge Rate	0.97195
WASTEVOL	Waste Volume	RECHARAT	Recharge Rate	0.85748
DURLEACH	Duration of Leaching Period	RECHARAT	Recharge Rate	0.78287
WMUAREA	WMU Area	LANDEPTH	Landfill Depth	-0.98253
RECHARAT	Recharge Rate	WASTEVOL	Waste Volume	0.85748
INFILRAT	Infiltration Rate	WASTEVOL	Waste Volume	0.7775
DURLEACH	Duration of Leaching Period	WASTEVOL	Waste Volume	0.75754
GWTEMP	Groundwater Temperature	DURLEACH	Duration of Leaching Period	0.80226
RECHARAT	Recharge Rate	DURLEACH	Duration of Leaching Period	0.78287
INFILRAT	Infiltration Rate	DURLEACH	Duration of Leaching Period	0.72658
WASTEVOL	Waste Volume	DURLEACH	Duration of Leaching Period	0.75754
UNSATHIK	Unsaturated Zone Thickness	LONDISPU	Longitudinal Dispersivity	0.93989
SATHYCON	Saturated Hydraulic Conductivity	SOILBDEN	Soil Bulk Density	-0.74598
MOISTRPA	Moisture Rention Parameter (a)	SOILBDEN	Soil Bulk Density	-0.7801
MOISTRPB	Moisture Rention Parameter (b)	SOILBDEN	Soil Bulk Density	-0.8645

Note: Parameters in the variable 2 column were removed from the analysis.

Table C-15. Summary of Crosspairs Analysis for Lead

Variable 1		Variable 2			
Code	Description	Code	Description	P<0.05	P<0.01
AVGPDIAM	Avg. Particle Diameter				
POROSITY	Porosity				
AQUTHIK	Aquifer Thickness			Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity			Y	Y
HYDGRAD	Hydraulic Gradient			Y	Y
LONDISPA	Longitudinal Dispersivity			Y	Y
FRORGCAR	Fraction Organic Carbon				
ANGLEW	Angle of Well Off Plume Centerline				
XDIST	Longitudinal Distance to Well			Y	Y
YDIST	Distance from Plume Centerline to Well				
ZDIST	Depth of Well Below Water Table				
FRCOEFA	Freundlich Isotherm Coefficient			Y	Y
WMUAREA	WMU Area				
LEACHCON	Leachate Concentration				
INFILRAT	Infiltration Rate			Y	Y
WASTDENS	Waste Density				
SATHYCON	Saturated Hydraulic Conductivity				
MOISTRPA	Moisture Rention Parameter (a)				
MOISTRPB	Moisture Rention Parameter (b)				
RESIDH2O	Residual Water Content			Y	
SATURH2O	Saturated Water Content			Y	Y
UNSATHIK	Unsaturated Zone Thickness			Y	Y
PERORGM	Percent Organic Matter				
FRCOEFU	Freundlich Isotherm Coefficient			Y	Y
AVGPDIAM	Avg. Particle Diameter	AVGPDIAM	Avg. Particle Diameter		
POROSITY	Porosity	AVGPDIAM	Avg. Particle Diameter		
POROSITY	Porosity	POROSITY	Porosity		
AQUTHIK	Aquifer Thickness	AVGPDIAM	Avg. Particle Diameter		
AQUTHIK	Aquifer Thickness	POROSITY	Porosity		
AQUTHIK	Aquifer Thickness	AQUTHIK	Aquifer Thickness	Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity	AVGPDIAM	Avg. Particle Diameter		
LONHYCON	Longitundinal Hydraulic Conductivity	POROSITY	Porosity		
LONHYCON	Longitundinal Hydraulic Conductivity	AQUTHIK	Aquifer Thickness		
LONHYCON	Longitundinal Hydraulic Conductivity	LONHYCON	Longitundinal Hydraulic Conductivity	Y	
HYDGRAD	Hydraulic Gradient	AVGPDIAM	Avg. Particle Diameter		
HYDGRAD	Hydraulic Gradient	POROSITY	Porosity		
HYDGRAD	Hydraulic Gradient	AQUTHIK	Aquifer Thickness		
HYDGRAD	Hydraulic Gradient	LONHYCON	Longitundinal Hydraulic Conductivity	Y	
HYDGRAD	Hydraulic Gradient	HYDGRAD	Hydraulic Gradient		
LONDISPA	Longitudinal Dispersivity	AVGPDIAM	Avg. Particle Diameter		
LONDISPA	Longitudinal Dispersivity	POROSITY	Porosity	Y	
LONDISPA	Longitudinal Dispersivity	AQUTHIK	Aquifer Thickness		
LONDISPA	Longitudinal Dispersivity	LONHYCON	Longitundinal Hydraulic Conductivity		
LONDISPA	Longitudinal Dispersivity	HYDGRAD	Hydraulic Gradient		
LONDISPA	Longitudinal Dispersivity	LONDISPA	Longitudinal Dispersivity		
FRORGCAR	Fraction Organic Carbon	AVGPDIAM	Avg. Particle Diameter		
FRORGCAR	Fraction Organic Carbon	POROSITY	Porosity		
FRORGCAR	Fraction Organic Carbon	AQUTHIK	Aquifer Thickness		
FRORGCAR	Fraction Organic Carbon	LONHYCON	Longitundinal Hydraulic Conductivity		

Table C-15. Summary of Crosspairs Analysis for Lead

Variable 1		Variable 2			
Code	Description	Code	Description	P<0.05	P<0.01
FRORGCAR	Fraction Organic Carbon	HYDGRAD	Hydraulic Gradient	Y	Y
FRORGCAR	Fraction Organic Carbon	LONDISPA	Longitudinal Dispersivity		
FRORGCAR	Fraction Organic Carbon	FRORGCAR	Fraction Organic Carbon		
ANGLEW	Angle of Well Off Plume Centerline	AVGPDIAM	Avg. Particle Diameter		
ANGLEW	Angle of Well Off Plume Centerline	POROSITY	Porosity		
ANGLEW	Angle of Well Off Plume Centerline	AQUTHIK	Aquifer Thickness		
ANGLEW	Angle of Well Off Plume Centerline	LONHYCON	Longitundinal Hydraulic Conductivity		
ANGLEW	Angle of Well Off Plume Centerline	HYDGRAD	Hydraulic Gradient		
ANGLEW	Angle of Well Off Plume Centerline	LONDISPA	Longitudinal Dispersivity		
ANGLEW	Angle of Well Off Plume Centerline	FRORGCAR	Fraction Organic Carbon		
ANGLEW	Angle of Well Off Plume Centerline	ANGLEW	Angle of Well Off Plume Centerline		
XDIST	Longitudinal Distance to Well	AVGPDIAM	Avg. Particle Diameter		
XDIST	Longitudinal Distance to Well	POROSITY	Porosity		
XDIST	Longitudinal Distance to Well	AQUTHIK	Aquifer Thickness		
XDIST	Longitudinal Distance to Well	LONHYCON	Longitundinal Hydraulic Conductivity		
XDIST	Longitudinal Distance to Well	HYDGRAD	Hydraulic Gradient		
XDIST	Longitudinal Distance to Well	LONDISPA	Longitudinal Dispersivity		
XDIST	Longitudinal Distance to Well	FRORGCAR	Fraction Organic Carbon		
XDIST	Longitudinal Distance to Well	ANGLEW	Angle of Well Off Plume Centerline		
XDIST	Longitudinal Distance to Well	XDIST	Longitudinal Distance to Well	Y	Y
YDIST	Distance from Plume Centerline to Well	AVGPDIAM	Avg. Particle Diameter		
YDIST	Distance from Plume Centerline to Well	POROSITY	Porosity		
YDIST	Distance from Plume Centerline to Well	AQUTHIK	Aquifer Thickness		
YDIST	Distance from Plume Centerline to Well	LONHYCON	Longitundinal Hydraulic Conductivity		
YDIST	Distance from Plume Centerline to Well	HYDGRAD	Hydraulic Gradient		
YDIST	Distance from Plume Centerline to Well	LONDISPA	Longitudinal Dispersivity		
YDIST	Distance from Plume Centerline to Well	FRORGCAR	Fraction Organic Carbon		
YDIST	Distance from Plume Centerline to Well	ANGLEW	Angle of Well Off Plume Centerline		
YDIST	Distance from Plume Centerline to Well	XDIST	Longitudinal Distance to Well		
YDIST	Distance from Plume Centerline to Well	YDIST	Distance from Plume Centerline to Well		
ZDIST	Depth of Well Below Water Table	AVGPDIAM	Avg. Particle Diameter		
ZDIST	Depth of Well Below Water Table	POROSITY	Porosity		
ZDIST	Depth of Well Below Water Table	AQUTHIK	Aquifer Thickness		
ZDIST	Depth of Well Below Water Table	LONHYCON	Longitundinal Hydraulic Conductivity		
ZDIST	Depth of Well Below Water Table	HYDGRAD	Hydraulic Gradient		
ZDIST	Depth of Well Below Water Table	LONDISPA	Longitudinal Dispersivity		
ZDIST	Depth of Well Below Water Table	FRORGCAR	Fraction Organic Carbon		
ZDIST	Depth of Well Below Water Table	ANGLEW	Angle of Well Off Plume Centerline		
ZDIST	Depth of Well Below Water Table	XDIST	Longitudinal Distance to Well		
ZDIST	Depth of Well Below Water Table	YDIST	Distance from Plume Centerline to Well		
ZDIST	Depth of Well Below Water Table	ZDIST	Depth of Well Below Water Table	Y	
FRCOEFA	Freundlich Isotherm Coefficient	AVGPDIAM	Avg. Particle Diameter		
FRCOEFA	Freundlich Isotherm Coefficient	POROSITY	Porosity		
FRCOEFA	Freundlich Isotherm Coefficient	AQUTHIK	Aquifer Thickness		
FRCOEFA	Freundlich Isotherm Coefficient	LONHYCON	Longitundinal Hydraulic Conductivity		
FRCOEFA	Freundlich Isotherm Coefficient	HYDGRAD	Hydraulic Gradient		
FRCOEFA	Freundlich Isotherm Coefficient	LONDISPA	Longitudinal Dispersivity	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	FRORGCAR	Fraction Organic Carbon	Y	
FRCOEFA	Freundlich Isotherm Coefficient	ANGLEW	Angle of Well Off Plume Centerline		

Table C-15. Summary of Crosspairs Analysis for Lead

Variable 1		Variable 2			
Code	Description	Code	Description	P<0.05	P<0.01
FRCOEFA	Freundlich Isotherm Coefficient	XDIST	Longitudinal Distance to Well	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	YDIST	Distance from Plume Centerline to Well		
FRCOEFA	Freundlich Isotherm Coefficient	ZDIST	Depth of Well Below Water Table		
FRCOEFA	Freundlich Isotherm Coefficient	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
WMUAREA	WMU Area	AVGPDIAM	Avg. Particle Diameter		
WMUAREA	WMU Area	POROSITY	Porosity		
WMUAREA	WMU Area	AQUTHIK	Aquifer Thickness		
WMUAREA	WMU Area	LONHYCON	Longitundinal Hydraulic Conductivity		
WMUAREA	WMU Area	HYDGRAD	Hydraulic Gradient		
WMUAREA	WMU Area	LONDISPA	Longitudinal Dispersivity		
WMUAREA	WMU Area	FRORGCAR	Fraction Organic Carbon		
WMUAREA	WMU Area	ANGLEW	Angle of Well Off Plume Centerline		
WMUAREA	WMU Area	XDIST	Longitudinal Distance to Well		
WMUAREA	WMU Area	YDIST	Distance from Plume Centerline to Well		
WMUAREA	WMU Area	ZDIST	Depth of Well Below Water Table		
WMUAREA	WMU Area	FRCOEFA	Freundlich Isotherm Coefficient	Y	
WMUAREA	WMU Area	WMUAREA	WMU Area		
LEACHCON	Leachate Concentration	AVGPDIAM	Avg. Particle Diameter		
LEACHCON	Leachate Concentration	POROSITY	Porosity		
LEACHCON	Leachate Concentration	AQUTHIK	Aquifer Thickness		
LEACHCON	Leachate Concentration	LONHYCON	Longitundinal Hydraulic Conductivity		
LEACHCON	Leachate Concentration	HYDGRAD	Hydraulic Gradient		
LEACHCON	Leachate Concentration	LONDISPA	Longitudinal Dispersivity		
LEACHCON	Leachate Concentration	FRORGCAR	Fraction Organic Carbon		
LEACHCON	Leachate Concentration	ANGLEW	Angle of Well Off Plume Centerline		
LEACHCON	Leachate Concentration	XDIST	Longitudinal Distance to Well	Y	Y
LEACHCON	Leachate Concentration	YDIST	Distance from Plume Centerline to Well		
LEACHCON	Leachate Concentration	ZDIST	Depth of Well Below Water Table		
LEACHCON	Leachate Concentration	FRCOEFA	Freundlich Isotherm Coefficient		
LEACHCON	Leachate Concentration	WMUAREA	WMU Area		
LEACHCON	Leachate Concentration	LEACHCON	Leachate Concentration		
INFILRAT	Infiltration Rate	AVGPDIAM	Avg. Particle Diameter		
INFILRAT	Infiltration Rate	POROSITY	Porosity		
INFILRAT	Infiltration Rate	AQUTHIK	Aquifer Thickness	Y	Y
INFILRAT	Infiltration Rate	LONHYCON	Longitundinal Hydraulic Conductivity	Y	
INFILRAT	Infiltration Rate	HYDGRAD	Hydraulic Gradient	Y	
INFILRAT	Infiltration Rate	LONDISPA	Longitudinal Dispersivity	Y	Y
INFILRAT	Infiltration Rate	FRORGCAR	Fraction Organic Carbon		
INFILRAT	Infiltration Rate	ANGLEW	Angle of Well Off Plume Centerline		
INFILRAT	Infiltration Rate	XDIST	Longitudinal Distance to Well	Y	Y
INFILRAT	Infiltration Rate	YDIST	Distance from Plume Centerline to Well	Y	Y
INFILRAT	Infiltration Rate	ZDIST	Depth of Well Below Water Table	Y	Y
INFILRAT	Infiltration Rate	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
INFILRAT	Infiltration Rate	WMUAREA	WMU Area	Y	Y
INFILRAT	Infiltration Rate	LEACHCON	Leachate Concentration		
INFILRAT	Infiltration Rate	INFILRAT	Infiltration Rate	Y	Y
WASTDENS	Waste Density	AVGPDIAM	Avg. Particle Diameter		
WASTDENS	Waste Density	POROSITY	Porosity		
WASTDENS	Waste Density	AQUTHIK	Aquifer Thickness		

Table C-15. Summary of Crosspairs Analysis for Lead

Variable 1		Variable 2			
Code	Description	Code	Description	P<0.05	P<0.01
WASTDENS	Waste Density	LONHYCON	Longitundinal Hydraulic Conductivity		
WASTDENS	Waste Density	HYDGRAD	Hydraulic Gradient		
WASTDENS	Waste Density	LONDISPA	Longitudinal Dispersivity		
WASTDENS	Waste Density	FRORGCAR	Fraction Organic Carbon		
WASTDENS	Waste Density	ANGLEW	Angle of Well Off Plume Centerline		
WASTDENS	Waste Density	XDIST	Longitudinal Distance to Well		
WASTDENS	Waste Density	YDIST	Distance from Plume Centerline to Well		
WASTDENS	Waste Density	ZDIST	Depth of Well Below Water Table		
WASTDENS	Waste Density	FRCOEFA	Freundlich Isotherm Coefficient		
WASTDENS	Waste Density	WMUAREA	WMU Area		
WASTDENS	Waste Density	LEACHCON	Leachate Concentration		
WASTDENS	Waste Density	INFILRAT	Infiltration Rate		
WASTDENS	Waste Density	WASTDENS	Waste Density		
SATHYCON	Saturated Hydraulic Conductivity	AVGPDIAM	Avg. Particle Diameter		
SATHYCON	Saturated Hydraulic Conductivity	POROSITY	Porosity		
SATHYCON	Saturated Hydraulic Conductivity	AQUTHIK	Aquifer Thickness		
SATHYCON	Saturated Hydraulic Conductivity	LONHYCON	Longitundinal Hydraulic Conductivity		
SATHYCON	Saturated Hydraulic Conductivity	HYDGRAD	Hydraulic Gradient		
SATHYCON	Saturated Hydraulic Conductivity	LONDISPA	Longitudinal Dispersivity		
SATHYCON	Saturated Hydraulic Conductivity	FRORGCAR	Fraction Organic Carbon		
SATHYCON	Saturated Hydraulic Conductivity	ANGLEW	Angle of Well Off Plume Centerline		
SATHYCON	Saturated Hydraulic Conductivity	XDIST	Longitudinal Distance to Well		
SATHYCON	Saturated Hydraulic Conductivity	YDIST	Distance from Plume Centerline to Well		
SATHYCON	Saturated Hydraulic Conductivity	ZDIST	Depth of Well Below Water Table		
SATHYCON	Saturated Hydraulic Conductivity	FRCOEFA	Freundlich Isotherm Coefficient		
SATHYCON	Saturated Hydraulic Conductivity	WMUAREA	WMU Area		
SATHYCON	Saturated Hydraulic Conductivity	LEACHCON	Leachate Concentration		
SATHYCON	Saturated Hydraulic Conductivity	INFILRAT	Infiltration Rate		
SATHYCON	Saturated Hydraulic Conductivity	WASTDENS	Waste Density		
SATHYCON	Saturated Hydraulic Conductivity	SATHYCON	Saturated Hydraulic Conductivity		
MOISTRPA	Moisture Rention Parameter (a)	AVGPDIAM	Avg. Particle Diameter		
MOISTRPA	Moisture Rention Parameter (a)	POROSITY	Porosity		
MOISTRPA	Moisture Rention Parameter (a)	AQUTHIK	Aquifer Thickness		
MOISTRPA	Moisture Rention Parameter (a)	LONHYCON	Longitundinal Hydraulic Conductivity		
MOISTRPA	Moisture Rention Parameter (a)	HYDGRAD	Hydraulic Gradient		
MOISTRPA	Moisture Rention Parameter (a)	LONDISPA	Longitudinal Dispersivity		
MOISTRPA	Moisture Rention Parameter (a)	FRORGCAR	Fraction Organic Carbon		
MOISTRPA	Moisture Rention Parameter (a)	ANGLEW	Angle of Well Off Plume Centerline		
MOISTRPA	Moisture Rention Parameter (a)	XDIST	Longitudinal Distance to Well		
MOISTRPA	Moisture Rention Parameter (a)	YDIST	Distance from Plume Centerline to Well		
MOISTRPA	Moisture Rention Parameter (a)	ZDIST	Depth of Well Below Water Table		
MOISTRPA	Moisture Rention Parameter (a)	FRCOEFA	Freundlich Isotherm Coefficient		
MOISTRPA	Moisture Rention Parameter (a)	WMUAREA	WMU Area		
MOISTRPA	Moisture Rention Parameter (a)	LEACHCON	Leachate Concentration		
MOISTRPA	Moisture Rention Parameter (a)	INFILRAT	Infiltration Rate		
MOISTRPA	Moisture Rention Parameter (a)	WASTDENS	Waste Density		
MOISTRPA	Moisture Rention Parameter (a)	SATHYCON	Saturated Hydraulic Conductivity		
MOISTRPA	Moisture Rention Parameter (a)	MOISTRPA	Moisture Rention Parameter (a)		
MOISTRPB	Moisture Rention Parameter (b)	AVGPDIAM	Avg. Particle Diameter		

Table C-15. Summary of Crosspairs Analysis for Lead

Variable 1		Variable 2			
Code	Description	Code	Description	P<0.05	P<0.01
MOISTRPB	Moisture Rention Parameter (b)	POROSITY	Porosity		
MOISTRPB	Moisture Rention Parameter (b)	AQUTHIK	Aquifer Thickness		
MOISTRPB	Moisture Rention Parameter (b)	LONHYCON	Longitundinal Hydraulic Conductivity		
MOISTRPB	Moisture Rention Parameter (b)	HYDGRAD	Hydraulic Gradient		
MOISTRPB	Moisture Rention Parameter (b)	LONDISPA	Longitudinal Dispersivity		
MOISTRPB	Moisture Rention Parameter (b)	FRORGCAR	Fraction Organic Carbon		
MOISTRPB	Moisture Rention Parameter (b)	ANGLEW	Angle of Well Off Plume Centerline		
MOISTRPB	Moisture Rention Parameter (b)	XDIST	Longitudinal Distance to Well		
MOISTRPB	Moisture Rention Parameter (b)	YDIST	Distance from Plume Centerline to Well		
MOISTRPB	Moisture Rention Parameter (b)	ZDIST	Depth of Well Below Water Table		
MOISTRPB	Moisture Rention Parameter (b)	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
MOISTRPB	Moisture Rention Parameter (b)	WMUAREA	WMU Area		
MOISTRPB	Moisture Rention Parameter (b)	LEACHCON	Leachate Concentration		
MOISTRPB	Moisture Rention Parameter (b)	INFILRAT	Infiltration Rate		
MOISTRPB	Moisture Rention Parameter (b)	WASTDENS	Waste Density		
MOISTRPB	Moisture Rention Parameter (b)	SATHYCON	Saturated Hydraulic Conductivity		
MOISTRPB	Moisture Rention Parameter (b)	MOISTRPA	Moisture Rention Parameter (a)		
MOISTRPB	Moisture Rention Parameter (b)	MOISTRPB	Moisture Rention Parameter (b)		
RESIDH2O	Residual Water Content	AVGPDIAM	Avg. Particle Diameter		
RESIDH2O	Residual Water Content	POROSITY	Porosity		
RESIDH2O	Residual Water Content	AQUTHIK	Aquifer Thickness		
RESIDH2O	Residual Water Content	LONHYCON	Longitundinal Hydraulic Conductivity		
RESIDH2O	Residual Water Content	HYDGRAD	Hydraulic Gradient		
RESIDH2O	Residual Water Content	LONDISPA	Longitudinal Dispersivity		
RESIDH2O	Residual Water Content	FRORGCAR	Fraction Organic Carbon		
RESIDH2O	Residual Water Content	ANGLEW	Angle of Well Off Plume Centerline		
RESIDH2O	Residual Water Content	XDIST	Longitudinal Distance to Well		
RESIDH2O	Residual Water Content	YDIST	Distance from Plume Centerline to Well		
RESIDH2O	Residual Water Content	ZDIST	Depth of Well Below Water Table		
RESIDH2O	Residual Water Content	FRCOEFA	Freundlich Isotherm Coefficient		
RESIDH2O	Residual Water Content	WMUAREA	WMU Area		
RESIDH2O	Residual Water Content	LEACHCON	Leachate Concentration		
RESIDH2O	Residual Water Content	INFILRAT	Infiltration Rate		
RESIDH2O	Residual Water Content	WASTDENS	Waste Density		
RESIDH2O	Residual Water Content	SATHYCON	Saturated Hydraulic Conductivity		
RESIDH2O	Residual Water Content	MOISTRPA	Moisture Rention Parameter (a)		
RESIDH2O	Residual Water Content	MOISTRPB	Moisture Rention Parameter (b)		
RESIDH2O	Residual Water Content	RESIDH2O	Residual Water Content		
SATURH2O	Saturated Water Content	AVGPDIAM	Avg. Particle Diameter		
SATURH2O	Saturated Water Content	POROSITY	Porosity		
SATURH2O	Saturated Water Content	AQUTHIK	Aquifer Thickness		
SATURH2O	Saturated Water Content	LONHYCON	Longitundinal Hydraulic Conductivity		
SATURH2O	Saturated Water Content	HYDGRAD	Hydraulic Gradient		
SATURH2O	Saturated Water Content	LONDISPA	Longitudinal Dispersivity	Y	Y
SATURH2O	Saturated Water Content	FRORGCAR	Fraction Organic Carbon		
SATURH2O	Saturated Water Content	ANGLEW	Angle of Well Off Plume Centerline		
SATURH2O	Saturated Water Content	XDIST	Longitudinal Distance to Well	Y	Y
SATURH2O	Saturated Water Content	YDIST	Distance from Plume Centerline to Well	Y	Y
SATURH2O	Saturated Water Content	ZDIST	Depth of Well Below Water Table	Y	Y

Table C-15. Summary of Crosspairs Analysis for Lead

Variable 1		Variable 2			
Code	Description	Code	Description	P<0.05	P<0.01
SATURH2O	Saturated Water Content	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
SATURH2O	Saturated Water Content	WMUAREA	WMU Area	Y	Y
SATURH2O	Saturated Water Content	LEACHCON	Leachate Concentration		
SATURH2O	Saturated Water Content	INFILRAT	Infiltration Rate	Y	Y
SATURH2O	Saturated Water Content	WASTDENS	Waste Density		
SATURH2O	Saturated Water Content	SATHYCON	Saturated Hydraulic Conductivity		
SATURH2O	Saturated Water Content	MOISTRPA	Moisture Rention Parameter (a)		
SATURH2O	Saturated Water Content	MOISTRPB	Moisture Rention Parameter (b)		
SATURH2O	Saturated Water Content	RESIDH2O	Residual Water Content		
SATURH2O	Saturated Water Content	SATURH2O	Saturated Water Content		
UNSATHIK	Unsaturated Zone Thickness	AVGPDIAM	Avg. Particle Diameter	Y	
UNSATHIK	Unsaturated Zone Thickness	POROSITY	Porosity		
UNSATHIK	Unsaturated Zone Thickness	AQUTHIK	Aquifer Thickness	Y	
UNSATHIK	Unsaturated Zone Thickness	LONHYCON	Longitundinal Hydraulic Conductivity		
UNSATHIK	Unsaturated Zone Thickness	HYDGRAD	Hydraulic Gradient		
UNSATHIK	Unsaturated Zone Thickness	LONDISPA	Longitudinal Dispersivity	Y	Y
UNSATHIK	Unsaturated Zone Thickness	FRORGCAR	Fraction Organic Carbon		
UNSATHIK	Unsaturated Zone Thickness	ANGLEW	Angle of Well Off Plume Centerline		
UNSATHIK	Unsaturated Zone Thickness	XDIST	Longitudinal Distance to Well	Y	Y
UNSATHIK	Unsaturated Zone Thickness	YDIST	Distance from Plume Centerline to Well		
UNSATHIK	Unsaturated Zone Thickness	ZDIST	Depth of Well Below Water Table		
UNSATHIK	Unsaturated Zone Thickness	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
UNSATHIK	Unsaturated Zone Thickness	WMUAREA	WMU Area		
UNSATHIK	Unsaturated Zone Thickness	LEACHCON	Leachate Concentration	Y	Y
UNSATHIK	Unsaturated Zone Thickness	INFILRAT	Infiltration Rate	Y	Y
UNSATHIK	Unsaturated Zone Thickness	WASTDENS	Waste Density		
UNSATHIK	Unsaturated Zone Thickness	SATHYCON	Saturated Hydraulic Conductivity		
UNSATHIK	Unsaturated Zone Thickness	MOISTRPA	Moisture Rention Parameter (a)		
UNSATHIK	Unsaturated Zone Thickness	MOISTRPB	Moisture Rention Parameter (b)		
UNSATHIK	Unsaturated Zone Thickness	RESIDH2O	Residual Water Content		
UNSATHIK	Unsaturated Zone Thickness	SATURH2O	Saturated Water Content	Y	
UNSATHIK	Unsaturated Zone Thickness	UNSATHIK	Unsaturated Zone Thickness	Y	
PERORGM	Percent Organic Matter	AVGPDIAM	Avg. Particle Diameter	Y	
PERORGM	Percent Organic Matter	POROSITY	Porosity		
PERORGM	Percent Organic Matter	AQUTHIK	Aquifer Thickness		
PERORGM	Percent Organic Matter	LONHYCON	Longitundinal Hydraulic Conductivity		
PERORGM	Percent Organic Matter	HYDGRAD	Hydraulic Gradient		
PERORGM	Percent Organic Matter	LONDISPA	Longitudinal Dispersivity		
PERORGM	Percent Organic Matter	FRORGCAR	Fraction Organic Carbon		
PERORGM	Percent Organic Matter	ANGLEW	Angle of Well Off Plume Centerline		
PERORGM	Percent Organic Matter	XDIST	Longitudinal Distance to Well		
PERORGM	Percent Organic Matter	YDIST	Distance from Plume Centerline to Well		
PERORGM	Percent Organic Matter	ZDIST	Depth of Well Below Water Table		
PERORGM	Percent Organic Matter	FRCOEFA	Freundlich Isotherm Coefficient	Y	
PERORGM	Percent Organic Matter	WMUAREA	WMU Area		
PERORGM	Percent Organic Matter	LEACHCON	Leachate Concentration		
PERORGM	Percent Organic Matter	INFILRAT	Infiltration Rate		
PERORGM	Percent Organic Matter	WASTDENS	Waste Density		
PERORGM	Percent Organic Matter	SATHYCON	Saturated Hydraulic Conductivity		

Table C-15. Summary of Crosspairs Analysis for Lead

Variable 1		Variable 2			
Code	Description	Code	Description	P<0.05	P<0.01
PERORGM	Percent Organic Matter	MOISTRPA	Moisture Rention Parameter (a)		
PERORGM	Percent Organic Matter	MOISTRPB	Moisture Rention Parameter (b)	Y	
PERORGM	Percent Organic Matter	RESIDH2O	Residual Water Content		
PERORGM	Percent Organic Matter	SATURH2O	Saturated Water Content		
PERORGM	Percent Organic Matter	UNSATHIK	Unsaturated Zone Thickness		
PERORGM	Percent Organic Matter	PERORGM	Percent Organic Matter		
FRCOEFU	Freundlich Isotherm Coefficient	AVGPDIAM	Avg. Particle Diameter		
FRCOEFU	Freundlich Isotherm Coefficient	POROSITY	Porosity		
FRCOEFU	Freundlich Isotherm Coefficient	AQUTHIK	Aquifer Thickness	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	HYDGRAD	Hydraulic Gradient	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	LONDISPA	Longitudinal Dispersivity	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	FRORGCAR	Fraction Organic Carbon		
FRCOEFU	Freundlich Isotherm Coefficient	ANGLEW	Angle of Well Off Plume Centerline		
FRCOEFU	Freundlich Isotherm Coefficient	XDIST	Longitudinal Distance to Well	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	YDIST	Distance from Plume Centerline to Well	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	ZDIST	Depth of Well Below Water Table		
FRCOEFU	Freundlich Isotherm Coefficient	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	WMUAREA	WMU Area	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	LEACHCON	Leachate Concentration		
FRCOEFU	Freundlich Isotherm Coefficient	INFILRAT	Infiltration Rate	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	WASTDENS	Waste Density		
FRCOEFU	Freundlich Isotherm Coefficient	SATHYCON	Saturated Hydraulic Conductivity	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	MOISTRPA	Moisture Rention Parameter (a)		
FRCOEFU	Freundlich Isotherm Coefficient	MOISTRPB	Moisture Rention Parameter (b)	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	RESIDH2O	Residual Water Content		
FRCOEFU	Freundlich Isotherm Coefficient	SATURH2O	Saturated Water Content	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	UNSATHIK	Unsaturated Zone Thickness	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	PERORGM	Percent Organic Matter	Y	
FRCOEFU	Freundlich Isotherm Coefficient	FRCOEFU	Freundlich Isotherm Coefficient	Y	

Table C-16. Ranking of Parameters According to Percentage of Risk for Lead

Variable Description	Reduced Sums of Square	Variable Sums of Square	Variable Degrees of Freedom	% Risk Variation	Mean Square Variable	F VALUE	P VALUE
Freundlich Isotherm Coefficient {Unsaturated} (cm3/g)	349765.7	532754.67	16	41.2%	33297.17	401.60	0.00E+00
Freundlich Isotherm Coefficient {Aquifer} (cm3/g)	668683.3	213837.08	9	16.6%	23759.68	286.57	0.00E+00
Infiltration Rate (m/yr)	709609.4	172910.97	12	13.4%	14409.25	173.79	0.00E+00
Saturated Water Content (unitless)	823921.4	58598.94	9	4.5%	6510.99	78.53	1.66E-136
Longitudinal Distance to Well (m)	833892.1	48628.28	8	3.8%	6078.53	73.31	1.37E-114
Unsaturated Zone Thickness (m)	849497.3	33023.01	7	2.6%	4717.57	56.90	9.36E-79
WMU Area (m2)	861159.1	21361.24	4	1.7%	5340.31	64.41	3.60E-53
Longitudinal Dispersivity {Aquifer} (m)	861875.2	20645.16	6	1.6%	3440.86	41.50	1.27E-49
Distance from Plume Centerline to Well (m)	866656.1	15864.28	4	1.2%	3966.07	47.84	1.60E-39
Aquifer Thickness (m)	874959.8	7560.50	4	0.6%	1890.12	22.80	1.10E-18
Moisture Retention Parameter b	876907.7	5612.65	3	0.4%	1870.88	22.56	1.66E-14
Longitudinal Hydraulic Conductivity (m/yr)	877563.9	4956.42	2	0.4%	2478.21	29.89	1.25E-13
Hydraluic Gradient (m/m)	878865.5	3654.89	3	0.3%	1218.30	14.69	1.59E-09
Leachate Concentration (mg/l)	880077.0	2443.32	3	0.2%	814.44	9.82	1.86E-06
Waste Volume (m3)	880395.9	2124.47	2	0.2%	1062.23	12.81	2.82E-06
Fraction Organic Carbon (g/g)	881821.8	698.51	2	0.1%	349.25	4.21	1.49E-02
Depth of Well Below Water Table (m)	880612.3	1908.00	3	0.1%	636.00	7.67	4.11E-05
Percent Organic Matter	881620.5	899.85	2	0.1%	449.93	5.43	4.42E-03

Constants

Full Model SS	882520.34
Error SS	409416.38
Error DF	4938
MS Error	82.911

Appendix D

Titanium Dioxide

Appendix D
Titanium Dioxide Production Sector

This appendix provides supporting data for the Titanium Dioxide Production industry sector. This industry sector considers eight waste stream/waste management scenarios. The data used to model these scenarios and the sensitivity analyses conducted for them are presented in the following sections of this appendix:

D.1 Sulfate Process Digestion Sludge Managed in an Onsite Landfill

Tables D-1 through D-6 present the data used to characterize the waste stream and the waste management units and the site-specific data used to model the Sulfate Process Digestion Sludge in the titanium dioxide industry sector.

Tables D-7 through D- 14 present the results of the sensitivity analysis for sulfate process digestion sludge managed in an onsite landfill. The following constituents were evaluated:

- # Antimony
- # Vanadium

Table D-7 Summary of Parameters Considered in Sensitivity Analysis for Antimony

Table D-8 Summary of Correlated Parameters for Antimony

Table D-9 Summary of Cross Pairs Analysis–Antimony

Table D-10 Ranking of Parameters According to Percentage of Risk–Antimony

Table D-11 Summary of Parameters Considered in Sensitivity Analysis for Vanadium

Table D-12 Summary of Correlated Parameters for Vanadium

Table D-13 Summary of Cross Pairs Analysis–Vanadium

Table D-14 Ranking of Parameters According to Percentage of Risk–Vanadium

D.2 Secondary Gypsum Managed in an Onsite Landfill

Tables D-15 through D-20 present the data used to characterize the waste stream and the waste management units and the site-specific data used to model the secondary gypsum waste in the titanium dioxide industry sector.

Table D-15 Chemical-Specific Properties for Constituents of Concern for the Secondary Gypsum in the TiO_2 Sector

Table D-16 Waste Management Unit Parameters for Onsite Landfill Managing Secondary Gypsum in the TiO_2 Sector

Table D-17 Waste Stream Parameters for the Secondary Gypsum in the TiO_2 Sector

Table D-18 Site-Specific Climate-Based Parameters for the Secondary Gypsum in the TiO_2 Sector

Table D-19 Aquifer Types Common in Area of Onsite Landfill Managing Secondary Gypsum in the TiO_2 Sector

Table D-20 Soil Textures Common in Area of Onsite Landfill Managing Secondary Gypsum in the TiO_2 Sector

Tables D-21 through D- 33 present the results of the sensitivity analysis for secondary gypsum managed in an onsite landfill. The following constituents were evaluated:

- # Antimony
- # Arsenic
- # Manganese

D.3 Chloride Sulfate Process Milling Sand Managed in an Industrial D Landfill

Tables D-33 through D-37 present the data used to characterize the waste stream and the waste management units and the site-specific data used to model the chloride sulfate process milling sand in the titanium dioxide industry sector.

Table D-37 Aquifer Types Common in Area of Offsite Industrial Landfill Managing Chloride Sulfate Process Milling Sand in the TiO_2 Sector

Table D-38 Soil Textures Common in Area of Offsite Industrial Landfill Managing Chloride Sulfate Process Milling Sand in the TiO_2 Sector

Tables D-39 through D-42 present the results of the sensitivity analysis for chloride sulfate process milling sand managed in an offsite industrial D landfill. The following constituents were evaluated:

Antimony

Table D-39 Summary of Parameters Considered in Sensitivity Analysis for Antimony

Table D-40 Summary of Correlated Parameters for Antimony

Table D-41 Summary of Cross Pairs Analysis–Antimony

Table D-42 Ranking of Parameters According to Percentage of Risk–Antimony

D.4 Chloride Sulfate Process Mixed Wastewater Treatment Solids Managed in an Onsite Landfill

Tables D-43 through D-48 present the data used to characterize the waste stream and the waste management units and the site-specific data used to model the chloride sulfate process mixed waste water treatment solids in the titanium dioxide industry sector.

Table D-43 Chemical-Specific Properties for Constituents of Concern for the Chloride Sulfate Process Mixed Wastewater Treatment Solids in the TiO_2 Sector

Table D-44 Waste Management Unit Parameters for Onsite Landfill Managing the Chloride Sulfate Process Mixed Wastewater Treatment Solids in the TiO_2 Sector

Table D-45 Waste Stream Parameters for the Chloride Sulfate Process Mixed Wastewater Treatment Solids in the TiO_2 Sector

Table D-46 Site-Specific Climate-Based Parameters for the Chloride Sulfate Process Mixed Wastewater Treatment Solids in the TiO_2 Sector

Table D-47 Aquifer Types Common in Area of Onsite Landfill Managing the Chloride Sulfate Process Mixed Wastewater Treatment Solids in the TiO_2 Sector

Table D-48 Soil Textures Common in Area of Onsite Landfill Managing Chloride Sulfate Process Mixed Wastewater Treatment Solids in the TiO_2 Sector

Tables D-49 through D-56 present the results of the sensitivity analysis for chloride sulfate process Mixed Wastewater Treatment Solids managed in an onsite industrial D landfill. The following constituents were evaluated:

- Manganese
- Thallium

Table D-49 Summary of Parameters Considered in Sensitivity Analysis for Manganese

Table D-50 Summary of Correlated Parameters for Manganese

Table D-51 Summary of Cross Pairs Analysis–Manganese

Table D-52 Ranking of Parameters According to Percentage of Risk–Manganese

Table D-53 Summary of Parameters Considered in Sensitivity Analysis for Thallium

Table D-54 Summary of Correlated Parameters for Thallium

Table D-55 Summary of Cross Pairs Analysis–Thallium

Table D-56 Ranking of Parameters According to Percentage of Risk–Thallium

D.5 Combined Chloride Sulfate Process Wastewaters Managed in an Onsite Surface Impoundment

Tables D-57 through D-61 present the data used to characterize the waste stream and the waste management units and the site-specific data used to model the sulfate process wastewaters in the titanium dioxide industry sector.

Table D-57 Chemical-Specific Properties for Constituents of Concern for the Chloride Sulfate Process Mixed Wastewaters in the TiO_2 Sector

Table D-58 Waste Management Unit Parameters for Onsite Surface Impoundment Managing the Chloride Sulfate Process Mixed Wastewaters in the TiO_2 Sector

Table D-59 Waste Stream Parameters for the Chloride Sulfate Process Mixed Wastewater Treatment Solids in the TiO_2 Sector

Table D-60 Site-Specific Climate-Based Parameters for the Chloride Sulfate Process Mixed Wastewaters in the TiO_2 Sector

Table D-61 Aquifer Types Common in Area of Onsite Surface Impoundment Managing the Chloride Sulfate Process Mixed Wastewaters in the TiO_2 Sector

Table D-62 Soil Textures Common in Area of Onsite Surface Impoundment Managing the Chloride Sulfate Process Mixed Wastewaters in the TiO_2 Sector

Tables D-63 through D-70 present the results of the sensitivity analysis for combined chloride sulfate process mixed wastewaters managed in an onsite surface impoundment. The following constituents were evaluated:

- Arsenic
- Manganese

Table D-63 Summary of Parameters Considered in Sensitivity Analysis for Arsenic

Table D-64 Summary of Correlated Parameters for Arsenic

Table D-65 Summary of Cross Pairs Analysis–Arsenic

Table D-66 Ranking of Parameters According to Percentage of Risk–Arsenic

Table D-67 Summary of Parameters Considered in Sensitivity Analysis for Manganese

Table D-68 Summary of Correlated Parameters for Manganese

Table D-69 Summary of Cross Pairs Analysis–Manganese

Table D-70 Ranking of Parameters According to Percentage of Risk–Manganese

D.6 Chloride Process Wastewaters Managed in an Onsite Surface Impoundment

Tables D- 71 through D-76 present the data used to characterize the waste stream and the waste management units and the site-specific data used to model the chloride process wastewaters in the titanium dioxide industry sector.

Table D-71 Chemical-Specific Properties for Constituents of Concern for the Chloride Process Mixed Wastewaters in the TiO_2 Sector

Table D-72 Waste Management Unit Parameters for Onsite Surface Impoundment Managing the Chloride Process Mixed Wastewaters in the TiO_2 Sector

Table D-73 Waste Stream Parameters for the Chloride Process Mixed Wastewater Treatment Solids in the TiO_2 Sector

Table D-74 Site-Specific Climate-Based Parameters for the Chloride Process Mixed Wastewaters in the TiO_2 Sector

Tables D-77 through D-92 present the results of the sensitivity analysis for combined chloride sulfate process mixed wastewaters managed in an onsite surface impoundment. The following constituents were evaluated:

- Antimony
- Arsenic
- Molybdenum
- Thallium

Table D-92 Ranking of Parameters According to Percentage of Risk–Thallium

D.7 Ilmenite Process Wastewaters Managed in an Onsite Surface Impoundment

Tables D-93 through D-98 present the data used to characterize the waste stream and the waste management units and the site-specific data used to model the ilmenite process wastewaters in the titanium dioxide industry sector.

Table D-93 Chemical-Specific Properties for Constituents of Concern for the Ilmenite Process Mixed Wastewaters in the TiO_2 Sector

Table D-94 Waste Management Unit Parameters for Onsite Surface Impoundment Managing the Ilmenite Process Mixed Wastewaters in the TiO_2 Sector

Table D-95 Waste Stream Parameters for the Ilmenite Process Mixed Wastewater Treatment Solids in the TiO_2 Sector

Table D-96 Site-Specific Climate-Based Parameters for the Ilmenite Process Mixed Wastewaters in the TiO_2 Sector

Table D-97 Aquifer Types Common in Area of Onsite Surface Impoundment Managing the Ilmenite Process Mixed Wastewaters in the TiO_2 Sector

Table D-98 Soil Textures Common in Area of Onsite Surface Impoundment Managing the Ilmenite Process Mixed Wastewaters in the TiO_2 Sector

Tables D-99 through D-110 present the results of the sensitivity analysis for combined ilmenite process wastewaters managed in an onsite surface impoundment. The following constituents were evaluated:

- Manganese
- Thallium
- Vanadium

Table D-99 Summary of Parameters Considered in Sensitivity Analysis for Manganese

Table D-100 Summary of Correlated Parameters for Manganese

Table D-101 Summary of Cross Pairs Analysis–Manganese

Table D-102 Ranking of Parameters According to Percentage of Risk–Manganese

Table D-103 Summary of Parameters Considered in Sensitivity Analysis for Thallium

D.8 Ilmenite Process Wastewater Treatment Sludge Managed in an Onsite Landfill

Tables D-111 through D-116 present the data used to characterize the waste stream and the waste management units and the site-specific data used to model the ilmenite process wastewater treatment sludge in the titanium dioxide industry sector.

Tables D-117 through D-132 present the results of the sensitivity analysis for combined ilmenite process wastewater treatment sludge managed in an offsite landfill. The following constituents were evaluated:

- Antimony
- Arsenic

Manganese
Thallium

Table D-1. Chemical-Specific Properties for Constituents of Concern for Sulfate Process Digestion Sludge in the TiO_2 Sector

	Waste Constituent Concentrations			*Degradation Rates*	
Constituent	**SPLP (Industrial D Landfill) (mg/L)**	**Total waste (mg/kg)**	**Finite Source Ratio (L/kg)**	**Overall Hydrolysis rate(1/yr)**	**Biodegrd. Rate(1/yr)**
Antimony	0.023	2.4	104	0	0
Vanadium	0.42	17.7	42	0	0

underline italics indicate values set at 1/2 of detection limit

Table D-2. Waste Management Unit Parameters for Onsite Landfill Managing Sulfate Process Digestion Sludge in the TiO_2 Sector

WMU	Location	Landfill Area (acres)	Landfill Area (m^2)
Onsite Landfill	Baltimore, MD	95	384452.9

Table D-3. Waste Stream Parameters for Onsite Landfill Managing Sulfate Process Digestion Sludge in the TiO_2 Sector

WMU	Location	'Waste Quantity (MT/y)	Waste Density (g/cm^3)	Waste Density (kg/m^3)	Total Waste Vol (m^3)
Onsite Landfill	Baltimore, MD	24,494	1.884	1884	13001.1

Table D-4. Site-Specific Climate-Based Parameters for Onsite Landfill Managing Sulfate Process Digestion Sludge in the TiO_2 Sector

				Landfill Infiltartion Rate (m/yr)			Recharge Rate (m/yr)				GWpH		
WMU	**Location**	**Climate Index**	**Climate Center**	**SCL**	**SLT**	**SNL**	**SCL**	**SLT**	**SNL**	**GW TempC**	**SCL**	**SLT**	**SNL**
Onsite Landfill	Baltimore, MD	71	Philadelphia, PA	0.16	0.20	0.26	0.16	0.20	0.26	13	4.5	4.3	4.8

Table D-5. Aquifer Type Common in Area of Onsite Landfill Managing Sulfate Process Digestion Sludge in the TiO_2 Sector

Aquifer Types	Aquifer Code	Baltimore, MD
Unconsolidated and semiconsolidated shallow aquifers	10	100%

Table D-6. Soil Textures Common in Area of Onsite Landfill Managing Sulfate Process Digestion Sludge in the TiO_2 Sector

		Baltimore, MD
silty clay loam	SCL	39%
silt loam	SIL	25%
sandy loam	SNL	36%

Table D-7. Summary of Parameters Considered in Sensitivity Analysis for Antimony

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
ACIDCAT	Acid Catalyzed Hydrolysis Rate Constant	C			
ANGLEW	Angle of Well Off Plume Centerline	anglew		Y	
ANISORAT	Anisotropy Ratio	C			
AQUTHIK	Aquifer Thickness	aquthik**-0.01		Y	Y
AVGPDIAM	Avg. Particle Diameter	log(avgpdiam+.004)		Y	Y
BASECAT	Base Catalyzed Hydrolysis Rate Constant	C			
BIODRATA	Biodegradation Rate	C			
BIODRATU	Biodegradation Rate	C			
BULKDENS	Bulk Density	bulkdens**3.5	Y		
CHEMDRU	Chemical Decay Rate	C			
CHEMDRA	Chemical Decay Rate	C			
CONSH2OA	Consump of drinking water	log(consh2oa)			Y
ZDIST	Depth of Well Below Water Table	log(zdist+1)		Y	Y
DISHYD	Dissolved Hydrolysis Rate	C			
YDIST	Distance from Plume Centerline to Well	log(ydist+150)		Y	Y
DURLEACH	Duration of Leaching Period	log(durleach-761)	Y		
GWAVTIM	Exposure Duration	C			
FRORGCAR	Fraction Organic Carbon	log(frorgcar)		Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	log(frcoefa-0.3)		Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	log(frcoefu)		Y	Y
FREXPA	Freundlich Isotherm Exponent	C			
FREXPU	Freundlich Isotherm Exponent	C			
GWPH	Groundwater pH	gwph	Y		
GWSEEPV	Groundwater Seepage Velocity	log(gwseepv)		Y	Y
GWTEMP	Groundwater Temperature	C			
HYDGRAD	Hydraulic Gradient	log(hydgrad+0.001)		Y	
INFILRAT	Infiltration Rate	infilrat**1.5		Y	Y
LANDEPTH	Landfill Depth	C			
LEACHCON	Leachate Concentration	C			
LFFRACT	LF Fraction	C			
LONDISPU	Longitudinal Dispersivity	log(londispu+2.5)	Y		
LONDISPA	Longitudinal Dispersivity	log(londispa+0.3)		Y	Y
XDIST	Longitudinal Distance to Well	log(xdist+500)		Y	Y

Table D-7. Summary of Parameters Considered in Sensitivity Analysis for Antimony

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
LONHYCON	Longitundinal Hydraulic Conductivity	log(lonhycon-3)		Y	
MLLA	ml/L	C			
MOISTRPA	Moisture Rention Parameter (a)	log(moistrpa)	Y		
MOISTRPB	Moisture Rention Parameter (b)	log(moistrpb-0.5)	Y		
MOLDIFF	Molecular Diffusion Coefficient	C			
NEUTHYD	Neutral Hydrolysis Rate Constant	C			
ORGCDIS	Organic Carbon Distribution Coefficient	C			
PERORGM	Percent Organic Matter	log(perorgm)		Y	Y
POROSITY	Porosity	porosity**1.3		Y	Y
RADISTW	Radial Distance to Well	log(radistw+250)	Y		
RECHARAT	Recharge Rate	recharat	Y		
RESIDH2O	Residual Water Content	residh2o**2.1		Y	Y
RETCOEF	Retardation Coefficient	log(retcoef-2)	Y		
RFDA	RfD (mg/kg/day)	C			
SATHYCON	Saturated Hydraulic Conductivity	log(sathycon)	Y		
SATURH2O	Saturated Water Content	saturh2o		Y	Y
SOILBDEN	Soil Bulk Density	soilbden	Y		
SORBHYD	Sorbed Hydrolysis Rate	C			
TRANDISP	Transverse Dispersivity	log(trandisp)	Y		
UNSATHIK	Unsaturated Zone Thickness	log(unsathik+10)		Y	Y
VERTDISP	Vertical Dispersivity	log(vertdisp-0.004)	Y		
WASTDENS	Waste Density	C			
WASTEVOL	Waste Volume	C			
WMUAREA	WMU Area	C			
WMULEN	WMU Length	C			
WMUWIDTH	WMU Width	C			

Table D-8. Summary of Correlated Parameters for Antimony

Variable 1		Variable 2		Correlation Coefficient
Code	Description	Code	Description	
AVGPDIAM	Avg. Particle Diameter	BULKDENS	Bulk Density	0.99614
FRCOEFA	Freundlich Isotherm Coefficient	RETCOEF	Retardation Coefficient	0.96074
LONDISPA	Longitudinal Dispersivity	TRANDISP	Transverse Dispersivity	0.99938
LONDISPA	Longitudinal Dispersivity	VERTDISP	Vertical Dispersivity	0.99194
RECHARAT	Recharge Rate	GWPH	Groundwater pH	0.78659
INFILRAT	Infiltration Rate	GWPH	Groundwater pH	0.77724
DURLEACH	Duration of Leaching Period	GWPH	Groundwater pH	-0.9124
MOISTRPA	Moisture Rention Parameter (a)	GWPH	Groundwater pH	0.7037
MOISTRPB	Moisture Rention Parameter (b)	GWPH	Groundwater pH	0.7617
SATURH2O	Saturated Water Content	GWPH	Groundwater pH	-0.97653
SOILBDEN	Soil Bulk Density	GWPH	Groundwater pH	-0.84118
XDIST	Longitudinal Distance to Well	RADISTW	Radial Distance to Well	0.99822
INFILRAT	Infiltration Rate	RECHARAT	Recharge Rate	0.98146
DURLEACH	Duration of Leaching Period	RECHARAT	Recharge Rate	-0.96654
SATHYCON	Saturated Hydraulic Conductivity	RECHARAT	Recharge Rate	0.82071
MOISTRPA	Moisture Rention Parameter (a)	RECHARAT	Recharge Rate	0.83677
MOISTRPB	Moisture Rention Parameter (b)	RECHARAT	Recharge Rate	0.93044
SOILBDEN	Soil Bulk Density	RECHARAT	Recharge Rate	-0.99557
RECHARAT	Recharge Rate	DURLEACH	Duration of Leaching Period	-0.96654
INFILRAT	Infiltration Rate	DURLEACH	Duration of Leaching Period	-0.96414
SATHYCON	Saturated Hydraulic Conductivity	DURLEACH	Duration of Leaching Period	-0.80043
MOISTRPA	Moisture Rention Parameter (a)	DURLEACH	Duration of Leaching Period	-0.82664
MOISTRPB	Moisture Rention Parameter (b)	DURLEACH	Duration of Leaching Period	-0.91106
SATURH2O	Saturated Water Content	DURLEACH	Duration of Leaching Period	0.80418
SOILBDEN	Soil Bulk Density	DURLEACH	Duration of Leaching Period	0.98543
RECHARAT	Recharge Rate	SATHYCON	Saturated Hydraulic Conductivity	0.82071
INFILRAT	Infiltration Rate	SATHYCON	Saturated Hydraulic Conductivity	0.84015
DURLEACH	Duration of Leaching Period	SATHYCON	Saturated Hydraulic Conductivity	-0.80043
MOISTRPB	Moisture Rention Parameter (b)	SATHYCON	Saturated Hydraulic Conductivity	0.75895
RECHARAT	Recharge Rate	MOISTRPA	Moisture Rention Parameter (a)	0.83677
INFILRAT	Infiltration Rate	MOISTRPA	Moisture Rention Parameter (a)	0.82139
DURLEACH	Duration of Leaching Period	MOISTRPA	Moisture Rention Parameter (a)	-0.82664
MOISTRPB	Moisture Rention Parameter (b)	MOISTRPA	Moisture Rention Parameter (a)	0.78163

Table D-8. Summary of Correlated Parameters for Antimony

Variable 1		Variable 2		Correlation Coefficient
Code	**Description**	**Code**	**Description**	
RECHARAT	Recharge Rate	MOISTRPB	Moisture Rention Parameter (b)	0.93044
INFILRAT	Infiltration Rate	MOISTRPB	Moisture Rention Parameter (b)	0.91324
DURLEACH	Duration of Leaching Period	MOISTRPB	Moisture Rention Parameter (b)	-0.91106
SATHYCON	Saturated Hydraulic Conductivity	MOISTRPB	Moisture Rention Parameter (b)	0.75895
DURLEACH	Duration of Leaching Period	SATURH2O	Saturated Water Content	0.80418
SOILBDEN	Soil Bulk Density	SATURH2O	Saturated Water Content	0.70498
UNSATHIK	Unsaturated Zone Thickness	LONDISPU	Longitudinal Dispersivity	0.99954
RECHARAT	Recharge Rate	SOILBDEN	Soil Bulk Density	-0.99557
INFILRAT	Infiltration Rate	SOILBDEN	Soil Bulk Density	-0.97791
DURLEACH	Duration of Leaching Period	SOILBDEN	Soil Bulk Density	0.98543
SATHYCON	Saturated Hydraulic Conductivity	SOILBDEN	Soil Bulk Density	-0.81504
MOISTRPA	Moisture Rention Parameter (a)	SOILBDEN	Soil Bulk Density	-0.84
MOISTRPB	Moisture Rention Parameter (b)	SOILBDEN	Soil Bulk Density	-0.93085
SATURH2O	Saturated Water Content	SOILBDEN	Soil Bulk Density	0.70498

Note: Parameters in the variable 2 column were removed from the analysis.

Table D-9. Summary of Crosspairs Analysis for Antimony

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
AVGPDIAM	Avg. Particle Diameter			Y	Y
POROSITY	Porosity			Y	Y
AQUTHIK	Aquifer Thickness			Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity				
HYDGRAD	Hydraulic Gradient				
GWSEEPV	Groundwater Seepage Velocity			Y	Y
LONDISPA	Longitudinal Dispersivity			Y	Y
FRORGCAR	Fraction Organic Carbon				
ANGLEW	Angle of Well Off Plume Centerline				
XDIST	Longitudinal Distance to Well			Y	Y
YDIST	Distance from Plume Centerline to Well			Y	Y
ZDIST	Depth of Well Below Water Table				
FRCOEFA	Freundlich Isotherm Coefficient			Y	Y
INFILRAT	Infiltration Rate			Y	Y
RESIDH2O	Residual Water Content				
SATURH2O	Saturated Water Content			Y	Y
UNSATHIK	Unsaturated Zone Thickness			Y	Y
PERORGM	Percent Organic Matter				
FRCOEFU	Freundlich Isotherm Coefficient			Y	Y
AVGPDIAM	Avg. Particle Diameter	AVGPDIAM	Avg. Particle Diameter		
POROSITY	Porosity	AVGPDIAM	Avg. Particle Diameter	Y	
POROSITY	Porosity	POROSITY	Porosity		
AQUTHIK	Aquifer Thickness	AVGPDIAM	Avg. Particle Diameter	Y	
AQUTHIK	Aquifer Thickness	POROSITY	Porosity		
AQUTHIK	Aquifer Thickness	AQUTHIK	Aquifer Thickness	Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity	AVGPDIAM	Avg. Particle Diameter		
LONHYCON	Longitundinal Hydraulic Conductivity	POROSITY	Porosity		
LONHYCON	Longitundinal Hydraulic Conductivity	AQUTHIK	Aquifer Thickness	Y	
LONHYCON	Longitundinal Hydraulic Conductivity	LONHYCON	Longitundinal Hydraulic Conductivity		
HYDGRAD	Hydraulic Gradient	AVGPDIAM	Avg. Particle Diameter		
HYDGRAD	Hydraulic Gradient	POROSITY	Porosity		
HYDGRAD	Hydraulic Gradient	AQUTHIK	Aquifer Thickness	Y	
HYDGRAD	Hydraulic Gradient	LONHYCON	Longitundinal Hydraulic Conductivity		
HYDGRAD	Hydraulic Gradient	HYDGRAD	Hydraulic Gradient		
GWSEEPV	Groundwater Seepage Velocity	AVGPDIAM	Avg. Particle Diameter		
GWSEEPV	Groundwater Seepage Velocity	POROSITY	Porosity		
GWSEEPV	Groundwater Seepage Velocity	AQUTHIK	Aquifer Thickness	Y	
GWSEEPV	Groundwater Seepage Velocity	LONHYCON	Longitundinal Hydraulic Conductivity		
GWSEEPV	Groundwater Seepage Velocity	HYDGRAD	Hydraulic Gradient		
GWSEEPV	Groundwater Seepage Velocity	GWSEEPV	Groundwater Seepage Velocity		
LONDISPA	Longitudinal Dispersivity	AVGPDIAM	Avg. Particle Diameter		
LONDISPA	Longitudinal Dispersivity	POROSITY	Porosity		
LONDISPA	Longitudinal Dispersivity	AQUTHIK	Aquifer Thickness		
LONDISPA	Longitudinal Dispersivity	LONHYCON	Longitundinal Hydraulic Conductivity		
LONDISPA	Longitudinal Dispersivity	HYDGRAD	Hydraulic Gradient		
LONDISPA	Longitudinal Dispersivity	GWSEEPV	Groundwater Seepage Velocity		
LONDISPA	Longitudinal Dispersivity	LONDISPA	Longitudinal Dispersivity	Y	Y
FRORGCAR	Fraction Organic Carbon	AVGPDIAM	Avg. Particle Diameter		
FRORGCAR	Fraction Organic Carbon	POROSITY	Porosity		

Table D-9. Summary of Crosspairs Analysis for Antimony

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
FRORGCAR	Fraction Organic Carbon	AQUTHIK	Aquifer Thickness		
FRORGCAR	Fraction Organic Carbon	LONHYCON	Longitundinal Hydraulic Conductivity		
FRORGCAR	Fraction Organic Carbon	HYDGRAD	Hydraulic Gradient		
FRORGCAR	Fraction Organic Carbon	GWSEEPV	Groundwater Seepage Velocity		
FRORGCAR	Fraction Organic Carbon	LONDISPA	Longitudinal Dispersivity		
FRORGCAR	Fraction Organic Carbon	FRORGCAR	Fraction Organic Carbon		
ANGLEW	Angle of Well Off Plume Centerline	AVGPDIAM	Avg. Particle Diameter		
ANGLEW	Angle of Well Off Plume Centerline	POROSITY	Porosity		
ANGLEW	Angle of Well Off Plume Centerline	AQUTHIK	Aquifer Thickness		
ANGLEW	Angle of Well Off Plume Centerline	LONHYCON	Longitundinal Hydraulic Conductivity		
ANGLEW	Angle of Well Off Plume Centerline	HYDGRAD	Hydraulic Gradient		
ANGLEW	Angle of Well Off Plume Centerline	GWSEEPV	Groundwater Seepage Velocity		
ANGLEW	Angle of Well Off Plume Centerline	LONDISPA	Longitudinal Dispersivity	Y	
ANGLEW	Angle of Well Off Plume Centerline	FRORGCAR	Fraction Organic Carbon		
ANGLEW	Angle of Well Off Plume Centerline	ANGLEW	Angle of Well Off Plume Centerline		
XDIST	Longitudinal Distance to Well	AVGPDIAM	Avg. Particle Diameter		
XDIST	Longitudinal Distance to Well	POROSITY	Porosity		
XDIST	Longitudinal Distance to Well	AQUTHIK	Aquifer Thickness		
XDIST	Longitudinal Distance to Well	LONHYCON	Longitundinal Hydraulic Conductivity		
XDIST	Longitudinal Distance to Well	HYDGRAD	Hydraulic Gradient		
XDIST	Longitudinal Distance to Well	GWSEEPV	Groundwater Seepage Velocity		
XDIST	Longitudinal Distance to Well	LONDISPA	Longitudinal Dispersivity		
XDIST	Longitudinal Distance to Well	FRORGCAR	Fraction Organic Carbon		
XDIST	Longitudinal Distance to Well	ANGLEW	Angle of Well Off Plume Centerline		
XDIST	Longitudinal Distance to Well	XDIST	Longitudinal Distance to Well		
YDIST	Distance from Plume Centerline to Well	AVGPDIAM	Avg. Particle Diameter		
YDIST	Distance from Plume Centerline to Well	POROSITY	Porosity		
YDIST	Distance from Plume Centerline to Well	AQUTHIK	Aquifer Thickness		
YDIST	Distance from Plume Centerline to Well	LONHYCON	Longitundinal Hydraulic Conductivity		
YDIST	Distance from Plume Centerline to Well	HYDGRAD	Hydraulic Gradient		
YDIST	Distance from Plume Centerline to Well	GWSEEPV	Groundwater Seepage Velocity		
YDIST	Distance from Plume Centerline to Well	LONDISPA	Longitudinal Dispersivity	Y	Y
YDIST	Distance from Plume Centerline to Well	FRORGCAR	Fraction Organic Carbon		
YDIST	Distance from Plume Centerline to Well	ANGLEW	Angle of Well Off Plume Centerline		
YDIST	Distance from Plume Centerline to Well	XDIST	Longitudinal Distance to Well	Y	Y
YDIST	Distance from Plume Centerline to Well	YDIST	Distance from Plume Centerline to Well	Y	Y
ZDIST	Depth of Well Below Water Table	AVGPDIAM	Avg. Particle Diameter		
ZDIST	Depth of Well Below Water Table	POROSITY	Porosity		
ZDIST	Depth of Well Below Water Table	AQUTHIK	Aquifer Thickness		
ZDIST	Depth of Well Below Water Table	LONHYCON	Longitundinal Hydraulic Conductivity		
ZDIST	Depth of Well Below Water Table	HYDGRAD	Hydraulic Gradient		
ZDIST	Depth of Well Below Water Table	GWSEEPV	Groundwater Seepage Velocity		
ZDIST	Depth of Well Below Water Table	LONDISPA	Longitudinal Dispersivity	Y	Y
ZDIST	Depth of Well Below Water Table	FRORGCAR	Fraction Organic Carbon		
ZDIST	Depth of Well Below Water Table	ANGLEW	Angle of Well Off Plume Centerline		
ZDIST	Depth of Well Below Water Table	XDIST	Longitudinal Distance to Well		
ZDIST	Depth of Well Below Water Table	YDIST	Distance from Plume Centerline to Well		
ZDIST	Depth of Well Below Water Table	ZDIST	Depth of Well Below Water Table		
FRCOEFA	Freundlich Isotherm Coefficient	AVGPDIAM	Avg. Particle Diameter	Y	

Table D-9. Summary of Crosspairs Analysis for Antimony

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
FRCOEFA	Freundlich Isotherm Coefficient	POROSITY	Porosity	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	AQUTHIK	Aquifer Thickness	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	LONHYCON	Longitundinal Hydraulic Conductivity		
FRCOEFA	Freundlich Isotherm Coefficient	HYDGRAD	Hydraulic Gradient		
FRCOEFA	Freundlich Isotherm Coefficient	GWSEEPV	Groundwater Seepage Velocity	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	LONDISPA	Longitudinal Dispersivity	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	FRORGCAR	Fraction Organic Carbon		
FRCOEFA	Freundlich Isotherm Coefficient	ANGLEW	Angle of Well Off Plume Centerline		
FRCOEFA	Freundlich Isotherm Coefficient	XDIST	Longitudinal Distance to Well		
FRCOEFA	Freundlich Isotherm Coefficient	YDIST	Distance from Plume Centerline to Well	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	ZDIST	Depth of Well Below Water Table	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
INFILRAT	Infiltration Rate	AVGPDIAM	Avg. Particle Diameter		
INFILRAT	Infiltration Rate	POROSITY	Porosity		
INFILRAT	Infiltration Rate	AQUTHIK	Aquifer Thickness	Y	Y
INFILRAT	Infiltration Rate	LONHYCON	Longitundinal Hydraulic Conductivity		
INFILRAT	Infiltration Rate	HYDGRAD	Hydraulic Gradient		
INFILRAT	Infiltration Rate	GWSEEPV	Groundwater Seepage Velocity		
INFILRAT	Infiltration Rate	LONDISPA	Longitudinal Dispersivity		
INFILRAT	Infiltration Rate	FRORGCAR	Fraction Organic Carbon		
INFILRAT	Infiltration Rate	ANGLEW	Angle of Well Off Plume Centerline		
INFILRAT	Infiltration Rate	XDIST	Longitudinal Distance to Well		
INFILRAT	Infiltration Rate	YDIST	Distance from Plume Centerline to Well	Y	Y
INFILRAT	Infiltration Rate	ZDIST	Depth of Well Below Water Table		
INFILRAT	Infiltration Rate	FRCOEFA	Freundlich Isotherm Coefficient		
INFILRAT	Infiltration Rate	INFILRAT	Infiltration Rate	Y	Y
RESIDH2O	Residual Water Content	AVGPDIAM	Avg. Particle Diameter		
RESIDH2O	Residual Water Content	POROSITY	Porosity		
RESIDH2O	Residual Water Content	AQUTHIK	Aquifer Thickness	Y	Y
RESIDH2O	Residual Water Content	LONHYCON	Longitundinal Hydraulic Conductivity		
RESIDH2O	Residual Water Content	HYDGRAD	Hydraulic Gradient		
RESIDH2O	Residual Water Content	GWSEEPV	Groundwater Seepage Velocity		
RESIDH2O	Residual Water Content	LONDISPA	Longitudinal Dispersivity		
RESIDH2O	Residual Water Content	FRORGCAR	Fraction Organic Carbon	Y	Y
RESIDH2O	Residual Water Content	ANGLEW	Angle of Well Off Plume Centerline		
RESIDH2O	Residual Water Content	XDIST	Longitudinal Distance to Well		
RESIDH2O	Residual Water Content	YDIST	Distance from Plume Centerline to Well		
RESIDH2O	Residual Water Content	ZDIST	Depth of Well Below Water Table		
RESIDH2O	Residual Water Content	FRCOEFA	Freundlich Isotherm Coefficient		
RESIDH2O	Residual Water Content	INFILRAT	Infiltration Rate		
RESIDH2O	Residual Water Content	RESIDH2O	Residual Water Content		
SATURH2O	Saturated Water Content	AVGPDIAM	Avg. Particle Diameter		
SATURH2O	Saturated Water Content	POROSITY	Porosity		
SATURH2O	Saturated Water Content	AQUTHIK	Aquifer Thickness	Y	Y
SATURH2O	Saturated Water Content	LONHYCON	Longitundinal Hydraulic Conductivity		
SATURH2O	Saturated Water Content	HYDGRAD	Hydraulic Gradient		
SATURH2O	Saturated Water Content	GWSEEPV	Groundwater Seepage Velocity		
SATURH2O	Saturated Water Content	LONDISPA	Longitudinal Dispersivity		
SATURH2O	Saturated Water Content	FRORGCAR	Fraction Organic Carbon		

Table D-9. Summary of Crosspairs Analysis for Antimony

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
SATURH2O	Saturated Water Content	ANGLEW	Angle of Well Off Plume Centerline		
SATURH2O	Saturated Water Content	XDIST	Longitudinal Distance to Well		
SATURH2O	Saturated Water Content	YDIST	Distance from Plume Centerline to Well		
SATURH2O	Saturated Water Content	ZDIST	Depth of Well Below Water Table	Y	Y
SATURH2O	Saturated Water Content	FRCOEFA	Freundlich Isotherm Coefficient		
SATURH2O	Saturated Water Content	INFILRAT	Infiltration Rate		
SATURH2O	Saturated Water Content	RESIDH2O	Residual Water Content		
SATURH2O	Saturated Water Content	SATURH2O	Saturated Water Content	Y	Y
UNSATHIK	Unsaturated Zone Thickness	AVGPDIAM	Avg. Particle Diameter		
UNSATHIK	Unsaturated Zone Thickness	POROSITY	Porosity		
UNSATHIK	Unsaturated Zone Thickness	AQUTHIK	Aquifer Thickness	Y	
UNSATHIK	Unsaturated Zone Thickness	LONHYCON	Longitundinal Hydraulic Conductivity		
UNSATHIK	Unsaturated Zone Thickness	HYDGRAD	Hydraulic Gradient		
UNSATHIK	Unsaturated Zone Thickness	GWSEEPV	Groundwater Seepage Velocity		
UNSATHIK	Unsaturated Zone Thickness	LONDISPA	Longitudinal Dispersivity		
UNSATHIK	Unsaturated Zone Thickness	FRORGCAR	Fraction Organic Carbon		
UNSATHIK	Unsaturated Zone Thickness	ANGLEW	Angle of Well Off Plume Centerline		
UNSATHIK	Unsaturated Zone Thickness	XDIST	Longitudinal Distance to Well		
UNSATHIK	Unsaturated Zone Thickness	YDIST	Distance from Plume Centerline to Well	Y	
UNSATHIK	Unsaturated Zone Thickness	ZDIST	Depth of Well Below Water Table	Y	Y
UNSATHIK	Unsaturated Zone Thickness	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
UNSATHIK	Unsaturated Zone Thickness	INFILRAT	Infiltration Rate		
UNSATHIK	Unsaturated Zone Thickness	RESIDH2O	Residual Water Content		
UNSATHIK	Unsaturated Zone Thickness	SATURH2O	Saturated Water Content		
UNSATHIK	Unsaturated Zone Thickness	UNSATHIK	Unsaturated Zone Thickness		
PERORGM	Percent Organic Matter	AVGPDIAM	Avg. Particle Diameter		
PERORGM	Percent Organic Matter	POROSITY	Porosity		
PERORGM	Percent Organic Matter	AQUTHIK	Aquifer Thickness		
PERORGM	Percent Organic Matter	LONHYCON	Longitundinal Hydraulic Conductivity		
PERORGM	Percent Organic Matter	HYDGRAD	Hydraulic Gradient		
PERORGM	Percent Organic Matter	GWSEEPV	Groundwater Seepage Velocity		
PERORGM	Percent Organic Matter	LONDISPA	Longitudinal Dispersivity	Y	
PERORGM	Percent Organic Matter	FRORGCAR	Fraction Organic Carbon		
PERORGM	Percent Organic Matter	ANGLEW	Angle of Well Off Plume Centerline		
PERORGM	Percent Organic Matter	XDIST	Longitudinal Distance to Well		
PERORGM	Percent Organic Matter	YDIST	Distance from Plume Centerline to Well	Y	Y
PERORGM	Percent Organic Matter	ZDIST	Depth of Well Below Water Table		
PERORGM	Percent Organic Matter	FRCOEFA	Freundlich Isotherm Coefficient		
PERORGM	Percent Organic Matter	INFILRAT	Infiltration Rate		
PERORGM	Percent Organic Matter	RESIDH2O	Residual Water Content		
PERORGM	Percent Organic Matter	SATURH2O	Saturated Water Content		
PERORGM	Percent Organic Matter	UNSATHIK	Unsaturated Zone Thickness		
PERORGM	Percent Organic Matter	PERORGM	Percent Organic Matter		
FRCOEFU	Freundlich Isotherm Coefficient	AVGPDIAM	Avg. Particle Diameter		
FRCOEFU	Freundlich Isotherm Coefficient	POROSITY	Porosity		
FRCOEFU	Freundlich Isotherm Coefficient	AQUTHIK	Aquifer Thickness	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	LONHYCON	Longitundinal Hydraulic Conductivity		
FRCOEFU	Freundlich Isotherm Coefficient	HYDGRAD	Hydraulic Gradient		
FRCOEFU	Freundlich Isotherm Coefficient	GWSEEPV	Groundwater Seepage Velocity		

Table D-9. Summary of Crosspairs Analysis for Antimony

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
FRCOEFU	Freundlich Isotherm Coefficient	LONDISPA	Longitudinal Dispersivity		
FRCOEFU	Freundlich Isotherm Coefficient	FRORGCAR	Fraction Organic Carbon		
FRCOEFU	Freundlich Isotherm Coefficient	ANGLEW	Angle of Well Off Plume Centerline		
FRCOEFU	Freundlich Isotherm Coefficient	XDIST	Longitudinal Distance to Well		
FRCOEFU	Freundlich Isotherm Coefficient	YDIST	Distance from Plume Centerline to Well		
FRCOEFU	Freundlich Isotherm Coefficient	ZDIST	Depth of Well Below Water Table		
FRCOEFU	Freundlich Isotherm Coefficient	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	INFILRAT	Infiltration Rate	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	RESIDH2O	Residual Water Content		
FRCOEFU	Freundlich Isotherm Coefficient	SATURH2O	Saturated Water Content	Y	
FRCOEFU	Freundlich Isotherm Coefficient	UNSATHIK	Unsaturated Zone Thickness	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	PERORGM	Percent Organic Matter		
FRCOEFU	Freundlich Isotherm Coefficient	FRCOEFU	Freundlich Isotherm Coefficient	Y	Y

Table D-10. Ranking of Parameters According to Percentage of Risk for Antimony

Variable Description	Reduced Sums of Square	Variable Sums of Square	Variable Degrees of Freedom	% Risk Variation	Mean Square Variable	F VALUE	P VALUE
Freund. Iso. Coeff.--Aquifer (cm^3/g)	1289.9	905.24	10	35.3%	90.52	1204.67	0.00E+00
Dist. Plume Center. To Well (m)	1355.8	839.33	7	32.7%	119.91	1595.65	0.00E+00
Consumption of Drinking Water (ml/kg/day)	1461.6	733.53	1	28.6%	733.53	9761.60	0.00E+00
Aquifer Thickness (m)	2049.6	145.49	7	5.7%	20.78	276.59	0.00E+00
Long. Dispersivity--Aquifer (m)	2067.1	128.07	5	5.0%	25.61	340.85	0.00E+00
Freund. Iso. Coeff.--Unsat. Zone (cm^3/g)	2103.0	92.12	6	3.6%	15.35	204.32	1.69E-233
Long. Distance To Well (m)	2134.3	60.82	2	2.4%	30.41	404.71	1.60E-163
Groundwater Seepage Velocity (m/yr)	2133.2	61.89	2	2.4%	30.95	411.80	3.63E-166
Infiltration Rate	2172.9	22.18	5	0.9%	4.43	59.02	7.08E-60
Unsaturated Zone Thickness (m)	2173.7	21.41	4	0.8%	5.35	71.22	9.59E-59
Saturated Water Content (unitless)	2188.1	7.04	4	0.3%	1.76	23.42	3.30E-19
Porosity (unitless)	2191.1	4.04	2	0.2%	2.02	26.84	2.54E-12
Depth of Well Water Below Table (m)	2191.1	4.02	5	0.2%	0.80	10.69	3.09E-10
Residual Water Content (unitless)	2193.4	1.75	3	0.1%	0.58	7.78	3.52E-05
Avg. Particle Diameter (cm)	2191.5	3.62	1	0.1%	3.62	48.23	4.29E-12
Percent Organic Matter (unitless)	2194.0	1.09	2	0.0%	0.54	7.24	7.28E-04
Fraction Organic Carbon (g/g)	2194.5	0.60	2	0.0%	0.30	3.99	1.86E-02

Constants

Full Model SS	2195.1224
Error SS	372.192
Error DF	4953
MS Error	0.075

Table D-11. Summary of Parameters Considered in Sensitivity Analysis for Vanadium

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
OBS					
ACIDCAT	Acid Catalyzed Hydrolysis Rate Constant	C			
ANGLEW	Angle of Well Off Plume Centerline	anglew			
ANISORAT	Anisotropy Ratio	C			
AQUTHIK	Aquifer Thickness	aquthik**-0.1		Y	Y
AVGPDIAM	Avg. Particle Diameter	log(avgpdiam+.001)		Y	Y
BASECAT	Base Catalyzed Hydrolysis Rate Constant	C			
BIODRATA	Biodegradation Rate	C			
BIODRATU	Biodegradation Rate	C			
BULKDENS	Bulk Density	bulkdens**3.5	Y		
CHEMDRA	Chemical Decay Rate	C			
CHEMDRU	Chemical Decay Rate	C			
CONSH2OA	Consump of drinking water	log(consh2oa)			Y
ZDIST	Depth of Well Below Water Table	log(zdist+1)			
DISHYD	Dissolved Hydrolysis Rate	C			
YDIST	Distance from Plume Centerline to Well	log(ydist+150)		Y	Y
DURLEACH	Duration of Leaching Period	log(durleach-307)	Y		
GWAVTIM	Exposure Duration	C			
FRORGCAR	Fraction Organic Carbon	log(frorgcar)		Y	
FRCOEFA	Freundlich Isotherm Coefficient	log(frcoefa-4.5)		Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	log(frcoefu-4)		Y	Y
FREXPA	Freundlich Isotherm Exponent	C			
FREXPU	Freundlich Isotherm Exponent	C			
GWPH	Groundwater pH	gwph	Y		
GWSEEPV	Groundwater Seepage Velocity	log(gwseepv-0.09)		Y	Y
GWTEMP	Groundwater Temperature	C			
HYDGRAD	Hydraulic Gradient	log(hydgrad+0.0002)		Y	Y
INFILRAT	Infiltration Rate	infilrat**1.5		Y	Y
LANDEPTH	Landfill Depth	C			
LEACHCON	Leachate Concentration	C			
LFFRACT	LF Fraction	C			
LONDISPA	Longitudinal Dispersivity	log(londispa+3)		Y	Y
LONDISPU	Longitudinal Dispersivity	log(londispu+0.1)	Y		

Table D-11. Summary of Parameters Considered in Sensitivity Analysis for Vanadium

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
XDIST	Longitudinal Distance to Well	xdist**1.4		Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity	log(lonhycon)		Y	Y
MLLA	ml/L	C			
MOISTRPA	Moisture Rention Parameter (a)	log(moistrpa)	Y		
MOISTRPB	Moisture Rention Parameter (b)	log(moistrpb-0.9)	Y		
MOLDIFF	Molecular Diffusion Coefficient	C			
NEUTHYD	Neutral Hydrolysis Rate Constant	C			
ORGCDIS	Organic Carbon Distribution Coefficient	C			
PERORGM	Percent Organic Matter	log(perorgm)		Y	
POROSITY	Porosity	porosity			
RADISTW	Radial Distance to Well	log(radistw+250)	Y		
RECHARAT	Recharge Rate	recharat	Y		
RESIDH2O	Residual Water Content	residh2o**1.4		Y	
RETCOEF	Retardation Coefficient	log(retcoef-15)	Y		
RFDA	RfD (mg/kg/day)	C			
SATHYCON	Saturated Hydraulic Conductivity	log(sathycon+0.1)	Y		
SATURH2O	Saturated Water Content	saturh2o		Y	Y
SOILBDEN	Soil Bulk Density	soilbden	Y		
SORBHYD	Sorbed Hydrolysis Rate	C			
TRANDISP	Transverse Dispersivity	log(trandisp+0.45)	Y		
UNSATHIK	Unsaturated Zone Thickness	log(unsathik+5)		Y	Y
VERTDISP	Vertical Dispersivity	log(vertdisp+0.01)	Y		
WASTDENS	Waste Density	C			
WASTEVOL	Waste Volume	C			
WMUAREA	WMU Area	C			
WMULEN	WMU Length	C			
WMUWIDTH	WMU Width	C			

Table D-12. Summary of Correlated Parameters for Vanadium

Variable 1		Variable 2		Correlation Coefficient
Code	**Description**	**Code**	**Description**	
AVGPDIAM	Avg. Particle Diameter	BULKDENS	Bulk Density	0.99821
FRCOEFA	Freundlich Isotherm Coefficient	RETCOEF	Retardation Coefficient	0.94019
LONDISPA	Longitudinal Dispersivity	TRANDISP	Transverse Dispersivity	0.99991
LONDISPA	Longitudinal Dispersivity	VERTDISP	Vertical Dispersivity	0.9993
RECHARAT	Recharge Rate	GWPH	Groundwater pH	0.79757
INFILRAT	Infiltration Rate	GWPH	Groundwater pH	0.78725
DURLEACH	Duration of Leaching Period	GWPH	Groundwater pH	-0.90892
MOISTRPA	Moisture Rention Parameter (a)	GWPH	Groundwater pH	0.71484
MOISTRPB	Moisture Rention Parameter (b)	GWPH	Groundwater pH	0.74051
SATURH2O	Saturated Water Content	GWPH	Groundwater pH	-0.97811
SOILBDEN	Soil Bulk Density	GWPH	Groundwater pH	-0.85011
XDIST	Longitudinal Distance to Well	RADISTW	Radial Distance to Well	0.95824
INFILRAT	Infiltration Rate	RECHARAT	Recharge Rate	0.98115
DURLEACH	Duration of Leaching Period	RECHARAT	Recharge Rate	-0.9707
SATHYCON	Saturated Hydraulic Conductivity	RECHARAT	Recharge Rate	0.83052
MOISTRPA	Moisture Rention Parameter (a)	RECHARAT	Recharge Rate	0.83832
MOISTRPB	Moisture Rention Parameter (b)	RECHARAT	Recharge Rate	0.92556
SOILBDEN	Soil Bulk Density	RECHARAT	Recharge Rate	-0.99568
RECHARAT	Recharge Rate	DURLEACH	Duration of Leaching Period	-0.9707
INFILRAT	Infiltration Rate	DURLEACH	Duration of Leaching Period	-0.97085
SATHYCON	Saturated Hydraulic Conductivity	DURLEACH	Duration of Leaching Period	-0.81763
MOISTRPA	Moisture Rention Parameter (a)	DURLEACH	Duration of Leaching Period	-0.83128
MOISTRPB	Moisture Rention Parameter (b)	DURLEACH	Duration of Leaching Period	-0.89845
SATURH2O	Saturated Water Content	DURLEACH	Duration of Leaching Period	0.80424
SOILBDEN	Soil Bulk Density	DURLEACH	Duration of Leaching Period	0.98724
RECHARAT	Recharge Rate	SATHYCON	Saturated Hydraulic Conductivity	0.83052
INFILRAT	Infiltration Rate	SATHYCON	Saturated Hydraulic Conductivity	0.84193
DURLEACH	Duration of Leaching Period	SATHYCON	Saturated Hydraulic Conductivity	-0.81763
MOISTRPA	Moisture Rention Parameter (a)	SATHYCON	Saturated Hydraulic Conductivity	0.70305
MOISTRPB	Moisture Rention Parameter (b)	SATHYCON	Saturated Hydraulic Conductivity	0.76449
RECHARAT	Recharge Rate	MOISTRPA	Moisture Rention Parameter (a)	0.83832
INFILRAT	Infiltration Rate	MOISTRPA	Moisture Rention Parameter (a)	0.82449
DURLEACH	Duration of Leaching Period	MOISTRPA	Moisture Rention Parameter (a)	-0.83128

Table D-12. Summary of Correlated Parameters for Vanadium

Variable 1		Variable 2		Correlation Coefficient
Code	**Description**	**Code**	**Description**	
SATHYCON	Saturated Hydraulic Conductivity	MOISTRPA	Moisture Rention Parameter (a)	0.70305
MOISTRPB	Moisture Rention Parameter (b)	MOISTRPA	Moisture Rention Parameter (a)	0.77967
RECHARAT	Recharge Rate	MOISTRPB	Moisture Rention Parameter (b)	0.92556
INFILRAT	Infiltration Rate	MOISTRPB	Moisture Rention Parameter (b)	0.90632
DURLEACH	Duration of Leaching Period	MOISTRPB	Moisture Rention Parameter (b)	-0.89845
SATHYCON	Saturated Hydraulic Conductivity	MOISTRPB	Moisture Rention Parameter (b)	0.76449
DURLEACH	Duration of Leaching Period	SATURH2O	Saturated Water Content	0.80424
SOILBDEN	Soil Bulk Density	SATURH2O	Saturated Water Content	0.72192
UNSATHIK	Unsaturated Zone Thickness	LONDISPU	Longitudinal Dispersivity	0.99999
RECHARAT	Recharge Rate	SOILBDEN	Soil Bulk Density	-0.99568
INFILRAT	Infiltration Rate	SOILBDEN	Soil Bulk Density	-0.97764
DURLEACH	Duration of Leaching Period	SOILBDEN	Soil Bulk Density	0.98724
SATHYCON	Saturated Hydraulic Conductivity	SOILBDEN	Soil Bulk Density	-0.82686
MOISTRPA	Moisture Rention Parameter (a)	SOILBDEN	Soil Bulk Density	-0.84181
MOISTRPB	Moisture Rention Parameter (b)	SOILBDEN	Soil Bulk Density	-0.92192
SATURH2O	Saturated Water Content	SOILBDEN	Soil Bulk Density	0.72192

Note: Parameters in the variable 2 column were removed from the analysis.

Table D-13. Summary of Crosspairs Analysis for Vanadium

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
AVGPDIAM	Avg. Particle Diameter			Y	Y
POROSITY	Porosity				
AQUTHIK	Aquifer Thickness			Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity				Y
HYDGRAD	Hydraulic Gradient				Y
GWSEEPV	Groundwater Seepage Velocity				
LONDISPA	Longitudinal Dispersivity			Y	Y
FRORGCAR	Fraction Organic Carbon				
ANGLEW	Angle of Well Off Plume Centerline				
XDIST	Longitudinal Distance to Well			Y	Y
YDIST	Distance from Plume Centerline to Well			Y	Y
ZDIST	Depth of Well Below Water Table				
FRCOEFA	Freundlich Isotherm Coefficient			Y	Y
INFILRAT	Infiltration Rate				
RESIDH2O	Residual Water Content				
SATURH2O	Saturated Water Content				Y
UNSATHIK	Unsaturated Zone Thickness			Y	Y
PERORGM	Percent Organic Matter				
FRCOEFU	Freundlich Isotherm Coefficient			Y	Y
AVGPDIAM	Avg. Particle Diameter	AVGPDIAM	Avg. Particle Diameter		
POROSITY	Porosity	AVGPDIAM	Avg. Particle Diameter		
POROSITY	Porosity	POROSITY	Porosity		
AQUTHIK	Aquifer Thickness	AVGPDIAM	Avg. Particle Diameter	Y	Y
AQUTHIK	Aquifer Thickness	POROSITY	Porosity		
AQUTHIK	Aquifer Thickness	AQUTHIK	Aquifer Thickness	Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity	AVGPDIAM	Avg. Particle Diameter		
LONHYCON	Longitundinal Hydraulic Conductivity	POROSITY	Porosity		
LONHYCON	Longitundinal Hydraulic Conductivity	AQUTHIK	Aquifer Thickness		
LONHYCON	Longitundinal Hydraulic Conductivity	LONHYCON	Longitundinal Hydraulic Conductivity		
HYDGRAD	Hydraulic Gradient	AVGPDIAM	Avg. Particle Diameter		
HYDGRAD	Hydraulic Gradient	POROSITY	Porosity		
HYDGRAD	Hydraulic Gradient	AQUTHIK	Aquifer Thickness		
HYDGRAD	Hydraulic Gradient	LONHYCON	Longitundinal Hydraulic Conductivity		
HYDGRAD	Hydraulic Gradient	HYDGRAD	Hydraulic Gradient		
GWSEEPV	Groundwater Seepage Velocity	AVGPDIAM	Avg. Particle Diameter		
GWSEEPV	Groundwater Seepage Velocity	POROSITY	Porosity		
GWSEEPV	Groundwater Seepage Velocity	AQUTHIK	Aquifer Thickness		
GWSEEPV	Groundwater Seepage Velocity	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
GWSEEPV	Groundwater Seepage Velocity	HYDGRAD	Hydraulic Gradient	Y	Y
GWSEEPV	Groundwater Seepage Velocity	GWSEEPV	Groundwater Seepage Velocity		
LONDISPA	Longitudinal Dispersivity	AVGPDIAM	Avg. Particle Diameter		
LONDISPA	Longitudinal Dispersivity	POROSITY	Porosity		
LONDISPA	Longitudinal Dispersivity	AQUTHIK	Aquifer Thickness		
LONDISPA	Longitudinal Dispersivity	LONHYCON	Longitundinal Hydraulic Conductivity		
LONDISPA	Longitudinal Dispersivity	HYDGRAD	Hydraulic Gradient		
LONDISPA	Longitudinal Dispersivity	GWSEEPV	Groundwater Seepage Velocity		
LONDISPA	Longitudinal Dispersivity	LONDISPA	Longitudinal Dispersivity	Y	Y
FRORGCAR	Fraction Organic Carbon	AVGPDIAM	Avg. Particle Diameter		
FRORGCAR	Fraction Organic Carbon	POROSITY	Porosity		

Table D-13. Summary of Crosspairs Analysis for Vanadium

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
FRORGCAR	Fraction Organic Carbon	AQUTHIK	Aquifer Thickness		
FRORGCAR	Fraction Organic Carbon	LONHYCON	Longitundinal Hydraulic Conductivity		
FRORGCAR	Fraction Organic Carbon	HYDGRAD	Hydraulic Gradient		
FRORGCAR	Fraction Organic Carbon	GWSEEPV	Groundwater Seepage Velocity		
FRORGCAR	Fraction Organic Carbon	LONDISPA	Longitudinal Dispersivity		
FRORGCAR	Fraction Organic Carbon	FRORGCAR	Fraction Organic Carbon		
ANGLEW	Angle of Well Off Plume Centerline	AVGPDIAM	Avg. Particle Diameter		
ANGLEW	Angle of Well Off Plume Centerline	POROSITY	Porosity		
ANGLEW	Angle of Well Off Plume Centerline	AQUTHIK	Aquifer Thickness		
ANGLEW	Angle of Well Off Plume Centerline	LONHYCON	Longitundinal Hydraulic Conductivity		
ANGLEW	Angle of Well Off Plume Centerline	HYDGRAD	Hydraulic Gradient		
ANGLEW	Angle of Well Off Plume Centerline	GWSEEPV	Groundwater Seepage Velocity		
ANGLEW	Angle of Well Off Plume Centerline	LONDISPA	Longitudinal Dispersivity		
ANGLEW	Angle of Well Off Plume Centerline	FRORGCAR	Fraction Organic Carbon		
ANGLEW	Angle of Well Off Plume Centerline	ANGLEW	Angle of Well Off Plume Centerline		
XDIST	Longitudinal Distance to Well	AVGPDIAM	Avg. Particle Diameter		
XDIST	Longitudinal Distance to Well	POROSITY	Porosity		
XDIST	Longitudinal Distance to Well	AQUTHIK	Aquifer Thickness		
XDIST	Longitudinal Distance to Well	LONHYCON	Longitundinal Hydraulic Conductivity		
XDIST	Longitudinal Distance to Well	HYDGRAD	Hydraulic Gradient		
XDIST	Longitudinal Distance to Well	GWSEEPV	Groundwater Seepage Velocity		
XDIST	Longitudinal Distance to Well	LONDISPA	Longitudinal Dispersivity		
XDIST	Longitudinal Distance to Well	FRORGCAR	Fraction Organic Carbon		
XDIST	Longitudinal Distance to Well	ANGLEW	Angle of Well Off Plume Centerline		
XDIST	Longitudinal Distance to Well	XDIST	Longitudinal Distance to Well		
YDIST	Distance from Plume Centerline to Well	AVGPDIAM	Avg. Particle Diameter	Y	
YDIST	Distance from Plume Centerline to Well	POROSITY	Porosity		
YDIST	Distance from Plume Centerline to Well	AQUTHIK	Aquifer Thickness	Y	Y
YDIST	Distance from Plume Centerline to Well	LONHYCON	Longitundinal Hydraulic Conductivity		
YDIST	Distance from Plume Centerline to Well	HYDGRAD	Hydraulic Gradient		
YDIST	Distance from Plume Centerline to Well	GWSEEPV	Groundwater Seepage Velocity		
YDIST	Distance from Plume Centerline to Well	LONDISPA	Longitudinal Dispersivity	Y	Y
YDIST	Distance from Plume Centerline to Well	FRORGCAR	Fraction Organic Carbon		
YDIST	Distance from Plume Centerline to Well	ANGLEW	Angle of Well Off Plume Centerline		
YDIST	Distance from Plume Centerline to Well	XDIST	Longitudinal Distance to Well	Y	Y
YDIST	Distance from Plume Centerline to Well	YDIST	Distance from Plume Centerline to Well	Y	Y
ZDIST	Depth of Well Below Water Table	AVGPDIAM	Avg. Particle Diameter		
ZDIST	Depth of Well Below Water Table	POROSITY	Porosity		
ZDIST	Depth of Well Below Water Table	AQUTHIK	Aquifer Thickness		
ZDIST	Depth of Well Below Water Table	LONHYCON	Longitundinal Hydraulic Conductivity		
ZDIST	Depth of Well Below Water Table	HYDGRAD	Hydraulic Gradient		
ZDIST	Depth of Well Below Water Table	GWSEEPV	Groundwater Seepage Velocity		
ZDIST	Depth of Well Below Water Table	LONDISPA	Longitudinal Dispersivity		
ZDIST	Depth of Well Below Water Table	FRORGCAR	Fraction Organic Carbon		
ZDIST	Depth of Well Below Water Table	ANGLEW	Angle of Well Off Plume Centerline		
ZDIST	Depth of Well Below Water Table	XDIST	Longitudinal Distance to Well		
ZDIST	Depth of Well Below Water Table	YDIST	Distance from Plume Centerline to Well		
ZDIST	Depth of Well Below Water Table	ZDIST	Depth of Well Below Water Table		
FRCOEFA	Freundlich Isotherm Coefficient	AVGPDIAM	Avg. Particle Diameter	Y	Y

Table D-13. Summary of Crosspairs Analysis for Vanadium

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
FRCOEFA	Freundlich Isotherm Coefficient	POROSITY	Porosity		
FRCOEFA	Freundlich Isotherm Coefficient	AQUTHIK	Aquifer Thickness	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	HYDGRAD	Hydraulic Gradient	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	GWSEEPV	Groundwater Seepage Velocity		
FRCOEFA	Freundlich Isotherm Coefficient	LONDISPA	Longitudinal Dispersivity	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	FRORGCAR	Fraction Organic Carbon		
FRCOEFA	Freundlich Isotherm Coefficient	ANGLEW	Angle of Well Off Plume Centerline		
FRCOEFA	Freundlich Isotherm Coefficient	XDIST	Longitudinal Distance to Well	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	YDIST	Distance from Plume Centerline to Well	Y	
FRCOEFA	Freundlich Isotherm Coefficient	ZDIST	Depth of Well Below Water Table		
FRCOEFA	Freundlich Isotherm Coefficient	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
INFILRAT	Infiltration Rate	AVGPDIAM	Avg. Particle Diameter		
INFILRAT	Infiltration Rate	POROSITY	Porosity		
INFILRAT	Infiltration Rate	AQUTHIK	Aquifer Thickness	Y	
INFILRAT	Infiltration Rate	LONHYCON	Longitundinal Hydraulic Conductivity		
INFILRAT	Infiltration Rate	HYDGRAD	Hydraulic Gradient		
INFILRAT	Infiltration Rate	GWSEEPV	Groundwater Seepage Velocity		
INFILRAT	Infiltration Rate	LONDISPA	Longitudinal Dispersivity		
INFILRAT	Infiltration Rate	FRORGCAR	Fraction Organic Carbon		
INFILRAT	Infiltration Rate	ANGLEW	Angle of Well Off Plume Centerline		
INFILRAT	Infiltration Rate	XDIST	Longitudinal Distance to Well		
INFILRAT	Infiltration Rate	YDIST	Distance from Plume Centerline to Well		
INFILRAT	Infiltration Rate	ZDIST	Depth of Well Below Water Table		
INFILRAT	Infiltration Rate	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
INFILRAT	Infiltration Rate	INFILRAT	Infiltration Rate	Y	Y
RESIDH2O	Residual Water Content	AVGPDIAM	Avg. Particle Diameter		
RESIDH2O	Residual Water Content	POROSITY	Porosity		
RESIDH2O	Residual Water Content	AQUTHIK	Aquifer Thickness	Y	
RESIDH2O	Residual Water Content	LONHYCON	Longitundinal Hydraulic Conductivity		
RESIDH2O	Residual Water Content	HYDGRAD	Hydraulic Gradient		
RESIDH2O	Residual Water Content	GWSEEPV	Groundwater Seepage Velocity		
RESIDH2O	Residual Water Content	LONDISPA	Longitudinal Dispersivity		
RESIDH2O	Residual Water Content	FRORGCAR	Fraction Organic Carbon		
RESIDH2O	Residual Water Content	ANGLEW	Angle of Well Off Plume Centerline		
RESIDH2O	Residual Water Content	XDIST	Longitudinal Distance to Well		
RESIDH2O	Residual Water Content	YDIST	Distance from Plume Centerline to Well		
RESIDH2O	Residual Water Content	ZDIST	Depth of Well Below Water Table		
RESIDH2O	Residual Water Content	FRCOEFA	Freundlich Isotherm Coefficient		
RESIDH2O	Residual Water Content	INFILRAT	Infiltration Rate		
RESIDH2O	Residual Water Content	RESIDH2O	Residual Water Content		
SATURH2O	Saturated Water Content	AVGPDIAM	Avg. Particle Diameter		
SATURH2O	Saturated Water Content	POROSITY	Porosity		
SATURH2O	Saturated Water Content	AQUTHIK	Aquifer Thickness	Y	
SATURH2O	Saturated Water Content	LONHYCON	Longitundinal Hydraulic Conductivity		
SATURH2O	Saturated Water Content	HYDGRAD	Hydraulic Gradient		
SATURH2O	Saturated Water Content	GWSEEPV	Groundwater Seepage Velocity		
SATURH2O	Saturated Water Content	LONDISPA	Longitudinal Dispersivity		
SATURH2O	Saturated Water Content	FRORGCAR	Fraction Organic Carbon		

Table D-13. Summary of Crosspairs Analysis for Vanadium

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
SATURH2O	Saturated Water Content	ANGLEW	Angle of Well Off Plume Centerline		
SATURH2O	Saturated Water Content	XDIST	Longitudinal Distance to Well		
SATURH2O	Saturated Water Content	YDIST	Distance from Plume Centerline to Well		
SATURH2O	Saturated Water Content	ZDIST	Depth of Well Below Water Table		
SATURH2O	Saturated Water Content	FRCOEFA	Freundlich Isotherm Coefficient		
SATURH2O	Saturated Water Content	INFILRAT	Infiltration Rate		
SATURH2O	Saturated Water Content	RESIDH2O	Residual Water Content		
SATURH2O	Saturated Water Content	SATURH2O	Saturated Water Content		
UNSATHIK	Unsaturated Zone Thickness	AVGPDIAM	Avg. Particle Diameter		
UNSATHIK	Unsaturated Zone Thickness	POROSITY	Porosity		
UNSATHIK	Unsaturated Zone Thickness	AQUTHIK	Aquifer Thickness		
UNSATHIK	Unsaturated Zone Thickness	LONHYCON	Longitundinal Hydraulic Conductivity		
UNSATHIK	Unsaturated Zone Thickness	HYDGRAD	Hydraulic Gradient		
UNSATHIK	Unsaturated Zone Thickness	GWSEEPV	Groundwater Seepage Velocity		
UNSATHIK	Unsaturated Zone Thickness	LONDISPA	Longitudinal Dispersivity		
UNSATHIK	Unsaturated Zone Thickness	FRORGCAR	Fraction Organic Carbon		
UNSATHIK	Unsaturated Zone Thickness	ANGLEW	Angle of Well Off Plume Centerline		
UNSATHIK	Unsaturated Zone Thickness	XDIST	Longitudinal Distance to Well		
UNSATHIK	Unsaturated Zone Thickness	YDIST	Distance from Plume Centerline to Well	Y	
UNSATHIK	Unsaturated Zone Thickness	ZDIST	Depth of Well Below Water Table		
UNSATHIK	Unsaturated Zone Thickness	FRCOEFA	Freundlich Isotherm Coefficient	Y	
UNSATHIK	Unsaturated Zone Thickness	INFILRAT	Infiltration Rate		
UNSATHIK	Unsaturated Zone Thickness	RESIDH2O	Residual Water Content		
UNSATHIK	Unsaturated Zone Thickness	SATURH2O	Saturated Water Content		
UNSATHIK	Unsaturated Zone Thickness	UNSATHIK	Unsaturated Zone Thickness	Y	Y
PERORGM	Percent Organic Matter	AVGPDIAM	Avg. Particle Diameter		
PERORGM	Percent Organic Matter	POROSITY	Porosity		
PERORGM	Percent Organic Matter	AQUTHIK	Aquifer Thickness		
PERORGM	Percent Organic Matter	LONHYCON	Longitundinal Hydraulic Conductivity		
PERORGM	Percent Organic Matter	HYDGRAD	Hydraulic Gradient		
PERORGM	Percent Organic Matter	GWSEEPV	Groundwater Seepage Velocity		
PERORGM	Percent Organic Matter	LONDISPA	Longitudinal Dispersivity		
PERORGM	Percent Organic Matter	FRORGCAR	Fraction Organic Carbon	Y	
PERORGM	Percent Organic Matter	ANGLEW	Angle of Well Off Plume Centerline		
PERORGM	Percent Organic Matter	XDIST	Longitudinal Distance to Well		
PERORGM	Percent Organic Matter	YDIST	Distance from Plume Centerline to Well		
PERORGM	Percent Organic Matter	ZDIST	Depth of Well Below Water Table		
PERORGM	Percent Organic Matter	FRCOEFA	Freundlich Isotherm Coefficient		
PERORGM	Percent Organic Matter	INFILRAT	Infiltration Rate		
PERORGM	Percent Organic Matter	RESIDH2O	Residual Water Content		
PERORGM	Percent Organic Matter	SATURH2O	Saturated Water Content		
PERORGM	Percent Organic Matter	UNSATHIK	Unsaturated Zone Thickness		
PERORGM	Percent Organic Matter	PERORGM	Percent Organic Matter		
FRCOEFU	Freundlich Isotherm Coefficient	AVGPDIAM	Avg. Particle Diameter	Y	
FRCOEFU	Freundlich Isotherm Coefficient	POROSITY	Porosity		
FRCOEFU	Freundlich Isotherm Coefficient	AQUTHIK	Aquifer Thickness	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	LONHYCON	Longitundinal Hydraulic Conductivity		
FRCOEFU	Freundlich Isotherm Coefficient	HYDGRAD	Hydraulic Gradient		
FRCOEFU	Freundlich Isotherm Coefficient	GWSEEPV	Groundwater Seepage Velocity		

Table D-13. Summary of Crosspairs Analysis for Vanadium

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
FRCOEFU	Freundlich Isotherm Coefficient	LONDISPA	Longitudinal Dispersivity		
FRCOEFU	Freundlich Isotherm Coefficient	FRORGCAR	Fraction Organic Carbon		
FRCOEFU	Freundlich Isotherm Coefficient	ANGLEW	Angle of Well Off Plume Centerline		
FRCOEFU	Freundlich Isotherm Coefficient	XDIST	Longitudinal Distance to Well		
FRCOEFU	Freundlich Isotherm Coefficient	YDIST	Distance from Plume Centerline to Well	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	ZDIST	Depth of Well Below Water Table		
FRCOEFU	Freundlich Isotherm Coefficient	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	INFILRAT	Infiltration Rate	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	RESIDH2O	Residual Water Content	Y	
FRCOEFU	Freundlich Isotherm Coefficient	SATURH2O	Saturated Water Content		
FRCOEFU	Freundlich Isotherm Coefficient	UNSATHIK	Unsaturated Zone Thickness	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	PERORGM	Percent Organic Matter		
FRCOEFU	Freundlich Isotherm Coefficient	FRCOEFU	Freundlich Isotherm Coefficient	Y	Y

Table D-14. Ranking of Parameters According to Percentage of Risk for Vanadium

Variable Description	Reduced Sums of Square	Variable Sums of Square	Variable Degrees of Freedom	% Risk Variation	Mean Square Variable	F VALUE	P VALUE
Freundlich Isotherm Coefficient {Aquifer} (cm3/g)	7806.7	8006.94	10	42.4%	800.69	1295.17	0.00E+00
Distance from Plume Centerline to Well (m)	8812.0	7001.58	6	37.1%	1166.93	1887.59	0.00E+00
Aquifer Thickness (m)	13799.8	2013.84	6	10.7%	335.64	542.92	0.00E+00
Freundlich Isotherm Coefficient {Unsaturated} (cm3/g)	13968.0	1845.56	7	9.8%	263.65	426.47	0.00E+00
Consumption of Drinking Water	14779.1	1034.51	1	5.5%	1034.51	1673.39	0.00E+00
Longitudinal Dispersivity {Aquifer} (m)	14772.9	1040.73	4	5.5%	260.18	420.86	0.00E+00
Unsaturated Zone Thickness (m)	15280.1	533.47	3	2.8%	177.82	287.64	3.80E-172
Longitudinal Hydraulic Conductivity (m/yr)	15673.3	140.30	3	0.7%	46.77	75.65	7.67E-48
Longitudinal Distance to Well (m)	15708.5	105.10	3	0.6%	35.03	56.67	5.21E-36
Infiltration Rate (m/yr)	15722.0	91.56	4	0.5%	22.89	37.03	1.48E-30
Hydraulic Gradient (m/m)	15720.7	92.93	3	0.5%	30.98	50.11	6.76E-32
Groundwater Seepage Velocity (m/yr)	15765.0	48.59	3	0.3%	16.20	26.20	8.27E-17
Avg. Particle Diameter (cm)	15759.8	53.81	3	0.3%	17.94	29.02	1.36E-18
Saturated Water Content (unitness)	15807.5	6.16	1	0.0%	6.16	9.96	1.61E-03

Constants

Full Model SS	15813.613
Error SS	3066.336
Error DF	4960
MS Error	0.618

Table D-15. Chemical-Specific Properties for Constituents of Concern for the Sulfate Process Secondary Gypsum

	Waste Constituent Concentrations			*Degradation Rates*	
Constituent	**SPLP (Industrial D Landfill) (mg/L)**	**Total waste (mg/kg)**	**Finite MSW Source Ratio (L/kg)**	**Overall Hydrolysis rate(1/yr)**	**Biodegrd. Rate(1/yr)**
Antimony	0.055	3.2	58	0	0
Manganese	3.1	673	217	0	0
Arsenic	*0.00175*	0.8	457	0	0

underline italics indicate values set at 1/2 of detection limit

Table D-16. Waste Management Unit Parameters for Onsite Landfill Managing Sulfate Process Secondary Gypsum

WMU	Location	Landfill Area (acres)	Landfill Area (m^2)
Onsite Landfill	Baltimore, MD	95	384452.9

Table D-17. Waste Stream Parameters for Sulfate Process Secondary Gypsum

WMU	Location	Waste Quantity (MT/y)	Waste Density (g/cm^3)	Waste Density (kg/m^3)	Total Waste Vol (m^3)
Onsite Landfill	Baltimore, MD	51,710	1.507	1507	34313.2

Table D-18. Site-Specific Climate-Based Parameters for Sulfate Process Secondary Gypsum

WMU	Location	Climate Index	Climate Center	Landfill Infiltartion Rate (m/yr)			Recharge Rate (m/yr)				GWpH		
				SCL	SLT	SNL	SCL	SLT	SNL	GW TempC	SCL	SLT	SNL
Onsite Landfill	Baltimore, MD	71	Philadelphia, PA	0.16	0.20	0.26	0.16	0.20	0.26	13	4.5	4.3	4.8

Table D-19. Aquifer Types Common Within Area of WMU Currently Managing Sulfate Process Secondary Gypsum

Aquifer Types	Aquifer Code	Baltimore, MD
Unconsolidated and semiconsolidated shallow aquifers	10	100%

Table D-20. Soil Textures Common in Area of WMU Currently Managing Sulfate Process Secondary Gypsum

		Baltimore, MD
silty clay loam	SCL	39%
silt loam	SIL	25%
sandy loam	SNL	36%

Table D-21. Summary of Parameters Considered in Sensitivity Analysis for Antimony

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
ACIDCAT	Acid Catalyzed Hydrolysis Rate Constant	C			
ANGLEW	Angle of Well Off Plume Centerline	anglew		Y	
ANISORAT	Anisotropy Ratio	C			
AQUTHIK	Aquifer Thickness	aquthik**-0.2		Y	Y
AVGPDIAM	Avg. Particle Diameter	log(avgpdiam+.004)		Y	Y
BASECAT	Base Catalyzed Hydrolysis Rate Constant	C			
BIODRATA	Biodegradation Rate	C			
BIODRATU	Biodegradation Rate	C			
BULKDENS	Bulk Density	bulkdens**3.5	Y		
CHEMDRU	Chemical Decay Rate	C			
CHEMDRA	Chemical Decay Rate	C			
CONSH2OA	Consump of drinking water	log(consh2oa)			Y
ZDIST	Depth of Well Below Water Table	log(zdist+1)		Y	Y
DISHYD	Dissolved Hydrolysis Rate	C			
YDIST	Distance from Plume Centerline to Well	log(ydist+150)		Y	Y
DURLEACH	Duration of Leaching Period	log(durleach-888)	Y		
GWAVTIM	Exposure Duration	C			
FRORGCAR	Fraction Organic Carbon	log(frorgcar)		Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	log(frcoefa-.3)		Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	log(frcoefu)		Y	Y
FREXPA	Freundlich Isotherm Exponent	C			
FREXPU	Freundlich Isotherm Exponent	C			
GWPH	Groundwater pH	gwph	Y		
GWSEEPV	Groundwater Seepage Velocity	log(gwseepv)		Y	Y
GWTEMP	Groundwater Temperature	C			
HYDGRAD	Hydraulic Gradient	log(hydgrad+0.001)		Y	Y
INFILRAT	Infiltration Rate	infilrat**1.5		Y	Y
LANDEPTH	Landfill Depth	C			
LEACHCON	Leachate Concentration	C			
LFFRACT	LF Fraction	C			
LONDISPU	Longitudinal Dispersivity	log(londispu+2.5)	Y		
LONDISPA	Longitudinal Dispersivity	log(londispa+3)		Y	Y
XDIST	Longitudinal Distance to Well	log(xdist+2000)		Y	Y

Table D-21. Summary of Parameters Considered in Sensitivity Analysis for Antimony

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
LONHYCON	Longitundinal Hydraulic Conductivity	log(lonhycon)		Y	Y
MLLA	ml/L	C			
MOISTRPA	Moisture Rention Parameter (a)	log(moistrpa)	Y		
MOISTRPB	Moisture Rention Parameter (b)	log(moistrpb-0.7)	Y		
MOLDIFF	Molecular Diffusion Coefficient	C			
NEUTHYD	Neutral Hydrolysis Rate Constant	C			
ORGCDIS	Organic Carbon Distribution Coefficient	C			
PERORGM	Percent Organic Matter	log(perorgm)		Y	
POROSITY	Porosity	porosity**1.3		Y	Y
RADISTW	Radial Distance to Well	log(radistw+250)	Y		
RECHARAT	Recharge Rate	recharat	Y		
RESIDH2O	Residual Water Content	residh2o**2.1		Y	Y
RETCOEF	Retardation Coefficient	log(retcoef-2)	Y		
RFDA	RfD (mg/kg/day)	C			
SATHYCON	Saturated Hydraulic Conductivity	log(sathycon)	Y		
SATURH2O	Saturated Water Content	saturh2o		Y	Y
SOILBDEN	Soil Bulk Density	soilbden	Y		
SORBHYD	Sorbed Hydrolysis Rate	C			
TRANDISP	Transverse Dispersivity	log(trandisp+0.01)	Y		
UNSATHIK	Unsaturated Zone Thickness	log(unsathik+2.5)		Y	Y
VERTDISP	Vertical Dispersivity	log(vertdisp+0.001)	Y		
WASTDENS	Waste Density	C			
WASTEVOL	Waste Volume	C			
WMUAREA	WMU Area	C			
WMULEN	WMU Length	C			
WMUWIDTH	WMU Width	C			

Table D-22. Summary of Correlated Parameters for Antimony

Variable 1		Variable 2		Correlation Coefficient
Code	Description	Code	Description	
AVGPDIAM	Avg. Particle Diameter	BULKDENS	Bulk Density	0.99613
FRCOEFA	Freundlich Isotherm Coefficient	RETCOEF	Retardation Coefficient	0.96093
LONDISPA	Longitudinal Dispersivity	TRANDISP	Transverse Dispersivity	0.98927
LONDISPA	Longitudinal Dispersivity	VERTDISP	Vertical Dispersivity	0.9926
RECHARAT	Recharge Rate	GWPH	Groundwater pH	0.78737
INFILRAT	Infiltration Rate	GWPH	Groundwater pH	0.77814
DURLEACH	Duration of Leaching Period	GWPH	Groundwater pH	-0.88538
MOISTRPA	Moisture Rention Parameter (a)	GWPH	Groundwater pH	0.705
MOISTRPB	Moisture Rention Parameter (b)	GWPH	Groundwater pH	0.75347
SATURH2O	Saturated Water Content	GWPH	Groundwater pH	-0.97661
SOILBDEN	Soil Bulk Density	GWPH	Groundwater pH	-0.8418
XDIST	Longitudinal Distance to Well	RADISTW	Radial Distance to Well	0.99782
INFILRAT	Infiltration Rate	RECHARAT	Recharge Rate	0.98204
DURLEACH	Duration of Leaching Period	RECHARAT	Recharge Rate	-0.97552
SATHYCON	Saturated Hydraulic Conductivity	RECHARAT	Recharge Rate	0.8208
MOISTRPA	Moisture Rention Parameter (a)	RECHARAT	Recharge Rate	0.83754
MOISTRPB	Moisture Rention Parameter (b)	RECHARAT	Recharge Rate	0.92994
SOILBDEN	Soil Bulk Density	RECHARAT	Recharge Rate	-0.99558
RECHARAT	Recharge Rate	DURLEACH	Duration of Leaching Period	-0.97552
INFILRAT	Infiltration Rate	DURLEACH	Duration of Leaching Period	-0.97991
SATHYCON	Saturated Hydraulic Conductivity	DURLEACH	Duration of Leaching Period	-0.81548
MOISTRPA	Moisture Rention Parameter (a)	DURLEACH	Duration of Leaching Period	-0.83068
MOISTRPB	Moisture Rention Parameter (b)	DURLEACH	Duration of Leaching Period	-0.91368
SATURH2O	Saturated Water Content	DURLEACH	Duration of Leaching Period	0.76757
SOILBDEN	Soil Bulk Density	DURLEACH	Duration of Leaching Period	0.98908
RECHARAT	Recharge Rate	SATHYCON	Saturated Hydraulic Conductivity	0.8208
INFILRAT	Infiltration Rate	SATHYCON	Saturated Hydraulic Conductivity	0.83973
DURLEACH	Duration of Leaching Period	SATHYCON	Saturated Hydraulic Conductivity	-0.81548
MOISTRPB	Moisture Rention Parameter (b)	SATHYCON	Saturated Hydraulic Conductivity	0.75861
RECHARAT	Recharge Rate	MOISTRPA	Moisture Rention Parameter (a)	0.83754
INFILRAT	Infiltration Rate	MOISTRPA	Moisture Rention Parameter (a)	0.82271
DURLEACH	Duration of Leaching Period	MOISTRPA	Moisture Rention Parameter (a)	-0.83068
MOISTRPB	Moisture Rention Parameter (b)	MOISTRPA	Moisture Rention Parameter (a)	0.78106

Table D-22. Summary of Correlated Parameters for Antimony

Variable 1		Variable 2		Correlation Coefficient
Code	**Description**	**Code**	**Description**	
RECHARAT	Recharge Rate	MOISTRPB	Moisture Rention Parameter (b)	0.92994
INFILRAT	Infiltration Rate	MOISTRPB	Moisture Rention Parameter (b)	0.91349
DURLEACH	Duration of Leaching Period	MOISTRPB	Moisture Rention Parameter (b)	-0.91368
SATHYCON	Saturated Hydraulic Conductivity	MOISTRPB	Moisture Rention Parameter (b)	0.75861
DURLEACH	Duration of Leaching Period	SATURH2O	Saturated Water Content	0.76757
SOILBDEN	Soil Bulk Density	SATURH2O	Saturated Water Content	0.70604
UNSATHIK	Unsaturated Zone Thickness	LONDISPU	Longitudinal Dispersivity	0.99525
RECHARAT	Recharge Rate	SOILBDEN	Soil Bulk Density	-0.99558
INFILRAT	Infiltration Rate	SOILBDEN	Soil Bulk Density	-0.97844
DURLEACH	Duration of Leaching Period	SOILBDEN	Soil Bulk Density	0.98908
SATHYCON	Saturated Hydraulic Conductivity	SOILBDEN	Soil Bulk Density	-0.81508
MOISTRPA	Moisture Rention Parameter (a)	SOILBDEN	Soil Bulk Density	-0.84078
MOISTRPB	Moisture Rention Parameter (b)	SOILBDEN	Soil Bulk Density	-0.92907
SATURH2O	Saturated Water Content	SOILBDEN	Soil Bulk Density	0.70604

Note: Parameters in the variable 2 column were removed from the analysis.

Table D-23. Summary of Crosspairs Analysis for Antimony

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
AVGPDIAM	Avg. Particle Diameter			Y	Y
POROSITY	Porosity				Y
AQUTHIK	Aquifer Thickness			Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity				
HYDGRAD	Hydraulic Gradient				Y
GWSEEPV	Groundwater Seepage Velocity				Y
LONDISPA	Longitudinal Dispersivity			Y	Y
FRORGCAR	Fraction Organic Carbon				
ANGLEW	Angle of Well Off Plume Centerline				
XDIST	Longitudinal Distance to Well			Y	Y
YDIST	Distance from Plume Centerline to Well			Y	Y
ZDIST	Depth of Well Below Water Table				Y
FRCOEFA	Freundlich Isotherm Coefficient			Y	Y
INFILRAT	Infiltration Rate			Y	Y
RESIDH2O	Residual Water Content				
SATURH2O	Saturated Water Content			Y	Y
UNSATHIK	Unsaturated Zone Thickness			Y	Y
PERORGM	Percent Organic Matter				
FRCOEFU	Freundlich Isotherm Coefficient			Y	Y
AVGPDIAM	Avg. Particle Diameter	AVGPDIAM	Avg. Particle Diameter		
POROSITY	Porosity	AVGPDIAM	Avg. Particle Diameter	Y	Y
POROSITY	Porosity	POROSITY	Porosity	Y	Y
AQUTHIK	Aquifer Thickness	AVGPDIAM	Avg. Particle Diameter	Y	
AQUTHIK	Aquifer Thickness	POROSITY	Porosity	Y	
AQUTHIK	Aquifer Thickness	AQUTHIK	Aquifer Thickness	Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity	AVGPDIAM	Avg. Particle Diameter		
LONHYCON	Longitundinal Hydraulic Conductivity	POROSITY	Porosity		
LONHYCON	Longitundinal Hydraulic Conductivity	AQUTHIK	Aquifer Thickness		
LONHYCON	Longitundinal Hydraulic Conductivity	LONHYCON	Longitundinal Hydraulic Conductivity		
HYDGRAD	Hydraulic Gradient	AVGPDIAM	Avg. Particle Diameter		
HYDGRAD	Hydraulic Gradient	POROSITY	Porosity		
HYDGRAD	Hydraulic Gradient	AQUTHIK	Aquifer Thickness		
HYDGRAD	Hydraulic Gradient	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
HYDGRAD	Hydraulic Gradient	HYDGRAD	Hydraulic Gradient		
GWSEEPV	Groundwater Seepage Velocity	AVGPDIAM	Avg. Particle Diameter		
GWSEEPV	Groundwater Seepage Velocity	POROSITY	Porosity		
GWSEEPV	Groundwater Seepage Velocity	AQUTHIK	Aquifer Thickness	Y	
GWSEEPV	Groundwater Seepage Velocity	LONHYCON	Longitundinal Hydraulic Conductivity		
GWSEEPV	Groundwater Seepage Velocity	HYDGRAD	Hydraulic Gradient	Y	Y
GWSEEPV	Groundwater Seepage Velocity	GWSEEPV	Groundwater Seepage Velocity	Y	Y
LONDISPA	Longitudinal Dispersivity	AVGPDIAM	Avg. Particle Diameter		
LONDISPA	Longitudinal Dispersivity	POROSITY	Porosity		
LONDISPA	Longitudinal Dispersivity	AQUTHIK	Aquifer Thickness		
LONDISPA	Longitudinal Dispersivity	LONHYCON	Longitundinal Hydraulic Conductivity	Y	
LONDISPA	Longitudinal Dispersivity	HYDGRAD	Hydraulic Gradient	Y	
LONDISPA	Longitudinal Dispersivity	GWSEEPV	Groundwater Seepage Velocity	Y	
LONDISPA	Longitudinal Dispersivity	LONDISPA	Longitudinal Dispersivity	Y	Y
FRORGCAR	Fraction Organic Carbon	AVGPDIAM	Avg. Particle Diameter		
FRORGCAR	Fraction Organic Carbon	POROSITY	Porosity		

Table D-23. Summary of Crosspairs Analysis for Antimony

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
FRORGCAR	Fraction Organic Carbon	AQUTHIK	Aquifer Thickness		
FRORGCAR	Fraction Organic Carbon	LONHYCON	Longitundinal Hydraulic Conductivity		
FRORGCAR	Fraction Organic Carbon	HYDGRAD	Hydraulic Gradient		
FRORGCAR	Fraction Organic Carbon	GWSEEPV	Groundwater Seepage Velocity		
FRORGCAR	Fraction Organic Carbon	LONDISPA	Longitudinal Dispersivity		
FRORGCAR	Fraction Organic Carbon	FRORGCAR	Fraction Organic Carbon		
ANGLEW	Angle of Well Off Plume Centerline	AVGPDIAM	Avg. Particle Diameter		
ANGLEW	Angle of Well Off Plume Centerline	POROSITY	Porosity		
ANGLEW	Angle of Well Off Plume Centerline	AQUTHIK	Aquifer Thickness		
ANGLEW	Angle of Well Off Plume Centerline	LONHYCON	Longitundinal Hydraulic Conductivity		
ANGLEW	Angle of Well Off Plume Centerline	HYDGRAD	Hydraulic Gradient		
ANGLEW	Angle of Well Off Plume Centerline	GWSEEPV	Groundwater Seepage Velocity		
ANGLEW	Angle of Well Off Plume Centerline	LONDISPA	Longitudinal Dispersivity	Y	
ANGLEW	Angle of Well Off Plume Centerline	FRORGCAR	Fraction Organic Carbon		
ANGLEW	Angle of Well Off Plume Centerline	ANGLEW	Angle of Well Off Plume Centerline		
XDIST	Longitudinal Distance to Well	AVGPDIAM	Avg. Particle Diameter		
XDIST	Longitudinal Distance to Well	POROSITY	Porosity		
XDIST	Longitudinal Distance to Well	AQUTHIK	Aquifer Thickness		
XDIST	Longitudinal Distance to Well	LONHYCON	Longitundinal Hydraulic Conductivity	Y	
XDIST	Longitudinal Distance to Well	HYDGRAD	Hydraulic Gradient	Y	
XDIST	Longitudinal Distance to Well	GWSEEPV	Groundwater Seepage Velocity		
XDIST	Longitudinal Distance to Well	LONDISPA	Longitudinal Dispersivity		
XDIST	Longitudinal Distance to Well	FRORGCAR	Fraction Organic Carbon		
XDIST	Longitudinal Distance to Well	ANGLEW	Angle of Well Off Plume Centerline		
XDIST	Longitudinal Distance to Well	XDIST	Longitudinal Distance to Well		
YDIST	Distance from Plume Centerline to Well	AVGPDIAM	Avg. Particle Diameter		
YDIST	Distance from Plume Centerline to Well	POROSITY	Porosity		
YDIST	Distance from Plume Centerline to Well	AQUTHIK	Aquifer Thickness	Y	Y
YDIST	Distance from Plume Centerline to Well	LONHYCON	Longitundinal Hydraulic Conductivity		
YDIST	Distance from Plume Centerline to Well	HYDGRAD	Hydraulic Gradient		
YDIST	Distance from Plume Centerline to Well	GWSEEPV	Groundwater Seepage Velocity		
YDIST	Distance from Plume Centerline to Well	LONDISPA	Longitudinal Dispersivity	Y	Y
YDIST	Distance from Plume Centerline to Well	FRORGCAR	Fraction Organic Carbon		
YDIST	Distance from Plume Centerline to Well	ANGLEW	Angle of Well Off Plume Centerline		
YDIST	Distance from Plume Centerline to Well	XDIST	Longitudinal Distance to Well	Y	Y
YDIST	Distance from Plume Centerline to Well	YDIST	Distance from Plume Centerline to Well	Y	Y
ZDIST	Depth of Well Below Water Table	AVGPDIAM	Avg. Particle Diameter		
ZDIST	Depth of Well Below Water Table	POROSITY	Porosity		
ZDIST	Depth of Well Below Water Table	AQUTHIK	Aquifer Thickness		
ZDIST	Depth of Well Below Water Table	LONHYCON	Longitundinal Hydraulic Conductivity		
ZDIST	Depth of Well Below Water Table	HYDGRAD	Hydraulic Gradient		
ZDIST	Depth of Well Below Water Table	GWSEEPV	Groundwater Seepage Velocity		
ZDIST	Depth of Well Below Water Table	LONDISPA	Longitudinal Dispersivity		
ZDIST	Depth of Well Below Water Table	FRORGCAR	Fraction Organic Carbon		
ZDIST	Depth of Well Below Water Table	ANGLEW	Angle of Well Off Plume Centerline		
ZDIST	Depth of Well Below Water Table	XDIST	Longitudinal Distance to Well		
ZDIST	Depth of Well Below Water Table	YDIST	Distance from Plume Centerline to Well		
ZDIST	Depth of Well Below Water Table	ZDIST	Depth of Well Below Water Table		
FRCOEFA	Freundlich Isotherm Coefficient	AVGPDIAM	Avg. Particle Diameter	Y	Y

Table D-23. Summary of Crosspairs Analysis for Antimony

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
FRCOEFA	Freundlich Isotherm Coefficient	POROSITY	Porosity		
FRCOEFA	Freundlich Isotherm Coefficient	AQUTHIK	Aquifer Thickness	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	HYDGRAD	Hydraulic Gradient	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	GWSEEPV	Groundwater Seepage Velocity		
FRCOEFA	Freundlich Isotherm Coefficient	LONDISPA	Longitudinal Dispersivity	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	FRORGCAR	Fraction Organic Carbon		
FRCOEFA	Freundlich Isotherm Coefficient	ANGLEW	Angle of Well Off Plume Centerline		
FRCOEFA	Freundlich Isotherm Coefficient	XDIST	Longitudinal Distance to Well		
FRCOEFA	Freundlich Isotherm Coefficient	YDIST	Distance from Plume Centerline to Well	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	ZDIST	Depth of Well Below Water Table	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
INFILRAT	Infiltration Rate	AVGPDIAM	Avg. Particle Diameter		
INFILRAT	Infiltration Rate	POROSITY	Porosity		
INFILRAT	Infiltration Rate	AQUTHIK	Aquifer Thickness	Y	Y
INFILRAT	Infiltration Rate	LONHYCON	Longitundinal Hydraulic Conductivity		
INFILRAT	Infiltration Rate	HYDGRAD	Hydraulic Gradient		
INFILRAT	Infiltration Rate	GWSEEPV	Groundwater Seepage Velocity		
INFILRAT	Infiltration Rate	LONDISPA	Longitudinal Dispersivity		
INFILRAT	Infiltration Rate	FRORGCAR	Fraction Organic Carbon		
INFILRAT	Infiltration Rate	ANGLEW	Angle of Well Off Plume Centerline		
INFILRAT	Infiltration Rate	XDIST	Longitudinal Distance to Well		
INFILRAT	Infiltration Rate	YDIST	Distance from Plume Centerline to Well	Y	
INFILRAT	Infiltration Rate	ZDIST	Depth of Well Below Water Table		
INFILRAT	Infiltration Rate	FRCOEFA	Freundlich Isotherm Coefficient		
INFILRAT	Infiltration Rate	INFILRAT	Infiltration Rate	Y	Y
RESIDH2O	Residual Water Content	AVGPDIAM	Avg. Particle Diameter		
RESIDH2O	Residual Water Content	POROSITY	Porosity		
RESIDH2O	Residual Water Content	AQUTHIK	Aquifer Thickness	Y	Y
RESIDH2O	Residual Water Content	LONHYCON	Longitundinal Hydraulic Conductivity		
RESIDH2O	Residual Water Content	HYDGRAD	Hydraulic Gradient		
RESIDH2O	Residual Water Content	GWSEEPV	Groundwater Seepage Velocity		
RESIDH2O	Residual Water Content	LONDISPA	Longitudinal Dispersivity		
RESIDH2O	Residual Water Content	FRORGCAR	Fraction Organic Carbon	Y	Y
RESIDH2O	Residual Water Content	ANGLEW	Angle of Well Off Plume Centerline		
RESIDH2O	Residual Water Content	XDIST	Longitudinal Distance to Well		
RESIDH2O	Residual Water Content	YDIST	Distance from Plume Centerline to Well		
RESIDH2O	Residual Water Content	ZDIST	Depth of Well Below Water Table		
RESIDH2O	Residual Water Content	FRCOEFA	Freundlich Isotherm Coefficient		
RESIDH2O	Residual Water Content	INFILRAT	Infiltration Rate		
RESIDH2O	Residual Water Content	RESIDH2O	Residual Water Content		
SATURH2O	Saturated Water Content	AVGPDIAM	Avg. Particle Diameter		
SATURH2O	Saturated Water Content	POROSITY	Porosity		
SATURH2O	Saturated Water Content	AQUTHIK	Aquifer Thickness	Y	Y
SATURH2O	Saturated Water Content	LONHYCON	Longitundinal Hydraulic Conductivity		
SATURH2O	Saturated Water Content	HYDGRAD	Hydraulic Gradient		
SATURH2O	Saturated Water Content	GWSEEPV	Groundwater Seepage Velocity		
SATURH2O	Saturated Water Content	LONDISPA	Longitudinal Dispersivity		
SATURH2O	Saturated Water Content	FRORGCAR	Fraction Organic Carbon		

Table D-23. Summary of Crosspairs Analysis for Antimony

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
SATURH2O	Saturated Water Content	ANGLEW	Angle of Well Off Plume Centerline		
SATURH2O	Saturated Water Content	XDIST	Longitudinal Distance to Well		
SATURH2O	Saturated Water Content	YDIST	Distance from Plume Centerline to Well		
SATURH2O	Saturated Water Content	ZDIST	Depth of Well Below Water Table	Y	
SATURH2O	Saturated Water Content	FRCOEFA	Freundlich Isotherm Coefficient		
SATURH2O	Saturated Water Content	INFILRAT	Infiltration Rate		
SATURH2O	Saturated Water Content	RESIDH2O	Residual Water Content		
SATURH2O	Saturated Water Content	SATURH2O	Saturated Water Content	Y	Y
UNSATHIK	Unsaturated Zone Thickness	AVGPDIAM	Avg. Particle Diameter		
UNSATHIK	Unsaturated Zone Thickness	POROSITY	Porosity		
UNSATHIK	Unsaturated Zone Thickness	AQUTHIK	Aquifer Thickness		
UNSATHIK	Unsaturated Zone Thickness	LONHYCON	Longitundinal Hydraulic Conductivity		
UNSATHIK	Unsaturated Zone Thickness	HYDGRAD	Hydraulic Gradient		
UNSATHIK	Unsaturated Zone Thickness	GWSEEPV	Groundwater Seepage Velocity		
UNSATHIK	Unsaturated Zone Thickness	LONDISPA	Longitudinal Dispersivity		
UNSATHIK	Unsaturated Zone Thickness	FRORGCAR	Fraction Organic Carbon		
UNSATHIK	Unsaturated Zone Thickness	ANGLEW	Angle of Well Off Plume Centerline		
UNSATHIK	Unsaturated Zone Thickness	XDIST	Longitudinal Distance to Well		
UNSATHIK	Unsaturated Zone Thickness	YDIST	Distance from Plume Centerline to Well	Y	
UNSATHIK	Unsaturated Zone Thickness	ZDIST	Depth of Well Below Water Table	Y	Y
UNSATHIK	Unsaturated Zone Thickness	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
UNSATHIK	Unsaturated Zone Thickness	INFILRAT	Infiltration Rate		
UNSATHIK	Unsaturated Zone Thickness	RESIDH2O	Residual Water Content		
UNSATHIK	Unsaturated Zone Thickness	SATURH2O	Saturated Water Content		
UNSATHIK	Unsaturated Zone Thickness	UNSATHIK	Unsaturated Zone Thickness		
PERORGM	Percent Organic Matter	AVGPDIAM	Avg. Particle Diameter		
PERORGM	Percent Organic Matter	POROSITY	Porosity		
PERORGM	Percent Organic Matter	AQUTHIK	Aquifer Thickness		
PERORGM	Percent Organic Matter	LONHYCON	Longitundinal Hydraulic Conductivity		
PERORGM	Percent Organic Matter	HYDGRAD	Hydraulic Gradient		
PERORGM	Percent Organic Matter	GWSEEPV	Groundwater Seepage Velocity		
PERORGM	Percent Organic Matter	LONDISPA	Longitudinal Dispersivity		
PERORGM	Percent Organic Matter	FRORGCAR	Fraction Organic Carbon		
PERORGM	Percent Organic Matter	ANGLEW	Angle of Well Off Plume Centerline		
PERORGM	Percent Organic Matter	XDIST	Longitudinal Distance to Well		
PERORGM	Percent Organic Matter	YDIST	Distance from Plume Centerline to Well	Y	
PERORGM	Percent Organic Matter	ZDIST	Depth of Well Below Water Table		
PERORGM	Percent Organic Matter	FRCOEFA	Freundlich Isotherm Coefficient		
PERORGM	Percent Organic Matter	INFILRAT	Infiltration Rate		
PERORGM	Percent Organic Matter	RESIDH2O	Residual Water Content		
PERORGM	Percent Organic Matter	SATURH2O	Saturated Water Content		
PERORGM	Percent Organic Matter	UNSATHIK	Unsaturated Zone Thickness		
PERORGM	Percent Organic Matter	PERORGM	Percent Organic Matter	Y	
FRCOEFU	Freundlich Isotherm Coefficient	AVGPDIAM	Avg. Particle Diameter		
FRCOEFU	Freundlich Isotherm Coefficient	POROSITY	Porosity		
FRCOEFU	Freundlich Isotherm Coefficient	AQUTHIK	Aquifer Thickness	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	LONHYCON	Longitundinal Hydraulic Conductivity		
FRCOEFU	Freundlich Isotherm Coefficient	HYDGRAD	Hydraulic Gradient		
FRCOEFU	Freundlich Isotherm Coefficient	GWSEEPV	Groundwater Seepage Velocity		

Table D-23. Summary of Crosspairs Analysis for Antimony

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
FRCOEFU	Freundlich Isotherm Coefficient	LONDISPA	Longitudinal Dispersivity	Y	
FRCOEFU	Freundlich Isotherm Coefficient	FRORGCAR	Fraction Organic Carbon		
FRCOEFU	Freundlich Isotherm Coefficient	ANGLEW	Angle of Well Off Plume Centerline		
FRCOEFU	Freundlich Isotherm Coefficient	XDIST	Longitudinal Distance to Well		
FRCOEFU	Freundlich Isotherm Coefficient	YDIST	Distance from Plume Centerline to Well		
FRCOEFU	Freundlich Isotherm Coefficient	ZDIST	Depth of Well Below Water Table		
FRCOEFU	Freundlich Isotherm Coefficient	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	INFILRAT	Infiltration Rate	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	RESIDH2O	Residual Water Content		
FRCOEFU	Freundlich Isotherm Coefficient	SATURH2O	Saturated Water Content	Y	
FRCOEFU	Freundlich Isotherm Coefficient	UNSATHIK	Unsaturated Zone Thickness	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	PERORGM	Percent Organic Matter		
FRCOEFU	Freundlich Isotherm Coefficient	FRCOEFU	Freundlich Isotherm Coefficient	Y	Y

Table D-24. Ranking of Parameters According to Percentage of Risk for Antimony

Variable Description	Reduced Sums of Square	Variable Sums of Square	Variable Degrees of Freedom	% Risk Variation	Mean Square Variable	F VALUE	P VALUE
Freund. Iso. Coeff.--Aquifer (cm^3/g)	1362.0	865.76	11	33.4%	78.70	1073.53	0.00E+00
Dist. Plume Center. To Well (m)	1371.2	856.55	6	33.1%	142.76	1947.19	0.00E+00
Consumption of Drinking Water (ml/kg/day)	1454.5	773.22	1	29.8%	773.22	10546.56	0.00E+00
Aquifer Thickness (m)	2088.5	139.31	8	5.4%	17.41	237.52	0.00E+00
Long. Dispersivity--Aquifer (m)	2094.7	133.06	3	5.1%	44.35	604.97	0.00E+00
Freund. Iso. Coeff.--Unsat. Zone (cm^3/g)	2144.3	83.49	6	3.2%	13.91	189.80	2.92E-218
Long. Distance To Well (m)	2163.3	64.43	2	2.5%	32.21	439.38	2.24E-176
Infiltration Rate	2204.2	23.51	4	0.9%	5.88	80.18	5.03E-66
Long. Hydraulic Conduct. (m/yr)	2205.9	21.84	3	0.8%	7.28	99.31	2.02E-62
Unsaturated Zone Thickness (m)	2209.1	18.65	4	0.7%	4.66	63.59	1.66E-52
Hydraulic Gradient (m/m)	2215.4	12.38	4	0.5%	3.10	42.23	7.10E-35
Saturated Water Content (unitless)	2221.1	6.62	3	0.3%	2.21	30.09	2.87E-19
Groundwater Seepage Velocity (m/yr)	2219.7	8.01	3	0.3%	2.67	36.44	2.76E-23
Avg. Particle Diameter (cm)	2223.2	4.60	3	0.2%	1.53	20.89	1.90E-13
Depth of Well Below Water Table (m)	2225.2	2.54	3	0.1%	0.85	11.54	1.54E-07
Residual Water Content (unitless)	2225.6	2.16	3	0.1%	0.72	9.81	1.89E-06
Porosity (unitless)	2225.1	2.70	3	0.1%	0.90	12.27	5.41E-08
Fraction Organic Carbon (g/g)	2227.2	0.61	2	0.0%	0.30	4.13	1.61E-02

Variable Description	Reduced Sums of Square	Variable Sums of Square	Variable Degrees of Freedom	% Risk Variation	Mean Square Variable	F VALUE	P VALUE

Constants

Full Model SS	2227.761
Error SS	362.835
Error DF	4949
MS Error	0.073

Table D-25. Summary of Parameters Considered in Sensitivity Analysis for Arsenic

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
ACIDCAT	Acid Catalyzed Hydrolysis Rate Constant	C			
ANGLEW	Angle of Well Off Plume Centerline	anglew		Y	
ANISORAT	Anisotropy Ratio	C			
AQUTHIK	Aquifer Thickness	aquthik**-0.01		Y	Y
AVGPDIAM	Avg. Particle Diameter	log(avgpdiam+0.002)		Y	Y
BASECAT	Base Catalyzed Hydrolysis Rate Constant	C			
BIODRATA	Biodegradation Rate	C			
BIODRATU	Biodegradation Rate	C			
BULKDENS	Bulk Density	bulkdens**3.5	Y		
CANSLOPE	Cancer Slope Factor	C			
CHEMDRU	Chemical Decay Rate	C			
CHEMDRA	Chemical Decay Rate	C			
CONSH2OA	Consump of drinking water	log(consh2oa)			Y
ZDIST	Depth of Well Below Water Table	log(zdist+1)			
DISHYD	Dissolved Hydrolysis Rate	C			
YDIST	Distance from Plume Centerline to Well	log(ydist+150)		Y	Y
DURLEACH	Duration of Leaching Period	log(durleach-7089)	Y		
GWAVTIM	Exposure Duration	gwavtim		Y	
EXPDURA	Exposure Duration	log(expdura)			Y
FRORGCAR	Fraction Organic Carbon	log(frorgcar)		Y	
FRCOEFA	Freundlich Isotherm Coefficient	log(frcoefa+0.2)		Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	log(frcoefu+0.3)		Y	Y
FREXPA	Freundlich Isotherm Exponent	C			
FREXPU	Freundlich Isotherm Exponent	C			
GWPH	Groundwater pH	gwph	Y		
GWSEEPV	Groundwater Seepage Velocity	log(gwseepv-0.08)			
GWTEMP	Groundwater Temperature	C			
HYDGRAD	Hydraulic Gradient	log(hydgrad+0.0003)		Y	Y
INFILRAT	Infiltration Rate	infilrat**1.5		Y	Y
LANDEPTH	Landfill Depth	C			
LEACHCON	Leachate Concentration	C			
LFFRACT	LF Fraction	C			
LONDISPA	Longitudinal Dispersivity	log(londispa+20)		Y	Y

Table D-25. Summary of Parameters Considered in Sensitivity Analysis for Arsenic

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
LONDISPU	Longitudinal Dispersivity	log(londispu+1)	Y		
XDIST	Longitudinal Distance to Well	log(xdist+200000000)		Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity	log(lonhycon)		Y	Y
MOISTRPA	Moisture Rention Parameter (a)	log(moistrpa)	Y		
MOISTRPB	Moisture Rention Parameter (b)	log(moistrpb-0.8)	Y		
MOLDIFF	Molecular Diffusion Coefficient	C			
NEUTHYD	Neutral Hydrolysis Rate Constant	C			
ORGCDIS	Organic Carbon Distribution Coefficient	C			
PERORGM	Percent Organic Matter	log(perorgm)		Y	
POROSITY	Porosity	porosity**0.8		Y	
RADISTW	Radial Distance to Well	log(radistw+250)	Y		
RECHARAT	Recharge Rate	recharat	Y		
RESIDH2O	Residual Water Content	residh2o**1.5		Y	Y
RETCOEF	Retardation Coefficient	log(retcoef-0.5)	Y		
SATHYCON	Saturated Hydraulic Conductivity	log(sathycon+0.08)	Y		
SATURH2O	Saturated Water Content	saturh2o		Y	
SOILBDEN	Soil Bulk Density	soilbden	Y		
SORBHYD	Sorbed Hydrolysis Rate	C			
TRANDISP	Transverse Dispersivity	log(trandisp+1)	Y		
UNSATHIK	Unsaturated Zone Thickness	log(unsathik+2.5)		Y	Y
VERTDISP	Vertical Dispersivity	log(vertdisp+0.05)	Y		
WASTDENS	Waste Density	C			
WASTEVOL	Waste Volume	C			
WMUAREA	WMU Area	C			
WMULEN	WMU Length	C			
WMUWIDTH	WMU Width	C			

Table D-26. Summary of Correlated Parameters for Arsenic

Variable 1		Variable 2		Correlation Coefficient
Code	**Description**	**Code**	**Description**	
AVGPDIAM	Avg. Particle Diameter	BULKDENS	Bulk Density	0.99879
FRCOEFA	Freundlich Isotherm Coefficient	RETCOEF	Retardation Coefficient	0.98548
LONDISPA	Longitudinal Dispersivity	TRANDISP	Transverse Dispersivity	0.99694
LONDISPA	Longitudinal Dispersivity	VERTDISP	Vertical Dispersivity	0.99701
RECHARAT	Recharge Rate	GWPH	Groundwater pH	0.80046
INFILRAT	Infiltration Rate	GWPH	Groundwater pH	0.78708
DURLEACH	Duration of Leaching Period	GWPH	Groundwater pH	-0.92875
MOISTRPA	Moisture Rention Parameter (a)	GWPH	Groundwater pH	0.71746
MOISTRPB	Moisture Rention Parameter (b)	GWPH	Groundwater pH	0.758
SATURH2O	Saturated Water Content	GWPH	Groundwater pH	-0.97837
SOILBDEN	Soil Bulk Density	GWPH	Groundwater pH	-0.85233
XDIST	Longitudinal Distance to Well	RADISTW	Radial Distance to Well	0.9505
INFILRAT	Infiltration Rate	RECHARAT	Recharge Rate	0.97909
DURLEACH	Duration of Leaching Period	RECHARAT	Recharge Rate	-0.96279
SATHYCON	Saturated Hydraulic Conductivity	RECHARAT	Recharge Rate	0.83072
MOISTRPA	Moisture Rention Parameter (a)	RECHARAT	Recharge Rate	0.83997
MOISTRPB	Moisture Rention Parameter (b)	RECHARAT	Recharge Rate	0.92946
SOILBDEN	Soil Bulk Density	RECHARAT	Recharge Rate	-0.99574
RECHARAT	Recharge Rate	DURLEACH	Duration of Leaching Period	-0.96279
INFILRAT	Infiltration Rate	DURLEACH	Duration of Leaching Period	-0.95577
SATHYCON	Saturated Hydraulic Conductivity	DURLEACH	Duration of Leaching Period	-0.80722
MOISTRPA	Moisture Rention Parameter (a)	DURLEACH	Duration of Leaching Period	-0.8288
MOISTRPB	Moisture Rention Parameter (b)	DURLEACH	Duration of Leaching Period	-0.90059
SATURH2O	Saturated Water Content	DURLEACH	Duration of Leaching Period	0.83295
SOILBDEN	Soil Bulk Density	DURLEACH	Duration of Leaching Period	0.98301
RECHARAT	Recharge Rate	SATHYCON	Saturated Hydraulic Conductivity	0.83072
INFILRAT	Infiltration Rate	SATHYCON	Saturated Hydraulic Conductivity	0.84402
DURLEACH	Duration of Leaching Period	SATHYCON	Saturated Hydraulic Conductivity	-0.80722
MOISTRPA	Moisture Rention Parameter (a)	SATHYCON	Saturated Hydraulic Conductivity	0.70167
MOISTRPB	Moisture Rention Parameter (b)	SATHYCON	Saturated Hydraulic Conductivity	0.76979
RECHARAT	Recharge Rate	MOISTRPA	Moisture Rention Parameter (a)	0.83997
INFILRAT	Infiltration Rate	MOISTRPA	Moisture Rention Parameter (a)	0.82387
DURLEACH	Duration of Leaching Period	MOISTRPA	Moisture Rention Parameter (a)	-0.8288

Table D-26. Summary of Correlated Parameters for Arsenic

Variable 1		Variable 2		Correlation Coefficient
Code	**Description**	**Code**	**Description**	
SATHYCON	Saturated Hydraulic Conductivity	MOISTRPA	Moisture Rention Parameter (a)	0.70167
MOISTRPB	Moisture Rention Parameter (b)	MOISTRPA	Moisture Rention Parameter (a)	0.78493
RECHARAT	Recharge Rate	MOISTRPB	Moisture Rention Parameter (b)	0.92946
INFILRAT	Infiltration Rate	MOISTRPB	Moisture Rention Parameter (b)	0.90871
DURLEACH	Duration of Leaching Period	MOISTRPB	Moisture Rention Parameter (b)	-0.90059
SATHYCON	Saturated Hydraulic Conductivity	MOISTRPB	Moisture Rention Parameter (b)	0.76979
DURLEACH	Duration of Leaching Period	SATURH2O	Saturated Water Content	0.83295
SOILBDEN	Soil Bulk Density	SATURH2O	Saturated Water Content	0.72571
UNSATHIK	Unsaturated Zone Thickness	LONDISPU	Longitudinal Dispersivity	0.99567
RECHARAT	Recharge Rate	SOILBDEN	Soil Bulk Density	-0.99574
INFILRAT	Infiltration Rate	SOILBDEN	Soil Bulk Density	-0.97544
DURLEACH	Duration of Leaching Period	SOILBDEN	Soil Bulk Density	0.98301
SATHYCON	Saturated Hydraulic Conductivity	SOILBDEN	Soil Bulk Density	-0.82687
MOISTRPA	Moisture Rention Parameter (a)	SOILBDEN	Soil Bulk Density	-0.84333
MOISTRPB	Moisture Rention Parameter (b)	SOILBDEN	Soil Bulk Density	-0.92766
SATURH2O	Saturated Water Content	SOILBDEN	Soil Bulk Density	0.72571

Note: Parameters in the variable 2 column were removed from the analysis.

Table D-27. Summary of Crosspairs Analysis for Arsenic

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
AVGPDIAM	Avg. Particle Diameter			Y	Y
POROSITY	Porosity				
AQUTHIK	Aquifer Thickness			Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity				Y
HYDGRAD	Hydraulic Gradient				Y
GWSEEPV	Groundwater Seepage Velocity				
LONDISPA	Longitudinal Dispersivity			Y	Y
FRORGCAR	Fraction Organic Carbon				
ANGLEW	Angle of Well Off Plume Centerline			Y	
XDIST	Longitudinal Distance to Well			Y	Y
YDIST	Distance from Plume Centerline to Well			Y	Y
ZDIST	Depth of Well Below Water Table				
FRCOEFA	Freundlich Isotherm Coefficient			Y	Y
GWAVTIM	Exposure Duration				
INFILRAT	Infiltration Rate				Y
RESIDH2O	Residual Water Content				
SATURH2O	Saturated Water Content				
UNSATHIK	Unsaturated Zone Thickness			Y	Y
PERORGM	Percent Organic Matter				
FRCOEFU	Freundlich Isotherm Coefficient			Y	Y
AVGPDIAM	Avg. Particle Diameter	AVGPDIAM	Avg. Particle Diameter		
POROSITY	Porosity	AVGPDIAM	Avg. Particle Diameter		
POROSITY	Porosity	POROSITY	Porosity		
AQUTHIK	Aquifer Thickness	AVGPDIAM	Avg. Particle Diameter		
AQUTHIK	Aquifer Thickness	POROSITY	Porosity		
AQUTHIK	Aquifer Thickness	AQUTHIK	Aquifer Thickness		
LONHYCON	Longitundinal Hydraulic Conductivity	AVGPDIAM	Avg. Particle Diameter		
LONHYCON	Longitundinal Hydraulic Conductivity	POROSITY	Porosity		
LONHYCON	Longitundinal Hydraulic Conductivity	AQUTHIK	Aquifer Thickness		
LONHYCON	Longitundinal Hydraulic Conductivity	LONHYCON	Longitundinal Hydraulic Conductivity		
HYDGRAD	Hydraulic Gradient	AVGPDIAM	Avg. Particle Diameter		
HYDGRAD	Hydraulic Gradient	POROSITY	Porosity		
HYDGRAD	Hydraulic Gradient	AQUTHIK	Aquifer Thickness		
HYDGRAD	Hydraulic Gradient	LONHYCON	Longitundinal Hydraulic Conductivity		
HYDGRAD	Hydraulic Gradient	HYDGRAD	Hydraulic Gradient		
GWSEEPV	Groundwater Seepage Velocity	AVGPDIAM	Avg. Particle Diameter		
GWSEEPV	Groundwater Seepage Velocity	POROSITY	Porosity		
GWSEEPV	Groundwater Seepage Velocity	AQUTHIK	Aquifer Thickness		
GWSEEPV	Groundwater Seepage Velocity	LONHYCON	Longitundinal Hydraulic Conductivity		
GWSEEPV	Groundwater Seepage Velocity	HYDGRAD	Hydraulic Gradient		
GWSEEPV	Groundwater Seepage Velocity	GWSEEPV	Groundwater Seepage Velocity		
LONDISPA	Longitudinal Dispersivity	AVGPDIAM	Avg. Particle Diameter		
LONDISPA	Longitudinal Dispersivity	POROSITY	Porosity		
LONDISPA	Longitudinal Dispersivity	AQUTHIK	Aquifer Thickness		
LONDISPA	Longitudinal Dispersivity	LONHYCON	Longitundinal Hydraulic Conductivity		
LONDISPA	Longitudinal Dispersivity	HYDGRAD	Hydraulic Gradient		
LONDISPA	Longitudinal Dispersivity	GWSEEPV	Groundwater Seepage Velocity		
LONDISPA	Longitudinal Dispersivity	LONDISPA	Longitudinal Dispersivity	Y	
FRORGCAR	Fraction Organic Carbon	AVGPDIAM	Avg. Particle Diameter		

Table D-27. Summary of Crosspairs Analysis for Arsenic

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
FRORGCAR	Fraction Organic Carbon	POROSITY	Porosity		
FRORGCAR	Fraction Organic Carbon	AQUTHIK	Aquifer Thickness		
FRORGCAR	Fraction Organic Carbon	LONHYCON	Longitundinal Hydraulic Conductivity		
FRORGCAR	Fraction Organic Carbon	HYDGRAD	Hydraulic Gradient		
FRORGCAR	Fraction Organic Carbon	GWSEEPV	Groundwater Seepage Velocity		
FRORGCAR	Fraction Organic Carbon	LONDISPA	Longitudinal Dispersivity	Y	
FRORGCAR	Fraction Organic Carbon	FRORGCAR	Fraction Organic Carbon		
ANGLEW	Angle of Well Off Plume Centerline	AVGPDIAM	Avg. Particle Diameter		
ANGLEW	Angle of Well Off Plume Centerline	POROSITY	Porosity	Y	
ANGLEW	Angle of Well Off Plume Centerline	AQUTHIK	Aquifer Thickness		
ANGLEW	Angle of Well Off Plume Centerline	LONHYCON	Longitundinal Hydraulic Conductivity		
ANGLEW	Angle of Well Off Plume Centerline	HYDGRAD	Hydraulic Gradient		
ANGLEW	Angle of Well Off Plume Centerline	GWSEEPV	Groundwater Seepage Velocity		
ANGLEW	Angle of Well Off Plume Centerline	LONDISPA	Longitudinal Dispersivity		
ANGLEW	Angle of Well Off Plume Centerline	FRORGCAR	Fraction Organic Carbon		
ANGLEW	Angle of Well Off Plume Centerline	ANGLEW	Angle of Well Off Plume Centerline		
XDIST	Longitudinal Distance to Well	AVGPDIAM	Avg. Particle Diameter		
XDIST	Longitudinal Distance to Well	POROSITY	Porosity		
XDIST	Longitudinal Distance to Well	AQUTHIK	Aquifer Thickness	Y	Y
XDIST	Longitudinal Distance to Well	LONHYCON	Longitundinal Hydraulic Conductivity		
XDIST	Longitudinal Distance to Well	HYDGRAD	Hydraulic Gradient		
XDIST	Longitudinal Distance to Well	GWSEEPV	Groundwater Seepage Velocity		
XDIST	Longitudinal Distance to Well	LONDISPA	Longitudinal Dispersivity	Y	
XDIST	Longitudinal Distance to Well	FRORGCAR	Fraction Organic Carbon		
XDIST	Longitudinal Distance to Well	ANGLEW	Angle of Well Off Plume Centerline	Y	
XDIST	Longitudinal Distance to Well	XDIST	Longitudinal Distance to Well	Y	Y
YDIST	Distance from Plume Centerline to Well	AVGPDIAM	Avg. Particle Diameter		
YDIST	Distance from Plume Centerline to Well	POROSITY	Porosity		
YDIST	Distance from Plume Centerline to Well	AQUTHIK	Aquifer Thickness		
YDIST	Distance from Plume Centerline to Well	LONHYCON	Longitundinal Hydraulic Conductivity		
YDIST	Distance from Plume Centerline to Well	HYDGRAD	Hydraulic Gradient		
YDIST	Distance from Plume Centerline to Well	GWSEEPV	Groundwater Seepage Velocity		
YDIST	Distance from Plume Centerline to Well	LONDISPA	Longitudinal Dispersivity	Y	Y
YDIST	Distance from Plume Centerline to Well	FRORGCAR	Fraction Organic Carbon		
YDIST	Distance from Plume Centerline to Well	ANGLEW	Angle of Well Off Plume Centerline		
YDIST	Distance from Plume Centerline to Well	XDIST	Longitudinal Distance to Well	Y	Y
YDIST	Distance from Plume Centerline to Well	YDIST	Distance from Plume Centerline to Well	Y	Y
ZDIST	Depth of Well Below Water Table	AVGPDIAM	Avg. Particle Diameter		
ZDIST	Depth of Well Below Water Table	POROSITY	Porosity		
ZDIST	Depth of Well Below Water Table	AQUTHIK	Aquifer Thickness		
ZDIST	Depth of Well Below Water Table	LONHYCON	Longitundinal Hydraulic Conductivity		
ZDIST	Depth of Well Below Water Table	HYDGRAD	Hydraulic Gradient		
ZDIST	Depth of Well Below Water Table	GWSEEPV	Groundwater Seepage Velocity		
ZDIST	Depth of Well Below Water Table	LONDISPA	Longitudinal Dispersivity		
ZDIST	Depth of Well Below Water Table	FRORGCAR	Fraction Organic Carbon		
ZDIST	Depth of Well Below Water Table	ANGLEW	Angle of Well Off Plume Centerline		
ZDIST	Depth of Well Below Water Table	XDIST	Longitudinal Distance to Well		
ZDIST	Depth of Well Below Water Table	YDIST	Distance from Plume Centerline to Well		
ZDIST	Depth of Well Below Water Table	ZDIST	Depth of Well Below Water Table		

Table D-27. Summary of Crosspairs Analysis for Arsenic

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
FRCOEFA	Freundlich Isotherm Coefficient	AVGPDIAM	Avg. Particle Diameter	Y	
FRCOEFA	Freundlich Isotherm Coefficient	POROSITY	Porosity		
FRCOEFA	Freundlich Isotherm Coefficient	AQUTHIK	Aquifer Thickness	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	HYDGRAD	Hydraulic Gradient	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	GWSEEPV	Groundwater Seepage Velocity		
FRCOEFA	Freundlich Isotherm Coefficient	LONDISPA	Longitudinal Dispersivity	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	FRORGCAR	Fraction Organic Carbon		
FRCOEFA	Freundlich Isotherm Coefficient	ANGLEW	Angle of Well Off Plume Centerline		
FRCOEFA	Freundlich Isotherm Coefficient	XDIST	Longitudinal Distance to Well	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	YDIST	Distance from Plume Centerline to Well	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	ZDIST	Depth of Well Below Water Table		
FRCOEFA	Freundlich Isotherm Coefficient	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
GWAVTIM	Exposure Duration	AVGPDIAM	Avg. Particle Diameter		
GWAVTIM	Exposure Duration	POROSITY	Porosity		
GWAVTIM	Exposure Duration	AQUTHIK	Aquifer Thickness		
GWAVTIM	Exposure Duration	LONHYCON	Longitundinal Hydraulic Conductivity		
GWAVTIM	Exposure Duration	HYDGRAD	Hydraulic Gradient		
GWAVTIM	Exposure Duration	GWSEEPV	Groundwater Seepage Velocity		
GWAVTIM	Exposure Duration	LONDISPA	Longitudinal Dispersivity		
GWAVTIM	Exposure Duration	FRORGCAR	Fraction Organic Carbon		
GWAVTIM	Exposure Duration	ANGLEW	Angle of Well Off Plume Centerline		
GWAVTIM	Exposure Duration	XDIST	Longitudinal Distance to Well		
GWAVTIM	Exposure Duration	YDIST	Distance from Plume Centerline to Well		
GWAVTIM	Exposure Duration	ZDIST	Depth of Well Below Water Table		
GWAVTIM	Exposure Duration	FRCOEFA	Freundlich Isotherm Coefficient		
GWAVTIM	Exposure Duration	GWAVTIM	Exposure Duration		
INFILRAT	Infiltration Rate	AVGPDIAM	Avg. Particle Diameter		
INFILRAT	Infiltration Rate	POROSITY	Porosity		
INFILRAT	Infiltration Rate	AQUTHIK	Aquifer Thickness	Y	
INFILRAT	Infiltration Rate	LONHYCON	Longitundinal Hydraulic Conductivity		
INFILRAT	Infiltration Rate	HYDGRAD	Hydraulic Gradient		
INFILRAT	Infiltration Rate	GWSEEPV	Groundwater Seepage Velocity		
INFILRAT	Infiltration Rate	LONDISPA	Longitudinal Dispersivity		
INFILRAT	Infiltration Rate	FRORGCAR	Fraction Organic Carbon		
INFILRAT	Infiltration Rate	ANGLEW	Angle of Well Off Plume Centerline		
INFILRAT	Infiltration Rate	XDIST	Longitudinal Distance to Well	Y	
INFILRAT	Infiltration Rate	YDIST	Distance from Plume Centerline to Well		
INFILRAT	Infiltration Rate	ZDIST	Depth of Well Below Water Table		
INFILRAT	Infiltration Rate	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
INFILRAT	Infiltration Rate	GWAVTIM	Exposure Duration	Y	
INFILRAT	Infiltration Rate	INFILRAT	Infiltration Rate	Y	Y
RESIDH2O	Residual Water Content	AVGPDIAM	Avg. Particle Diameter		
RESIDH2O	Residual Water Content	POROSITY	Porosity		
RESIDH2O	Residual Water Content	AQUTHIK	Aquifer Thickness	Y	
RESIDH2O	Residual Water Content	LONHYCON	Longitundinal Hydraulic Conductivity		
RESIDH2O	Residual Water Content	HYDGRAD	Hydraulic Gradient		
RESIDH2O	Residual Water Content	GWSEEPV	Groundwater Seepage Velocity		
RESIDH2O	Residual Water Content	LONDISPA	Longitudinal Dispersivity		

Table D-27. Summary of Crosspairs Analysis for Arsenic

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
RESIDH2O	Residual Water Content	FRORGCAR	Fraction Organic Carbon		
RESIDH2O	Residual Water Content	ANGLEW	Angle of Well Off Plume Centerline		
RESIDH2O	Residual Water Content	XDIST	Longitudinal Distance to Well		
RESIDH2O	Residual Water Content	YDIST	Distance from Plume Centerline to Well	Y	Y
RESIDH2O	Residual Water Content	ZDIST	Depth of Well Below Water Table		
RESIDH2O	Residual Water Content	FRCOEFA	Freundlich Isotherm Coefficient		
RESIDH2O	Residual Water Content	GWAVTIM	Exposure Duration		
RESIDH2O	Residual Water Content	INFILRAT	Infiltration Rate		
RESIDH2O	Residual Water Content	RESIDH2O	Residual Water Content		
SATURH2O	Saturated Water Content	AVGPDIAM	Avg. Particle Diameter		
SATURH2O	Saturated Water Content	POROSITY	Porosity		
SATURH2O	Saturated Water Content	AQUTHIK	Aquifer Thickness	Y	
SATURH2O	Saturated Water Content	LONHYCON	Longitundinal Hydraulic Conductivity		
SATURH2O	Saturated Water Content	HYDGRAD	Hydraulic Gradient		
SATURH2O	Saturated Water Content	GWSEEPV	Groundwater Seepage Velocity		
SATURH2O	Saturated Water Content	LONDISPA	Longitudinal Dispersivity		
SATURH2O	Saturated Water Content	FRORGCAR	Fraction Organic Carbon		
SATURH2O	Saturated Water Content	ANGLEW	Angle of Well Off Plume Centerline		
SATURH2O	Saturated Water Content	XDIST	Longitudinal Distance to Well		
SATURH2O	Saturated Water Content	YDIST	Distance from Plume Centerline to Well		
SATURH2O	Saturated Water Content	ZDIST	Depth of Well Below Water Table		
SATURH2O	Saturated Water Content	FRCOEFA	Freundlich Isotherm Coefficient		
SATURH2O	Saturated Water Content	GWAVTIM	Exposure Duration	Y	
SATURH2O	Saturated Water Content	INFILRAT	Infiltration Rate		
SATURH2O	Saturated Water Content	RESIDH2O	Residual Water Content		
SATURH2O	Saturated Water Content	SATURH2O	Saturated Water Content		
UNSATHIK	Unsaturated Zone Thickness	AVGPDIAM	Avg. Particle Diameter		
UNSATHIK	Unsaturated Zone Thickness	POROSITY	Porosity		
UNSATHIK	Unsaturated Zone Thickness	AQUTHIK	Aquifer Thickness		
UNSATHIK	Unsaturated Zone Thickness	LONHYCON	Longitundinal Hydraulic Conductivity		
UNSATHIK	Unsaturated Zone Thickness	HYDGRAD	Hydraulic Gradient		
UNSATHIK	Unsaturated Zone Thickness	GWSEEPV	Groundwater Seepage Velocity		
UNSATHIK	Unsaturated Zone Thickness	LONDISPA	Longitudinal Dispersivity		
UNSATHIK	Unsaturated Zone Thickness	FRORGCAR	Fraction Organic Carbon		
UNSATHIK	Unsaturated Zone Thickness	ANGLEW	Angle of Well Off Plume Centerline		
UNSATHIK	Unsaturated Zone Thickness	XDIST	Longitudinal Distance to Well		
UNSATHIK	Unsaturated Zone Thickness	YDIST	Distance from Plume Centerline to Well		
UNSATHIK	Unsaturated Zone Thickness	ZDIST	Depth of Well Below Water Table		
UNSATHIK	Unsaturated Zone Thickness	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
UNSATHIK	Unsaturated Zone Thickness	GWAVTIM	Exposure Duration		
UNSATHIK	Unsaturated Zone Thickness	INFILRAT	Infiltration Rate		
UNSATHIK	Unsaturated Zone Thickness	RESIDH2O	Residual Water Content		
UNSATHIK	Unsaturated Zone Thickness	SATURH2O	Saturated Water Content		
UNSATHIK	Unsaturated Zone Thickness	UNSATHIK	Unsaturated Zone Thickness	Y	Y
PERORGM	Percent Organic Matter	AVGPDIAM	Avg. Particle Diameter		
PERORGM	Percent Organic Matter	POROSITY	Porosity		
PERORGM	Percent Organic Matter	AQUTHIK	Aquifer Thickness		
PERORGM	Percent Organic Matter	LONHYCON	Longitundinal Hydraulic Conductivity		
PERORGM	Percent Organic Matter	HYDGRAD	Hydraulic Gradient		

Table D-27. Summary of Crosspairs Analysis for Arsenic

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
PERORGM	Percent Organic Matter	GWSEEPV	Groundwater Seepage Velocity		
PERORGM	Percent Organic Matter	LONDISPA	Longitudinal Dispersivity		
PERORGM	Percent Organic Matter	FRORGCAR	Fraction Organic Carbon		
PERORGM	Percent Organic Matter	ANGLEW	Angle of Well Off Plume Centerline		
PERORGM	Percent Organic Matter	XDIST	Longitudinal Distance to Well	Y	
PERORGM	Percent Organic Matter	YDIST	Distance from Plume Centerline to Well		
PERORGM	Percent Organic Matter	ZDIST	Depth of Well Below Water Table		
PERORGM	Percent Organic Matter	FRCOEFA	Freundlich Isotherm Coefficient		
PERORGM	Percent Organic Matter	GWAVTIM	Exposure Duration		
PERORGM	Percent Organic Matter	INFILRAT	Infiltration Rate		
PERORGM	Percent Organic Matter	RESIDH2O	Residual Water Content		
PERORGM	Percent Organic Matter	SATURH2O	Saturated Water Content		
PERORGM	Percent Organic Matter	UNSATHIK	Unsaturated Zone Thickness		
PERORGM	Percent Organic Matter	PERORGM	Percent Organic Matter		
FRCOEFU	Freundlich Isotherm Coefficient	AVGPDIAM	Avg. Particle Diameter		
FRCOEFU	Freundlich Isotherm Coefficient	POROSITY	Porosity		
FRCOEFU	Freundlich Isotherm Coefficient	AQUTHIK	Aquifer Thickness		
FRCOEFU	Freundlich Isotherm Coefficient	LONHYCON	Longitundinal Hydraulic Conductivity		
FRCOEFU	Freundlich Isotherm Coefficient	HYDGRAD	Hydraulic Gradient		
FRCOEFU	Freundlich Isotherm Coefficient	GWSEEPV	Groundwater Seepage Velocity		
FRCOEFU	Freundlich Isotherm Coefficient	LONDISPA	Longitudinal Dispersivity		
FRCOEFU	Freundlich Isotherm Coefficient	FRORGCAR	Fraction Organic Carbon		
FRCOEFU	Freundlich Isotherm Coefficient	ANGLEW	Angle of Well Off Plume Centerline		
FRCOEFU	Freundlich Isotherm Coefficient	XDIST	Longitudinal Distance to Well	Y	
FRCOEFU	Freundlich Isotherm Coefficient	YDIST	Distance from Plume Centerline to Well		
FRCOEFU	Freundlich Isotherm Coefficient	ZDIST	Depth of Well Below Water Table		
FRCOEFU	Freundlich Isotherm Coefficient	FRCOEFA	Freundlich Isotherm Coefficient		
FRCOEFU	Freundlich Isotherm Coefficient	GWAVTIM	Exposure Duration		
FRCOEFU	Freundlich Isotherm Coefficient	INFILRAT	Infiltration Rate	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	RESIDH2O	Residual Water Content		
FRCOEFU	Freundlich Isotherm Coefficient	SATURH2O	Saturated Water Content		
FRCOEFU	Freundlich Isotherm Coefficient	UNSATHIK	Unsaturated Zone Thickness	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	PERORGM	Percent Organic Matter		
FRCOEFU	Freundlich Isotherm Coefficient	FRCOEFU	Freundlich Isotherm Coefficient	Y	Y

Table D-28. Ranking of Parameters According to Percentage of Risk for Arsenic

Variable Description	Reduced Sums of Square	Variable Sums of Square	Variable Degrees of Freedom	% Risk Variation	Mean Square Variable	F VALUE	P VALUE
Freundlich Isotherm Coefficient {Aquifer} (cm3/g)	31089.0	81716.89	10	58.3%	8171.69	1488.44	0.00E+00
Freundlich Isotherm Coefficient {Unsaturated} (cm3/g)	71431.9	41374.03	4	29.5%	10343.51	1884.03	0.00E+00
Unsaturated Zone Thickness (m)	96647.4	16158.53	4	11.5%	4039.63	735.80	0.00E+00
Distance from Plume Centerline to Well (m)	102361.1	10444.73	6	7.5%	1740.79	317.08	0.00E+00
Aquifer Thickness (m)	105323.7	7482.20	3	5.3%	2494.07	454.28	8.26E-261
Longitudinal Dispersivity (m)	108372.7	4433.20	3	3.2%	1477.73	269.16	7.22E-162
Exposure Duration	111034.1	1771.79	1	1.3%	1771.79	322.73	5.81E-70
Infiltration Rate (m/yr)	111321.0	1484.88	4	1.1%	371.22	67.62	8.40E-56
Longitudinal Hydraulic Conductivity (m/yr)	111307.4	1498.47	2	1.1%	749.23	136.47	2.01E-58
Consumption of Drinking Water (ml/kg-day)	111356.7	1449.16	1	1.0%	1449.16	263.96	7.15E-58
Longitudinal Distance to Well (m)	111928.9	877.00	5	0.6%	175.40	31.95	3.77E-32
Hydraulic Gradient (m/m)	112145.9	659.96	2	0.5%	329.98	60.10	1.61E-26
Average Particle Diameter (cm)	112619.8	186.03	1	0.1%	186.03	33.89	6.21E-09
Residual Water Content	112752.1	53.79	2	0.0%	26.90	4.90	7.49E-03

Constants

Full Model SS	112805.88
Error SS	27258.321
Error DF	4965
MS Error	5.49

Table D-29. Summary of Parameters Considered in Sensitivity Analysis for Manganese

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
ACIDCAT	Acid Catalyzed Hydrolysis Rate Constant	C			
ANGLEW	Angle of Well Off Plume Centerline	anglew		Y	Y
ANISORAT	Anisotropy Ratio	C			
AQUTHIK	Aquifer Thickness	aquthik**-0.05		Y	Y
AVGPDIAM	Avg. Particle Diameter	log(avgpdiam+.001)		Y	Y
BASECAT	Base Catalyzed Hydrolysis Rate Constant	C			
BIODRATA	Biodegradation Rate	C			
BIODRATU	Biodegradation Rate	C			
BULKDENS	Bulk Density	bulkdens**3.5	Y		
CHEMDRU	Chemical Decay Rate	C			
CHEMDRA	Chemical Decay Rate	C			
CONSH2OA	Consump of drinking water	log(consh2oa)			Y
ZDIST	Depth of Well Below Water Table	log(zdist+1)		Y	Y
DISHYD	Dissolved Hydrolysis Rate	C			
YDIST	Distance from Plume Centerline to Well	log(ydist+150)		Y	Y
DURLEACH	Duration of Leaching Period	log(durleach-3359)	Y		
GWAVTIM	Exposure Duration	C			
FRORGCAR	Fraction Organic Carbon	log(frorgcar)		Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	log(frcoefa-31)		Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	log(frcoefu-31)		Y	Y
FREXPA	Freundlich Isotherm Exponent	C			
FREXPU	Freundlich Isotherm Exponent	C			
GWPH	Groundwater pH	gwph	Y		
GWSEEPV	Groundwater Seepage Velocity	log(gwseepv)			
GWTEMP	Groundwater Temperature	C			
HYDGRAD	Hydraulic Gradient	log(hydgrad+0.0003)		Y	Y
INFILRAT	Infiltration Rate	infilrat**1.5		Y	Y
LANDEPTH	Landfill Depth	C			
LEACHCON	Leachate Concentration	C			
LFFRACT	LF Fraction	C			
LONDISPU	Longitudinal Dispersivity	log(londispu+2.5)	Y		
LONDISPA	Longitudinal Dispersivity	log(londispa)		Y	Y
XDIST	Longitudinal Distance to Well	log(xdist+200)		Y	Y

Table D-29. Summary of Parameters Considered in Sensitivity Analysis for Manganese

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
LONHYCON	Longitundinal Hydraulic Conductivity	log(lonhycon)		Y	Y
MLLA	ml/L	C			
MOISTRPA	Moisture Rention Parameter (a)	log(moistrpa-0.05)	Y		
MOISTRPB	Moisture Rention Parameter (b)	log(moistrpb-0.7)	Y		
MOLDIFF	Molecular Diffusion Coefficient	C			
NEUTHYD	Neutral Hydrolysis Rate Constant	C			
ORGCDIS	Organic Carbon Distribution Coefficient	C			
PERORGM	Percent Organic Matter	log(perorgm)		Y	Y
POROSITY	Porosity	porosity**1.3		Y	Y
RADISTW	Radial Distance to Well	log(radistw+250)	Y		
RECHARAT	Recharge Rate	recharat	Y		
RESIDH2O	Residual Water Content	residh2o**2.1		Y	Y
RETCOEF	Retardation Coefficient	log(retcoef-93)	Y		
RFDA	RfD (mg/kg/day)	C			
SATHYCON	Saturated Hydraulic Conductivity	log(sathycon)	Y		
SATURH2O	Saturated Water Content	saturh2o			
SOILBDEN	Soil Bulk Density	soilbden	Y		
SORBHYD	Sorbed Hydrolysis Rate	C			
TRANDISP	Transverse Dispersivity	log(trandisp-0.03)	Y		
UNSATHIK	Unsaturated Zone Thickness	log(unsathik+2.5)		Y	Y
VERTDISP	Vertical Dispersivity	log(vertdisp+0.001)	Y		
WASTDENS	Waste Density	C			
WASTEVOL	Waste Volume	C			
WMUAREA	WMU Area	C			
WMULEN	WMU Length	C			
WMUWIDTH	WMU Width	C			

Table D-30. Summary of Correlated Parameters for Manganese

Variable 1		Variable 2		Correlation Coefficient
Code	Description	Code	Description	
AVGPDIAM	Avg. Particle Diameter	BULKDENS	Bulk Density	0.99825
FRCOEFA	Freundlich Isotherm Coefficient	RETCOEF	Retardation Coefficient	0.8084
LONDISPA	Longitudinal Dispersivity	TRANDISP	Transverse Dispersivity	0.99872
LONDISPA	Longitudinal Dispersivity	VERTDISP	Vertical Dispersivity	0.99901
RECHARAT	Recharge Rate	GWPH	Groundwater pH	0.79875
INFILRAT	Infiltration Rate	GWPH	Groundwater pH	0.79458
DURLEACH	Duration of Leaching Period	GWPH	Groundwater pH	-0.92729
MOISTRPA	Moisture Rention Parameter (a)	GWPH	Groundwater pH	0.714
MOISTRPB	Moisture Rention Parameter (b)	GWPH	Groundwater pH	0.76354
SATURH2O	Saturated Water Content	GWPH	Groundwater pH	-0.97829
SOILBDEN	Soil Bulk Density	GWPH	Groundwater pH	-0.85107
XDIST	Longitudinal Distance to Well	RADISTW	Radial Distance to Well	0.96394
INFILRAT	Infiltration Rate	RECHARAT	Recharge Rate	0.98576
DURLEACH	Duration of Leaching Period	RECHARAT	Recharge Rate	-0.96399
SATHYCON	Saturated Hydraulic Conductivity	RECHARAT	Recharge Rate	0.82683
MOISTRPA	Moisture Rention Parameter (a)	RECHARAT	Recharge Rate	0.83687
MOISTRPB	Moisture Rention Parameter (b)	RECHARAT	Recharge Rate	0.93111
SOILBDEN	Soil Bulk Density	RECHARAT	Recharge Rate	-0.9957
RECHARAT	Recharge Rate	DURLEACH	Duration of Leaching Period	-0.96399
INFILRAT	Infiltration Rate	DURLEACH	Duration of Leaching Period	-0.96139
SATHYCON	Saturated Hydraulic Conductivity	DURLEACH	Duration of Leaching Period	-0.80318
MOISTRPA	Moisture Rention Parameter (a)	DURLEACH	Duration of Leaching Period	-0.8265
MOISTRPB	Moisture Rention Parameter (b)	DURLEACH	Duration of Leaching Period	-0.90574
SATURH2O	Saturated Water Content	DURLEACH	Duration of Leaching Period	0.83024
SOILBDEN	Soil Bulk Density	DURLEACH	Duration of Leaching Period	0.98407
RECHARAT	Recharge Rate	SATHYCON	Saturated Hydraulic Conductivity	0.82683
INFILRAT	Infiltration Rate	SATHYCON	Saturated Hydraulic Conductivity	0.84227
DURLEACH	Duration of Leaching Period	SATHYCON	Saturated Hydraulic Conductivity	-0.80318
MOISTRPB	Moisture Rention Parameter (b)	SATHYCON	Saturated Hydraulic Conductivity	0.7652
RECHARAT	Recharge Rate	MOISTRPA	Moisture Rention Parameter (a)	0.83687
INFILRAT	Infiltration Rate	MOISTRPA	Moisture Rention Parameter (a)	0.82604
DURLEACH	Duration of Leaching Period	MOISTRPA	Moisture Rention Parameter (a)	-0.8265
MOISTRPB	Moisture Rention Parameter (b)	MOISTRPA	Moisture Rention Parameter (a)	0.78387

Table D-30. Summary of Correlated Parameters for Manganese

Variable 1		Variable 2		Correlation Coefficient
Code	**Description**	**Code**	**Description**	
RECHARAT	Recharge Rate	MOISTRPB	Moisture Rention Parameter (b)	0.93111
INFILRAT	Infiltration Rate	MOISTRPB	Moisture Rention Parameter (b)	0.91665
DURLEACH	Duration of Leaching Period	MOISTRPB	Moisture Rention Parameter (b)	-0.90574
SATHYCON	Saturated Hydraulic Conductivity	MOISTRPB	Moisture Rention Parameter (b)	0.7652
DURLEACH	Duration of Leaching Period	SATURH2O	Saturated Water Content	0.83024
SOILBDEN	Soil Bulk Density	SATURH2O	Saturated Water Content	0.72379
UNSATHIK	Unsaturated Zone Thickness	LONDISPU	Longitudinal Dispersivity	0.99523
RECHARAT	Recharge Rate	SOILBDEN	Soil Bulk Density	-0.9957
INFILRAT	Infiltration Rate	SOILBDEN	Soil Bulk Density	-0.98263
DURLEACH	Duration of Leaching Period	SOILBDEN	Soil Bulk Density	0.98407
SATHYCON	Saturated Hydraulic Conductivity	SOILBDEN	Soil Bulk Density	-0.82274
MOISTRPA	Moisture Rention Parameter (a)	SOILBDEN	Soil Bulk Density	-0.84029
MOISTRPB	Moisture Rention Parameter (b)	SOILBDEN	Soil Bulk Density	-0.93016
SATURH2O	Saturated Water Content	SOILBDEN	Soil Bulk Density	0.72379

Note: Parameters in the variable 2 column were removed from the analysis.

Table D-31. Summary of Crosspairs Analysis for Manganese

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
AVGPDIAM	Avg. Particle Diameter			Y	Y
POROSITY	Porosity				
AQUTHIK	Aquifer Thickness			Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity				Y
HYDGRAD	Hydraulic Gradient				Y
GWSEEPV	Groundwater Seepage Velocity				
LONDISPA	Longitudinal Dispersivity			Y	Y
FRORGCAR	Fraction Organic Carbon				
ANGLEW	Angle of Well Off Plume Centerline				
XDIST	Longitudinal Distance to Well			Y	Y
YDIST	Distance from Plume Centerline to Well			Y	Y
ZDIST	Depth of Well Below Water Table				
FRCOEFA	Freundlich Isotherm Coefficient			Y	Y
INFILRAT	Infiltration Rate				Y
RESIDH2O	Residual Water Content				
SATURH2O	Saturated Water Content				
UNSATHIK	Unsaturated Zone Thickness			Y	Y
PERORGM	Percent Organic Matter				
FRCOEFU	Freundlich Isotherm Coefficient			Y	Y
AVGPDIAM	Avg. Particle Diameter	AVGPDIAM	Avg. Particle Diameter		
POROSITY	Porosity	AVGPDIAM	Avg. Particle Diameter		
POROSITY	Porosity	POROSITY	Porosity		
AQUTHIK	Aquifer Thickness	AVGPDIAM	Avg. Particle Diameter	Y	Y
AQUTHIK	Aquifer Thickness	POROSITY	Porosity	Y	
AQUTHIK	Aquifer Thickness	AQUTHIK	Aquifer Thickness	Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity	AVGPDIAM	Avg. Particle Diameter		
LONHYCON	Longitundinal Hydraulic Conductivity	POROSITY	Porosity		
LONHYCON	Longitundinal Hydraulic Conductivity	AQUTHIK	Aquifer Thickness		
LONHYCON	Longitundinal Hydraulic Conductivity	LONHYCON	Longitundinal Hydraulic Conductivity		
HYDGRAD	Hydraulic Gradient	AVGPDIAM	Avg. Particle Diameter		
HYDGRAD	Hydraulic Gradient	POROSITY	Porosity		
HYDGRAD	Hydraulic Gradient	AQUTHIK	Aquifer Thickness		
HYDGRAD	Hydraulic Gradient	LONHYCON	Longitundinal Hydraulic Conductivity		
HYDGRAD	Hydraulic Gradient	HYDGRAD	Hydraulic Gradient		
GWSEEPV	Groundwater Seepage Velocity	AVGPDIAM	Avg. Particle Diameter		
GWSEEPV	Groundwater Seepage Velocity	POROSITY	Porosity		
GWSEEPV	Groundwater Seepage Velocity	AQUTHIK	Aquifer Thickness		
GWSEEPV	Groundwater Seepage Velocity	LONHYCON	Longitundinal Hydraulic Conductivity		
GWSEEPV	Groundwater Seepage Velocity	HYDGRAD	Hydraulic Gradient		
GWSEEPV	Groundwater Seepage Velocity	GWSEEPV	Groundwater Seepage Velocity		
LONDISPA	Longitudinal Dispersivity	AVGPDIAM	Avg. Particle Diameter		
LONDISPA	Longitudinal Dispersivity	POROSITY	Porosity		
LONDISPA	Longitudinal Dispersivity	AQUTHIK	Aquifer Thickness		
LONDISPA	Longitudinal Dispersivity	LONHYCON	Longitundinal Hydraulic Conductivity		
LONDISPA	Longitudinal Dispersivity	HYDGRAD	Hydraulic Gradient		
LONDISPA	Longitudinal Dispersivity	GWSEEPV	Groundwater Seepage Velocity		
LONDISPA	Longitudinal Dispersivity	LONDISPA	Longitudinal Dispersivity	Y	Y
FRORGCAR	Fraction Organic Carbon	AVGPDIAM	Avg. Particle Diameter	Y	Y
FRORGCAR	Fraction Organic Carbon	POROSITY	Porosity	Y	Y

Table D-31. Summary of Crosspairs Analysis for Manganese

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
FRORGCAR	Fraction Organic Carbon	AQUTHIK	Aquifer Thickness		
FRORGCAR	Fraction Organic Carbon	LONHYCON	Longitundinal Hydraulic Conductivity		
FRORGCAR	Fraction Organic Carbon	HYDGRAD	Hydraulic Gradient		
FRORGCAR	Fraction Organic Carbon	GWSEEPV	Groundwater Seepage Velocity		
FRORGCAR	Fraction Organic Carbon	LONDISPA	Longitudinal Dispersivity		
FRORGCAR	Fraction Organic Carbon	FRORGCAR	Fraction Organic Carbon	Y	Y
ANGLEW	Angle of Well Off Plume Centerline	AVGPDIAM	Avg. Particle Diameter		
ANGLEW	Angle of Well Off Plume Centerline	POROSITY	Porosity		
ANGLEW	Angle of Well Off Plume Centerline	AQUTHIK	Aquifer Thickness		
ANGLEW	Angle of Well Off Plume Centerline	LONHYCON	Longitundinal Hydraulic Conductivity		
ANGLEW	Angle of Well Off Plume Centerline	HYDGRAD	Hydraulic Gradient		
ANGLEW	Angle of Well Off Plume Centerline	GWSEEPV	Groundwater Seepage Velocity		
ANGLEW	Angle of Well Off Plume Centerline	LONDISPA	Longitudinal Dispersivity		
ANGLEW	Angle of Well Off Plume Centerline	FRORGCAR	Fraction Organic Carbon	Y	
ANGLEW	Angle of Well Off Plume Centerline	ANGLEW	Angle of Well Off Plume Centerline		
XDIST	Longitudinal Distance to Well	AVGPDIAM	Avg. Particle Diameter		
XDIST	Longitudinal Distance to Well	POROSITY	Porosity		
XDIST	Longitudinal Distance to Well	AQUTHIK	Aquifer Thickness	Y	
XDIST	Longitudinal Distance to Well	LONHYCON	Longitundinal Hydraulic Conductivity		
XDIST	Longitudinal Distance to Well	HYDGRAD	Hydraulic Gradient		
XDIST	Longitudinal Distance to Well	GWSEEPV	Groundwater Seepage Velocity		
XDIST	Longitudinal Distance to Well	LONDISPA	Longitudinal Dispersivity		
XDIST	Longitudinal Distance to Well	FRORGCAR	Fraction Organic Carbon		
XDIST	Longitudinal Distance to Well	ANGLEW	Angle of Well Off Plume Centerline		
XDIST	Longitudinal Distance to Well	XDIST	Longitudinal Distance to Well		
YDIST	Distance from Plume Centerline to Well	AVGPDIAM	Avg. Particle Diameter		
YDIST	Distance from Plume Centerline to Well	POROSITY	Porosity		
YDIST	Distance from Plume Centerline to Well	AQUTHIK	Aquifer Thickness	Y	Y
YDIST	Distance from Plume Centerline to Well	LONHYCON	Longitundinal Hydraulic Conductivity		
YDIST	Distance from Plume Centerline to Well	HYDGRAD	Hydraulic Gradient		
YDIST	Distance from Plume Centerline to Well	GWSEEPV	Groundwater Seepage Velocity		
YDIST	Distance from Plume Centerline to Well	LONDISPA	Longitudinal Dispersivity	Y	Y
YDIST	Distance from Plume Centerline to Well	FRORGCAR	Fraction Organic Carbon		
YDIST	Distance from Plume Centerline to Well	ANGLEW	Angle of Well Off Plume Centerline		
YDIST	Distance from Plume Centerline to Well	XDIST	Longitudinal Distance to Well	Y	Y
YDIST	Distance from Plume Centerline to Well	YDIST	Distance from Plume Centerline to Well	Y	Y
ZDIST	Depth of Well Below Water Table	AVGPDIAM	Avg. Particle Diameter	Y	
ZDIST	Depth of Well Below Water Table	POROSITY	Porosity		
ZDIST	Depth of Well Below Water Table	AQUTHIK	Aquifer Thickness		
ZDIST	Depth of Well Below Water Table	LONHYCON	Longitundinal Hydraulic Conductivity		
ZDIST	Depth of Well Below Water Table	HYDGRAD	Hydraulic Gradient		
ZDIST	Depth of Well Below Water Table	GWSEEPV	Groundwater Seepage Velocity		
ZDIST	Depth of Well Below Water Table	LONDISPA	Longitudinal Dispersivity		
ZDIST	Depth of Well Below Water Table	FRORGCAR	Fraction Organic Carbon		
ZDIST	Depth of Well Below Water Table	ANGLEW	Angle of Well Off Plume Centerline		
ZDIST	Depth of Well Below Water Table	XDIST	Longitudinal Distance to Well		
ZDIST	Depth of Well Below Water Table	YDIST	Distance from Plume Centerline to Well		
ZDIST	Depth of Well Below Water Table	ZDIST	Depth of Well Below Water Table		
FRCOEFA	Freundlich Isotherm Coefficient	AVGPDIAM	Avg. Particle Diameter	Y	

Table D-31. Summary of Crosspairs Analysis for Manganese

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
FRCOEFA	Freundlich Isotherm Coefficient	POROSITY	Porosity		
FRCOEFA	Freundlich Isotherm Coefficient	AQUTHIK	Aquifer Thickness	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	HYDGRAD	Hydraulic Gradient	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	GWSEEPV	Groundwater Seepage Velocity		
FRCOEFA	Freundlich Isotherm Coefficient	LONDISPA	Longitudinal Dispersivity		
FRCOEFA	Freundlich Isotherm Coefficient	FRORGCAR	Fraction Organic Carbon		
FRCOEFA	Freundlich Isotherm Coefficient	ANGLEW	Angle of Well Off Plume Centerline		
FRCOEFA	Freundlich Isotherm Coefficient	XDIST	Longitudinal Distance to Well	Y	
FRCOEFA	Freundlich Isotherm Coefficient	YDIST	Distance from Plume Centerline to Well	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	ZDIST	Depth of Well Below Water Table	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
INFILRAT	Infiltration Rate	AVGPDIAM	Avg. Particle Diameter		
INFILRAT	Infiltration Rate	POROSITY	Porosity		
INFILRAT	Infiltration Rate	AQUTHIK	Aquifer Thickness		
INFILRAT	Infiltration Rate	LONHYCON	Longitundinal Hydraulic Conductivity		
INFILRAT	Infiltration Rate	HYDGRAD	Hydraulic Gradient		
INFILRAT	Infiltration Rate	GWSEEPV	Groundwater Seepage Velocity		
INFILRAT	Infiltration Rate	LONDISPA	Longitudinal Dispersivity		
INFILRAT	Infiltration Rate	FRORGCAR	Fraction Organic Carbon		
INFILRAT	Infiltration Rate	ANGLEW	Angle of Well Off Plume Centerline		
INFILRAT	Infiltration Rate	XDIST	Longitudinal Distance to Well		
INFILRAT	Infiltration Rate	YDIST	Distance from Plume Centerline to Well		
INFILRAT	Infiltration Rate	ZDIST	Depth of Well Below Water Table		
INFILRAT	Infiltration Rate	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
INFILRAT	Infiltration Rate	INFILRAT	Infiltration Rate	Y	Y
RESIDH2O	Residual Water Content	AVGPDIAM	Avg. Particle Diameter	Y	
RESIDH2O	Residual Water Content	POROSITY	Porosity		
RESIDH2O	Residual Water Content	AQUTHIK	Aquifer Thickness		
RESIDH2O	Residual Water Content	LONHYCON	Longitundinal Hydraulic Conductivity		
RESIDH2O	Residual Water Content	HYDGRAD	Hydraulic Gradient		
RESIDH2O	Residual Water Content	GWSEEPV	Groundwater Seepage Velocity		
RESIDH2O	Residual Water Content	LONDISPA	Longitudinal Dispersivity		
RESIDH2O	Residual Water Content	FRORGCAR	Fraction Organic Carbon		
RESIDH2O	Residual Water Content	ANGLEW	Angle of Well Off Plume Centerline	Y	Y
RESIDH2O	Residual Water Content	XDIST	Longitudinal Distance to Well		
RESIDH2O	Residual Water Content	YDIST	Distance from Plume Centerline to Well		
RESIDH2O	Residual Water Content	ZDIST	Depth of Well Below Water Table		
RESIDH2O	Residual Water Content	FRCOEFA	Freundlich Isotherm Coefficient		
RESIDH2O	Residual Water Content	INFILRAT	Infiltration Rate		
RESIDH2O	Residual Water Content	RESIDH2O	Residual Water Content		
SATURH2O	Saturated Water Content	AVGPDIAM	Avg. Particle Diameter		
SATURH2O	Saturated Water Content	POROSITY	Porosity		
SATURH2O	Saturated Water Content	AQUTHIK	Aquifer Thickness		
SATURH2O	Saturated Water Content	LONHYCON	Longitundinal Hydraulic Conductivity		
SATURH2O	Saturated Water Content	HYDGRAD	Hydraulic Gradient		
SATURH2O	Saturated Water Content	GWSEEPV	Groundwater Seepage Velocity		
SATURH2O	Saturated Water Content	LONDISPA	Longitudinal Dispersivity		
SATURH2O	Saturated Water Content	FRORGCAR	Fraction Organic Carbon		

Table D-31. Summary of Crosspairs Analysis for Manganese

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
SATURH2O	Saturated Water Content	ANGLEW	Angle of Well Off Plume Centerline		
SATURH2O	Saturated Water Content	XDIST	Longitudinal Distance to Well		
SATURH2O	Saturated Water Content	YDIST	Distance from Plume Centerline to Well		
SATURH2O	Saturated Water Content	ZDIST	Depth of Well Below Water Table		
SATURH2O	Saturated Water Content	FRCOEFA	Freundlich Isotherm Coefficient		
SATURH2O	Saturated Water Content	INFILRAT	Infiltration Rate		
SATURH2O	Saturated Water Content	RESIDH2O	Residual Water Content		
SATURH2O	Saturated Water Content	SATURH2O	Saturated Water Content		
UNSATHIK	Unsaturated Zone Thickness	AVGPDIAM	Avg. Particle Diameter		
UNSATHIK	Unsaturated Zone Thickness	POROSITY	Porosity		
UNSATHIK	Unsaturated Zone Thickness	AQUTHIK	Aquifer Thickness	Y	
UNSATHIK	Unsaturated Zone Thickness	LONHYCON	Longitundinal Hydraulic Conductivity		
UNSATHIK	Unsaturated Zone Thickness	HYDGRAD	Hydraulic Gradient		
UNSATHIK	Unsaturated Zone Thickness	GWSEEPV	Groundwater Seepage Velocity		
UNSATHIK	Unsaturated Zone Thickness	LONDISPA	Longitudinal Dispersivity		
UNSATHIK	Unsaturated Zone Thickness	FRORGCAR	Fraction Organic Carbon		
UNSATHIK	Unsaturated Zone Thickness	ANGLEW	Angle of Well Off Plume Centerline		
UNSATHIK	Unsaturated Zone Thickness	XDIST	Longitudinal Distance to Well		
UNSATHIK	Unsaturated Zone Thickness	YDIST	Distance from Plume Centerline to Well	Y	
UNSATHIK	Unsaturated Zone Thickness	ZDIST	Depth of Well Below Water Table		
UNSATHIK	Unsaturated Zone Thickness	FRCOEFA	Freundlich Isotherm Coefficient		
UNSATHIK	Unsaturated Zone Thickness	INFILRAT	Infiltration Rate	Y	Y
UNSATHIK	Unsaturated Zone Thickness	RESIDH2O	Residual Water Content	Y	Y
UNSATHIK	Unsaturated Zone Thickness	SATURH2O	Saturated Water Content		
UNSATHIK	Unsaturated Zone Thickness	UNSATHIK	Unsaturated Zone Thickness		
PERORGM	Percent Organic Matter	AVGPDIAM	Avg. Particle Diameter		
PERORGM	Percent Organic Matter	POROSITY	Porosity		
PERORGM	Percent Organic Matter	AQUTHIK	Aquifer Thickness		
PERORGM	Percent Organic Matter	LONHYCON	Longitundinal Hydraulic Conductivity	Y	
PERORGM	Percent Organic Matter	HYDGRAD	Hydraulic Gradient		
PERORGM	Percent Organic Matter	GWSEEPV	Groundwater Seepage Velocity		
PERORGM	Percent Organic Matter	LONDISPA	Longitudinal Dispersivity		
PERORGM	Percent Organic Matter	FRORGCAR	Fraction Organic Carbon		
PERORGM	Percent Organic Matter	ANGLEW	Angle of Well Off Plume Centerline		
PERORGM	Percent Organic Matter	XDIST	Longitudinal Distance to Well	Y	Y
PERORGM	Percent Organic Matter	YDIST	Distance from Plume Centerline to Well		
PERORGM	Percent Organic Matter	ZDIST	Depth of Well Below Water Table		
PERORGM	Percent Organic Matter	FRCOEFA	Freundlich Isotherm Coefficient	Y	
PERORGM	Percent Organic Matter	INFILRAT	Infiltration Rate		
PERORGM	Percent Organic Matter	RESIDH2O	Residual Water Content		
PERORGM	Percent Organic Matter	SATURH2O	Saturated Water Content		
PERORGM	Percent Organic Matter	UNSATHIK	Unsaturated Zone Thickness		
PERORGM	Percent Organic Matter	PERORGM	Percent Organic Matter		
FRCOEFU	Freundlich Isotherm Coefficient	AVGPDIAM	Avg. Particle Diameter		
FRCOEFU	Freundlich Isotherm Coefficient	POROSITY	Porosity		
FRCOEFU	Freundlich Isotherm Coefficient	AQUTHIK	Aquifer Thickness		
FRCOEFU	Freundlich Isotherm Coefficient	LONHYCON	Longitundinal Hydraulic Conductivity		
FRCOEFU	Freundlich Isotherm Coefficient	HYDGRAD	Hydraulic Gradient		
FRCOEFU	Freundlich Isotherm Coefficient	GWSEEPV	Groundwater Seepage Velocity		

Table D-31. Summary of Crosspairs Analysis for Manganese

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
FRCOEFU	Freundlich Isotherm Coefficient	LONDISPA	Longitudinal Dispersivity	Y	
FRCOEFU	Freundlich Isotherm Coefficient	FRORGCAR	Fraction Organic Carbon		
FRCOEFU	Freundlich Isotherm Coefficient	ANGLEW	Angle of Well Off Plume Centerline		
FRCOEFU	Freundlich Isotherm Coefficient	XDIST	Longitudinal Distance to Well		
FRCOEFU	Freundlich Isotherm Coefficient	YDIST	Distance from Plume Centerline to Well	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	ZDIST	Depth of Well Below Water Table		
FRCOEFU	Freundlich Isotherm Coefficient	FRCOEFA	Freundlich Isotherm Coefficient		
FRCOEFU	Freundlich Isotherm Coefficient	INFILRAT	Infiltration Rate	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	RESIDH2O	Residual Water Content		
FRCOEFU	Freundlich Isotherm Coefficient	SATURH2O	Saturated Water Content		
FRCOEFU	Freundlich Isotherm Coefficient	UNSATHIK	Unsaturated Zone Thickness	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	PERORGM	Percent Organic Matter		
FRCOEFU	Freundlich Isotherm Coefficient	FRCOEFU	Freundlich Isotherm Coefficient	Y	Y

Table D-32. Ranking of Parameters According to Percentage of Risk for Manganese

Variable Description	Reduced Sums of Square	Variable Sums of Square	Variable Degrees of Freedom	% Risk Variation	Mean Square Variable	F VALUE	P VALUE
Longitudinal Distance to Well (m)	2959.2	4654.52	7	47.7%	664.93	1530.14	0.00E+00
Freundlich Isotherm Coefficient {Aquifer} (cm3/g)	5591.5	2022.22	8	20.7%	252.78	581.69	0.00E+00
Consumption of Drinking Water (ml/kg-day)	6748.0	865.70	1	8.9%	865.70	1992.16	0.00E+00
Aquifer Thickness (m)	6753.4	860.33	5	8.8%	172.07	395.96	0.00E+00
Longitudinal Dispersivity	7151.7	461.97	3	4.7%	153.99	354.36	1.71E-208
Freundlich Isotherm Coefficient {Unsaturated} (cm3/g)	7238.1	375.59	5	3.8%	75.12	172.86	5.30E-170
Longitudinal Hydraulic Conductivity (m/yr)	7277.9	335.78	2	3.4%	167.89	386.35	1.19E-156
Unsaturated Zone Thickness (m)	7467.9	145.82	4	1.5%	36.45	83.89	4.94E-69
Hydraluic Gradient (m/m)	7474.2	139.55	2	1.4%	69.78	160.57	2.70E-68
Longitudinal Dispersivity (m)	7494.5	119.17	3	1.2%	39.72	91.41	1.41E-57
Infiltration Rate (m/yr)	7536.0	77.67	5	0.8%	15.53	35.75	4.57E-36
Average Particle Diameter (cm)	7577.7	36.05	3	0.4%	12.02	27.65	9.92E-18
Fraction Organic Carbon (g/g)	7605.3	8.40	3	0.1%	2.80	6.44	2.38E-04
Distance from Plume Centerline to Well (m)	7607.4	6.27	2	0.1%	3.13	7.21	7.46E-04
Residual Water Content (unitless)	7605.6	8.15	3	0.1%	2.72	6.25	3.11E-04
Porosity (unitless)	7609.0	4.72	2	0.0%	2.36	5.43	4.40E-03
Angle of Well Off Plume Centerline	7609.9	3.80	2	0.0%	1.90	4.37	1.27E-02

Constants

Full Model SS	7613.705
Error SS	2153.654
Error DF	4956
MS Error	0.435

Table D-33. Chemical-Specific Properties for Constituents of Concern in the Chloride Sulfate Process Milling Sand

	Waste Constituent Concentrations			*Degradation Rates*	
Constituent	**SPLP (Industrial D Landfill) (mg/L)**	**Total waste (mg/kg)**	**Finite MSW Source Ratio (L/kg)**	**Overall Hydrolysis rate(1/yr)**	**Biodegrd. Rate(1/yr)**
Antimony	0.024	*0.25*	10	0	0

underline italics indicate values set at 1/2 of detection limit

Table D-34. Distribution of Industrial D Landfill Areas

	Area Range			
Empirical distribution	**Minimum m2**		**Maximum m2**	**Relative Prob.**
	4,000	to	8,090	0.100
	8,090	to	20,200	0.150
	20,200	to	60,700	0.250
	60,700	to	194,000	0.250
	194,000	to	420,000	0.150
	420,000	to	9,350,000	0.100
				1.000
Total Relative Probability				

Table D-35. Waste Stream Parameters for Chloride Sulfate Processing Milling Sand

WMU	**Location**	**Landfill Area**	**Waste Quantity(MT/y)**	**Waste Density (g/cm^3)**	**Waste Density (kg/m^3)**	**Total Waste Vol (m^3)**
Industrial D Landfill	Savannah, GA	Distribution	200	1.6	1600	3750

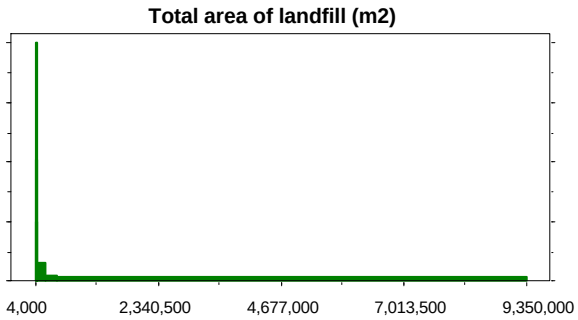

Figure D-1. Distribution of industrial landfill areas

Table D-36. Site-Specific Climate-Based Parameters for Chloride Sulfate Process Milling Sand

WMU	Location	Climate Index	Climate Center	Landfill Infiltartion Rate (m/yr)			Recharge Rate (m/yr)				GWpH		
				SCL	SLT	SNL	SCL	SLT	SNL	GW TempC	SCL	SLT	SNL
Industrial D Landfill	Savannah, GA	93	Savannah, GA	0.21	0.26	0.33	0.21	0.26	0.33	20.00	5.30	5.00	5.40

Table D-37. Aquifer Types Within 100-Mile Radius of WMU Currently Managing Chloride/Sulfate Process Milling Sand

Aquifer Types	Aquifer Code	Savannah, GA
Sand and Gravel	4	50%
Unconsolidated and semiconsolidated shallow aquifers	10	50%

Table D-3-38. Soil Textures Common Within 100-Mile Radius of WMU Currently Managing Chloride/Sulfate Process Milling Sand

		Savannah, GA
silty clay loam	SCL	11%
silt loam	SIL	49%
sandy loam	SNL	40%

Table D-39. Summary of Parameters Considered in Sensitivity Analysis for Antimony

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
ACIDCAT	Acid Catalyzed Hydrolysis Rate Constant	C			
ANGLEW	Angle of Well Off Plume Centerline	anglew			
ANISORAT	Anisotropy Ratio	C			
AQUTHIK	Aquifer Thickness	aquthik**-0.01		Y	Y
AVGPDIAM	Avg. Particle Diameter	log(avgpdiam+.001)		Y	Y
BASECAT	Base Catalyzed Hydrolysis Rate Constant	C			
BIODRATA	Biodegradation Rate	C			
BIODRATU	Biodegradation Rate	C			
BULKDENS	Bulk Density	bulkdens**3.5	Y		
CHEMDRU	Chemical Decay Rate	C			
CHEMDRA	Chemical Decay Rate	C			
CONSH2OA	Consump of drinking water	log(consh2oa)			Y
ZDIST	Depth of Well Below Water Table	log(zdist+1)		Y	Y
DISHYD	Dissolved Hydrolysis Rate	C			
YDIST	Distance from Plume Centerline to Well	log(ydist+5)		Y	Y
DURLEACH	Duration of Leaching Period	log(durleach)	Y		
GWAVTIM	Exposure Duration	C			
FRORGCAR	Fraction Organic Carbon	log(frorgcar)			
FRCOEFA	Freundlich Isotherm Coefficient	log(frcoefa-0.33)		Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	log(frcoefu-0.3)		Y	Y
FREXPA	Freundlich Isotherm Exponent	C			
FREXPU	Freundlich Isotherm Exponent	C			
GWPH	Groundwater pH	gwph	Y		
GWSEEPV	Groundwater Seepage Velocity	log(gwseepv-0.099)	Y		
GWTEMP	Groundwater Temperature	C			
HYDGRAD	Hydraulic Gradient	log(hydgrad+0.0003)		Y	Y
INFILRAT	Infiltration Rate	infilrat**1.5		Y	Y
LANDEPTH	Landfill Depth	log(landepth+0.001)	Y		
LEACHCON	Leachate Concentration	C			
LFFRACT	LF Fraction	C			
LONDISPU	Longitudinal Dispersivity	log(londispu-0.021)	Y		
LONDISPA	Longitudinal Dispersivity	log(londispa+0.3)		Y	Y
XDIST	Longitudinal Distance to Well	log(xdist+200)		Y	Y

Table D-39. Summary of Parameters Considered in Sensitivity Analysis for Antimony

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
LONHYCON	Longitundinal Hydraulic Conductivity	log(lonhycon-2.5)		Y	Y
MLLA	ml/L	C			
MOISTRPA	Moisture Rention Parameter (a)	log(moistrpa-0.05)	Y		
MOISTRPB	Moisture Rention Parameter (b)	log(moistrpb-0.7)	Y		
MOLDIFF	Molecular Diffusion Coefficient	C			
NEUTHYD	Neutral Hydrolysis Rate Constant	C			
ORGCDIS	Organic Carbon Distribution Coefficient	C			
PERORGM	Percent Organic Matter	log(perorgm)		Y	
POROSITY	Porosity	porosity**1.3			
RADISTW	Radial Distance to Well	log(radistw+100)	Y		
RECHARAT	Recharge Rate	recharat	Y		
RESIDH2O	Residual Water Content	residh2o**-.2			
RETCOEF	Retardation Coefficient	log(retcoef-2.2)	Y		
RFDA	RfD (mg/kg/day)	C			
SATHYCON	Saturated Hydraulic Conductivity	log(sathycon+0.25)	Y		
SATURH2O	Saturated Water Content	saturh2o	Y		
SOILBDEN	Soil Bulk Density	soilbden	Y		
SORBHYD	Sorbed Hydrolysis Rate	C			
TRANDISP	Transverse Dispersivity	log(trandisp+0.01)	Y		
UNSATHIK	Unsaturated Zone Thickness	log(unsathik-0.1)		Y	Y
VERTDISP	Vertical Dispersivity	log(vertdisp+0.001)	Y		
WASTDENS	Waste Density	C			
WASTEVOL	Waste Volume	C			
WMUAREA	WMU Area	log(wmuarea-3900)		Y	Y
WMULEN	WMU Length	log(wmulen-60)	Y		
WMUWIDTH	WMU Width	log(wmuwidth-60)	Y		

Table D-40. Summary of Correlated Parameters for Antimony

Variable 1		Variable 2		Correlation Coefficient
Code	Description	Code	Description	
AVGPDIAM	Avg. Particle Diameter	BULKDENS	Bulk Density	0.99823
LONHYCON	Longitundinal Hydraulic Conductivi	GWSEEPV	Groundwater Seepage Velocity	0.76018
FRCOEFA	Freundlich Isotherm Coefficient	RETCOEF	Retardation Coefficient	0.96082
LONDISPA	Longitudinal Dispersivity	TRANDISP	Transverse Dispersivity	0.99915
LONDISPA	Longitudinal Dispersivity	VERTDISP	Vertical Dispersivity	0.9991
SATURH2O	Saturated Water Content	GWPH	Groundwater pH	-0.98684
SOILBDEN	Soil Bulk Density	GWPH	Groundwater pH	-0.75981
XDIST	Longitudinal Distance to Well	RADISTW	Radial Distance to Well	0.99468
WMUAREA	WMU Area	WMULEN	WMU Length	0.99614
LANDEPTH	Landfill Depth	WMULEN	WMU Length	-0.97577
DURLEACH	Duration of Leaching Period	WMULEN	WMU Length	-0.95927
WMUAREA	WMU Area	WMUWIDTH	WMU Width	0.99614
LANDEPTH	Landfill Depth	WMUWIDTH	WMU Width	-0.97577
DURLEACH	Duration of Leaching Period	WMUWIDTH	WMU Width	-0.95927
INFILRAT	Infiltration Rate	RECHARAT	Recharge Rate	0.97755
SATHYCON	Saturated Hydraulic Conductivity	RECHARAT	Recharge Rate	0.76356
MOISTRPA	Moisture Rention Parameter (a)	RECHARAT	Recharge Rate	0.78672
MOISTRPB	Moisture Rention Parameter (b)	RECHARAT	Recharge Rate	0.88112
SATURH2O	Saturated Water Content	RECHARAT	Recharge Rate	-0.76964
SOILBDEN	Soil Bulk Density	RECHARAT	Recharge Rate	-0.9892
WMUAREA	WMU Area	LANDEPTH	Landfill Depth	-0.98694
WMUAREA	WMU Area	DURLEACH	Duration of Leaching Period	-0.97568
LANDEPTH	Landfill Depth	DURLEACH	Duration of Leaching Period	0.98898
RECHARAT	Recharge Rate	SATHYCON	Saturated Hydraulic Conductivity	0.76356
INFILRAT	Infiltration Rate	SATHYCON	Saturated Hydraulic Conductivity	0.77083
RECHARAT	Recharge Rate	MOISTRPA	Moisture Rention Parameter (a)	0.78672
INFILRAT	Infiltration Rate	MOISTRPA	Moisture Rention Parameter (a)	0.77303
MOISTRPB	Moisture Rention Parameter (b)	MOISTRPA	Moisture Rention Parameter (a)	0.70942
RECHARAT	Recharge Rate	MOISTRPB	Moisture Rention Parameter (b)	0.88112
INFILRAT	Infiltration Rate	MOISTRPB	Moisture Rention Parameter (b)	0.86161
SATURH2O	Saturated Water Content	MOISTRPB	Moisture Rention Parameter (b)	-0.72612
RECHARAT	Recharge Rate	SATURH2O	Saturated Water Content	-0.76964
INFILRAT	Infiltration Rate	SATURH2O	Saturated Water Content	-0.75413

Table D-40. Summary of Correlated Parameters for Antimony

Variable 1		Variable 2		Correlation Coefficient
Code	**Description**	**Code**	**Description**	
MOISTRPB	Moisture Rention Parameter (b)	SATURH2O	Saturated Water Content	-0.72612
SOILBDEN	Soil Bulk Density	SATURH2O	Saturated Water Content	0.85493
UNSATHIK	Unsaturated Zone Thickness	LONDISPU	Longitudinal Dispersivity	0.99972
RECHARAT	Recharge Rate	SOILBDEN	Soil Bulk Density	-0.9892
INFILRAT	Infiltration Rate	SOILBDEN	Soil Bulk Density	-0.96739
SATHYCON	Saturated Hydraulic Conductivity	SOILBDEN	Soil Bulk Density	-0.76527
MOISTRPA	Moisture Rention Parameter (a)	SOILBDEN	Soil Bulk Density	-0.79374
MOISTRPB	Moisture Rention Parameter (b)	SOILBDEN	Soil Bulk Density	-0.88262
SATURH2O	Saturated Water Content	SOILBDEN	Soil Bulk Density	0.85493

Note: Parameters in the variable 2 column were removed from the analysis.

Table D-41. Summary of Crosspairs Analysis for Antimony

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
AVGPDIAM	Avg. Particle Diameter			Y	Y
POROSITY	Porosity				
AQUTHIK	Aquifer Thickness			Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity			Y	Y
HYDGRAD	Hydraulic Gradient			Y	Y
LONDISPA	Longitudinal Dispersivity			Y	Y
FRORGCAR	Fraction Organic Carbon				
ANGLEW	Angle of Well Off Plume Centerline				
XDIST	Longitudinal Distance to Well			Y	Y
YDIST	Distance from Plume Centerline to Well			Y	Y
ZDIST	Depth of Well Below Water Table			Y	Y
FRCOEFA	Freundlich Isotherm Coefficient			Y	Y
WMUAREA	WMU Area			Y	Y
INFILRAT	Infiltration Rate				
RESIDH2O	Residual Water Content				
UNSATHIK	Unsaturated Zone Thickness			Y	Y
PERORGM	Percent Organic Matter				
FRCOEFU	Freundlich Isotherm Coefficient			Y	Y
AVGPDIAM	Avg. Particle Diameter	AVGPDIAM	Avg. Particle Diameter		
POROSITY	Porosity	AVGPDIAM	Avg. Particle Diameter		
POROSITY	Porosity	POROSITY	Porosity		
AQUTHIK	Aquifer Thickness	AVGPDIAM	Avg. Particle Diameter	Y	
AQUTHIK	Aquifer Thickness	POROSITY	Porosity		
AQUTHIK	Aquifer Thickness	AQUTHIK	Aquifer Thickness	Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity	AVGPDIAM	Avg. Particle Diameter		
LONHYCON	Longitundinal Hydraulic Conductivity	POROSITY	Porosity		
LONHYCON	Longitundinal Hydraulic Conductivity	AQUTHIK	Aquifer Thickness	Y	
LONHYCON	Longitundinal Hydraulic Conductivity	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
HYDGRAD	Hydraulic Gradient	AVGPDIAM	Avg. Particle Diameter		
HYDGRAD	Hydraulic Gradient	POROSITY	Porosity		
HYDGRAD	Hydraulic Gradient	AQUTHIK	Aquifer Thickness		
HYDGRAD	Hydraulic Gradient	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
HYDGRAD	Hydraulic Gradient	HYDGRAD	Hydraulic Gradient	Y	Y
LONDISPA	Longitudinal Dispersivity	AVGPDIAM	Avg. Particle Diameter		
LONDISPA	Longitudinal Dispersivity	POROSITY	Porosity		
LONDISPA	Longitudinal Dispersivity	AQUTHIK	Aquifer Thickness	Y	Y
LONDISPA	Longitudinal Dispersivity	LONHYCON	Longitundinal Hydraulic Conductivity	Y	
LONDISPA	Longitudinal Dispersivity	HYDGRAD	Hydraulic Gradient		
LONDISPA	Longitudinal Dispersivity	LONDISPA	Longitudinal Dispersivity		
FRORGCAR	Fraction Organic Carbon	AVGPDIAM	Avg. Particle Diameter		
FRORGCAR	Fraction Organic Carbon	POROSITY	Porosity		
FRORGCAR	Fraction Organic Carbon	AQUTHIK	Aquifer Thickness		
FRORGCAR	Fraction Organic Carbon	LONHYCON	Longitundinal Hydraulic Conductivity		
FRORGCAR	Fraction Organic Carbon	HYDGRAD	Hydraulic Gradient		
FRORGCAR	Fraction Organic Carbon	LONDISPA	Longitudinal Dispersivity		
FRORGCAR	Fraction Organic Carbon	FRORGCAR	Fraction Organic Carbon		
ANGLEW	Angle of Well Off Plume Centerline	AVGPDIAM	Avg. Particle Diameter		
ANGLEW	Angle of Well Off Plume Centerline	POROSITY	Porosity		
ANGLEW	Angle of Well Off Plume Centerline	AQUTHIK	Aquifer Thickness		

Table D-41. Summary of Crosspairs Analysis for Antimony

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
ANGLEW	Angle of Well Off Plume Centerline	LONHYCON	Longitundinal Hydraulic Conductivity		
ANGLEW	Angle of Well Off Plume Centerline	HYDGRAD	Hydraulic Gradient		
ANGLEW	Angle of Well Off Plume Centerline	LONDISPA	Longitudinal Dispersivity		
ANGLEW	Angle of Well Off Plume Centerline	FRORGCAR	Fraction Organic Carbon		
ANGLEW	Angle of Well Off Plume Centerline	ANGLEW	Angle of Well Off Plume Centerline		
XDIST	Longitudinal Distance to Well	AVGPDIAM	Avg. Particle Diameter		
XDIST	Longitudinal Distance to Well	POROSITY	Porosity		
XDIST	Longitudinal Distance to Well	AQUTHIK	Aquifer Thickness	Y	
XDIST	Longitudinal Distance to Well	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
XDIST	Longitudinal Distance to Well	HYDGRAD	Hydraulic Gradient	Y	Y
XDIST	Longitudinal Distance to Well	LONDISPA	Longitudinal Dispersivity		
XDIST	Longitudinal Distance to Well	FRORGCAR	Fraction Organic Carbon		
XDIST	Longitudinal Distance to Well	ANGLEW	Angle of Well Off Plume Centerline		
XDIST	Longitudinal Distance to Well	XDIST	Longitudinal Distance to Well	Y	Y
YDIST	Distance from Plume Centerline to Well	AVGPDIAM	Avg. Particle Diameter		
YDIST	Distance from Plume Centerline to Well	POROSITY	Porosity		
YDIST	Distance from Plume Centerline to Well	AQUTHIK	Aquifer Thickness	Y	Y
YDIST	Distance from Plume Centerline to Well	LONHYCON	Longitundinal Hydraulic Conductivity	Y	
YDIST	Distance from Plume Centerline to Well	HYDGRAD	Hydraulic Gradient	Y	
YDIST	Distance from Plume Centerline to Well	LONDISPA	Longitudinal Dispersivity	Y	Y
YDIST	Distance from Plume Centerline to Well	FRORGCAR	Fraction Organic Carbon		
YDIST	Distance from Plume Centerline to Well	ANGLEW	Angle of Well Off Plume Centerline		
YDIST	Distance from Plume Centerline to Well	XDIST	Longitudinal Distance to Well	Y	Y
YDIST	Distance from Plume Centerline to Well	YDIST	Distance from Plume Centerline to Well	Y	Y
ZDIST	Depth of Well Below Water Table	AVGPDIAM	Avg. Particle Diameter		
ZDIST	Depth of Well Below Water Table	POROSITY	Porosity		
ZDIST	Depth of Well Below Water Table	AQUTHIK	Aquifer Thickness		
ZDIST	Depth of Well Below Water Table	LONHYCON	Longitundinal Hydraulic Conductivity	Y	
ZDIST	Depth of Well Below Water Table	HYDGRAD	Hydraulic Gradient		
ZDIST	Depth of Well Below Water Table	LONDISPA	Longitudinal Dispersivity		
ZDIST	Depth of Well Below Water Table	FRORGCAR	Fraction Organic Carbon		
ZDIST	Depth of Well Below Water Table	ANGLEW	Angle of Well Off Plume Centerline		
ZDIST	Depth of Well Below Water Table	XDIST	Longitudinal Distance to Well		
ZDIST	Depth of Well Below Water Table	YDIST	Distance from Plume Centerline to Well		
ZDIST	Depth of Well Below Water Table	ZDIST	Depth of Well Below Water Table		
FRCOEFA	Freundlich Isotherm Coefficient	AVGPDIAM	Avg. Particle Diameter	Y	
FRCOEFA	Freundlich Isotherm Coefficient	POROSITY	Porosity		
FRCOEFA	Freundlich Isotherm Coefficient	AQUTHIK	Aquifer Thickness	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	HYDGRAD	Hydraulic Gradient	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	LONDISPA	Longitudinal Dispersivity	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	FRORGCAR	Fraction Organic Carbon		
FRCOEFA	Freundlich Isotherm Coefficient	ANGLEW	Angle of Well Off Plume Centerline		
FRCOEFA	Freundlich Isotherm Coefficient	XDIST	Longitudinal Distance to Well	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	YDIST	Distance from Plume Centerline to Well	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	ZDIST	Depth of Well Below Water Table	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
WMUAREA	WMU Area	AVGPDIAM	Avg. Particle Diameter		
WMUAREA	WMU Area	POROSITY	Porosity		

Table D-41. Summary of Crosspairs Analysis for Antimony

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
WMUAREA	WMU Area	AQUTHIK	Aquifer Thickness	Y	Y
WMUAREA	WMU Area	LONHYCON	Longitundinal Hydraulic Conductivity		
WMUAREA	WMU Area	HYDGRAD	Hydraulic Gradient		
WMUAREA	WMU Area	LONDISPA	Longitudinal Dispersivity	Y	Y
WMUAREA	WMU Area	FRORGCAR	Fraction Organic Carbon		
WMUAREA	WMU Area	ANGLEW	Angle of Well Off Plume Centerline		
WMUAREA	WMU Area	XDIST	Longitudinal Distance to Well	Y	Y
WMUAREA	WMU Area	YDIST	Distance from Plume Centerline to Well	Y	Y
WMUAREA	WMU Area	ZDIST	Depth of Well Below Water Table		
WMUAREA	WMU Area	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
WMUAREA	WMU Area	WMUAREA	WMU Area	Y	Y
INFILRAT	Infiltration Rate	AVGPDIAM	Avg. Particle Diameter		
INFILRAT	Infiltration Rate	POROSITY	Porosity		
INFILRAT	Infiltration Rate	AQUTHIK	Aquifer Thickness		
INFILRAT	Infiltration Rate	LONHYCON	Longitundinal Hydraulic Conductivity		
INFILRAT	Infiltration Rate	HYDGRAD	Hydraulic Gradient		
INFILRAT	Infiltration Rate	LONDISPA	Longitudinal Dispersivity		
INFILRAT	Infiltration Rate	FRORGCAR	Fraction Organic Carbon		
INFILRAT	Infiltration Rate	ANGLEW	Angle of Well Off Plume Centerline		
INFILRAT	Infiltration Rate	XDIST	Longitudinal Distance to Well		
INFILRAT	Infiltration Rate	YDIST	Distance from Plume Centerline to Well		
INFILRAT	Infiltration Rate	ZDIST	Depth of Well Below Water Table		
INFILRAT	Infiltration Rate	FRCOEFA	Freundlich Isotherm Coefficient		
INFILRAT	Infiltration Rate	WMUAREA	WMU Area		
INFILRAT	Infiltration Rate	INFILRAT	Infiltration Rate	Y	Y
RESIDH2O	Residual Water Content	AVGPDIAM	Avg. Particle Diameter		
RESIDH2O	Residual Water Content	POROSITY	Porosity		
RESIDH2O	Residual Water Content	AQUTHIK	Aquifer Thickness		
RESIDH2O	Residual Water Content	LONHYCON	Longitundinal Hydraulic Conductivity		
RESIDH2O	Residual Water Content	HYDGRAD	Hydraulic Gradient		
RESIDH2O	Residual Water Content	LONDISPA	Longitudinal Dispersivity		
RESIDH2O	Residual Water Content	FRORGCAR	Fraction Organic Carbon		
RESIDH2O	Residual Water Content	ANGLEW	Angle of Well Off Plume Centerline		
RESIDH2O	Residual Water Content	XDIST	Longitudinal Distance to Well		
RESIDH2O	Residual Water Content	YDIST	Distance from Plume Centerline to Well		
RESIDH2O	Residual Water Content	ZDIST	Depth of Well Below Water Table		
RESIDH2O	Residual Water Content	FRCOEFA	Freundlich Isotherm Coefficient		
RESIDH2O	Residual Water Content	WMUAREA	WMU Area		
RESIDH2O	Residual Water Content	INFILRAT	Infiltration Rate		
RESIDH2O	Residual Water Content	RESIDH2O	Residual Water Content		
UNSATHIK	Unsaturated Zone Thickness	AVGPDIAM	Avg. Particle Diameter		
UNSATHIK	Unsaturated Zone Thickness	POROSITY	Porosity		
UNSATHIK	Unsaturated Zone Thickness	AQUTHIK	Aquifer Thickness	Y	Y
UNSATHIK	Unsaturated Zone Thickness	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
UNSATHIK	Unsaturated Zone Thickness	HYDGRAD	Hydraulic Gradient	Y	Y
UNSATHIK	Unsaturated Zone Thickness	LONDISPA	Longitudinal Dispersivity	Y	
UNSATHIK	Unsaturated Zone Thickness	FRORGCAR	Fraction Organic Carbon		
UNSATHIK	Unsaturated Zone Thickness	ANGLEW	Angle of Well Off Plume Centerline		
UNSATHIK	Unsaturated Zone Thickness	XDIST	Longitudinal Distance to Well	Y	Y

Table D-41. Summary of Crosspairs Analysis for Antimony

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
UNSATHIK	Unsaturated Zone Thickness	YDIST	Distance from Plume Centerline to Well	Y	Y
UNSATHIK	Unsaturated Zone Thickness	ZDIST	Depth of Well Below Water Table		
UNSATHIK	Unsaturated Zone Thickness	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
UNSATHIK	Unsaturated Zone Thickness	WMUAREA	WMU Area	Y	Y
UNSATHIK	Unsaturated Zone Thickness	INFILRAT	Infiltration Rate		
UNSATHIK	Unsaturated Zone Thickness	RESIDH2O	Residual Water Content		
UNSATHIK	Unsaturated Zone Thickness	UNSATHIK	Unsaturated Zone Thickness	Y	Y
PERORGM	Percent Organic Matter	AVGPDIAM	Avg. Particle Diameter		
PERORGM	Percent Organic Matter	POROSITY	Porosity		
PERORGM	Percent Organic Matter	AQUTHIK	Aquifer Thickness		
PERORGM	Percent Organic Matter	LONHYCON	Longitundinal Hydraulic Conductivity		
PERORGM	Percent Organic Matter	HYDGRAD	Hydraulic Gradient		
PERORGM	Percent Organic Matter	LONDISPA	Longitudinal Dispersivity		
PERORGM	Percent Organic Matter	FRORGCAR	Fraction Organic Carbon		
PERORGM	Percent Organic Matter	ANGLEW	Angle of Well Off Plume Centerline		
PERORGM	Percent Organic Matter	XDIST	Longitudinal Distance to Well		
PERORGM	Percent Organic Matter	YDIST	Distance from Plume Centerline to Well	Y	
PERORGM	Percent Organic Matter	ZDIST	Depth of Well Below Water Table		
PERORGM	Percent Organic Matter	FRCOEFA	Freundlich Isotherm Coefficient		
PERORGM	Percent Organic Matter	WMUAREA	WMU Area		
PERORGM	Percent Organic Matter	INFILRAT	Infiltration Rate		
PERORGM	Percent Organic Matter	RESIDH2O	Residual Water Content		
PERORGM	Percent Organic Matter	UNSATHIK	Unsaturated Zone Thickness		
PERORGM	Percent Organic Matter	PERORGM	Percent Organic Matter		
FRCOEFU	Freundlich Isotherm Coefficient	AVGPDIAM	Avg. Particle Diameter		
FRCOEFU	Freundlich Isotherm Coefficient	POROSITY	Porosity		
FRCOEFU	Freundlich Isotherm Coefficient	AQUTHIK	Aquifer Thickness	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	HYDGRAD	Hydraulic Gradient	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	LONDISPA	Longitudinal Dispersivity		
FRCOEFU	Freundlich Isotherm Coefficient	FRORGCAR	Fraction Organic Carbon		
FRCOEFU	Freundlich Isotherm Coefficient	ANGLEW	Angle of Well Off Plume Centerline		
FRCOEFU	Freundlich Isotherm Coefficient	XDIST	Longitudinal Distance to Well	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	YDIST	Distance from Plume Centerline to Well	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	ZDIST	Depth of Well Below Water Table	Y	
FRCOEFU	Freundlich Isotherm Coefficient	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	WMUAREA	WMU Area	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	INFILRAT	Infiltration Rate		
FRCOEFU	Freundlich Isotherm Coefficient	RESIDH2O	Residual Water Content		
FRCOEFU	Freundlich Isotherm Coefficient	UNSATHIK	Unsaturated Zone Thickness	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	PERORGM	Percent Organic Matter		
FRCOEFU	Freundlich Isotherm Coefficient	FRCOEFU	Freundlich Isotherm Coefficient	Y	Y

Table D-42. Ranking of Parameters According to Percentage of Risk for Antimony

Variable Description	Reduced Sums of Square	Variable Sums of Square	Variable Degrees of Freedom	% Risk Variation	Mean Square Variable	F VALUE	P VALUE
Freundlich Isotherm Coefficient {Aquifer} (cm3/g)	5339.3	3908.71	12	35.0%	325.73	836.78	0.00E+00
Distance from Plume Centerline to Well (m)	7194.7	2053.32	9	18.4%	228.15	586.10	0.00E+00
Freundlich Isotherm Coefficient {Unsaturated} (cm3/g)	8282.4	965.57	9	8.6%	107.29	275.61	0.00E+00
Consumption of Drinking Water (ml/kg-day)	8399.1	848.86	1	7.6%	848.86	2180.68	0.00E+00
WMU Area (m2)	8414.4	833.58	9	7.5%	92.62	237.94	0.00E+00
Unsaturated Zone Thickness (m)	8583.4	664.64	10	5.9%	66.46	170.74	0.00E+00
Aquifer Thickness (m)	8772.1	475.94	8	4.3%	59.49	152.84	1.16E-230
Longitudinal Hydraulic Conductivity (m/yr)	8953.1	294.86	7	2.6%	42.12	108.21	5.48E-148
Longitudinal Distance to Well (m)	9061.9	186.11	8	1.7%	23.26	59.76	1.39E-93
Hydraluic Gradient (m/m)	9090.1	157.90	7	1.4%	22.56	57.95	3.26E-80
Longitudinal Dispersivity {Aquifer} (m)	9106.2	141.75	4	1.3%	35.44	91.04	8.65E-75
Depth of Well Below Water Table (m)	9240.1	7.87	2	0.1%	3.94	10.11	4.14E-05
Avg. Particle Diameter (cm)	9238.5	9.55	1	0.1%	9.55	24.52	7.58E-07
Infiltration Rate (m/yr)	9244.3	3.70	2	0.0%	1.85	4.76	8.64E-03

Constants

Full Model SS	9247.9969
Error SS	1923.345
Error DF	4941
MS Error	0.389

Table D-43. Chemical-Specific Properties for Constituents of Concern for Chloride/Sulfate Process Mixed Wastewater Treatment Solids

	Waste Constituent Concentrations			*Degradation Rates*	
Constituent	**SPLP (Industrial D Landfill) (mg/L)**	**Total waste (mg/kg)**	**Finite MSW Source Ratio (L/kg)**	**Overall Hydrolysis rate(1/yr)**	**Biodegrd. Rate(1/yr)**
Manganese	2.63	12700	8,829	0	0
Thallium	0.003	3	1,000	0	0

underline italics indicate values set at 1/2 of detection limit

Table D-44. Waste Management Unit Parameters for Onsite Landfill Managing Chloride/Sulfate Process Mixed Wastewater Treatment Solids

WMU	Location	Landfill Area (acres)	Landfill Area (m^2)
Onsite Landfill	Baltimore, MD	95	384452.9

Table D-45. Waste Stream Parameters for Chloride/Sulfate Process Mixed Wastewater Treatment Solids

WMU	Location	Landfill Area (acres)	Waste Quantity (MT/y)	Waste Density (g/cm^3)	Waste Density (kg/m^3)	Total Waste Vol (m^3)
Onsite Industrial D Landfill	Baltimore, MD	95	93,121	1.3	1300	2148946.2

Table D-46. Site-Specific Climate-Based Parameters for Chloride/Sulfate Process Mixed Wastewater Treatment Solids

WMU	Location	Climate Index	Climate Center	Landfill Infiltartion Rate (m/yr)			Recharge Rate (m/yr)				GWpH		
				SCL	SLT	SNL	SCL	SLT	SNL	GW TempC	SCL	SLT	SNL
Onsite Landfill	Baltimore, MD	71	Philadelphia, PA	0.16	0.20	0.26	0.16	0.20	0.26	13	4.5	4.3	4.8

Table D-47. Aquifer Types Common in Area of WMU Currently Managing Chloride/Sulfate Process Mixed Wastewater Treatment Solids

Aquifer Types	Aquifer Code	Baltimore, MD
Unconsolidated and semiconsolidated shallow aquifers	10	100%

Table D-48. Soil Textures Common in Area of WMU Currently Managing Chloride/Sulfate Process Mixed Wastewater Treatment Solids

		Baltimore, MD
silty clay loam	SCL	39%
silt loam	SIL	25%
sandy loam	SNL	36%

Table D-49. Summary of Parameters Considered in Sensitivity Analysis for Manganese

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
ACIDCAT	Acid Catalyzed Hydrolysis Rate Constant	C			
ANGLEW	Angle of Well Off Plume Centerline	anglew		Y	
ANISORAT	Anisotropy Ratio	C			
AQUTHIK	Aquifer Thickness	aquthik**-0.005		Y	Y
AVGPDIAM	Avg. Particle Diameter	log(avgpdiam+.001)		Y	Y
BASECAT	Base Catalyzed Hydrolysis Rate Constant	C			
BIODRATA	Biodegradation Rate	C			
BIODRATU	Biodegradation Rate	C			
BULKDENS	Bulk Density	bulkdens**3	Y		
CHEMDRU	Chemical Decay Rate	C			
CHEMDRA	Chemical Decay Rate	C			
CONSH2OA	Consump of drinking water	log(consh2oa)			Y
ZDIST	Depth of Well Below Water Table	log(zdist+0.8)		Y	Y
DISHYD	Dissolved Hydrolysis Rate	C			
YDIST	Distance from Plume Centerline to Well	log(ydist+75)		Y	Y
DURLEACH	Duration of Leaching Period	log(durleach+500)	Y		
GWAVTIM	Exposure Duration	C			
FRORGCAR	Fraction Organic Carbon	log(frorgcar-0.00001)		Y	
FRCOEFA	Freundlich Isotherm Coefficient	log(frcoefa-31.9)		Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	log(frcoefu-31.9)		Y	Y
FREXPA	Freundlich Isotherm Exponent	C			
FREXPU	Freundlich Isotherm Exponent	C			
GWPH	Groundwater pH	gwph	Y		
GWSEEPV	Groundwater Seepage Velocity	log(gwseepv-0.09)		Y	Y
GWTEMP	Groundwater Temperature	C			
HYDGRAD	Hydraulic Gradient	log(hydgrad+0.0002)		Y	Y
INFILRAT	Infiltration Rate	infilrat**1.5		Y	Y
LANDEPTH	Landfill Depth	C			
LEACHCON	Leachate Concentration	C			
LFFRACT	LF Fraction	C			
LONDISPU	Longitudinal Dispersivity	log(londispu+0.1)	Y		
LONDISPA	Longitudinal Dispersivity	log(londispa+1.5)		Y	Y
XDIST	Longitudinal Distance to Well	xdist**1.7		Y	Y

Table D-49. Summary of Parameters Considered in Sensitivity Analysis for Manganese

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
LONHYCON	Longitundinal Hydraulic Conductivity	log(lonhycon-0.2)		Y	Y
MLLA	ml/L	C			
MOISTRPA	Moisture Rention Parameter (a)	moistrpa**0.06	Y		
MOISTRPB	Moisture Rention Parameter (b)	log(moistrpb-0.7)	Y		
MOLDIFF	Molecular Diffusion Coefficient	C			
NEUTHYD	Neutral Hydrolysis Rate Constant	C			
ORGCDIS	Organic Carbon Distribution Coefficient	C			
PERORGM	Percent Organic Matter	log(perorgm)		Y	
POROSITY	Porosity	porosity**0.93			
RADISTW	Radial Distance to Well	log(radistw+150)	Y		
RECHARAT	Recharge Rate	recharat	Y		
RESIDH2O	Residual Water Content	residh2o**1.7			
RETCOEF	Retardation Coefficient	log(retcoef-90)	Y		
RFDA	RfD (mg/kg/day)	C			
SATHYCON	Saturated Hydraulic Conductivity	log(sathycon+0.05)	Y		
SATURH2O	Saturated Water Content	saturh2o		Y	Y
SOILBDEN	Soil Bulk Density	soilbden	Y		
SORBHYD	Sorbed Hydrolysis Rate	C			
TRANDISP	Transverse Dispersivity	log(trandisp+0.3)	Y		
UNSATHIK	Unsaturated Zone Thickness	log(unsathik+10)		Y	Y
VERTDISP	Vertical Dispersivity	log(vertdisp+0.008)	Y		
WASTDENS	Waste Density	C			
WASTEVOL	Waste Volume	C			
WMUAREA	WMU Area	C			
WMULEN	WMU Length	C			
WMUWIDTH	WMU Width	C			

Table D-50. Summary of Correlated Parameters for Manganese

Variable 1		Variable 2		Correlation Coefficient
Code	Description	Code	Description	
AVGPDIAM	Avg. Particle Diameter	BULKDENS	Bulk Density	0.9991
FRCOEFA	Freundlich Isotherm Coefficient	RETCOEF	Retardation Coefficient	0.79209
LONDISPA	Longitudinal Dispersivity	TRANDISP	Transverse Dispersivity	0.99956
LONDISPA	Longitudinal Dispersivity	VERTDISP	Vertical Dispersivity	0.99995
RECHARAT	Recharge Rate	GWPH	Groundwater pH	0.80607
INFILRAT	Infiltration Rate	GWPH	Groundwater pH	0.80321
DURLEACH	Duration of Leaching Period	GWPH	Groundwater pH	-0.70568
MOISTRPA	Moisture Rention Parameter (a)	GWPH	Groundwater pH	0.72377
MOISTRPB	Moisture Rention Parameter (b)	GWPH	Groundwater pH	0.76672
SATURH2O	Saturated Water Content	GWPH	Groundwater pH	-0.97864
SOILBDEN	Soil Bulk Density	GWPH	Groundwater pH	-0.85644
XDIST	Longitudinal Distance to Well	RADISTW	Radial Distance to Well	0.96261
INFILRAT	Infiltration Rate	RECHARAT	Recharge Rate	0.98679
DURLEACH	Duration of Leaching Period	RECHARAT	Recharge Rate	-0.92601
SOILBDEN	Soil Bulk Density	RECHARAT	Recharge Rate	-0.99588
RECHARAT	Recharge Rate	DURLEACH	Duration of Leaching Period	-0.92601
INFILRAT	Infiltration Rate	DURLEACH	Duration of Leaching Period	-0.97138
SATHYCON	Saturated Hydraulic Conductivity	DURLEACH	Duration of Leaching Period	-0.81377
MOISTRPA	Moisture Rention Parameter (a)	DURLEACH	Duration of Leaching Period	-0.77797
MOISTRPB	Moisture Rention Parameter (b)	DURLEACH	Duration of Leaching Period	-0.85611
SOILBDEN	Soil Bulk Density	DURLEACH	Duration of Leaching Period	0.91594
RECHARAT	Recharge Rate	SATHYCON	Saturated Hydraulic Conductivity	0.82809
INFILRAT	Infiltration Rate	SATHYCON	Saturated Hydraulic Conductivity	0.84005
DURLEACH	Duration of Leaching Period	SATHYCON	Saturated Hydraulic Conductivity	-0.81377
MOISTRPA	Moisture Rention Parameter (a)	SATHYCON	Saturated Hydraulic Conductivity	0.70379
MOISTRPB	Moisture Rention Parameter (b)	SATHYCON	Saturated Hydraulic Conductivity	0.76944
RECHARAT	Recharge Rate	MOISTRPA	Moisture Rention Parameter (a)	0.8437
INFILRAT	Infiltration Rate	MOISTRPA	Moisture Rention Parameter (a)	0.83419
DURLEACH	Duration of Leaching Period	MOISTRPA	Moisture Rention Parameter (a)	-0.77797
SATHYCON	Saturated Hydraulic Conductivity	MOISTRPA	Moisture Rention Parameter (a)	0.70379
MOISTRPB	Moisture Rention Parameter (b)	MOISTRPA	Moisture Rention Parameter (a)	0.78665
RECHARAT	Recharge Rate	MOISTRPB	Moisture Rention Parameter (b)	0.92985
INFILRAT	Infiltration Rate	MOISTRPB	Moisture Rention Parameter (b)	0.91662

Table D-50. Summary of Correlated Parameters for Manganese

Variable 1		Variable 2		Correlation Coefficient
Code	**Description**	**Code**	**Description**	
DURLEACH	Duration of Leaching Period	MOISTRPB	Moisture Rention Parameter (b)	-0.85611
SATHYCON	Saturated Hydraulic Conductivity	MOISTRPB	Moisture Rention Parameter (b)	0.76944
SOILBDEN	Soil Bulk Density	SATURH2O	Saturated Water Content	0.732
UNSATHIK	Unsaturated Zone Thickness	LONDISPU	Longitudinal Dispersivity	0.99975
RECHARAT	Recharge Rate	SOILBDEN	Soil Bulk Density	-0.99588
INFILRAT	Infiltration Rate	SOILBDEN	Soil Bulk Density	-0.98391
DURLEACH	Duration of Leaching Period	SOILBDEN	Soil Bulk Density	0.91594
SATHYCON	Saturated Hydraulic Conductivity	SOILBDEN	Soil Bulk Density	-0.82618
MOISTRPA	Moisture Rention Parameter (a)	SOILBDEN	Soil Bulk Density	-0.84691
MOISTRPB	Moisture Rention Parameter (b)	SOILBDEN	Soil Bulk Density	-0.92865
SATURH2O	Saturated Water Content	SOILBDEN	Soil Bulk Density	0.732

Note: Parameters in the variable 2 column were removed from the analysis.

Table D-51. Summary of Crosspairs Analysis for Manganese

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
AVGPDIAM	Avg. Particle Diameter			Y	Y
POROSITY	Porosity				
AQUTHIK	Aquifer Thickness			Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity				Y
HYDGRAD	Hydraulic Gradient				Y
GWSEEPV	Groundwater Seepage Velocity				
LONDISPA	Longitudinal Dispersivity			Y	Y
FRORGCAR	Fraction Organic Carbon				
ANGLEW	Angle of Well Off Plume Centerline				
XDIST	Longitudinal Distance to Well			Y	Y
YDIST	Distance from Plume Centerline to Well			Y	Y
ZDIST	Depth of Well Below Water Table				
FRCOEFA	Freundlich Isotherm Coefficient			Y	Y
INFILRAT	Infiltration Rate				Y
RESIDH2O	Residual Water Content				
SATURH2O	Saturated Water Content				Y
UNSATHIK	Unsaturated Zone Thickness			Y	Y
PERORGM	Percent Organic Matter				
FRCOEFU	Freundlich Isotherm Coefficient			Y	Y
AVGPDIAM	Avg. Particle Diameter	AVGPDIAM	Avg. Particle Diameter		
POROSITY	Porosity	AVGPDIAM	Avg. Particle Diameter		
POROSITY	Porosity	POROSITY	Porosity		
AQUTHIK	Aquifer Thickness	AVGPDIAM	Avg. Particle Diameter	Y	Y
AQUTHIK	Aquifer Thickness	POROSITY	Porosity		
AQUTHIK	Aquifer Thickness	AQUTHIK	Aquifer Thickness	Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity	AVGPDIAM	Avg. Particle Diameter		
LONHYCON	Longitundinal Hydraulic Conductivity	POROSITY	Porosity		
LONHYCON	Longitundinal Hydraulic Conductivity	AQUTHIK	Aquifer Thickness		
LONHYCON	Longitundinal Hydraulic Conductivity	LONHYCON	Longitundinal Hydraulic Conductivity	Y	
HYDGRAD	Hydraulic Gradient	AVGPDIAM	Avg. Particle Diameter		
HYDGRAD	Hydraulic Gradient	POROSITY	Porosity		
HYDGRAD	Hydraulic Gradient	AQUTHIK	Aquifer Thickness		
HYDGRAD	Hydraulic Gradient	LONHYCON	Longitundinal Hydraulic Conductivity	Y	
HYDGRAD	Hydraulic Gradient	HYDGRAD	Hydraulic Gradient	Y	Y
GWSEEPV	Groundwater Seepage Velocity	AVGPDIAM	Avg. Particle Diameter		
GWSEEPV	Groundwater Seepage Velocity	POROSITY	Porosity		
GWSEEPV	Groundwater Seepage Velocity	AQUTHIK	Aquifer Thickness		
GWSEEPV	Groundwater Seepage Velocity	LONHYCON	Longitundinal Hydraulic Conductivity	Y	
GWSEEPV	Groundwater Seepage Velocity	HYDGRAD	Hydraulic Gradient	Y	Y
GWSEEPV	Groundwater Seepage Velocity	GWSEEPV	Groundwater Seepage Velocity		
LONDISPA	Longitudinal Dispersivity	AVGPDIAM	Avg. Particle Diameter		
LONDISPA	Longitudinal Dispersivity	POROSITY	Porosity		
LONDISPA	Longitudinal Dispersivity	AQUTHIK	Aquifer Thickness		
LONDISPA	Longitudinal Dispersivity	LONHYCON	Longitundinal Hydraulic Conductivity		
LONDISPA	Longitudinal Dispersivity	HYDGRAD	Hydraulic Gradient		
LONDISPA	Longitudinal Dispersivity	GWSEEPV	Groundwater Seepage Velocity		
LONDISPA	Longitudinal Dispersivity	LONDISPA	Longitudinal Dispersivity	Y	Y
FRORGCAR	Fraction Organic Carbon	AVGPDIAM	Avg. Particle Diameter		
FRORGCAR	Fraction Organic Carbon	POROSITY	Porosity		

Table D-51. Summary of Crosspairs Analysis for Manganese

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
FRORGCAR	Fraction Organic Carbon	AQUTHIK	Aquifer Thickness		
FRORGCAR	Fraction Organic Carbon	LONHYCON	Longitundinal Hydraulic Conductivity		
FRORGCAR	Fraction Organic Carbon	HYDGRAD	Hydraulic Gradient		
FRORGCAR	Fraction Organic Carbon	GWSEEPV	Groundwater Seepage Velocity		
FRORGCAR	Fraction Organic Carbon	LONDISPA	Longitudinal Dispersivity		
FRORGCAR	Fraction Organic Carbon	FRORGCAR	Fraction Organic Carbon		
ANGLEW	Angle of Well Off Plume Centerline	AVGPDIAM	Avg. Particle Diameter		
ANGLEW	Angle of Well Off Plume Centerline	POROSITY	Porosity		
ANGLEW	Angle of Well Off Plume Centerline	AQUTHIK	Aquifer Thickness		
ANGLEW	Angle of Well Off Plume Centerline	LONHYCON	Longitundinal Hydraulic Conductivity		
ANGLEW	Angle of Well Off Plume Centerline	HYDGRAD	Hydraulic Gradient		
ANGLEW	Angle of Well Off Plume Centerline	GWSEEPV	Groundwater Seepage Velocity		
ANGLEW	Angle of Well Off Plume Centerline	LONDISPA	Longitudinal Dispersivity	Y	
ANGLEW	Angle of Well Off Plume Centerline	FRORGCAR	Fraction Organic Carbon		
ANGLEW	Angle of Well Off Plume Centerline	ANGLEW	Angle of Well Off Plume Centerline		
XDIST	Longitudinal Distance to Well	AVGPDIAM	Avg. Particle Diameter		
XDIST	Longitudinal Distance to Well	POROSITY	Porosity		
XDIST	Longitudinal Distance to Well	AQUTHIK	Aquifer Thickness	Y	
XDIST	Longitudinal Distance to Well	LONHYCON	Longitundinal Hydraulic Conductivity		
XDIST	Longitudinal Distance to Well	HYDGRAD	Hydraulic Gradient		
XDIST	Longitudinal Distance to Well	GWSEEPV	Groundwater Seepage Velocity		
XDIST	Longitudinal Distance to Well	LONDISPA	Longitudinal Dispersivity		
XDIST	Longitudinal Distance to Well	FRORGCAR	Fraction Organic Carbon	Y	
XDIST	Longitudinal Distance to Well	ANGLEW	Angle of Well Off Plume Centerline		
XDIST	Longitudinal Distance to Well	XDIST	Longitudinal Distance to Well		
YDIST	Distance from Plume Centerline to Well	AVGPDIAM	Avg. Particle Diameter		
YDIST	Distance from Plume Centerline to Well	POROSITY	Porosity		
YDIST	Distance from Plume Centerline to Well	AQUTHIK	Aquifer Thickness	Y	Y
YDIST	Distance from Plume Centerline to Well	LONHYCON	Longitundinal Hydraulic Conductivity		
YDIST	Distance from Plume Centerline to Well	HYDGRAD	Hydraulic Gradient		
YDIST	Distance from Plume Centerline to Well	GWSEEPV	Groundwater Seepage Velocity		
YDIST	Distance from Plume Centerline to Well	LONDISPA	Longitudinal Dispersivity	Y	Y
YDIST	Distance from Plume Centerline to Well	FRORGCAR	Fraction Organic Carbon		
YDIST	Distance from Plume Centerline to Well	ANGLEW	Angle of Well Off Plume Centerline		
YDIST	Distance from Plume Centerline to Well	XDIST	Longitudinal Distance to Well	Y	Y
YDIST	Distance from Plume Centerline to Well	YDIST	Distance from Plume Centerline to Well	Y	Y
ZDIST	Depth of Well Below Water Table	AVGPDIAM	Avg. Particle Diameter		
ZDIST	Depth of Well Below Water Table	POROSITY	Porosity		
ZDIST	Depth of Well Below Water Table	AQUTHIK	Aquifer Thickness		
ZDIST	Depth of Well Below Water Table	LONHYCON	Longitundinal Hydraulic Conductivity		
ZDIST	Depth of Well Below Water Table	HYDGRAD	Hydraulic Gradient		
ZDIST	Depth of Well Below Water Table	GWSEEPV	Groundwater Seepage Velocity		
ZDIST	Depth of Well Below Water Table	LONDISPA	Longitudinal Dispersivity		
ZDIST	Depth of Well Below Water Table	FRORGCAR	Fraction Organic Carbon		
ZDIST	Depth of Well Below Water Table	ANGLEW	Angle of Well Off Plume Centerline		
ZDIST	Depth of Well Below Water Table	XDIST	Longitudinal Distance to Well		
ZDIST	Depth of Well Below Water Table	YDIST	Distance from Plume Centerline to Well		
ZDIST	Depth of Well Below Water Table	ZDIST	Depth of Well Below Water Table		
FRCOEFA	Freundlich Isotherm Coefficient	AVGPDIAM	Avg. Particle Diameter	Y	Y

Table D-51. Summary of Crosspairs Analysis for Manganese

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
FRCOEFA	Freundlich Isotherm Coefficient	POROSITY	Porosity		
FRCOEFA	Freundlich Isotherm Coefficient	AQUTHIK	Aquifer Thickness	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	HYDGRAD	Hydraulic Gradient	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	GWSEEPV	Groundwater Seepage Velocity		
FRCOEFA	Freundlich Isotherm Coefficient	LONDISPA	Longitudinal Dispersivity	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	FRORGCAR	Fraction Organic Carbon		
FRCOEFA	Freundlich Isotherm Coefficient	ANGLEW	Angle of Well Off Plume Centerline		
FRCOEFA	Freundlich Isotherm Coefficient	XDIST	Longitudinal Distance to Well	Y	
FRCOEFA	Freundlich Isotherm Coefficient	YDIST	Distance from Plume Centerline to Well	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	ZDIST	Depth of Well Below Water Table	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
INFILRAT	Infiltration Rate	AVGPDIAM	Avg. Particle Diameter	Y	
INFILRAT	Infiltration Rate	POROSITY	Porosity		
INFILRAT	Infiltration Rate	AQUTHIK	Aquifer Thickness	Y	Y
INFILRAT	Infiltration Rate	LONHYCON	Longitundinal Hydraulic Conductivity		
INFILRAT	Infiltration Rate	HYDGRAD	Hydraulic Gradient		
INFILRAT	Infiltration Rate	GWSEEPV	Groundwater Seepage Velocity		
INFILRAT	Infiltration Rate	LONDISPA	Longitudinal Dispersivity		
INFILRAT	Infiltration Rate	FRORGCAR	Fraction Organic Carbon		
INFILRAT	Infiltration Rate	ANGLEW	Angle of Well Off Plume Centerline		
INFILRAT	Infiltration Rate	XDIST	Longitudinal Distance to Well		
INFILRAT	Infiltration Rate	YDIST	Distance from Plume Centerline to Well		
INFILRAT	Infiltration Rate	ZDIST	Depth of Well Below Water Table		
INFILRAT	Infiltration Rate	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
INFILRAT	Infiltration Rate	INFILRAT	Infiltration Rate		
RESIDH2O	Residual Water Content	AVGPDIAM	Avg. Particle Diameter		
RESIDH2O	Residual Water Content	POROSITY	Porosity		
RESIDH2O	Residual Water Content	AQUTHIK	Aquifer Thickness		
RESIDH2O	Residual Water Content	LONHYCON	Longitundinal Hydraulic Conductivity		
RESIDH2O	Residual Water Content	HYDGRAD	Hydraulic Gradient		
RESIDH2O	Residual Water Content	GWSEEPV	Groundwater Seepage Velocity		
RESIDH2O	Residual Water Content	LONDISPA	Longitudinal Dispersivity		
RESIDH2O	Residual Water Content	FRORGCAR	Fraction Organic Carbon		
RESIDH2O	Residual Water Content	ANGLEW	Angle of Well Off Plume Centerline		
RESIDH2O	Residual Water Content	XDIST	Longitudinal Distance to Well		
RESIDH2O	Residual Water Content	YDIST	Distance from Plume Centerline to Well		
RESIDH2O	Residual Water Content	ZDIST	Depth of Well Below Water Table		
RESIDH2O	Residual Water Content	FRCOEFA	Freundlich Isotherm Coefficient		
RESIDH2O	Residual Water Content	INFILRAT	Infiltration Rate		
RESIDH2O	Residual Water Content	RESIDH2O	Residual Water Content		
SATURH2O	Saturated Water Content	AVGPDIAM	Avg. Particle Diameter		
SATURH2O	Saturated Water Content	POROSITY	Porosity		
SATURH2O	Saturated Water Content	AQUTHIK	Aquifer Thickness		
SATURH2O	Saturated Water Content	LONHYCON	Longitundinal Hydraulic Conductivity		
SATURH2O	Saturated Water Content	HYDGRAD	Hydraulic Gradient		
SATURH2O	Saturated Water Content	GWSEEPV	Groundwater Seepage Velocity		
SATURH2O	Saturated Water Content	LONDISPA	Longitudinal Dispersivity	Y	
SATURH2O	Saturated Water Content	FRORGCAR	Fraction Organic Carbon		

Table D-51. Summary of Crosspairs Analysis for Manganese

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
SATURH2O	Saturated Water Content	ANGLEW	Angle of Well Off Plume Centerline		
SATURH2O	Saturated Water Content	XDIST	Longitudinal Distance to Well		
SATURH2O	Saturated Water Content	YDIST	Distance from Plume Centerline to Well	Y	
SATURH2O	Saturated Water Content	ZDIST	Depth of Well Below Water Table		
SATURH2O	Saturated Water Content	FRCOEFA	Freundlich Isotherm Coefficient		
SATURH2O	Saturated Water Content	INFILRAT	Infiltration Rate		
SATURH2O	Saturated Water Content	RESIDH2O	Residual Water Content		
SATURH2O	Saturated Water Content	SATURH2O	Saturated Water Content		
UNSATHIK	Unsaturated Zone Thickness	AVGPDIAM	Avg. Particle Diameter		
UNSATHIK	Unsaturated Zone Thickness	POROSITY	Porosity		
UNSATHIK	Unsaturated Zone Thickness	AQUTHIK	Aquifer Thickness	Y	
UNSATHIK	Unsaturated Zone Thickness	LONHYCON	Longitundinal Hydraulic Conductivity		
UNSATHIK	Unsaturated Zone Thickness	HYDGRAD	Hydraulic Gradient		
UNSATHIK	Unsaturated Zone Thickness	GWSEEPV	Groundwater Seepage Velocity		
UNSATHIK	Unsaturated Zone Thickness	LONDISPA	Longitudinal Dispersivity		
UNSATHIK	Unsaturated Zone Thickness	FRORGCAR	Fraction Organic Carbon		
UNSATHIK	Unsaturated Zone Thickness	ANGLEW	Angle of Well Off Plume Centerline		
UNSATHIK	Unsaturated Zone Thickness	XDIST	Longitudinal Distance to Well		
UNSATHIK	Unsaturated Zone Thickness	YDIST	Distance from Plume Centerline to Well	Y	Y
UNSATHIK	Unsaturated Zone Thickness	ZDIST	Depth of Well Below Water Table		
UNSATHIK	Unsaturated Zone Thickness	FRCOEFA	Freundlich Isotherm Coefficient		
UNSATHIK	Unsaturated Zone Thickness	INFILRAT	Infiltration Rate	Y	Y
UNSATHIK	Unsaturated Zone Thickness	RESIDH2O	Residual Water Content		
UNSATHIK	Unsaturated Zone Thickness	SATURH2O	Saturated Water Content		
UNSATHIK	Unsaturated Zone Thickness	UNSATHIK	Unsaturated Zone Thickness		
PERORGM	Percent Organic Matter	AVGPDIAM	Avg. Particle Diameter		
PERORGM	Percent Organic Matter	POROSITY	Porosity		
PERORGM	Percent Organic Matter	AQUTHIK	Aquifer Thickness		
PERORGM	Percent Organic Matter	LONHYCON	Longitundinal Hydraulic Conductivity		
PERORGM	Percent Organic Matter	HYDGRAD	Hydraulic Gradient		
PERORGM	Percent Organic Matter	GWSEEPV	Groundwater Seepage Velocity		
PERORGM	Percent Organic Matter	LONDISPA	Longitudinal Dispersivity		
PERORGM	Percent Organic Matter	FRORGCAR	Fraction Organic Carbon		
PERORGM	Percent Organic Matter	ANGLEW	Angle of Well Off Plume Centerline		
PERORGM	Percent Organic Matter	XDIST	Longitudinal Distance to Well		
PERORGM	Percent Organic Matter	YDIST	Distance from Plume Centerline to Well		
PERORGM	Percent Organic Matter	ZDIST	Depth of Well Below Water Table		
PERORGM	Percent Organic Matter	FRCOEFA	Freundlich Isotherm Coefficient		
PERORGM	Percent Organic Matter	INFILRAT	Infiltration Rate		
PERORGM	Percent Organic Matter	RESIDH2O	Residual Water Content		
PERORGM	Percent Organic Matter	SATURH2O	Saturated Water Content	Y	
PERORGM	Percent Organic Matter	UNSATHIK	Unsaturated Zone Thickness		
PERORGM	Percent Organic Matter	PERORGM	Percent Organic Matter		
FRCOEFU	Freundlich Isotherm Coefficient	AVGPDIAM	Avg. Particle Diameter		
FRCOEFU	Freundlich Isotherm Coefficient	POROSITY	Porosity		
FRCOEFU	Freundlich Isotherm Coefficient	AQUTHIK	Aquifer Thickness		
FRCOEFU	Freundlich Isotherm Coefficient	LONHYCON	Longitundinal Hydraulic Conductivity		
FRCOEFU	Freundlich Isotherm Coefficient	HYDGRAD	Hydraulic Gradient		
FRCOEFU	Freundlich Isotherm Coefficient	GWSEEPV	Groundwater Seepage Velocity		

Table D-51. Summary of Crosspairs Analysis for Manganese

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
FRCOEFU	Freundlich Isotherm Coefficient	LONDISPA	Longitudinal Dispersivity	Y	
FRCOEFU	Freundlich Isotherm Coefficient	FRORGCAR	Fraction Organic Carbon		
FRCOEFU	Freundlich Isotherm Coefficient	ANGLEW	Angle of Well Off Plume Centerline		
FRCOEFU	Freundlich Isotherm Coefficient	XDIST	Longitudinal Distance to Well		
FRCOEFU	Freundlich Isotherm Coefficient	YDIST	Distance from Plume Centerline to Well	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	ZDIST	Depth of Well Below Water Table		
FRCOEFU	Freundlich Isotherm Coefficient	FRCOEFA	Freundlich Isotherm Coefficient		
FRCOEFU	Freundlich Isotherm Coefficient	INFILRAT	Infiltration Rate		
FRCOEFU	Freundlich Isotherm Coefficient	RESIDH2O	Residual Water Content		
FRCOEFU	Freundlich Isotherm Coefficient	SATURH2O	Saturated Water Content		
FRCOEFU	Freundlich Isotherm Coefficient	UNSATHIK	Unsaturated Zone Thickness	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	PERORGM	Percent Organic Matter		
FRCOEFU	Freundlich Isotherm Coefficient	FRCOEFU	Freundlich Isotherm Coefficient	Y	Y

Table D-52. Ranking of Parameters According to Percentage of Risk for Manganese

Variable Description	Reduced Sums of Square	Variable Sums of Square	Variable Degrees of Freedom	% Risk Variation	Mean Square Variable	F VALUE	P VALUE
Dist. Plume Center. To Well (m)	2722.6	4681.06	8	46.3%	585.13	1074.47	0.00E+00
Freund. Iso. Coeff.--Aquifer (cm^3/g)	5467.9	1935.68	10	19.2%	193.57	355.45	0.00E+00
Consumption of Drinking Water (ml/kg/day)	6544.0	859.66	1	8.5%	859.66	1578.59	5.71E-300
Aquifer Thickness (m)	6642.2	761.40	6	7.5%	126.90	233.02	5.11E-263
Long. Dispersivity--Aquifer (m)	6964.5	439.14	4	4.3%	109.79	201.60	1.97E-160
Freund. Iso. Coeff.--Unsat. Zone (cm^3/g)	7023.3	380.33	4	3.8%	95.08	174.60	4.01E-140
Infiltration Rate (m/yr)	7245.5	158.10	4	1.6%	39.52	72.58	7.52E-60
Unsaturated Zone Thickness (m)	7267.0	136.63	4	1.4%	34.16	62.72	8.59E-52
Long. Distance To Well (m)	7292.6	111.06	2	1.1%	55.53	101.97	3.99E-44
Long. Hydraulic Conduct. (m/yr)	7342.6	61.00	2	0.6%	30.50	56.01	8.82E-25
Hydraulic Gradient (m/m)	7348.8	54.85	4	0.5%	13.71	25.18	1.12E-20
Avg. Particle Diameter (cm)	7376.8	26.80	3	0.3%	8.93	16.40	1.32E-10
Groundwater Seepage Velocity (m/yr)	7397.7	5.93	2	0.1%	2.96	5.44	4.36E-03
Depth of Well below Water Table (m)	7390.1	13.51	2	0.1%	6.75	12.40	4.23E-06
Saturated Water Content (unitless)	7399.7	3.91	1	0.0%	3.91	7.17	7.42E-03

Constants

Full Model SS	7403.616
Error SS	2701.104
Error DF	4960
MS Error	0.545

Table D-53. Summary of Parameters Considered in Sensitivity Analysis for Thallium

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
ACIDCAT	Acid Catalyzed Hydrolysis Rate Constant	C			
ANGLEW	Angle of Well Off Plume Centerline	anglew		Y	
ANISORAT	Anisotropy Ratio	C			
AQUTHIK	Aquifer Thickness	aquthik**-0.005		Y	Y
AVGPDIAM	Avg. Particle Diameter	log(avgpdiam+.001)		Y	Y
BASECAT	Base Catalyzed Hydrolysis Rate Constant	C			
BIODRATA	Biodegradation Rate	C			
BIODRATU	Biodegradation Rate	C			
BULKDENS	Bulk Density	bulkdens**3	Y		
CHEMDRU	Chemical Decay Rate	C			
CHEMDRA	Chemical Decay Rate	C			
CONSH2OA	Consump of drinking water	log(consh2oa)			Y
ZDIST	Depth of Well Below Water Table	log(zdist+0.8)		Y	Y
DISHYD	Dissolved Hydrolysis Rate	C			
YDIST	Distance from Plume Centerline to Well	log(ydist+75)		Y	Y
DURLEACH	Duration of Leaching Period	log(durleach+500)	Y		
GWAVTIM	Exposure Duration	C			
FRORGCAR	Fraction Organic Carbon	log(frorgcar-0.00001)		Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	log(frcoefa-0.9)		Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	log(frcoefu-0.7)		Y	Y
FREXPA	Freundlich Isotherm Exponent	C			
FREXPU	Freundlich Isotherm Exponent	C			
GWPH	Groundwater pH	gwph	Y		
GWSEEPV	Groundwater Seepage Velocity	log(gwseepv-0.09)		Y	Y
GWTEMP	Groundwater Temperature	C			
HYDGRAD	Hydraulic Gradient	log(hydgrad+0.0002)		Y	Y
INFILRAT	Infiltration Rate	infilrat**1.5		Y	Y
LANDEPTH	Landfill Depth	C			
LEACHCON	Leachate Concentration	C			
LFFRACT	LF Fraction	C			
LONDISPU	Longitudinal Dispersivity	log(londispu+0.1)	Y		
LONDISPA	Longitudinal Dispersivity	log(londispa+1.5)		Y	Y
XDIST	Longitudinal Distance to Well	xdist**1.7		Y	Y

Table D-53. Summary of Parameters Considered in Sensitivity Analysis for Thallium

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
LONHYCON	Longitundinal Hydraulic Conductivity	log(lonhycon-0.2)		Y	Y
MLLA	ml/L	C			
MOISTRPA	Moisture Rention Parameter (a)	moistrpa**0.06	Y		
MOISTRPB	Moisture Rention Parameter (b)	log(moistrpb-0.9)	Y		
MOLDIFF	Molecular Diffusion Coefficient	C			
NEUTHYD	Neutral Hydrolysis Rate Constant	C			
ORGCDIS	Organic Carbon Distribution Coefficient	C			
PERORGM	Percent Organic Matter	log(perorgm)			
POROSITY	Porosity	porosity**0.93		Y	Y
RADISTW	Radial Distance to Well	log(radistw+150)	Y		
RECHARAT	Recharge Rate	recharat	Y		
RESIDH2O	Residual Water Content	residh2o**1.7		Y	
RETCOEF	Retardation Coefficient	log(retcoef-4.4)	Y		
RFDA	RfD (mg/kg/day)	C			
SATHYCON	Saturated Hydraulic Conductivity	log(sathycon+0.05)	Y		
SATURH2O	Saturated Water Content	saturh2o		Y	
SOILBDEN	Soil Bulk Density	soilbden	Y		
SORBHYD	Sorbed Hydrolysis Rate	C			
TRANDISP	Transverse Dispersivity	log(trandisp+0.3)	Y		
UNSATHIK	Unsaturated Zone Thickness	log(unsathik+10)		Y	Y
VERTDISP	Vertical Dispersivity	log(vertdisp+0.008)	Y		
WASTDENS	Waste Density	C			
WASTEVOL	Waste Volume	C			
WMUAREA	WMU Area	C			
WMULEN	WMU Length	C			
WMUWIDTH	WMU Width	C			

Table D-54. Summary of Correlated Parameters for Thallium

Variable 1		Variable 2		Correlation Coefficient
Code	Description	Code	Description	
AVGPDIAM	Avg. Particle Diameter	BULKDENS	Bulk Density	0.99907
FRCOEFA	Freundlich Isotherm Coefficient	RETCOEF	Retardation Coefficient	0.95441
LONDISPA	Longitudinal Dispersivity	TRANDISP	Transverse Dispersivity	0.99949
LONDISPA	Longitudinal Dispersivity	VERTDISP	Vertical Dispersivity	0.99993
RECHARAT	Recharge Rate	GWPH	Groundwater pH	0.79572
INFILRAT	Infiltration Rate	GWPH	Groundwater pH	0.78996
MOISTRPA	Moisture Rention Parameter (a)	GWPH	Groundwater pH	0.71882
MOISTRPB	Moisture Rention Parameter (b)	GWPH	Groundwater pH	0.73837
SATURH2O	Saturated Water Content	GWPH	Groundwater pH	-0.97794
SOILBDEN	Soil Bulk Density	GWPH	Groundwater pH	-0.84869
XDIST	Longitudinal Distance to Well	RADISTW	Radial Distance to Well	0.98714
INFILRAT	Infiltration Rate	RECHARAT	Recharge Rate	0.98452
DURLEACH	Duration of Leaching Period	RECHARAT	Recharge Rate	-0.89067
SOILBDEN	Soil Bulk Density	RECHARAT	Recharge Rate	-0.99565
RECHARAT	Recharge Rate	DURLEACH	Duration of Leaching Period	-0.89067
INFILRAT	Infiltration Rate	DURLEACH	Duration of Leaching Period	-0.95035
SATHYCON	Saturated Hydraulic Conductivity	DURLEACH	Duration of Leaching Period	-0.79331
MOISTRPA	Moisture Rention Parameter (a)	DURLEACH	Duration of Leaching Period	-0.7437
MOISTRPB	Moisture Rention Parameter (b)	DURLEACH	Duration of Leaching Period	-0.82411
SOILBDEN	Soil Bulk Density	DURLEACH	Duration of Leaching Period	0.87918
RECHARAT	Recharge Rate	SATHYCON	Saturated Hydraulic Conductivity	0.82474
INFILRAT	Infiltration Rate	SATHYCON	Saturated Hydraulic Conductivity	0.83763
DURLEACH	Duration of Leaching Period	SATHYCON	Saturated Hydraulic Conductivity	-0.79331
MOISTRPB	Moisture Rention Parameter (b)	SATHYCON	Saturated Hydraulic Conductivity	0.75788
RECHARAT	Recharge Rate	MOISTRPA	Moisture Rention Parameter (a)	0.84249
INFILRAT	Infiltration Rate	MOISTRPA	Moisture Rention Parameter (a)	0.83083
DURLEACH	Duration of Leaching Period	MOISTRPA	Moisture Rention Parameter (a)	-0.7437
MOISTRPB	Moisture Rention Parameter (b)	MOISTRPA	Moisture Rention Parameter (a)	0.78317
RECHARAT	Recharge Rate	MOISTRPB	Moisture Rention Parameter (b)	0.92526
INFILRAT	Infiltration Rate	MOISTRPB	Moisture Rention Parameter (b)	0.91104
DURLEACH	Duration of Leaching Period	MOISTRPB	Moisture Rention Parameter (b)	-0.82411
SATHYCON	Saturated Hydraulic Conductivity	MOISTRPB	Moisture Rention Parameter (b)	0.75788
SOILBDEN	Soil Bulk Density	SATURH2O	Saturated Water Content	0.71949

Table D-54. Summary of Correlated Parameters for Thallium

Variable 1		Variable 2		Correlation Coefficient
Code	**Description**	**Code**	**Description**	
UNSATHIK	Unsaturated Zone Thickness	LONDISPU	Longitudinal Dispersivity	0.99974
RECHARAT	Recharge Rate	SOILBDEN	Soil Bulk Density	-0.99565
INFILRAT	Infiltration Rate	SOILBDEN	Soil Bulk Density	-0.98125
DURLEACH	Duration of Leaching Period	SOILBDEN	Soil Bulk Density	0.87918
SATHYCON	Saturated Hydraulic Conductivity	SOILBDEN	Soil Bulk Density	-0.82051
MOISTRPA	Moisture Rention Parameter (a)	SOILBDEN	Soil Bulk Density	-0.84628
MOISTRPB	Moisture Rention Parameter (b)	SOILBDEN	Soil Bulk Density	-0.92156
SATURH2O	Saturated Water Content	SOILBDEN	Soil Bulk Density	0.71949

Note: Parameters in the variable 2 column were removed from the analysis.

Table D-55. Summary of Crosspairs Analysis for Thallium

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
AVGPDIAM	Avg. Particle Diameter			Y	Y
POROSITY	Porosity				Y
AQUTHIK	Aquifer Thickness			Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity			Y	Y
HYDGRAD	Hydraulic Gradient			Y	Y
GWSEEPV	Groundwater Seepage Velocity			Y	Y
LONDISPA	Longitudinal Dispersivity			Y	Y
FRORGCAR	Fraction Organic Carbon				
ANGLEW	Angle of Well Off Plume Centerline				
XDIST	Longitudinal Distance to Well			Y	Y
YDIST	Distance from Plume Centerline to Well			Y	Y
ZDIST	Depth of Well Below Water Table				Y
FRCOEFA	Freundlich Isotherm Coefficient			Y	Y
INFILRAT	Infiltration Rate			Y	Y
RESIDH2O	Residual Water Content			Y	
SATURH2O	Saturated Water Content			Y	
UNSATHIK	Unsaturated Zone Thickness			Y	Y
PERORGM	Percent Organic Matter				
FRCOEFU	Freundlich Isotherm Coefficient			Y	Y
AVGPDIAM	Avg. Particle Diameter	AVGPDIAM	Avg. Particle Diameter		
POROSITY	Porosity	AVGPDIAM	Avg. Particle Diameter		
POROSITY	Porosity	POROSITY	Porosity		
AQUTHIK	Aquifer Thickness	AVGPDIAM	Avg. Particle Diameter		
AQUTHIK	Aquifer Thickness	POROSITY	Porosity		
AQUTHIK	Aquifer Thickness	AQUTHIK	Aquifer Thickness	Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity	AVGPDIAM	Avg. Particle Diameter		
LONHYCON	Longitundinal Hydraulic Conductivity	POROSITY	Porosity	Y	
LONHYCON	Longitundinal Hydraulic Conductivity	AQUTHIK	Aquifer Thickness		
LONHYCON	Longitundinal Hydraulic Conductivity	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
HYDGRAD	Hydraulic Gradient	AVGPDIAM	Avg. Particle Diameter		
HYDGRAD	Hydraulic Gradient	POROSITY	Porosity		
HYDGRAD	Hydraulic Gradient	AQUTHIK	Aquifer Thickness		
HYDGRAD	Hydraulic Gradient	LONHYCON	Longitundinal Hydraulic Conductivity		
HYDGRAD	Hydraulic Gradient	HYDGRAD	Hydraulic Gradient		
GWSEEPV	Groundwater Seepage Velocity	AVGPDIAM	Avg. Particle Diameter		
GWSEEPV	Groundwater Seepage Velocity	POROSITY	Porosity	Y	
GWSEEPV	Groundwater Seepage Velocity	AQUTHIK	Aquifer Thickness		
GWSEEPV	Groundwater Seepage Velocity	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
GWSEEPV	Groundwater Seepage Velocity	HYDGRAD	Hydraulic Gradient		
GWSEEPV	Groundwater Seepage Velocity	GWSEEPV	Groundwater Seepage Velocity		
LONDISPA	Longitudinal Dispersivity	AVGPDIAM	Avg. Particle Diameter		
LONDISPA	Longitudinal Dispersivity	POROSITY	Porosity		
LONDISPA	Longitudinal Dispersivity	AQUTHIK	Aquifer Thickness		
LONDISPA	Longitudinal Dispersivity	LONHYCON	Longitundinal Hydraulic Conductivity		
LONDISPA	Longitudinal Dispersivity	HYDGRAD	Hydraulic Gradient		
LONDISPA	Longitudinal Dispersivity	GWSEEPV	Groundwater Seepage Velocity		
LONDISPA	Longitudinal Dispersivity	LONDISPA	Longitudinal Dispersivity		
FRORGCAR	Fraction Organic Carbon	AVGPDIAM	Avg. Particle Diameter		
FRORGCAR	Fraction Organic Carbon	POROSITY	Porosity		

Table D-55. Summary of Crosspairs Analysis for Thallium

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
FRORGCAR	Fraction Organic Carbon	AQUTHIK	Aquifer Thickness		
FRORGCAR	Fraction Organic Carbon	LONHYCON	Longitundinal Hydraulic Conductivity		
FRORGCAR	Fraction Organic Carbon	HYDGRAD	Hydraulic Gradient		
FRORGCAR	Fraction Organic Carbon	GWSEEPV	Groundwater Seepage Velocity		
FRORGCAR	Fraction Organic Carbon	LONDISPA	Longitudinal Dispersivity	Y	Y
FRORGCAR	Fraction Organic Carbon	FRORGCAR	Fraction Organic Carbon		
ANGLEW	Angle of Well Off Plume Centerline	AVGPDIAM	Avg. Particle Diameter		
ANGLEW	Angle of Well Off Plume Centerline	POROSITY	Porosity		
ANGLEW	Angle of Well Off Plume Centerline	AQUTHIK	Aquifer Thickness		
ANGLEW	Angle of Well Off Plume Centerline	LONHYCON	Longitundinal Hydraulic Conductivity		
ANGLEW	Angle of Well Off Plume Centerline	HYDGRAD	Hydraulic Gradient		
ANGLEW	Angle of Well Off Plume Centerline	GWSEEPV	Groundwater Seepage Velocity		
ANGLEW	Angle of Well Off Plume Centerline	LONDISPA	Longitudinal Dispersivity	Y	
ANGLEW	Angle of Well Off Plume Centerline	FRORGCAR	Fraction Organic Carbon		
ANGLEW	Angle of Well Off Plume Centerline	ANGLEW	Angle of Well Off Plume Centerline		
XDIST	Longitudinal Distance to Well	AVGPDIAM	Avg. Particle Diameter		
XDIST	Longitudinal Distance to Well	POROSITY	Porosity		
XDIST	Longitudinal Distance to Well	AQUTHIK	Aquifer Thickness		
XDIST	Longitudinal Distance to Well	LONHYCON	Longitundinal Hydraulic Conductivity		
XDIST	Longitudinal Distance to Well	HYDGRAD	Hydraulic Gradient		
XDIST	Longitudinal Distance to Well	GWSEEPV	Groundwater Seepage Velocity		
XDIST	Longitudinal Distance to Well	LONDISPA	Longitudinal Dispersivity		
XDIST	Longitudinal Distance to Well	FRORGCAR	Fraction Organic Carbon		
XDIST	Longitudinal Distance to Well	ANGLEW	Angle of Well Off Plume Centerline		
XDIST	Longitudinal Distance to Well	XDIST	Longitudinal Distance to Well	Y	
YDIST	Distance from Plume Centerline to Well	AVGPDIAM	Avg. Particle Diameter		
YDIST	Distance from Plume Centerline to Well	POROSITY	Porosity		
YDIST	Distance from Plume Centerline to Well	AQUTHIK	Aquifer Thickness		
YDIST	Distance from Plume Centerline to Well	LONHYCON	Longitundinal Hydraulic Conductivity		
YDIST	Distance from Plume Centerline to Well	HYDGRAD	Hydraulic Gradient		
YDIST	Distance from Plume Centerline to Well	GWSEEPV	Groundwater Seepage Velocity		
YDIST	Distance from Plume Centerline to Well	LONDISPA	Longitudinal Dispersivity	Y	Y
YDIST	Distance from Plume Centerline to Well	FRORGCAR	Fraction Organic Carbon		
YDIST	Distance from Plume Centerline to Well	ANGLEW	Angle of Well Off Plume Centerline	Y	
YDIST	Distance from Plume Centerline to Well	XDIST	Longitudinal Distance to Well	Y	Y
YDIST	Distance from Plume Centerline to Well	YDIST	Distance from Plume Centerline to Well	Y	Y
ZDIST	Depth of Well Below Water Table	AVGPDIAM	Avg. Particle Diameter		
ZDIST	Depth of Well Below Water Table	POROSITY	Porosity	Y	
ZDIST	Depth of Well Below Water Table	AQUTHIK	Aquifer Thickness		
ZDIST	Depth of Well Below Water Table	LONHYCON	Longitundinal Hydraulic Conductivity		
ZDIST	Depth of Well Below Water Table	HYDGRAD	Hydraulic Gradient		
ZDIST	Depth of Well Below Water Table	GWSEEPV	Groundwater Seepage Velocity		
ZDIST	Depth of Well Below Water Table	LONDISPA	Longitudinal Dispersivity	Y	
ZDIST	Depth of Well Below Water Table	FRORGCAR	Fraction Organic Carbon		
ZDIST	Depth of Well Below Water Table	ANGLEW	Angle of Well Off Plume Centerline		
ZDIST	Depth of Well Below Water Table	XDIST	Longitudinal Distance to Well	Y	
ZDIST	Depth of Well Below Water Table	YDIST	Distance from Plume Centerline to Well		
ZDIST	Depth of Well Below Water Table	ZDIST	Depth of Well Below Water Table		
FRCOEFA	Freundlich Isotherm Coefficient	AVGPDIAM	Avg. Particle Diameter		

Table D-55. Summary of Crosspairs Analysis for Thallium

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
FRCOEFA	Freundlich Isotherm Coefficient	POROSITY	Porosity		
FRCOEFA	Freundlich Isotherm Coefficient	AQUTHIK	Aquifer Thickness	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	HYDGRAD	Hydraulic Gradient	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	GWSEEPV	Groundwater Seepage Velocity		
FRCOEFA	Freundlich Isotherm Coefficient	LONDISPA	Longitudinal Dispersivity		
FRCOEFA	Freundlich Isotherm Coefficient	FRORGCAR	Fraction Organic Carbon		
FRCOEFA	Freundlich Isotherm Coefficient	ANGLEW	Angle of Well Off Plume Centerline		
FRCOEFA	Freundlich Isotherm Coefficient	XDIST	Longitudinal Distance to Well		
FRCOEFA	Freundlich Isotherm Coefficient	YDIST	Distance from Plume Centerline to Well	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	ZDIST	Depth of Well Below Water Table	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
INFILRAT	Infiltration Rate	AVGPDIAM	Avg. Particle Diameter		
INFILRAT	Infiltration Rate	POROSITY	Porosity		
INFILRAT	Infiltration Rate	AQUTHIK	Aquifer Thickness		
INFILRAT	Infiltration Rate	LONHYCON	Longitundinal Hydraulic Conductivity		
INFILRAT	Infiltration Rate	HYDGRAD	Hydraulic Gradient		
INFILRAT	Infiltration Rate	GWSEEPV	Groundwater Seepage Velocity		
INFILRAT	Infiltration Rate	LONDISPA	Longitudinal Dispersivity		
INFILRAT	Infiltration Rate	FRORGCAR	Fraction Organic Carbon		
INFILRAT	Infiltration Rate	ANGLEW	Angle of Well Off Plume Centerline		
INFILRAT	Infiltration Rate	XDIST	Longitudinal Distance to Well		
INFILRAT	Infiltration Rate	YDIST	Distance from Plume Centerline to Well		
INFILRAT	Infiltration Rate	ZDIST	Depth of Well Below Water Table		
INFILRAT	Infiltration Rate	FRCOEFA	Freundlich Isotherm Coefficient		
INFILRAT	Infiltration Rate	INFILRAT	Infiltration Rate	Y	Y
RESIDH2O	Residual Water Content	AVGPDIAM	Avg. Particle Diameter		
RESIDH2O	Residual Water Content	POROSITY	Porosity		
RESIDH2O	Residual Water Content	AQUTHIK	Aquifer Thickness	Y	
RESIDH2O	Residual Water Content	LONHYCON	Longitundinal Hydraulic Conductivity		
RESIDH2O	Residual Water Content	HYDGRAD	Hydraulic Gradient		
RESIDH2O	Residual Water Content	GWSEEPV	Groundwater Seepage Velocity		
RESIDH2O	Residual Water Content	LONDISPA	Longitudinal Dispersivity		
RESIDH2O	Residual Water Content	FRORGCAR	Fraction Organic Carbon		
RESIDH2O	Residual Water Content	ANGLEW	Angle of Well Off Plume Centerline		
RESIDH2O	Residual Water Content	XDIST	Longitudinal Distance to Well		
RESIDH2O	Residual Water Content	YDIST	Distance from Plume Centerline to Well		
RESIDH2O	Residual Water Content	ZDIST	Depth of Well Below Water Table	Y	
RESIDH2O	Residual Water Content	FRCOEFA	Freundlich Isotherm Coefficient		
RESIDH2O	Residual Water Content	INFILRAT	Infiltration Rate		
RESIDH2O	Residual Water Content	RESIDH2O	Residual Water Content		
SATURH2O	Saturated Water Content	AVGPDIAM	Avg. Particle Diameter		
SATURH2O	Saturated Water Content	POROSITY	Porosity		
SATURH2O	Saturated Water Content	AQUTHIK	Aquifer Thickness	Y	
SATURH2O	Saturated Water Content	LONHYCON	Longitundinal Hydraulic Conductivity		
SATURH2O	Saturated Water Content	HYDGRAD	Hydraulic Gradient		
SATURH2O	Saturated Water Content	GWSEEPV	Groundwater Seepage Velocity		
SATURH2O	Saturated Water Content	LONDISPA	Longitudinal Dispersivity		
SATURH2O	Saturated Water Content	FRORGCAR	Fraction Organic Carbon		

Table D-55. Summary of Crosspairs Analysis for Thallium

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
SATURH2O	Saturated Water Content	ANGLEW	Angle of Well Off Plume Centerline		
SATURH2O	Saturated Water Content	XDIST	Longitudinal Distance to Well		
SATURH2O	Saturated Water Content	YDIST	Distance from Plume Centerline to Well		
SATURH2O	Saturated Water Content	ZDIST	Depth of Well Below Water Table	Y	
SATURH2O	Saturated Water Content	FRCOEFA	Freundlich Isotherm Coefficient		
SATURH2O	Saturated Water Content	INFILRAT	Infiltration Rate		
SATURH2O	Saturated Water Content	RESIDH2O	Residual Water Content		
SATURH2O	Saturated Water Content	SATURH2O	Saturated Water Content	Y	
UNSATHIK	Unsaturated Zone Thickness	AVGPDIAM	Avg. Particle Diameter		
UNSATHIK	Unsaturated Zone Thickness	POROSITY	Porosity		
UNSATHIK	Unsaturated Zone Thickness	AQUTHIK	Aquifer Thickness		
UNSATHIK	Unsaturated Zone Thickness	LONHYCON	Longitundinal Hydraulic Conductivity		
UNSATHIK	Unsaturated Zone Thickness	HYDGRAD	Hydraulic Gradient		
UNSATHIK	Unsaturated Zone Thickness	GWSEEPV	Groundwater Seepage Velocity		
UNSATHIK	Unsaturated Zone Thickness	LONDISPA	Longitudinal Dispersivity		
UNSATHIK	Unsaturated Zone Thickness	FRORGCAR	Fraction Organic Carbon		
UNSATHIK	Unsaturated Zone Thickness	ANGLEW	Angle of Well Off Plume Centerline		
UNSATHIK	Unsaturated Zone Thickness	XDIST	Longitudinal Distance to Well		
UNSATHIK	Unsaturated Zone Thickness	YDIST	Distance from Plume Centerline to Well	Y	
UNSATHIK	Unsaturated Zone Thickness	ZDIST	Depth of Well Below Water Table		
UNSATHIK	Unsaturated Zone Thickness	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
UNSATHIK	Unsaturated Zone Thickness	INFILRAT	Infiltration Rate		
UNSATHIK	Unsaturated Zone Thickness	RESIDH2O	Residual Water Content		
UNSATHIK	Unsaturated Zone Thickness	SATURH2O	Saturated Water Content		
UNSATHIK	Unsaturated Zone Thickness	UNSATHIK	Unsaturated Zone Thickness		
PERORGM	Percent Organic Matter	AVGPDIAM	Avg. Particle Diameter		
PERORGM	Percent Organic Matter	POROSITY	Porosity		
PERORGM	Percent Organic Matter	AQUTHIK	Aquifer Thickness		
PERORGM	Percent Organic Matter	LONHYCON	Longitundinal Hydraulic Conductivity		
PERORGM	Percent Organic Matter	HYDGRAD	Hydraulic Gradient		
PERORGM	Percent Organic Matter	GWSEEPV	Groundwater Seepage Velocity		
PERORGM	Percent Organic Matter	LONDISPA	Longitudinal Dispersivity		
PERORGM	Percent Organic Matter	FRORGCAR	Fraction Organic Carbon		
PERORGM	Percent Organic Matter	ANGLEW	Angle of Well Off Plume Centerline		
PERORGM	Percent Organic Matter	XDIST	Longitudinal Distance to Well		
PERORGM	Percent Organic Matter	YDIST	Distance from Plume Centerline to Well		
PERORGM	Percent Organic Matter	ZDIST	Depth of Well Below Water Table		
PERORGM	Percent Organic Matter	FRCOEFA	Freundlich Isotherm Coefficient		
PERORGM	Percent Organic Matter	INFILRAT	Infiltration Rate		
PERORGM	Percent Organic Matter	RESIDH2O	Residual Water Content		
PERORGM	Percent Organic Matter	SATURH2O	Saturated Water Content		
PERORGM	Percent Organic Matter	UNSATHIK	Unsaturated Zone Thickness		
PERORGM	Percent Organic Matter	PERORGM	Percent Organic Matter		
FRCOEFU	Freundlich Isotherm Coefficient	AVGPDIAM	Avg. Particle Diameter		
FRCOEFU	Freundlich Isotherm Coefficient	POROSITY	Porosity		
FRCOEFU	Freundlich Isotherm Coefficient	AQUTHIK	Aquifer Thickness	Y	
FRCOEFU	Freundlich Isotherm Coefficient	LONHYCON	Longitundinal Hydraulic Conductivity		
FRCOEFU	Freundlich Isotherm Coefficient	HYDGRAD	Hydraulic Gradient		
FRCOEFU	Freundlich Isotherm Coefficient	GWSEEPV	Groundwater Seepage Velocity		

Table D-55. Summary of Crosspairs Analysis for Thallium

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
FRCOEFU	Freundlich Isotherm Coefficient	LONDISPA	Longitudinal Dispersivity		
FRCOEFU	Freundlich Isotherm Coefficient	FRORGCAR	Fraction Organic Carbon		
FRCOEFU	Freundlich Isotherm Coefficient	ANGLEW	Angle of Well Off Plume Centerline		
FRCOEFU	Freundlich Isotherm Coefficient	XDIST	Longitudinal Distance to Well	Y	
FRCOEFU	Freundlich Isotherm Coefficient	YDIST	Distance from Plume Centerline to Well		
FRCOEFU	Freundlich Isotherm Coefficient	ZDIST	Depth of Well Below Water Table		
FRCOEFU	Freundlich Isotherm Coefficient	FRCOEFA	Freundlich Isotherm Coefficient		
FRCOEFU	Freundlich Isotherm Coefficient	INFILRAT	Infiltration Rate		
FRCOEFU	Freundlich Isotherm Coefficient	RESIDH2O	Residual Water Content		
FRCOEFU	Freundlich Isotherm Coefficient	SATURH2O	Saturated Water Content		
FRCOEFU	Freundlich Isotherm Coefficient	UNSATHIK	Unsaturated Zone Thickness	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	PERORGM	Percent Organic Matter		
FRCOEFU	Freundlich Isotherm Coefficient	FRCOEFU	Freundlich Isotherm Coefficient	Y	Y

Table D-56. Ranking of Parameters According to Percentage of Risk for Thallium

Variable Description	Reduced Sums of Square	Variable Sums of Square	Variable Degrees of Freedom	% Risk Variation	Mean Square Variable	F VALUE	P VALUE
Distance from Plume Centerline to Well (m)	1236.0	2508.73	33	127271.0%	726.94	254.54	1.46E-01
Consumption of Drinking Water (ml/kg-day)	1719.8	2508.73	33	78891.0%	726.94	788.91	1.46E-01
Freundlich Isotherm Coefficient {Aquifer} (cm3/g)	2104.1	2508.73	33	40464.0%	726.94	50.58	1.46E-01
Longitudinal Dispersivity {Aquifer} (m)	2409.9	2508.73	33	9879.0%	726.94	32.93	1.46E-01
Aquifer Thickness (m)	2414.1	2508.73	33	9459.0%	726.94	31.53	1.46E-01
Longitudinal Distance to Well (m)	2448.5	2508.73	33	6021.0%	726.94	30.11	1.46E-01
Freundlich Isotherm Coefficient {Unsaturated} (cm3/g)	2457.3	2508.73	33	5144.0%	726.94	17.15	1.46E-01
Infiltration Rate (m/yr)	2476.4	2508.73	33	3235.0%	726.94	16.18	1.46E-01
Unsaturated Zone Thickness (m)	2485.1	2508.73	33	2360.0%	726.94	7.87	1.46E-01
Longitudinal Hydraulic Conductivity (m/yr)	2490.4	2508.73	33	1834.0%	726.94	4.59	1.46E-01
Groundwater Seepage Velocity (m/yr)	2498.3	2508.73	33	1040.0%	726.94	5.20	1.46E-01
Hydraluic Gradient (m/m)	2500.6	2508.73	33	815.0%	726.94	4.08	1.46E-01
Porosity (unitless)	2503.3	2508.73	33	548.0%	726.94	5.48	1.46E-01
Depth of Well below Water Table (m)	2505.0	2508.73	33	372.0%	726.94	1.86	1.46E-01
Fraction Organic Carbon (g/g)	2506.2	2508.73	33	255.0%	726.94	1.27	1.46E-01
Average Particle Diameter (cm)	2506.7	2508.73	33	200.0%	726.94	2.00	1.46E-01

Constants

Full Model SS	28
Error SS	5
Error DF	0
MS Error	4966

Table D-57. Chemical-Specific Properties for Constituents of Concern for the Combined Sulfate and Chloride Wastewaters Millennium HPP

Waste Constituent Concentrations	
Constituent	**SPLP filtrate (SI) (mg/L)**
Manganese	9.95
Arsenic	*0.0025*

underline italics indicate values set at 1/2 of detection limit

Table D-58. Waste Management Unit Parameters for Onsite Surface Impoundment Managing Combined Sulfate and Chloride Wastewaters

WMU	Location	Surface Impoundment Area (m^2)	Depth of Water Column (m)	Depth of Sludge Layer (m)	Wastewater Throughput (Mt/yr)	Particle Density (g/cm^3)
Onsite Surface Impoundment	Baltimore, MD	450,000	1.8	1 to 0.2	2,961,801	2.6

Table D-59. Intentionally omitted

Table D-60. Site-Specific Climate-Based Parameters for Onsite Surface Impoundment Managing Combined Sulfate and Chloride Wastewaters Millennium HPP

				Recharge Rate (m/yr)				GWpH		
WMU	Location	Climate Index	Climate Center	SCL	SLT	SNL	GW TempC	SCL	SLT	SNL
Onsite Surface Impoundment	Baltimore, MD	71	Philadelphia, PA	0.16	0.20	0.26	13	4.5	4.3	4.8

Table D-61. Aquifer Types Common in Area of Onsite Surface Impoundment Currently Managing Combined Sulfate and Chloride Wastewaters Millennium HPP

Aquifer Types	Aquifer Code	Baltimore, MD
Unconsolidated and semiconsolidated shallow aquifers	10	100%

Table D-62. Soil Textures Common in Area of Onsite Surface Impoundment Currently Managing Combined Sulfate and Chloride Wastewaters Millennium HPP

	Soil Code	Baltimore, MD
silty clay loam	SCL	39%
silt loam	SIL	25%
sandy loam	SNL	32%

Table D-63. Summary of Parameters Considered in Sensitivity Analysis for Arsenic

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
EXPDURA					
CANSLOPE		C			
ACIDCAT	Acid Catalyzed Hydrolysis Rate Constant	C			
ANGLEW	Angle of Well Off Plume Centerline	anglew		Y	Y
ANISORAT	Anisotropy Ratio	C			
AQUTHIK	Aquifer Thickness	log(aquthik)		Y	Y
AVGPDIAM	Avg. Particle Diameter	log(avgpdiam+0.001)		Y	Y
BASECAT	Base Catalyzed Hydrolysis Rate Constant	C			
BIODRATA	Biodegradation Rate	C			
BIODRATU	Biodegradation Rate	C			
BULKDENS	Bulk Density	bulkdens**3.5	Y		
CHEMDRU	Chemical Decay Rate	C			
CHEMDRA	Chemical Decay Rate	C			
CONSH2OA	Consump of drinking water	log(consh2oa)			Y
ZDIST	Depth of Well Below Water Table	log(zdist+100)		Y	
DISHYD	Dissolved Hydrolysis Rate	C			
YDIST	Distance from Plume Centerline to Well	log(ydist+200)		Y	Y
DURLEACH	Duration of Leaching Period	C			
GWAVTIM	Exposure Duration	gwavtim			
FRORGCAR	Fraction Organic Carbon	log(frorgcar)		Y	
FRCOEFA	Freundlich Isotherm Coefficient	log(frcoefa+0.1)		Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	log(frcoefu+1)		Y	Y
FREXPA	Freundlich Isotherm Exponent	C			
FREXPU	Freundlich Isotherm Exponent	C			
GWPH	Groundwater pH	gwph	Y		
GWSEEPV	Groundwater Seepage Velocity	log(gwseepv+3)	Y		
GWTEMP	Groundwater Temperature	C			
HYDGRAD	Hydraulic Gradient	log(hydgrad+0.003)		Y	Y
INFILRAT	Infiltration Rate	log(infilrat+0.5)		Y	Y
LANDEPTH	Landfill Depth	C			
LEACHCON	Leachate Concentration	C			
LFFRACT	LF Fraction	C			
LONDISPA	Longitudinal Dispersivity	log(londispa+10)		Y	Y

Table D-63. Summary of Parameters Considered in Sensitivity Analysis for Arsenic

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
LONDISPU	Longitudinal Dispersivity	log(londispu-0.017)	Y		
XDIST	Longitudinal Distance to Well	log(xdist+500000)		Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity	log(lonhycon+800)		Y	Y
MOISTRPA	Moisture Rention Parameter (a)	log(moistrpa)	Y		
MOISTRPB	Moisture Rention Parameter (b)	log(moistrpb-0.8)	Y		
MOLDIFF	Molecular Diffusion Coefficient	C			
NEUTHYD	Neutral Hydrolysis Rate Constant	C			
ORGCDIS	Organic Carbon Distribution Coefficient	C			
PERORGM	Percent Organic Matter	log(perorgm)		Y	Y
POROSITY	Porosity	porosity**1.1		Y	
RADISTW	Radial Distance to Well	log(radistw+250)	Y		
RECHARAT	Recharge Rate	recharat			
RESIDH2O	Residual Water Content	residh2o**1.7		Y	
RETCOEF	Retardation Coefficient	log(retcoef-0.5)	Y		
SATHYCON	Saturated Hydraulic Conductivity	log(sathycon+0.05)	Y		
SATURH2O	Saturated Water Content	saturh2o		Y	Y
SOILBDEN	Soil Bulk Density	soilbden	Y		
SORBHYD	Sorbed Hydrolysis Rate	C			
TRANDISP	Transverse Dispersivity	log(trandisp+1)	Y		
UNSATHIK	Unsaturated Zone Thickness	log(unsathik-0.3)		Y	Y
VERTDISP	Vertical Dispersivity	log(vertdisp+0.1)	Y		
WASTDENS	Waste Density	C			
WASTEVOL	Waste Volume	C			
WMUAREA	WMU Area	C			
WMULEN	WMU Length	C			
WMUWIDTH	WMU Width	C			

Table D-64. Summary of Correlated Parameters for Arsenic

Variable 1		Variable 2		Correlation Coefficient
Code	**Description**	**Code**	**Description**	
AVGPDIAM	Avg. Particle Diameter	BULKDENS	Bulk Density	0.99825
LONHYCON	Longitundinal Hydraulic Conductivi	GWSEEPV	Groundwater Seepage Velocity	0.88746
FRCOEFA	Freundlich Isotherm Coefficient	RETCOEF	Retardation Coefficient	0.98772
AVRECWF	Average Receptor Well Concentrati	RETCOEF	Retardation Coefficient	-0.7222
LONDISPA	Longitudinal Dispersivity	TRANDISP	Transverse Dispersivity	0.99983
LONDISPA	Longitudinal Dispersivity	VERTDISP	Vertical Dispersivity	0.99919
RECHARAT	Recharge Rate	GWPH	Groundwater pH	0.79984
MOISTRPA	Moisture Rention Parameter (a)	GWPH	Groundwater pH	0.71138
MOISTRPB	Moisture Rention Parameter (b)	GWPH	Groundwater pH	0.7578
SATURH2O	Saturated Water Content	GWPH	Groundwater pH	-0.97867
SOILBDEN	Soil Bulk Density	GWPH	Groundwater pH	-0.85213
XDIST	Longitudinal Distance to Well	RADISTW	Radial Distance to Well	0.94718
SOILBDEN	Soil Bulk Density	RECHARAT	Recharge Rate	-0.99568
RECHARAT	Recharge Rate	SATHYCON	Saturated Hydraulic Conductivity	0.8181
INFILRAT	Infiltration Rate	SATHYCON	Saturated Hydraulic Conductivity	0.71558
MOISTRPB	Moisture Rention Parameter (b)	SATHYCON	Saturated Hydraulic Conductivity	0.75921
RECHARAT	Recharge Rate	MOISTRPA	Moisture Rention Parameter (a)	0.83759
MOISTRPB	Moisture Rention Parameter (b)	MOISTRPA	Moisture Rention Parameter (a)	0.77712
RECHARAT	Recharge Rate	MOISTRPB	Moisture Rention Parameter (b)	0.92844
SATHYCON	Saturated Hydraulic Conductivity	MOISTRPB	Moisture Rention Parameter (b)	0.75921
SOILBDEN	Soil Bulk Density	SATURH2O	Saturated Water Content	0.72643
UNSATHIK	Unsaturated Zone Thickness	LONDISPU	Longitudinal Dispersivity	0.99995
RECHARAT	Recharge Rate	SOILBDEN	Soil Bulk Density	-0.99568
SATHYCON	Saturated Hydraulic Conductivity	SOILBDEN	Soil Bulk Density	-0.81393
MOISTRPA	Moisture Rention Parameter (a)	SOILBDEN	Soil Bulk Density	-0.84039
MOISTRPB	Moisture Rention Parameter (b)	SOILBDEN	Soil Bulk Density	-0.92678
SATURH2O	Saturated Water Content	SOILBDEN	Soil Bulk Density	0.72643
RETCOEF	Retardation Coefficient	AVRECWF	Average Receptor Well Concentr	-0.7222
FRCOEFA	Freundlich Isotherm Coefficient	AVRECWF	Average Receptor Well Concentr	-0.73415
RETCOEF	Retardation Coefficient	DRH2OCNA	drinking water well conc	-0.7222
FRCOEFA	Freundlich Isotherm Coefficient	DRH2OCNA	drinking water well conc	-0.73415

Note: Parameters in the variable 2 column were removed from the analysis.

Table D-65. Summary of Crosspairs Analysis for Arsenic

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
AVGPDIAM	Avg. Particle Diameter			Y	Y
POROSITY	Porosity				
AQUTHIK	Aquifer Thickness			Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity			Y	Y
HYDGRAD	Hydraulic Gradient			Y	Y
LONDISPA	Longitudinal Dispersivity			Y	Y
FRORGCAR	Fraction Organic Carbon				
ANGLEW	Angle of Well Off Plume Centerline				
XDIST	Longitudinal Distance to Well			Y	Y
YDIST	Distance from Plume Centerline to Well			Y	Y
ZDIST	Depth of Well Below Water Table				
FRCOEFA	Freundlich Isotherm Coefficient			Y	Y
GWAVTIM	Exposure Duration				
RECHARAT	Recharge Rate				
INFILRAT	Infiltration Rate			Y	Y
RESIDH2O	Residual Water Content				
SATURH2O	Saturated Water Content			Y	Y
UNSATHIK	Unsaturated Zone Thickness			Y	Y
PERORGM	Percent Organic Matter				
FRCOEFU	Freundlich Isotherm Coefficient			Y	Y
AVGPDIAM	Avg. Particle Diameter	AVGPDIAM	Avg. Particle Diameter		
POROSITY	Porosity	AVGPDIAM	Avg. Particle Diameter		
POROSITY	Porosity	POROSITY	Porosity		
AQUTHIK	Aquifer Thickness	AVGPDIAM	Avg. Particle Diameter		
AQUTHIK	Aquifer Thickness	POROSITY	Porosity		
AQUTHIK	Aquifer Thickness	AQUTHIK	Aquifer Thickness		
LONHYCON	Longitundinal Hydraulic Conductivity	AVGPDIAM	Avg. Particle Diameter		
LONHYCON	Longitundinal Hydraulic Conductivity	POROSITY	Porosity		
LONHYCON	Longitundinal Hydraulic Conductivity	AQUTHIK	Aquifer Thickness	Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity	LONHYCON	Longitundinal Hydraulic Conductivity		
HYDGRAD	Hydraulic Gradient	AVGPDIAM	Avg. Particle Diameter		
HYDGRAD	Hydraulic Gradient	POROSITY	Porosity		
HYDGRAD	Hydraulic Gradient	AQUTHIK	Aquifer Thickness		
HYDGRAD	Hydraulic Gradient	LONHYCON	Longitundinal Hydraulic Conductivity		
HYDGRAD	Hydraulic Gradient	HYDGRAD	Hydraulic Gradient		
LONDISPA	Longitudinal Dispersivity	AVGPDIAM	Avg. Particle Diameter		
LONDISPA	Longitudinal Dispersivity	POROSITY	Porosity		
LONDISPA	Longitudinal Dispersivity	AQUTHIK	Aquifer Thickness	Y	
LONDISPA	Longitudinal Dispersivity	LONHYCON	Longitundinal Hydraulic Conductivity	Y	
LONDISPA	Longitudinal Dispersivity	HYDGRAD	Hydraulic Gradient		
LONDISPA	Longitudinal Dispersivity	LONDISPA	Longitudinal Dispersivity		
FRORGCAR	Fraction Organic Carbon	AVGPDIAM	Avg. Particle Diameter		
FRORGCAR	Fraction Organic Carbon	POROSITY	Porosity		
FRORGCAR	Fraction Organic Carbon	AQUTHIK	Aquifer Thickness	Y	
FRORGCAR	Fraction Organic Carbon	LONHYCON	Longitundinal Hydraulic Conductivity		
FRORGCAR	Fraction Organic Carbon	HYDGRAD	Hydraulic Gradient		
FRORGCAR	Fraction Organic Carbon	LONDISPA	Longitudinal Dispersivity		
FRORGCAR	Fraction Organic Carbon	FRORGCAR	Fraction Organic Carbon		
ANGLEW	Angle of Well Off Plume Centerline	AVGPDIAM	Avg. Particle Diameter		

Table D-65. Summary of Crosspairs Analysis for Arsenic

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
ANGLEW	Angle of Well Off Plume Centerline	POROSITY	Porosity		
ANGLEW	Angle of Well Off Plume Centerline	AQUTHIK	Aquifer Thickness		
ANGLEW	Angle of Well Off Plume Centerline	LONHYCON	Longitundinal Hydraulic Conductivity		
ANGLEW	Angle of Well Off Plume Centerline	HYDGRAD	Hydraulic Gradient		
ANGLEW	Angle of Well Off Plume Centerline	LONDISPA	Longitudinal Dispersivity		
ANGLEW	Angle of Well Off Plume Centerline	FRORGCAR	Fraction Organic Carbon		
ANGLEW	Angle of Well Off Plume Centerline	ANGLEW	Angle of Well Off Plume Centerline		
XDIST	Longitudinal Distance to Well	AVGPDIAM	Avg. Particle Diameter	Y	Y
XDIST	Longitudinal Distance to Well	POROSITY	Porosity		
XDIST	Longitudinal Distance to Well	AQUTHIK	Aquifer Thickness		
XDIST	Longitudinal Distance to Well	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
XDIST	Longitudinal Distance to Well	HYDGRAD	Hydraulic Gradient		
XDIST	Longitudinal Distance to Well	LONDISPA	Longitudinal Dispersivity	Y	Y
XDIST	Longitudinal Distance to Well	FRORGCAR	Fraction Organic Carbon	Y	
XDIST	Longitudinal Distance to Well	ANGLEW	Angle of Well Off Plume Centerline		
XDIST	Longitudinal Distance to Well	XDIST	Longitudinal Distance to Well		
YDIST	Distance from Plume Centerline to Well	AVGPDIAM	Avg. Particle Diameter	Y	
YDIST	Distance from Plume Centerline to Well	POROSITY	Porosity		
YDIST	Distance from Plume Centerline to Well	AQUTHIK	Aquifer Thickness	Y	Y
YDIST	Distance from Plume Centerline to Well	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
YDIST	Distance from Plume Centerline to Well	HYDGRAD	Hydraulic Gradient		
YDIST	Distance from Plume Centerline to Well	LONDISPA	Longitudinal Dispersivity	Y	Y
YDIST	Distance from Plume Centerline to Well	FRORGCAR	Fraction Organic Carbon		
YDIST	Distance from Plume Centerline to Well	ANGLEW	Angle of Well Off Plume Centerline		
YDIST	Distance from Plume Centerline to Well	XDIST	Longitudinal Distance to Well	Y	Y
YDIST	Distance from Plume Centerline to Well	YDIST	Distance from Plume Centerline to Well	Y	Y
ZDIST	Depth of Well Below Water Table	AVGPDIAM	Avg. Particle Diameter	Y	
ZDIST	Depth of Well Below Water Table	POROSITY	Porosity		
ZDIST	Depth of Well Below Water Table	AQUTHIK	Aquifer Thickness		
ZDIST	Depth of Well Below Water Table	LONHYCON	Longitundinal Hydraulic Conductivity		
ZDIST	Depth of Well Below Water Table	HYDGRAD	Hydraulic Gradient		
ZDIST	Depth of Well Below Water Table	LONDISPA	Longitudinal Dispersivity		
ZDIST	Depth of Well Below Water Table	FRORGCAR	Fraction Organic Carbon		
ZDIST	Depth of Well Below Water Table	ANGLEW	Angle of Well Off Plume Centerline		
ZDIST	Depth of Well Below Water Table	XDIST	Longitudinal Distance to Well		
ZDIST	Depth of Well Below Water Table	YDIST	Distance from Plume Centerline to Well		
ZDIST	Depth of Well Below Water Table	ZDIST	Depth of Well Below Water Table		
FRCOEFA	Freundlich Isotherm Coefficient	AVGPDIAM	Avg. Particle Diameter	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	POROSITY	Porosity		
FRCOEFA	Freundlich Isotherm Coefficient	AQUTHIK	Aquifer Thickness	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	HYDGRAD	Hydraulic Gradient	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	LONDISPA	Longitudinal Dispersivity	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	FRORGCAR	Fraction Organic Carbon		
FRCOEFA	Freundlich Isotherm Coefficient	ANGLEW	Angle of Well Off Plume Centerline		
FRCOEFA	Freundlich Isotherm Coefficient	XDIST	Longitudinal Distance to Well	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	YDIST	Distance from Plume Centerline to Well	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	ZDIST	Depth of Well Below Water Table		
FRCOEFA	Freundlich Isotherm Coefficient	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y

Table D-65. Summary of Crosspairs Analysis for Arsenic

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
GWAVTIM	Exposure Duration	AVGPDIAM	Avg. Particle Diameter		
GWAVTIM	Exposure Duration	POROSITY	Porosity		
GWAVTIM	Exposure Duration	AQUTHIK	Aquifer Thickness		
GWAVTIM	Exposure Duration	LONHYCON	Longitundinal Hydraulic Conductivity		
GWAVTIM	Exposure Duration	HYDGRAD	Hydraulic Gradient		
GWAVTIM	Exposure Duration	LONDISPA	Longitudinal Dispersivity		
GWAVTIM	Exposure Duration	FRORGCAR	Fraction Organic Carbon		
GWAVTIM	Exposure Duration	ANGLEW	Angle of Well Off Plume Centerline		
GWAVTIM	Exposure Duration	XDIST	Longitudinal Distance to Well		
GWAVTIM	Exposure Duration	YDIST	Distance from Plume Centerline to Well		
GWAVTIM	Exposure Duration	ZDIST	Depth of Well Below Water Table		
GWAVTIM	Exposure Duration	FRCOEFA	Freundlich Isotherm Coefficient		
GWAVTIM	Exposure Duration	GWAVTIM	Exposure Duration		
RECHARAT	Recharge Rate	AVGPDIAM	Avg. Particle Diameter		
RECHARAT	Recharge Rate	POROSITY	Porosity		
RECHARAT	Recharge Rate	AQUTHIK	Aquifer Thickness		
RECHARAT	Recharge Rate	LONHYCON	Longitundinal Hydraulic Conductivity		
RECHARAT	Recharge Rate	HYDGRAD	Hydraulic Gradient		
RECHARAT	Recharge Rate	LONDISPA	Longitudinal Dispersivity		
RECHARAT	Recharge Rate	FRORGCAR	Fraction Organic Carbon		
RECHARAT	Recharge Rate	ANGLEW	Angle of Well Off Plume Centerline		
RECHARAT	Recharge Rate	XDIST	Longitudinal Distance to Well		
RECHARAT	Recharge Rate	YDIST	Distance from Plume Centerline to Well		
RECHARAT	Recharge Rate	ZDIST	Depth of Well Below Water Table		
RECHARAT	Recharge Rate	FRCOEFA	Freundlich Isotherm Coefficient		
RECHARAT	Recharge Rate	GWAVTIM	Exposure Duration		
RECHARAT	Recharge Rate	RECHARAT	Recharge Rate		
INFILRAT	Infiltration Rate	AVGPDIAM	Avg. Particle Diameter		
INFILRAT	Infiltration Rate	POROSITY	Porosity		
INFILRAT	Infiltration Rate	AQUTHIK	Aquifer Thickness		
INFILRAT	Infiltration Rate	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
INFILRAT	Infiltration Rate	HYDGRAD	Hydraulic Gradient		
INFILRAT	Infiltration Rate	LONDISPA	Longitudinal Dispersivity		
INFILRAT	Infiltration Rate	FRORGCAR	Fraction Organic Carbon		
INFILRAT	Infiltration Rate	ANGLEW	Angle of Well Off Plume Centerline		
INFILRAT	Infiltration Rate	XDIST	Longitudinal Distance to Well		
INFILRAT	Infiltration Rate	YDIST	Distance from Plume Centerline to Well		
INFILRAT	Infiltration Rate	ZDIST	Depth of Well Below Water Table		
INFILRAT	Infiltration Rate	FRCOEFA	Freundlich Isotherm Coefficient		
INFILRAT	Infiltration Rate	GWAVTIM	Exposure Duration		
INFILRAT	Infiltration Rate	RECHARAT	Recharge Rate		
INFILRAT	Infiltration Rate	INFILRAT	Infiltration Rate	Y	Y
RESIDH2O	Residual Water Content	AVGPDIAM	Avg. Particle Diameter		
RESIDH2O	Residual Water Content	POROSITY	Porosity		
RESIDH2O	Residual Water Content	AQUTHIK	Aquifer Thickness	Y	
RESIDH2O	Residual Water Content	LONHYCON	Longitundinal Hydraulic Conductivity		
RESIDH2O	Residual Water Content	HYDGRAD	Hydraulic Gradient		
RESIDH2O	Residual Water Content	LONDISPA	Longitudinal Dispersivity		
RESIDH2O	Residual Water Content	FRORGCAR	Fraction Organic Carbon		

Table D-65. Summary of Crosspairs Analysis for Arsenic

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
RESIDH2O	Residual Water Content	ANGLEW	Angle of Well Off Plume Centerline		
RESIDH2O	Residual Water Content	XDIST	Longitudinal Distance to Well		
RESIDH2O	Residual Water Content	YDIST	Distance from Plume Centerline to Well		
RESIDH2O	Residual Water Content	ZDIST	Depth of Well Below Water Table		
RESIDH2O	Residual Water Content	FRCOEFA	Freundlich Isotherm Coefficient		
RESIDH2O	Residual Water Content	GWAVTIM	Exposure Duration		
RESIDH2O	Residual Water Content	RECHARAT	Recharge Rate		
RESIDH2O	Residual Water Content	INFILRAT	Infiltration Rate		
RESIDH2O	Residual Water Content	RESIDH2O	Residual Water Content		
SATURH2O	Saturated Water Content	AVGPDIAM	Avg. Particle Diameter		
SATURH2O	Saturated Water Content	POROSITY	Porosity		
SATURH2O	Saturated Water Content	AQUTHIK	Aquifer Thickness		
SATURH2O	Saturated Water Content	LONHYCON	Longitundinal Hydraulic Conductivity		
SATURH2O	Saturated Water Content	HYDGRAD	Hydraulic Gradient		
SATURH2O	Saturated Water Content	LONDISPA	Longitudinal Dispersivity		
SATURH2O	Saturated Water Content	FRORGCAR	Fraction Organic Carbon		
SATURH2O	Saturated Water Content	ANGLEW	Angle of Well Off Plume Centerline		
SATURH2O	Saturated Water Content	XDIST	Longitudinal Distance to Well		
SATURH2O	Saturated Water Content	YDIST	Distance from Plume Centerline to Well		
SATURH2O	Saturated Water Content	ZDIST	Depth of Well Below Water Table		
SATURH2O	Saturated Water Content	FRCOEFA	Freundlich Isotherm Coefficient		
SATURH2O	Saturated Water Content	GWAVTIM	Exposure Duration		
SATURH2O	Saturated Water Content	RECHARAT	Recharge Rate		
SATURH2O	Saturated Water Content	INFILRAT	Infiltration Rate		
SATURH2O	Saturated Water Content	RESIDH2O	Residual Water Content		
SATURH2O	Saturated Water Content	SATURH2O	Saturated Water Content		
UNSATHIK	Unsaturated Zone Thickness	AVGPDIAM	Avg. Particle Diameter		
UNSATHIK	Unsaturated Zone Thickness	POROSITY	Porosity	Y	
UNSATHIK	Unsaturated Zone Thickness	AQUTHIK	Aquifer Thickness		
UNSATHIK	Unsaturated Zone Thickness	LONHYCON	Longitundinal Hydraulic Conductivity		
UNSATHIK	Unsaturated Zone Thickness	HYDGRAD	Hydraulic Gradient		
UNSATHIK	Unsaturated Zone Thickness	LONDISPA	Longitudinal Dispersivity		
UNSATHIK	Unsaturated Zone Thickness	FRORGCAR	Fraction Organic Carbon	Y	
UNSATHIK	Unsaturated Zone Thickness	ANGLEW	Angle of Well Off Plume Centerline	Y	Y
UNSATHIK	Unsaturated Zone Thickness	XDIST	Longitudinal Distance to Well		
UNSATHIK	Unsaturated Zone Thickness	YDIST	Distance from Plume Centerline to Well		
UNSATHIK	Unsaturated Zone Thickness	ZDIST	Depth of Well Below Water Table		
UNSATHIK	Unsaturated Zone Thickness	FRCOEFA	Freundlich Isotherm Coefficient		
UNSATHIK	Unsaturated Zone Thickness	GWAVTIM	Exposure Duration		
UNSATHIK	Unsaturated Zone Thickness	RECHARAT	Recharge Rate		
UNSATHIK	Unsaturated Zone Thickness	INFILRAT	Infiltration Rate		
UNSATHIK	Unsaturated Zone Thickness	RESIDH2O	Residual Water Content		
UNSATHIK	Unsaturated Zone Thickness	SATURH2O	Saturated Water Content	Y	
UNSATHIK	Unsaturated Zone Thickness	UNSATHIK	Unsaturated Zone Thickness		
PERORGM	Percent Organic Matter	AVGPDIAM	Avg. Particle Diameter		
PERORGM	Percent Organic Matter	POROSITY	Porosity		
PERORGM	Percent Organic Matter	AQUTHIK	Aquifer Thickness		
PERORGM	Percent Organic Matter	LONHYCON	Longitundinal Hydraulic Conductivity		
PERORGM	Percent Organic Matter	HYDGRAD	Hydraulic Gradient		

Table D-65. Summary of Crosspairs Analysis for Arsenic

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
PERORGM	Percent Organic Matter	LONDISPA	Longitudinal Dispersivity		
PERORGM	Percent Organic Matter	FRORGCAR	Fraction Organic Carbon		
PERORGM	Percent Organic Matter	ANGLEW	Angle of Well Off Plume Centerline		
PERORGM	Percent Organic Matter	XDIST	Longitudinal Distance to Well		
PERORGM	Percent Organic Matter	YDIST	Distance from Plume Centerline to Well		
PERORGM	Percent Organic Matter	ZDIST	Depth of Well Below Water Table		
PERORGM	Percent Organic Matter	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
PERORGM	Percent Organic Matter	GWAVTIM	Exposure Duration		
PERORGM	Percent Organic Matter	RECHARAT	Recharge Rate		
PERORGM	Percent Organic Matter	INFILRAT	Infiltration Rate		
PERORGM	Percent Organic Matter	RESIDH2O	Residual Water Content		
PERORGM	Percent Organic Matter	SATURH2O	Saturated Water Content		
PERORGM	Percent Organic Matter	UNSATHIK	Unsaturated Zone Thickness		
PERORGM	Percent Organic Matter	PERORGM	Percent Organic Matter		
FRCOEFU	Freundlich Isotherm Coefficient	AVGPDIAM	Avg. Particle Diameter		
FRCOEFU	Freundlich Isotherm Coefficient	POROSITY	Porosity		
FRCOEFU	Freundlich Isotherm Coefficient	AQUTHIK	Aquifer Thickness		
FRCOEFU	Freundlich Isotherm Coefficient	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	HYDGRAD	Hydraulic Gradient		
FRCOEFU	Freundlich Isotherm Coefficient	LONDISPA	Longitudinal Dispersivity	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	FRORGCAR	Fraction Organic Carbon		
FRCOEFU	Freundlich Isotherm Coefficient	ANGLEW	Angle of Well Off Plume Centerline	Y	
FRCOEFU	Freundlich Isotherm Coefficient	XDIST	Longitudinal Distance to Well		
FRCOEFU	Freundlich Isotherm Coefficient	YDIST	Distance from Plume Centerline to Well		
FRCOEFU	Freundlich Isotherm Coefficient	ZDIST	Depth of Well Below Water Table		
FRCOEFU	Freundlich Isotherm Coefficient	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	GWAVTIM	Exposure Duration		
FRCOEFU	Freundlich Isotherm Coefficient	RECHARAT	Recharge Rate		
FRCOEFU	Freundlich Isotherm Coefficient	INFILRAT	Infiltration Rate	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	RESIDH2O	Residual Water Content		
FRCOEFU	Freundlich Isotherm Coefficient	SATURH2O	Saturated Water Content	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	UNSATHIK	Unsaturated Zone Thickness	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	PERORGM	Percent Organic Matter		
FRCOEFU	Freundlich Isotherm Coefficient	FRCOEFU	Freundlich Isotherm Coefficient	Y	Y

Table D-66. Ranking of Parameters According to Percentage of Risk for Arsenic

Variable Description	Reduced Sums of Square	Variable Sums of Square	Variable Degrees of Freedom	% Risk Variation	Mean Square Variable	F VALUE	P VALUE
Freundlich Isotherm Coefficient {Aquifer} (cm3/g)	38271.2	238443.30	44	20017210.0%	27968.27	18197.46	5.64E+00
Freundlich Isotherm Coefficient {Unsaturated} (cm3/g)	187808.5	238443.30	44	5063477.0%	27968.27	6329.35	5.64E+00
Distance from Plume Centerline to Well (m)	229221.2	238443.30	44	922206.0%	27968.27	1317.44	5.64E+00
Longitudinal Dispersivity {Aquifer} (m)	231239.5	238443.30	44	720382.0%	27968.27	1440.76	5.64E+00
Infiltration Rate (m/yr)	231263.1	238443.30	44	718020.0%	27968.27	1795.05	5.64E+00
Longitudinal Hydraulic Conductivity (m/yr)	232969.1	238443.30	44	547421.0%	27968.27	782.03	5.64E+00
Aquifer Thickness (m)	235190.3	238443.30	44	325300.0%	27968.27	813.25	5.64E+00
Longitudinal Distance to Well (m)	235230.2	238443.30	44	321307.0%	27968.27	535.51	5.64E+00
Exposure Duration (yr)	236878.0	238443.30	44	156527.0%	27968.27	1565.27	5.64E+00
Consumption of Drinking Water (ml/kg-day)	237608.3	238443.30	44	83501.0%	27968.27	835.01	5.64E+00
Unsaturated Zone Thickness (m)	237825.4	238443.30	44	61794.0%	27968.27	205.98	5.64E+00
Average Particle Diameter (cm)	237834.2	238443.30	44	60911.0%	27968.27	203.04	5.64E+00
Hydraulic Gradient (m/m)	238331.9	238443.30	44	11142.0%	27968.27	55.71	5.64E+00
Saturated Water Content	238332.4	238443.30	44	11088.0%	27968.27	55.44	5.64E+00
Percent Organic Matter	238387.7	238443.30	44	5556.0%	27968.27	27.78	5.64E+00
Angle of Well Off Plume Centerline (degrees)	238394.3	238443.30	44	4901.0%	27968.27	24.50	5.64E+00

Constants

Full Model SS	33
Error SS	11
Error DF	1
MS Error	4955

Table D-67. Summary of Parameters Considered in Sensitivity Analysis for Manganese

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
EXPDURA		C			
CANSLOPE		C			
ACIDCAT	Acid Catalyzed Hydrolysis Rate Constant	C			
ANGLEW	Angle of Well Off Plume Centerline	anglew		Y	
ANISORAT	Anisotropy Ratio	C			
AQUTHIK	Aquifer Thickness	log(aquthik)		Y	Y
AVGPDIAM	Avg. Particle Diameter	log(avgpdiam+0.001)		Y	Y
BASECAT	Base Catalyzed Hydrolysis Rate Constant	C			
BIODRATA	Biodegradation Rate	C			
BIODRATU	Biodegradation Rate	C			
BULKDENS	Bulk Density	bulkdens**3.5	Y		
CHEMDRU	Chemical Decay Rate	C			
CHEMDRA	Chemical Decay Rate	C			
CONSH2OA	Consump of drinking water	log(consh2oa)			Y
ZDIST	Depth of Well Below Water Table	log(zdist+100)		Y	Y
DISHYD	Dissolved Hydrolysis Rate	C			
YDIST	Distance from Plume Centerline to Well	log(ydist+200)		Y	Y
DURLEACH	Duration of Leaching Period	C			
GWAVTIM	Exposure Duration	C			
FRORGCAR	Fraction Organic Carbon	log(frorgcar)			
FRCOEFA	Freundlich Isotherm Coefficient	log(frcoefa-31)		Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	log(frcoefu-30)		Y	Y
FREXPA	Freundlich Isotherm Exponent	C			
FREXPU	Freundlich Isotherm Exponent	C			
GWPH	Groundwater pH	gwph	Y		
GWSEEPV	Groundwater Seepage Velocity	log(gwseepv+3)	Y		
GWTEMP	Groundwater Temperature	C			
HYDGRAD	Hydraulic Gradient	log(hydgrad+0.003)		Y	Y
INFILRAT	Infiltration Rate	log(infilrat+0.5)		Y	Y
LANDEPTH	Landfill Depth	C			
LEACHCON	Leachate Concentration	C			
LFFRACT	LF Fraction	C			
LONDISPA	Longitudinal Dispersivity	log(londispa+10)		Y	Y

Table D-67. Summary of Parameters Considered in Sensitivity Analysis for Manganese

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
LONDISPU	Longitudinal Dispersivity	log(londispu-0.017)	Y		
XDIST	Longitudinal Distance to Well	log(xdist+50000000)		Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity	log(lonhycon+800)		Y	Y
MOISTRPA	Moisture Rention Parameter (a)	log(moistrpa)	Y		
MOISTRPB	Moisture Rention Parameter (b)	log(moistrpb-0.8)	Y		
MOLDIFF	Molecular Diffusion Coefficient	C			
NEUTHYD	Neutral Hydrolysis Rate Constant	C			
ORGCDIS	Organic Carbon Distribution Coefficient	C			
PERORGM	Percent Organic Matter	log(perorgm)		Y	
POROSITY	Porosity	porosity**1.3		Y	
RADISTW	Radial Distance to Well	log(radistw+250)	Y		
RECHARAT	Recharge Rate	recharat		Y	Y
RESIDH2O	Residual Water Content	residh2o**1.7			
RETCOEF	Retardation Coefficient	log(retcoef-95)	Y		
SATHYCON	Saturated Hydraulic Conductivity	log(sathycon+0.05)	Y		
SATURH2O	Saturated Water Content	saturh2o			
SOILBDEN	Soil Bulk Density	soilbden	Y		
SORBHYD	Sorbed Hydrolysis Rate	C			
TRANDISP	Transverse Dispersivity	log(trandisp+1)	Y		
UNSATHIK	Unsaturated Zone Thickness	log(unsathik-0.3)		Y	
VERTDISP	Vertical Dispersivity	log(vertdisp+0.1)	Y		
WASTDENS	Waste Density	C			
WASTEVOL	Waste Volume	C			
WMUAREA	WMU Area	C			
WMULEN	WMU Length	C			
WMUWIDTH	WMU Width	C			

Table D-68. Summary of Correlated Parameters for Manganese

Variable 1		Variable 2		Correlation Coefficient
Code	**Description**	**Code**	**Description**	
AVGPDIAM	Avg. Particle Diameter	BULKDENS	Bulk Density	0.99827
LONHYCON	Longitundinal Hydraulic Conductivi	GWSEEPV	Groundwater Seepage Velocity	0.87635
FRCOEFA	Freundlich Isotherm Coefficient	RETCOEF	Retardation Coefficient	0.77483
LONDISPA	Longitudinal Dispersivity	TRANDISP	Transverse Dispersivity	0.99981
LONDISPA	Longitudinal Dispersivity	VERTDISP	Vertical Dispersivity	0.9991
RECHARAT	Recharge Rate	GWPH	Groundwater pH	0.79894
MOISTRPA	Moisture Rention Parameter (a)	GWPH	Groundwater pH	0.71147
MOISTRPB	Moisture Rention Parameter (b)	GWPH	Groundwater pH	0.7546
SATURH2O	Saturated Water Content	GWPH	Groundwater pH	-0.97883
SOILBDEN	Soil Bulk Density	GWPH	Groundwater pH	-0.85164
XDIST	Longitudinal Distance to Well	RADISTW	Radial Distance to Well	0.95798
SOILBDEN	Soil Bulk Density	RECHARAT	Recharge Rate	-0.99563
RECHARAT	Recharge Rate	SATHYCON	Saturated Hydraulic Conductivity	0.81445
INFILRAT	Infiltration Rate	SATHYCON	Saturated Hydraulic Conductivity	0.70696
MOISTRPB	Moisture Rention Parameter (b)	SATHYCON	Saturated Hydraulic Conductivity	0.7551
RECHARAT	Recharge Rate	MOISTRPA	Moisture Rention Parameter (a)	0.83547
MOISTRPB	Moisture Rention Parameter (b)	MOISTRPA	Moisture Rention Parameter (a)	0.77439
RECHARAT	Recharge Rate	MOISTRPB	Moisture Rention Parameter (b)	0.92827
SATHYCON	Saturated Hydraulic Conductivity	MOISTRPB	Moisture Rention Parameter (b)	0.7551
SOILBDEN	Soil Bulk Density	SATURH2O	Saturated Water Content	0.72632
UNSATHIK	Unsaturated Zone Thickness	LONDISPU	Longitudinal Dispersivity	0.99995
RECHARAT	Recharge Rate	SOILBDEN	Soil Bulk Density	-0.99563
SATHYCON	Saturated Hydraulic Conductivity	SOILBDEN	Soil Bulk Density	-0.81009
MOISTRPA	Moisture Rention Parameter (a)	SOILBDEN	Soil Bulk Density	-0.83865
MOISTRPB	Moisture Rention Parameter (b)	SOILBDEN	Soil Bulk Density	-0.92622
SATURH2O	Saturated Water Content	SOILBDEN	Soil Bulk Density	0.72632

Note: Parameters in the variable 2 column were removed from the analysis.

Table D-69. Summary of Crosspairs Analysis for Manganese

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
AVGPDIAM	Avg. Particle Diameter			Y	Y
POROSITY	Porosity				
AQUTHIK	Aquifer Thickness			Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity			Y	Y
HYDGRAD	Hydraulic Gradient			Y	Y
LONDISPA	Longitudinal Dispersivity			Y	Y
FRORGCAR	Fraction Organic Carbon				
ANGLEW	Angle of Well Off Plume Centerline				
XDIST	Longitudinal Distance to Well			Y	Y
YDIST	Distance from Plume Centerline to Well			Y	Y
ZDIST	Depth of Well Below Water Table			Y	Y
FRCOEFA	Freundlich Isotherm Coefficient			Y	Y
RECHARAT	Recharge Rate				
INFILRAT	Infiltration Rate			Y	Y
RESIDH2O	Residual Water Content				
SATURH2O	Saturated Water Content				
UNSATHIK	Unsaturated Zone Thickness			Y	
PERORGM	Percent Organic Matter				
FRCOEFU	Freundlich Isotherm Coefficient			Y	Y
AVGPDIAM	Avg. Particle Diameter	AVGPDIAM	Avg. Particle Diameter		
POROSITY	Porosity	AVGPDIAM	Avg. Particle Diameter		
POROSITY	Porosity	POROSITY	Porosity		
AQUTHIK	Aquifer Thickness	AVGPDIAM	Avg. Particle Diameter		
AQUTHIK	Aquifer Thickness	POROSITY	Porosity		
AQUTHIK	Aquifer Thickness	AQUTHIK	Aquifer Thickness		
LONHYCON	Longitundinal Hydraulic Conductivity	AVGPDIAM	Avg. Particle Diameter	Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity	POROSITY	Porosity		
LONHYCON	Longitundinal Hydraulic Conductivity	AQUTHIK	Aquifer Thickness	Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
HYDGRAD	Hydraulic Gradient	AVGPDIAM	Avg. Particle Diameter		
HYDGRAD	Hydraulic Gradient	POROSITY	Porosity		
HYDGRAD	Hydraulic Gradient	AQUTHIK	Aquifer Thickness	Y	
HYDGRAD	Hydraulic Gradient	LONHYCON	Longitundinal Hydraulic Conductivity		
HYDGRAD	Hydraulic Gradient	HYDGRAD	Hydraulic Gradient		
LONDISPA	Longitudinal Dispersivity	AVGPDIAM	Avg. Particle Diameter	Y	Y
LONDISPA	Longitudinal Dispersivity	POROSITY	Porosity		
LONDISPA	Longitudinal Dispersivity	AQUTHIK	Aquifer Thickness	Y	Y
LONDISPA	Longitudinal Dispersivity	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
LONDISPA	Longitudinal Dispersivity	HYDGRAD	Hydraulic Gradient	Y	Y
LONDISPA	Longitudinal Dispersivity	LONDISPA	Longitudinal Dispersivity	Y	
FRORGCAR	Fraction Organic Carbon	AVGPDIAM	Avg. Particle Diameter		
FRORGCAR	Fraction Organic Carbon	POROSITY	Porosity		
FRORGCAR	Fraction Organic Carbon	AQUTHIK	Aquifer Thickness		
FRORGCAR	Fraction Organic Carbon	LONHYCON	Longitundinal Hydraulic Conductivity		
FRORGCAR	Fraction Organic Carbon	HYDGRAD	Hydraulic Gradient		
FRORGCAR	Fraction Organic Carbon	LONDISPA	Longitudinal Dispersivity		
FRORGCAR	Fraction Organic Carbon	FRORGCAR	Fraction Organic Carbon		
ANGLEW	Angle of Well Off Plume Centerline	AVGPDIAM	Avg. Particle Diameter		
ANGLEW	Angle of Well Off Plume Centerline	POROSITY	Porosity		

Table D-69. Summary of Crosspairs Analysis for Manganese

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
ANGLEW	Angle of Well Off Plume Centerline	AQUTHIK	Aquifer Thickness		
ANGLEW	Angle of Well Off Plume Centerline	LONHYCON	Longitundinal Hydraulic Conductivity		
ANGLEW	Angle of Well Off Plume Centerline	HYDGRAD	Hydraulic Gradient		
ANGLEW	Angle of Well Off Plume Centerline	LONDISPA	Longitudinal Dispersivity		
ANGLEW	Angle of Well Off Plume Centerline	FRORGCAR	Fraction Organic Carbon		
ANGLEW	Angle of Well Off Plume Centerline	ANGLEW	Angle of Well Off Plume Centerline		
XDIST	Longitudinal Distance to Well	AVGPDIAM	Avg. Particle Diameter		
XDIST	Longitudinal Distance to Well	POROSITY	Porosity		
XDIST	Longitudinal Distance to Well	AQUTHIK	Aquifer Thickness	Y	Y
XDIST	Longitudinal Distance to Well	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
XDIST	Longitudinal Distance to Well	HYDGRAD	Hydraulic Gradient		
XDIST	Longitudinal Distance to Well	LONDISPA	Longitudinal Dispersivity		
XDIST	Longitudinal Distance to Well	FRORGCAR	Fraction Organic Carbon		
XDIST	Longitudinal Distance to Well	ANGLEW	Angle of Well Off Plume Centerline		
XDIST	Longitudinal Distance to Well	XDIST	Longitudinal Distance to Well		
YDIST	Distance from Plume Centerline to Well	AVGPDIAM	Avg. Particle Diameter		
YDIST	Distance from Plume Centerline to Well	POROSITY	Porosity		
YDIST	Distance from Plume Centerline to Well	AQUTHIK	Aquifer Thickness	Y	Y
YDIST	Distance from Plume Centerline to Well	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
YDIST	Distance from Plume Centerline to Well	HYDGRAD	Hydraulic Gradient		
YDIST	Distance from Plume Centerline to Well	LONDISPA	Longitudinal Dispersivity	Y	Y
YDIST	Distance from Plume Centerline to Well	FRORGCAR	Fraction Organic Carbon		
YDIST	Distance from Plume Centerline to Well	ANGLEW	Angle of Well Off Plume Centerline		
YDIST	Distance from Plume Centerline to Well	XDIST	Longitudinal Distance to Well	Y	Y
YDIST	Distance from Plume Centerline to Well	YDIST	Distance from Plume Centerline to Well	Y	Y
ZDIST	Depth of Well Below Water Table	AVGPDIAM	Avg. Particle Diameter		
ZDIST	Depth of Well Below Water Table	POROSITY	Porosity		
ZDIST	Depth of Well Below Water Table	AQUTHIK	Aquifer Thickness		
ZDIST	Depth of Well Below Water Table	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
ZDIST	Depth of Well Below Water Table	HYDGRAD	Hydraulic Gradient		
ZDIST	Depth of Well Below Water Table	LONDISPA	Longitudinal Dispersivity	Y	Y
ZDIST	Depth of Well Below Water Table	FRORGCAR	Fraction Organic Carbon		
ZDIST	Depth of Well Below Water Table	ANGLEW	Angle of Well Off Plume Centerline	Y	
ZDIST	Depth of Well Below Water Table	XDIST	Longitudinal Distance to Well		
ZDIST	Depth of Well Below Water Table	YDIST	Distance from Plume Centerline to Well		
ZDIST	Depth of Well Below Water Table	ZDIST	Depth of Well Below Water Table		
FRCOEFA	Freundlich Isotherm Coefficient	AVGPDIAM	Avg. Particle Diameter	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	POROSITY	Porosity		
FRCOEFA	Freundlich Isotherm Coefficient	AQUTHIK	Aquifer Thickness	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	HYDGRAD	Hydraulic Gradient	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	LONDISPA	Longitudinal Dispersivity	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	FRORGCAR	Fraction Organic Carbon		
FRCOEFA	Freundlich Isotherm Coefficient	ANGLEW	Angle of Well Off Plume Centerline		
FRCOEFA	Freundlich Isotherm Coefficient	XDIST	Longitudinal Distance to Well	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	YDIST	Distance from Plume Centerline to Well		
FRCOEFA	Freundlich Isotherm Coefficient	ZDIST	Depth of Well Below Water Table		
FRCOEFA	Freundlich Isotherm Coefficient	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
RECHARAT	Recharge Rate	AVGPDIAM	Avg. Particle Diameter		

Table D-69. Summary of Crosspairs Analysis for Manganese

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
RECHARAT	Recharge Rate	POROSITY	Porosity		
RECHARAT	Recharge Rate	AQUTHIK	Aquifer Thickness		
RECHARAT	Recharge Rate	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
RECHARAT	Recharge Rate	HYDGRAD	Hydraulic Gradient		
RECHARAT	Recharge Rate	LONDISPA	Longitudinal Dispersivity	Y	Y
RECHARAT	Recharge Rate	FRORGCAR	Fraction Organic Carbon		
RECHARAT	Recharge Rate	ANGLEW	Angle of Well Off Plume Centerline		
RECHARAT	Recharge Rate	XDIST	Longitudinal Distance to Well	Y	
RECHARAT	Recharge Rate	YDIST	Distance from Plume Centerline to Well	Y	Y
RECHARAT	Recharge Rate	ZDIST	Depth of Well Below Water Table		
RECHARAT	Recharge Rate	FRCOEFA	Freundlich Isotherm Coefficient	Y	
RECHARAT	Recharge Rate	RECHARAT	Recharge Rate		
INFILRAT	Infiltration Rate	AVGPDIAM	Avg. Particle Diameter		
INFILRAT	Infiltration Rate	POROSITY	Porosity		
INFILRAT	Infiltration Rate	AQUTHIK	Aquifer Thickness		
INFILRAT	Infiltration Rate	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
INFILRAT	Infiltration Rate	HYDGRAD	Hydraulic Gradient		
INFILRAT	Infiltration Rate	LONDISPA	Longitudinal Dispersivity	Y	Y
INFILRAT	Infiltration Rate	FRORGCAR	Fraction Organic Carbon		
INFILRAT	Infiltration Rate	ANGLEW	Angle of Well Off Plume Centerline		
INFILRAT	Infiltration Rate	XDIST	Longitudinal Distance to Well		
INFILRAT	Infiltration Rate	YDIST	Distance from Plume Centerline to Well	Y	Y
INFILRAT	Infiltration Rate	ZDIST	Depth of Well Below Water Table		
INFILRAT	Infiltration Rate	FRCOEFA	Freundlich Isotherm Coefficient		
INFILRAT	Infiltration Rate	RECHARAT	Recharge Rate		
INFILRAT	Infiltration Rate	INFILRAT	Infiltration Rate	Y	Y
RESIDH2O	Residual Water Content	AVGPDIAM	Avg. Particle Diameter		
RESIDH2O	Residual Water Content	POROSITY	Porosity		
RESIDH2O	Residual Water Content	AQUTHIK	Aquifer Thickness		
RESIDH2O	Residual Water Content	LONHYCON	Longitundinal Hydraulic Conductivity		
RESIDH2O	Residual Water Content	HYDGRAD	Hydraulic Gradient		
RESIDH2O	Residual Water Content	LONDISPA	Longitudinal Dispersivity		
RESIDH2O	Residual Water Content	FRORGCAR	Fraction Organic Carbon		
RESIDH2O	Residual Water Content	ANGLEW	Angle of Well Off Plume Centerline		
RESIDH2O	Residual Water Content	XDIST	Longitudinal Distance to Well		
RESIDH2O	Residual Water Content	YDIST	Distance from Plume Centerline to Well		
RESIDH2O	Residual Water Content	ZDIST	Depth of Well Below Water Table		
RESIDH2O	Residual Water Content	FRCOEFA	Freundlich Isotherm Coefficient		
RESIDH2O	Residual Water Content	RECHARAT	Recharge Rate		
RESIDH2O	Residual Water Content	INFILRAT	Infiltration Rate		
RESIDH2O	Residual Water Content	RESIDH2O	Residual Water Content		
SATURH2O	Saturated Water Content	AVGPDIAM	Avg. Particle Diameter		
SATURH2O	Saturated Water Content	POROSITY	Porosity		
SATURH2O	Saturated Water Content	AQUTHIK	Aquifer Thickness		
SATURH2O	Saturated Water Content	LONHYCON	Longitundinal Hydraulic Conductivity		
SATURH2O	Saturated Water Content	HYDGRAD	Hydraulic Gradient		
SATURH2O	Saturated Water Content	LONDISPA	Longitudinal Dispersivity		
SATURH2O	Saturated Water Content	FRORGCAR	Fraction Organic Carbon		
SATURH2O	Saturated Water Content	ANGLEW	Angle of Well Off Plume Centerline		

Table D-69. Summary of Crosspairs Analysis for Manganese

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
SATURH2O	Saturated Water Content	XDIST	Longitudinal Distance to Well		
SATURH2O	Saturated Water Content	YDIST	Distance from Plume Centerline to Well		
SATURH2O	Saturated Water Content	ZDIST	Depth of Well Below Water Table		
SATURH2O	Saturated Water Content	FRCOEFA	Freundlich Isotherm Coefficient		
SATURH2O	Saturated Water Content	RECHARAT	Recharge Rate		
SATURH2O	Saturated Water Content	INFILRAT	Infiltration Rate		
SATURH2O	Saturated Water Content	RESIDH2O	Residual Water Content		
SATURH2O	Saturated Water Content	SATURH2O	Saturated Water Content		
UNSATHIK	Unsaturated Zone Thickness	AVGPDIAM	Avg. Particle Diameter		
UNSATHIK	Unsaturated Zone Thickness	POROSITY	Porosity		
UNSATHIK	Unsaturated Zone Thickness	AQUTHIK	Aquifer Thickness		
UNSATHIK	Unsaturated Zone Thickness	LONHYCON	Longitundinal Hydraulic Conductivity		
UNSATHIK	Unsaturated Zone Thickness	HYDGRAD	Hydraulic Gradient		
UNSATHIK	Unsaturated Zone Thickness	LONDISPA	Longitudinal Dispersivity		
UNSATHIK	Unsaturated Zone Thickness	FRORGCAR	Fraction Organic Carbon		
UNSATHIK	Unsaturated Zone Thickness	ANGLEW	Angle of Well Off Plume Centerline		
UNSATHIK	Unsaturated Zone Thickness	XDIST	Longitudinal Distance to Well		
UNSATHIK	Unsaturated Zone Thickness	YDIST	Distance from Plume Centerline to Well		
UNSATHIK	Unsaturated Zone Thickness	ZDIST	Depth of Well Below Water Table		
UNSATHIK	Unsaturated Zone Thickness	FRCOEFA	Freundlich Isotherm Coefficient		
UNSATHIK	Unsaturated Zone Thickness	RECHARAT	Recharge Rate		
UNSATHIK	Unsaturated Zone Thickness	INFILRAT	Infiltration Rate		
UNSATHIK	Unsaturated Zone Thickness	RESIDH2O	Residual Water Content		
UNSATHIK	Unsaturated Zone Thickness	SATURH2O	Saturated Water Content		
UNSATHIK	Unsaturated Zone Thickness	UNSATHIK	Unsaturated Zone Thickness		
PERORGM	Percent Organic Matter	AVGPDIAM	Avg. Particle Diameter	Y	
PERORGM	Percent Organic Matter	POROSITY	Porosity		
PERORGM	Percent Organic Matter	AQUTHIK	Aquifer Thickness	Y	
PERORGM	Percent Organic Matter	LONHYCON	Longitundinal Hydraulic Conductivity		
PERORGM	Percent Organic Matter	HYDGRAD	Hydraulic Gradient		
PERORGM	Percent Organic Matter	LONDISPA	Longitudinal Dispersivity		
PERORGM	Percent Organic Matter	FRORGCAR	Fraction Organic Carbon		
PERORGM	Percent Organic Matter	ANGLEW	Angle of Well Off Plume Centerline		
PERORGM	Percent Organic Matter	XDIST	Longitudinal Distance to Well		
PERORGM	Percent Organic Matter	YDIST	Distance from Plume Centerline to Well		
PERORGM	Percent Organic Matter	ZDIST	Depth of Well Below Water Table		
PERORGM	Percent Organic Matter	FRCOEFA	Freundlich Isotherm Coefficient		
PERORGM	Percent Organic Matter	RECHARAT	Recharge Rate		
PERORGM	Percent Organic Matter	INFILRAT	Infiltration Rate		
PERORGM	Percent Organic Matter	RESIDH2O	Residual Water Content		
PERORGM	Percent Organic Matter	SATURH2O	Saturated Water Content		
PERORGM	Percent Organic Matter	UNSATHIK	Unsaturated Zone Thickness		
PERORGM	Percent Organic Matter	PERORGM	Percent Organic Matter		
FRCOEFU	Freundlich Isotherm Coefficient	AVGPDIAM	Avg. Particle Diameter		
FRCOEFU	Freundlich Isotherm Coefficient	POROSITY	Porosity	Y	
FRCOEFU	Freundlich Isotherm Coefficient	AQUTHIK	Aquifer Thickness		
FRCOEFU	Freundlich Isotherm Coefficient	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	HYDGRAD	Hydraulic Gradient		
FRCOEFU	Freundlich Isotherm Coefficient	LONDISPA	Longitudinal Dispersivity	Y	Y

Table D-69. Summary of Crosspairs Analysis for Manganese

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
FRCOEFU	Freundlich Isotherm Coefficient	FRORGCAR	Fraction Organic Carbon		
FRCOEFU	Freundlich Isotherm Coefficient	ANGLEW	Angle of Well Off Plume Centerline		
FRCOEFU	Freundlich Isotherm Coefficient	XDIST	Longitudinal Distance to Well		
FRCOEFU	Freundlich Isotherm Coefficient	YDIST	Distance from Plume Centerline to Well	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	ZDIST	Depth of Well Below Water Table		
FRCOEFU	Freundlich Isotherm Coefficient	FRCOEFA	Freundlich Isotherm Coefficient	Y	
FRCOEFU	Freundlich Isotherm Coefficient	RECHARAT	Recharge Rate	Y	
FRCOEFU	Freundlich Isotherm Coefficient	INFILRAT	Infiltration Rate	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	RESIDH2O	Residual Water Content		
FRCOEFU	Freundlich Isotherm Coefficient	SATURH2O	Saturated Water Content		
FRCOEFU	Freundlich Isotherm Coefficient	UNSATHIK	Unsaturated Zone Thickness	Y	
FRCOEFU	Freundlich Isotherm Coefficient	PERORGM	Percent Organic Matter		
FRCOEFU	Freundlich Isotherm Coefficient	FRCOEFU	Freundlich Isotherm Coefficient	Y	Y

Table D-70. Ranking of Parameters According to Percentage of Risk for Manganese

Variable Description	Reduced Sums of Square	Variable Sums of Square	Variable Degrees of Freedom	% Risk Variation	Mean Square Variable	F VALUE	P VALUE
Freundlich Isotherm Coefficient {Aquifer} (cm3/g)	5881.6	11095.73	50	521412.0%	2138.96	651.76	4.32E-01
Distance from Plume Centerline to Well (m)	7792.4	11095.73	50	330337.0%	2138.96	367.04	4.32E-01
Longitudinal Hydraulic Conductivity (m/yr)	9657.3	11095.73	50	143840.0%	2138.96	119.87	4.32E-01
Aquifer Thickness (m)	9797.8	11095.73	50	129794.0%	2138.96	216.32	4.32E-01
Infiltration Rate (m/yr)	10023.3	11095.73	50	107241.0%	2138.96	178.74	4.32E-01
Consumption of Drinking Water (ml/kg-day)	10099.7	11095.73	50	99608.0%	2138.96	996.08	4.32E-01
Freundlich Isotherm Coefficient {Unsaturated} (cm3/g)	10651.2	11095.73	50	44452.0%	2138.96	63.50	4.32E-01
Longitudinal Dispersivity {Aquifer} (m)	10759.2	11095.73	50	33654.0%	2138.96	30.59	4.32E-01
Longitudinal Distance to Well (m)	10806.8	11095.73	50	28892.0%	2138.96	57.78	4.32E-01
Average Particle Diameter (cm)	10950.9	11095.73	50	14479.0%	2138.96	36.20	4.32E-01
Hydraulic Gradient (m/m)	11064.7	11095.73	50	3104.0%	2138.96	10.35	4.32E-01
Depth of Well Below Water Table (m)	11079.3	11095.73	50	1639.0%	2138.96	5.46	4.32E-01
Recharge Rate (m/yr)	11083.0	11095.73	50	1273.0%	2138.96	3.18	4.32E-01
Unsaturated Zone Thickness (m)	11092.0	11095.73	50	375.0%	2138.96	1.88	4.32E-01

Constants

Full Model SS	42
Error SS	8
Error DF	0
MS Error	4949

Table D-71. Chemical-Specific Properties for Constituents of Concern for the Chloride Process Wastewaters Kerr McGee

Waste Constituent Concentrations	
Constituent	**SPLPfiltrate (SI) (mg/L)**
Antimony	0.044
Arsenic	0.001
Molybdenum	0.23
Thallium	*0.0025*

underline italics indicate values set at 1/2 of detection limit

Table D-72. Waste Management Unit Parameter for Onsite Surface Impoundment Managing Chloride Process Wastewaters Kerr McGee

WMU	Location	Surface Impoundment Area (m^2)	Depth of Water Column (m)	Depth of Sludge Layer (m)	Wastewater Throughput (Mt/yr)	Particle Density (g/cm^3)
Onsite Surface Impoundment	New Hamilton, MS	148,645	2.44	1.22 to 0.20	7,356,798	1.3

Table D-73. Intentionally omitted

Table D-74. Site-Specific Climate-Based Parameters for Onsite Surface Impoundment Managing Chloride Process Wastewaters Kerr McGee

WMU	Location	Climate Index	Climate Center	Recharge Rate (m/yr)			GW TempC	GWpH		
				SCL	SLT	SNL		SCL	SLT	SNL
Onsite Surface Impoundment	New Hanover, MS	90	Little Rock, Ar	N/A	0.35	0.43	18	N/A	4.96	4.95

Table D-75. Aquifer Types Common in Area of Onsite Surface Impoundment Managing Chloride Process Wastewaters Kerr McGee

Aquifer Types	Aquifer Code	New Hanover, MS
River Valleys/Flood Plains w/o overbank deposits	7	100%

Table D-76. Soil Textures Common in Area of Onsite Surface Impoundment Managing Chloride Process Wastewaters Kerr McGee

		New Hanover MS
silty clay loam	SCL	0%
silt loam	SIL	66%
sandy loam	SNL	34%

Table D-77. Summary of Parameters Considered in Sensitivity Analysis for Antimony

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
EXPDURA		C			
CANSLOPE		C			
ACIDCAT	Acid Catalyzed Hydrolysis Rate Constant	C			
ANGLEW	Angle of Well Off Plume Centerline	anglew		Y	
ANISORAT	Anisotropy Ratio	C			
AQUTHIK	Aquifer Thickness	aquthik		Y	Y
AVGPDIAM	Avg. Particle Diameter	log(avgpdiam+0.004)		Y	Y
BASECAT	Base Catalyzed Hydrolysis Rate Constant	C			
BIODRATA	Biodegradation Rate	C			
BIODRATU	Biodegradation Rate	C			
BULKDENS	Bulk Density	bulkdens**3.5	Y		
CHEMDRU	Chemical Decay Rate	C			
CHEMDRA	Chemical Decay Rate	C			
CONSH2OA	Consump of drinking water	log(consh2oa)			Y
ZDIST	Depth of Well Below Water Table	log(zdist+3)		Y	
DISHYD	Dissolved Hydrolysis Rate	C			
YDIST	Distance from Plume Centerline to Well	log(ydist+50)		Y	Y
DURLEACH	Duration of Leaching Period	C			
GWAVTIM	Exposure Duration	C			
FRORGCAR	Fraction Organic Carbon	log(frorgcar)			
FRCOEFA	Freundlich Isotherm Coefficient	log(frcoefa-0.35)		Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	log(frcoefu)		Y	Y
FREXPA	Freundlich Isotherm Exponent	C			
FREXPU	Freundlich Isotherm Exponent	C			
GWPH	Groundwater pH	gwph	Y		
GWSEEPV	Groundwater Seepage Velocity	log(gwseepv-70)		Y	
GWTEMP	Groundwater Temperature	C			
HYDGRAD	Hydraulic Gradient	C			
INFILRAT	Infiltration Rate	infilrat**0.001		Y	Y
LANDEPTH	Landfill Depth	C			
LEACHCON	Leachate Concentration	C			
LFFRACT	LF Fraction	C			
LONDISPA	Longitudinal Dispersivity	log(londispa)		Y	Y

Table D-77. Summary of Parameters Considered in Sensitivity Analysis for Antimony

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
LONDISPU	Longitudinal Dispersivity	log(londispu)	Y		
XDIST	Longitudinal Distance to Well	log(xdist+250)		Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity	C			
MOISTRPA	Moisture Rention Parameter (a)	log(moistrpa-0.05)	Y		
MOISTRPB	Moisture Rention Parameter (b)	moistrpb**-3	Y		
MOLDIFF	Molecular Diffusion Coefficient	C			
NEUTHYD	Neutral Hydrolysis Rate Constant	C			
ORGCDIS	Organic Carbon Distribution Coefficient	C			
PERORGM	Percent Organic Matter	log(perorgm)			
POROSITY	Porosity	porosity**1.3	Y		
RADISTW	Radial Distance to Well	log(radistw+250)	Y		
RECHARAT	Recharge Rate	recharat		Y	Y
RESIDH2O	Residual Water Content	residh2o**1.8		Y	
RETCOEF	Retardation Coefficient	log(retcoef-2.3)	Y		
SATHYCON	Saturated Hydraulic Conductivity	log(sathycon-0.1)	Y		
SATURH2O	Saturated Water Content	saturh2o	Y		
SOILBDEN	Soil Bulk Density	soilbden	Y		
SORBHYD	Sorbed Hydrolysis Rate	C			
TRANDISP	Transverse Dispersivity	log(trandisp+0.01)	Y		
UNSATHIK	Unsaturated Zone Thickness	unsathik**-0.01		Y	Y
VERTDISP	Vertical Dispersivity	log(vertdisp-0.004)	Y		
WASTDENS	Waste Density	C			
WASTEVOL	Waste Volume	C			
WMUAREA	WMU Area	C			
WMULEN	WMU Length	C			
WMUWIDTH	WMU Width	C			

Table D-78. Summary of Correlated Parameters for Antimony

Variable 1		Variable 2		Correlation Coefficient
Code	**Description**	**Code**	**Description**	
GWSEEPV	Groundwater Seepage Velocity	POROSITY	Porosity	-0.9915
AVGPDIAM	Avg. Particle Diameter	BULKDENS	Bulk Density	0.99606
FRCOEFA	Freundlich Isotherm Coefficient	RETCOEF	Retardation Coefficient	0.9524
LONDISPA	Longitudinal Dispersivity	TRANDISP	Transverse Dispersivity	0.99994
LONDISPA	Longitudinal Dispersivity	VERTDISP	Vertical Dispersivity	0.99549
RECHARAT	Recharge Rate	GWPH	Groundwater pH	-1
SATHYCON	Saturated Hydraulic Conductivity	GWPH	Groundwater pH	-0.7014
MOISTRPA	Moisture Rention Parameter (a)	GWPH	Groundwater pH	-0.75962
MOISTRPB	Moisture Rention Parameter (b)	GWPH	Groundwater pH	0.78639
XDIST	Longitudinal Distance to Well	RADISTW	Radial Distance to Well	0.99101
SOILBDEN	Soil Bulk Density	RECHARAT	Recharge Rate	-1
RECHARAT	Recharge Rate	SATHYCON	Saturated Hydraulic Conductivity	0.7014
SATURH2O	Saturated Water Content	SATHYCON	Saturated Hydraulic Conductivity	-0.7014
RECHARAT	Recharge Rate	MOISTRPA	Moisture Rention Parameter (a)	0.75962
SATURH2O	Saturated Water Content	MOISTRPA	Moisture Rention Parameter (a)	-0.75962
RECHARAT	Recharge Rate	MOISTRPB	Moisture Rention Parameter (b)	-0.78639
SATURH2O	Saturated Water Content	MOISTRPB	Moisture Rention Parameter (b)	0.78639
RECHARAT	Recharge Rate	SATURH2O	Saturated Water Content	-1
SATHYCON	Saturated Hydraulic Conductivity	SATURH2O	Saturated Water Content	-0.7014
MOISTRPA	Moisture Rention Parameter (a)	SATURH2O	Saturated Water Content	-0.75962
MOISTRPB	Moisture Rention Parameter (b)	SATURH2O	Saturated Water Content	0.78639
UNSATHIK	Unsaturated Zone Thickness	LONDISPU	Longitudinal Dispersivity	-0.99579
RECHARAT	Recharge Rate	SOILBDEN	Soil Bulk Density	-1
SATHYCON	Saturated Hydraulic Conductivity	SOILBDEN	Soil Bulk Density	-0.7014
MOISTRPA	Moisture Rention Parameter (a)	SOILBDEN	Soil Bulk Density	-0.75962
MOISTRPB	Moisture Rention Parameter (b)	SOILBDEN	Soil Bulk Density	0.78639

Note: Parameters in the variable 2 column were removed from the analysis.

Table D-79. Summary of Crosspairs Analysis for Antimony

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
AVGPDIAM	Avg. Particle Diameter			Y	Y
AQUTHIK	Aquifer Thickness			Y	Y
GWSEEPV	Groundwater Seepage Velocity				
LONDISPA	Longitudinal Dispersivity			Y	Y
FRORGCAR	Fraction Organic Carbon				
ANGLEW	Angle of Well Off Plume Centerline				
XDIST	Longitudinal Distance to Well			Y	Y
YDIST	Distance from Plume Centerline to Well			Y	Y
ZDIST	Depth of Well Below Water Table				
FRCOEFA	Freundlich Isotherm Coefficient			Y	Y
RECHARAT	Recharge Rate			Y	Y
INFILRAT	Infiltration Rate			Y	Y
RESIDH2O	Residual Water Content				
UNSATHIK	Unsaturated Zone Thickness			Y	Y
PERORGM	Percent Organic Matter				
FRCOEFU	Freundlich Isotherm Coefficient			Y	Y
AVGPDIAM	Avg. Particle Diameter	AVGPDIAM	Avg. Particle Diameter		
AQUTHIK	Aquifer Thickness	AVGPDIAM	Avg. Particle Diameter	Y	
AQUTHIK	Aquifer Thickness	AQUTHIK	Aquifer Thickness	Y	Y
GWSEEPV	Groundwater Seepage Velocity	AVGPDIAM	Avg. Particle Diameter		
GWSEEPV	Groundwater Seepage Velocity	AQUTHIK	Aquifer Thickness		
GWSEEPV	Groundwater Seepage Velocity	GWSEEPV	Groundwater Seepage Velocity		
LONDISPA	Longitudinal Dispersivity	AVGPDIAM	Avg. Particle Diameter		
LONDISPA	Longitudinal Dispersivity	AQUTHIK	Aquifer Thickness	Y	Y
LONDISPA	Longitudinal Dispersivity	GWSEEPV	Groundwater Seepage Velocity		
LONDISPA	Longitudinal Dispersivity	LONDISPA	Longitudinal Dispersivity	Y	Y
FRORGCAR	Fraction Organic Carbon	AVGPDIAM	Avg. Particle Diameter		
FRORGCAR	Fraction Organic Carbon	AQUTHIK	Aquifer Thickness		
FRORGCAR	Fraction Organic Carbon	GWSEEPV	Groundwater Seepage Velocity		
FRORGCAR	Fraction Organic Carbon	LONDISPA	Longitudinal Dispersivity		
FRORGCAR	Fraction Organic Carbon	FRORGCAR	Fraction Organic Carbon		
ANGLEW	Angle of Well Off Plume Centerline	AVGPDIAM	Avg. Particle Diameter		
ANGLEW	Angle of Well Off Plume Centerline	AQUTHIK	Aquifer Thickness		
ANGLEW	Angle of Well Off Plume Centerline	GWSEEPV	Groundwater Seepage Velocity		
ANGLEW	Angle of Well Off Plume Centerline	LONDISPA	Longitudinal Dispersivity		
ANGLEW	Angle of Well Off Plume Centerline	FRORGCAR	Fraction Organic Carbon		
ANGLEW	Angle of Well Off Plume Centerline	ANGLEW	Angle of Well Off Plume Centerline		
XDIST	Longitudinal Distance to Well	AVGPDIAM	Avg. Particle Diameter		
XDIST	Longitudinal Distance to Well	AQUTHIK	Aquifer Thickness		
XDIST	Longitudinal Distance to Well	GWSEEPV	Groundwater Seepage Velocity		
XDIST	Longitudinal Distance to Well	LONDISPA	Longitudinal Dispersivity		
XDIST	Longitudinal Distance to Well	FRORGCAR	Fraction Organic Carbon		
XDIST	Longitudinal Distance to Well	ANGLEW	Angle of Well Off Plume Centerline		
XDIST	Longitudinal Distance to Well	XDIST	Longitudinal Distance to Well	Y	Y
YDIST	Distance from Plume Centerline to Well	AVGPDIAM	Avg. Particle Diameter		
YDIST	Distance from Plume Centerline to Well	AQUTHIK	Aquifer Thickness		
YDIST	Distance from Plume Centerline to Well	GWSEEPV	Groundwater Seepage Velocity		
YDIST	Distance from Plume Centerline to Well	LONDISPA	Longitudinal Dispersivity	Y	Y
YDIST	Distance from Plume Centerline to Well	FRORGCAR	Fraction Organic Carbon		

Table D-79. Summary of Crosspairs Analysis for Antimony

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
YDIST	Distance from Plume Centerline to Well	ANGLEW	Angle of Well Off Plume Centerline		
YDIST	Distance from Plume Centerline to Well	XDIST	Longitudinal Distance to Well	Y	Y
YDIST	Distance from Plume Centerline to Well	YDIST	Distance from Plume Centerline to Well	Y	Y
ZDIST	Depth of Well Below Water Table	AVGPDIAM	Avg. Particle Diameter		
ZDIST	Depth of Well Below Water Table	AQUTHIK	Aquifer Thickness		
ZDIST	Depth of Well Below Water Table	GWSEEPV	Groundwater Seepage Velocity		
ZDIST	Depth of Well Below Water Table	LONDISPA	Longitudinal Dispersivity	Y	
ZDIST	Depth of Well Below Water Table	FRORGCAR	Fraction Organic Carbon		
ZDIST	Depth of Well Below Water Table	ANGLEW	Angle of Well Off Plume Centerline		
ZDIST	Depth of Well Below Water Table	XDIST	Longitudinal Distance to Well		
ZDIST	Depth of Well Below Water Table	YDIST	Distance from Plume Centerline to Well		
ZDIST	Depth of Well Below Water Table	ZDIST	Depth of Well Below Water Table	Y	
FRCOEFA	Freundlich Isotherm Coefficient	AVGPDIAM	Avg. Particle Diameter	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	AQUTHIK	Aquifer Thickness	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	GWSEEPV	Groundwater Seepage Velocity		
FRCOEFA	Freundlich Isotherm Coefficient	LONDISPA	Longitudinal Dispersivity	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	FRORGCAR	Fraction Organic Carbon		
FRCOEFA	Freundlich Isotherm Coefficient	ANGLEW	Angle of Well Off Plume Centerline		
FRCOEFA	Freundlich Isotherm Coefficient	XDIST	Longitudinal Distance to Well	Y	
FRCOEFA	Freundlich Isotherm Coefficient	YDIST	Distance from Plume Centerline to Well	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	ZDIST	Depth of Well Below Water Table		
FRCOEFA	Freundlich Isotherm Coefficient	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
RECHARAT	Recharge Rate	AVGPDIAM	Avg. Particle Diameter		
RECHARAT	Recharge Rate	AQUTHIK	Aquifer Thickness	Y	
RECHARAT	Recharge Rate	GWSEEPV	Groundwater Seepage Velocity		
RECHARAT	Recharge Rate	LONDISPA	Longitudinal Dispersivity		
RECHARAT	Recharge Rate	FRORGCAR	Fraction Organic Carbon		
RECHARAT	Recharge Rate	ANGLEW	Angle of Well Off Plume Centerline		
RECHARAT	Recharge Rate	XDIST	Longitudinal Distance to Well		
RECHARAT	Recharge Rate	YDIST	Distance from Plume Centerline to Well		
RECHARAT	Recharge Rate	ZDIST	Depth of Well Below Water Table		
RECHARAT	Recharge Rate	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
RECHARAT	Recharge Rate	RECHARAT	Recharge Rate		
INFILRAT	Infiltration Rate	AVGPDIAM	Avg. Particle Diameter		
INFILRAT	Infiltration Rate	AQUTHIK	Aquifer Thickness	Y	Y
INFILRAT	Infiltration Rate	GWSEEPV	Groundwater Seepage Velocity		
INFILRAT	Infiltration Rate	LONDISPA	Longitudinal Dispersivity		
INFILRAT	Infiltration Rate	FRORGCAR	Fraction Organic Carbon		
INFILRAT	Infiltration Rate	ANGLEW	Angle of Well Off Plume Centerline		
INFILRAT	Infiltration Rate	XDIST	Longitudinal Distance to Well		
INFILRAT	Infiltration Rate	YDIST	Distance from Plume Centerline to Well	Y	Y
INFILRAT	Infiltration Rate	ZDIST	Depth of Well Below Water Table		
INFILRAT	Infiltration Rate	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
INFILRAT	Infiltration Rate	RECHARAT	Recharge Rate		
INFILRAT	Infiltration Rate	INFILRAT	Infiltration Rate		
RESIDH2O	Residual Water Content	AVGPDIAM	Avg. Particle Diameter		
RESIDH2O	Residual Water Content	AQUTHIK	Aquifer Thickness		
RESIDH2O	Residual Water Content	GWSEEPV	Groundwater Seepage Velocity	Y	
RESIDH2O	Residual Water Content	LONDISPA	Longitudinal Dispersivity		

Table D-79. Summary of Crosspairs Analysis for Antimony

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
RESIDH2O	Residual Water Content	FRORGCAR	Fraction Organic Carbon		
RESIDH2O	Residual Water Content	ANGLEW	Angle of Well Off Plume Centerline		
RESIDH2O	Residual Water Content	XDIST	Longitudinal Distance to Well		
RESIDH2O	Residual Water Content	YDIST	Distance from Plume Centerline to Well		
RESIDH2O	Residual Water Content	ZDIST	Depth of Well Below Water Table		
RESIDH2O	Residual Water Content	FRCOEFA	Freundlich Isotherm Coefficient		
RESIDH2O	Residual Water Content	RECHARAT	Recharge Rate		
RESIDH2O	Residual Water Content	INFILRAT	Infiltration Rate		
RESIDH2O	Residual Water Content	RESIDH2O	Residual Water Content	Y	
UNSATHIK	Unsaturated Zone Thickness	AVGPDIAM	Avg. Particle Diameter		
UNSATHIK	Unsaturated Zone Thickness	AQUTHIK	Aquifer Thickness		
UNSATHIK	Unsaturated Zone Thickness	GWSEEPV	Groundwater Seepage Velocity		
UNSATHIK	Unsaturated Zone Thickness	LONDISPA	Longitudinal Dispersivity		
UNSATHIK	Unsaturated Zone Thickness	FRORGCAR	Fraction Organic Carbon		
UNSATHIK	Unsaturated Zone Thickness	ANGLEW	Angle of Well Off Plume Centerline		
UNSATHIK	Unsaturated Zone Thickness	XDIST	Longitudinal Distance to Well		
UNSATHIK	Unsaturated Zone Thickness	YDIST	Distance from Plume Centerline to Well		
UNSATHIK	Unsaturated Zone Thickness	ZDIST	Depth of Well Below Water Table		
UNSATHIK	Unsaturated Zone Thickness	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
UNSATHIK	Unsaturated Zone Thickness	RECHARAT	Recharge Rate		
UNSATHIK	Unsaturated Zone Thickness	INFILRAT	Infiltration Rate	Y	Y
UNSATHIK	Unsaturated Zone Thickness	RESIDH2O	Residual Water Content		
UNSATHIK	Unsaturated Zone Thickness	UNSATHIK	Unsaturated Zone Thickness	Y	Y
PERORGM	Percent Organic Matter	AVGPDIAM	Avg. Particle Diameter		
PERORGM	Percent Organic Matter	AQUTHIK	Aquifer Thickness		
PERORGM	Percent Organic Matter	GWSEEPV	Groundwater Seepage Velocity		
PERORGM	Percent Organic Matter	LONDISPA	Longitudinal Dispersivity		
PERORGM	Percent Organic Matter	FRORGCAR	Fraction Organic Carbon		
PERORGM	Percent Organic Matter	ANGLEW	Angle of Well Off Plume Centerline		
PERORGM	Percent Organic Matter	XDIST	Longitudinal Distance to Well		
PERORGM	Percent Organic Matter	YDIST	Distance from Plume Centerline to Well		
PERORGM	Percent Organic Matter	ZDIST	Depth of Well Below Water Table		
PERORGM	Percent Organic Matter	FRCOEFA	Freundlich Isotherm Coefficient		
PERORGM	Percent Organic Matter	RECHARAT	Recharge Rate		
PERORGM	Percent Organic Matter	INFILRAT	Infiltration Rate		
PERORGM	Percent Organic Matter	RESIDH2O	Residual Water Content		
PERORGM	Percent Organic Matter	UNSATHIK	Unsaturated Zone Thickness		
PERORGM	Percent Organic Matter	PERORGM	Percent Organic Matter		
FRCOEFU	Freundlich Isotherm Coefficient	AVGPDIAM	Avg. Particle Diameter		
FRCOEFU	Freundlich Isotherm Coefficient	AQUTHIK	Aquifer Thickness	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	GWSEEPV	Groundwater Seepage Velocity		
FRCOEFU	Freundlich Isotherm Coefficient	LONDISPA	Longitudinal Dispersivity		
FRCOEFU	Freundlich Isotherm Coefficient	FRORGCAR	Fraction Organic Carbon		
FRCOEFU	Freundlich Isotherm Coefficient	ANGLEW	Angle of Well Off Plume Centerline	Y	
FRCOEFU	Freundlich Isotherm Coefficient	XDIST	Longitudinal Distance to Well		
FRCOEFU	Freundlich Isotherm Coefficient	YDIST	Distance from Plume Centerline to Well	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	ZDIST	Depth of Well Below Water Table		
FRCOEFU	Freundlich Isotherm Coefficient	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	RECHARAT	Recharge Rate		

Table D-79. Summary of Crosspairs Analysis for Antimony

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
FRCOEFU	Freundlich Isotherm Coefficient	INFILRAT	Infiltration Rate	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	RESIDH2O	Residual Water Content		
FRCOEFU	Freundlich Isotherm Coefficient	UNSATHIK	Unsaturated Zone Thickness	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	PERORGM	Percent Organic Matter		
FRCOEFU	Freundlich Isotherm Coefficient	FRCOEFU	Freundlich Isotherm Coefficient	Y	Y

Table D-80. Ranking of Parameters According to Percentage of Risk for Antimony

Variable Description	Reduced Sums of Square	Variable Sums of Square	Variable Degrees of Freedom	% Risk Variation	Mean Square Variable	F VALUE	P VALUE
Freundlich Isotherm Coefficient {Aquifer} (cm3/g)	2644.9	5797.86	37	315298.0%	590.12	286.63	1.19E-01
Distance from Plume Centerline to Well (m)	3801.7	5797.86	37	199612.0%	590.12	285.16	1.19E-01
Freundlich Isotherm Coefficient {Unsaturated} (cm3/g)	4024.7	5797.86	37	177315.0%	590.12	253.31	1.19E-01
Consumption of Drinking Water (ml/kg-day)	4818.1	5797.86	37	97974.0%	590.12	979.74	1.19E-01
Infiltration Rate (m/yr)	5091.6	5797.86	37	70630.0%	590.12	117.72	1.19E-01
Longitudinal Dispersivity {Aquifer} (m)	5487.2	5797.86	37	31069.0%	590.12	62.14	1.19E-01
Unsaturated Zone Thickness (m)	5638.9	5797.86	37	15897.0%	590.12	31.79	1.19E-01
Aquifer Thickness (m)	5644.2	5797.86	37	15370.0%	590.12	25.62	1.19E-01
Longitudinal Distance to Well (m)	5681.5	5797.86	37	11637.0%	590.12	29.09	1.19E-01
Average Particle Diameter (cm)	5783.3	5797.86	37	1457.0%	590.12	7.29	1.19E-01
Recharge Rate (m/yr)	5789.1	5797.86	37	873.0%	590.12	4.37	1.19E-01

Constants

Full Model SS	26
Error SS	11
Error DF	0
MS Error	4962

Table D-81. Summary of Parameters Considered in Sensitivity Analysis for Arsenic

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
EXPDURA					
CANSLOPE		C			
ACIDCAT	Acid Catalyzed Hydrolysis Rate Constant	C			
ANGLEW	Angle of Well Off Plume Centerline	anglew			
ANISORAT	Anisotropy Ratio	C			
AQUTHIK	Aquifer Thickness	aquthik		Y	Y
AVGPDIAM	Avg. Particle Diameter	log(avgpdiam+0.001)		Y	Y
BASECAT	Base Catalyzed Hydrolysis Rate Constant	C			
BIODRATA	Biodegradation Rate	C			
BIODRATU	Biodegradation Rate	C			
BULKDENS	Bulk Density	bulkdens**3.5	Y		
CHEMDRU	Chemical Decay Rate	C			
CHEMDRA	Chemical Decay Rate	C			
CONSH2OA	Consump of drinking water	log(consh2oa)			Y
ZDIST	Depth of Well Below Water Table	log(zdist+2)		Y	
DISHYD	Dissolved Hydrolysis Rate	C			
YDIST	Distance from Plume Centerline to Well	log(ydist+100)		Y	Y
DURLEACH	Duration of Leaching Period	C			
GWAVTIM	Exposure Duration	log(gwavtim)		Y	Y
FRORGCAR	Fraction Organic Carbon	log(frorgcar)		Y	
FRCOEFA	Freundlich Isotherm Coefficient	log(frcoefa+0.5)		Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	log(frcoefu+0.5)		Y	Y
FREXPA	Freundlich Isotherm Exponent	C			
FREXPU	Freundlich Isotherm Exponent	C			
GWPH	Groundwater pH	gwph	Y		
GWSEEPV	Groundwater Seepage Velocity	log(gwseepv-70)			
GWTEMP	Groundwater Temperature	C			
HYDGRAD	Hydraulic Gradient	C			
INFILRAT	Infiltration Rate	infilrat**0.001		Y	Y
LANDEPTH	Landfill Depth	C			
LEACHCON	Leachate Concentration	C			
LFFRACT	LF Fraction	C			
LONDISPA	Longitudinal Dispersivity	log(londispa+10)		Y	Y

Table D-81. Summary of Parameters Considered in Sensitivity Analysis for Arsenic

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
LONDISPU	Longitudinal Dispersivity	log(londispu)	Y		
XDIST	Longitudinal Distance to Well	log(xdist+5000)		Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity	C			
MOISTRPA	Moisture Rention Parameter (a)	log(moistrpa-0.05)	Y		
MOISTRPB	Moisture Rention Parameter (b)	log(moistrpb-0.8)	Y		
MOLDIFF	Molecular Diffusion Coefficient	C			
NEUTHYD	Neutral Hydrolysis Rate Constant	C			
ORGCDIS	Organic Carbon Distribution Coefficient	C			
PERORGM	Percent Organic Matter	log(perorgm)			
POROSITY	Porosity	porosity**1.1	Y		
RADISTW	Radial Distance to Well	log(radistw+250)	Y		
RECHARAT	Recharge Rate	log(recharat)		Y	
RESIDH2O	Residual Water Content	residh2o**1.8		Y	
RETCOEF	Retardation Coefficient	log(retcoef)	Y		
SATHYCON	Saturated Hydraulic Conductivity	log(sathycon+0.1)	Y		
SATURH2O	Saturated Water Content	log(saturh2o)	Y		
SOILBDEN	Soil Bulk Density	log(soilbden)	Y		
SORBHYD	Sorbed Hydrolysis Rate	C			
TRANDISP	Transverse Dispersivity	log(trandisp+1)	Y		
UNSATHIK	Unsaturated Zone Thickness	log(unsathik+1)		Y	Y
VERTDISP	Vertical Dispersivity	log(vertdisp+0.05)	Y		
WASTDENS	Waste Density	C			
WASTEVOL	Waste Volume	C			
WMUAREA	WMU Area	C			
WMULEN	WMU Length	C			
WMUWIDTH	WMU Width	C			

Table D-82. Summary of Correlated Parameters for Arsenic

Variable 1		Variable 2		Correlation Coefficient
Code	**Description**	**Code**	**Description**	
GWSEEPV	Groundwater Seepage Velocity	POROSITY	Porosity	-0.99528
AVGPDIAM	Avg. Particle Diameter	BULKDENS	Bulk Density	0.99828
FRCOEFA	Freundlich Isotherm Coefficient	RETCOEF	Retardation Coefficient	0.98478
LONDISPA	Longitudinal Dispersivity	TRANDISP	Transverse Dispersivity	0.99983
LONDISPA	Longitudinal Dispersivity	VERTDISP	Vertical Dispersivity	0.99984
RECHARAT	Recharge Rate	GWPH	Groundwater pH	-1
SATHYCON	Saturated Hydraulic Conductivity	GWPH	Groundwater pH	-0.70462
MOISTRPA	Moisture Rention Parameter (a)	GWPH	Groundwater pH	-0.7649
MOISTRPB	Moisture Rention Parameter (b)	GWPH	Groundwater pH	-0.83974
XDIST	Longitudinal Distance to Well	RADISTW	Radial Distance to Well	0.97277
SOILBDEN	Soil Bulk Density	RECHARAT	Recharge Rate	-1
RECHARAT	Recharge Rate	SATHYCON	Saturated Hydraulic Conductivity	0.70462
SATURH2O	Saturated Water Content	SATHYCON	Saturated Hydraulic Conductivity	-0.70462
RECHARAT	Recharge Rate	MOISTRPA	Moisture Rention Parameter (a)	0.7649
SATURH2O	Saturated Water Content	MOISTRPA	Moisture Rention Parameter (a)	-0.7649
RECHARAT	Recharge Rate	MOISTRPB	Moisture Rention Parameter (b)	0.83974
SATURH2O	Saturated Water Content	MOISTRPB	Moisture Rention Parameter (b)	-0.83974
RECHARAT	Recharge Rate	SATURH2O	Saturated Water Content	-1
SATHYCON	Saturated Hydraulic Conductivity	SATURH2O	Saturated Water Content	-0.70462
MOISTRPA	Moisture Rention Parameter (a)	SATURH2O	Saturated Water Content	-0.7649
MOISTRPB	Moisture Rention Parameter (b)	SATURH2O	Saturated Water Content	-0.83974
UNSATHIK	Unsaturated Zone Thickness	LONDISPU	Longitudinal Dispersivity	0.99999
RECHARAT	Recharge Rate	SOILBDEN	Soil Bulk Density	-1
SATHYCON	Saturated Hydraulic Conductivity	SOILBDEN	Soil Bulk Density	-0.70462
MOISTRPA	Moisture Rention Parameter (a)	SOILBDEN	Soil Bulk Density	-0.7649
MOISTRPB	Moisture Rention Parameter (b)	SOILBDEN	Soil Bulk Density	-0.83974

Note: Parameters in the variable 2 column were removed from the analysis.

Table D-83. Summary of Crosspairs Analysis for Arsenic

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
AVGPDIAM	Avg. Particle Diameter			Y	Y
AQUTHIK	Aquifer Thickness			Y	Y
GWSEEPV	Groundwater Seepage Velocity				
LONDISPA	Longitudinal Dispersivity			Y	Y
FRORGCAR	Fraction Organic Carbon			Y	
ANGLEW	Angle of Well Off Plume Centerline				
XDIST	Longitudinal Distance to Well			Y	Y
YDIST	Distance from Plume Centerline to Well			Y	Y
ZDIST	Depth of Well Below Water Table				
FRCOEFA	Freundlich Isotherm Coefficient			Y	Y
GWAVTIM	Exposure Duration				
RECHARAT	Recharge Rate				
INFILRAT	Infiltration Rate			Y	Y
RESIDH2O	Residual Water Content				
UNSATHIK	Unsaturated Zone Thickness			Y	Y
PERORGM	Percent Organic Matter				
FRCOEFU	Freundlich Isotherm Coefficient			Y	Y
AVGPDIAM	Avg. Particle Diameter	AVGPDIAM	Avg. Particle Diameter		
AQUTHIK	Aquifer Thickness	AVGPDIAM	Avg. Particle Diameter		
AQUTHIK	Aquifer Thickness	AQUTHIK	Aquifer Thickness	Y	
GWSEEPV	Groundwater Seepage Velocity	AVGPDIAM	Avg. Particle Diameter		
GWSEEPV	Groundwater Seepage Velocity	AQUTHIK	Aquifer Thickness		
GWSEEPV	Groundwater Seepage Velocity	GWSEEPV	Groundwater Seepage Velocity		
LONDISPA	Longitudinal Dispersivity	AVGPDIAM	Avg. Particle Diameter		
LONDISPA	Longitudinal Dispersivity	AQUTHIK	Aquifer Thickness	Y	Y
LONDISPA	Longitudinal Dispersivity	GWSEEPV	Groundwater Seepage Velocity		
LONDISPA	Longitudinal Dispersivity	LONDISPA	Longitudinal Dispersivity	Y	
FRORGCAR	Fraction Organic Carbon	AVGPDIAM	Avg. Particle Diameter		
FRORGCAR	Fraction Organic Carbon	AQUTHIK	Aquifer Thickness		
FRORGCAR	Fraction Organic Carbon	GWSEEPV	Groundwater Seepage Velocity		
FRORGCAR	Fraction Organic Carbon	LONDISPA	Longitudinal Dispersivity		
FRORGCAR	Fraction Organic Carbon	FRORGCAR	Fraction Organic Carbon		
ANGLEW	Angle of Well Off Plume Centerline	AVGPDIAM	Avg. Particle Diameter		
ANGLEW	Angle of Well Off Plume Centerline	AQUTHIK	Aquifer Thickness		
ANGLEW	Angle of Well Off Plume Centerline	GWSEEPV	Groundwater Seepage Velocity		
ANGLEW	Angle of Well Off Plume Centerline	LONDISPA	Longitudinal Dispersivity		
ANGLEW	Angle of Well Off Plume Centerline	FRORGCAR	Fraction Organic Carbon		
ANGLEW	Angle of Well Off Plume Centerline	ANGLEW	Angle of Well Off Plume Centerline		
XDIST	Longitudinal Distance to Well	AVGPDIAM	Avg. Particle Diameter		
XDIST	Longitudinal Distance to Well	AQUTHIK	Aquifer Thickness		
XDIST	Longitudinal Distance to Well	GWSEEPV	Groundwater Seepage Velocity		
XDIST	Longitudinal Distance to Well	LONDISPA	Longitudinal Dispersivity	Y	Y
XDIST	Longitudinal Distance to Well	FRORGCAR	Fraction Organic Carbon		
XDIST	Longitudinal Distance to Well	ANGLEW	Angle of Well Off Plume Centerline		
XDIST	Longitudinal Distance to Well	XDIST	Longitudinal Distance to Well		
YDIST	Distance from Plume Centerline to Well	AVGPDIAM	Avg. Particle Diameter		
YDIST	Distance from Plume Centerline to Well	AQUTHIK	Aquifer Thickness		
YDIST	Distance from Plume Centerline to Well	GWSEEPV	Groundwater Seepage Velocity		
YDIST	Distance from Plume Centerline to Well	LONDISPA	Longitudinal Dispersivity	Y	Y

Table D-83. Summary of Crosspairs Analysis for Arsenic

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
YDIST	Distance from Plume Centerline to Well	FRORGCAR	Fraction Organic Carbon		
YDIST	Distance from Plume Centerline to Well	ANGLEW	Angle of Well Off Plume Centerline		
YDIST	Distance from Plume Centerline to Well	XDIST	Longitudinal Distance to Well	Y	Y
YDIST	Distance from Plume Centerline to Well	YDIST	Distance from Plume Centerline to Well	Y	Y
ZDIST	Depth of Well Below Water Table	AVGPDIAM	Avg. Particle Diameter		
ZDIST	Depth of Well Below Water Table	AQUTHIK	Aquifer Thickness		
ZDIST	Depth of Well Below Water Table	GWSEEPV	Groundwater Seepage Velocity		
ZDIST	Depth of Well Below Water Table	LONDISPA	Longitudinal Dispersivity		
ZDIST	Depth of Well Below Water Table	FRORGCAR	Fraction Organic Carbon		
ZDIST	Depth of Well Below Water Table	ANGLEW	Angle of Well Off Plume Centerline		
ZDIST	Depth of Well Below Water Table	XDIST	Longitudinal Distance to Well		
ZDIST	Depth of Well Below Water Table	YDIST	Distance from Plume Centerline to Well		
ZDIST	Depth of Well Below Water Table	ZDIST	Depth of Well Below Water Table		
FRCOEFA	Freundlich Isotherm Coefficient	AVGPDIAM	Avg. Particle Diameter	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	AQUTHIK	Aquifer Thickness	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	GWSEEPV	Groundwater Seepage Velocity		
FRCOEFA	Freundlich Isotherm Coefficient	LONDISPA	Longitudinal Dispersivity	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	FRORGCAR	Fraction Organic Carbon	Y	
FRCOEFA	Freundlich Isotherm Coefficient	ANGLEW	Angle of Well Off Plume Centerline		
FRCOEFA	Freundlich Isotherm Coefficient	XDIST	Longitudinal Distance to Well	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	YDIST	Distance from Plume Centerline to Well	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	ZDIST	Depth of Well Below Water Table		
FRCOEFA	Freundlich Isotherm Coefficient	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
GWAVTIM	Exposure Duration	AVGPDIAM	Avg. Particle Diameter		
GWAVTIM	Exposure Duration	AQUTHIK	Aquifer Thickness		
GWAVTIM	Exposure Duration	GWSEEPV	Groundwater Seepage Velocity		
GWAVTIM	Exposure Duration	LONDISPA	Longitudinal Dispersivity		
GWAVTIM	Exposure Duration	FRORGCAR	Fraction Organic Carbon		
GWAVTIM	Exposure Duration	ANGLEW	Angle of Well Off Plume Centerline		
GWAVTIM	Exposure Duration	XDIST	Longitudinal Distance to Well		
GWAVTIM	Exposure Duration	YDIST	Distance from Plume Centerline to Well		
GWAVTIM	Exposure Duration	ZDIST	Depth of Well Below Water Table		
GWAVTIM	Exposure Duration	FRCOEFA	Freundlich Isotherm Coefficient		
GWAVTIM	Exposure Duration	GWAVTIM	Exposure Duration		
RECHARAT	Recharge Rate	AVGPDIAM	Avg. Particle Diameter		
RECHARAT	Recharge Rate	AQUTHIK	Aquifer Thickness		
RECHARAT	Recharge Rate	GWSEEPV	Groundwater Seepage Velocity		
RECHARAT	Recharge Rate	LONDISPA	Longitudinal Dispersivity		
RECHARAT	Recharge Rate	FRORGCAR	Fraction Organic Carbon		
RECHARAT	Recharge Rate	ANGLEW	Angle of Well Off Plume Centerline		
RECHARAT	Recharge Rate	XDIST	Longitudinal Distance to Well		
RECHARAT	Recharge Rate	YDIST	Distance from Plume Centerline to Well		
RECHARAT	Recharge Rate	ZDIST	Depth of Well Below Water Table	Y	
RECHARAT	Recharge Rate	FRCOEFA	Freundlich Isotherm Coefficient	Y	
RECHARAT	Recharge Rate	GWAVTIM	Exposure Duration		
RECHARAT	Recharge Rate	RECHARAT	Recharge Rate		
INFILRAT	Infiltration Rate	AVGPDIAM	Avg. Particle Diameter		
INFILRAT	Infiltration Rate	AQUTHIK	Aquifer Thickness		
INFILRAT	Infiltration Rate	GWSEEPV	Groundwater Seepage Velocity		

Table D-83. Summary of Crosspairs Analysis for Arsenic

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
INFILRAT	Infiltration Rate	LONDISPA	Longitudinal Dispersivity	Y	Y
INFILRAT	Infiltration Rate	FRORGCAR	Fraction Organic Carbon		
INFILRAT	Infiltration Rate	ANGLEW	Angle of Well Off Plume Centerline		
INFILRAT	Infiltration Rate	XDIST	Longitudinal Distance to Well		
INFILRAT	Infiltration Rate	YDIST	Distance from Plume Centerline to Well	Y	Y
INFILRAT	Infiltration Rate	ZDIST	Depth of Well Below Water Table		
INFILRAT	Infiltration Rate	FRCOEFA	Freundlich Isotherm Coefficient		
INFILRAT	Infiltration Rate	GWAVTIM	Exposure Duration		
INFILRAT	Infiltration Rate	RECHARAT	Recharge Rate		
INFILRAT	Infiltration Rate	INFILRAT	Infiltration Rate		
RESIDH2O	Residual Water Content	AVGPDIAM	Avg. Particle Diameter		
RESIDH2O	Residual Water Content	AQUTHIK	Aquifer Thickness		
RESIDH2O	Residual Water Content	GWSEEPV	Groundwater Seepage Velocity		
RESIDH2O	Residual Water Content	LONDISPA	Longitudinal Dispersivity		
RESIDH2O	Residual Water Content	FRORGCAR	Fraction Organic Carbon		
RESIDH2O	Residual Water Content	ANGLEW	Angle of Well Off Plume Centerline		
RESIDH2O	Residual Water Content	XDIST	Longitudinal Distance to Well		
RESIDH2O	Residual Water Content	YDIST	Distance from Plume Centerline to Well		
RESIDH2O	Residual Water Content	ZDIST	Depth of Well Below Water Table		
RESIDH2O	Residual Water Content	FRCOEFA	Freundlich Isotherm Coefficient	Y	
RESIDH2O	Residual Water Content	GWAVTIM	Exposure Duration		
RESIDH2O	Residual Water Content	RECHARAT	Recharge Rate		
RESIDH2O	Residual Water Content	INFILRAT	Infiltration Rate		
RESIDH2O	Residual Water Content	RESIDH2O	Residual Water Content		
UNSATHIK	Unsaturated Zone Thickness	AVGPDIAM	Avg. Particle Diameter		
UNSATHIK	Unsaturated Zone Thickness	AQUTHIK	Aquifer Thickness		
UNSATHIK	Unsaturated Zone Thickness	GWSEEPV	Groundwater Seepage Velocity		
UNSATHIK	Unsaturated Zone Thickness	LONDISPA	Longitudinal Dispersivity		
UNSATHIK	Unsaturated Zone Thickness	FRORGCAR	Fraction Organic Carbon		
UNSATHIK	Unsaturated Zone Thickness	ANGLEW	Angle of Well Off Plume Centerline		
UNSATHIK	Unsaturated Zone Thickness	XDIST	Longitudinal Distance to Well		
UNSATHIK	Unsaturated Zone Thickness	YDIST	Distance from Plume Centerline to Well		
UNSATHIK	Unsaturated Zone Thickness	ZDIST	Depth of Well Below Water Table		
UNSATHIK	Unsaturated Zone Thickness	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
UNSATHIK	Unsaturated Zone Thickness	GWAVTIM	Exposure Duration		
UNSATHIK	Unsaturated Zone Thickness	RECHARAT	Recharge Rate		
UNSATHIK	Unsaturated Zone Thickness	INFILRAT	Infiltration Rate		
UNSATHIK	Unsaturated Zone Thickness	RESIDH2O	Residual Water Content		
UNSATHIK	Unsaturated Zone Thickness	UNSATHIK	Unsaturated Zone Thickness	Y	Y
PERORGM	Percent Organic Matter	AVGPDIAM	Avg. Particle Diameter		
PERORGM	Percent Organic Matter	AQUTHIK	Aquifer Thickness		
PERORGM	Percent Organic Matter	GWSEEPV	Groundwater Seepage Velocity		
PERORGM	Percent Organic Matter	LONDISPA	Longitudinal Dispersivity		
PERORGM	Percent Organic Matter	FRORGCAR	Fraction Organic Carbon		
PERORGM	Percent Organic Matter	ANGLEW	Angle of Well Off Plume Centerline		
PERORGM	Percent Organic Matter	XDIST	Longitudinal Distance to Well		
PERORGM	Percent Organic Matter	YDIST	Distance from Plume Centerline to Well		
PERORGM	Percent Organic Matter	ZDIST	Depth of Well Below Water Table		
PERORGM	Percent Organic Matter	FRCOEFA	Freundlich Isotherm Coefficient		

Table D-83. Summary of Crosspairs Analysis for Arsenic

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
PERORGM	Percent Organic Matter	GWAVTIM	Exposure Duration		
PERORGM	Percent Organic Matter	RECHARAT	Recharge Rate		
PERORGM	Percent Organic Matter	INFILRAT	Infiltration Rate		
PERORGM	Percent Organic Matter	RESIDH2O	Residual Water Content		
PERORGM	Percent Organic Matter	UNSATHIK	Unsaturated Zone Thickness		
PERORGM	Percent Organic Matter	PERORGM	Percent Organic Matter		
FRCOEFU	Freundlich Isotherm Coefficient	AVGPDIAM	Avg. Particle Diameter	Y	
FRCOEFU	Freundlich Isotherm Coefficient	AQUTHIK	Aquifer Thickness		
FRCOEFU	Freundlich Isotherm Coefficient	GWSEEPV	Groundwater Seepage Velocity		
FRCOEFU	Freundlich Isotherm Coefficient	LONDISPA	Longitudinal Dispersivity	Y	
FRCOEFU	Freundlich Isotherm Coefficient	FRORGCAR	Fraction Organic Carbon	Y	
FRCOEFU	Freundlich Isotherm Coefficient	ANGLEW	Angle of Well Off Plume Centerline		
FRCOEFU	Freundlich Isotherm Coefficient	XDIST	Longitudinal Distance to Well		
FRCOEFU	Freundlich Isotherm Coefficient	YDIST	Distance from Plume Centerline to Well	Y	
FRCOEFU	Freundlich Isotherm Coefficient	ZDIST	Depth of Well Below Water Table		
FRCOEFU	Freundlich Isotherm Coefficient	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	GWAVTIM	Exposure Duration	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	RECHARAT	Recharge Rate		
FRCOEFU	Freundlich Isotherm Coefficient	INFILRAT	Infiltration Rate	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	RESIDH2O	Residual Water Content		
FRCOEFU	Freundlich Isotherm Coefficient	UNSATHIK	Unsaturated Zone Thickness	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	PERORGM	Percent Organic Matter		
FRCOEFU	Freundlich Isotherm Coefficient	FRCOEFU	Freundlich Isotherm Coefficient	Y	Y

Table D-84. Ranking of Parameters According to Percentage of Risk for Arsenic

Variable Description	Reduced Sums of Square	Variable Sums of Square	Variable Degrees of Freedom	% Risk Variation	Mean Square Variable	F VALUE	P VALUE
Freundlich Isotherm Coefficient {Aquifer} (cm3/g)	22328.4	91497.95	32	6916954.0%	12694.65	7685.50	2.56E+00
Freundlich Isotherm Coefficient {Unsaturated} (cm3/g)	64345.9	91497.95	32	2715208.0%	12694.65	4525.35	2.56E+00
Distance from Plume Centerline to Well (m)	84033.8	91497.95	32	746411.0%	12694.65	1244.02	2.56E+00
Infiltration Rate (m/yr)	88321.4	91497.95	32	317653.0%	12694.65	794.13	2.56E+00
Unsaturated Zone Thickness (m)	88453.5	91497.95	32	304449.0%	12694.65	761.12	2.56E+00
Longitudinal Dispersivity {Aquifer} (m)	88943.5	91497.95	32	255444.0%	12694.65	425.74	2.56E+00
Exposure Duration (yr)	89736.3	91497.95	32	176170.0%	12694.65	1761.70	2.56E+00
Aquifer Thickness (m)	90359.2	91497.95	32	113873.0%	12694.65	379.58	2.56E+00
Consumption of Drinking Water (ml/kg-day)	90506.9	91497.95	32	99102.0%	12694.65	991.02	2.56E+00
Longitudinal Distance to Well (m)	90581.8	91497.95	32	91615.0%	12694.65	229.04	2.56E+00
Average Particle Diameter (cm)	91243.9	91497.95	32	25410.0%	12694.65	127.05	2.56E+00
Groundwater Averaging Time (yr)	91474.6	91497.95	32	2336.0%	12694.65	11.68	2.56E+00

Constants

Full Model SS	23
Error SS	9
Error DF	1
MS Error	4967

Table D-85. Summary of Parameters Considered in Sensitivity Analysis for Molybdenum

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
EXPDURA		C			
CANSLOPE		C			
ACIDCAT	Acid Catalyzed Hydrolysis Rate Constant	C			
ANGLEW	Angle of Well Off Plume Centerline	anglew		Y	
ANISORAT	Anisotropy Ratio	C			
AQUTHIK	Aquifer Thickness	aquthik		Y	Y
AVGPDIAM	Avg. Particle Diameter	log(avgpdiam+0.004)		Y	Y
BASECAT	Base Catalyzed Hydrolysis Rate Constant	C			
BIODRATA	Biodegradation Rate	C			
BIODRATU	Biodegradation Rate	C			
BULKDENS	Bulk Density	bulkdens**3.5	Y		
CHEMDRU	Chemical Decay Rate	C			
CHEMDRA	Chemical Decay Rate	C			
CONSH2OA	Consump of drinking water	log(consh2oa)			Y
ZDIST	Depth of Well Below Water Table	log(zdist+3)		Y	
DISHYD	Dissolved Hydrolysis Rate	C			
YDIST	Distance from Plume Centerline to Well	log(ydist+50)		Y	Y
DURLEACH	Duration of Leaching Period	C			
GWAVTIM	Exposure Duration	C			
FRORGCAR	Fraction Organic Carbon	log(frorgcar)			
FRCOEFA	Freundlich Isotherm Coefficient	log(frcoefa-0.5)		Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	log(frcoefu)		Y	Y
FREXPA	Freundlich Isotherm Exponent	C			
FREXPU	Freundlich Isotherm Exponent	C			
GWPH	Groundwater pH	gwph	Y		
GWSEEPV	Groundwater Seepage Velocity	log(gwseepv-70)		Y	
GWTEMP	Groundwater Temperature	C			
HYDGRAD	Hydraulic Gradient	C			
INFILRAT	Infiltration Rate	infilrat**0.001		Y	Y
LANDEPTH	Landfill Depth	C			
LEACHCON	Leachate Concentration	C			
LFFRACT	LF Fraction	C			
LONDISPA	Longitudinal Dispersivity	log(londispa)		Y	Y

Table D-85. Summary of Parameters Considered in Sensitivity Analysis for Molybdenum

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
LONDISPU	Longitudinal Dispersivity	log(londispu)	Y		
XDIST	Longitudinal Distance to Well	log(xdist+250)		Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity	C			
MOISTRPA	Moisture Rention Parameter (a)	log(moistrpa-0.05)	Y		
MOISTRPB	Moisture Rention Parameter (b)	moistrpb**-3	Y		
MOLDIFF	Molecular Diffusion Coefficient	C			
NEUTHYD	Neutral Hydrolysis Rate Constant	C			
ORGCDIS	Organic Carbon Distribution Coefficient	C			
PERORGM	Percent Organic Matter	log(perorgm)		Y	
POROSITY	Porosity	porosity**1.3	Y		
RADISTW	Radial Distance to Well	log(radistw+250)	Y		
RECHARAT	Recharge Rate	recharat		Y	Y
RESIDH2O	Residual Water Content	residh2o**1.8		Y	
RETCOEF	Retardation Coefficient	log(retcoef-3)	Y		
SATHYCON	Saturated Hydraulic Conductivity	log(sathycon-0.1)	Y		
SATURH2O	Saturated Water Content	saturh2o	Y		
SOILBDEN	Soil Bulk Density	soilbden	Y		
SORBHYD	Sorbed Hydrolysis Rate	C			
TRANDISP	Transverse Dispersivity	log(trandisp+0.01)	Y		
UNSATHIK	Unsaturated Zone Thickness	unsathik**-0.01		Y	Y
VERTDISP	Vertical Dispersivity	log(vertdisp-0.004)	Y		
WASTDENS	Waste Density	C			
WASTEVOL	Waste Volume	C			
WMUAREA	WMU Area	C			
WMULEN	WMU Length	C			
WMUWIDTH	WMU Width	C			

Table D-86. Summary of Correlated Parameters for Molybdenum

Variable 1		Variable 2		Correlation Coefficient
Code	**Description**	**Code**	**Description**	
GWSEEPV	Groundwater Seepage Velocity	POROSITY	Porosity	-0.9915
AVGPDIAM	Avg. Particle Diameter	BULKDENS	Bulk Density	0.99606
FRCOEFA	Freundlich Isotherm Coefficient	RETCOEF	Retardation Coefficient	0.95589
LONDISPA	Longitudinal Dispersivity	TRANDISP	Transverse Dispersivity	0.99994
LONDISPA	Longitudinal Dispersivity	VERTDISP	Vertical Dispersivity	0.99554
RECHARAT	Recharge Rate	GWPH	Groundwater pH	-1
SATHYCON	Saturated Hydraulic Conductivity	GWPH	Groundwater pH	-0.70196
MOISTRPA	Moisture Rention Parameter (a)	GWPH	Groundwater pH	-0.76048
MOISTRPB	Moisture Rention Parameter (b)	GWPH	Groundwater pH	0.78712
XDIST	Longitudinal Distance to Well	RADISTW	Radial Distance to Well	0.9906
SOILBDEN	Soil Bulk Density	RECHARAT	Recharge Rate	-1
RECHARAT	Recharge Rate	SATHYCON	Saturated Hydraulic Conductivity	0.70196
SATURH2O	Saturated Water Content	SATHYCON	Saturated Hydraulic Conductivity	-0.70196
RECHARAT	Recharge Rate	MOISTRPA	Moisture Rention Parameter (a)	0.76048
SATURH2O	Saturated Water Content	MOISTRPA	Moisture Rention Parameter (a)	-0.76048
RECHARAT	Recharge Rate	MOISTRPB	Moisture Rention Parameter (b)	-0.78712
SATURH2O	Saturated Water Content	MOISTRPB	Moisture Rention Parameter (b)	0.78712
RECHARAT	Recharge Rate	SATURH2O	Saturated Water Content	-1
SATHYCON	Saturated Hydraulic Conductivity	SATURH2O	Saturated Water Content	-0.70196
MOISTRPA	Moisture Rention Parameter (a)	SATURH2O	Saturated Water Content	-0.76048
MOISTRPB	Moisture Rention Parameter (b)	SATURH2O	Saturated Water Content	0.78712
UNSATHIK	Unsaturated Zone Thickness	LONDISPU	Longitudinal Dispersivity	-0.9958
RECHARAT	Recharge Rate	SOILBDEN	Soil Bulk Density	-1
SATHYCON	Saturated Hydraulic Conductivity	SOILBDEN	Soil Bulk Density	-0.70196
MOISTRPA	Moisture Rention Parameter (a)	SOILBDEN	Soil Bulk Density	-0.76048
MOISTRPB	Moisture Rention Parameter (b)	SOILBDEN	Soil Bulk Density	0.78712

Note: Parameters in the variable 2 column were removed from the analysis.

Table D-87. Summary of Crosspairs Analysis for Molybdenum

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
AVGPDIAM	Avg. Particle Diameter			Y	Y
AQUTHIK	Aquifer Thickness			Y	Y
GWSEEPV	Groundwater Seepage Velocity				
LONDISPA	Longitudinal Dispersivity			Y	Y
FRORGCAR	Fraction Organic Carbon				
ANGLEW	Angle of Well Off Plume Centerline				
XDIST	Longitudinal Distance to Well			Y	Y
YDIST	Distance from Plume Centerline to Well			Y	Y
ZDIST	Depth of Well Below Water Table				
FRCOEFA	Freundlich Isotherm Coefficient			Y	Y
RECHARAT	Recharge Rate			Y	Y
INFILRAT	Infiltration Rate			Y	Y
RESIDH2O	Residual Water Content				
UNSATHIK	Unsaturated Zone Thickness			Y	Y
PERORGM	Percent Organic Matter				
FRCOEFU	Freundlich Isotherm Coefficient			Y	Y
AVGPDIAM	Avg. Particle Diameter	AVGPDIAM	Avg. Particle Diameter		
AQUTHIK	Aquifer Thickness	AVGPDIAM	Avg. Particle Diameter		
AQUTHIK	Aquifer Thickness	AQUTHIK	Aquifer Thickness	Y	Y
GWSEEPV	Groundwater Seepage Velocity	AVGPDIAM	Avg. Particle Diameter		
GWSEEPV	Groundwater Seepage Velocity	AQUTHIK	Aquifer Thickness		
GWSEEPV	Groundwater Seepage Velocity	GWSEEPV	Groundwater Seepage Velocity		
LONDISPA	Longitudinal Dispersivity	AVGPDIAM	Avg. Particle Diameter		
LONDISPA	Longitudinal Dispersivity	AQUTHIK	Aquifer Thickness	Y	Y
LONDISPA	Longitudinal Dispersivity	GWSEEPV	Groundwater Seepage Velocity		
LONDISPA	Longitudinal Dispersivity	LONDISPA	Longitudinal Dispersivity	Y	Y
FRORGCAR	Fraction Organic Carbon	AVGPDIAM	Avg. Particle Diameter		
FRORGCAR	Fraction Organic Carbon	AQUTHIK	Aquifer Thickness		
FRORGCAR	Fraction Organic Carbon	GWSEEPV	Groundwater Seepage Velocity		
FRORGCAR	Fraction Organic Carbon	LONDISPA	Longitudinal Dispersivity		
FRORGCAR	Fraction Organic Carbon	FRORGCAR	Fraction Organic Carbon		
ANGLEW	Angle of Well Off Plume Centerline	AVGPDIAM	Avg. Particle Diameter		
ANGLEW	Angle of Well Off Plume Centerline	AQUTHIK	Aquifer Thickness		
ANGLEW	Angle of Well Off Plume Centerline	GWSEEPV	Groundwater Seepage Velocity		
ANGLEW	Angle of Well Off Plume Centerline	LONDISPA	Longitudinal Dispersivity		
ANGLEW	Angle of Well Off Plume Centerline	FRORGCAR	Fraction Organic Carbon		
ANGLEW	Angle of Well Off Plume Centerline	ANGLEW	Angle of Well Off Plume Centerline		
XDIST	Longitudinal Distance to Well	AVGPDIAM	Avg. Particle Diameter		
XDIST	Longitudinal Distance to Well	AQUTHIK	Aquifer Thickness		
XDIST	Longitudinal Distance to Well	GWSEEPV	Groundwater Seepage Velocity		
XDIST	Longitudinal Distance to Well	LONDISPA	Longitudinal Dispersivity		
XDIST	Longitudinal Distance to Well	FRORGCAR	Fraction Organic Carbon		
XDIST	Longitudinal Distance to Well	ANGLEW	Angle of Well Off Plume Centerline		
XDIST	Longitudinal Distance to Well	XDIST	Longitudinal Distance to Well	Y	Y
YDIST	Distance from Plume Centerline to Well	AVGPDIAM	Avg. Particle Diameter		
YDIST	Distance from Plume Centerline to Well	AQUTHIK	Aquifer Thickness		
YDIST	Distance from Plume Centerline to Well	GWSEEPV	Groundwater Seepage Velocity		
YDIST	Distance from Plume Centerline to Well	LONDISPA	Longitudinal Dispersivity	Y	Y
YDIST	Distance from Plume Centerline to Well	FRORGCAR	Fraction Organic Carbon		

Table D-87. Summary of Crosspairs Analysis for Molybdenum

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
YDIST	Distance from Plume Centerline to Well	ANGLEW	Angle of Well Off Plume Centerline		
YDIST	Distance from Plume Centerline to Well	XDIST	Longitudinal Distance to Well	Y	Y
YDIST	Distance from Plume Centerline to Well	YDIST	Distance from Plume Centerline to Well	Y	Y
ZDIST	Depth of Well Below Water Table	AVGPDIAM	Avg. Particle Diameter		
ZDIST	Depth of Well Below Water Table	AQUTHIK	Aquifer Thickness		
ZDIST	Depth of Well Below Water Table	GWSEEPV	Groundwater Seepage Velocity		
ZDIST	Depth of Well Below Water Table	LONDISPA	Longitudinal Dispersivity		
ZDIST	Depth of Well Below Water Table	FRORGCAR	Fraction Organic Carbon		
ZDIST	Depth of Well Below Water Table	ANGLEW	Angle of Well Off Plume Centerline		
ZDIST	Depth of Well Below Water Table	XDIST	Longitudinal Distance to Well		
ZDIST	Depth of Well Below Water Table	YDIST	Distance from Plume Centerline to Well		
ZDIST	Depth of Well Below Water Table	ZDIST	Depth of Well Below Water Table	Y	
FRCOEFA	Freundlich Isotherm Coefficient	AVGPDIAM	Avg. Particle Diameter	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	AQUTHIK	Aquifer Thickness	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	GWSEEPV	Groundwater Seepage Velocity		
FRCOEFA	Freundlich Isotherm Coefficient	LONDISPA	Longitudinal Dispersivity	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	FRORGCAR	Fraction Organic Carbon		
FRCOEFA	Freundlich Isotherm Coefficient	ANGLEW	Angle of Well Off Plume Centerline		
FRCOEFA	Freundlich Isotherm Coefficient	XDIST	Longitudinal Distance to Well	Y	
FRCOEFA	Freundlich Isotherm Coefficient	YDIST	Distance from Plume Centerline to Well	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	ZDIST	Depth of Well Below Water Table		
FRCOEFA	Freundlich Isotherm Coefficient	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
RECHARAT	Recharge Rate	AVGPDIAM	Avg. Particle Diameter		
RECHARAT	Recharge Rate	AQUTHIK	Aquifer Thickness	Y	
RECHARAT	Recharge Rate	GWSEEPV	Groundwater Seepage Velocity		
RECHARAT	Recharge Rate	LONDISPA	Longitudinal Dispersivity		
RECHARAT	Recharge Rate	FRORGCAR	Fraction Organic Carbon		
RECHARAT	Recharge Rate	ANGLEW	Angle of Well Off Plume Centerline		
RECHARAT	Recharge Rate	XDIST	Longitudinal Distance to Well		
RECHARAT	Recharge Rate	YDIST	Distance from Plume Centerline to Well	Y	Y
RECHARAT	Recharge Rate	ZDIST	Depth of Well Below Water Table		
RECHARAT	Recharge Rate	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
RECHARAT	Recharge Rate	RECHARAT	Recharge Rate		
INFILRAT	Infiltration Rate	AVGPDIAM	Avg. Particle Diameter		
INFILRAT	Infiltration Rate	AQUTHIK	Aquifer Thickness	Y	Y
INFILRAT	Infiltration Rate	GWSEEPV	Groundwater Seepage Velocity		
INFILRAT	Infiltration Rate	LONDISPA	Longitudinal Dispersivity	Y	
INFILRAT	Infiltration Rate	FRORGCAR	Fraction Organic Carbon		
INFILRAT	Infiltration Rate	ANGLEW	Angle of Well Off Plume Centerline		
INFILRAT	Infiltration Rate	XDIST	Longitudinal Distance to Well		
INFILRAT	Infiltration Rate	YDIST	Distance from Plume Centerline to Well	Y	Y
INFILRAT	Infiltration Rate	ZDIST	Depth of Well Below Water Table		
INFILRAT	Infiltration Rate	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
INFILRAT	Infiltration Rate	RECHARAT	Recharge Rate		
INFILRAT	Infiltration Rate	INFILRAT	Infiltration Rate	Y	
RESIDH2O	Residual Water Content	AVGPDIAM	Avg. Particle Diameter		
RESIDH2O	Residual Water Content	AQUTHIK	Aquifer Thickness		
RESIDH2O	Residual Water Content	GWSEEPV	Groundwater Seepage Velocity	Y	
RESIDH2O	Residual Water Content	LONDISPA	Longitudinal Dispersivity		

Table D-87. Summary of Crosspairs Analysis for Molybdenum

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
RESIDH2O	Residual Water Content	FRORGCAR	Fraction Organic Carbon		
RESIDH2O	Residual Water Content	ANGLEW	Angle of Well Off Plume Centerline		
RESIDH2O	Residual Water Content	XDIST	Longitudinal Distance to Well		
RESIDH2O	Residual Water Content	YDIST	Distance from Plume Centerline to Well		
RESIDH2O	Residual Water Content	ZDIST	Depth of Well Below Water Table		
RESIDH2O	Residual Water Content	FRCOEFA	Freundlich Isotherm Coefficient		
RESIDH2O	Residual Water Content	RECHARAT	Recharge Rate		
RESIDH2O	Residual Water Content	INFILRAT	Infiltration Rate		
RESIDH2O	Residual Water Content	RESIDH2O	Residual Water Content	Y	
UNSATHIK	Unsaturated Zone Thickness	AVGPDIAM	Avg. Particle Diameter		
UNSATHIK	Unsaturated Zone Thickness	AQUTHIK	Aquifer Thickness		
UNSATHIK	Unsaturated Zone Thickness	GWSEEPV	Groundwater Seepage Velocity		
UNSATHIK	Unsaturated Zone Thickness	LONDISPA	Longitudinal Dispersivity		
UNSATHIK	Unsaturated Zone Thickness	FRORGCAR	Fraction Organic Carbon		
UNSATHIK	Unsaturated Zone Thickness	ANGLEW	Angle of Well Off Plume Centerline		
UNSATHIK	Unsaturated Zone Thickness	XDIST	Longitudinal Distance to Well		
UNSATHIK	Unsaturated Zone Thickness	YDIST	Distance from Plume Centerline to Well	Y	Y
UNSATHIK	Unsaturated Zone Thickness	ZDIST	Depth of Well Below Water Table		
UNSATHIK	Unsaturated Zone Thickness	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
UNSATHIK	Unsaturated Zone Thickness	RECHARAT	Recharge Rate		
UNSATHIK	Unsaturated Zone Thickness	INFILRAT	Infiltration Rate	Y	Y
UNSATHIK	Unsaturated Zone Thickness	RESIDH2O	Residual Water Content		
UNSATHIK	Unsaturated Zone Thickness	UNSATHIK	Unsaturated Zone Thickness	Y	Y
PERORGM	Percent Organic Matter	AVGPDIAM	Avg. Particle Diameter		
PERORGM	Percent Organic Matter	AQUTHIK	Aquifer Thickness		
PERORGM	Percent Organic Matter	GWSEEPV	Groundwater Seepage Velocity		
PERORGM	Percent Organic Matter	LONDISPA	Longitudinal Dispersivity		
PERORGM	Percent Organic Matter	FRORGCAR	Fraction Organic Carbon		
PERORGM	Percent Organic Matter	ANGLEW	Angle of Well Off Plume Centerline		
PERORGM	Percent Organic Matter	XDIST	Longitudinal Distance to Well		
PERORGM	Percent Organic Matter	YDIST	Distance from Plume Centerline to Well		
PERORGM	Percent Organic Matter	ZDIST	Depth of Well Below Water Table	Y	
PERORGM	Percent Organic Matter	FRCOEFA	Freundlich Isotherm Coefficient		
PERORGM	Percent Organic Matter	RECHARAT	Recharge Rate		
PERORGM	Percent Organic Matter	INFILRAT	Infiltration Rate		
PERORGM	Percent Organic Matter	RESIDH2O	Residual Water Content		
PERORGM	Percent Organic Matter	UNSATHIK	Unsaturated Zone Thickness		
PERORGM	Percent Organic Matter	PERORGM	Percent Organic Matter		
FRCOEFU	Freundlich Isotherm Coefficient	AVGPDIAM	Avg. Particle Diameter	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	AQUTHIK	Aquifer Thickness	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	GWSEEPV	Groundwater Seepage Velocity		
FRCOEFU	Freundlich Isotherm Coefficient	LONDISPA	Longitudinal Dispersivity		
FRCOEFU	Freundlich Isotherm Coefficient	FRORGCAR	Fraction Organic Carbon		
FRCOEFU	Freundlich Isotherm Coefficient	ANGLEW	Angle of Well Off Plume Centerline	Y	
FRCOEFU	Freundlich Isotherm Coefficient	XDIST	Longitudinal Distance to Well		
FRCOEFU	Freundlich Isotherm Coefficient	YDIST	Distance from Plume Centerline to Well	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	ZDIST	Depth of Well Below Water Table		
FRCOEFU	Freundlich Isotherm Coefficient	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	RECHARAT	Recharge Rate		

Table D-87. Summary of Crosspairs Analysis for Molybdenum

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
FRCOEFU	Freundlich Isotherm Coefficient	INFILRAT	Infiltration Rate	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	RESIDH2O	Residual Water Content		
FRCOEFU	Freundlich Isotherm Coefficient	UNSATHIK	Unsaturated Zone Thickness	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	PERORGM	Percent Organic Matter		
FRCOEFU	Freundlich Isotherm Coefficient	FRCOEFU	Freundlich Isotherm Coefficient	Y	Y

Table D-88. Ranking of Parameters According to Percentage of Risk for Molybdenum

Variable Description	Reduced Sums of Square	Variable Sums of Square	Variable Degrees of Freedom	% Risk Variation	Mean Square Variable	F VALUE	P VALUE
Freundlich Isotherm Coefficient {Aquifer} (cm3/g)	2883.4	6601.35	40	371794.0%	588.53	338.00	1.19E-01
Distance from Plume Centerline to Well (m)	4440.5	6601.35	40	216083.0%	588.53	240.09	1.19E-01
Freundlich Isotherm Coefficient {Unsaturated} (cm3/g)	4445.9	6601.35	40	215545.0%	588.53	269.43	1.19E-01
Consumption of Drinking Water (ml/kg-day)	5605.5	6601.35	40	99588.0%	588.53	995.88	1.19E-01
Infiltration Rate (m/yr)	5858.6	6601.35	40	74271.0%	588.53	123.79	1.19E-01
Longitudinal Dispersivity {Aquifer} (m)	6275.2	6601.35	40	32615.0%	588.53	65.23	1.19E-01
Unsaturated Zone Thickness (m)	6417.7	6601.35	40	18365.0%	588.53	30.61	1.19E-01
Aquifer Thickness (m)	6425.9	6601.35	40	17541.0%	588.53	29.23	1.19E-01
Longitudinal Distance to Well (m)	6481.3	6601.35	40	12002.0%	588.53	30.00	1.19E-01
Average Particle Diameter (cm)	6585.8	6601.35	40	1553.0%	588.53	5.18	1.19E-01
Recharge Rate (m/yr)	6591.9	6601.35	40	940.0%	588.53	3.13	1.19E-01

Constants

Full Model SS	29
Error SS	11
Error DF	1
MS Error	4959

Table D-89. Summary of Parameters Considered in Sensitivity Analysis for Thallium

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
EXPDURA		C			
CANSLOPE		C			
ACIDCAT	Acid Catalyzed Hydrolysis Rate Constant	C			
ANGLEW	Angle of Well Off Plume Centerline	anglew		Y	
ANISORAT	Anisotropy Ratio	C			
AQUTHIK	Aquifer Thickness	aquthik		Y	Y
AVGPDIAM	Avg. Particle Diameter	log(avgpdiam+0.004)		Y	Y
BASECAT	Base Catalyzed Hydrolysis Rate Constant	C			
BIODRATA	Biodegradation Rate	C			
BIODRATU	Biodegradation Rate	C			
BULKDENS	Bulk Density	bulkdens**3.5	Y		
CHEMDRU	Chemical Decay Rate	C			
CHEMDRA	Chemical Decay Rate	C			
CONSH2OA	Consump of drinking water	log(consh2oa)			Y
ZDIST	Depth of Well Below Water Table	log(zdist+3)		Y	
DISHYD	Dissolved Hydrolysis Rate	C			
YDIST	Distance from Plume Centerline to Well	log(ydist+50)		Y	Y
DURLEACH	Duration of Leaching Period	C			
GWAVTIM	Exposure Duration	C			
FRORGCAR	Fraction Organic Carbon	log(frorgcar)			
FRCOEFA	Freundlich Isotherm Coefficient	log(frcoefa-0.35)		Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	log(frcoefu)		Y	Y
FREXPA	Freundlich Isotherm Exponent	C			
FREXPU	Freundlich Isotherm Exponent	C			
GWPH	Groundwater pH	gwph	Y		
GWSEEPV	Groundwater Seepage Velocity	log(gwseepv-70)		Y	
GWTEMP	Groundwater Temperature	C			
HYDGRAD	Hydraulic Gradient	C			
INFILRAT	Infiltration Rate	infilrat**0.001		Y	Y
LANDEPTH	Landfill Depth	C			
LEACHCON	Leachate Concentration	C			
LFFRACT	LF Fraction	C			
LONDISPA	Longitudinal Dispersivity	log(londispa)		Y	Y

Table D-89. Summary of Parameters Considered in Sensitivity Analysis for Thallium

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
LONDISPU	Longitudinal Dispersivity	log(londispu)	Y		
XDIST	Longitudinal Distance to Well	log(xdist+250)		Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity	C			
MOISTRPA	Moisture Rention Parameter (a)	log(moistrpa-0.05)	Y		
MOISTRPB	Moisture Rention Parameter (b)	moistrpb**-3	Y		
MOLDIFF	Molecular Diffusion Coefficient	C			
NEUTHYD	Neutral Hydrolysis Rate Constant	C			
ORGCDIS	Organic Carbon Distribution Coefficient	C			
PERORGM	Percent Organic Matter	log(perorgm)		Y	
POROSITY	Porosity	porosity**1.3	Y		
RADISTW	Radial Distance to Well	log(radistw+250)	Y		
RECHARAT	Recharge Rate	recharat		Y	Y
RESIDH2O	Residual Water Content	residh2o**1.8		Y	
RETCOEF	Retardation Coefficient	log(retcoef-2.3)	Y		
SATHYCON	Saturated Hydraulic Conductivity	log(sathycon-0.1)	Y		
SATURH2O	Saturated Water Content	saturh2o	Y		
SOILBDEN	Soil Bulk Density	soilbden	Y		
SORBHYD	Sorbed Hydrolysis Rate	C			
TRANDISP	Transverse Dispersivity	log(trandisp)	Y		
UNSATHIK	Unsaturated Zone Thickness	unsathik**-0.01		Y	Y
VERTDISP	Vertical Dispersivity	log(vertdisp-0.004)	Y		
WASTDENS	Waste Density	C			
WASTEVOL	Waste Volume	C			
WMUAREA	WMU Area	C			
WMULEN	WMU Length	C			
WMUWIDTH	WMU Width	C			

Table D-90. Summary of Correlated Parameters for Thallium

Variable 1		Variable 2		Correlation Coefficient
Code	**Description**	**Code**	**Description**	
GWSEEPV	Groundwater Seepage Velocity	POROSITY	Porosity	-0.99152
AVGPDIAM	Avg. Particle Diameter	BULKDENS	Bulk Density	0.99607
FRCOEFA	Freundlich Isotherm Coefficient	RETCOEF	Retardation Coefficient	0.95865
LONDISPA	Longitudinal Dispersivity	VERTDISP	Vertical Dispersivity	0.99564
RECHARAT	Recharge Rate	GWPH	Groundwater pH	-1
SATHYCON	Saturated Hydraulic Conductivity	GWPH	Groundwater pH	-0.70109
MOISTRPA	Moisture Rention Parameter (a)	GWPH	Groundwater pH	-0.76065
MOISTRPB	Moisture Rention Parameter (b)	GWPH	Groundwater pH	0.78806
XDIST	Longitudinal Distance to Well	RADISTW	Radial Distance to Well	0.98995
SOILBDEN	Soil Bulk Density	RECHARAT	Recharge Rate	-1
RECHARAT	Recharge Rate	SATHYCON	Saturated Hydraulic Conductivity	0.70109
SATURH2O	Saturated Water Content	SATHYCON	Saturated Hydraulic Conductivity	-0.70109
RECHARAT	Recharge Rate	MOISTRPA	Moisture Rention Parameter (a)	0.76065
SATURH2O	Saturated Water Content	MOISTRPA	Moisture Rention Parameter (a)	-0.76065
RECHARAT	Recharge Rate	MOISTRPB	Moisture Rention Parameter (b)	-0.78806
SATURH2O	Saturated Water Content	MOISTRPB	Moisture Rention Parameter (b)	0.78806
RECHARAT	Recharge Rate	SATURH2O	Saturated Water Content	-1
SATHYCON	Saturated Hydraulic Conductivity	SATURH2O	Saturated Water Content	-0.70109
MOISTRPA	Moisture Rention Parameter (a)	SATURH2O	Saturated Water Content	-0.76065
MOISTRPB	Moisture Rention Parameter (b)	SATURH2O	Saturated Water Content	0.78806
UNSATHIK	Unsaturated Zone Thickness	LONDISPU	Longitudinal Dispersivity	-0.99574
RECHARAT	Recharge Rate	SOILBDEN	Soil Bulk Density	-1
SATHYCON	Saturated Hydraulic Conductivity	SOILBDEN	Soil Bulk Density	-0.70109
MOISTRPA	Moisture Rention Parameter (a)	SOILBDEN	Soil Bulk Density	-0.76065
MOISTRPB	Moisture Rention Parameter (b)	SOILBDEN	Soil Bulk Density	0.78806

Note: Parameters in the variable 2 column were removed from the analysis.

Table D-91. Summary of Crosspairs Analysis for Thallium

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
AVGPDIAM	Avg. Particle Diameter			Y	Y
AQUTHIK	Aquifer Thickness			Y	Y
GWSEEPV	Groundwater Seepage Velocity				
LONDISPA	Longitudinal Dispersivity			Y	Y
FRORGCAR	Fraction Organic Carbon				
ANGLEW	Angle of Well Off Plume Centerline				
XDIST	Longitudinal Distance to Well			Y	Y
YDIST	Distance from Plume Centerline to Well			Y	Y
ZDIST	Depth of Well Below Water Table				
FRCOEFA	Freundlich Isotherm Coefficient			Y	Y
RECHARAT	Recharge Rate			Y	Y
INFILRAT	Infiltration Rate			Y	Y
RESIDH2O	Residual Water Content				
UNSATHIK	Unsaturated Zone Thickness			Y	Y
PERORGM	Percent Organic Matter				
FRCOEFU	Freundlich Isotherm Coefficient			Y	Y
AVGPDIAM	Avg. Particle Diameter	AVGPDIAM	Avg. Particle Diameter	Y	
AQUTHIK	Aquifer Thickness	AVGPDIAM	Avg. Particle Diameter		
AQUTHIK	Aquifer Thickness	AQUTHIK	Aquifer Thickness	Y	Y
GWSEEPV	Groundwater Seepage Velocity	AVGPDIAM	Avg. Particle Diameter		
GWSEEPV	Groundwater Seepage Velocity	AQUTHIK	Aquifer Thickness		
GWSEEPV	Groundwater Seepage Velocity	GWSEEPV	Groundwater Seepage Velocity		
LONDISPA	Longitudinal Dispersivity	AVGPDIAM	Avg. Particle Diameter		
LONDISPA	Longitudinal Dispersivity	AQUTHIK	Aquifer Thickness	Y	Y
LONDISPA	Longitudinal Dispersivity	GWSEEPV	Groundwater Seepage Velocity		
LONDISPA	Longitudinal Dispersivity	LONDISPA	Longitudinal Dispersivity	Y	Y
FRORGCAR	Fraction Organic Carbon	AVGPDIAM	Avg. Particle Diameter		
FRORGCAR	Fraction Organic Carbon	AQUTHIK	Aquifer Thickness		
FRORGCAR	Fraction Organic Carbon	GWSEEPV	Groundwater Seepage Velocity		
FRORGCAR	Fraction Organic Carbon	LONDISPA	Longitudinal Dispersivity		
FRORGCAR	Fraction Organic Carbon	FRORGCAR	Fraction Organic Carbon		
ANGLEW	Angle of Well Off Plume Centerline	AVGPDIAM	Avg. Particle Diameter		
ANGLEW	Angle of Well Off Plume Centerline	AQUTHIK	Aquifer Thickness		
ANGLEW	Angle of Well Off Plume Centerline	GWSEEPV	Groundwater Seepage Velocity		
ANGLEW	Angle of Well Off Plume Centerline	LONDISPA	Longitudinal Dispersivity		
ANGLEW	Angle of Well Off Plume Centerline	FRORGCAR	Fraction Organic Carbon		
ANGLEW	Angle of Well Off Plume Centerline	ANGLEW	Angle of Well Off Plume Centerline		
XDIST	Longitudinal Distance to Well	AVGPDIAM	Avg. Particle Diameter		
XDIST	Longitudinal Distance to Well	AQUTHIK	Aquifer Thickness		
XDIST	Longitudinal Distance to Well	GWSEEPV	Groundwater Seepage Velocity		
XDIST	Longitudinal Distance to Well	LONDISPA	Longitudinal Dispersivity		
XDIST	Longitudinal Distance to Well	FRORGCAR	Fraction Organic Carbon		
XDIST	Longitudinal Distance to Well	ANGLEW	Angle of Well Off Plume Centerline		
XDIST	Longitudinal Distance to Well	XDIST	Longitudinal Distance to Well	Y	Y
YDIST	Distance from Plume Centerline to Well	AVGPDIAM	Avg. Particle Diameter		
YDIST	Distance from Plume Centerline to Well	AQUTHIK	Aquifer Thickness		
YDIST	Distance from Plume Centerline to Well	GWSEEPV	Groundwater Seepage Velocity		
YDIST	Distance from Plume Centerline to Well	LONDISPA	Longitudinal Dispersivity	Y	Y
YDIST	Distance from Plume Centerline to Well	FRORGCAR	Fraction Organic Carbon		

Table D-91. Summary of Crosspairs Analysis for Thallium

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
YDIST	Distance from Plume Centerline to Well	ANGLEW	Angle of Well Off Plume Centerline		
YDIST	Distance from Plume Centerline to Well	XDIST	Longitudinal Distance to Well	Y	Y
YDIST	Distance from Plume Centerline to Well	YDIST	Distance from Plume Centerline to Well	Y	Y
ZDIST	Depth of Well Below Water Table	AVGPDIAM	Avg. Particle Diameter		
ZDIST	Depth of Well Below Water Table	AQUTHIK	Aquifer Thickness		
ZDIST	Depth of Well Below Water Table	GWSEEPV	Groundwater Seepage Velocity		
ZDIST	Depth of Well Below Water Table	LONDISPA	Longitudinal Dispersivity		
ZDIST	Depth of Well Below Water Table	FRORGCAR	Fraction Organic Carbon		
ZDIST	Depth of Well Below Water Table	ANGLEW	Angle of Well Off Plume Centerline		
ZDIST	Depth of Well Below Water Table	XDIST	Longitudinal Distance to Well		
ZDIST	Depth of Well Below Water Table	YDIST	Distance from Plume Centerline to Well		
ZDIST	Depth of Well Below Water Table	ZDIST	Depth of Well Below Water Table	Y	
FRCOEFA	Freundlich Isotherm Coefficient	AVGPDIAM	Avg. Particle Diameter	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	AQUTHIK	Aquifer Thickness	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	GWSEEPV	Groundwater Seepage Velocity		
FRCOEFA	Freundlich Isotherm Coefficient	LONDISPA	Longitudinal Dispersivity	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	FRORGCAR	Fraction Organic Carbon		
FRCOEFA	Freundlich Isotherm Coefficient	ANGLEW	Angle of Well Off Plume Centerline		
FRCOEFA	Freundlich Isotherm Coefficient	XDIST	Longitudinal Distance to Well	Y	
FRCOEFA	Freundlich Isotherm Coefficient	YDIST	Distance from Plume Centerline to Well	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	ZDIST	Depth of Well Below Water Table		
FRCOEFA	Freundlich Isotherm Coefficient	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
RECHARAT	Recharge Rate	AVGPDIAM	Avg. Particle Diameter		
RECHARAT	Recharge Rate	AQUTHIK	Aquifer Thickness		
RECHARAT	Recharge Rate	GWSEEPV	Groundwater Seepage Velocity		
RECHARAT	Recharge Rate	LONDISPA	Longitudinal Dispersivity		
RECHARAT	Recharge Rate	FRORGCAR	Fraction Organic Carbon		
RECHARAT	Recharge Rate	ANGLEW	Angle of Well Off Plume Centerline		
RECHARAT	Recharge Rate	XDIST	Longitudinal Distance to Well		
RECHARAT	Recharge Rate	YDIST	Distance from Plume Centerline to Well	Y	Y
RECHARAT	Recharge Rate	ZDIST	Depth of Well Below Water Table		
RECHARAT	Recharge Rate	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
RECHARAT	Recharge Rate	RECHARAT	Recharge Rate		
INFILRAT	Infiltration Rate	AVGPDIAM	Avg. Particle Diameter		
INFILRAT	Infiltration Rate	AQUTHIK	Aquifer Thickness	Y	Y
INFILRAT	Infiltration Rate	GWSEEPV	Groundwater Seepage Velocity		
INFILRAT	Infiltration Rate	LONDISPA	Longitudinal Dispersivity	Y	
INFILRAT	Infiltration Rate	FRORGCAR	Fraction Organic Carbon		
INFILRAT	Infiltration Rate	ANGLEW	Angle of Well Off Plume Centerline		
INFILRAT	Infiltration Rate	XDIST	Longitudinal Distance to Well		
INFILRAT	Infiltration Rate	YDIST	Distance from Plume Centerline to Well	Y	Y
INFILRAT	Infiltration Rate	ZDIST	Depth of Well Below Water Table		
INFILRAT	Infiltration Rate	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
INFILRAT	Infiltration Rate	RECHARAT	Recharge Rate		
INFILRAT	Infiltration Rate	INFILRAT	Infiltration Rate	Y	
RESIDH2O	Residual Water Content	AVGPDIAM	Avg. Particle Diameter	Y	
RESIDH2O	Residual Water Content	AQUTHIK	Aquifer Thickness		
RESIDH2O	Residual Water Content	GWSEEPV	Groundwater Seepage Velocity	Y	
RESIDH2O	Residual Water Content	LONDISPA	Longitudinal Dispersivity		

Table D-91. Summary of Crosspairs Analysis for Thallium

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
RESIDH2O	Residual Water Content	FRORGCAR	Fraction Organic Carbon		
RESIDH2O	Residual Water Content	ANGLEW	Angle of Well Off Plume Centerline		
RESIDH2O	Residual Water Content	XDIST	Longitudinal Distance to Well		
RESIDH2O	Residual Water Content	YDIST	Distance from Plume Centerline to Well		
RESIDH2O	Residual Water Content	ZDIST	Depth of Well Below Water Table		
RESIDH2O	Residual Water Content	FRCOEFA	Freundlich Isotherm Coefficient		
RESIDH2O	Residual Water Content	RECHARAT	Recharge Rate		
RESIDH2O	Residual Water Content	INFILRAT	Infiltration Rate		
RESIDH2O	Residual Water Content	RESIDH2O	Residual Water Content		
UNSATHIK	Unsaturated Zone Thickness	AVGPDIAM	Avg. Particle Diameter		
UNSATHIK	Unsaturated Zone Thickness	AQUTHIK	Aquifer Thickness		
UNSATHIK	Unsaturated Zone Thickness	GWSEEPV	Groundwater Seepage Velocity		
UNSATHIK	Unsaturated Zone Thickness	LONDISPA	Longitudinal Dispersivity		
UNSATHIK	Unsaturated Zone Thickness	FRORGCAR	Fraction Organic Carbon		
UNSATHIK	Unsaturated Zone Thickness	ANGLEW	Angle of Well Off Plume Centerline		
UNSATHIK	Unsaturated Zone Thickness	XDIST	Longitudinal Distance to Well		
UNSATHIK	Unsaturated Zone Thickness	YDIST	Distance from Plume Centerline to Well	Y	Y
UNSATHIK	Unsaturated Zone Thickness	ZDIST	Depth of Well Below Water Table		
UNSATHIK	Unsaturated Zone Thickness	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
UNSATHIK	Unsaturated Zone Thickness	RECHARAT	Recharge Rate		
UNSATHIK	Unsaturated Zone Thickness	INFILRAT	Infiltration Rate	Y	Y
UNSATHIK	Unsaturated Zone Thickness	RESIDH2O	Residual Water Content		
UNSATHIK	Unsaturated Zone Thickness	UNSATHIK	Unsaturated Zone Thickness	Y	Y
PERORGM	Percent Organic Matter	AVGPDIAM	Avg. Particle Diameter		
PERORGM	Percent Organic Matter	AQUTHIK	Aquifer Thickness		
PERORGM	Percent Organic Matter	GWSEEPV	Groundwater Seepage Velocity		
PERORGM	Percent Organic Matter	LONDISPA	Longitudinal Dispersivity		
PERORGM	Percent Organic Matter	FRORGCAR	Fraction Organic Carbon		
PERORGM	Percent Organic Matter	ANGLEW	Angle of Well Off Plume Centerline		
PERORGM	Percent Organic Matter	XDIST	Longitudinal Distance to Well		
PERORGM	Percent Organic Matter	YDIST	Distance from Plume Centerline to Well		
PERORGM	Percent Organic Matter	ZDIST	Depth of Well Below Water Table	Y	
PERORGM	Percent Organic Matter	FRCOEFA	Freundlich Isotherm Coefficient	Y	
PERORGM	Percent Organic Matter	RECHARAT	Recharge Rate		
PERORGM	Percent Organic Matter	INFILRAT	Infiltration Rate		
PERORGM	Percent Organic Matter	RESIDH2O	Residual Water Content		
PERORGM	Percent Organic Matter	UNSATHIK	Unsaturated Zone Thickness		
PERORGM	Percent Organic Matter	PERORGM	Percent Organic Matter		
FRCOEFU	Freundlich Isotherm Coefficient	AVGPDIAM	Avg. Particle Diameter	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	AQUTHIK	Aquifer Thickness	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	GWSEEPV	Groundwater Seepage Velocity		
FRCOEFU	Freundlich Isotherm Coefficient	LONDISPA	Longitudinal Dispersivity	Y	
FRCOEFU	Freundlich Isotherm Coefficient	FRORGCAR	Fraction Organic Carbon		
FRCOEFU	Freundlich Isotherm Coefficient	ANGLEW	Angle of Well Off Plume Centerline	Y	
FRCOEFU	Freundlich Isotherm Coefficient	XDIST	Longitudinal Distance to Well		
FRCOEFU	Freundlich Isotherm Coefficient	YDIST	Distance from Plume Centerline to Well	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	ZDIST	Depth of Well Below Water Table		
FRCOEFU	Freundlich Isotherm Coefficient	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	RECHARAT	Recharge Rate		

Table D-91. Summary of Crosspairs Analysis for Thallium

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
FRCOEFU	Freundlich Isotherm Coefficient	INFILRAT	Infiltration Rate	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	RESIDH2O	Residual Water Content		
FRCOEFU	Freundlich Isotherm Coefficient	UNSATHIK	Unsaturated Zone Thickness	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	PERORGM	Percent Organic Matter		
FRCOEFU	Freundlich Isotherm Coefficient	FRCOEFU	Freundlich Isotherm Coefficient	Y	Y

Table D-92. Ranking of Parameters According to Percentage of Risk for Thallium

Variable Description	Reduced Sums of Square	Variable Sums of Square	Variable Degrees of Freedom	% Risk Variation	Mean Square Variable	F VALUE	P VALUE
Freundlich Isotherm Coefficient {Aquifer} (cm3/g)	3061.0	7040.87	40	397986.0%	594.69	361.81	1.20E-01
Freundlich Isotherm Coefficient {Unsaturated} (cm3/g)	4721.6	7040.87	40	231926.0%	594.69	289.91	1.20E-01
Distance from Plume Centerline to Well (m)	4754.2	7040.87	40	228669.0%	594.69	254.08	1.20E-01
Consumption of Drinking Water (ml/kg-day)	6053.9	7040.87	40	98698.0%	594.69	986.98	1.20E-01
Infiltration Rate (m/yr)	6272.5	7040.87	40	76838.0%	594.69	128.06	1.20E-01
Longitudinal Dispersivity {Aquifer} (m)	6710.1	7040.87	40	33082.0%	594.69	66.16	1.20E-01
Unsaturated Zone Thickness (m)	6846.4	7040.87	40	19445.0%	594.69	32.41	1.20E-01
Aquifer Thickness (m)	6856.2	7040.87	40	18467.0%	594.69	30.78	1.20E-01
Longitudinal Distance to Well (m)	6921.0	7040.87	40	11989.0%	594.69	29.97	1.20E-01
Average Particle Diameter (cm)	7024.1	7040.87	40	1676.0%	594.69	5.59	1.20E-01
Recharge Rate (m/yr)	7032.0	7040.87	40	888.0%	594.69	2.96	1.20E-01

Constants

Full Model SS	29
Error SS	11
Error DF	1
MS Error	4959

Table D-93. Chemical-Specific Properties for Constituents of Concern for the Ilmenite Process Combined Wastewaters Dupont Delisle

Waste Constituent Concentrations	
Constituent	**SPLPfiltrate (SI) (mg/L)**
Manganese	3.3
Thallium	*0.0025*
Vanadium	0.018
Manganese	3.34
Thallium	0.013
Vanadium	0.63

underline italics indicate values set at 1/2 of detection limit

Table D-94. Waste Management Unit Parameters for Onsite Surface Impoundment Managing Ilmenite Process Combined Wastewaters Dupont Delisle

WMU	Location	Surface Impoundment Area (m^2)	Depth of Water Column (m)	Depth of Sludge Layer (m)	Wastewater Throughput (Mt/yr)	Particle Density (g/cm^3)
Onsite Surface Impoundment	Delisle, MS	13,904	2.53	0.91 to 0.20	11,178,200	4.4, 3.5

Table D-95. Intentionally omitted

Table D-96. Site-Specific Climate-Based Parameters for Onsite Surface Impoundment Managing Ilmenite Process Combined Wastewaters Dupont Delisle

WMU	Location	Climate Index	Climate Center	Recharge Rate (m/yr)			GWpH			
				SCL	SLT	SNL	GW TempC	SCL	SLT	SNL
Onsite Surface Impoundment	Delisle, MS	92	New Orleans, LA	N/A	0.59	0.74	21	N/A	4.6	4.8

Table D-97. Aquifer Types Common in Areas of Onsite Surface Impoundment Managing Ilmenite Process Combined Wastewaters Dupont Delisle

Aquifer Types	Aquifer Code	Delisle, MS
Unconsolidated and semiconsolidated shallow aquifers	10	100%

Table D-98. Soil Textures Common in Areas of Onsite Surface Impoundment Managing Ilmenite Process Combined Wastewaters Dupont Delisle

		Delisle MS
silty clay loam	SCL	0%
silt loam	SIL	48%
sandy loam	SNL	52%

Table D-99. Summary of Parameters Considered in Sensitivity Analysis for Manganese

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
ACIDCAT	Acid Catalyzed Hydrolysis Rate Constant	C			
ANGLEW	Angle of Well Off Plume Centerline	anglew			
ANISORAT	Anisotropy Ratio	C			
AQUTHIK	Aquifer Thickness	log(aquthik)		Y	Y
AVGPDIAM	Avg. Particle Diameter	log(avgpdiam+0.001)		Y	Y
BASECAT	Base Catalyzed Hydrolysis Rate Constant	C			
BIODRATA	Biodegradation Rate	C			
BIODRATU	Biodegradation Rate	C			
BULKDENS	Bulk Density	bulkdens**3	Y		
CHEMDRU	Chemical Decay Rate	C			
CHEMDRA	Chemical Decay Rate	C			
CONSH2OA	Consump of drinking water	log(consh2oa)			Y
ZDIST	Depth of Well Below Water Table	log(zdist+100)		Y	Y
DISHYD	Dissolved Hydrolysis Rate	C			
YDIST	Distance from Plume Centerline to Well	log(ydist+20)		Y	Y
DURLEACH	Duration of Leaching Period	C			
GWAVTIM	Exposure Duration	C			
FRORGCAR	Fraction Organic Carbon	log(frorgcar)		Y	
FRCOEFA	Freundlich Isotherm Coefficient	log(frcoefa-31.9)		Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	log(frcoefu-31.5)		Y	Y
FREXPA	Freundlich Isotherm Exponent	C			
FREXPU	Freundlich Isotherm Exponent	C			
GWPH	Groundwater pH	gwph	Y		
GWSEEPV	Groundwater Seepage Velocity	log(gwseepv+3)	Y		
GWTEMP	Groundwater Temperature	C			
HYDGRAD	Hydraulic Gradient	log(hydgrad+0.03)		Y	Y
INFILRAT	Infiltration Rate	log(infilrat+5)		Y	Y
LANDEPTH	Landfill Depth	C			
LEACHCON	Leachate Concentration	leachcon		Y	
LFFRACT	LF Fraction	C			
LONDISPU	Longitudinal Dispersivity	log(londispu-0.039)	Y		
LONDISPA	Longitudinal Dispersivity	log(londispa+20)		Y	Y
XDIST	Longitudinal Distance to Well	log(xdist+500)		Y	Y

Table D-99. Summary of Parameters Considered in Sensitivity Analysis for Manganese

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
LONHYCON	Longitundinal Hydraulic Conductivity	log(lonhycon+20000)		Y	Y
MLLA	ml/L	C			
MOISTRPA	Moisture Rention Parameter (a)	log(moistrpa+0.5)	Y		
MOISTRPB	Moisture Rention Parameter (b)	log(moistrpb-0.1)	Y		
MOLDIFF	Molecular Diffusion Coefficient	C			
NEUTHYD	Neutral Hydrolysis Rate Constant	C			
ORGCDIS	Organic Carbon Distribution Coefficient	C			
PERORGM	Percent Organic Matter	log(perorgm)		Y	Y
POROSITY	Porosity	porosity		Y	
RADISTW	Radial Distance to Well	log(radistw+250)	Y		
RECHARAT	Recharge Rate	recharat		Y	Y
RESIDH2O	Residual Water Content	residh2o**1.4		Y	
RETCOEF	Retardation Coefficient	log(retcoef-93)	Y		
RFDA	RfD (mg/kg/day)	C			
SATHYCON	Saturated Hydraulic Conductivity	log(sathycon+1)	Y		
SATURH2O	Saturated Water Content	saturh2o	Y		
SOILBDEN	Soil Bulk Density	soilbden	Y		
SORBHYD	Sorbed Hydrolysis Rate	C			
TRANDISP	Transverse Dispersivity	log(trandisp+3)	Y		
UNSATHIK	Unsaturated Zone Thickness	log(unsathik-0.7)		Y	
VERTDISP	Vertical Dispersivity	log(vertdisp+0.15)	Y		
WASTDENS	Waste Density	C			
WASTEVOL	Waste Volume	C			
WMUAREA	WMU Area	C			
WMULEN	WMU Length	C			
WMUWIDTH	WMU Width	C			

Table D-100. Summary of Correlated Parameters for Manganese

Variable 1		Variable 2		Correlation Coefficient
Code	**Description**	**Code**	**Description**	
AVGPDIAM	Avg. Particle Diameter	BULKDENS	Bulk Density	0.9991
LONHYCON	Longitundinal Hydraulic Conductivi	GWSEEPV	Groundwater Seepage Velocity	0.77044
FRCOEFA	Freundlich Isotherm Coefficient	RETCOEF	Retardation Coefficient	0.73837
LONDISPA	Longitudinal Dispersivity	TRANDISP	Transverse Dispersivity	0.99989
LONDISPA	Longitudinal Dispersivity	VERTDISP	Vertical Dispersivity	0.99988
SATHYCON	Saturated Hydraulic Conductivity	GWPH	Groundwater pH	0.72115
MOISTRPA	Moisture Rention Parameter (a)	GWPH	Groundwater pH	0.78225
MOISTRPB	Moisture Rention Parameter (b)	GWPH	Groundwater pH	0.86843
SATURH2O	Saturated Water Content	GWPH	Groundwater pH	-1
SOILBDEN	Soil Bulk Density	GWPH	Groundwater pH	-1
XDIST	Longitudinal Distance to Well	RADISTW	Radial Distance to Well	0.98644
SOILBDEN	Soil Bulk Density	RECHARAT	Recharge Rate	-1
RECHARAT	Recharge Rate	SATHYCON	Saturated Hydraulic Conductivity	0.72115
SATURH2O	Saturated Water Content	SATHYCON	Saturated Hydraulic Conductivity	-0.72115
RECHARAT	Recharge Rate	MOISTRPA	Moisture Rention Parameter (a)	0.78225
SATURH2O	Saturated Water Content	MOISTRPA	Moisture Rention Parameter (a)	-0.78225
RECHARAT	Recharge Rate	MOISTRPB	Moisture Rention Parameter (b)	0.86843
SATURH2O	Saturated Water Content	MOISTRPB	Moisture Rention Parameter (b)	-0.86843
RECHARAT	Recharge Rate	SATURH2O	Saturated Water Content	-1
SATHYCON	Saturated Hydraulic Conductivity	SATURH2O	Saturated Water Content	-0.72115
MOISTRPA	Moisture Rention Parameter (a)	SATURH2O	Saturated Water Content	-0.78225
MOISTRPB	Moisture Rention Parameter (b)	SATURH2O	Saturated Water Content	-0.86843
UNSATHIK	Unsaturated Zone Thickness	LONDISPU	Longitudinal Dispersivity	0.99811
RECHARAT	Recharge Rate	SOILBDEN	Soil Bulk Density	-1
SATHYCON	Saturated Hydraulic Conductivity	SOILBDEN	Soil Bulk Density	-0.72115
MOISTRPA	Moisture Rention Parameter (a)	SOILBDEN	Soil Bulk Density	-0.78225
MOISTRPB	Moisture Rention Parameter (b)	SOILBDEN	Soil Bulk Density	-0.86843

Note: Parameters in the variable 2 column were removed from the analysis.

Table D-101. Summary of Crosspairs Analysis for Manganese

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
AVGPDIAM	Avg. Particle Diameter			Y	Y
POROSITY	Porosity				
AQUTHIK	Aquifer Thickness			Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity			Y	Y
HYDGRAD	Hydraulic Gradient			Y	Y
LONDISPA	Longitudinal Dispersivity			Y	Y
FRORGCAR	Fraction Organic Carbon				
ANGLEW	Angle of Well Off Plume Centerline				
XDIST	Longitudinal Distance to Well			Y	Y
YDIST	Distance from Plume Centerline to Well			Y	Y
ZDIST	Depth of Well Below Water Table			Y	Y
FRCOEFA	Freundlich Isotherm Coefficient			Y	Y
LEACHCON	Leachate Concentration				
RECHARAT	Recharge Rate			Y	
INFILRAT	Infiltration Rate			Y	Y
RESIDH2O	Residual Water Content				
UNSATHIK	Unsaturated Zone Thickness				
PERORGM	Percent Organic Matter				
FRCOEFU	Freundlich Isotherm Coefficient			Y	Y
AVGPDIAM	Avg. Particle Diameter	AVGPDIAM	Avg. Particle Diameter		
POROSITY	Porosity	AVGPDIAM	Avg. Particle Diameter		
POROSITY	Porosity	POROSITY	Porosity	Y	
AQUTHIK	Aquifer Thickness	AVGPDIAM	Avg. Particle Diameter		
AQUTHIK	Aquifer Thickness	POROSITY	Porosity		
AQUTHIK	Aquifer Thickness	AQUTHIK	Aquifer Thickness		
LONHYCON	Longitundinal Hydraulic Conductivity	AVGPDIAM	Avg. Particle Diameter		
LONHYCON	Longitundinal Hydraulic Conductivity	POROSITY	Porosity		
LONHYCON	Longitundinal Hydraulic Conductivity	AQUTHIK	Aquifer Thickness		
LONHYCON	Longitundinal Hydraulic Conductivity	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
HYDGRAD	Hydraulic Gradient	AVGPDIAM	Avg. Particle Diameter		
HYDGRAD	Hydraulic Gradient	POROSITY	Porosity		
HYDGRAD	Hydraulic Gradient	AQUTHIK	Aquifer Thickness	Y	Y
HYDGRAD	Hydraulic Gradient	LONHYCON	Longitundinal Hydraulic Conductivity		
HYDGRAD	Hydraulic Gradient	HYDGRAD	Hydraulic Gradient		
LONDISPA	Longitudinal Dispersivity	AVGPDIAM	Avg. Particle Diameter	Y	Y
LONDISPA	Longitudinal Dispersivity	POROSITY	Porosity		
LONDISPA	Longitudinal Dispersivity	AQUTHIK	Aquifer Thickness	Y	Y
LONDISPA	Longitudinal Dispersivity	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
LONDISPA	Longitudinal Dispersivity	HYDGRAD	Hydraulic Gradient		
LONDISPA	Longitudinal Dispersivity	LONDISPA	Longitudinal Dispersivity	Y	Y
FRORGCAR	Fraction Organic Carbon	AVGPDIAM	Avg. Particle Diameter		
FRORGCAR	Fraction Organic Carbon	POROSITY	Porosity		
FRORGCAR	Fraction Organic Carbon	AQUTHIK	Aquifer Thickness		
FRORGCAR	Fraction Organic Carbon	LONHYCON	Longitundinal Hydraulic Conductivity		
FRORGCAR	Fraction Organic Carbon	HYDGRAD	Hydraulic Gradient		
FRORGCAR	Fraction Organic Carbon	LONDISPA	Longitudinal Dispersivity		
FRORGCAR	Fraction Organic Carbon	FRORGCAR	Fraction Organic Carbon		
ANGLEW	Angle of Well Off Plume Centerline	AVGPDIAM	Avg. Particle Diameter		
ANGLEW	Angle of Well Off Plume Centerline	POROSITY	Porosity		

Table D-101. Summary of Crosspairs Analysis for Manganese

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
ANGLEW	Angle of Well Off Plume Centerline	AQUTHIK	Aquifer Thickness		
ANGLEW	Angle of Well Off Plume Centerline	LONHYCON	Longitundinal Hydraulic Conductivity		
ANGLEW	Angle of Well Off Plume Centerline	HYDGRAD	Hydraulic Gradient		
ANGLEW	Angle of Well Off Plume Centerline	LONDISPA	Longitudinal Dispersivity		
ANGLEW	Angle of Well Off Plume Centerline	FRORGCAR	Fraction Organic Carbon		
ANGLEW	Angle of Well Off Plume Centerline	ANGLEW	Angle of Well Off Plume Centerline		
XDIST	Longitudinal Distance to Well	AVGPDIAM	Avg. Particle Diameter		
XDIST	Longitudinal Distance to Well	POROSITY	Porosity		
XDIST	Longitudinal Distance to Well	AQUTHIK	Aquifer Thickness		
XDIST	Longitudinal Distance to Well	LONHYCON	Longitundinal Hydraulic Conductivity		
XDIST	Longitudinal Distance to Well	HYDGRAD	Hydraulic Gradient	Y	Y
XDIST	Longitudinal Distance to Well	LONDISPA	Longitudinal Dispersivity	Y	Y
XDIST	Longitudinal Distance to Well	FRORGCAR	Fraction Organic Carbon		
XDIST	Longitudinal Distance to Well	ANGLEW	Angle of Well Off Plume Centerline		
XDIST	Longitudinal Distance to Well	XDIST	Longitudinal Distance to Well		
YDIST	Distance from Plume Centerline to Well	AVGPDIAM	Avg. Particle Diameter		
YDIST	Distance from Plume Centerline to Well	POROSITY	Porosity		
YDIST	Distance from Plume Centerline to Well	AQUTHIK	Aquifer Thickness		
YDIST	Distance from Plume Centerline to Well	LONHYCON	Longitundinal Hydraulic Conductivity	Y	
YDIST	Distance from Plume Centerline to Well	HYDGRAD	Hydraulic Gradient		
YDIST	Distance from Plume Centerline to Well	LONDISPA	Longitudinal Dispersivity	Y	Y
YDIST	Distance from Plume Centerline to Well	FRORGCAR	Fraction Organic Carbon		
YDIST	Distance from Plume Centerline to Well	ANGLEW	Angle of Well Off Plume Centerline		
YDIST	Distance from Plume Centerline to Well	XDIST	Longitudinal Distance to Well	Y	Y
YDIST	Distance from Plume Centerline to Well	YDIST	Distance from Plume Centerline to Well	Y	Y
ZDIST	Depth of Well Below Water Table	AVGPDIAM	Avg. Particle Diameter		
ZDIST	Depth of Well Below Water Table	POROSITY	Porosity		
ZDIST	Depth of Well Below Water Table	AQUTHIK	Aquifer Thickness		
ZDIST	Depth of Well Below Water Table	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
ZDIST	Depth of Well Below Water Table	HYDGRAD	Hydraulic Gradient	Y	Y
ZDIST	Depth of Well Below Water Table	LONDISPA	Longitudinal Dispersivity		
ZDIST	Depth of Well Below Water Table	FRORGCAR	Fraction Organic Carbon		
ZDIST	Depth of Well Below Water Table	ANGLEW	Angle of Well Off Plume Centerline		
ZDIST	Depth of Well Below Water Table	XDIST	Longitudinal Distance to Well	Y	Y
ZDIST	Depth of Well Below Water Table	YDIST	Distance from Plume Centerline to Well	Y	Y
ZDIST	Depth of Well Below Water Table	ZDIST	Depth of Well Below Water Table		
FRCOEFA	Freundlich Isotherm Coefficient	AVGPDIAM	Avg. Particle Diameter	Y	
FRCOEFA	Freundlich Isotherm Coefficient	POROSITY	Porosity		
FRCOEFA	Freundlich Isotherm Coefficient	AQUTHIK	Aquifer Thickness		
FRCOEFA	Freundlich Isotherm Coefficient	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	HYDGRAD	Hydraulic Gradient	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	LONDISPA	Longitudinal Dispersivity	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	FRORGCAR	Fraction Organic Carbon		
FRCOEFA	Freundlich Isotherm Coefficient	ANGLEW	Angle of Well Off Plume Centerline		
FRCOEFA	Freundlich Isotherm Coefficient	XDIST	Longitudinal Distance to Well	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	YDIST	Distance from Plume Centerline to Well	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	ZDIST	Depth of Well Below Water Table		
FRCOEFA	Freundlich Isotherm Coefficient	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
LEACHCON	Leachate Concentration	AVGPDIAM	Avg. Particle Diameter		

Table D-101. Summary of Crosspairs Analysis for Manganese

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
LEACHCON	Leachate Concentration	POROSITY	Porosity		
LEACHCON	Leachate Concentration	AQUTHIK	Aquifer Thickness		
LEACHCON	Leachate Concentration	LONHYCON	Longitundinal Hydraulic Conductivity		
LEACHCON	Leachate Concentration	HYDGRAD	Hydraulic Gradient		
LEACHCON	Leachate Concentration	LONDISPA	Longitudinal Dispersivity	Y	
LEACHCON	Leachate Concentration	FRORGCAR	Fraction Organic Carbon		
LEACHCON	Leachate Concentration	ANGLEW	Angle of Well Off Plume Centerline		
LEACHCON	Leachate Concentration	XDIST	Longitudinal Distance to Well		
LEACHCON	Leachate Concentration	YDIST	Distance from Plume Centerline to Well		
LEACHCON	Leachate Concentration	ZDIST	Depth of Well Below Water Table		
LEACHCON	Leachate Concentration	FRCOEFA	Freundlich Isotherm Coefficient		
LEACHCON	Leachate Concentration	LEACHCON	Leachate Concentration		
RECHARAT	Recharge Rate	AVGPDIAM	Avg. Particle Diameter		
RECHARAT	Recharge Rate	POROSITY	Porosity		
RECHARAT	Recharge Rate	AQUTHIK	Aquifer Thickness		
RECHARAT	Recharge Rate	LONHYCON	Longitundinal Hydraulic Conductivity		
RECHARAT	Recharge Rate	HYDGRAD	Hydraulic Gradient	Y	
RECHARAT	Recharge Rate	LONDISPA	Longitudinal Dispersivity	Y	Y
RECHARAT	Recharge Rate	FRORGCAR	Fraction Organic Carbon	Y	
RECHARAT	Recharge Rate	ANGLEW	Angle of Well Off Plume Centerline		
RECHARAT	Recharge Rate	XDIST	Longitudinal Distance to Well		
RECHARAT	Recharge Rate	YDIST	Distance from Plume Centerline to Well		
RECHARAT	Recharge Rate	ZDIST	Depth of Well Below Water Table		
RECHARAT	Recharge Rate	FRCOEFA	Freundlich Isotherm Coefficient		
RECHARAT	Recharge Rate	LEACHCON	Leachate Concentration		
RECHARAT	Recharge Rate	RECHARAT	Recharge Rate		
INFILRAT	Infiltration Rate	AVGPDIAM	Avg. Particle Diameter		
INFILRAT	Infiltration Rate	POROSITY	Porosity		
INFILRAT	Infiltration Rate	AQUTHIK	Aquifer Thickness		
INFILRAT	Infiltration Rate	LONHYCON	Longitundinal Hydraulic Conductivity		
INFILRAT	Infiltration Rate	HYDGRAD	Hydraulic Gradient		
INFILRAT	Infiltration Rate	LONDISPA	Longitudinal Dispersivity	Y	
INFILRAT	Infiltration Rate	FRORGCAR	Fraction Organic Carbon		
INFILRAT	Infiltration Rate	ANGLEW	Angle of Well Off Plume Centerline		
INFILRAT	Infiltration Rate	XDIST	Longitudinal Distance to Well		
INFILRAT	Infiltration Rate	YDIST	Distance from Plume Centerline to Well		
INFILRAT	Infiltration Rate	ZDIST	Depth of Well Below Water Table		
INFILRAT	Infiltration Rate	FRCOEFA	Freundlich Isotherm Coefficient		
INFILRAT	Infiltration Rate	LEACHCON	Leachate Concentration		
INFILRAT	Infiltration Rate	RECHARAT	Recharge Rate		
INFILRAT	Infiltration Rate	INFILRAT	Infiltration Rate	Y	Y
RESIDH2O	Residual Water Content	AVGPDIAM	Avg. Particle Diameter		
RESIDH2O	Residual Water Content	POROSITY	Porosity		
RESIDH2O	Residual Water Content	AQUTHIK	Aquifer Thickness		
RESIDH2O	Residual Water Content	LONHYCON	Longitundinal Hydraulic Conductivity		
RESIDH2O	Residual Water Content	HYDGRAD	Hydraulic Gradient		
RESIDH2O	Residual Water Content	LONDISPA	Longitudinal Dispersivity		
RESIDH2O	Residual Water Content	FRORGCAR	Fraction Organic Carbon		
RESIDH2O	Residual Water Content	ANGLEW	Angle of Well Off Plume Centerline		

Table D-101. Summary of Crosspairs Analysis for Manganese

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
RESIDH2O	Residual Water Content	XDIST	Longitudinal Distance to Well		
RESIDH2O	Residual Water Content	YDIST	Distance from Plume Centerline to Well		
RESIDH2O	Residual Water Content	ZDIST	Depth of Well Below Water Table		
RESIDH2O	Residual Water Content	FRCOEFA	Freundlich Isotherm Coefficient		
RESIDH2O	Residual Water Content	LEACHCON	Leachate Concentration		
RESIDH2O	Residual Water Content	RECHARAT	Recharge Rate		
RESIDH2O	Residual Water Content	INFILRAT	Infiltration Rate		
RESIDH2O	Residual Water Content	RESIDH2O	Residual Water Content		
UNSATHIK	Unsaturated Zone Thickness	AVGPDIAM	Avg. Particle Diameter		
UNSATHIK	Unsaturated Zone Thickness	POROSITY	Porosity		
UNSATHIK	Unsaturated Zone Thickness	AQUTHIK	Aquifer Thickness		
UNSATHIK	Unsaturated Zone Thickness	LONHYCON	Longitundinal Hydraulic Conductivity		
UNSATHIK	Unsaturated Zone Thickness	HYDGRAD	Hydraulic Gradient		
UNSATHIK	Unsaturated Zone Thickness	LONDISPA	Longitudinal Dispersivity		
UNSATHIK	Unsaturated Zone Thickness	FRORGCAR	Fraction Organic Carbon	Y	
UNSATHIK	Unsaturated Zone Thickness	ANGLEW	Angle of Well Off Plume Centerline		
UNSATHIK	Unsaturated Zone Thickness	XDIST	Longitudinal Distance to Well		
UNSATHIK	Unsaturated Zone Thickness	YDIST	Distance from Plume Centerline to Well		
UNSATHIK	Unsaturated Zone Thickness	ZDIST	Depth of Well Below Water Table		
UNSATHIK	Unsaturated Zone Thickness	FRCOEFA	Freundlich Isotherm Coefficient		
UNSATHIK	Unsaturated Zone Thickness	LEACHCON	Leachate Concentration		
UNSATHIK	Unsaturated Zone Thickness	RECHARAT	Recharge Rate		
UNSATHIK	Unsaturated Zone Thickness	INFILRAT	Infiltration Rate		
UNSATHIK	Unsaturated Zone Thickness	RESIDH2O	Residual Water Content		
UNSATHIK	Unsaturated Zone Thickness	UNSATHIK	Unsaturated Zone Thickness		
PERORGM	Percent Organic Matter	AVGPDIAM	Avg. Particle Diameter		
PERORGM	Percent Organic Matter	POROSITY	Porosity		
PERORGM	Percent Organic Matter	AQUTHIK	Aquifer Thickness		
PERORGM	Percent Organic Matter	LONHYCON	Longitundinal Hydraulic Conductivity		
PERORGM	Percent Organic Matter	HYDGRAD	Hydraulic Gradient		
PERORGM	Percent Organic Matter	LONDISPA	Longitudinal Dispersivity		
PERORGM	Percent Organic Matter	FRORGCAR	Fraction Organic Carbon		
PERORGM	Percent Organic Matter	ANGLEW	Angle of Well Off Plume Centerline		
PERORGM	Percent Organic Matter	XDIST	Longitudinal Distance to Well	Y	Y
PERORGM	Percent Organic Matter	YDIST	Distance from Plume Centerline to Well		
PERORGM	Percent Organic Matter	ZDIST	Depth of Well Below Water Table		
PERORGM	Percent Organic Matter	FRCOEFA	Freundlich Isotherm Coefficient		
PERORGM	Percent Organic Matter	LEACHCON	Leachate Concentration		
PERORGM	Percent Organic Matter	RECHARAT	Recharge Rate		
PERORGM	Percent Organic Matter	INFILRAT	Infiltration Rate		
PERORGM	Percent Organic Matter	RESIDH2O	Residual Water Content		
PERORGM	Percent Organic Matter	UNSATHIK	Unsaturated Zone Thickness		
PERORGM	Percent Organic Matter	PERORGM	Percent Organic Matter		
FRCOEFU	Freundlich Isotherm Coefficient	AVGPDIAM	Avg. Particle Diameter		
FRCOEFU	Freundlich Isotherm Coefficient	POROSITY	Porosity		
FRCOEFU	Freundlich Isotherm Coefficient	AQUTHIK	Aquifer Thickness		
FRCOEFU	Freundlich Isotherm Coefficient	LONHYCON	Longitundinal Hydraulic Conductivity		
FRCOEFU	Freundlich Isotherm Coefficient	HYDGRAD	Hydraulic Gradient		
FRCOEFU	Freundlich Isotherm Coefficient	LONDISPA	Longitudinal Dispersivity	Y	

Table D-101. Summary of Crosspairs Analysis for Manganese

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
FRCOEFU	Freundlich Isotherm Coefficient	FRORGCAR	Fraction Organic Carbon		
FRCOEFU	Freundlich Isotherm Coefficient	ANGLEW	Angle of Well Off Plume Centerline		
FRCOEFU	Freundlich Isotherm Coefficient	XDIST	Longitudinal Distance to Well		
FRCOEFU	Freundlich Isotherm Coefficient	YDIST	Distance from Plume Centerline to Well	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	ZDIST	Depth of Well Below Water Table		
FRCOEFU	Freundlich Isotherm Coefficient	FRCOEFA	Freundlich Isotherm Coefficient	Y	
FRCOEFU	Freundlich Isotherm Coefficient	LEACHCON	Leachate Concentration		
FRCOEFU	Freundlich Isotherm Coefficient	RECHARAT	Recharge Rate		
FRCOEFU	Freundlich Isotherm Coefficient	INFILRAT	Infiltration Rate	Y	
FRCOEFU	Freundlich Isotherm Coefficient	RESIDH2O	Residual Water Content	Y	
FRCOEFU	Freundlich Isotherm Coefficient	UNSATHIK	Unsaturated Zone Thickness		
FRCOEFU	Freundlich Isotherm Coefficient	PERORGM	Percent Organic Matter		
FRCOEFU	Freundlich Isotherm Coefficient	FRCOEFU	Freundlich Isotherm Coefficient	Y	Y

Table D-102. Ranking of Parameters According to Percentage of Risk for Manganese

Variable Description	Reduced Sums of Square	Variable Sums of Square	Variable Degrees of Freedom	% Risk Variation	Mean Square Variable	F VALUE	P VALUE
Longitudinal Distance to Well (m)	3433.6	8165.39	40	473176.0%	3264.81	675.97	6.58E-01
Freundlich Isotherm Coefficient {Aquifer} (cm3/g)	5120.0	8165.39	40	304535.0%	3264.81	435.05	6.58E-01
Longitudinal Dispersivity {Aquifer} (m)	7250.3	8165.39	40	91506.0%	3264.81	101.67	6.58E-01
Consumption of Drinking Water (ml/kg-day)	7325.8	8165.39	40	83956.0%	3264.81	839.56	6.58E-01
Freundlich Isotherm Coefficient {Unsaturated} (cm3/g)	7815.5	8165.39	40	34986.0%	3264.81	116.62	6.58E-01
Infiltration Rate (m/yr)	7838.0	8165.39	40	32736.0%	3264.81	163.68	6.58E-01
Angle of Well Off Plume Centerline (degrees)	7865.5	8165.39	40	29986.0%	3264.81	42.84	6.58E-01
Longitudinal Hydraulic Conductivity (m/yr)	7877.2	8165.39	40	28817.0%	3264.81	57.63	6.58E-01
Average Particle Diameter (cm)	8058.8	8165.39	40	10655.0%	3264.81	53.27	6.58E-01
Aquifer Thickness (m)	8073.4	8165.39	40	9199.0%	3264.81	30.66	6.58E-01
Hydraulic Gradient (m/m)	8079.1	8165.39	40	8627.0%	3264.81	17.25	6.58E-01
Depth of Well Below Water Table (m)	8112.0	8165.39	40	5341.0%	3264.81	10.68	6.58E-01
Recharge Rate (m/yr)	8154.5	8165.39	40	1092.0%	3264.81	5.46	6.58E-01
Percent Organic Matter (unitless)	8156.5	8165.39	40	889.0%	3264.81	4.45	6.58E-01

Constants

Full Model SS	33
Error SS	7
Error DF	0
MS Error	4959

Table D-103. Summary of Parameters Considered in Sensitivity Analysis for Thallium

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
EXPDURA		C			
CANSLOPE		C			
ACIDCAT	Acid Catalyzed Hydrolysis Rate Constant	C			
ANGLEW	Angle of Well Off Plume Centerline	anglew		Y	Y
ANISORAT	Anisotropy Ratio	C			
AQUTHIK	Aquifer Thickness	log(aquthik)		Y	Y
AVGPDIAM	Avg. Particle Diameter	log(avgpdiam+0.001)		Y	Y
BASECAT	Base Catalyzed Hydrolysis Rate Constant	C			
BIODRATA	Biodegradation Rate	C			
BIODRATU	Biodegradation Rate	C			
BULKDENS	Bulk Density	bulkdens**3.5	Y		
CHEMDRU	Chemical Decay Rate	C			
CHEMDRA	Chemical Decay Rate	C			
CONSH2OA	Consump of drinking water	log(consh2oa)			Y
ZDIST	Depth of Well Below Water Table	log(zdist+100)		Y	Y
DISHYD	Dissolved Hydrolysis Rate	C			
YDIST	Distance from Plume Centerline to Well	log(ydist+20)		Y	Y
DURLEACH	Duration of Leaching Period	C			
GWAVTIM	Exposure Duration	C			
FRORGCAR	Fraction Organic Carbon	log(frorgcar)		Y	
FRCOEFA	Freundlich Isotherm Coefficient	log(frcoefa-0.9)		Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	log(frcoefu)		Y	Y
FREXPA	Freundlich Isotherm Exponent	C			
FREXPU	Freundlich Isotherm Exponent	C			
GWPH	Groundwater pH	gwph	Y		
GWSEEPV	Groundwater Seepage Velocity	log(gwseepv+3)	Y		
GWTEMP	Groundwater Temperature	C			
HYDGRAD	Hydraulic Gradient	log(hydgrad+0.03)		Y	Y
INFILRAT	Infiltration Rate	log(infilrat+5)		Y	Y
LANDEPTH	Landfill Depth	C			
LEACHCON	Leachate Concentration	leachcon		Y	Y
LFFRACT	LF Fraction	C			
LONDISPA	Longitudinal Dispersivity	log(londispa+10)		Y	Y

Table D-103. Summary of Parameters Considered in Sensitivity Analysis for Thallium

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
LONDISPU	Longitudinal Dispersivity	log(londispu-0.033)	Y		
XDIST	Longitudinal Distance to Well	log(xdist+500)		Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity	log(lonhycon+9000)		Y	Y
MOISTRPA	Moisture Rention Parameter (a)	log(moistrpa+1)	Y		
MOISTRPB	Moisture Rention Parameter (b)	log(moistrpb-0.1)	Y		
MOLDIFF	Molecular Diffusion Coefficient	C			
NEUTHYD	Neutral Hydrolysis Rate Constant	C			
ORGCDIS	Organic Carbon Distribution Coefficient	C			
PERORGM	Percent Organic Matter	log(perorgm)		Y	
POROSITY	Porosity	porosity			
RADISTW	Radial Distance to Well	log(radistw+250)	Y		
RECHARAT	Recharge Rate	recharat			
RESIDH2O	Residual Water Content	residh2o**1.7		Y	
RETCOEF	Retardation Coefficient	log(retcoef-4)	Y		
SATHYCON	Saturated Hydraulic Conductivity	log(sathycon+1)	Y		
SATURH2O	Saturated Water Content	saturh2o	Y		
SOILBDEN	Soil Bulk Density	soilbden	Y		
SORBHYD	Sorbed Hydrolysis Rate	C			
TRANDISP	Transverse Dispersivity	log(trandisp+1)	Y		
UNSATHIK	Unsaturated Zone Thickness	log(unsathik-0.7)			
VERTDISP	Vertical Dispersivity	log(vertdisp+0.05)	Y		
WASTDENS	Waste Density	C			
WASTEVOL	Waste Volume	C			
WMUAREA	WMU Area	C			
WMULEN	WMU Length	C			
WMUWIDTH	WMU Width	C			

Table D-104. Summary of Correlated Parameters for Thallium

Variable 1		Variable 2		Correlation Coefficient
Code	**Description**	**Code**	**Description**	
AVGPDIAM	Avg. Particle Diameter	BULKDENS	Bulk Density	0.99827
LONHYCON	Longitundinal Hydraulic Conductivi	GWSEEPV	Groundwater Seepage Velocity	0.79388
FRCOEFA	Freundlich Isotherm Coefficient	RETCOEF	Retardation Coefficient	0.93876
LONDISPA	Longitudinal Dispersivity	TRANDISP	Transverse Dispersivity	0.99983
LONDISPA	Longitudinal Dispersivity	VERTDISP	Vertical Dispersivity	0.99984
SATHYCON	Saturated Hydraulic Conductivity	GWPH	Groundwater pH	0.72881
MOISTRPA	Moisture Rention Parameter (a)	GWPH	Groundwater pH	0.78232
MOISTRPB	Moisture Rention Parameter (b)	GWPH	Groundwater pH	0.86842
SATURH2O	Saturated Water Content	GWPH	Groundwater pH	-1
SOILBDEN	Soil Bulk Density	GWPH	Groundwater pH	-1
XDIST	Longitudinal Distance to Well	RADISTW	Radial Distance to Well	0.98926
SOILBDEN	Soil Bulk Density	RECHARAT	Recharge Rate	-1
RECHARAT	Recharge Rate	SATHYCON	Saturated Hydraulic Conductivity	0.72881
SATURH2O	Saturated Water Content	SATHYCON	Saturated Hydraulic Conductivity	-0.72881
RECHARAT	Recharge Rate	MOISTRPA	Moisture Rention Parameter (a)	0.78232
SATURH2O	Saturated Water Content	MOISTRPA	Moisture Rention Parameter (a)	-0.78232
RECHARAT	Recharge Rate	MOISTRPB	Moisture Rention Parameter (b)	0.86842
SATURH2O	Saturated Water Content	MOISTRPB	Moisture Rention Parameter (b)	-0.86842
RECHARAT	Recharge Rate	SATURH2O	Saturated Water Content	-1
SATHYCON	Saturated Hydraulic Conductivity	SATURH2O	Saturated Water Content	-0.72881
MOISTRPA	Moisture Rention Parameter (a)	SATURH2O	Saturated Water Content	-0.78232
MOISTRPB	Moisture Rention Parameter (b)	SATURH2O	Saturated Water Content	-0.86842
UNSATHIK	Unsaturated Zone Thickness	LONDISPU	Longitudinal Dispersivity	0.99978
RECHARAT	Recharge Rate	SOILBDEN	Soil Bulk Density	-1
SATHYCON	Saturated Hydraulic Conductivity	SOILBDEN	Soil Bulk Density	-0.72881
MOISTRPA	Moisture Rention Parameter (a)	SOILBDEN	Soil Bulk Density	-0.78232
MOISTRPB	Moisture Rention Parameter (b)	SOILBDEN	Soil Bulk Density	-0.86842

Note: Parameters in the variable 2 column were removed from the analysis.

Table D-105. Summary of Crosspairs Analysis for Thallium

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
AVGPDIAM	Avg. Particle Diameter			Y	Y
POROSITY	Porosity				
AQUTHIK	Aquifer Thickness			Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity			Y	Y
HYDGRAD	Hydraulic Gradient			Y	Y
LONDISPA	Longitudinal Dispersivity			Y	Y
FRORGCAR	Fraction Organic Carbon				
ANGLEW	Angle of Well Off Plume Centerline				
XDIST	Longitudinal Distance to Well			Y	Y
YDIST	Distance from Plume Centerline to Well			Y	Y
ZDIST	Depth of Well Below Water Table			Y	Y
FRCOEFA	Freundlich Isotherm Coefficient			Y	Y
LEACHCON	Leachate Concentration			Y	Y
RECHARAT	Recharge Rate				
INFILRAT	Infiltration Rate			Y	Y
RESIDH2O	Residual Water Content				
UNSATHIK	Unsaturated Zone Thickness				
PERORGM	Percent Organic Matter				
FRCOEFU	Freundlich Isotherm Coefficient			Y	Y
AVGPDIAM	Avg. Particle Diameter	AVGPDIAM	Avg. Particle Diameter		
POROSITY	Porosity	AVGPDIAM	Avg. Particle Diameter		
POROSITY	Porosity	POROSITY	Porosity		
AQUTHIK	Aquifer Thickness	AVGPDIAM	Avg. Particle Diameter		
AQUTHIK	Aquifer Thickness	POROSITY	Porosity		
AQUTHIK	Aquifer Thickness	AQUTHIK	Aquifer Thickness		
LONHYCON	Longitundinal Hydraulic Conductivity	AVGPDIAM	Avg. Particle Diameter		
LONHYCON	Longitundinal Hydraulic Conductivity	POROSITY	Porosity		
LONHYCON	Longitundinal Hydraulic Conductivity	AQUTHIK	Aquifer Thickness		
LONHYCON	Longitundinal Hydraulic Conductivity	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
HYDGRAD	Hydraulic Gradient	AVGPDIAM	Avg. Particle Diameter		
HYDGRAD	Hydraulic Gradient	POROSITY	Porosity		
HYDGRAD	Hydraulic Gradient	AQUTHIK	Aquifer Thickness		
HYDGRAD	Hydraulic Gradient	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
HYDGRAD	Hydraulic Gradient	HYDGRAD	Hydraulic Gradient		
LONDISPA	Longitudinal Dispersivity	AVGPDIAM	Avg. Particle Diameter		
LONDISPA	Longitudinal Dispersivity	POROSITY	Porosity		
LONDISPA	Longitudinal Dispersivity	AQUTHIK	Aquifer Thickness	Y	Y
LONDISPA	Longitudinal Dispersivity	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
LONDISPA	Longitudinal Dispersivity	HYDGRAD	Hydraulic Gradient	Y	Y
LONDISPA	Longitudinal Dispersivity	LONDISPA	Longitudinal Dispersivity	Y	Y
FRORGCAR	Fraction Organic Carbon	AVGPDIAM	Avg. Particle Diameter		
FRORGCAR	Fraction Organic Carbon	POROSITY	Porosity		
FRORGCAR	Fraction Organic Carbon	AQUTHIK	Aquifer Thickness		
FRORGCAR	Fraction Organic Carbon	LONHYCON	Longitundinal Hydraulic Conductivity		
FRORGCAR	Fraction Organic Carbon	HYDGRAD	Hydraulic Gradient		
FRORGCAR	Fraction Organic Carbon	LONDISPA	Longitudinal Dispersivity		
FRORGCAR	Fraction Organic Carbon	FRORGCAR	Fraction Organic Carbon		
ANGLEW	Angle of Well Off Plume Centerline	AVGPDIAM	Avg. Particle Diameter		
ANGLEW	Angle of Well Off Plume Centerline	POROSITY	Porosity		

Table D-105. Summary of Crosspairs Analysis for Thallium

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
ANGLEW	Angle of Well Off Plume Centerline	AQUTHIK	Aquifer Thickness		
ANGLEW	Angle of Well Off Plume Centerline	LONHYCON	Longitundinal Hydraulic Conductivity		
ANGLEW	Angle of Well Off Plume Centerline	HYDGRAD	Hydraulic Gradient		
ANGLEW	Angle of Well Off Plume Centerline	LONDISPA	Longitudinal Dispersivity		
ANGLEW	Angle of Well Off Plume Centerline	FRORGCAR	Fraction Organic Carbon		
ANGLEW	Angle of Well Off Plume Centerline	ANGLEW	Angle of Well Off Plume Centerline	Y	Y
XDIST	Longitudinal Distance to Well	AVGPDIAM	Avg. Particle Diameter		
XDIST	Longitudinal Distance to Well	POROSITY	Porosity		
XDIST	Longitudinal Distance to Well	AQUTHIK	Aquifer Thickness		
XDIST	Longitudinal Distance to Well	LONHYCON	Longitundinal Hydraulic Conductivity		
XDIST	Longitudinal Distance to Well	HYDGRAD	Hydraulic Gradient	Y	Y
XDIST	Longitudinal Distance to Well	LONDISPA	Longitudinal Dispersivity	Y	Y
XDIST	Longitudinal Distance to Well	FRORGCAR	Fraction Organic Carbon		
XDIST	Longitudinal Distance to Well	ANGLEW	Angle of Well Off Plume Centerline		
XDIST	Longitudinal Distance to Well	XDIST	Longitudinal Distance to Well		
YDIST	Distance from Plume Centerline to Well	AVGPDIAM	Avg. Particle Diameter		
YDIST	Distance from Plume Centerline to Well	POROSITY	Porosity		
YDIST	Distance from Plume Centerline to Well	AQUTHIK	Aquifer Thickness		
YDIST	Distance from Plume Centerline to Well	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
YDIST	Distance from Plume Centerline to Well	HYDGRAD	Hydraulic Gradient	Y	Y
YDIST	Distance from Plume Centerline to Well	LONDISPA	Longitudinal Dispersivity	Y	Y
YDIST	Distance from Plume Centerline to Well	FRORGCAR	Fraction Organic Carbon		
YDIST	Distance from Plume Centerline to Well	ANGLEW	Angle of Well Off Plume Centerline		
YDIST	Distance from Plume Centerline to Well	XDIST	Longitudinal Distance to Well	Y	Y
YDIST	Distance from Plume Centerline to Well	YDIST	Distance from Plume Centerline to Well	Y	Y
ZDIST	Depth of Well Below Water Table	AVGPDIAM	Avg. Particle Diameter		
ZDIST	Depth of Well Below Water Table	POROSITY	Porosity		
ZDIST	Depth of Well Below Water Table	AQUTHIK	Aquifer Thickness		
ZDIST	Depth of Well Below Water Table	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
ZDIST	Depth of Well Below Water Table	HYDGRAD	Hydraulic Gradient	Y	Y
ZDIST	Depth of Well Below Water Table	LONDISPA	Longitudinal Dispersivity		
ZDIST	Depth of Well Below Water Table	FRORGCAR	Fraction Organic Carbon	Y	
ZDIST	Depth of Well Below Water Table	ANGLEW	Angle of Well Off Plume Centerline		
ZDIST	Depth of Well Below Water Table	XDIST	Longitudinal Distance to Well	Y	Y
ZDIST	Depth of Well Below Water Table	YDIST	Distance from Plume Centerline to Well	Y	Y
ZDIST	Depth of Well Below Water Table	ZDIST	Depth of Well Below Water Table		
FRCOEFA	Freundlich Isotherm Coefficient	AVGPDIAM	Avg. Particle Diameter	Y	
FRCOEFA	Freundlich Isotherm Coefficient	POROSITY	Porosity		
FRCOEFA	Freundlich Isotherm Coefficient	AQUTHIK	Aquifer Thickness	Y	
FRCOEFA	Freundlich Isotherm Coefficient	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	HYDGRAD	Hydraulic Gradient	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	LONDISPA	Longitudinal Dispersivity	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	FRORGCAR	Fraction Organic Carbon		
FRCOEFA	Freundlich Isotherm Coefficient	ANGLEW	Angle of Well Off Plume Centerline		
FRCOEFA	Freundlich Isotherm Coefficient	XDIST	Longitudinal Distance to Well	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	YDIST	Distance from Plume Centerline to Well	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	ZDIST	Depth of Well Below Water Table		
FRCOEFA	Freundlich Isotherm Coefficient	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
LEACHCON	Leachate Concentration	AVGPDIAM	Avg. Particle Diameter		

Table D-105. Summary of Crosspairs Analysis for Thallium

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
LEACHCON	Leachate Concentration	POROSITY	Porosity		
LEACHCON	Leachate Concentration	AQUTHIK	Aquifer Thickness		
LEACHCON	Leachate Concentration	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
LEACHCON	Leachate Concentration	HYDGRAD	Hydraulic Gradient		
LEACHCON	Leachate Concentration	LONDISPA	Longitudinal Dispersivity	Y	Y
LEACHCON	Leachate Concentration	FRORGCAR	Fraction Organic Carbon		
LEACHCON	Leachate Concentration	ANGLEW	Angle of Well Off Plume Centerline		
LEACHCON	Leachate Concentration	XDIST	Longitudinal Distance to Well		
LEACHCON	Leachate Concentration	YDIST	Distance from Plume Centerline to Well	Y	Y
LEACHCON	Leachate Concentration	ZDIST	Depth of Well Below Water Table		
LEACHCON	Leachate Concentration	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
LEACHCON	Leachate Concentration	LEACHCON	Leachate Concentration		
RECHARAT	Recharge Rate	AVGPDIAM	Avg. Particle Diameter		
RECHARAT	Recharge Rate	POROSITY	Porosity		
RECHARAT	Recharge Rate	AQUTHIK	Aquifer Thickness		
RECHARAT	Recharge Rate	LONHYCON	Longitundinal Hydraulic Conductivity		
RECHARAT	Recharge Rate	HYDGRAD	Hydraulic Gradient		
RECHARAT	Recharge Rate	LONDISPA	Longitudinal Dispersivity		
RECHARAT	Recharge Rate	FRORGCAR	Fraction Organic Carbon		
RECHARAT	Recharge Rate	ANGLEW	Angle of Well Off Plume Centerline		
RECHARAT	Recharge Rate	XDIST	Longitudinal Distance to Well		
RECHARAT	Recharge Rate	YDIST	Distance from Plume Centerline to Well		
RECHARAT	Recharge Rate	ZDIST	Depth of Well Below Water Table		
RECHARAT	Recharge Rate	FRCOEFA	Freundlich Isotherm Coefficient		
RECHARAT	Recharge Rate	LEACHCON	Leachate Concentration		
RECHARAT	Recharge Rate	RECHARAT	Recharge Rate		
INFILRAT	Infiltration Rate	AVGPDIAM	Avg. Particle Diameter		
INFILRAT	Infiltration Rate	POROSITY	Porosity		
INFILRAT	Infiltration Rate	AQUTHIK	Aquifer Thickness		
INFILRAT	Infiltration Rate	LONHYCON	Longitundinal Hydraulic Conductivity		
INFILRAT	Infiltration Rate	HYDGRAD	Hydraulic Gradient		
INFILRAT	Infiltration Rate	LONDISPA	Longitudinal Dispersivity	Y	
INFILRAT	Infiltration Rate	FRORGCAR	Fraction Organic Carbon	Y	
INFILRAT	Infiltration Rate	ANGLEW	Angle of Well Off Plume Centerline		
INFILRAT	Infiltration Rate	XDIST	Longitudinal Distance to Well		
INFILRAT	Infiltration Rate	YDIST	Distance from Plume Centerline to Well	Y	
INFILRAT	Infiltration Rate	ZDIST	Depth of Well Below Water Table		
INFILRAT	Infiltration Rate	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
INFILRAT	Infiltration Rate	LEACHCON	Leachate Concentration		
INFILRAT	Infiltration Rate	RECHARAT	Recharge Rate		
INFILRAT	Infiltration Rate	INFILRAT	Infiltration Rate	Y	Y
RESIDH2O	Residual Water Content	AVGPDIAM	Avg. Particle Diameter		
RESIDH2O	Residual Water Content	POROSITY	Porosity		
RESIDH2O	Residual Water Content	AQUTHIK	Aquifer Thickness		
RESIDH2O	Residual Water Content	LONHYCON	Longitundinal Hydraulic Conductivity		
RESIDH2O	Residual Water Content	HYDGRAD	Hydraulic Gradient		
RESIDH2O	Residual Water Content	LONDISPA	Longitudinal Dispersivity		
RESIDH2O	Residual Water Content	FRORGCAR	Fraction Organic Carbon		
RESIDH2O	Residual Water Content	ANGLEW	Angle of Well Off Plume Centerline		

Table D-105. Summary of Crosspairs Analysis for Thallium

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
RESIDH2O	Residual Water Content	XDIST	Longitudinal Distance to Well		
RESIDH2O	Residual Water Content	YDIST	Distance from Plume Centerline to Well	Y	
RESIDH2O	Residual Water Content	ZDIST	Depth of Well Below Water Table		
RESIDH2O	Residual Water Content	FRCOEFA	Freundlich Isotherm Coefficient		
RESIDH2O	Residual Water Content	LEACHCON	Leachate Concentration		
RESIDH2O	Residual Water Content	RECHARAT	Recharge Rate		
RESIDH2O	Residual Water Content	INFILRAT	Infiltration Rate		
RESIDH2O	Residual Water Content	RESIDH2O	Residual Water Content		
UNSATHIK	Unsaturated Zone Thickness	AVGPDIAM	Avg. Particle Diameter		
UNSATHIK	Unsaturated Zone Thickness	POROSITY	Porosity		
UNSATHIK	Unsaturated Zone Thickness	AQUTHIK	Aquifer Thickness		
UNSATHIK	Unsaturated Zone Thickness	LONHYCON	Longitundinal Hydraulic Conductivity		
UNSATHIK	Unsaturated Zone Thickness	HYDGRAD	Hydraulic Gradient		
UNSATHIK	Unsaturated Zone Thickness	LONDISPA	Longitudinal Dispersivity		
UNSATHIK	Unsaturated Zone Thickness	FRORGCAR	Fraction Organic Carbon		
UNSATHIK	Unsaturated Zone Thickness	ANGLEW	Angle of Well Off Plume Centerline		
UNSATHIK	Unsaturated Zone Thickness	XDIST	Longitudinal Distance to Well		
UNSATHIK	Unsaturated Zone Thickness	YDIST	Distance from Plume Centerline to Well		
UNSATHIK	Unsaturated Zone Thickness	ZDIST	Depth of Well Below Water Table		
UNSATHIK	Unsaturated Zone Thickness	FRCOEFA	Freundlich Isotherm Coefficient		
UNSATHIK	Unsaturated Zone Thickness	LEACHCON	Leachate Concentration		
UNSATHIK	Unsaturated Zone Thickness	RECHARAT	Recharge Rate		
UNSATHIK	Unsaturated Zone Thickness	INFILRAT	Infiltration Rate		
UNSATHIK	Unsaturated Zone Thickness	RESIDH2O	Residual Water Content		
UNSATHIK	Unsaturated Zone Thickness	UNSATHIK	Unsaturated Zone Thickness		
PERORGM	Percent Organic Matter	AVGPDIAM	Avg. Particle Diameter		
PERORGM	Percent Organic Matter	POROSITY	Porosity		
PERORGM	Percent Organic Matter	AQUTHIK	Aquifer Thickness		
PERORGM	Percent Organic Matter	LONHYCON	Longitundinal Hydraulic Conductivity		
PERORGM	Percent Organic Matter	HYDGRAD	Hydraulic Gradient		
PERORGM	Percent Organic Matter	LONDISPA	Longitudinal Dispersivity		
PERORGM	Percent Organic Matter	FRORGCAR	Fraction Organic Carbon		
PERORGM	Percent Organic Matter	ANGLEW	Angle of Well Off Plume Centerline		
PERORGM	Percent Organic Matter	XDIST	Longitudinal Distance to Well	Y	
PERORGM	Percent Organic Matter	YDIST	Distance from Plume Centerline to Well		
PERORGM	Percent Organic Matter	ZDIST	Depth of Well Below Water Table		
PERORGM	Percent Organic Matter	FRCOEFA	Freundlich Isotherm Coefficient		
PERORGM	Percent Organic Matter	LEACHCON	Leachate Concentration		
PERORGM	Percent Organic Matter	RECHARAT	Recharge Rate		
PERORGM	Percent Organic Matter	INFILRAT	Infiltration Rate		
PERORGM	Percent Organic Matter	RESIDH2O	Residual Water Content		
PERORGM	Percent Organic Matter	UNSATHIK	Unsaturated Zone Thickness		
PERORGM	Percent Organic Matter	PERORGM	Percent Organic Matter		
FRCOEFU	Freundlich Isotherm Coefficient	AVGPDIAM	Avg. Particle Diameter	Y	
FRCOEFU	Freundlich Isotherm Coefficient	POROSITY	Porosity		
FRCOEFU	Freundlich Isotherm Coefficient	AQUTHIK	Aquifer Thickness		
FRCOEFU	Freundlich Isotherm Coefficient	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	HYDGRAD	Hydraulic Gradient	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	LONDISPA	Longitudinal Dispersivity		

Table D-105. Summary of Crosspairs Analysis for Thallium

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
FRCOEFU	Freundlich Isotherm Coefficient	FRORGCAR	Fraction Organic Carbon		
FRCOEFU	Freundlich Isotherm Coefficient	ANGLEW	Angle of Well Off Plume Centerline		
FRCOEFU	Freundlich Isotherm Coefficient	XDIST	Longitudinal Distance to Well		
FRCOEFU	Freundlich Isotherm Coefficient	YDIST	Distance from Plume Centerline to Well	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	ZDIST	Depth of Well Below Water Table		
FRCOEFU	Freundlich Isotherm Coefficient	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	LEACHCON	Leachate Concentration		
FRCOEFU	Freundlich Isotherm Coefficient	RECHARAT	Recharge Rate		
FRCOEFU	Freundlich Isotherm Coefficient	INFILRAT	Infiltration Rate	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	RESIDH2O	Residual Water Content		
FRCOEFU	Freundlich Isotherm Coefficient	UNSATHIK	Unsaturated Zone Thickness		
FRCOEFU	Freundlich Isotherm Coefficient	PERORGM	Percent Organic Matter		
FRCOEFU	Freundlich Isotherm Coefficient	FRCOEFU	Freundlich Isotherm Coefficient	Y	Y

Table D-106. Ranking of Parameters According to Percentage of Risk for Thallium

Variable Description	Reduced Sums of Square	Variable Sums of Square	Variable Degrees of Freedom	% Risk Variation	Mean Square Variable	F VALUE	P VALUE
Freundlich Isotherm Coefficient {Aquifer} (cm3/g)	4373.9	9432.07	50	505818.0%	2123.63	505.82	4.29E-01
Distance from Plume Centerline to Well (m)	5540.7	9432.07	50	389141.0%	2123.63	389.14	4.29E-01
Leachate Concentration (mg/l)	7290.9	9432.07	50	214115.0%	2123.63	428.23	4.29E-01
Consumption of Drinking Water (ml/kg-day)	8579.2	9432.07	50	85285.0%	2123.63	852.85	4.29E-01
Longitudinal Dispersivity {Aquifer} (m)	8617.7	9432.07	50	81433.0%	2123.63	90.48	4.29E-01
Infiltration Rate (m/yr)	9095.6	9432.07	50	33644.0%	2123.63	84.11	4.29E-01
Longitudinal Hydraulic Conductivity (m/yr)	9149.2	9432.07	50	28286.0%	2123.63	31.43	4.29E-01
Freundlich Isotherm Coefficient {Unsaturated} (cm3/g)	9226.8	9432.07	50	20525.0%	2123.63	29.32	4.29E-01
Longitudinal Distance to Well (m)	9266.8	9432.07	50	16529.0%	2123.63	27.55	4.29E-01
Hydraulic Gradient (m/m)	9354.2	9432.07	50	7786.0%	2123.63	9.73	4.29E-01
Aquifer Thickness (m)	9374.3	9432.07	50	5773.0%	2123.63	28.86	4.29E-01
Average Particle Diameter (cm)	9401.3	9432.07	50	3076.0%	2123.63	30.76	4.29E-01
Depth of Well Below Water Table (m)	9401.8	9432.07	50	3030.0%	2123.63	6.06	4.29E-01
Angle of Well Off Plume Centerline (degrees)	9426.9	9432.07	50	520.0%	2123.63	2.60	4.29E-01

Constants

Full Model SS	40
Error SS	10
Error DF	0
MS Error	4949

Table D-107. Summary of Parameters Considered in Sensitivity Analysis for Vanadium

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
ACIDCAT	Acid Catalyzed Hydrolysis Rate Constant	C			
ANGLEW	Angle of Well Off Plume Centerline	anglew		Y	
ANISORAT	Anisotropy Ratio	C			
AQUTHIK	Aquifer Thickness	log(aquthik)		Y	Y
AVGPDIAM	Avg. Particle Diameter	log(avgpdiam+0.001)		Y	Y
BASECAT	Base Catalyzed Hydrolysis Rate Constant	C			
BIODRATA	Biodegradation Rate	C			
BIODRATU	Biodegradation Rate	C			
BULKDENS	Bulk Density	bulkdens**3.5	Y		
CHEMDRU	Chemical Decay Rate	C			
CHEMDRA	Chemical Decay Rate	C			
CONSH2OA	Consump of drinking water	log(consh2oa)			Y
ZDIST	Depth of Well Below Water Table	log(zdist+100)		Y	Y
DISHYD	Dissolved Hydrolysis Rate	C			
YDIST	Distance from Plume Centerline to Well	log(ydist+40)		Y	Y
DURLEACH	Duration of Leaching Period	C			
GWAVTIM	Exposure Duration	C			
FRORGCAR	Fraction Organic Carbon	log(frorgcar)		Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	log(frcoefa-4.9)		Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	log(frcoefu-3)		Y	Y
FREXPA	Freundlich Isotherm Exponent	C			
FREXPU	Freundlich Isotherm Exponent	C			
GWPH	Groundwater pH	gwph	Y		
GWSEEPV	Groundwater Seepage Velocity	log(gwseepv+3)	Y		
GWTEMP	Groundwater Temperature	C			
HYDGRAD	Hydraulic Gradient	log(hydgrad+0.03)		Y	Y
INFILRAT	Infiltration Rate	log(infilrat+5)		Y	Y
LANDEPTH	Landfill Depth	C			
LEACHCON	Leachate Concentration	leachcon		Y	Y
LFFRACT	LF Fraction	C			
LONDISPU	Longitudinal Dispersivity	log(londispu-0.033)	Y		
LONDISPA	Longitudinal Dispersivity	log(londispa+30)		Y	Y
XDIST	Longitudinal Distance to Well	log(xdist+500)		Y	Y

Table D-107. Summary of Parameters Considered in Sensitivity Analysis for Vanadium

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
LONHYCON	Longitundinal Hydraulic Conductivity	log(lonhycon+90000)		Y	Y
MLLA	ml/L	C			
MOISTRPA	Moisture Rention Parameter (a)	log(moistrpa+1)	Y		
MOISTRPB	Moisture Rention Parameter (b)	log(moistrpb-0.1)	Y		
MOLDIFF	Molecular Diffusion Coefficient	C			
NEUTHYD	Neutral Hydrolysis Rate Constant	C			
ORGCDIS	Organic Carbon Distribution Coefficient	C			
PERORGM	Percent Organic Matter	log(perorgm)			
POROSITY	Porosity	porosity			
RADISTW	Radial Distance to Well	log(radistw+250)	Y		
RECHARAT	Recharge Rate	recharat		Y	Y
RESIDH2O	Residual Water Content	residh2o**1.7		Y	
RETCOEF	Retardation Coefficient	log(retcoef-17)	Y		
RFDA	RfD (mg/kg/day)	C			
SATHYCON	Saturated Hydraulic Conductivity	log(sathycon+1)	Y		
SATURH2O	Saturated Water Content	saturh2o	Y		
SOILBDEN	Soil Bulk Density	soilbden	Y		
SORBHYD	Sorbed Hydrolysis Rate	C			
TRANDISP	Transverse Dispersivity	log(trandisp+3)	Y		
UNSATHIK	Unsaturated Zone Thickness	log(unsathik-0.7)			
VERTDISP	Vertical Dispersivity	log(vertdisp+0.1)	Y		
WASTDENS	Waste Density	C			
WASTEVOL	Waste Volume	C			
WMUAREA	WMU Area	C			
WMULEN	WMU Length	C			
WMUWIDTH	WMU Width	C			

Table D-108. Summary of Correlated Parameters for Vanadium

Variable 1		Variable 2		Correlation Coefficient
Code	**Description**	**Code**	**Description**	
AVGPDIAM	Avg. Particle Diameter	BULKDENS	Bulk Density	0.99826
LONHYCON	Longitundinal Hydraulic Conductivi	GWSEEPV	Groundwater Seepage Velocity	0.77924
FRCOEFA	Freundlich Isotherm Coefficient	RETCOEF	Retardation Coefficient	0.91712
LONDISPA	Longitudinal Dispersivity	TRANDISP	Transverse Dispersivity	0.99983
LONDISPA	Longitudinal Dispersivity	VERTDISP	Vertical Dispersivity	0.9987
SATHYCON	Saturated Hydraulic Conductivity	GWPH	Groundwater pH	0.72686
MOISTRPA	Moisture Rention Parameter (a)	GWPH	Groundwater pH	0.78549
MOISTRPB	Moisture Rention Parameter (b)	GWPH	Groundwater pH	0.869
SATURH2O	Saturated Water Content	GWPH	Groundwater pH	-1
SOILBDEN	Soil Bulk Density	GWPH	Groundwater pH	-1
XDIST	Longitudinal Distance to Well	RADISTW	Radial Distance to Well	0.98415
SOILBDEN	Soil Bulk Density	RECHARAT	Recharge Rate	-1
RECHARAT	Recharge Rate	SATHYCON	Saturated Hydraulic Conductivity	0.72686
SATURH2O	Saturated Water Content	SATHYCON	Saturated Hydraulic Conductivity	-0.72686
RECHARAT	Recharge Rate	MOISTRPA	Moisture Rention Parameter (a)	0.78549
SATURH2O	Saturated Water Content	MOISTRPA	Moisture Rention Parameter (a)	-0.78549
RECHARAT	Recharge Rate	MOISTRPB	Moisture Rention Parameter (b)	0.869
SATURH2O	Saturated Water Content	MOISTRPB	Moisture Rention Parameter (b)	-0.869
RECHARAT	Recharge Rate	SATURH2O	Saturated Water Content	-1
SATHYCON	Saturated Hydraulic Conductivity	SATURH2O	Saturated Water Content	-0.72686
MOISTRPA	Moisture Rention Parameter (a)	SATURH2O	Saturated Water Content	-0.78549
MOISTRPB	Moisture Rention Parameter (b)	SATURH2O	Saturated Water Content	-0.869
UNSATHIK	Unsaturated Zone Thickness	LONDISPU	Longitudinal Dispersivity	0.99978
RECHARAT	Recharge Rate	SOILBDEN	Soil Bulk Density	-1
SATHYCON	Saturated Hydraulic Conductivity	SOILBDEN	Soil Bulk Density	-0.72686
MOISTRPA	Moisture Rention Parameter (a)	SOILBDEN	Soil Bulk Density	-0.78549
MOISTRPB	Moisture Rention Parameter (b)	SOILBDEN	Soil Bulk Density	-0.869

Note: Parameters in the variable 2 column were removed from the analysis.

Table D-109. Summary of Crosspairs Analysis for Vanadium

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
AVGPDIAM	Avg. Particle Diameter			Y	Y
POROSITY	Porosity				
AQUTHIK	Aquifer Thickness			Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity			Y	Y
HYDGRAD	Hydraulic Gradient				
LONDISPA	Longitudinal Dispersivity			Y	Y
FRORGCAR	Fraction Organic Carbon				
ANGLEW	Angle of Well Off Plume Centerline				
XDIST	Longitudinal Distance to Well			Y	Y
YDIST	Distance from Plume Centerline to Well			Y	Y
ZDIST	Depth of Well Below Water Table			Y	Y
FRCOEFA	Freundlich Isotherm Coefficient			Y	Y
LEACHCON	Leachate Concentration			Y	Y
RECHARAT	Recharge Rate				
INFILRAT	Infiltration Rate			Y	Y
RESIDH2O	Residual Water Content				
UNSATHIK	Unsaturated Zone Thickness				
PERORGM	Percent Organic Matter				
FRCOEFU	Freundlich Isotherm Coefficient			Y	Y
AVGPDIAM	Avg. Particle Diameter	AVGPDIAM	Avg. Particle Diameter	Y	
POROSITY	Porosity	AVGPDIAM	Avg. Particle Diameter		
POROSITY	Porosity	POROSITY	Porosity		
AQUTHIK	Aquifer Thickness	AVGPDIAM	Avg. Particle Diameter		
AQUTHIK	Aquifer Thickness	POROSITY	Porosity		
AQUTHIK	Aquifer Thickness	AQUTHIK	Aquifer Thickness		
LONHYCON	Longitundinal Hydraulic Conductivity	AVGPDIAM	Avg. Particle Diameter		
LONHYCON	Longitundinal Hydraulic Conductivity	POROSITY	Porosity		
LONHYCON	Longitundinal Hydraulic Conductivity	AQUTHIK	Aquifer Thickness		
LONHYCON	Longitundinal Hydraulic Conductivity	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
HYDGRAD	Hydraulic Gradient	AVGPDIAM	Avg. Particle Diameter		
HYDGRAD	Hydraulic Gradient	POROSITY	Porosity		
HYDGRAD	Hydraulic Gradient	AQUTHIK	Aquifer Thickness		
HYDGRAD	Hydraulic Gradient	LONHYCON	Longitundinal Hydraulic Conductivity		
HYDGRAD	Hydraulic Gradient	HYDGRAD	Hydraulic Gradient		
LONDISPA	Longitudinal Dispersivity	AVGPDIAM	Avg. Particle Diameter		
LONDISPA	Longitudinal Dispersivity	POROSITY	Porosity		
LONDISPA	Longitudinal Dispersivity	AQUTHIK	Aquifer Thickness	Y	Y
LONDISPA	Longitudinal Dispersivity	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
LONDISPA	Longitudinal Dispersivity	HYDGRAD	Hydraulic Gradient	Y	Y
LONDISPA	Longitudinal Dispersivity	LONDISPA	Longitudinal Dispersivity	Y	Y
FRORGCAR	Fraction Organic Carbon	AVGPDIAM	Avg. Particle Diameter		
FRORGCAR	Fraction Organic Carbon	POROSITY	Porosity		
FRORGCAR	Fraction Organic Carbon	AQUTHIK	Aquifer Thickness		
FRORGCAR	Fraction Organic Carbon	LONHYCON	Longitundinal Hydraulic Conductivity		
FRORGCAR	Fraction Organic Carbon	HYDGRAD	Hydraulic Gradient		
FRORGCAR	Fraction Organic Carbon	LONDISPA	Longitudinal Dispersivity		
FRORGCAR	Fraction Organic Carbon	FRORGCAR	Fraction Organic Carbon		
ANGLEW	Angle of Well Off Plume Centerline	AVGPDIAM	Avg. Particle Diameter		
ANGLEW	Angle of Well Off Plume Centerline	POROSITY	Porosity		

Table D-109. Summary of Crosspairs Analysis for Vanadium

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
ANGLEW	Angle of Well Off Plume Centerline	AQUTHIK	Aquifer Thickness		
ANGLEW	Angle of Well Off Plume Centerline	LONHYCON	Longitundinal Hydraulic Conductivity		
ANGLEW	Angle of Well Off Plume Centerline	HYDGRAD	Hydraulic Gradient		
ANGLEW	Angle of Well Off Plume Centerline	LONDISPA	Longitudinal Dispersivity		
ANGLEW	Angle of Well Off Plume Centerline	FRORGCAR	Fraction Organic Carbon		
ANGLEW	Angle of Well Off Plume Centerline	ANGLEW	Angle of Well Off Plume Centerline		
XDIST	Longitudinal Distance to Well	AVGPDIAM	Avg. Particle Diameter		
XDIST	Longitudinal Distance to Well	POROSITY	Porosity		
XDIST	Longitudinal Distance to Well	AQUTHIK	Aquifer Thickness		
XDIST	Longitudinal Distance to Well	LONHYCON	Longitundinal Hydraulic Conductivity		
XDIST	Longitudinal Distance to Well	HYDGRAD	Hydraulic Gradient	Y	Y
XDIST	Longitudinal Distance to Well	LONDISPA	Longitudinal Dispersivity	Y	Y
XDIST	Longitudinal Distance to Well	FRORGCAR	Fraction Organic Carbon		
XDIST	Longitudinal Distance to Well	ANGLEW	Angle of Well Off Plume Centerline		
XDIST	Longitudinal Distance to Well	XDIST	Longitudinal Distance to Well	Y	
YDIST	Distance from Plume Centerline to Well	AVGPDIAM	Avg. Particle Diameter		
YDIST	Distance from Plume Centerline to Well	POROSITY	Porosity		
YDIST	Distance from Plume Centerline to Well	AQUTHIK	Aquifer Thickness		
YDIST	Distance from Plume Centerline to Well	LONHYCON	Longitundinal Hydraulic Conductivity		
YDIST	Distance from Plume Centerline to Well	HYDGRAD	Hydraulic Gradient		
YDIST	Distance from Plume Centerline to Well	LONDISPA	Longitudinal Dispersivity	Y	Y
YDIST	Distance from Plume Centerline to Well	FRORGCAR	Fraction Organic Carbon		
YDIST	Distance from Plume Centerline to Well	ANGLEW	Angle of Well Off Plume Centerline		
YDIST	Distance from Plume Centerline to Well	XDIST	Longitudinal Distance to Well	Y	Y
YDIST	Distance from Plume Centerline to Well	YDIST	Distance from Plume Centerline to Well	Y	Y
ZDIST	Depth of Well Below Water Table	AVGPDIAM	Avg. Particle Diameter		
ZDIST	Depth of Well Below Water Table	POROSITY	Porosity		
ZDIST	Depth of Well Below Water Table	AQUTHIK	Aquifer Thickness		
ZDIST	Depth of Well Below Water Table	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
ZDIST	Depth of Well Below Water Table	HYDGRAD	Hydraulic Gradient	Y	Y
ZDIST	Depth of Well Below Water Table	LONDISPA	Longitudinal Dispersivity		
ZDIST	Depth of Well Below Water Table	FRORGCAR	Fraction Organic Carbon		
ZDIST	Depth of Well Below Water Table	ANGLEW	Angle of Well Off Plume Centerline		
ZDIST	Depth of Well Below Water Table	XDIST	Longitudinal Distance to Well	Y	Y
ZDIST	Depth of Well Below Water Table	YDIST	Distance from Plume Centerline to Well	Y	Y
ZDIST	Depth of Well Below Water Table	ZDIST	Depth of Well Below Water Table		
FRCOEFA	Freundlich Isotherm Coefficient	AVGPDIAM	Avg. Particle Diameter	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	POROSITY	Porosity		
FRCOEFA	Freundlich Isotherm Coefficient	AQUTHIK	Aquifer Thickness		
FRCOEFA	Freundlich Isotherm Coefficient	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	HYDGRAD	Hydraulic Gradient	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	LONDISPA	Longitudinal Dispersivity		
FRCOEFA	Freundlich Isotherm Coefficient	FRORGCAR	Fraction Organic Carbon		
FRCOEFA	Freundlich Isotherm Coefficient	ANGLEW	Angle of Well Off Plume Centerline	Y	
FRCOEFA	Freundlich Isotherm Coefficient	XDIST	Longitudinal Distance to Well	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	YDIST	Distance from Plume Centerline to Well	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	ZDIST	Depth of Well Below Water Table		
FRCOEFA	Freundlich Isotherm Coefficient	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
LEACHCON	Leachate Concentration	AVGPDIAM	Avg. Particle Diameter		

Table D-109. Summary of Crosspairs Analysis for Vanadium

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
LEACHCON	Leachate Concentration	POROSITY	Porosity		
LEACHCON	Leachate Concentration	AQUTHIK	Aquifer Thickness		
LEACHCON	Leachate Concentration	LONHYCON	Longitundinal Hydraulic Conductivity	Y	
LEACHCON	Leachate Concentration	HYDGRAD	Hydraulic Gradient		
LEACHCON	Leachate Concentration	LONDISPA	Longitudinal Dispersivity	Y	Y
LEACHCON	Leachate Concentration	FRORGCAR	Fraction Organic Carbon		
LEACHCON	Leachate Concentration	ANGLEW	Angle of Well Off Plume Centerline		
LEACHCON	Leachate Concentration	XDIST	Longitudinal Distance to Well		
LEACHCON	Leachate Concentration	YDIST	Distance from Plume Centerline to Well	Y	Y
LEACHCON	Leachate Concentration	ZDIST	Depth of Well Below Water Table	Y	
LEACHCON	Leachate Concentration	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
LEACHCON	Leachate Concentration	LEACHCON	Leachate Concentration		
RECHARAT	Recharge Rate	AVGPDIAM	Avg. Particle Diameter		
RECHARAT	Recharge Rate	POROSITY	Porosity		
RECHARAT	Recharge Rate	AQUTHIK	Aquifer Thickness		
RECHARAT	Recharge Rate	LONHYCON	Longitundinal Hydraulic Conductivity		
RECHARAT	Recharge Rate	HYDGRAD	Hydraulic Gradient		
RECHARAT	Recharge Rate	LONDISPA	Longitudinal Dispersivity		
RECHARAT	Recharge Rate	FRORGCAR	Fraction Organic Carbon	Y	Y
RECHARAT	Recharge Rate	ANGLEW	Angle of Well Off Plume Centerline		
RECHARAT	Recharge Rate	XDIST	Longitudinal Distance to Well		
RECHARAT	Recharge Rate	YDIST	Distance from Plume Centerline to Well		
RECHARAT	Recharge Rate	ZDIST	Depth of Well Below Water Table		
RECHARAT	Recharge Rate	FRCOEFA	Freundlich Isotherm Coefficient		
RECHARAT	Recharge Rate	LEACHCON	Leachate Concentration		
RECHARAT	Recharge Rate	RECHARAT	Recharge Rate		
INFILRAT	Infiltration Rate	AVGPDIAM	Avg. Particle Diameter		
INFILRAT	Infiltration Rate	POROSITY	Porosity		
INFILRAT	Infiltration Rate	AQUTHIK	Aquifer Thickness	Y	Y
INFILRAT	Infiltration Rate	LONHYCON	Longitundinal Hydraulic Conductivity		
INFILRAT	Infiltration Rate	HYDGRAD	Hydraulic Gradient	Y	
INFILRAT	Infiltration Rate	LONDISPA	Longitudinal Dispersivity		
INFILRAT	Infiltration Rate	FRORGCAR	Fraction Organic Carbon		
INFILRAT	Infiltration Rate	ANGLEW	Angle of Well Off Plume Centerline		
INFILRAT	Infiltration Rate	XDIST	Longitudinal Distance to Well		
INFILRAT	Infiltration Rate	YDIST	Distance from Plume Centerline to Well		
INFILRAT	Infiltration Rate	ZDIST	Depth of Well Below Water Table		
INFILRAT	Infiltration Rate	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
INFILRAT	Infiltration Rate	LEACHCON	Leachate Concentration		
INFILRAT	Infiltration Rate	RECHARAT	Recharge Rate		
INFILRAT	Infiltration Rate	INFILRAT	Infiltration Rate	Y	Y
RESIDH2O	Residual Water Content	AVGPDIAM	Avg. Particle Diameter		
RESIDH2O	Residual Water Content	POROSITY	Porosity		
RESIDH2O	Residual Water Content	AQUTHIK	Aquifer Thickness		
RESIDH2O	Residual Water Content	LONHYCON	Longitundinal Hydraulic Conductivity		
RESIDH2O	Residual Water Content	HYDGRAD	Hydraulic Gradient		
RESIDH2O	Residual Water Content	LONDISPA	Longitudinal Dispersivity		
RESIDH2O	Residual Water Content	FRORGCAR	Fraction Organic Carbon		
RESIDH2O	Residual Water Content	ANGLEW	Angle of Well Off Plume Centerline		

Table D-109. Summary of Crosspairs Analysis for Vanadium

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
RESIDH2O	Residual Water Content	XDIST	Longitudinal Distance to Well		
RESIDH2O	Residual Water Content	YDIST	Distance from Plume Centerline to Well		
RESIDH2O	Residual Water Content	ZDIST	Depth of Well Below Water Table		
RESIDH2O	Residual Water Content	FRCOEFA	Freundlich Isotherm Coefficient	Y	
RESIDH2O	Residual Water Content	LEACHCON	Leachate Concentration		
RESIDH2O	Residual Water Content	RECHARAT	Recharge Rate		
RESIDH2O	Residual Water Content	INFILRAT	Infiltration Rate		
RESIDH2O	Residual Water Content	RESIDH2O	Residual Water Content		
UNSATHIK	Unsaturated Zone Thickness	AVGPDIAM	Avg. Particle Diameter		
UNSATHIK	Unsaturated Zone Thickness	POROSITY	Porosity		
UNSATHIK	Unsaturated Zone Thickness	AQUTHIK	Aquifer Thickness		
UNSATHIK	Unsaturated Zone Thickness	LONHYCON	Longitundinal Hydraulic Conductivity		
UNSATHIK	Unsaturated Zone Thickness	HYDGRAD	Hydraulic Gradient		
UNSATHIK	Unsaturated Zone Thickness	LONDISPA	Longitudinal Dispersivity		
UNSATHIK	Unsaturated Zone Thickness	FRORGCAR	Fraction Organic Carbon		
UNSATHIK	Unsaturated Zone Thickness	ANGLEW	Angle of Well Off Plume Centerline		
UNSATHIK	Unsaturated Zone Thickness	XDIST	Longitudinal Distance to Well		
UNSATHIK	Unsaturated Zone Thickness	YDIST	Distance from Plume Centerline to Well		
UNSATHIK	Unsaturated Zone Thickness	ZDIST	Depth of Well Below Water Table		
UNSATHIK	Unsaturated Zone Thickness	FRCOEFA	Freundlich Isotherm Coefficient		
UNSATHIK	Unsaturated Zone Thickness	LEACHCON	Leachate Concentration		
UNSATHIK	Unsaturated Zone Thickness	RECHARAT	Recharge Rate		
UNSATHIK	Unsaturated Zone Thickness	INFILRAT	Infiltration Rate		
UNSATHIK	Unsaturated Zone Thickness	RESIDH2O	Residual Water Content		
UNSATHIK	Unsaturated Zone Thickness	UNSATHIK	Unsaturated Zone Thickness		
PERORGM	Percent Organic Matter	AVGPDIAM	Avg. Particle Diameter		
PERORGM	Percent Organic Matter	POROSITY	Porosity		
PERORGM	Percent Organic Matter	AQUTHIK	Aquifer Thickness		
PERORGM	Percent Organic Matter	LONHYCON	Longitundinal Hydraulic Conductivity		
PERORGM	Percent Organic Matter	HYDGRAD	Hydraulic Gradient		
PERORGM	Percent Organic Matter	LONDISPA	Longitudinal Dispersivity		
PERORGM	Percent Organic Matter	FRORGCAR	Fraction Organic Carbon		
PERORGM	Percent Organic Matter	ANGLEW	Angle of Well Off Plume Centerline		
PERORGM	Percent Organic Matter	XDIST	Longitudinal Distance to Well		
PERORGM	Percent Organic Matter	YDIST	Distance from Plume Centerline to Well		
PERORGM	Percent Organic Matter	ZDIST	Depth of Well Below Water Table		
PERORGM	Percent Organic Matter	FRCOEFA	Freundlich Isotherm Coefficient		
PERORGM	Percent Organic Matter	LEACHCON	Leachate Concentration		
PERORGM	Percent Organic Matter	RECHARAT	Recharge Rate		
PERORGM	Percent Organic Matter	INFILRAT	Infiltration Rate		
PERORGM	Percent Organic Matter	RESIDH2O	Residual Water Content		
PERORGM	Percent Organic Matter	UNSATHIK	Unsaturated Zone Thickness		
PERORGM	Percent Organic Matter	PERORGM	Percent Organic Matter		
FRCOEFU	Freundlich Isotherm Coefficient	AVGPDIAM	Avg. Particle Diameter		
FRCOEFU	Freundlich Isotherm Coefficient	POROSITY	Porosity		
FRCOEFU	Freundlich Isotherm Coefficient	AQUTHIK	Aquifer Thickness		
FRCOEFU	Freundlich Isotherm Coefficient	LONHYCON	Longitundinal Hydraulic Conductivity		
FRCOEFU	Freundlich Isotherm Coefficient	HYDGRAD	Hydraulic Gradient	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	LONDISPA	Longitudinal Dispersivity		

Table D-109. Summary of Crosspairs Analysis for Vanadium

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
FRCOEFU	Freundlich Isotherm Coefficient	FRORGCAR	Fraction Organic Carbon		
FRCOEFU	Freundlich Isotherm Coefficient	ANGLEW	Angle of Well Off Plume Centerline		
FRCOEFU	Freundlich Isotherm Coefficient	XDIST	Longitudinal Distance to Well		
FRCOEFU	Freundlich Isotherm Coefficient	YDIST	Distance from Plume Centerline to Well	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	ZDIST	Depth of Well Below Water Table		
FRCOEFU	Freundlich Isotherm Coefficient	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	LEACHCON	Leachate Concentration		
FRCOEFU	Freundlich Isotherm Coefficient	RECHARAT	Recharge Rate		
FRCOEFU	Freundlich Isotherm Coefficient	INFILRAT	Infiltration Rate	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	RESIDH2O	Residual Water Content		
FRCOEFU	Freundlich Isotherm Coefficient	UNSATHIK	Unsaturated Zone Thickness		
FRCOEFU	Freundlich Isotherm Coefficient	PERORGM	Percent Organic Matter		
FRCOEFU	Freundlich Isotherm Coefficient	FRCOEFU	Freundlich Isotherm Coefficient	Y	Y

Table D-110. Ranking of Parameters According to Percentage of Risk for Vanadium

Variable Description	Reduced Sums of Square	Variable Sums of Square	Variable Degrees of Freedom	% Risk Variation	Mean Square Variable	F VALUE	P VALUE
Freundlich Isotherm Coefficient {Aquifer} (cm3/g)	13171.3	24409.70	47	1123843.0%	5303.26	1123.84	1.07E+00
Leachate Concentration (mg/l)	13226.0	24409.70	47	1118366.0%	5303.26	2795.92	1.07E+00
Distance from Plume Centerline to Well (m)	17926.0	24409.70	47	648366.0%	5303.26	810.46	1.07E+00
Longitudinal Dispersivity {Aquifer} (m)	22357.2	24409.70	47	205251.0%	5303.26	256.56	1.07E+00
Consumption of Drinking Water (ml/kg-day)	23485.3	24409.70	47	92441.0%	5303.26	924.41	1.07E+00
Freundlich Isotherm Coefficient {Unsaturated} (cm3/g)	23679.3	24409.70	47	73037.0%	5303.26	121.73	1.07E+00
Longitudinal Hydraulic Conductivity (m/yr)	23703.9	24409.70	47	70579.0%	5303.26	141.16	1.07E+00
Infiltration Rate (m/yr)	23813.6	24409.70	47	59612.0%	5303.26	119.22	1.07E+00
Longitudinal Distance to Well (m)	24047.4	24409.70	47	36233.0%	5303.26	60.39	1.07E+00
Hydraulic Gradient (m/m)	24221.2	24409.70	47	18854.0%	5303.26	31.42	1.07E+00
Aquifer Thickness (m)	24299.0	24409.70	47	11068.0%	5303.26	36.89	1.07E+00
Average Particle Diameter (cm)	24327.5	24409.70	47	8224.0%	5303.26	41.12	1.07E+00
Depth of Well Below Water Table (m)	24334.1	24409.70	47	7558.0%	5303.26	15.12	1.07E+00
Fraction Organic Carbon (g/g)	24400.8	24409.70	47	892.0%	5303.26	4.46	1.07E+00
Recharge Rate (m/yr)	24401.0	24409.70	47	865.0%	5303.26	4.33	1.07E+00

Constants

Full Model SS	37
Error SS	10
Error DF	0
MS Error	4952

Table D-111. Chemical-Specific Properties for Constituents of Concern for Ilmenite Process Wastewater Treatment Solids

	Waste Constituent Concentrations			*Degradation Rates*	
Constituent	**SPLP (Industrial D landfill) (mg/L)**	**Total waste (mg/kg)**	**Finite MSW Source Ratio (L/kg)**	**Overall Hydrolysis rate(1/yr)**	**Biodegrd. Rate(1/yr)**
Antimony	0.02	0.7	45	0	0
Arsenic	0.002	2.8	2200	0	0
Manganese	1.5	2390	650	0	0
Thallium	0.0011	7.2	308	0	0

underline italics indicate values set at 1/2 of detection limit

Table D-112. Distribution of Industrial D Landfill Areas

	Area Range			
Empirical distribution	**Minimum m2**		**Maximum m2**	**Relative Prob.**
	4,000	to	8,090	0.100
	8,090	to	20,200	0.150
	20,200	to	60,700	0.250
	60,700	to	194,000	0.250
	194,000	to	420,000	0.150
	420,000	to	9,350,000	0.100
Total Relative Probability				1.000

D-113. Waste Stream Parameters for Ilmenite Process Wastewater Treatment Solids

WMU	**Location**	**Landfill Area**	**Waste Quantity. (MT/y)**	**Waste Density (g/cm^3)**	**Waste Density (kg/m^3)**	**Total Waste Vol (m^3)**
Offsite Industrial D Landfill	Edgemore, DE	Distribution	108,862	1.50	1500	2177242

Table D-114. Site-Specific Climate-Based Parameters for Ilmenite Process Wastewater Treatment Solids

WMU	Location	Climate Index	Climate Center	Landfill Infiltartion Rate (m/yr)			Recharge Rate (m/yr)				GWpH		
				SCL	SLT	SNL	SCL	SLT	SNL	GW TempC	SCL	SLT	SNL
Offsite Industrial D Landfill	Edgemore, DE	71	Philadelphia, PA	0.16	0.20	0.26	0.16	0.20	0.26	13	5.5	5.2	4.8

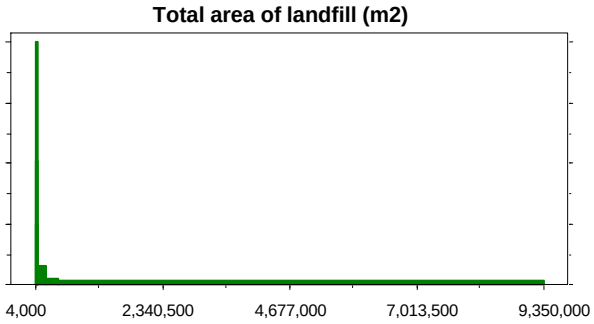

Figure D-1. Distribution of industrial landfill areas.

Table D-115. Aquifer Types Common in 100-Mile Radius of WMUs Managing Ilmenite Process Wastewater Treatment Solids

Aquifer Types	Aquifer Code	Edgemore, DE
Metamorphic & igneous	1	33%
Bedded Sedimentary Rock	2	33%
Unconsolidated and semiconsolidated shallow aquifers	10	33%

Table D-116. Soil Textures Common in 100-Mile Radius of WMUs Managing Ilmenite Process Wastewater Treatment Solids

		Edgemore, DE
silty clay loam	SCL	7%
silt loam	SIL	58%
sandy loam	SNL	35%

Table D-117. Summary of Parameters Considered in Sensitivity Analysis for Antimony

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
ACIDCAT	Acid Catalyzed Hydrolysis Rate Constant	C			
ANGLEW	Angle of Well Off Plume Centerline	anglew			
ANISORAT	Anisotropy Ratio	C			
AQUTHIK	Aquifer Thickness	aquthik**-0.2		Y	Y
AVGPDIAM	Avg. Particle Diameter	log(avgpdiam+.004)		Y	
BASECAT	Base Catalyzed Hydrolysis Rate Constant	C			
BIODRATA	Biodegradation Rate	C			
BIODRATU	Biodegradation Rate	C			
BULKDENS	Bulk Density	bulkdens**3.5	Y		
CHEMDRU	Chemical Decay Rate	C			
CHEMDRA	Chemical Decay Rate	C			
CONSH2OA	Consump of drinking water	log(consh2oa)			Y
ZDIST	Depth of Well Below Water Table	log(zdist+5)			
DISHYD	Dissolved Hydrolysis Rate	C			
YDIST	Distance from Plume Centerline to Well	log(ydist+10)		Y	Y
DURLEACH	Duration of Leaching Period	log(durleach+1000)	Y		
GWAVTIM	Exposure Duration	C			
FRORGCAR	Fraction Organic Carbon	log(frorgcar)		Y	
FRCOEFA	Freundlich Isotherm Coefficient	log(frcoefa-.01)		Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	log(frcoefu)		Y	Y
FREXPA	Freundlich Isotherm Exponent	C			
FREXPU	Freundlich Isotherm Exponent	C			
GWPH	Groundwater pH	gwph	Y		
GWSEEPV	Groundwater Seepage Velocity	log(gwseepv-0.099)		Y	Y
GWTEMP	Groundwater Temperature	C			
HYDGRAD	Hydraulic Gradient	log(hydgrad+0.0003)		Y	Y
INFILRAT	Infiltration Rate	infilrat**1.5		Y	
LANDEPTH	Landfill Depth	log(landepth+100)	Y		
LEACHCON	Leachate Concentration	C			
LFFRACT	LF Fraction	C			
LONDISPU	Longitudinal Dispersivity	log(londispu-0.015)	Y		
LONDISPA	Longitudinal Dispersivity	log(londispa+0.3)		Y	Y
XDIST	Longitudinal Distance to Well	log(xdist+200)		Y	Y

Table D-117. Summary of Parameters Considered in Sensitivity Analysis for Antimony

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
LONHYCON	Longitundinal Hydraulic Conductivity	log(lonhycon-1)		Y	Y
MLLA	ml/L	C			
MOISTRPA	Moisture Rention Parameter (a)	log(moistrpa-0.05)	Y		
MOISTRPB	Moisture Rention Parameter (b)	log(moistrpb-0.7)	Y		
MOLDIFF	Molecular Diffusion Coefficient	C			
NEUTHYD	Neutral Hydrolysis Rate Constant	C			
ORGCDIS	Organic Carbon Distribution Coefficient	C			
PERORGM	Percent Organic Matter	log(perorgm)		Y	
POROSITY	Porosity	porosity**1.3		Y	
RADISTW	Radial Distance to Well	log(radistw+250)	Y		
RECHARAT	Recharge Rate	recharat	Y		
RESIDH2O	Residual Water Content	residh2o**1.7		Y	
RETCOEF	Retardation Coefficient	log(retcoef-1)	Y		
RFDA	RfD (mg/kg/day)	C			
SATHYCON	Saturated Hydraulic Conductivity	log(sathycon)	Y		
SATURH2O	Saturated Water Content	saturh2o	Y		
SOILBDEN	Soil Bulk Density	soilbden	Y		
SORBHYD	Sorbed Hydrolysis Rate	C			
TRANDISP	Transverse Dispersivity	log(trandisp+0.01)	Y		
UNSATHIK	Unsaturated Zone Thickness	log(unsathik)		Y	Y
VERTDISP	Vertical Dispersivity	log(vertdisp+0.001)	Y		
WASTDENS	Waste Density	C			
WASTEVOL	Waste Volume	C			
WMUAREA	WMU Area	log(wmuarea-36000)		Y	Y
WMULEN	WMU Length	log(wmulen-185)	Y		
WMUWIDTH	WMU Width	log(wmuwidth-185)	Y		

Table D-118. Summary of Correlated Parameters for Antimony

Variable 1		Variable 2		Correlation Coefficient
Code	Description	Code	Description	
AVGPDIAM	Avg. Particle Diameter	BULKDENS	Bulk Density	0.99615
FRCOEFA	Freundlich Isotherm Coefficient	RETCOEF	Retardation Coefficient	0.97042
LONDISPA	Longitudinal Dispersivity	TRANDISP	Transverse Dispersivity	0.9992
LONDISPA	Longitudinal Dispersivity	VERTDISP	Vertical Dispersivity	0.9991
RECHARAT	Recharge Rate	GWPH	Groundwater pH	-0.99859
INFILRAT	Infiltration Rate	GWPH	Groundwater pH	-0.98952
SATHYCON	Saturated Hydraulic Conductivity	GWPH	Groundwater pH	-0.7369
MOISTRPA	Moisture Rention Parameter (a)	GWPH	Groundwater pH	-0.77769
MOISTRPB	Moisture Rention Parameter (b)	GWPH	Groundwater pH	-0.86172
SATURH2O	Saturated Water Content	GWPH	Groundwater pH	0.82861
SOILBDEN	Soil Bulk Density	GWPH	Groundwater pH	0.98936
XDIST	Longitudinal Distance to Well	RADISTW	Radial Distance to Well	0.99761
WMUAREA	WMU Area	WMULEN	WMU Length	0.99592
LANDEPTH	Landfill Depth	WMULEN	WMU Length	-0.98362
DURLEACH	Duration of Leaching Period	WMULEN	WMU Length	-0.95212
WMUAREA	WMU Area	WMUWIDTH	WMU Width	0.99592
LANDEPTH	Landfill Depth	WMUWIDTH	WMU Width	-0.98362
DURLEACH	Duration of Leaching Period	WMUWIDTH	WMU Width	-0.95212
INFILRAT	Infiltration Rate	RECHARAT	Recharge Rate	0.99162
SATHYCON	Saturated Hydraulic Conductivity	RECHARAT	Recharge Rate	0.73751
MOISTRPA	Moisture Rention Parameter (a)	RECHARAT	Recharge Rate	0.7829
MOISTRPB	Moisture Rention Parameter (b)	RECHARAT	Recharge Rate	0.86427
SATURH2O	Saturated Water Content	RECHARAT	Recharge Rate	-0.85716
SOILBDEN	Soil Bulk Density	RECHARAT	Recharge Rate	-0.99569
WMUAREA	WMU Area	LANDEPTH	Landfill Depth	-0.9683
WMUAREA	WMU Area	DURLEACH	Duration of Leaching Period	-0.92984
LANDEPTH	Landfill Depth	DURLEACH	Duration of Leaching Period	0.95076
RECHARAT	Recharge Rate	SATHYCON	Saturated Hydraulic Conductivity	0.73751
INFILRAT	Infiltration Rate	SATHYCON	Saturated Hydraulic Conductivity	0.7477
RECHARAT	Recharge Rate	MOISTRPA	Moisture Rention Parameter (a)	0.7829
INFILRAT	Infiltration Rate	MOISTRPA	Moisture Rention Parameter (a)	0.77775
SATURH2O	Saturated Water Content	MOISTRPA	Moisture Rention Parameter (a)	-0.71095
RECHARAT	Recharge Rate	MOISTRPB	Moisture Rention Parameter (b)	0.86427

Table D-118. Summary of Correlated Parameters for Antimony

Variable 1		Variable 2		Correlation Coefficient
Code	**Description**	**Code**	**Description**	
INFILRAT	Infiltration Rate	MOISTRPB	Moisture Rention Parameter (b)	0.85806
SATURH2O	Saturated Water Content	MOISTRPB	Moisture Rention Parameter (b)	-0.75378
RECHARAT	Recharge Rate	SATURH2O	Saturated Water Content	-0.85716
INFILRAT	Infiltration Rate	SATURH2O	Saturated Water Content	-0.85679
MOISTRPA	Moisture Rention Parameter (a)	SATURH2O	Saturated Water Content	-0.71095
MOISTRPB	Moisture Rention Parameter (b)	SATURH2O	Saturated Water Content	-0.75378
SOILBDEN	Soil Bulk Density	SATURH2O	Saturated Water Content	0.90123
UNSATHIK	Unsaturated Zone Thickness	LONDISPU	Longitudinal Dispersivity	0.98671
RECHARAT	Recharge Rate	SOILBDEN	Soil Bulk Density	-0.99569
INFILRAT	Infiltration Rate	SOILBDEN	Soil Bulk Density	-0.98858
SATHYCON	Saturated Hydraulic Conductivity	SOILBDEN	Soil Bulk Density	-0.73357
MOISTRPA	Moisture Rention Parameter (a)	SOILBDEN	Soil Bulk Density	-0.78671
MOISTRPB	Moisture Rention Parameter (b)	SOILBDEN	Soil Bulk Density	-0.86288
SATURH2O	Saturated Water Content	SOILBDEN	Soil Bulk Density	0.90123

Note: Parameters in the variable 2 column were removed from the analysis.

Table D-119. Summary of Crosspairs Analysis for Antimony

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
AVGPDIAM	Avg. Particle Diameter				
POROSITY	Porosity			Y	
AQUTHIK	Aquifer Thickness			Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity			Y	Y
HYDGRAD	Hydraulic Gradient			Y	Y
GWSEEPV	Groundwater Seepage Velocity			Y	
LONDISPA	Longitudinal Dispersivity			Y	Y
FRORGCAR	Fraction Organic Carbon				
ANGLEW	Angle of Well Off Plume Centerline				
XDIST	Longitudinal Distance to Well			Y	Y
YDIST	Distance from Plume Centerline to Well			Y	Y
ZDIST	Depth of Well Below Water Table				
FRCOEFA	Freundlich Isotherm Coefficient			Y	Y
WMUAREA	WMU Area			Y	Y
INFILRAT	Infiltration Rate				
RESIDH2O	Residual Water Content				
UNSATHIK	Unsaturated Zone Thickness			Y	Y
PERORGM	Percent Organic Matter				
FRCOEFU	Freundlich Isotherm Coefficient			Y	Y
AVGPDIAM	Avg. Particle Diameter	AVGPDIAM	Avg. Particle Diameter		
POROSITY	Porosity	AVGPDIAM	Avg. Particle Diameter		
POROSITY	Porosity	POROSITY	Porosity		
AQUTHIK	Aquifer Thickness	AVGPDIAM	Avg. Particle Diameter		
AQUTHIK	Aquifer Thickness	POROSITY	Porosity	Y	
AQUTHIK	Aquifer Thickness	AQUTHIK	Aquifer Thickness	Y	
LONHYCON	Longitundinal Hydraulic Conductivity	AVGPDIAM	Avg. Particle Diameter		
LONHYCON	Longitundinal Hydraulic Conductivity	POROSITY	Porosity	Y	
LONHYCON	Longitundinal Hydraulic Conductivity	AQUTHIK	Aquifer Thickness	Y	
LONHYCON	Longitundinal Hydraulic Conductivity	LONHYCON	Longitundinal Hydraulic Conductivity	Y	
HYDGRAD	Hydraulic Gradient	AVGPDIAM	Avg. Particle Diameter		
HYDGRAD	Hydraulic Gradient	POROSITY	Porosity		
HYDGRAD	Hydraulic Gradient	AQUTHIK	Aquifer Thickness	Y	
HYDGRAD	Hydraulic Gradient	LONHYCON	Longitundinal Hydraulic Conductivity		
HYDGRAD	Hydraulic Gradient	HYDGRAD	Hydraulic Gradient		
GWSEEPV	Groundwater Seepage Velocity	AVGPDIAM	Avg. Particle Diameter		
GWSEEPV	Groundwater Seepage Velocity	POROSITY	Porosity		
GWSEEPV	Groundwater Seepage Velocity	AQUTHIK	Aquifer Thickness	Y	
GWSEEPV	Groundwater Seepage Velocity	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
GWSEEPV	Groundwater Seepage Velocity	HYDGRAD	Hydraulic Gradient		
GWSEEPV	Groundwater Seepage Velocity	GWSEEPV	Groundwater Seepage Velocity		
LONDISPA	Longitudinal Dispersivity	AVGPDIAM	Avg. Particle Diameter		
LONDISPA	Longitudinal Dispersivity	POROSITY	Porosity	Y	
LONDISPA	Longitudinal Dispersivity	AQUTHIK	Aquifer Thickness	Y	Y
LONDISPA	Longitudinal Dispersivity	LONHYCON	Longitundinal Hydraulic Conductivity	Y	
LONDISPA	Longitudinal Dispersivity	HYDGRAD	Hydraulic Gradient	Y	
LONDISPA	Longitudinal Dispersivity	GWSEEPV	Groundwater Seepage Velocity	Y	
LONDISPA	Longitudinal Dispersivity	LONDISPA	Longitudinal Dispersivity		
FRORGCAR	Fraction Organic Carbon	AVGPDIAM	Avg. Particle Diameter		
FRORGCAR	Fraction Organic Carbon	POROSITY	Porosity		

Table D-119. Summary of Crosspairs Analysis for Antimony

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
FRORGCAR	Fraction Organic Carbon	AQUTHIK	Aquifer Thickness		
FRORGCAR	Fraction Organic Carbon	LONHYCON	Longitundinal Hydraulic Conductivity		
FRORGCAR	Fraction Organic Carbon	HYDGRAD	Hydraulic Gradient		
FRORGCAR	Fraction Organic Carbon	GWSEEPV	Groundwater Seepage Velocity		
FRORGCAR	Fraction Organic Carbon	LONDISPA	Longitudinal Dispersivity		
FRORGCAR	Fraction Organic Carbon	FRORGCAR	Fraction Organic Carbon		
ANGLEW	Angle of Well Off Plume Centerline	AVGPDIAM	Avg. Particle Diameter		
ANGLEW	Angle of Well Off Plume Centerline	POROSITY	Porosity		
ANGLEW	Angle of Well Off Plume Centerline	AQUTHIK	Aquifer Thickness		
ANGLEW	Angle of Well Off Plume Centerline	LONHYCON	Longitundinal Hydraulic Conductivity		
ANGLEW	Angle of Well Off Plume Centerline	HYDGRAD	Hydraulic Gradient		
ANGLEW	Angle of Well Off Plume Centerline	GWSEEPV	Groundwater Seepage Velocity		
ANGLEW	Angle of Well Off Plume Centerline	LONDISPA	Longitudinal Dispersivity		
ANGLEW	Angle of Well Off Plume Centerline	FRORGCAR	Fraction Organic Carbon		
ANGLEW	Angle of Well Off Plume Centerline	ANGLEW	Angle of Well Off Plume Centerline		
XDIST	Longitudinal Distance to Well	AVGPDIAM	Avg. Particle Diameter		
XDIST	Longitudinal Distance to Well	POROSITY	Porosity		
XDIST	Longitudinal Distance to Well	AQUTHIK	Aquifer Thickness	Y	Y
XDIST	Longitudinal Distance to Well	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
XDIST	Longitudinal Distance to Well	HYDGRAD	Hydraulic Gradient	Y	Y
XDIST	Longitudinal Distance to Well	GWSEEPV	Groundwater Seepage Velocity		
XDIST	Longitudinal Distance to Well	LONDISPA	Longitudinal Dispersivity	Y	Y
XDIST	Longitudinal Distance to Well	FRORGCAR	Fraction Organic Carbon		
XDIST	Longitudinal Distance to Well	ANGLEW	Angle of Well Off Plume Centerline		
XDIST	Longitudinal Distance to Well	XDIST	Longitudinal Distance to Well	Y	Y
YDIST	Distance from Plume Centerline to Well	AVGPDIAM	Avg. Particle Diameter		
YDIST	Distance from Plume Centerline to Well	POROSITY	Porosity		
YDIST	Distance from Plume Centerline to Well	AQUTHIK	Aquifer Thickness	Y	Y
YDIST	Distance from Plume Centerline to Well	LONHYCON	Longitundinal Hydraulic Conductivity		
YDIST	Distance from Plume Centerline to Well	HYDGRAD	Hydraulic Gradient		
YDIST	Distance from Plume Centerline to Well	GWSEEPV	Groundwater Seepage Velocity		
YDIST	Distance from Plume Centerline to Well	LONDISPA	Longitudinal Dispersivity		
YDIST	Distance from Plume Centerline to Well	FRORGCAR	Fraction Organic Carbon		
YDIST	Distance from Plume Centerline to Well	ANGLEW	Angle of Well Off Plume Centerline		
YDIST	Distance from Plume Centerline to Well	XDIST	Longitudinal Distance to Well	Y	Y
YDIST	Distance from Plume Centerline to Well	YDIST	Distance from Plume Centerline to Well	Y	Y
ZDIST	Depth of Well Below Water Table	AVGPDIAM	Avg. Particle Diameter		
ZDIST	Depth of Well Below Water Table	POROSITY	Porosity		
ZDIST	Depth of Well Below Water Table	AQUTHIK	Aquifer Thickness		
ZDIST	Depth of Well Below Water Table	LONHYCON	Longitundinal Hydraulic Conductivity		
ZDIST	Depth of Well Below Water Table	HYDGRAD	Hydraulic Gradient		
ZDIST	Depth of Well Below Water Table	GWSEEPV	Groundwater Seepage Velocity		
ZDIST	Depth of Well Below Water Table	LONDISPA	Longitudinal Dispersivity		
ZDIST	Depth of Well Below Water Table	FRORGCAR	Fraction Organic Carbon		
ZDIST	Depth of Well Below Water Table	ANGLEW	Angle of Well Off Plume Centerline		
ZDIST	Depth of Well Below Water Table	XDIST	Longitudinal Distance to Well		
ZDIST	Depth of Well Below Water Table	YDIST	Distance from Plume Centerline to Well		
ZDIST	Depth of Well Below Water Table	ZDIST	Depth of Well Below Water Table		
FRCOEFA	Freundlich Isotherm Coefficient	AVGPDIAM	Avg. Particle Diameter		

Table D-119. Summary of Crosspairs Analysis for Antimony

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
FRCOEFA	Freundlich Isotherm Coefficient	POROSITY	Porosity		
FRCOEFA	Freundlich Isotherm Coefficient	AQUTHIK	Aquifer Thickness	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	HYDGRAD	Hydraulic Gradient		
FRCOEFA	Freundlich Isotherm Coefficient	GWSEEPV	Groundwater Seepage Velocity		
FRCOEFA	Freundlich Isotherm Coefficient	LONDISPA	Longitudinal Dispersivity		
FRCOEFA	Freundlich Isotherm Coefficient	FRORGCAR	Fraction Organic Carbon	Y	
FRCOEFA	Freundlich Isotherm Coefficient	ANGLEW	Angle of Well Off Plume Centerline		
FRCOEFA	Freundlich Isotherm Coefficient	XDIST	Longitudinal Distance to Well		
FRCOEFA	Freundlich Isotherm Coefficient	YDIST	Distance from Plume Centerline to Well		
FRCOEFA	Freundlich Isotherm Coefficient	ZDIST	Depth of Well Below Water Table		
FRCOEFA	Freundlich Isotherm Coefficient	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
WMUAREA	WMU Area	AVGPDIAM	Avg. Particle Diameter		
WMUAREA	WMU Area	POROSITY	Porosity		
WMUAREA	WMU Area	AQUTHIK	Aquifer Thickness	Y	Y
WMUAREA	WMU Area	LONHYCON	Longitundinal Hydraulic Conductivity		
WMUAREA	WMU Area	HYDGRAD	Hydraulic Gradient		
WMUAREA	WMU Area	GWSEEPV	Groundwater Seepage Velocity		
WMUAREA	WMU Area	LONDISPA	Longitudinal Dispersivity	Y	
WMUAREA	WMU Area	FRORGCAR	Fraction Organic Carbon		
WMUAREA	WMU Area	ANGLEW	Angle of Well Off Plume Centerline		
WMUAREA	WMU Area	XDIST	Longitudinal Distance to Well	Y	Y
WMUAREA	WMU Area	YDIST	Distance from Plume Centerline to Well	Y	Y
WMUAREA	WMU Area	ZDIST	Depth of Well Below Water Table		
WMUAREA	WMU Area	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
WMUAREA	WMU Area	WMUAREA	WMU Area	Y	Y
INFILRAT	Infiltration Rate	AVGPDIAM	Avg. Particle Diameter		
INFILRAT	Infiltration Rate	POROSITY	Porosity		
INFILRAT	Infiltration Rate	AQUTHIK	Aquifer Thickness		
INFILRAT	Infiltration Rate	LONHYCON	Longitundinal Hydraulic Conductivity		
INFILRAT	Infiltration Rate	HYDGRAD	Hydraulic Gradient		
INFILRAT	Infiltration Rate	GWSEEPV	Groundwater Seepage Velocity		
INFILRAT	Infiltration Rate	LONDISPA	Longitudinal Dispersivity		
INFILRAT	Infiltration Rate	FRORGCAR	Fraction Organic Carbon		
INFILRAT	Infiltration Rate	ANGLEW	Angle of Well Off Plume Centerline		
INFILRAT	Infiltration Rate	XDIST	Longitudinal Distance to Well		
INFILRAT	Infiltration Rate	YDIST	Distance from Plume Centerline to Well		
INFILRAT	Infiltration Rate	ZDIST	Depth of Well Below Water Table		
INFILRAT	Infiltration Rate	FRCOEFA	Freundlich Isotherm Coefficient		
INFILRAT	Infiltration Rate	WMUAREA	WMU Area		
INFILRAT	Infiltration Rate	INFILRAT	Infiltration Rate		
RESIDH2O	Residual Water Content	AVGPDIAM	Avg. Particle Diameter		
RESIDH2O	Residual Water Content	POROSITY	Porosity		
RESIDH2O	Residual Water Content	AQUTHIK	Aquifer Thickness		
RESIDH2O	Residual Water Content	LONHYCON	Longitundinal Hydraulic Conductivity		
RESIDH2O	Residual Water Content	HYDGRAD	Hydraulic Gradient		
RESIDH2O	Residual Water Content	GWSEEPV	Groundwater Seepage Velocity		
RESIDH2O	Residual Water Content	LONDISPA	Longitudinal Dispersivity		
RESIDH2O	Residual Water Content	FRORGCAR	Fraction Organic Carbon	Y	

Table D-119. Summary of Crosspairs Analysis for Antimony

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
RESIDH2O	Residual Water Content	ANGLEW	Angle of Well Off Plume Centerline		
RESIDH2O	Residual Water Content	XDIST	Longitudinal Distance to Well		
RESIDH2O	Residual Water Content	YDIST	Distance from Plume Centerline to Well		
RESIDH2O	Residual Water Content	ZDIST	Depth of Well Below Water Table		
RESIDH2O	Residual Water Content	FRCOEFA	Freundlich Isotherm Coefficient		
RESIDH2O	Residual Water Content	WMUAREA	WMU Area		
RESIDH2O	Residual Water Content	INFILRAT	Infiltration Rate		
RESIDH2O	Residual Water Content	RESIDH2O	Residual Water Content		
UNSATHIK	Unsaturated Zone Thickness	AVGPDIAM	Avg. Particle Diameter		
UNSATHIK	Unsaturated Zone Thickness	POROSITY	Porosity	Y	
UNSATHIK	Unsaturated Zone Thickness	AQUTHIK	Aquifer Thickness		
UNSATHIK	Unsaturated Zone Thickness	LONHYCON	Longitundinal Hydraulic Conductivity	Y	
UNSATHIK	Unsaturated Zone Thickness	HYDGRAD	Hydraulic Gradient	Y	
UNSATHIK	Unsaturated Zone Thickness	GWSEEPV	Groundwater Seepage Velocity	Y	
UNSATHIK	Unsaturated Zone Thickness	LONDISPA	Longitudinal Dispersivity	Y	
UNSATHIK	Unsaturated Zone Thickness	FRORGCAR	Fraction Organic Carbon		
UNSATHIK	Unsaturated Zone Thickness	ANGLEW	Angle of Well Off Plume Centerline		
UNSATHIK	Unsaturated Zone Thickness	XDIST	Longitudinal Distance to Well		
UNSATHIK	Unsaturated Zone Thickness	YDIST	Distance from Plume Centerline to Well		
UNSATHIK	Unsaturated Zone Thickness	ZDIST	Depth of Well Below Water Table		
UNSATHIK	Unsaturated Zone Thickness	FRCOEFA	Freundlich Isotherm Coefficient		
UNSATHIK	Unsaturated Zone Thickness	WMUAREA	WMU Area		
UNSATHIK	Unsaturated Zone Thickness	INFILRAT	Infiltration Rate		
UNSATHIK	Unsaturated Zone Thickness	RESIDH2O	Residual Water Content		
UNSATHIK	Unsaturated Zone Thickness	UNSATHIK	Unsaturated Zone Thickness	Y	Y
PERORGM	Percent Organic Matter	AVGPDIAM	Avg. Particle Diameter	Y	
PERORGM	Percent Organic Matter	POROSITY	Porosity		
PERORGM	Percent Organic Matter	AQUTHIK	Aquifer Thickness		
PERORGM	Percent Organic Matter	LONHYCON	Longitundinal Hydraulic Conductivity		
PERORGM	Percent Organic Matter	HYDGRAD	Hydraulic Gradient		
PERORGM	Percent Organic Matter	GWSEEPV	Groundwater Seepage Velocity		
PERORGM	Percent Organic Matter	LONDISPA	Longitudinal Dispersivity		
PERORGM	Percent Organic Matter	FRORGCAR	Fraction Organic Carbon		
PERORGM	Percent Organic Matter	ANGLEW	Angle of Well Off Plume Centerline		
PERORGM	Percent Organic Matter	XDIST	Longitudinal Distance to Well		
PERORGM	Percent Organic Matter	YDIST	Distance from Plume Centerline to Well		
PERORGM	Percent Organic Matter	ZDIST	Depth of Well Below Water Table		
PERORGM	Percent Organic Matter	FRCOEFA	Freundlich Isotherm Coefficient		
PERORGM	Percent Organic Matter	WMUAREA	WMU Area		
PERORGM	Percent Organic Matter	INFILRAT	Infiltration Rate		
PERORGM	Percent Organic Matter	RESIDH2O	Residual Water Content		
PERORGM	Percent Organic Matter	UNSATHIK	Unsaturated Zone Thickness		
PERORGM	Percent Organic Matter	PERORGM	Percent Organic Matter		
FRCOEFU	Freundlich Isotherm Coefficient	AVGPDIAM	Avg. Particle Diameter		
FRCOEFU	Freundlich Isotherm Coefficient	POROSITY	Porosity		
FRCOEFU	Freundlich Isotherm Coefficient	AQUTHIK	Aquifer Thickness		
FRCOEFU	Freundlich Isotherm Coefficient	LONHYCON	Longitundinal Hydraulic Conductivity		
FRCOEFU	Freundlich Isotherm Coefficient	HYDGRAD	Hydraulic Gradient		
FRCOEFU	Freundlich Isotherm Coefficient	GWSEEPV	Groundwater Seepage Velocity		

Table D-119. Summary of Crosspairs Analysis for Antimony

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
FRCOEFU	Freundlich Isotherm Coefficient	LONDISPA	Longitudinal Dispersivity	Y	
FRCOEFU	Freundlich Isotherm Coefficient	FRORGCAR	Fraction Organic Carbon		
FRCOEFU	Freundlich Isotherm Coefficient	ANGLEW	Angle of Well Off Plume Centerline		
FRCOEFU	Freundlich Isotherm Coefficient	XDIST	Longitudinal Distance to Well	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	YDIST	Distance from Plume Centerline to Well		
FRCOEFU	Freundlich Isotherm Coefficient	ZDIST	Depth of Well Below Water Table		
FRCOEFU	Freundlich Isotherm Coefficient	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	WMUAREA	WMU Area	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	INFILRAT	Infiltration Rate	Y	
FRCOEFU	Freundlich Isotherm Coefficient	RESIDH2O	Residual Water Content		
FRCOEFU	Freundlich Isotherm Coefficient	UNSATHIK	Unsaturated Zone Thickness	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	PERORGM	Percent Organic Matter		
FRCOEFU	Freundlich Isotherm Coefficient	FRCOEFU	Freundlich Isotherm Coefficient	Y	Y

Table D-120. Ranking of Parameters According to Percentage of Risk for Antimony

Variable Description	Reduced Sums of Square	Variable Sums of Square	Variable Degrees of Freedom	% Risk Variation	Mean Square Variable	F VALUE	P VALUE
Longitudinal Distance to Well (m)	2260.6	943.76	9	19.6%	104.86	321.74	0.00E+00
Distance from Plume Centerline to Well (m)	2412.5	791.83	5	16.4%	158.37	485.90	0.00E+00
Consumption of Drinking Water (ml/kg-day)	2541.7	662.70	1	13.7%	662.70	2033.31	0.00E+00
WMU Area (m2)	2662.3	542.09	7	11.2%	77.44	237.61	9.31E-306
Freundlich Isotherm Coefficient {Aquifer} (cm3/g)	2744.9	459.48	4	9.5%	114.87	352.44	1.91E-267
Longitudinal Hydraulic Conductivity (m/yr)	2999.8	204.58	4	4.2%	51.14	156.92	1.26E-126
Longitudinal Dispersivity {Aquifer} (m)	3029.1	175.24	3	3.6%	58.41	179.23	2.45E-110
Freundlich Isotherm Coefficient {Unsaturated} (cm3/g)	3083.2	121.16	6	2.5%	20.19	61.96	2.18E-74
Aquifer Thickness (m)	3100.7	103.70	6	2.2%	17.28	53.03	1.22E-63
Unsaturated Zone Thickness (m)	3171.3	33.02	3	0.7%	11.01	33.77	1.34E-21
Hydraluic Gradient (m/m)	3174.4	30.00	2	0.6%	15.00	46.02	1.58E-20

Constants

Full Model SS	3204.367
Error SS	1617.875
Error DF	4964
MS Error	0.326

Table D-121. Summary of Parameters Considered in Sensitivity Analysis for Arsenic

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
EXPDURA		log(expdura)			Y
CANSLOPE		C			
ACIDCAT	Acid Catalyzed Hydrolysis Rate Constant	C			
ANGLEW	Angle of Well Off Plume Centerline	anglew		Y	
ANISORAT	Anisotropy Ratio	C			
AQUTHIK	Aquifer Thickness	aquthik**-0.2		Y	Y
AVGPDIAM	Avg. Particle Diameter	log(avgpdiam+0.002)		Y	Y
BASECAT	Base Catalyzed Hydrolysis Rate Constant	C			
BIODRATA	Biodegradation Rate	C			
BIODRATU	Biodegradation Rate	C			
BULKDENS	Bulk Density	bulkdens**3.5	Y		
CHEMDRA	Chemical Decay Rate	C			
CHEMDRU	Chemical Decay Rate	C			
CONSH2OA	Consump of drinking water	log(consh2oa)			Y
ZDIST	Depth of Well Below Water Table	log(zdist+3)		Y	Y
DISHYD	Dissolved Hydrolysis Rate	C			
YDIST	Distance from Plume Centerline to Well	log(ydist+10)		Y	Y
DURLEACH	Duration of Leaching Period	log(durleach+10000)	Y		
GWAVTIM	Exposure Duration	gwavtim			
FRORGCAR	Fraction Organic Carbon	log(frorgcar)		Y	
FRCOEFA	Freundlich Isotherm Coefficient	log(frcoefa+1.5)		Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	log(frcoefu+.01)		Y	Y
FREXPA	Freundlich Isotherm Exponent	C			
FREXPU	Freundlich Isotherm Exponent	C			
GWPH	Groundwater pH	gwph	Y		
GWSEEPV	Groundwater Seepage Velocity	log(gwseepv-0.099)		Y	Y
GWTEMP	Groundwater Temperature	C			
HYDGRAD	Hydraulic Gradient	log(hydgrad+0.0003)		Y	Y
INFILRAT	Infiltration Rate	infilrat**1.5		Y	Y
LANDEPTH	Landfill Depth	log(landepth+10000)	Y		
LEACHCON	Leachate Concentration	C			
LFFRACT	LF Fraction	C			
LONDISPU	Longitudinal Dispersivity	log(londispu-0.015)	Y		

Table D-121. Summary of Parameters Considered in Sensitivity Analysis for Arsenic

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
LONDISPA	Longitudinal Dispersivity	log(londispa+0.3)		Y	Y
XDIST	Longitudinal Distance to Well	log(xdist+200)		Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity	lonhycon**-0.1		Y	Y
MOISTRPA	Moisture Rention Parameter (a)	log(moistrpa-0.05)	Y		
MOISTRPB	Moisture Rention Parameter (b)	log(moistrpb-0.7)	Y		
MOLDIFF	Molecular Diffusion Coefficient	C			
NEUTHYD	Neutral Hydrolysis Rate Constant	C			
ORGCDIS	Organic Carbon Distribution Coefficient	C			
PERORGM	Percent Organic Matter	log(perorgm)			
POROSITY	Porosity	porosity**1.3		Y	Y
RADISTW	Radial Distance to Well	log(radistw+250)	Y		
RECHARAT	Recharge Rate	recharat	Y		
RESIDH2O	Residual Water Content	residh2o**1.3		Y	Y
RETCOEF	Retardation Coefficient	log(retcoef)	Y		
SATHYCON	Saturated Hydraulic Conductivity	log(sathycon+0.1)	Y		
SATURH2O	Saturated Water Content	saturh2o	Y		
SOILBDEN	Soil Bulk Density	soilbden	Y		
SORBHYD	Sorbed Hydrolysis Rate	C			
TRANDISP	Transverse Dispersivity	log(trandisp+0.01)	Y		
UNSATHIK	Unsaturated Zone Thickness	log(unsathik-0.28)		Y	Y
VERTDISP	Vertical Dispersivity	log(vertdisp+0.001)	Y		
WASTDENS	Waste Density	C			
WASTEVOL	Waste Volume	C			
WMUAREA	WMU Area	log(wmuarea-36000)		Y	Y
WMULEN	WMU Length	log(wmulen-189)	Y		
WMUWIDTH	WMU Width	log(wmuwidth-189)	Y		

Table D-122. Summary of Correlated Parameters for Arsenic

Variable 1		Variable 2		Correlation Coefficient
Code	Description	Code	Description	
AVGPDIAM	Avg. Particle Diameter	BULKDENS	Bulk Density	0.99878
FRCOEFA	Freundlich Isotherm Coefficient	RETCOEF	Retardation Coefficient	0.98099
LONDISPA	Longitudinal Dispersivity	TRANDISP	Transverse Dispersivity	0.99935
LONDISPA	Longitudinal Dispersivity	VERTDISP	Vertical Dispersivity	0.99928
RECHARAT	Recharge Rate	GWPH	Groundwater pH	-0.99864
INFILRAT	Infiltration Rate	GWPH	Groundwater pH	-0.98629
SATHYCON	Saturated Hydraulic Conductivity	GWPH	Groundwater pH	-0.74168
MOISTRPA	Moisture Rention Parameter (a)	GWPH	Groundwater pH	-0.77786
MOISTRPB	Moisture Rention Parameter (b)	GWPH	Groundwater pH	-0.86273
SATURH2O	Saturated Water Content	GWPH	Groundwater pH	0.83616
SOILBDEN	Soil Bulk Density	GWPH	Groundwater pH	0.98975
XDIST	Longitudinal Distance to Well	RADISTW	Radial Distance to Well	0.99314
WMUAREA	WMU Area	WMULEN	WMU Length	0.99744
LANDEPTH	Landfill Depth	WMULEN	WMU Length	-0.97508
DURLEACH	Duration of Leaching Period	WMULEN	WMU Length	-0.87584
WMUAREA	WMU Area	WMUWIDTH	WMU Width	0.99744
LANDEPTH	Landfill Depth	WMUWIDTH	WMU Width	-0.97508
DURLEACH	Duration of Leaching Period	WMUWIDTH	WMU Width	-0.87584
INFILRAT	Infiltration Rate	RECHARAT	Recharge Rate	0.98778
SATHYCON	Saturated Hydraulic Conductivity	RECHARAT	Recharge Rate	0.74228
MOISTRPA	Moisture Rention Parameter (a)	RECHARAT	Recharge Rate	0.78257
MOISTRPB	Moisture Rention Parameter (b)	RECHARAT	Recharge Rate	0.86482
SATURH2O	Saturated Water Content	RECHARAT	Recharge Rate	-0.86365
SOILBDEN	Soil Bulk Density	RECHARAT	Recharge Rate	-0.99586
WMUAREA	WMU Area	LANDEPTH	Landfill Depth	-0.97053
WMUAREA	WMU Area	DURLEACH	Duration of Leaching Period	-0.90314
LANDEPTH	Landfill Depth	DURLEACH	Duration of Leaching Period	0.88748
RECHARAT	Recharge Rate	SATHYCON	Saturated Hydraulic Conductivity	0.74228
INFILRAT	Infiltration Rate	SATHYCON	Saturated Hydraulic Conductivity	0.75109
RECHARAT	Recharge Rate	MOISTRPA	Moisture Rention Parameter (a)	0.78257
INFILRAT	Infiltration Rate	MOISTRPA	Moisture Rention Parameter (a)	0.77407
SATURH2O	Saturated Water Content	MOISTRPA	Moisture Rention Parameter (a)	-0.71113
RECHARAT	Recharge Rate	MOISTRPB	Moisture Rention Parameter (b)	0.86482

Table D-122. Summary of Correlated Parameters for Arsenic

Variable 1		Variable 2		Correlation Coefficient
Code	**Description**	**Code**	**Description**	
INFILRAT	Infiltration Rate	MOISTRPB	Moisture Rention Parameter (b)	0.85538
SATURH2O	Saturated Water Content	MOISTRPB	Moisture Rention Parameter (b)	-0.75578
RECHARAT	Recharge Rate	SATURH2O	Saturated Water Content	-0.86365
INFILRAT	Infiltration Rate	SATURH2O	Saturated Water Content	-0.85444
MOISTRPA	Moisture Rention Parameter (a)	SATURH2O	Saturated Water Content	-0.71113
MOISTRPB	Moisture Rention Parameter (b)	SATURH2O	Saturated Water Content	-0.75578
SOILBDEN	Soil Bulk Density	SATURH2O	Saturated Water Content	0.90592
UNSATHIK	Unsaturated Zone Thickness	LONDISPU	Longitudinal Dispersivity	0.95303
RECHARAT	Recharge Rate	SOILBDEN	Soil Bulk Density	-0.99586
INFILRAT	Infiltration Rate	SOILBDEN	Soil Bulk Density	-0.98393
SATHYCON	Saturated Hydraulic Conductivity	SOILBDEN	Soil Bulk Density	-0.7385
MOISTRPA	Moisture Rention Parameter (a)	SOILBDEN	Soil Bulk Density	-0.78569
MOISTRPB	Moisture Rention Parameter (b)	SOILBDEN	Soil Bulk Density	-0.86284
SATURH2O	Saturated Water Content	SOILBDEN	Soil Bulk Density	0.90592

Note: Parameters in the variable 2 column were removed from the analysis.

Table D-123. Summary of Crosspairs Analysis for Arsenic

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
AVGPDIAM	Avg. Particle Diameter			Y	Y
POROSITY	Porosity				
AQUTHIK	Aquifer Thickness			Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity			Y	Y
HYDGRAD	Hydraulic Gradient			Y	Y
GWSEEPV	Groundwater Seepage Velocity				
LONDISPA	Longitudinal Dispersivity			Y	Y
FRORGCAR	Fraction Organic Carbon				
ANGLEW	Angle of Well Off Plume Centerline				
XDIST	Longitudinal Distance to Well			Y	Y
YDIST	Distance from Plume Centerline to Well			Y	Y
ZDIST	Depth of Well Below Water Table				
FRCOEFA	Freundlich Isotherm Coefficient			Y	Y
GWAVTIM	Exposure Duration				
WMUAREA	WMU Area			Y	Y
INFILRAT	Infiltration Rate			Y	Y
RESIDH2O	Residual Water Content				
UNSATHIK	Unsaturated Zone Thickness			Y	Y
PERORGM	Percent Organic Matter				
FRCOEFU	Freundlich Isotherm Coefficient			Y	Y
AVGPDIAM	Avg. Particle Diameter	AVGPDIAM	Avg. Particle Diameter		
POROSITY	Porosity	AVGPDIAM	Avg. Particle Diameter		
POROSITY	Porosity	POROSITY	Porosity		
AQUTHIK	Aquifer Thickness	AVGPDIAM	Avg. Particle Diameter		
AQUTHIK	Aquifer Thickness	POROSITY	Porosity		
AQUTHIK	Aquifer Thickness	AQUTHIK	Aquifer Thickness		
LONHYCON	Longitundinal Hydraulic Conductivity	AVGPDIAM	Avg. Particle Diameter		
LONHYCON	Longitundinal Hydraulic Conductivity	POROSITY	Porosity		
LONHYCON	Longitundinal Hydraulic Conductivity	AQUTHIK	Aquifer Thickness		
LONHYCON	Longitundinal Hydraulic Conductivity	LONHYCON	Longitundinal Hydraulic Conductivity		
HYDGRAD	Hydraulic Gradient	AVGPDIAM	Avg. Particle Diameter		
HYDGRAD	Hydraulic Gradient	POROSITY	Porosity		
HYDGRAD	Hydraulic Gradient	AQUTHIK	Aquifer Thickness		
HYDGRAD	Hydraulic Gradient	LONHYCON	Longitundinal Hydraulic Conductivity		
HYDGRAD	Hydraulic Gradient	HYDGRAD	Hydraulic Gradient		
GWSEEPV	Groundwater Seepage Velocity	AVGPDIAM	Avg. Particle Diameter		
GWSEEPV	Groundwater Seepage Velocity	POROSITY	Porosity		
GWSEEPV	Groundwater Seepage Velocity	AQUTHIK	Aquifer Thickness		
GWSEEPV	Groundwater Seepage Velocity	LONHYCON	Longitundinal Hydraulic Conductivity		
GWSEEPV	Groundwater Seepage Velocity	HYDGRAD	Hydraulic Gradient		
GWSEEPV	Groundwater Seepage Velocity	GWSEEPV	Groundwater Seepage Velocity		
LONDISPA	Longitudinal Dispersivity	AVGPDIAM	Avg. Particle Diameter		
LONDISPA	Longitudinal Dispersivity	POROSITY	Porosity		
LONDISPA	Longitudinal Dispersivity	AQUTHIK	Aquifer Thickness		
LONDISPA	Longitudinal Dispersivity	LONHYCON	Longitundinal Hydraulic Conductivity		
LONDISPA	Longitudinal Dispersivity	HYDGRAD	Hydraulic Gradient		
LONDISPA	Longitudinal Dispersivity	GWSEEPV	Groundwater Seepage Velocity		
LONDISPA	Longitudinal Dispersivity	LONDISPA	Longitudinal Dispersivity	Y	Y
FRORGCAR	Fraction Organic Carbon	AVGPDIAM	Avg. Particle Diameter		

Table D-123. Summary of Crosspairs Analysis for Arsenic

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
FRORGCAR	Fraction Organic Carbon	POROSITY	Porosity		
FRORGCAR	Fraction Organic Carbon	AQUTHIK	Aquifer Thickness		
FRORGCAR	Fraction Organic Carbon	LONHYCON	Longitundinal Hydraulic Conductivity		
FRORGCAR	Fraction Organic Carbon	HYDGRAD	Hydraulic Gradient		
FRORGCAR	Fraction Organic Carbon	GWSEEPV	Groundwater Seepage Velocity		
FRORGCAR	Fraction Organic Carbon	LONDISPA	Longitudinal Dispersivity		
FRORGCAR	Fraction Organic Carbon	FRORGCAR	Fraction Organic Carbon		
ANGLEW	Angle of Well Off Plume Centerline	AVGPDIAM	Avg. Particle Diameter		
ANGLEW	Angle of Well Off Plume Centerline	POROSITY	Porosity		
ANGLEW	Angle of Well Off Plume Centerline	AQUTHIK	Aquifer Thickness		
ANGLEW	Angle of Well Off Plume Centerline	LONHYCON	Longitundinal Hydraulic Conductivity		
ANGLEW	Angle of Well Off Plume Centerline	HYDGRAD	Hydraulic Gradient		
ANGLEW	Angle of Well Off Plume Centerline	GWSEEPV	Groundwater Seepage Velocity		
ANGLEW	Angle of Well Off Plume Centerline	LONDISPA	Longitudinal Dispersivity		
ANGLEW	Angle of Well Off Plume Centerline	FRORGCAR	Fraction Organic Carbon		
ANGLEW	Angle of Well Off Plume Centerline	ANGLEW	Angle of Well Off Plume Centerline		
XDIST	Longitudinal Distance to Well	AVGPDIAM	Avg. Particle Diameter	Y	
XDIST	Longitudinal Distance to Well	POROSITY	Porosity		
XDIST	Longitudinal Distance to Well	AQUTHIK	Aquifer Thickness	Y	Y
XDIST	Longitudinal Distance to Well	LONHYCON	Longitundinal Hydraulic Conductivity		
XDIST	Longitudinal Distance to Well	HYDGRAD	Hydraulic Gradient		
XDIST	Longitudinal Distance to Well	GWSEEPV	Groundwater Seepage Velocity	Y	Y
XDIST	Longitudinal Distance to Well	LONDISPA	Longitudinal Dispersivity	Y	Y
XDIST	Longitudinal Distance to Well	FRORGCAR	Fraction Organic Carbon		
XDIST	Longitudinal Distance to Well	ANGLEW	Angle of Well Off Plume Centerline		
XDIST	Longitudinal Distance to Well	XDIST	Longitudinal Distance to Well	Y	
YDIST	Distance from Plume Centerline to Well	AVGPDIAM	Avg. Particle Diameter		
YDIST	Distance from Plume Centerline to Well	POROSITY	Porosity		
YDIST	Distance from Plume Centerline to Well	AQUTHIK	Aquifer Thickness	Y	
YDIST	Distance from Plume Centerline to Well	LONHYCON	Longitundinal Hydraulic Conductivity		
YDIST	Distance from Plume Centerline to Well	HYDGRAD	Hydraulic Gradient		
YDIST	Distance from Plume Centerline to Well	GWSEEPV	Groundwater Seepage Velocity		
YDIST	Distance from Plume Centerline to Well	LONDISPA	Longitudinal Dispersivity	Y	Y
YDIST	Distance from Plume Centerline to Well	FRORGCAR	Fraction Organic Carbon		
YDIST	Distance from Plume Centerline to Well	ANGLEW	Angle of Well Off Plume Centerline	Y	
YDIST	Distance from Plume Centerline to Well	XDIST	Longitudinal Distance to Well	Y	Y
YDIST	Distance from Plume Centerline to Well	YDIST	Distance from Plume Centerline to Well	Y	Y
ZDIST	Depth of Well Below Water Table	AVGPDIAM	Avg. Particle Diameter		
ZDIST	Depth of Well Below Water Table	POROSITY	Porosity		
ZDIST	Depth of Well Below Water Table	AQUTHIK	Aquifer Thickness		
ZDIST	Depth of Well Below Water Table	LONHYCON	Longitundinal Hydraulic Conductivity		
ZDIST	Depth of Well Below Water Table	HYDGRAD	Hydraulic Gradient		
ZDIST	Depth of Well Below Water Table	GWSEEPV	Groundwater Seepage Velocity		
ZDIST	Depth of Well Below Water Table	LONDISPA	Longitudinal Dispersivity		
ZDIST	Depth of Well Below Water Table	FRORGCAR	Fraction Organic Carbon		
ZDIST	Depth of Well Below Water Table	ANGLEW	Angle of Well Off Plume Centerline		
ZDIST	Depth of Well Below Water Table	XDIST	Longitudinal Distance to Well		
ZDIST	Depth of Well Below Water Table	YDIST	Distance from Plume Centerline to Well		
ZDIST	Depth of Well Below Water Table	ZDIST	Depth of Well Below Water Table		

Table D-123. Summary of Crosspairs Analysis for Arsenic

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
FRCOEFA	Freundlich Isotherm Coefficient	AVGPDIAM	Avg. Particle Diameter	Y	
FRCOEFA	Freundlich Isotherm Coefficient	POROSITY	Porosity	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	AQUTHIK	Aquifer Thickness	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	HYDGRAD	Hydraulic Gradient	Y	
FRCOEFA	Freundlich Isotherm Coefficient	GWSEEPV	Groundwater Seepage Velocity	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	LONDISPA	Longitudinal Dispersivity	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	FRORGCAR	Fraction Organic Carbon	Y	
FRCOEFA	Freundlich Isotherm Coefficient	ANGLEW	Angle of Well Off Plume Centerline		
FRCOEFA	Freundlich Isotherm Coefficient	XDIST	Longitudinal Distance to Well	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	YDIST	Distance from Plume Centerline to Well	Y	
FRCOEFA	Freundlich Isotherm Coefficient	ZDIST	Depth of Well Below Water Table	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
GWAVTIM	Exposure Duration	AVGPDIAM	Avg. Particle Diameter		
GWAVTIM	Exposure Duration	POROSITY	Porosity		
GWAVTIM	Exposure Duration	AQUTHIK	Aquifer Thickness		
GWAVTIM	Exposure Duration	LONHYCON	Longitundinal Hydraulic Conductivity		
GWAVTIM	Exposure Duration	HYDGRAD	Hydraulic Gradient		
GWAVTIM	Exposure Duration	GWSEEPV	Groundwater Seepage Velocity		
GWAVTIM	Exposure Duration	LONDISPA	Longitudinal Dispersivity		
GWAVTIM	Exposure Duration	FRORGCAR	Fraction Organic Carbon		
GWAVTIM	Exposure Duration	ANGLEW	Angle of Well Off Plume Centerline		
GWAVTIM	Exposure Duration	XDIST	Longitudinal Distance to Well		
GWAVTIM	Exposure Duration	YDIST	Distance from Plume Centerline to Well		
GWAVTIM	Exposure Duration	ZDIST	Depth of Well Below Water Table		
GWAVTIM	Exposure Duration	FRCOEFA	Freundlich Isotherm Coefficient		
GWAVTIM	Exposure Duration	GWAVTIM	Exposure Duration		
WMUAREA	WMU Area	AVGPDIAM	Avg. Particle Diameter		
WMUAREA	WMU Area	POROSITY	Porosity		
WMUAREA	WMU Area	AQUTHIK	Aquifer Thickness		
WMUAREA	WMU Area	LONHYCON	Longitundinal Hydraulic Conductivity		
WMUAREA	WMU Area	HYDGRAD	Hydraulic Gradient		
WMUAREA	WMU Area	GWSEEPV	Groundwater Seepage Velocity		
WMUAREA	WMU Area	LONDISPA	Longitudinal Dispersivity	Y	Y
WMUAREA	WMU Area	FRORGCAR	Fraction Organic Carbon		
WMUAREA	WMU Area	ANGLEW	Angle of Well Off Plume Centerline		
WMUAREA	WMU Area	XDIST	Longitudinal Distance to Well		
WMUAREA	WMU Area	YDIST	Distance from Plume Centerline to Well	Y	Y
WMUAREA	WMU Area	ZDIST	Depth of Well Below Water Table		
WMUAREA	WMU Area	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
WMUAREA	WMU Area	GWAVTIM	Exposure Duration		
WMUAREA	WMU Area	WMUAREA	WMU Area	Y	Y
INFILRAT	Infiltration Rate	AVGPDIAM	Avg. Particle Diameter		
INFILRAT	Infiltration Rate	POROSITY	Porosity		
INFILRAT	Infiltration Rate	AQUTHIK	Aquifer Thickness		
INFILRAT	Infiltration Rate	LONHYCON	Longitundinal Hydraulic Conductivity		
INFILRAT	Infiltration Rate	HYDGRAD	Hydraulic Gradient	Y	Y
INFILRAT	Infiltration Rate	GWSEEPV	Groundwater Seepage Velocity		
INFILRAT	Infiltration Rate	LONDISPA	Longitudinal Dispersivity		

Table D-123. Summary of Crosspairs Analysis for Arsenic

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
INFILRAT	Infiltration Rate	FRORGCAR	Fraction Organic Carbon		
INFILRAT	Infiltration Rate	ANGLEW	Angle of Well Off Plume Centerline		
INFILRAT	Infiltration Rate	XDIST	Longitudinal Distance to Well		
INFILRAT	Infiltration Rate	YDIST	Distance from Plume Centerline to Well		
INFILRAT	Infiltration Rate	ZDIST	Depth of Well Below Water Table		
INFILRAT	Infiltration Rate	FRCOEFA	Freundlich Isotherm Coefficient	Y	
INFILRAT	Infiltration Rate	GWAVTIM	Exposure Duration		
INFILRAT	Infiltration Rate	WMUAREA	WMU Area		
INFILRAT	Infiltration Rate	INFILRAT	Infiltration Rate	Y	Y
RESIDH2O	Residual Water Content	AVGPDIAM	Avg. Particle Diameter		
RESIDH2O	Residual Water Content	POROSITY	Porosity	Y	Y
RESIDH2O	Residual Water Content	AQUTHIK	Aquifer Thickness		
RESIDH2O	Residual Water Content	LONHYCON	Longitundinal Hydraulic Conductivity		
RESIDH2O	Residual Water Content	HYDGRAD	Hydraulic Gradient		
RESIDH2O	Residual Water Content	GWSEEPV	Groundwater Seepage Velocity		
RESIDH2O	Residual Water Content	LONDISPA	Longitudinal Dispersivity		
RESIDH2O	Residual Water Content	FRORGCAR	Fraction Organic Carbon		
RESIDH2O	Residual Water Content	ANGLEW	Angle of Well Off Plume Centerline		
RESIDH2O	Residual Water Content	XDIST	Longitudinal Distance to Well		
RESIDH2O	Residual Water Content	YDIST	Distance from Plume Centerline to Well		
RESIDH2O	Residual Water Content	ZDIST	Depth of Well Below Water Table		
RESIDH2O	Residual Water Content	FRCOEFA	Freundlich Isotherm Coefficient		
RESIDH2O	Residual Water Content	GWAVTIM	Exposure Duration		
RESIDH2O	Residual Water Content	WMUAREA	WMU Area		
RESIDH2O	Residual Water Content	INFILRAT	Infiltration Rate		
RESIDH2O	Residual Water Content	RESIDH2O	Residual Water Content		
UNSATHIK	Unsaturated Zone Thickness	AVGPDIAM	Avg. Particle Diameter		
UNSATHIK	Unsaturated Zone Thickness	POROSITY	Porosity		
UNSATHIK	Unsaturated Zone Thickness	AQUTHIK	Aquifer Thickness	Y	
UNSATHIK	Unsaturated Zone Thickness	LONHYCON	Longitundinal Hydraulic Conductivity		
UNSATHIK	Unsaturated Zone Thickness	HYDGRAD	Hydraulic Gradient		
UNSATHIK	Unsaturated Zone Thickness	GWSEEPV	Groundwater Seepage Velocity		
UNSATHIK	Unsaturated Zone Thickness	LONDISPA	Longitudinal Dispersivity		
UNSATHIK	Unsaturated Zone Thickness	FRORGCAR	Fraction Organic Carbon		
UNSATHIK	Unsaturated Zone Thickness	ANGLEW	Angle of Well Off Plume Centerline		
UNSATHIK	Unsaturated Zone Thickness	XDIST	Longitudinal Distance to Well		
UNSATHIK	Unsaturated Zone Thickness	YDIST	Distance from Plume Centerline to Well		
UNSATHIK	Unsaturated Zone Thickness	ZDIST	Depth of Well Below Water Table		
UNSATHIK	Unsaturated Zone Thickness	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
UNSATHIK	Unsaturated Zone Thickness	GWAVTIM	Exposure Duration		
UNSATHIK	Unsaturated Zone Thickness	WMUAREA	WMU Area		
UNSATHIK	Unsaturated Zone Thickness	INFILRAT	Infiltration Rate	Y	
UNSATHIK	Unsaturated Zone Thickness	RESIDH2O	Residual Water Content		
UNSATHIK	Unsaturated Zone Thickness	UNSATHIK	Unsaturated Zone Thickness	Y	Y
PERORGM	Percent Organic Matter	AVGPDIAM	Avg. Particle Diameter		
PERORGM	Percent Organic Matter	POROSITY	Porosity		
PERORGM	Percent Organic Matter	AQUTHIK	Aquifer Thickness		
PERORGM	Percent Organic Matter	LONHYCON	Longitundinal Hydraulic Conductivity		
PERORGM	Percent Organic Matter	HYDGRAD	Hydraulic Gradient		

Table D-123. Summary of Crosspairs Analysis for Arsenic

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
PERORGM	Percent Organic Matter	GWSEEPV	Groundwater Seepage Velocity		
PERORGM	Percent Organic Matter	LONDISPA	Longitudinal Dispersivity		
PERORGM	Percent Organic Matter	FRORGCAR	Fraction Organic Carbon		
PERORGM	Percent Organic Matter	ANGLEW	Angle of Well Off Plume Centerline		
PERORGM	Percent Organic Matter	XDIST	Longitudinal Distance to Well		
PERORGM	Percent Organic Matter	YDIST	Distance from Plume Centerline to Well		
PERORGM	Percent Organic Matter	ZDIST	Depth of Well Below Water Table		
PERORGM	Percent Organic Matter	FRCOEFA	Freundlich Isotherm Coefficient		
PERORGM	Percent Organic Matter	GWAVTIM	Exposure Duration		
PERORGM	Percent Organic Matter	WMUAREA	WMU Area		
PERORGM	Percent Organic Matter	INFILRAT	Infiltration Rate		
PERORGM	Percent Organic Matter	RESIDH2O	Residual Water Content		
PERORGM	Percent Organic Matter	UNSATHIK	Unsaturated Zone Thickness		
PERORGM	Percent Organic Matter	PERORGM	Percent Organic Matter		
FRCOEFU	Freundlich Isotherm Coefficient	AVGPDIAM	Avg. Particle Diameter		
FRCOEFU	Freundlich Isotherm Coefficient	POROSITY	Porosity		
FRCOEFU	Freundlich Isotherm Coefficient	AQUTHIK	Aquifer Thickness		
FRCOEFU	Freundlich Isotherm Coefficient	LONHYCON	Longitundinal Hydraulic Conductivity		
FRCOEFU	Freundlich Isotherm Coefficient	HYDGRAD	Hydraulic Gradient		
FRCOEFU	Freundlich Isotherm Coefficient	GWSEEPV	Groundwater Seepage Velocity		
FRCOEFU	Freundlich Isotherm Coefficient	LONDISPA	Longitudinal Dispersivity		
FRCOEFU	Freundlich Isotherm Coefficient	FRORGCAR	Fraction Organic Carbon		
FRCOEFU	Freundlich Isotherm Coefficient	ANGLEW	Angle of Well Off Plume Centerline		
FRCOEFU	Freundlich Isotherm Coefficient	XDIST	Longitudinal Distance to Well		
FRCOEFU	Freundlich Isotherm Coefficient	YDIST	Distance from Plume Centerline to Well		
FRCOEFU	Freundlich Isotherm Coefficient	ZDIST	Depth of Well Below Water Table		
FRCOEFU	Freundlich Isotherm Coefficient	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	GWAVTIM	Exposure Duration		
FRCOEFU	Freundlich Isotherm Coefficient	WMUAREA	WMU Area	Y	
FRCOEFU	Freundlich Isotherm Coefficient	INFILRAT	Infiltration Rate	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	RESIDH2O	Residual Water Content		
FRCOEFU	Freundlich Isotherm Coefficient	UNSATHIK	Unsaturated Zone Thickness	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	PERORGM	Percent Organic Matter		
FRCOEFU	Freundlich Isotherm Coefficient	FRCOEFU	Freundlich Isotherm Coefficient	Y	Y

Table D-124. Ranking of Parameters According to Percentage of Risk for Arsenic

Variable Description	Reduced Sums of Square	Variable Sums of Square	Variable Degrees of Freedom	% Risk Variation	Mean Square Variable	F VALUE	P VALUE
Freundlich Isotherm Coefficient {Aquifer} (cm3/g)	81538.6	320793.74	12	64.4%	26732.81	1377.27	0.00E+00
Longitudinal Distance to Well (m)	335787.1	66545.24	6	13.3%	11090.87	571.40	0.00E+00
Freundlich Isotherm Coefficient {Unsaturated} (cm3/g)	336101.2	66231.12	5	13.3%	13246.22	682.44	0.00E+00
WMU Area (m2)	376851.0	25481.40	5	5.1%	5096.28	262.56	1.20E-249
Longitudinal Dispersivity {Aquifer} (m)	377257.1	25075.26	6	5.0%	4179.21	215.31	7.04E-245
Distance from Plume Centerline to Well (m)	386327.3	16005.03	5	3.2%	3201.01	164.92	1.20E-162
Unsaturated Zone Thickness (m)	386721.1	15611.28	4	3.1%	3902.82	201.07	5.03E-160
Aquifer Thickness (m)	390158.3	12174.06	3	2.4%	4058.02	209.07	1.09E-127
Groundwater Seepage Velocity (m/yr)	395903.8	6428.59	3	1.3%	2142.86	110.40	3.41E-69
Infiltration Rate (m/yr)	400017.6	2314.74	4	0.5%	578.69	29.81	1.53E-24
Longitudinal Hydraulic Conductivity (m/yr)	400552.0	1780.39	2	0.4%	890.19	45.86	1.84E-20
Consumption of Drinking Water (ml/kg-day)	400756.8	1575.57	1	0.3%	1575.57	81.17	2.90E-19
Exposure Duration (yr)	401126.5	1205.89	1	0.2%	1205.89	62.13	3.93E-15
Porosity	401603.2	729.17	3	0.1%	243.06	12.52	3.73E-08
Hydraluic Gradient (m/m)	402036.6	295.78	1	0.1%	295.78	15.24	9.60E-05
Depth of Well Below Water Table (m)	402005.9	326.46	2	0.1%	163.23	8.41	2.26E-04
Residual Water Content (unitless)	402136.2	196.17	2	0.0%	98.09	5.05	6.42E-03
Average Particle Diameter (cm)	402096.6	235.80	1	0.0%	235.80	12.15	4.96E-04

Constants

Full Model SS	402332.36
Error SS	96137.914
Error DF	4953
MS Error	19.41

Table D-125. Summary of Parameters Considered in Sensitivity Analysis for Manganese

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
ACIDCAT	Acid Catalyzed Hydrolysis Rate Constant	C			
ANGLEW	Angle of Well Off Plume Centerline	anglew		Y	
ANISORAT	Anisotropy Ratio	C			
AQUTHIK	Aquifer Thickness	aquthik**-0.2		Y	Y
AVGPDIAM	Avg. Particle Diameter	log(avgpdiam+.002)		Y	Y
BASECAT	Base Catalyzed Hydrolysis Rate Constant	C			
BIODRATU	Biodegradation Rate	C			
BIODRATA	Biodegradation Rate	C			
BULKDENS	Bulk Density	bulkdens**3.5	Y		
CHEMDRU	Chemical Decay Rate	C			
CHEMDRA	Chemical Decay Rate	C			
CONSH2OA	Consump of drinking water	log(consh2oa)			Y
ZDIST	Depth of Well Below Water Table	log(zdist+3)		Y	Y
DISHYD	Dissolved Hydrolysis Rate	C			
YDIST	Distance from Plume Centerline to Well	log(ydist+10)		Y	Y
DURLEACH	Duration of Leaching Period	log(durleach+10000)	Y		
GWAVTIM	Exposure Duration	C			
FRORGCAR	Fraction Organic Carbon	log(frorgcar)		Y	
FRCOEFA	Freundlich Isotherm Coefficient	log(frcoefa-30)		Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	log(frcoefu-30)		Y	Y
FREXPU	Freundlich Isotherm Exponent	C			
FREXPA	Freundlich Isotherm Exponent	C			
GWPH	Groundwater pH	gwph	Y		
GWSEEPV	Groundwater Seepage Velocity	gwseepv**-.1		Y	Y
GWTEMP	Groundwater Temperature	C			
HYDGRAD	Hydraulic Gradient	log(hydgrad+.001)		Y	Y
INFILRAT	Infiltration Rate	infilrat**1.5		Y	Y
LANDEPTH	Landfill Depth	log(landepth+50)	Y		
LEACHCON	Leachate Concentration	C			
LFFRACT	LF Fraction	C			
LONDISPU	Longitudinal Dispersivity	log(londispu)	Y		
LONDISPA	Longitudinal Dispersivity	log(londispa+0.3)		Y	Y
XDIST	Longitudinal Distance to Well	log(xdist+200)		Y	Y

Table D-125. Summary of Parameters Considered in Sensitivity Analysis for Manganese

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
LONHYCON	Longitundinal Hydraulic Conductivity	log(lonhycon-3)		Y	Y
MLLA	ml/L	C			
MOISTRPA	Moisture Rention Parameter (a)	log(moistrpa)	Y		
MOISTRPB	Moisture Rention Parameter (b)	log(moistrpb)	Y		
MOLDIFF	Molecular Diffusion Coefficient	C			
NEUTHYD	Neutral Hydrolysis Rate Constant	C			
ORGCDIS	Organic Carbon Distribution Coefficient	C			
PERORGM	Percent Organic Matter	log(perorgm)			
POROSITY	Porosity	porosity**1.3		Y	Y
RADISTW	Radial Distance to Well	log(radistw+300)	Y		
RECHARAT	Recharge Rate	recharat	Y		
RESIDH2O	Residual Water Content	residh2o**2.1		Y	
RETCOEF	Retardation Coefficient				
RFDA	RfD (mg/kg/day)	C			
SATHYCON	Saturated Hydraulic Conductivity	log(sathycon)	Y		
SATURH2O	Saturated Water Content	saturh2o	Y		
SOILBDEN	Soil Bulk Density	soilbden	Y		
SORBHYD	Sorbed Hydrolysis Rate	C			
TRANDISP	Transverse Dispersivity	log(trandisp+0.05)	Y		
UNSATHIK	Unsaturated Zone Thickness	log(unsathik)		Y	Y
VERTDISP	Vertical Dispersivity	log(vertdisp+0.001)	Y		
WASTDENS	Waste Density	C			
WASTEVOL	Waste Volume	C			
WMUAREA	WMU Area	log(wmuarea-36100)		Y	Y
WMULEN	WMU Length	log(wmulen-189)	Y		
WMUWIDTH	WMU Width	log(wmuwidth-189)	Y		

Table D-126. Summary of Correlated Parameters for Manganese

Variable 1		Variable 2		Correlation Coefficient
Code	Description	Code	Description	
AVGPDIAM	Avg. Particle Diameter	BULKDENS	Bulk Density	0.99879
FRCOEFA	Freundlich Isotherm Coefficient			0.93689
LONDISPA	Longitudinal Dispersivity	TRANDISP	Transverse Dispersivity	0.99936
LONDISPA	Longitudinal Dispersivity	VERTDISP	Vertical Dispersivity	0.99938
RECHARAT	Recharge Rate	GWPH	Groundwater pH	-0.99851
INFILRAT	Infiltration Rate	GWPH	Groundwater pH	-0.98533
SATHYCON	Saturated Hydraulic Conductivity	GWPH	Groundwater pH	-0.73321
MOISTRPA	Moisture Rention Parameter (a)	GWPH	Groundwater pH	-0.778
MOISTRPB	Moisture Rention Parameter (b)	GWPH	Groundwater pH	-0.86791
SATURH2O	Saturated Water Content	GWPH	Groundwater pH	0.81373
SOILBDEN	Soil Bulk Density	GWPH	Groundwater pH	0.98866
XDIST	Longitudinal Distance to Well	RADISTW	Radial Distance to Well	0.99325
WMUAREA	WMU Area	WMULEN	WMU Length	0.99876
LANDEPTH	Landfill Depth	WMULEN	WMU Length	-0.95954
DURLEACH	Duration of Leaching Period	WMULEN	WMU Length	-0.88327
WMUAREA	WMU Area	WMUWIDTH	WMU Width	0.99876
LANDEPTH	Landfill Depth	WMUWIDTH	WMU Width	-0.95954
DURLEACH	Duration of Leaching Period	WMUWIDTH	WMU Width	-0.88327
INFILRAT	Infiltration Rate	RECHARAT	Recharge Rate	0.98699
SATHYCON	Saturated Hydraulic Conductivity	RECHARAT	Recharge Rate	0.73338
MOISTRPA	Moisture Rention Parameter (a)	RECHARAT	Recharge Rate	0.78341
MOISTRPB	Moisture Rention Parameter (b)	RECHARAT	Recharge Rate	0.87248
SATURH2O	Saturated Water Content	RECHARAT	Recharge Rate	-0.84426
SOILBDEN	Soil Bulk Density	RECHARAT	Recharge Rate	-0.99539
WMUAREA	WMU Area	LANDEPTH	Landfill Depth	-0.95508
WMUAREA	WMU Area	DURLEACH	Duration of Leaching Period	-0.89181
LANDEPTH	Landfill Depth	DURLEACH	Duration of Leaching Period	0.94153
RECHARAT	Recharge Rate	SATHYCON	Saturated Hydraulic Conductivity	0.73338
INFILRAT	Infiltration Rate	SATHYCON	Saturated Hydraulic Conductivity	0.74751
RECHARAT	Recharge Rate	MOISTRPA	Moisture Rention Parameter (a)	0.78341
INFILRAT	Infiltration Rate	MOISTRPA	Moisture Rention Parameter (a)	0.77363
SATURH2O	Saturated Water Content	MOISTRPA	Moisture Rention Parameter (a)	-0.70298
RECHARAT	Recharge Rate	MOISTRPB	Moisture Rention Parameter (b)	0.87248

Table D-126. Summary of Correlated Parameters for Manganese

Variable 1		Variable 2		Correlation Coefficient
Code	**Description**	**Code**	**Description**	
INFILRAT	Infiltration Rate	MOISTRPB	Moisture Rention Parameter (b)	0.86183
SATURH2O	Saturated Water Content	MOISTRPB	Moisture Rention Parameter (b)	-0.76875
RECHARAT	Recharge Rate	SATURH2O	Saturated Water Content	-0.84426
INFILRAT	Infiltration Rate	SATURH2O	Saturated Water Content	-0.83513
MOISTRPA	Moisture Rention Parameter (a)	SATURH2O	Saturated Water Content	-0.70298
MOISTRPB	Moisture Rention Parameter (b)	SATURH2O	Saturated Water Content	-0.76875
SOILBDEN	Soil Bulk Density	SATURH2O	Saturated Water Content	0.89179
UNSATHIK	Unsaturated Zone Thickness	LONDISPU	Longitudinal Dispersivity	0.9601
RECHARAT	Recharge Rate	SOILBDEN	Soil Bulk Density	-0.99539
INFILRAT	Infiltration Rate	SOILBDEN	Soil Bulk Density	-0.98277
SATHYCON	Saturated Hydraulic Conductivity	SOILBDEN	Soil Bulk Density	-0.72837
MOISTRPA	Moisture Rention Parameter (a)	SOILBDEN	Soil Bulk Density	-0.78724
MOISTRPB	Moisture Rention Parameter (b)	SOILBDEN	Soil Bulk Density	-0.87421
SATURH2O	Saturated Water Content	SOILBDEN	Soil Bulk Density	0.89179

Note: Parameters in the variable 2 column were removed from the analysis.

Table D-127. Summary of Crosspairs Analysis for Manganese

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
AVGPDIAM	Avg. Particle Diameter			Y	Y
POROSITY	Porosity			Y	Y
AQUTHIK	Aquifer Thickness			Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity			Y	Y
HYDGRAD	Hydraulic Gradient			Y	Y
GWSEEPV	Groundwater Seepage Velocity			Y	Y
LONDISPA	Longitudinal Dispersivity			Y	Y
FRORGCAR	Fraction Organic Carbon				
ANGLEW	Angle of Well Off Plume Centerline				
XDIST	Longitudinal Distance to Well			Y	Y
YDIST	Distance from Plume Centerline to Well			Y	Y
ZDIST	Depth of Well Below Water Table			Y	Y
FRCOEFA	Freundlich Isotherm Coefficient			Y	Y
WMUAREA	WMU Area			Y	Y
INFILRAT	Infiltration Rate			Y	Y
RESIDH2O	Residual Water Content				
UNSATHIK	Unsaturated Zone Thickness			Y	Y
PERORGM	Percent Organic Matter				
FRCOEFU	Freundlich Isotherm Coefficient			Y	Y
AVGPDIAM	Avg. Particle Diameter	AVGPDIAM	Avg. Particle Diameter	Y	Y
POROSITY	Porosity	AVGPDIAM	Avg. Particle Diameter		
POROSITY	Porosity	POROSITY	Porosity		
AQUTHIK	Aquifer Thickness	AVGPDIAM	Avg. Particle Diameter		
AQUTHIK	Aquifer Thickness	POROSITY	Porosity	Y	Y
AQUTHIK	Aquifer Thickness	AQUTHIK	Aquifer Thickness	Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity	AVGPDIAM	Avg. Particle Diameter		
LONHYCON	Longitundinal Hydraulic Conductivity	POROSITY	Porosity	Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity	AQUTHIK	Aquifer Thickness		
LONHYCON	Longitundinal Hydraulic Conductivity	LONHYCON	Longitundinal Hydraulic Conductivity		
HYDGRAD	Hydraulic Gradient	AVGPDIAM	Avg. Particle Diameter		
HYDGRAD	Hydraulic Gradient	POROSITY	Porosity		
HYDGRAD	Hydraulic Gradient	AQUTHIK	Aquifer Thickness		
HYDGRAD	Hydraulic Gradient	LONHYCON	Longitundinal Hydraulic Conductivity		
HYDGRAD	Hydraulic Gradient	HYDGRAD	Hydraulic Gradient		
GWSEEPV	Groundwater Seepage Velocity	AVGPDIAM	Avg. Particle Diameter		
GWSEEPV	Groundwater Seepage Velocity	POROSITY	Porosity	Y	
GWSEEPV	Groundwater Seepage Velocity	AQUTHIK	Aquifer Thickness	Y	Y
GWSEEPV	Groundwater Seepage Velocity	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
GWSEEPV	Groundwater Seepage Velocity	HYDGRAD	Hydraulic Gradient		
GWSEEPV	Groundwater Seepage Velocity	GWSEEPV	Groundwater Seepage Velocity	Y	Y
LONDISPA	Longitudinal Dispersivity	AVGPDIAM	Avg. Particle Diameter		
LONDISPA	Longitudinal Dispersivity	POROSITY	Porosity		
LONDISPA	Longitudinal Dispersivity	AQUTHIK	Aquifer Thickness		
LONDISPA	Longitudinal Dispersivity	LONHYCON	Longitundinal Hydraulic Conductivity		
LONDISPA	Longitudinal Dispersivity	HYDGRAD	Hydraulic Gradient		
LONDISPA	Longitudinal Dispersivity	GWSEEPV	Groundwater Seepage Velocity	Y	Y
LONDISPA	Longitudinal Dispersivity	LONDISPA	Longitudinal Dispersivity	Y	Y
FRORGCAR	Fraction Organic Carbon	AVGPDIAM	Avg. Particle Diameter		
FRORGCAR	Fraction Organic Carbon	POROSITY	Porosity	Y	

Table D-127. Summary of Crosspairs Analysis for Manganese

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
FRORGCAR	Fraction Organic Carbon	AQUTHIK	Aquifer Thickness	Y	
FRORGCAR	Fraction Organic Carbon	LONHYCON	Longitundinal Hydraulic Conductivity	Y	
FRORGCAR	Fraction Organic Carbon	HYDGRAD	Hydraulic Gradient		
FRORGCAR	Fraction Organic Carbon	GWSEEPV	Groundwater Seepage Velocity		
FRORGCAR	Fraction Organic Carbon	LONDISPA	Longitudinal Dispersivity		
FRORGCAR	Fraction Organic Carbon	FRORGCAR	Fraction Organic Carbon		
ANGLEW	Angle of Well Off Plume Centerline	AVGPDIAM	Avg. Particle Diameter		
ANGLEW	Angle of Well Off Plume Centerline	POROSITY	Porosity		
ANGLEW	Angle of Well Off Plume Centerline	AQUTHIK	Aquifer Thickness		
ANGLEW	Angle of Well Off Plume Centerline	LONHYCON	Longitundinal Hydraulic Conductivity		
ANGLEW	Angle of Well Off Plume Centerline	HYDGRAD	Hydraulic Gradient	Y	
ANGLEW	Angle of Well Off Plume Centerline	GWSEEPV	Groundwater Seepage Velocity	Y	
ANGLEW	Angle of Well Off Plume Centerline	LONDISPA	Longitudinal Dispersivity		
ANGLEW	Angle of Well Off Plume Centerline	FRORGCAR	Fraction Organic Carbon		
ANGLEW	Angle of Well Off Plume Centerline	ANGLEW	Angle of Well Off Plume Centerline		
XDIST	Longitudinal Distance to Well	AVGPDIAM	Avg. Particle Diameter	Y	Y
XDIST	Longitudinal Distance to Well	POROSITY	Porosity		
XDIST	Longitudinal Distance to Well	AQUTHIK	Aquifer Thickness	Y	Y
XDIST	Longitudinal Distance to Well	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
XDIST	Longitudinal Distance to Well	HYDGRAD	Hydraulic Gradient	Y	Y
XDIST	Longitudinal Distance to Well	GWSEEPV	Groundwater Seepage Velocity		
XDIST	Longitudinal Distance to Well	LONDISPA	Longitudinal Dispersivity	Y	Y
XDIST	Longitudinal Distance to Well	FRORGCAR	Fraction Organic Carbon		
XDIST	Longitudinal Distance to Well	ANGLEW	Angle of Well Off Plume Centerline		
XDIST	Longitudinal Distance to Well	XDIST	Longitudinal Distance to Well		
YDIST	Distance from Plume Centerline to Well	AVGPDIAM	Avg. Particle Diameter		
YDIST	Distance from Plume Centerline to Well	POROSITY	Porosity		
YDIST	Distance from Plume Centerline to Well	AQUTHIK	Aquifer Thickness	Y	
YDIST	Distance from Plume Centerline to Well	LONHYCON	Longitundinal Hydraulic Conductivity		
YDIST	Distance from Plume Centerline to Well	HYDGRAD	Hydraulic Gradient		
YDIST	Distance from Plume Centerline to Well	GWSEEPV	Groundwater Seepage Velocity		
YDIST	Distance from Plume Centerline to Well	LONDISPA	Longitudinal Dispersivity	Y	Y
YDIST	Distance from Plume Centerline to Well	FRORGCAR	Fraction Organic Carbon		
YDIST	Distance from Plume Centerline to Well	ANGLEW	Angle of Well Off Plume Centerline		
YDIST	Distance from Plume Centerline to Well	XDIST	Longitudinal Distance to Well	Y	Y
YDIST	Distance from Plume Centerline to Well	YDIST	Distance from Plume Centerline to Well	Y	Y
ZDIST	Depth of Well Below Water Table	AVGPDIAM	Avg. Particle Diameter		
ZDIST	Depth of Well Below Water Table	POROSITY	Porosity	Y	Y
ZDIST	Depth of Well Below Water Table	AQUTHIK	Aquifer Thickness		
ZDIST	Depth of Well Below Water Table	LONHYCON	Longitundinal Hydraulic Conductivity		
ZDIST	Depth of Well Below Water Table	HYDGRAD	Hydraulic Gradient		
ZDIST	Depth of Well Below Water Table	GWSEEPV	Groundwater Seepage Velocity		
ZDIST	Depth of Well Below Water Table	LONDISPA	Longitudinal Dispersivity		
ZDIST	Depth of Well Below Water Table	FRORGCAR	Fraction Organic Carbon		
ZDIST	Depth of Well Below Water Table	ANGLEW	Angle of Well Off Plume Centerline		
ZDIST	Depth of Well Below Water Table	XDIST	Longitudinal Distance to Well		
ZDIST	Depth of Well Below Water Table	YDIST	Distance from Plume Centerline to Well		
ZDIST	Depth of Well Below Water Table	ZDIST	Depth of Well Below Water Table		
FRCOEFA	Freundlich Isotherm Coefficient	AVGPDIAM	Avg. Particle Diameter		

Table D-127. Summary of Crosspairs Analysis for Manganese

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
FRCOEFA	Freundlich Isotherm Coefficient	POROSITY	Porosity		
FRCOEFA	Freundlich Isotherm Coefficient	AQUTHIK	Aquifer Thickness	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	HYDGRAD	Hydraulic Gradient	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	GWSEEPV	Groundwater Seepage Velocity	Y	
FRCOEFA	Freundlich Isotherm Coefficient	LONDISPA	Longitudinal Dispersivity	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	FRORGCAR	Fraction Organic Carbon		
FRCOEFA	Freundlich Isotherm Coefficient	ANGLEW	Angle of Well Off Plume Centerline		
FRCOEFA	Freundlich Isotherm Coefficient	XDIST	Longitudinal Distance to Well	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	YDIST	Distance from Plume Centerline to Well	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	ZDIST	Depth of Well Below Water Table	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
WMUAREA	WMU Area	AVGPDIAM	Avg. Particle Diameter		
WMUAREA	WMU Area	POROSITY	Porosity		
WMUAREA	WMU Area	AQUTHIK	Aquifer Thickness		
WMUAREA	WMU Area	LONHYCON	Longitundinal Hydraulic Conductivity		
WMUAREA	WMU Area	HYDGRAD	Hydraulic Gradient		
WMUAREA	WMU Area	GWSEEPV	Groundwater Seepage Velocity		
WMUAREA	WMU Area	LONDISPA	Longitudinal Dispersivity	Y	Y
WMUAREA	WMU Area	FRORGCAR	Fraction Organic Carbon		
WMUAREA	WMU Area	ANGLEW	Angle of Well Off Plume Centerline		
WMUAREA	WMU Area	XDIST	Longitudinal Distance to Well	Y	
WMUAREA	WMU Area	YDIST	Distance from Plume Centerline to Well	Y	Y
WMUAREA	WMU Area	ZDIST	Depth of Well Below Water Table		
WMUAREA	WMU Area	FRCOEFA	Freundlich Isotherm Coefficient	Y	
WMUAREA	WMU Area	WMUAREA	WMU Area	Y	Y
INFILRAT	Infiltration Rate	AVGPDIAM	Avg. Particle Diameter		
INFILRAT	Infiltration Rate	POROSITY	Porosity		
INFILRAT	Infiltration Rate	AQUTHIK	Aquifer Thickness		
INFILRAT	Infiltration Rate	LONHYCON	Longitundinal Hydraulic Conductivity		
INFILRAT	Infiltration Rate	HYDGRAD	Hydraulic Gradient		
INFILRAT	Infiltration Rate	GWSEEPV	Groundwater Seepage Velocity		
INFILRAT	Infiltration Rate	LONDISPA	Longitudinal Dispersivity		
INFILRAT	Infiltration Rate	FRORGCAR	Fraction Organic Carbon		
INFILRAT	Infiltration Rate	ANGLEW	Angle of Well Off Plume Centerline		
INFILRAT	Infiltration Rate	XDIST	Longitudinal Distance to Well		
INFILRAT	Infiltration Rate	YDIST	Distance from Plume Centerline to Well	Y	Y
INFILRAT	Infiltration Rate	ZDIST	Depth of Well Below Water Table		
INFILRAT	Infiltration Rate	FRCOEFA	Freundlich Isotherm Coefficient		
INFILRAT	Infiltration Rate	WMUAREA	WMU Area		
INFILRAT	Infiltration Rate	INFILRAT	Infiltration Rate	Y	Y
RESIDH2O	Residual Water Content	AVGPDIAM	Avg. Particle Diameter		
RESIDH2O	Residual Water Content	POROSITY	Porosity		
RESIDH2O	Residual Water Content	AQUTHIK	Aquifer Thickness		
RESIDH2O	Residual Water Content	LONHYCON	Longitundinal Hydraulic Conductivity		
RESIDH2O	Residual Water Content	HYDGRAD	Hydraulic Gradient		
RESIDH2O	Residual Water Content	GWSEEPV	Groundwater Seepage Velocity		
RESIDH2O	Residual Water Content	LONDISPA	Longitudinal Dispersivity	Y	
RESIDH2O	Residual Water Content	FRORGCAR	Fraction Organic Carbon	Y	

Table D-127. Summary of Crosspairs Analysis for Manganese

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
RESIDH2O	Residual Water Content	ANGLEW	Angle of Well Off Plume Centerline	Y	
RESIDH2O	Residual Water Content	XDIST	Longitudinal Distance to Well		
RESIDH2O	Residual Water Content	YDIST	Distance from Plume Centerline to Well		
RESIDH2O	Residual Water Content	ZDIST	Depth of Well Below Water Table		
RESIDH2O	Residual Water Content	FRCOEFA	Freundlich Isotherm Coefficient		
RESIDH2O	Residual Water Content	WMUAREA	WMU Area		
RESIDH2O	Residual Water Content	INFILRAT	Infiltration Rate		
RESIDH2O	Residual Water Content	RESIDH2O	Residual Water Content		
UNSATHIK	Unsaturated Zone Thickness	AVGPDIAM	Avg. Particle Diameter		
UNSATHIK	Unsaturated Zone Thickness	POROSITY	Porosity		
UNSATHIK	Unsaturated Zone Thickness	AQUTHIK	Aquifer Thickness		
UNSATHIK	Unsaturated Zone Thickness	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
UNSATHIK	Unsaturated Zone Thickness	HYDGRAD	Hydraulic Gradient	Y	
UNSATHIK	Unsaturated Zone Thickness	GWSEEPV	Groundwater Seepage Velocity		
UNSATHIK	Unsaturated Zone Thickness	LONDISPA	Longitudinal Dispersivity		
UNSATHIK	Unsaturated Zone Thickness	FRORGCAR	Fraction Organic Carbon		
UNSATHIK	Unsaturated Zone Thickness	ANGLEW	Angle of Well Off Plume Centerline		
UNSATHIK	Unsaturated Zone Thickness	XDIST	Longitudinal Distance to Well	Y	Y
UNSATHIK	Unsaturated Zone Thickness	YDIST	Distance from Plume Centerline to Well	Y	Y
UNSATHIK	Unsaturated Zone Thickness	ZDIST	Depth of Well Below Water Table		
UNSATHIK	Unsaturated Zone Thickness	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
UNSATHIK	Unsaturated Zone Thickness	WMUAREA	WMU Area		
UNSATHIK	Unsaturated Zone Thickness	INFILRAT	Infiltration Rate	Y	Y
UNSATHIK	Unsaturated Zone Thickness	RESIDH2O	Residual Water Content		
UNSATHIK	Unsaturated Zone Thickness	UNSATHIK	Unsaturated Zone Thickness	Y	Y
PERORGM	Percent Organic Matter	AVGPDIAM	Avg. Particle Diameter		
PERORGM	Percent Organic Matter	POROSITY	Porosity		
PERORGM	Percent Organic Matter	AQUTHIK	Aquifer Thickness		
PERORGM	Percent Organic Matter	LONHYCON	Longitundinal Hydraulic Conductivity		
PERORGM	Percent Organic Matter	HYDGRAD	Hydraulic Gradient		
PERORGM	Percent Organic Matter	GWSEEPV	Groundwater Seepage Velocity		
PERORGM	Percent Organic Matter	LONDISPA	Longitudinal Dispersivity		
PERORGM	Percent Organic Matter	FRORGCAR	Fraction Organic Carbon		
PERORGM	Percent Organic Matter	ANGLEW	Angle of Well Off Plume Centerline		
PERORGM	Percent Organic Matter	XDIST	Longitudinal Distance to Well		
PERORGM	Percent Organic Matter	YDIST	Distance from Plume Centerline to Well		
PERORGM	Percent Organic Matter	ZDIST	Depth of Well Below Water Table		
PERORGM	Percent Organic Matter	FRCOEFA	Freundlich Isotherm Coefficient		
PERORGM	Percent Organic Matter	WMUAREA	WMU Area		
PERORGM	Percent Organic Matter	INFILRAT	Infiltration Rate		
PERORGM	Percent Organic Matter	RESIDH2O	Residual Water Content		
PERORGM	Percent Organic Matter	UNSATHIK	Unsaturated Zone Thickness		
PERORGM	Percent Organic Matter	PERORGM	Percent Organic Matter		
FRCOEFU	Freundlich Isotherm Coefficient	AVGPDIAM	Avg. Particle Diameter	Y	
FRCOEFU	Freundlich Isotherm Coefficient	POROSITY	Porosity		
FRCOEFU	Freundlich Isotherm Coefficient	AQUTHIK	Aquifer Thickness		
FRCOEFU	Freundlich Isotherm Coefficient	LONHYCON	Longitundinal Hydraulic Conductivity		
FRCOEFU	Freundlich Isotherm Coefficient	HYDGRAD	Hydraulic Gradient		
FRCOEFU	Freundlich Isotherm Coefficient	GWSEEPV	Groundwater Seepage Velocity		

Table D-127. Summary of Crosspairs Analysis for Manganese

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
FRCOEFU	Freundlich Isotherm Coefficient	LONDISPA	Longitudinal Dispersivity		
FRCOEFU	Freundlich Isotherm Coefficient	FRORGCAR	Fraction Organic Carbon		
FRCOEFU	Freundlich Isotherm Coefficient	ANGLEW	Angle of Well Off Plume Centerline		
FRCOEFU	Freundlich Isotherm Coefficient	XDIST	Longitudinal Distance to Well		
FRCOEFU	Freundlich Isotherm Coefficient	YDIST	Distance from Plume Centerline to Well	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	ZDIST	Depth of Well Below Water Table		
FRCOEFU	Freundlich Isotherm Coefficient	FRCOEFA	Freundlich Isotherm Coefficient		
FRCOEFU	Freundlich Isotherm Coefficient	WMUAREA	WMU Area		
FRCOEFU	Freundlich Isotherm Coefficient	INFILRAT	Infiltration Rate	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	RESIDH2O	Residual Water Content		
FRCOEFU	Freundlich Isotherm Coefficient	UNSATHIK	Unsaturated Zone Thickness	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	PERORGM	Percent Organic Matter		
FRCOEFU	Freundlich Isotherm Coefficient	FRCOEFU	Freundlich Isotherm Coefficient	Y	Y

Table D-128. Ranking of Parameters According to Percentage of Risk for Manganese

Variable Description	Reduced Sums of Square	Variable Sums of Square	Variable Degrees of Freedom	% Risk Variation	Mean Square Variable	F VALUE	P VALUE
Freund. Iso. Coeff.--Aquifer (cm^3/g)	15602.2	10370.87	10	27.3%	1037.09	426.81	0.00E+00
WMU Area (m^2)	20226.9	5746.16	4	15.1%	1436.54	591.20	0.00E+00
Dist. Plume Center. To Well (m)	20321.0	5652.06	9	14.9%	628.01	258.45	0.00E+00
Long. Distance To Well (m)	20996.5	4976.58	9	13.1%	552.95	227.56	0.00E+00
Freund. Iso. Coeff.--Unsat. Zone (cm^3/g)	20986.6	4986.50	5	13.1%	997.30	410.43	0.00E+00
Unsaturated Zone Thickness (m)	21947.7	4025.41	8	10.6%	503.18	207.08	2.32E-303
Aquifer Thickness (m)	23382.5	2590.62	6	6.8%	431.77	177.69	2.24E-205
Groundwater Seepage Velocity (m/yr)	24677.0	1296.14	5	3.4%	259.23	106.68	2.86E-107
Long. Hydraulic Conduct. (m/yr)	24775.8	1197.28	6	3.2%	199.55	82.12	2.58E-98
Consumption of Drinking Water (ml/kg/day)	25107.7	865.45	1	2.3%	865.45	356.17	9.09E-77
Long. Dispersivity--Aquifer (m)	25141.3	831.77	7	2.2%	118.82	48.90	1.34E-67
Infiltration Rate	25446.5	526.59	5	1.4%	105.32	43.34	7.09E-44
Hydraulic Gradient (m/m)	25519.7	453.43	3	1.2%	151.14	62.20	1.81E-39
Porosity (unitless)	25712.3	260.84	4	0.7%	65.21	26.84	4.66E-22
Avg. Particle Diameter (cm)	25876.1	96.99	3	0.3%	32.33	13.31	1.20E-08
Depth of Well Below Water Table (m)	25911.1	62.04	3	0.2%	20.68	8.51	1.23E-05

Constants

Full Model SS	25973.104
Error SS	12008.455
Error DF	4942
MS Error	2.43

Table D-129. Summary of Parameters Considered in Sensitivity Analysis for Thallium

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
ACIDCAT	Acid Catalyzed Hydrolysis Rate Constant	C			
ANGLEW	Angle of Well Off Plume Centerline	anglew		Y	
ANISORAT	Anisotropy Ratio	C			
AQUTHIK	Aquifer Thickness	aquthik**-0.3		Y	Y
AVGPDIAM	Avg. Particle Diameter	log(avgpdiam+.001)		Y	Y
BASECAT	Base Catalyzed Hydrolysis Rate Constant	C			
BIODRATA	Biodegradation Rate	C			
BIODRATU	Biodegradation Rate	C			
BULKDENS	Bulk Density	bulkdens**3.5	Y		
CHEMDRU	Chemical Decay Rate	C			
CHEMDRA	Chemical Decay Rate	C			
CONSH2OA	Consump of drinking water	log(consh2oa)			Y
ZDIST	Depth of Well Below Water Table	log(zdist+2.5)		Y	
DISHYD	Dissolved Hydrolysis Rate	C			
YDIST	Distance from Plume Centerline to Well	log(ydist+10)		Y	Y
DURLEACH	Duration of Leaching Period	log(durleach+5000)	Y		
GWAVTIM	Exposure Duration	C			
FRORGCAR	Fraction Organic Carbon	log(frorgcar)		Y	
FRCOEFA	Freundlich Isotherm Coefficient	C			
FRCOEFU	Freundlich Isotherm Coefficient	C			
FREXPA	Freundlich Isotherm Exponent	C			
FREXPU	Freundlich Isotherm Exponent	C			
GWPH	Groundwater pH	gwph	Y		
GWSEEPV	Groundwater Seepage Velocity	log(gwseepv-0.09)		Y	Y
GWTEMP	Groundwater Temperature	C			
HYDGRAD	Hydraulic Gradient	log(hydgrad+0.0003)		Y	Y
INFILRAT	Infiltration Rate	infilrat**1.5		Y	Y
LANDEPTH	Landfill Depth	log(landepth+30)	Y		
LEACHCON	Leachate Concentration	C			
LFFRACT	LF Fraction	C			
LONDISPU	Longitudinal Dispersivity	log(londispu-0.015)	Y		
LONDISPA	Longitudinal Dispersivity	log(londispa+0.3)		Y	Y
XDIST	Longitudinal Distance to Well	log(xdist+100)		Y	Y

Table D-129. Summary of Parameters Considered in Sensitivity Analysis for Thallium

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
LONHYCON	Longitundinal Hydraulic Conductivity	log(lonhycon-3.1)		Y	Y
MLLA	ml/L	C			
MOISTRPA	Moisture Rention Parameter (a)	moistrpa**0.1	Y		
MOISTRPB	Moisture Rention Parameter (b)	log(moistrpb-0.5)	Y		
MOLDIFF	Molecular Diffusion Coefficient	C			
NEUTHYD	Neutral Hydrolysis Rate Constant	C			
ORGCDIS	Organic Carbon Distribution Coefficient	C			
PERORGM	Percent Organic Matter	log(perorgm)			
POROSITY	Porosity	porosity**1.3		Y	Y
RADISTW	Radial Distance to Well	log(radistw+150)	Y		
RECHARAT	Recharge Rate	recharat	Y		
RESIDH2O	Residual Water Content	residh2o		Y	
RETCOEF	Retardation Coefficient	C			
RFDA	RfD (mg/kg/day)	C			
SATHYCON	Saturated Hydraulic Conductivity	log(sathycon+0.1)	Y		
SATURH2O	Saturated Water Content	saturh2o	Y		
SOILBDEN	Soil Bulk Density	soilbden	Y		
SORBHYD	Sorbed Hydrolysis Rate	C			
TRANDISP	Transverse Dispersivity	log(trandisp+.01)	Y		
UNSATHIK	Unsaturated Zone Thickness	unsathik**-0.0000001		Y	Y
VERTDISP	Vertical Dispersivity	log(vertdisp+0.001)	Y		
WASTDENS	Waste Density	C			
WASTEVOL	Waste Volume	C			
WMUAREA	WMU Area	log(wmuarea-36000)		Y	Y
WMULEN	WMU Length	log(wmulen-180)	Y		
WMUWIDTH	WMU Width	log(wmuwidth-180)	Y		

Table D-130. Summary of Correlated Parameters for Thallium

Variable 1		Variable 2		Correlation Coefficient
Code	Description	Code	Description	
AVGPDIAM	Avg. Particle Diameter	BULKDENS	Bulk Density	0.99813
LONDISPA	Longitudinal Dispersivity	TRANDISP	Transverse Dispersivity	0.9992
LONDISPA	Longitudinal Dispersivity	VERTDISP	Vertical Dispersivity	0.99896
RECHARAT	Recharge Rate	GWPH	Groundwater pH	-0.99874
INFILRAT	Infiltration Rate	GWPH	Groundwater pH	-0.98913
SATHYCON	Saturated Hydraulic Conductivity	GWPH	Groundwater pH	-0.72765
MOISTRPA	Moisture Rention Parameter (a)	GWPH	Groundwater pH	-0.78434
MOISTRPB	Moisture Rention Parameter (b)	GWPH	Groundwater pH	-0.8655
SATURH2O	Saturated Water Content	GWPH	Groundwater pH	0.8516
SOILBDEN	Soil Bulk Density	GWPH	Groundwater pH	0.99056
XDIST	Longitudinal Distance to Well	RADISTW	Radial Distance to Well	0.99674
WMUAREA	WMU Area	WMULEN	WMU Length	0.98965
LANDEPTH	Landfill Depth	WMULEN	WMU Length	-0.98582
DURLEACH	Duration of Leaching Period	WMULEN	WMU Length	-0.96827
WMUAREA	WMU Area	WMUWIDTH	WMU Width	0.98965
LANDEPTH	Landfill Depth	WMUWIDTH	WMU Width	-0.98582
DURLEACH	Duration of Leaching Period	WMUWIDTH	WMU Width	-0.96827
INFILRAT	Infiltration Rate	RECHARAT	Recharge Rate	0.99124
SATHYCON	Saturated Hydraulic Conductivity	RECHARAT	Recharge Rate	0.7294
MOISTRPA	Moisture Rention Parameter (a)	RECHARAT	Recharge Rate	0.78911
MOISTRPB	Moisture Rention Parameter (b)	RECHARAT	Recharge Rate	0.8685
SATURH2O	Saturated Water Content	RECHARAT	Recharge Rate	-0.87688
SOILBDEN	Soil Bulk Density	RECHARAT	Recharge Rate	-0.9962
WMUAREA	WMU Area	LANDEPTH	Landfill Depth	-0.96672
WMUAREA	WMU Area	DURLEACH	Duration of Leaching Period	-0.93176
LANDEPTH	Landfill Depth	DURLEACH	Duration of Leaching Period	0.96012
RECHARAT	Recharge Rate	SATHYCON	Saturated Hydraulic Conductivity	0.7294
INFILRAT	Infiltration Rate	SATHYCON	Saturated Hydraulic Conductivity	0.73757
RECHARAT	Recharge Rate	MOISTRPA	Moisture Rention Parameter (a)	0.78911
INFILRAT	Infiltration Rate	MOISTRPA	Moisture Rention Parameter (a)	0.78335
SATURH2O	Saturated Water Content	MOISTRPA	Moisture Rention Parameter (a)	-0.72808
RECHARAT	Recharge Rate	MOISTRPB	Moisture Rention Parameter (b)	0.8685
INFILRAT	Infiltration Rate	MOISTRPB	Moisture Rention Parameter (b)	0.86127

Table D-130. Summary of Correlated Parameters for Thallium

Variable 1		Variable 2		Correlation Coefficient
Code	**Description**	**Code**	**Description**	
SATURH2O	Saturated Water Content	MOISTRPB	Moisture Rention Parameter (b)	-0.77974
RECHARAT	Recharge Rate	SATURH2O	Saturated Water Content	-0.87688
INFILRAT	Infiltration Rate	SATURH2O	Saturated Water Content	-0.87732
MOISTRPA	Moisture Rention Parameter (a)	SATURH2O	Saturated Water Content	-0.72808
MOISTRPB	Moisture Rention Parameter (b)	SATURH2O	Saturated Water Content	-0.77974
SOILBDEN	Soil Bulk Density	SATURH2O	Saturated Water Content	0.91543
UNSATHIK	Unsaturated Zone Thickness	LONDISPU	Longitudinal Dispersivity	-0.9983
RECHARAT	Recharge Rate	SOILBDEN	Soil Bulk Density	-0.9962
INFILRAT	Infiltration Rate	SOILBDEN	Soil Bulk Density	-0.98894
SATHYCON	Saturated Hydraulic Conductivity	SOILBDEN	Soil Bulk Density	-0.72804
MOISTRPA	Moisture Rention Parameter (a)	SOILBDEN	Soil Bulk Density	-0.79266
MOISTRPB	Moisture Rention Parameter (b)	SOILBDEN	Soil Bulk Density	-0.86849
SATURH2O	Saturated Water Content	SOILBDEN	Soil Bulk Density	0.91543

Note: Parameters in the variable 2 column were removed from the analysis.

Table D-131. Summary of Crosspairs Analysis for Thallium

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
AVGPDIAM	Avg. Particle Diameter			Y	Y
POROSITY	Porosity				
AQUTHIK	Aquifer Thickness			Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity			Y	
HYDGRAD	Hydraulic Gradient				
GWSEEPV	Groundwater Seepage Velocity			Y	
LONDISPA	Longitudinal Dispersivity			Y	Y
FRORGCAR	Fraction Organic Carbon				
ANGLEW	Angle of Well Off Plume Centerline			Y	
XDIST	Longitudinal Distance to Well			Y	Y
YDIST	Distance from Plume Centerline to Well			Y	Y
ZDIST	Depth of Well Below Water Table				
WMUAREA	WMU Area			Y	Y
INFILRAT	Infiltration Rate			Y	Y
RESIDH2O	Residual Water Content				
UNSATHIK	Unsaturated Zone Thickness			Y	Y
PERORGM	Percent Organic Matter				
AVGPDIAM	Avg. Particle Diameter	AVGPDIAM	Avg. Particle Diameter		
POROSITY	Porosity	AVGPDIAM	Avg. Particle Diameter		
POROSITY	Porosity	POROSITY	Porosity		
AQUTHIK	Aquifer Thickness	AVGPDIAM	Avg. Particle Diameter	Y	Y
AQUTHIK	Aquifer Thickness	POROSITY	Porosity		
AQUTHIK	Aquifer Thickness	AQUTHIK	Aquifer Thickness	Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity	AVGPDIAM	Avg. Particle Diameter		
LONHYCON	Longitundinal Hydraulic Conductivity	POROSITY	Porosity	Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity	AQUTHIK	Aquifer Thickness		
LONHYCON	Longitundinal Hydraulic Conductivity	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
HYDGRAD	Hydraulic Gradient	AVGPDIAM	Avg. Particle Diameter		
HYDGRAD	Hydraulic Gradient	POROSITY	Porosity	Y	Y
HYDGRAD	Hydraulic Gradient	AQUTHIK	Aquifer Thickness		
HYDGRAD	Hydraulic Gradient	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
HYDGRAD	Hydraulic Gradient	HYDGRAD	Hydraulic Gradient	Y	Y
GWSEEPV	Groundwater Seepage Velocity	AVGPDIAM	Avg. Particle Diameter		
GWSEEPV	Groundwater Seepage Velocity	POROSITY	Porosity		
GWSEEPV	Groundwater Seepage Velocity	AQUTHIK	Aquifer Thickness		
GWSEEPV	Groundwater Seepage Velocity	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
GWSEEPV	Groundwater Seepage Velocity	HYDGRAD	Hydraulic Gradient	Y	Y
GWSEEPV	Groundwater Seepage Velocity	GWSEEPV	Groundwater Seepage Velocity		
LONDISPA	Longitudinal Dispersivity	AVGPDIAM	Avg. Particle Diameter		
LONDISPA	Longitudinal Dispersivity	POROSITY	Porosity		
LONDISPA	Longitudinal Dispersivity	AQUTHIK	Aquifer Thickness	Y	Y
LONDISPA	Longitudinal Dispersivity	LONHYCON	Longitundinal Hydraulic Conductivity		
LONDISPA	Longitudinal Dispersivity	HYDGRAD	Hydraulic Gradient		
LONDISPA	Longitudinal Dispersivity	GWSEEPV	Groundwater Seepage Velocity		
LONDISPA	Longitudinal Dispersivity	LONDISPA	Longitudinal Dispersivity		
FRORGCAR	Fraction Organic Carbon	AVGPDIAM	Avg. Particle Diameter	Y	
FRORGCAR	Fraction Organic Carbon	POROSITY	Porosity		
FRORGCAR	Fraction Organic Carbon	AQUTHIK	Aquifer Thickness		
FRORGCAR	Fraction Organic Carbon	LONHYCON	Longitundinal Hydraulic Conductivity		

Table D-131. Summary of Crosspairs Analysis for Thallium

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
FRORGCAR	Fraction Organic Carbon	HYDGRAD	Hydraulic Gradient		
FRORGCAR	Fraction Organic Carbon	GWSEEPV	Groundwater Seepage Velocity		
FRORGCAR	Fraction Organic Carbon	LONDISPA	Longitudinal Dispersivity	Y	
FRORGCAR	Fraction Organic Carbon	FRORGCAR	Fraction Organic Carbon		
ANGLEW	Angle of Well Off Plume Centerline	AVGPDIAM	Avg. Particle Diameter		
ANGLEW	Angle of Well Off Plume Centerline	POROSITY	Porosity		
ANGLEW	Angle of Well Off Plume Centerline	AQUTHIK	Aquifer Thickness		
ANGLEW	Angle of Well Off Plume Centerline	LONHYCON	Longitundinal Hydraulic Conductivity		
ANGLEW	Angle of Well Off Plume Centerline	HYDGRAD	Hydraulic Gradient		
ANGLEW	Angle of Well Off Plume Centerline	GWSEEPV	Groundwater Seepage Velocity		
ANGLEW	Angle of Well Off Plume Centerline	LONDISPA	Longitudinal Dispersivity		
ANGLEW	Angle of Well Off Plume Centerline	FRORGCAR	Fraction Organic Carbon		
ANGLEW	Angle of Well Off Plume Centerline	ANGLEW	Angle of Well Off Plume Centerline		
XDIST	Longitudinal Distance to Well	AVGPDIAM	Avg. Particle Diameter		
XDIST	Longitudinal Distance to Well	POROSITY	Porosity	Y	
XDIST	Longitudinal Distance to Well	AQUTHIK	Aquifer Thickness		
XDIST	Longitudinal Distance to Well	LONHYCON	Longitundinal Hydraulic Conductivity		
XDIST	Longitudinal Distance to Well	HYDGRAD	Hydraulic Gradient		
XDIST	Longitudinal Distance to Well	GWSEEPV	Groundwater Seepage Velocity	Y	Y
XDIST	Longitudinal Distance to Well	LONDISPA	Longitudinal Dispersivity	Y	
XDIST	Longitudinal Distance to Well	FRORGCAR	Fraction Organic Carbon		
XDIST	Longitudinal Distance to Well	ANGLEW	Angle of Well Off Plume Centerline		
XDIST	Longitudinal Distance to Well	XDIST	Longitudinal Distance to Well	Y	
YDIST	Distance from Plume Centerline to Well	AVGPDIAM	Avg. Particle Diameter		
YDIST	Distance from Plume Centerline to Well	POROSITY	Porosity		
YDIST	Distance from Plume Centerline to Well	AQUTHIK	Aquifer Thickness	Y	
YDIST	Distance from Plume Centerline to Well	LONHYCON	Longitundinal Hydraulic Conductivity		
YDIST	Distance from Plume Centerline to Well	HYDGRAD	Hydraulic Gradient		
YDIST	Distance from Plume Centerline to Well	GWSEEPV	Groundwater Seepage Velocity		
YDIST	Distance from Plume Centerline to Well	LONDISPA	Longitudinal Dispersivity		
YDIST	Distance from Plume Centerline to Well	FRORGCAR	Fraction Organic Carbon		
YDIST	Distance from Plume Centerline to Well	ANGLEW	Angle of Well Off Plume Centerline		
YDIST	Distance from Plume Centerline to Well	XDIST	Longitudinal Distance to Well	Y	Y
YDIST	Distance from Plume Centerline to Well	YDIST	Distance from Plume Centerline to Well	Y	Y
ZDIST	Depth of Well Below Water Table	AVGPDIAM	Avg. Particle Diameter		
ZDIST	Depth of Well Below Water Table	POROSITY	Porosity		
ZDIST	Depth of Well Below Water Table	AQUTHIK	Aquifer Thickness		
ZDIST	Depth of Well Below Water Table	LONHYCON	Longitundinal Hydraulic Conductivity		
ZDIST	Depth of Well Below Water Table	HYDGRAD	Hydraulic Gradient	Y	
ZDIST	Depth of Well Below Water Table	GWSEEPV	Groundwater Seepage Velocity	Y	
ZDIST	Depth of Well Below Water Table	LONDISPA	Longitudinal Dispersivity	Y	
ZDIST	Depth of Well Below Water Table	FRORGCAR	Fraction Organic Carbon		
ZDIST	Depth of Well Below Water Table	ANGLEW	Angle of Well Off Plume Centerline		
ZDIST	Depth of Well Below Water Table	XDIST	Longitudinal Distance to Well		
ZDIST	Depth of Well Below Water Table	YDIST	Distance from Plume Centerline to Well		
ZDIST	Depth of Well Below Water Table	ZDIST	Depth of Well Below Water Table		
WMUAREA	WMU Area	AVGPDIAM	Avg. Particle Diameter		
WMUAREA	WMU Area	POROSITY	Porosity		
WMUAREA	WMU Area	AQUTHIK	Aquifer Thickness	Y	

Table D-131. Summary of Crosspairs Analysis for Thallium

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
WMUAREA	WMU Area	LONHYCON	Longitundinal Hydraulic Conductivity		
WMUAREA	WMU Area	HYDGRAD	Hydraulic Gradient		
WMUAREA	WMU Area	GWSEEPV	Groundwater Seepage Velocity		
WMUAREA	WMU Area	LONDISPA	Longitudinal Dispersivity		
WMUAREA	WMU Area	FRORGCAR	Fraction Organic Carbon		
WMUAREA	WMU Area	ANGLEW	Angle of Well Off Plume Centerline		
WMUAREA	WMU Area	XDIST	Longitudinal Distance to Well	Y	Y
WMUAREA	WMU Area	YDIST	Distance from Plume Centerline to Well	Y	Y
WMUAREA	WMU Area	ZDIST	Depth of Well Below Water Table		
WMUAREA	WMU Area	WMUAREA	WMU Area	Y	
INFILRAT	Infiltration Rate	AVGPDIAM	Avg. Particle Diameter		
INFILRAT	Infiltration Rate	POROSITY	Porosity		
INFILRAT	Infiltration Rate	AQUTHIK	Aquifer Thickness	Y	Y
INFILRAT	Infiltration Rate	LONHYCON	Longitundinal Hydraulic Conductivity		
INFILRAT	Infiltration Rate	HYDGRAD	Hydraulic Gradient	Y	
INFILRAT	Infiltration Rate	GWSEEPV	Groundwater Seepage Velocity	Y	Y
INFILRAT	Infiltration Rate	LONDISPA	Longitudinal Dispersivity		
INFILRAT	Infiltration Rate	FRORGCAR	Fraction Organic Carbon	Y	
INFILRAT	Infiltration Rate	ANGLEW	Angle of Well Off Plume Centerline		
INFILRAT	Infiltration Rate	XDIST	Longitudinal Distance to Well	Y	
INFILRAT	Infiltration Rate	YDIST	Distance from Plume Centerline to Well		
INFILRAT	Infiltration Rate	ZDIST	Depth of Well Below Water Table		
INFILRAT	Infiltration Rate	WMUAREA	WMU Area		
INFILRAT	Infiltration Rate	INFILRAT	Infiltration Rate	Y	Y
RESIDH2O	Residual Water Content	AVGPDIAM	Avg. Particle Diameter		
RESIDH2O	Residual Water Content	POROSITY	Porosity		
RESIDH2O	Residual Water Content	AQUTHIK	Aquifer Thickness		
RESIDH2O	Residual Water Content	LONHYCON	Longitundinal Hydraulic Conductivity		
RESIDH2O	Residual Water Content	HYDGRAD	Hydraulic Gradient		
RESIDH2O	Residual Water Content	GWSEEPV	Groundwater Seepage Velocity		
RESIDH2O	Residual Water Content	LONDISPA	Longitudinal Dispersivity		
RESIDH2O	Residual Water Content	FRORGCAR	Fraction Organic Carbon		
RESIDH2O	Residual Water Content	ANGLEW	Angle of Well Off Plume Centerline		
RESIDH2O	Residual Water Content	XDIST	Longitudinal Distance to Well		
RESIDH2O	Residual Water Content	YDIST	Distance from Plume Centerline to Well		
RESIDH2O	Residual Water Content	ZDIST	Depth of Well Below Water Table		
RESIDH2O	Residual Water Content	WMUAREA	WMU Area		
RESIDH2O	Residual Water Content	INFILRAT	Infiltration Rate		
RESIDH2O	Residual Water Content	RESIDH2O	Residual Water Content	Y	
UNSATHIK	Unsaturated Zone Thickness	AVGPDIAM	Avg. Particle Diameter		
UNSATHIK	Unsaturated Zone Thickness	POROSITY	Porosity		
UNSATHIK	Unsaturated Zone Thickness	AQUTHIK	Aquifer Thickness		
UNSATHIK	Unsaturated Zone Thickness	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
UNSATHIK	Unsaturated Zone Thickness	HYDGRAD	Hydraulic Gradient	Y	Y
UNSATHIK	Unsaturated Zone Thickness	GWSEEPV	Groundwater Seepage Velocity		
UNSATHIK	Unsaturated Zone Thickness	LONDISPA	Longitudinal Dispersivity		
UNSATHIK	Unsaturated Zone Thickness	FRORGCAR	Fraction Organic Carbon		
UNSATHIK	Unsaturated Zone Thickness	ANGLEW	Angle of Well Off Plume Centerline		
UNSATHIK	Unsaturated Zone Thickness	XDIST	Longitudinal Distance to Well	Y	

Table D-131. Summary of Crosspairs Analysis for Thallium

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
UNSATHIK	Unsaturated Zone Thickness	YDIST	Distance from Plume Centerline to Well	Y	Y
UNSATHIK	Unsaturated Zone Thickness	ZDIST	Depth of Well Below Water Table		
UNSATHIK	Unsaturated Zone Thickness	WMUAREA	WMU Area	Y	Y
UNSATHIK	Unsaturated Zone Thickness	INFILRAT	Infiltration Rate	Y	Y
UNSATHIK	Unsaturated Zone Thickness	RESIDH2O	Residual Water Content		
UNSATHIK	Unsaturated Zone Thickness	UNSATHIK	Unsaturated Zone Thickness	Y	Y
PERORGM	Percent Organic Matter	AVGPDIAM	Avg. Particle Diameter		
PERORGM	Percent Organic Matter	POROSITY	Porosity		
PERORGM	Percent Organic Matter	AQUTHIK	Aquifer Thickness		
PERORGM	Percent Organic Matter	LONHYCON	Longitundinal Hydraulic Conductivity		
PERORGM	Percent Organic Matter	HYDGRAD	Hydraulic Gradient		
PERORGM	Percent Organic Matter	GWSEEPV	Groundwater Seepage Velocity		
PERORGM	Percent Organic Matter	LONDISPA	Longitudinal Dispersivity		
PERORGM	Percent Organic Matter	FRORGCAR	Fraction Organic Carbon		
PERORGM	Percent Organic Matter	ANGLEW	Angle of Well Off Plume Centerline		
PERORGM	Percent Organic Matter	XDIST	Longitudinal Distance to Well		
PERORGM	Percent Organic Matter	YDIST	Distance from Plume Centerline to Well		
PERORGM	Percent Organic Matter	ZDIST	Depth of Well Below Water Table		
PERORGM	Percent Organic Matter	WMUAREA	WMU Area		
PERORGM	Percent Organic Matter	INFILRAT	Infiltration Rate		
PERORGM	Percent Organic Matter	RESIDH2O	Residual Water Content		
PERORGM	Percent Organic Matter	UNSATHIK	Unsaturated Zone Thickness		
PERORGM	Percent Organic Matter	PERORGM	Percent Organic Matter		

Table D-132. Ranking of Parameters According to Percentage of Risk for Thallium

Variable Description	Reduced Sums of Square	Variable Sums of Square	Variable Degrees of Freedom	% Risk Variation	Mean Square Variable	F VALUE	P VALUE
Longitudinal Distance to Well (m)	1599.5	989.71	5	25.9%	197.94	798.63	0.00E+00
Consumption of Drinking Water (ml/kg-day)	2002.7	586.54	1	15.4%	586.54	2366.49	0.00E+00
WMU Area (m2)	2081.8	507.37	4	13.3%	126.84	511.77	0.00E+00
Aquifer Thickness (m)	2358.9	230.30	5	6.0%	46.06	185.83	6.66E-182
Distance from Plume Centerline to Well (m)	2414.1	175.08	4	4.6%	43.77	176.59	1.22E-141
Longitudinal Dispersivity {Aquifer} (m)	2423.3	165.90	2	4.3%	82.95	334.68	4.50E-137
Longitudinal Hydraulic Conductivity (m/yr)	2481.6	107.59	6	2.8%	17.93	72.35	8.72E-87
Groundwater Seepage Velocity (m/yr)	2488.4	100.80	5	2.6%	20.16	81.34	2.60E-82
Unsaturated Zone Thickness	2493.3	95.91	7	2.5%	13.70	55.28	1.62E-76
Hydraluic Gradient (m/m)	2532.8	56.44	6	1.5%	9.41	37.95	2.74E-45
Infiltration Rate	2549.7	39.48	5	1.0%	7.89	31.86	4.71E-32
Porosity (unitless)	2560.7	28.51	3	0.7%	9.50	38.34	1.73E-24
Average Particle Diameter (cm)	2581.7	7.47	2	0.2%	3.74	15.07	2.97E-07

Constants

Full Model SS	2589.192
Error SS	1229.591
Error DF	4961
MS Error	0.248

Appendix E

Antimony

Appendix E
Antimony Oxide Production Sector

This appendix provides supporting data for the antimony oxide production industry sector. This industry sector considers one waste stream/waste management scenario. The data used to model this scenario and the sensitivity analyses conducted for it is presented in this appendix

Tables E-1 through E-6 present the data used to characterize the low antimony slag waste stream and the onsite landfill and the site-specific data used to model this waste stream in the antimony oxide industry sector.

Table E-1	Chemical-Specific Properties for Constituents of Concern for the Low Antimony Slag in the Antimony Oxide Sector
Table E-2	Onsite Industrial D Landfill Parameters
Table E-3	Waste Stream Parameters for the Low Antimony Slag in the Antimony Oxide Sector
Table E-4	Site-Specific Climate-Related Parameters for Low Antimony Slag in the Antimony Oxide Sector
Table E-5	Aquifer Types Common Near Current WMU Managing Low Antimony Slag in the Antimony Oxide Sector
Table E-6	Soil Textures Common Within 100-Mile Radius of Current WMU Managing Low Antimony Slag in the Antimony Oxide Sector

Tables E-7 through E-26 present the results of the sensitivity analysis for the ammonia recycle filters waste stream managed in industrial landfills. Sensitivity analyses have been performed for the following constituents:

- Antimony
- Arsenic
- Boron
- Selenium
- Vanadium

For each constituent, four sensitivity analysis summaries are presented:

- Summary of Parameters Considered in Sensitivity Analysis
- Summary of Correlated Parameters
- Summary of Cross Pairs Analysis
- Ranking of Parameters According to Percentage of Risk.

Table E-1. Chemical-Specific Properties for Constituents of Concern for Antimony Oxide Process Wastes

	Waste Constituent Concentrations				
Constituent	**SPLP (Industrial D Landfill) (mg/L)**	**Total waste (mg/kg)**	**Finite MSW Source Ratio (L/kg)**	**Overall Hydrolysis rate(1/yr)**	**Biodegrd. Rate(1/yr)**
Antimony	114	11500	101	0	0
Antimony	211	127000	602	0	0
Arsenic	2.93	301	103	0	0
Arsenic	3.81	478	125	0	0
Boron	9.27	*250*	27	0	0
Boron	8.06	*1250*	155	0	0
Selenium	0.55	*25*	45	0	0
Selenium	0.331	*125*	378	0	0
Vanadium	1.14	*25*	22	0	0
Vanadium	1	*125*	125	0	0

underline italics indicate values set at 1/2 of detection limit

Table E-2. Waste Management Unit Parameters for Onsite Landfill Managing Antimony Oxide Process Wastes

WMU	Location	Landfill Area (acres)	Landfill Area (m^2)
Onsite Landfill	Thompson Falls, MT	0.2	809

Table E-3. Waste Stream Parameters for Constituents of Concern for Antimony Oxide Process Wastes

WMU	Location	Landfill Area (acres)	Waste Quantity (MT/y)	Waste Density (g/cm^3)	Waste Density (kg/m^3)	Total Waste Vol (m^3)
Onsite Industrial D Landfill	Thompson Falls, MT	0.2	20	1.46	1460	411
				1.51	1510	397

Table E-4. Site-Specific Climate-Based Parameters for Constituents of Concern for Antimony Oxide Process Wastes

WMU	Location	Climate Index	Climate Center	Landfill Infiltartion Rate (m/yr)			Recharge Rate (m/yr)				GWpH		
				SCL	SLT	SNL	SCL	SLT	SNL	GW TempC	SCL	SLT	SNL
Onsite Landfill	Thompson Falls, MT	Not used	Not used	NA	Uniform Distribution from 0.25 - 0.38		NA	Uniform Distribution from 0.25 - 0.38		10	NA	7.71	6.32

Table E-5. Aquifer Type Common in Area of Onsite Landfill Managing Low Antimony Sludge in the Antimony Oxide Sector

Aquifer Types	Aquifer Code	Thompson Falls, Mt
Unconsolidated sand and gravel	NA	100%

Table E-6. Soil Textures Common in Area of Onsite Landfill Managing Low Antimony Sludge in the Antimony Oxide Sector

Soil Type	Soil Code	Thompson Falls, Mt
silty clay loam	SCL	0%
silt loam	SIL	5%
sandy loam	SNL	95%

Table E-7. Summary of Parameters Considered in Sensitivity Analysis for Antimony

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
ACIDCAT	Acid Catalyzed Hydrolysis Rate Constant	C			
ANGLEW	Angle of Well Off Plume Centerline	anglew		Y	Y
ANISORAT	Anisotropy Ratio	C			
AQUTHIK	Aquifer Thickness	aquthik**0.05	Y		
AVGPDIAM	Avg. Particle Diameter	C			
BASECAT	Base Catalyzed Hydrolysis Rate Constant	C			
BIODRATA	Biodegradation Rate	C			
BIODRATU	Biodegradation Rate	C			
BULKDENS	Bulk Density	C			
CHEMDRU	Chemical Decay Rate	C			
CHEMDRA	Chemical Decay Rate	C			
CONSH2OA	Consump of drinking water	log(consh2oa)			Y
ZDIST	Depth of Well Below Water Table	log(zdist+35)		Y	Y
DISHYD	Dissolved Hydrolysis Rate	C			
YDIST	Distance from Plume Centerline to Well	log(ydist+10)		Y	Y
DURLEACH	Duration of Leaching Period	log(durleach+225)	Y		
GWAVTIM	Exposure Duration	C			
FRORGCAR	Fraction Organic Carbon	log(frorgcar-0.000009)		Y	
FRCOEFA	Freundlich Isotherm Coefficient	log(frcoefa-0.1)		Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	log(frcoefu-0.3)		Y	Y
FREXPA	Freundlich Isotherm Exponent	C			
FREXPU	Freundlich Isotherm Exponent	C			
GWPH	Groundwater pH	gwph	Y		
GWSEEPV	Groundwater Seepage Velocity	log(gwseepv+60)	Y		
GWTEMP	Groundwater Temperature	C			
HYDGRAD	Hydraulic Gradient	log(hydgrad+0.007)		Y	Y
INFILRAT	Infiltration Rate	infilrat**3.5		Y	Y
LANDEPTH	Landfill Depth	log(landepth+0.0007)	Y		
LEACHCON	Leachate Concentration	leachcon		Y	Y
LFFRACT	LF Fraction	C			
LONDISPU	Longitudinal Dispersivity	log(londispu-0.007)	Y		
LONDISPA	Longitudinal Dispersivity	log(londispa+2)		Y	Y
XDIST	Longitudinal Distance to Well	log(xdist+650)		Y	Y

Table E-7. Summary of Parameters Considered in Sensitivity Analysis for Antimony

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
LONHYCON	Longitundinal Hydraulic Conductivity	lonhycon**0.4		Y	Y
MLLA	ml/L	C			
MOISTRPA	Moisture Rention Parameter (a)	log(moistrpa+4)		Y	Y
MOISTRPB	Moisture Rention Parameter (b)	moistrpb**0.7		Y	
MOLDIFF	Molecular Diffusion Coefficient	C			
NEUTHYD	Neutral Hydrolysis Rate Constant	C			
ORGCDIS	Organic Carbon Distribution Coefficient	C			
PERORGM	Percent Organic Matter	log(perorgm+0.002)		Y	
POROSITY	Porosity	C			
RADISTW	Radial Distance to Well	log(radistw+400)	Y		
RECHARAT	Recharge Rate	recharat	Y		
RESIDH2O	Residual Water Content	residh2o**1.25		Y	
RETCOEF	Retardation Coefficient	log(retcoef-1.7)	Y		
RFDA	RfD (mg/kg/day)	C			
SATHYCON	Saturated Hydraulic Conductivity	log(sathycon+10)		Y	Y
SATURH2O	Saturated Water Content	saturh2o			
SOILBDEN	Soil Bulk Density	soilbden	Y		
SORBHYD	Sorbed Hydrolysis Rate	C			
TRANDISP	Transverse Dispersivity	log(trandisp+0.35)	Y		
UNSATHIK	Unsaturated Zone Thickness	unsathik**0.01		Y	Y
VERTDISP	Vertical Dispersivity	log(vertdisp+0.008)	Y		
WASTDENS	Waste Density	wastdens	Y		
WASTEVOL	Waste Volume	wastevol	Y		
WMUAREA	WMU Area	C			
WMULEN	WMU Length	C			
WMUWIDTH	WMU Width	C			

Table E-8. Summary of Correlated Parameters for Antimony

Variable 1		Variable 2		Correlation Coefficient
Code	**Description**	**Code**	**Description**	
UNSATHIK	Unsaturated Zone Thickness	AQUTHIK	Aquifer Thickness	-0.99793
LONHYCON	Longitundinal Hydraulic Conductivi	GWSEEPV	Groundwater Seepage Velocity	0.72642
LONDISPA	Longitudinal Dispersivity	TRANDISP	Transverse Dispersivity	0.99977
LONDISPA	Longitudinal Dispersivity	VERTDISP	Vertical Dispersivity	0.99978
XDIST	Longitudinal Distance to Well	RADISTW	Radial Distance to Well	0.99666
INFILRAT	Infiltration Rate	RECHARAT	Recharge Rate	0.98956
WASTDENS	Waste Density	LANDEPTH	Landfill Depth	-1
WASTDENS	Waste Density	WASTEVOL	Waste Volume	-1
DURLEACH	Duration of Leaching Period	WASTEVOL	Waste Volume	0.98834
LEACHCON	Leachate Concentration	WASTDENS	Waste Density	-1
LANDEPTH	Landfill Depth	WASTDENS	Waste Density	-1
WASTEVOL	Waste Volume	WASTDENS	Waste Density	-1
DURLEACH	Duration of Leaching Period	WASTDENS	Waste Density	-0.98834
LEACHCON	Leachate Concentration	DURLEACH	Duration of Leaching Period	0.98834
LANDEPTH	Landfill Depth	DURLEACH	Duration of Leaching Period	0.98834
WASTEVOL	Waste Volume	DURLEACH	Duration of Leaching Period	0.98834
WASTDENS	Waste Density	DURLEACH	Duration of Leaching Period	-0.98834
AQUTHIK	Aquifer Thickness	LONDISPU	Longitudinal Dispersivity	-0.99795

Note: Parameters in the variable 2 column were removed from the analysis.

Table E-9. Summary of Crosspairs Analysis for Antimony

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
LONHYCON	Longitundinal Hydraulic Conductivity			Y	Y
HYDGRAD	Hydraulic Gradient			Y	Y
LONDISPA	Longitudinal Dispersivity			Y	Y
FRORGCAR	Fraction Organic Carbon				
ANGLEW	Angle of Well Off Plume Centerline				
XDIST	Longitudinal Distance to Well			Y	Y
YDIST	Distance from Plume Centerline to Well			Y	Y
ZDIST	Depth of Well Below Water Table			Y	Y
FRCOEFA	Freundlich Isotherm Coefficient			Y	Y
LEACHCON	Leachate Concentration			Y	Y
INFILRAT	Infiltration Rate			Y	Y
SATHYCON	Saturated Hydraulic Conductivity				
MOISTRPA	Moisture Rention Parameter (a)				
MOISTRPB	Moisture Rention Parameter (b)				
RESIDH2O	Residual Water Content				
SATURH2O	Saturated Water Content				
UNSATHIK	Unsaturated Zone Thickness			Y	Y
PERORGM	Percent Organic Matter				
FRCOEFU	Freundlich Isotherm Coefficient			Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
HYDGRAD	Hydraulic Gradient	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
HYDGRAD	Hydraulic Gradient	HYDGRAD	Hydraulic Gradient	Y	Y
LONDISPA	Longitudinal Dispersivity	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
LONDISPA	Longitudinal Dispersivity	HYDGRAD	Hydraulic Gradient	Y	Y
LONDISPA	Longitudinal Dispersivity	LONDISPA	Longitudinal Dispersivity	Y	Y
FRORGCAR	Fraction Organic Carbon	LONHYCON	Longitundinal Hydraulic Conductivity		
FRORGCAR	Fraction Organic Carbon	HYDGRAD	Hydraulic Gradient		
FRORGCAR	Fraction Organic Carbon	LONDISPA	Longitudinal Dispersivity	Y	
FRORGCAR	Fraction Organic Carbon	FRORGCAR	Fraction Organic Carbon		
ANGLEW	Angle of Well Off Plume Centerline	LONHYCON	Longitundinal Hydraulic Conductivity		
ANGLEW	Angle of Well Off Plume Centerline	HYDGRAD	Hydraulic Gradient		
ANGLEW	Angle of Well Off Plume Centerline	LONDISPA	Longitudinal Dispersivity		
ANGLEW	Angle of Well Off Plume Centerline	FRORGCAR	Fraction Organic Carbon		
ANGLEW	Angle of Well Off Plume Centerline	ANGLEW	Angle of Well Off Plume Centerline		
XDIST	Longitudinal Distance to Well	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
XDIST	Longitudinal Distance to Well	HYDGRAD	Hydraulic Gradient	Y	Y
XDIST	Longitudinal Distance to Well	LONDISPA	Longitudinal Dispersivity	Y	Y
XDIST	Longitudinal Distance to Well	FRORGCAR	Fraction Organic Carbon		
XDIST	Longitudinal Distance to Well	ANGLEW	Angle of Well Off Plume Centerline		
XDIST	Longitudinal Distance to Well	XDIST	Longitudinal Distance to Well	Y	Y
YDIST	Distance from Plume Centerline to Well	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
YDIST	Distance from Plume Centerline to Well	HYDGRAD	Hydraulic Gradient	Y	Y
YDIST	Distance from Plume Centerline to Well	LONDISPA	Longitudinal Dispersivity	Y	Y
YDIST	Distance from Plume Centerline to Well	FRORGCAR	Fraction Organic Carbon		
YDIST	Distance from Plume Centerline to Well	ANGLEW	Angle of Well Off Plume Centerline		
YDIST	Distance from Plume Centerline to Well	XDIST	Longitudinal Distance to Well	Y	Y
YDIST	Distance from Plume Centerline to Well	YDIST	Distance from Plume Centerline to Well	Y	Y
ZDIST	Depth of Well Below Water Table	LONHYCON	Longitundinal Hydraulic Conductivity		
ZDIST	Depth of Well Below Water Table	HYDGRAD	Hydraulic Gradient	Y	Y

Table E-9. Summary of Crosspairs Analysis for Antimony

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
ZDIST	Depth of Well Below Water Table	LONDISPA	Longitudinal Dispersivity	Y	Y
ZDIST	Depth of Well Below Water Table	FRORGCAR	Fraction Organic Carbon		
ZDIST	Depth of Well Below Water Table	ANGLEW	Angle of Well Off Plume Centerline		
ZDIST	Depth of Well Below Water Table	XDIST	Longitudinal Distance to Well	Y	Y
ZDIST	Depth of Well Below Water Table	YDIST	Distance from Plume Centerline to Well	Y	
ZDIST	Depth of Well Below Water Table	ZDIST	Depth of Well Below Water Table		
FRCOEFA	Freundlich Isotherm Coefficient	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	HYDGRAD	Hydraulic Gradient	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	LONDISPA	Longitudinal Dispersivity	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	FRORGCAR	Fraction Organic Carbon		
FRCOEFA	Freundlich Isotherm Coefficient	ANGLEW	Angle of Well Off Plume Centerline	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	XDIST	Longitudinal Distance to Well	Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	YDIST	Distance from Plume Centerline to Well		
FRCOEFA	Freundlich Isotherm Coefficient	ZDIST	Depth of Well Below Water Table		
FRCOEFA	Freundlich Isotherm Coefficient	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
LEACHCON	Leachate Concentration	LONHYCON	Longitundinal Hydraulic Conductivity	Y	Y
LEACHCON	Leachate Concentration	HYDGRAD	Hydraulic Gradient	Y	Y
LEACHCON	Leachate Concentration	LONDISPA	Longitudinal Dispersivity	Y	Y
LEACHCON	Leachate Concentration	FRORGCAR	Fraction Organic Carbon		
LEACHCON	Leachate Concentration	ANGLEW	Angle of Well Off Plume Centerline		
LEACHCON	Leachate Concentration	XDIST	Longitudinal Distance to Well	Y	Y
LEACHCON	Leachate Concentration	YDIST	Distance from Plume Centerline to Well	Y	Y
LEACHCON	Leachate Concentration	ZDIST	Depth of Well Below Water Table		
LEACHCON	Leachate Concentration	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
LEACHCON	Leachate Concentration	LEACHCON	Leachate Concentration		
INFILRAT	Infiltration Rate	LONHYCON	Longitundinal Hydraulic Conductivity		
INFILRAT	Infiltration Rate	HYDGRAD	Hydraulic Gradient		
INFILRAT	Infiltration Rate	LONDISPA	Longitudinal Dispersivity		
INFILRAT	Infiltration Rate	FRORGCAR	Fraction Organic Carbon		
INFILRAT	Infiltration Rate	ANGLEW	Angle of Well Off Plume Centerline		
INFILRAT	Infiltration Rate	XDIST	Longitudinal Distance to Well		
INFILRAT	Infiltration Rate	YDIST	Distance from Plume Centerline to Well		
INFILRAT	Infiltration Rate	ZDIST	Depth of Well Below Water Table		
INFILRAT	Infiltration Rate	FRCOEFA	Freundlich Isotherm Coefficient		
INFILRAT	Infiltration Rate	LEACHCON	Leachate Concentration	Y	Y
INFILRAT	Infiltration Rate	INFILRAT	Infiltration Rate	Y	Y
SATHYCON	Saturated Hydraulic Conductivity	LONHYCON	Longitundinal Hydraulic Conductivity		
SATHYCON	Saturated Hydraulic Conductivity	HYDGRAD	Hydraulic Gradient		
SATHYCON	Saturated Hydraulic Conductivity	LONDISPA	Longitudinal Dispersivity		
SATHYCON	Saturated Hydraulic Conductivity	FRORGCAR	Fraction Organic Carbon		
SATHYCON	Saturated Hydraulic Conductivity	ANGLEW	Angle of Well Off Plume Centerline		
SATHYCON	Saturated Hydraulic Conductivity	XDIST	Longitudinal Distance to Well		
SATHYCON	Saturated Hydraulic Conductivity	YDIST	Distance from Plume Centerline to Well	Y	Y
SATHYCON	Saturated Hydraulic Conductivity	ZDIST	Depth of Well Below Water Table		
SATHYCON	Saturated Hydraulic Conductivity	FRCOEFA	Freundlich Isotherm Coefficient		
SATHYCON	Saturated Hydraulic Conductivity	LEACHCON	Leachate Concentration		
SATHYCON	Saturated Hydraulic Conductivity	INFILRAT	Infiltration Rate		
SATHYCON	Saturated Hydraulic Conductivity	SATHYCON	Saturated Hydraulic Conductivity	Y	Y
MOISTRPA	Moisture Rention Parameter (a)	LONHYCON	Longitundinal Hydraulic Conductivity		

Table E-9. Summary of Crosspairs Analysis for Antimony

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
MOISTRPA	Moisture Rention Parameter (a)	HYDGRAD	Hydraulic Gradient		
MOISTRPA	Moisture Rention Parameter (a)	LONDISPA	Longitudinal Dispersivity	Y	Y
MOISTRPA	Moisture Rention Parameter (a)	FRORGCAR	Fraction Organic Carbon		
MOISTRPA	Moisture Rention Parameter (a)	ANGLEW	Angle of Well Off Plume Centerline		
MOISTRPA	Moisture Rention Parameter (a)	XDIST	Longitudinal Distance to Well		
MOISTRPA	Moisture Rention Parameter (a)	YDIST	Distance from Plume Centerline to Well		
MOISTRPA	Moisture Rention Parameter (a)	ZDIST	Depth of Well Below Water Table		
MOISTRPA	Moisture Rention Parameter (a)	FRCOEFA	Freundlich Isotherm Coefficient		
MOISTRPA	Moisture Rention Parameter (a)	LEACHCON	Leachate Concentration		
MOISTRPA	Moisture Rention Parameter (a)	INFILRAT	Infiltration Rate		
MOISTRPA	Moisture Rention Parameter (a)	SATHYCON	Saturated Hydraulic Conductivity		
MOISTRPA	Moisture Rention Parameter (a)	MOISTRPA	Moisture Rention Parameter (a)		
MOISTRPB	Moisture Rention Parameter (b)	LONHYCON	Longitundinal Hydraulic Conductivity		
MOISTRPB	Moisture Rention Parameter (b)	HYDGRAD	Hydraulic Gradient		
MOISTRPB	Moisture Rention Parameter (b)	LONDISPA	Longitudinal Dispersivity		
MOISTRPB	Moisture Rention Parameter (b)	FRORGCAR	Fraction Organic Carbon		
MOISTRPB	Moisture Rention Parameter (b)	ANGLEW	Angle of Well Off Plume Centerline		
MOISTRPB	Moisture Rention Parameter (b)	XDIST	Longitudinal Distance to Well		
MOISTRPB	Moisture Rention Parameter (b)	YDIST	Distance from Plume Centerline to Well		
MOISTRPB	Moisture Rention Parameter (b)	ZDIST	Depth of Well Below Water Table	Y	
MOISTRPB	Moisture Rention Parameter (b)	FRCOEFA	Freundlich Isotherm Coefficient		
MOISTRPB	Moisture Rention Parameter (b)	LEACHCON	Leachate Concentration		
MOISTRPB	Moisture Rention Parameter (b)	INFILRAT	Infiltration Rate		
MOISTRPB	Moisture Rention Parameter (b)	SATHYCON	Saturated Hydraulic Conductivity		
MOISTRPB	Moisture Rention Parameter (b)	MOISTRPA	Moisture Rention Parameter (a)		
MOISTRPB	Moisture Rention Parameter (b)	MOISTRPB	Moisture Rention Parameter (b)		
RESIDH2O	Residual Water Content	LONHYCON	Longitundinal Hydraulic Conductivity		
RESIDH2O	Residual Water Content	HYDGRAD	Hydraulic Gradient	Y	
RESIDH2O	Residual Water Content	LONDISPA	Longitudinal Dispersivity		
RESIDH2O	Residual Water Content	FRORGCAR	Fraction Organic Carbon		
RESIDH2O	Residual Water Content	ANGLEW	Angle of Well Off Plume Centerline		
RESIDH2O	Residual Water Content	XDIST	Longitudinal Distance to Well		
RESIDH2O	Residual Water Content	YDIST	Distance from Plume Centerline to Well		
RESIDH2O	Residual Water Content	ZDIST	Depth of Well Below Water Table		
RESIDH2O	Residual Water Content	FRCOEFA	Freundlich Isotherm Coefficient		
RESIDH2O	Residual Water Content	LEACHCON	Leachate Concentration		
RESIDH2O	Residual Water Content	INFILRAT	Infiltration Rate		
RESIDH2O	Residual Water Content	SATHYCON	Saturated Hydraulic Conductivity		
RESIDH2O	Residual Water Content	MOISTRPA	Moisture Rention Parameter (a)		
RESIDH2O	Residual Water Content	MOISTRPB	Moisture Rention Parameter (b)		
RESIDH2O	Residual Water Content	RESIDH2O	Residual Water Content		
SATURH2O	Saturated Water Content	LONHYCON	Longitundinal Hydraulic Conductivity		
SATURH2O	Saturated Water Content	HYDGRAD	Hydraulic Gradient		
SATURH2O	Saturated Water Content	LONDISPA	Longitudinal Dispersivity		
SATURH2O	Saturated Water Content	FRORGCAR	Fraction Organic Carbon		
SATURH2O	Saturated Water Content	ANGLEW	Angle of Well Off Plume Centerline		
SATURH2O	Saturated Water Content	XDIST	Longitudinal Distance to Well		
SATURH2O	Saturated Water Content	YDIST	Distance from Plume Centerline to Well		
SATURH2O	Saturated Water Content	ZDIST	Depth of Well Below Water Table		

Table E-9. Summary of Crosspairs Analysis for Antimony

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
SATURH2O	Saturated Water Content	FRCOEFA	Freundlich Isotherm Coefficient		
SATURH2O	Saturated Water Content	LEACHCON	Leachate Concentration		
SATURH2O	Saturated Water Content	INFILRAT	Infiltration Rate		
SATURH2O	Saturated Water Content	SATHYCON	Saturated Hydraulic Conductivity		
SATURH2O	Saturated Water Content	MOISTRPA	Moisture Rention Parameter (a)		
SATURH2O	Saturated Water Content	MOISTRPB	Moisture Rention Parameter (b)		
SATURH2O	Saturated Water Content	RESIDH2O	Residual Water Content		
SATURH2O	Saturated Water Content	SATURH2O	Saturated Water Content		
UNSATHIK	Unsaturated Zone Thickness	LONHYCON	Longitundinal Hydraulic Conductivity		
UNSATHIK	Unsaturated Zone Thickness	HYDGRAD	Hydraulic Gradient		
UNSATHIK	Unsaturated Zone Thickness	LONDISPA	Longitudinal Dispersivity		
UNSATHIK	Unsaturated Zone Thickness	FRORGCAR	Fraction Organic Carbon		
UNSATHIK	Unsaturated Zone Thickness	ANGLEW	Angle of Well Off Plume Centerline		
UNSATHIK	Unsaturated Zone Thickness	XDIST	Longitudinal Distance to Well		
UNSATHIK	Unsaturated Zone Thickness	YDIST	Distance from Plume Centerline to Well		
UNSATHIK	Unsaturated Zone Thickness	ZDIST	Depth of Well Below Water Table		
UNSATHIK	Unsaturated Zone Thickness	FRCOEFA	Freundlich Isotherm Coefficient		
UNSATHIK	Unsaturated Zone Thickness	LEACHCON	Leachate Concentration	Y	
UNSATHIK	Unsaturated Zone Thickness	INFILRAT	Infiltration Rate		
UNSATHIK	Unsaturated Zone Thickness	SATHYCON	Saturated Hydraulic Conductivity		
UNSATHIK	Unsaturated Zone Thickness	MOISTRPA	Moisture Rention Parameter (a)		
UNSATHIK	Unsaturated Zone Thickness	MOISTRPB	Moisture Rention Parameter (b)		
UNSATHIK	Unsaturated Zone Thickness	RESIDH2O	Residual Water Content		
UNSATHIK	Unsaturated Zone Thickness	SATURH2O	Saturated Water Content		
UNSATHIK	Unsaturated Zone Thickness	UNSATHIK	Unsaturated Zone Thickness		
PERORGM	Percent Organic Matter	LONHYCON	Longitundinal Hydraulic Conductivity		
PERORGM	Percent Organic Matter	HYDGRAD	Hydraulic Gradient		
PERORGM	Percent Organic Matter	LONDISPA	Longitudinal Dispersivity	Y	
PERORGM	Percent Organic Matter	FRORGCAR	Fraction Organic Carbon		
PERORGM	Percent Organic Matter	ANGLEW	Angle of Well Off Plume Centerline		
PERORGM	Percent Organic Matter	XDIST	Longitudinal Distance to Well		
PERORGM	Percent Organic Matter	YDIST	Distance from Plume Centerline to Well	Y	
PERORGM	Percent Organic Matter	ZDIST	Depth of Well Below Water Table		
PERORGM	Percent Organic Matter	FRCOEFA	Freundlich Isotherm Coefficient		
PERORGM	Percent Organic Matter	LEACHCON	Leachate Concentration		
PERORGM	Percent Organic Matter	INFILRAT	Infiltration Rate		
PERORGM	Percent Organic Matter	SATHYCON	Saturated Hydraulic Conductivity		
PERORGM	Percent Organic Matter	MOISTRPA	Moisture Rention Parameter (a)		
PERORGM	Percent Organic Matter	MOISTRPB	Moisture Rention Parameter (b)		
PERORGM	Percent Organic Matter	RESIDH2O	Residual Water Content		
PERORGM	Percent Organic Matter	SATURH2O	Saturated Water Content		
PERORGM	Percent Organic Matter	UNSATHIK	Unsaturated Zone Thickness		
PERORGM	Percent Organic Matter	PERORGM	Percent Organic Matter		
FRCOEFU	Freundlich Isotherm Coefficient	LONHYCON	Longitundinal Hydraulic Conductivity		
FRCOEFU	Freundlich Isotherm Coefficient	HYDGRAD	Hydraulic Gradient		
FRCOEFU	Freundlich Isotherm Coefficient	LONDISPA	Longitudinal Dispersivity		
FRCOEFU	Freundlich Isotherm Coefficient	FRORGCAR	Fraction Organic Carbon		
FRCOEFU	Freundlich Isotherm Coefficient	ANGLEW	Angle of Well Off Plume Centerline		
FRCOEFU	Freundlich Isotherm Coefficient	XDIST	Longitudinal Distance to Well		

Table E-9. Summary of Crosspairs Analysis for Antimony

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
FRCOEFU	Freundlich Isotherm Coefficient	YDIST	Distance from Plume Centerline to Well	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	ZDIST	Depth of Well Below Water Table		
FRCOEFU	Freundlich Isotherm Coefficient	FRCOEFA	Freundlich Isotherm Coefficient	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	LEACHCON	Leachate Concentration	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	INFILRAT	Infiltration Rate	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	SATHYCON	Saturated Hydraulic Conductivity		
FRCOEFU	Freundlich Isotherm Coefficient	MOISTRPA	Moisture Rention Parameter (a)		
FRCOEFU	Freundlich Isotherm Coefficient	MOISTRPB	Moisture Rention Parameter (b)		
FRCOEFU	Freundlich Isotherm Coefficient	RESIDH2O	Residual Water Content		
FRCOEFU	Freundlich Isotherm Coefficient	SATURH2O	Saturated Water Content		
FRCOEFU	Freundlich Isotherm Coefficient	UNSATHIK	Unsaturated Zone Thickness	Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	PERORGM	Percent Organic Matter		
FRCOEFU	Freundlich Isotherm Coefficient	FRCOEFU	Freundlich Isotherm Coefficient	Y	Y

Table E-10. Ranking of Parameters According to Percentage of Risk for Antimony

Variable Description	Reduced Sums of Square	Variable Sums of Square	Variable Degrees of Freedom	% Risk Variation	Mean Square Variable	F VALUE	P VALUE
Distance from Plume Centerline to Well (m)	3207.2	5966.69	56	275953.0%	703.81	306.61	1.42E-01
Leachate Concentration (mg/L)	4249.1	5966.69	56	171764.0%	703.81	190.85	1.42E-01
Longitudinal Hydraulic Conductivity (m/yr)	4778.9	5966.69	56	118774.0%	703.81	148.47	1.42E-01
Hydraulic Gradient (m/m)	4993.0	5966.69	56	97371.0%	703.81	108.19	1.42E-01
Consumption of Drinking Water (ml/kg-day)	5170.5	5966.69	56	79619.0%	703.81	796.19	1.42E-01
Freundlich Isotherm Coefficient {Unsaturated} (cm3/g)	5254.6	5966.69	56	71213.0%	703.81	101.73	1.42E-01
Longitudinal Dispersivity {Aquifer} (m)	5323.1	5966.69	56	64363.0%	703.81	64.36	1.42E-01
Freundlich Isotherm Coefficient {Aquifer} (cm3/g)	5765.8	5966.69	56	20092.0%	703.81	22.32	1.42E-01
Longitudinal Distance to Well (m)	5832.5	5966.69	56	13422.0%	703.81	14.91	1.42E-01
Depth of Well Below Water Table (m)	5926.1	5966.69	56	4057.0%	703.81	10.14	1.42E-01
Infiltration Rate (m/yr)	5931.5	5966.69	56	3517.0%	703.81	8.79	1.42E-01
Unsaturated Zone Thickness (m)	5952.1	5966.69	56	1458.0%	703.81	7.29	1.42E-01
Saturated Hydraulic Conductivity (m/yr)	5963.3	5966.69	56	335.0%	703.81	1.12	1.42E-01
Moisture Retention Parameter a (1/m)	5965.4	5966.69	56	127.0%	703.81	0.64	1.42E-01
Angle of Well Off Plume Centerline (degrees)	5965.6	5966.69	56	104.0%	703.81	0.52	1.42E-01

Constants

Full Model SS	47
Error SS	9
Error DF	0
MS Error	4943

Table E-11. Summary of Parameters Considered in Sensitivity Analysis for Arsenic

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
EXPDURA					
CANSLOPE		C			
ACIDCAT	Acid Catalyzed Hydrolysis Rate Constant	C			
ANGLEW	Angle of Well Off Plume Centerline	anglew		Y	Y
ANISORAT	Anisotropy Ratio	C			
AQUTHIK	Aquifer Thickness	aquthik**-0.2	Y		
AVGPDIAM	Avg. Particle Diameter	C			
BASECAT	Base Catalyzed Hydrolysis Rate Constant	C			
BIODRATA	Biodegradation Rate	C			
BIODRATU	Biodegradation Rate	C			
BULKDENS	Bulk Density	C			
CHEMDRU	Chemical Decay Rate	C			
CHEMDRA	Chemical Decay Rate	C			
CONSH2OA	Consump of drinking water	log(consh2oa)			Y
ZDIST	Depth of Well Below Water Table	log(zdist+50)		Y	Y
DISHYD	Dissolved Hydrolysis Rate	C			
YDIST	Distance from Plume Centerline to Well	log(ydist+30)		Y	Y
DURLEACH	Duration of Leaching Period	log(durleach-193)	Y		
GWAVTIM	Exposure Duration	gwavtim		Y	Y
FRORGCAR	Fraction Organic Carbon	log(frorgcar)		Y	
FRCOEFA	Freundlich Isotherm Coefficient	log(frcoefa+1)		Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	log(frcoefu+0.03)		Y	Y
FREXPA	Freundlich Isotherm Exponent	C			
FREXPU	Freundlich Isotherm Exponent	C			
GWPH	Groundwater pH	gwph	Y		
GWSEEPV	Groundwater Seepage Velocity	log(gwseepv+50)	Y		
GWTEMP	Groundwater Temperature	C			
HYDGRAD	Hydraulic Gradient	log(hydgrad+1)		Y	Y
INFILRAT	Infiltration Rate	infilrat**4		Y	Y
LANDEPTH	Landfill Depth	log(landepth+0.0007)	Y		
LEACHCON	Leachate Concentration	leachcon		Y	Y
LFFRACT	LF Fraction	C			
LONDISPA	Longitudinal Dispersivity	log(londispa+30)		Y	Y

Table E-11. Summary of Parameters Considered in Sensitivity Analysis for Arsenic

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
LONDISPU	Longitudinal Dispersivity	log(londispu+100)	Y		
XDIST	Longitudinal Distance to Well	log(xdist+2500)		Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity	log(lonhycon+1000)		Y	Y
MOISTRPA	Moisture Rention Parameter (a)	log(moistrpa+5)		Y	
MOISTRPB	Moisture Rention Parameter (b)	log(moistrpb+10)		Y	
MOLDIFF	Molecular Diffusion Coefficient	C			
NEUTHYD	Neutral Hydrolysis Rate Constant	C			
ORGCDIS	Organic Carbon Distribution Coefficient	C			
PERORGM	Percent Organic Matter	log(perorgm+0.005)		Y	
POROSITY	Porosity	C			
RADISTW	Radial Distance to Well	log(radistw+2500)	Y		
RECHARAT	Recharge Rate	recharat	Y		
RESIDH2O	Residual Water Content	residh2o		Y	Y
RETCOEF	Retardation Coefficient	log(retcoef+10)	Y		
SATHYCON	Saturated Hydraulic Conductivity	log(sathycon+20)		Y	
SATURH2O	Saturated Water Content	saturh2o		Y	
SOILBDEN	Soil Bulk Density	soilbden	Y		
SORBHYD	Sorbed Hydrolysis Rate	C			
TRANDISP	Transverse Dispersivity	log(trandisp+3)	Y		
UNSATHIK	Unsaturated Zone Thickness	log(unsathik+100)		Y	
VERTDISP	Vertical Dispersivity	log(vertdisp+0.2)	Y		
WASTDENS	Waste Density	wastdens	Y		
WASTEVOL	Waste Volume	wastevol	Y		
WMUAREA	WMU Area	C			
WMULEN	WMU Length	C			
WMUWIDTH	WMU Width	C			

Table E-12. Summary of Correlated Parameters for Arsenic

Variable 1		Variable 2		Correlation Coefficient
Code	**Description**	**Code**	**Description**	
UNSATHIK	Unsaturated Zone Thickness	AQUTHIK	Aquifer Thickness	0.99894
LONHYCON	Longitundinal Hydraulic Conductivi	GWSEEPV	Groundwater Seepage Velocity	0.77486
FRCOEFA	Freundlich Isotherm Coefficient	RETCOEF	Retardation Coefficient	0.99967
LONDISPA	Longitudinal Dispersivity	TRANDISP	Transverse Dispersivity	0.99982
LONDISPA	Longitudinal Dispersivity	VERTDISP	Vertical Dispersivity	0.99998
XDIST	Longitudinal Distance to Well	RADISTW	Radial Distance to Well	0.99301
INFILRAT	Infiltration Rate	RECHARAT	Recharge Rate	0.98606
DURLEACH	Duration of Leaching Period	RECHARAT	Recharge Rate	-0.73983
WASTDENS	Waste Density	LANDEPTH	Landfill Depth	-1
WASTDENS	Waste Density	WASTEVOL	Waste Volume	-1
LEACHCON	Leachate Concentration	WASTDENS	Waste Density	-1
LANDEPTH	Landfill Depth	WASTDENS	Waste Density	-1
WASTEVOL	Waste Volume	WASTDENS	Waste Density	-1
RECHARAT	Recharge Rate	DURLEACH	Duration of Leaching Period	-0.73983
INFILRAT	Infiltration Rate	DURLEACH	Duration of Leaching Period	-0.74997
AQUTHIK	Aquifer Thickness	LONDISPU	Longitudinal Dispersivity	0.99903
UNSATHIK	Unsaturated Zone Thickness	LONDISPU	Longitudinal Dispersivity	0.99999
AVRECWF	Average Receptor Well Concentrati	DRH2OCNA	drinking water well conc	0.99914

Note: Parameters in the variable 2 column were removed from the analysis.

Table E-13. Summary of Crosspairs Analysis for Arsenic

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
LONHYCON	Longitundinal Hydraulic Conductivity			Y	Y
HYDGRAD	Hydraulic Gradient			Y	Y
LONDISPA	Longitudinal Dispersivity			Y	Y
FRORGCAR	Fraction Organic Carbon				
ANGLEW	Angle of Well Off Plume Centerline			Y	
XDIST	Longitudinal Distance to Well			Y	Y
YDIST	Distance from Plume Centerline to Well			Y	Y
ZDIST	Depth of Well Below Water Table			Y	Y
FRCOEFA	Freundlich Isotherm Coefficient			Y	Y
GWAVTIM	Exposure Duration				
LEACHCON	Leachate Concentration			Y	Y
INFILRAT	Infiltration Rate			Y	Y
SATHYCON	Saturated Hydraulic Conductivity				
MOISTRPA	Moisture Rention Parameter (a)				
MOISTRPB	Moisture Rention Parameter (b)				
RESIDH2O	Residual Water Content				
SATURH2O	Saturated Water Content			Y	
UNSATHIK	Unsaturated Zone Thickness				
PERORGM	Percent Organic Matter			Y	
FRCOEFU	Freundlich Isotherm Coefficient			Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity	LONHYCON	Longitundinal Hydraulic Conductivity	Y	
HYDGRAD	Hydraulic Gradient	LONHYCON	Longitundinal Hydraulic Conductivity	Y	
HYDGRAD	Hydraulic Gradient	HYDGRAD	Hydraulic Gradient	Y	
LONDISPA	Longitudinal Dispersivity	LONHYCON	Longitundinal Hydraulic Conductivity	Y	
LONDISPA	Longitudinal Dispersivity	HYDGRAD	Hydraulic Gradient	Y	
LONDISPA	Longitudinal Dispersivity	LONDISPA	Longitudinal Dispersivity	Y	
FRORGCAR	Fraction Organic Carbon	LONHYCON	Longitundinal Hydraulic Conductivity		
FRORGCAR	Fraction Organic Carbon	HYDGRAD	Hydraulic Gradient		
FRORGCAR	Fraction Organic Carbon	LONDISPA	Longitudinal Dispersivity		
FRORGCAR	Fraction Organic Carbon	FRORGCAR	Fraction Organic Carbon		
ANGLEW	Angle of Well Off Plume Centerline	LONHYCON	Longitundinal Hydraulic Conductivity	Y	
ANGLEW	Angle of Well Off Plume Centerline	HYDGRAD	Hydraulic Gradient		
ANGLEW	Angle of Well Off Plume Centerline	LONDISPA	Longitudinal Dispersivity		
ANGLEW	Angle of Well Off Plume Centerline	FRORGCAR	Fraction Organic Carbon		
ANGLEW	Angle of Well Off Plume Centerline	ANGLEW	Angle of Well Off Plume Centerline		
XDIST	Longitudinal Distance to Well	LONHYCON	Longitundinal Hydraulic Conductivity	Y	
XDIST	Longitudinal Distance to Well	HYDGRAD	Hydraulic Gradient	Y	
XDIST	Longitudinal Distance to Well	LONDISPA	Longitudinal Dispersivity	Y	
XDIST	Longitudinal Distance to Well	FRORGCAR	Fraction Organic Carbon		
XDIST	Longitudinal Distance to Well	ANGLEW	Angle of Well Off Plume Centerline		
XDIST	Longitudinal Distance to Well	XDIST	Longitudinal Distance to Well		
YDIST	Distance from Plume Centerline to Well	LONHYCON	Longitundinal Hydraulic Conductivity		
YDIST	Distance from Plume Centerline to Well	HYDGRAD	Hydraulic Gradient	Y	
YDIST	Distance from Plume Centerline to Well	LONDISPA	Longitudinal Dispersivity	Y	
YDIST	Distance from Plume Centerline to Well	FRORGCAR	Fraction Organic Carbon		
YDIST	Distance from Plume Centerline to Well	ANGLEW	Angle of Well Off Plume Centerline		
YDIST	Distance from Plume Centerline to Well	XDIST	Longitudinal Distance to Well	Y	
YDIST	Distance from Plume Centerline to Well	YDIST	Distance from Plume Centerline to Well	Y	
ZDIST	Depth of Well Below Water Table	LONHYCON	Longitundinal Hydraulic Conductivity		

Table E-13. Summary of Crosspairs Analysis for Arsenic

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
ZDIST	Depth of Well Below Water Table	HYDGRAD	Hydraulic Gradient		
ZDIST	Depth of Well Below Water Table	LONDISPA	Longitudinal Dispersivity		
ZDIST	Depth of Well Below Water Table	FRORGCAR	Fraction Organic Carbon		
ZDIST	Depth of Well Below Water Table	ANGLEW	Angle of Well Off Plume Centerline		
ZDIST	Depth of Well Below Water Table	XDIST	Longitudinal Distance to Well		
ZDIST	Depth of Well Below Water Table	YDIST	Distance from Plume Centerline to Well		
ZDIST	Depth of Well Below Water Table	ZDIST	Depth of Well Below Water Table		
FRCOEFA	Freundlich Isotherm Coefficient	LONHYCON	Longitundinal Hydraulic Conductivity	Y	
FRCOEFA	Freundlich Isotherm Coefficient	HYDGRAD	Hydraulic Gradient	Y	
FRCOEFA	Freundlich Isotherm Coefficient	LONDISPA	Longitudinal Dispersivity	Y	
FRCOEFA	Freundlich Isotherm Coefficient	FRORGCAR	Fraction Organic Carbon		
FRCOEFA	Freundlich Isotherm Coefficient	ANGLEW	Angle of Well Off Plume Centerline		
FRCOEFA	Freundlich Isotherm Coefficient	XDIST	Longitudinal Distance to Well	Y	
FRCOEFA	Freundlich Isotherm Coefficient	YDIST	Distance from Plume Centerline to Well	Y	
FRCOEFA	Freundlich Isotherm Coefficient	ZDIST	Depth of Well Below Water Table		
FRCOEFA	Freundlich Isotherm Coefficient	FRCOEFA	Freundlich Isotherm Coefficient	Y	
GWAVTIM	Exposure Duration	LONHYCON	Longitundinal Hydraulic Conductivity		
GWAVTIM	Exposure Duration	HYDGRAD	Hydraulic Gradient		
GWAVTIM	Exposure Duration	LONDISPA	Longitudinal Dispersivity		
GWAVTIM	Exposure Duration	FRORGCAR	Fraction Organic Carbon		
GWAVTIM	Exposure Duration	ANGLEW	Angle of Well Off Plume Centerline		
GWAVTIM	Exposure Duration	XDIST	Longitudinal Distance to Well		
GWAVTIM	Exposure Duration	YDIST	Distance from Plume Centerline to Well		
GWAVTIM	Exposure Duration	ZDIST	Depth of Well Below Water Table		
GWAVTIM	Exposure Duration	FRCOEFA	Freundlich Isotherm Coefficient		
GWAVTIM	Exposure Duration	GWAVTIM	Exposure Duration		
LEACHCON	Leachate Concentration	LONHYCON	Longitundinal Hydraulic Conductivity		
LEACHCON	Leachate Concentration	HYDGRAD	Hydraulic Gradient		
LEACHCON	Leachate Concentration	LONDISPA	Longitudinal Dispersivity		
LEACHCON	Leachate Concentration	FRORGCAR	Fraction Organic Carbon		
LEACHCON	Leachate Concentration	ANGLEW	Angle of Well Off Plume Centerline		
LEACHCON	Leachate Concentration	XDIST	Longitudinal Distance to Well		
LEACHCON	Leachate Concentration	YDIST	Distance from Plume Centerline to Well	Y	
LEACHCON	Leachate Concentration	ZDIST	Depth of Well Below Water Table	Y	
LEACHCON	Leachate Concentration	FRCOEFA	Freundlich Isotherm Coefficient		
LEACHCON	Leachate Concentration	GWAVTIM	Exposure Duration		
LEACHCON	Leachate Concentration	LEACHCON	Leachate Concentration		
INFILRAT	Infiltration Rate	LONHYCON	Longitundinal Hydraulic Conductivity		
INFILRAT	Infiltration Rate	HYDGRAD	Hydraulic Gradient		
INFILRAT	Infiltration Rate	LONDISPA	Longitudinal Dispersivity		
INFILRAT	Infiltration Rate	FRORGCAR	Fraction Organic Carbon		
INFILRAT	Infiltration Rate	ANGLEW	Angle of Well Off Plume Centerline	Y	
INFILRAT	Infiltration Rate	XDIST	Longitudinal Distance to Well		
INFILRAT	Infiltration Rate	YDIST	Distance from Plume Centerline to Well		
INFILRAT	Infiltration Rate	ZDIST	Depth of Well Below Water Table		
INFILRAT	Infiltration Rate	FRCOEFA	Freundlich Isotherm Coefficient		
INFILRAT	Infiltration Rate	GWAVTIM	Exposure Duration		
INFILRAT	Infiltration Rate	LEACHCON	Leachate Concentration		
INFILRAT	Infiltration Rate	INFILRAT	Infiltration Rate		

Table E-13. Summary of Crosspairs Analysis for Arsenic

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
SATHYCON	Saturated Hydraulic Conductivity	LONHYCON	Longitundinal Hydraulic Conductivity		
SATHYCON	Saturated Hydraulic Conductivity	HYDGRAD	Hydraulic Gradient		
SATHYCON	Saturated Hydraulic Conductivity	LONDISPA	Longitudinal Dispersivity		
SATHYCON	Saturated Hydraulic Conductivity	FRORGCAR	Fraction Organic Carbon		
SATHYCON	Saturated Hydraulic Conductivity	ANGLEW	Angle of Well Off Plume Centerline		
SATHYCON	Saturated Hydraulic Conductivity	XDIST	Longitudinal Distance to Well		
SATHYCON	Saturated Hydraulic Conductivity	YDIST	Distance from Plume Centerline to Well		
SATHYCON	Saturated Hydraulic Conductivity	ZDIST	Depth of Well Below Water Table		
SATHYCON	Saturated Hydraulic Conductivity	FRCOEFA	Freundlich Isotherm Coefficient		
SATHYCON	Saturated Hydraulic Conductivity	GWAVTIM	Exposure Duration		
SATHYCON	Saturated Hydraulic Conductivity	LEACHCON	Leachate Concentration		
SATHYCON	Saturated Hydraulic Conductivity	INFILRAT	Infiltration Rate		
SATHYCON	Saturated Hydraulic Conductivity	SATHYCON	Saturated Hydraulic Conductivity		
MOISTRPA	Moisture Rention Parameter (a)	LONHYCON	Longitundinal Hydraulic Conductivity		
MOISTRPA	Moisture Rention Parameter (a)	HYDGRAD	Hydraulic Gradient		
MOISTRPA	Moisture Rention Parameter (a)	LONDISPA	Longitudinal Dispersivity		
MOISTRPA	Moisture Rention Parameter (a)	FRORGCAR	Fraction Organic Carbon		
MOISTRPA	Moisture Rention Parameter (a)	ANGLEW	Angle of Well Off Plume Centerline	Y	
MOISTRPA	Moisture Rention Parameter (a)	XDIST	Longitudinal Distance to Well		
MOISTRPA	Moisture Rention Parameter (a)	YDIST	Distance from Plume Centerline to Well		
MOISTRPA	Moisture Rention Parameter (a)	ZDIST	Depth of Well Below Water Table		
MOISTRPA	Moisture Rention Parameter (a)	FRCOEFA	Freundlich Isotherm Coefficient		
MOISTRPA	Moisture Rention Parameter (a)	GWAVTIM	Exposure Duration		
MOISTRPA	Moisture Rention Parameter (a)	LEACHCON	Leachate Concentration		
MOISTRPA	Moisture Rention Parameter (a)	INFILRAT	Infiltration Rate		
MOISTRPA	Moisture Rention Parameter (a)	SATHYCON	Saturated Hydraulic Conductivity		
MOISTRPA	Moisture Rention Parameter (a)	MOISTRPA	Moisture Rention Parameter (a)		
MOISTRPB	Moisture Rention Parameter (b)	LONHYCON	Longitundinal Hydraulic Conductivity		
MOISTRPB	Moisture Rention Parameter (b)	HYDGRAD	Hydraulic Gradient		
MOISTRPB	Moisture Rention Parameter (b)	LONDISPA	Longitudinal Dispersivity		
MOISTRPB	Moisture Rention Parameter (b)	FRORGCAR	Fraction Organic Carbon		
MOISTRPB	Moisture Rention Parameter (b)	ANGLEW	Angle of Well Off Plume Centerline		
MOISTRPB	Moisture Rention Parameter (b)	XDIST	Longitudinal Distance to Well		
MOISTRPB	Moisture Rention Parameter (b)	YDIST	Distance from Plume Centerline to Well		
MOISTRPB	Moisture Rention Parameter (b)	ZDIST	Depth of Well Below Water Table		
MOISTRPB	Moisture Rention Parameter (b)	FRCOEFA	Freundlich Isotherm Coefficient		
MOISTRPB	Moisture Rention Parameter (b)	GWAVTIM	Exposure Duration		
MOISTRPB	Moisture Rention Parameter (b)	LEACHCON	Leachate Concentration		
MOISTRPB	Moisture Rention Parameter (b)	INFILRAT	Infiltration Rate		
MOISTRPB	Moisture Rention Parameter (b)	SATHYCON	Saturated Hydraulic Conductivity		
MOISTRPB	Moisture Rention Parameter (b)	MOISTRPA	Moisture Rention Parameter (a)		
MOISTRPB	Moisture Rention Parameter (b)	MOISTRPB	Moisture Rention Parameter (b)	Y	
RESIDH2O	Residual Water Content	LONHYCON	Longitundinal Hydraulic Conductivity		
RESIDH2O	Residual Water Content	HYDGRAD	Hydraulic Gradient		
RESIDH2O	Residual Water Content	LONDISPA	Longitudinal Dispersivity		
RESIDH2O	Residual Water Content	FRORGCAR	Fraction Organic Carbon		
RESIDH2O	Residual Water Content	ANGLEW	Angle of Well Off Plume Centerline		
RESIDH2O	Residual Water Content	XDIST	Longitudinal Distance to Well		
RESIDH2O	Residual Water Content	YDIST	Distance from Plume Centerline to Well		

Table E-13. Summary of Crosspairs Analysis for Arsenic

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
RESIDH2O	Residual Water Content	ZDIST	Depth of Well Below Water Table		
RESIDH2O	Residual Water Content	FRCOEFA	Freundlich Isotherm Coefficient		
RESIDH2O	Residual Water Content	GWAVTIM	Exposure Duration		
RESIDH2O	Residual Water Content	LEACHCON	Leachate Concentration		
RESIDH2O	Residual Water Content	INFILRAT	Infiltration Rate		
RESIDH2O	Residual Water Content	SATHYCON	Saturated Hydraulic Conductivity	Y	
RESIDH2O	Residual Water Content	MOISTRPA	Moisture Rention Parameter (a)		
RESIDH2O	Residual Water Content	MOISTRPB	Moisture Rention Parameter (b)		
RESIDH2O	Residual Water Content	RESIDH2O	Residual Water Content		
SATURH2O	Saturated Water Content	LONHYCON	Longitundinal Hydraulic Conductivity		
SATURH2O	Saturated Water Content	HYDGRAD	Hydraulic Gradient		
SATURH2O	Saturated Water Content	LONDISPA	Longitudinal Dispersivity	Y	
SATURH2O	Saturated Water Content	FRORGCAR	Fraction Organic Carbon	Y	
SATURH2O	Saturated Water Content	ANGLEW	Angle of Well Off Plume Centerline		
SATURH2O	Saturated Water Content	XDIST	Longitudinal Distance to Well		
SATURH2O	Saturated Water Content	YDIST	Distance from Plume Centerline to Well	Y	
SATURH2O	Saturated Water Content	ZDIST	Depth of Well Below Water Table		
SATURH2O	Saturated Water Content	FRCOEFA	Freundlich Isotherm Coefficient		
SATURH2O	Saturated Water Content	GWAVTIM	Exposure Duration		
SATURH2O	Saturated Water Content	LEACHCON	Leachate Concentration		
SATURH2O	Saturated Water Content	INFILRAT	Infiltration Rate		
SATURH2O	Saturated Water Content	SATHYCON	Saturated Hydraulic Conductivity		
SATURH2O	Saturated Water Content	MOISTRPA	Moisture Rention Parameter (a)	Y	
SATURH2O	Saturated Water Content	MOISTRPB	Moisture Rention Parameter (b)	Y	
SATURH2O	Saturated Water Content	RESIDH2O	Residual Water Content		
SATURH2O	Saturated Water Content	SATURH2O	Saturated Water Content		
UNSATHIK	Unsaturated Zone Thickness	LONHYCON	Longitundinal Hydraulic Conductivity		
UNSATHIK	Unsaturated Zone Thickness	HYDGRAD	Hydraulic Gradient		
UNSATHIK	Unsaturated Zone Thickness	LONDISPA	Longitudinal Dispersivity		
UNSATHIK	Unsaturated Zone Thickness	FRORGCAR	Fraction Organic Carbon		
UNSATHIK	Unsaturated Zone Thickness	ANGLEW	Angle of Well Off Plume Centerline		
UNSATHIK	Unsaturated Zone Thickness	XDIST	Longitudinal Distance to Well		
UNSATHIK	Unsaturated Zone Thickness	YDIST	Distance from Plume Centerline to Well		
UNSATHIK	Unsaturated Zone Thickness	ZDIST	Depth of Well Below Water Table		
UNSATHIK	Unsaturated Zone Thickness	FRCOEFA	Freundlich Isotherm Coefficient		
UNSATHIK	Unsaturated Zone Thickness	GWAVTIM	Exposure Duration		
UNSATHIK	Unsaturated Zone Thickness	LEACHCON	Leachate Concentration		
UNSATHIK	Unsaturated Zone Thickness	INFILRAT	Infiltration Rate		
UNSATHIK	Unsaturated Zone Thickness	SATHYCON	Saturated Hydraulic Conductivity	Y	
UNSATHIK	Unsaturated Zone Thickness	MOISTRPA	Moisture Rention Parameter (a)		
UNSATHIK	Unsaturated Zone Thickness	MOISTRPB	Moisture Rention Parameter (b)		
UNSATHIK	Unsaturated Zone Thickness	RESIDH2O	Residual Water Content		
UNSATHIK	Unsaturated Zone Thickness	SATURH2O	Saturated Water Content		
UNSATHIK	Unsaturated Zone Thickness	UNSATHIK	Unsaturated Zone Thickness		
PERORGM	Percent Organic Matter	LONHYCON	Longitundinal Hydraulic Conductivity		
PERORGM	Percent Organic Matter	HYDGRAD	Hydraulic Gradient		
PERORGM	Percent Organic Matter	LONDISPA	Longitudinal Dispersivity		
PERORGM	Percent Organic Matter	FRORGCAR	Fraction Organic Carbon		
PERORGM	Percent Organic Matter	ANGLEW	Angle of Well Off Plume Centerline		

Table E-13. Summary of Crosspairs Analysis for Arsenic

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
PERORGM	Percent Organic Matter	XDIST	Longitudinal Distance to Well	Y	
PERORGM	Percent Organic Matter	YDIST	Distance from Plume Centerline to Well		
PERORGM	Percent Organic Matter	ZDIST	Depth of Well Below Water Table		
PERORGM	Percent Organic Matter	FRCOEFA	Freundlich Isotherm Coefficient		
PERORGM	Percent Organic Matter	GWAVTIM	Exposure Duration		
PERORGM	Percent Organic Matter	LEACHCON	Leachate Concentration		
PERORGM	Percent Organic Matter	INFILRAT	Infiltration Rate		
PERORGM	Percent Organic Matter	SATHYCON	Saturated Hydraulic Conductivity		
PERORGM	Percent Organic Matter	MOISTRPA	Moisture Rention Parameter (a)		
PERORGM	Percent Organic Matter	MOISTRPB	Moisture Rention Parameter (b)		
PERORGM	Percent Organic Matter	RESIDH2O	Residual Water Content		
PERORGM	Percent Organic Matter	SATURH2O	Saturated Water Content		
PERORGM	Percent Organic Matter	UNSATHIK	Unsaturated Zone Thickness		
PERORGM	Percent Organic Matter	PERORGM	Percent Organic Matter		
FRCOEFU	Freundlich Isotherm Coefficient	LONHYCON	Longitundinal Hydraulic Conductivity	Y	
FRCOEFU	Freundlich Isotherm Coefficient	HYDGRAD	Hydraulic Gradient		
FRCOEFU	Freundlich Isotherm Coefficient	LONDISPA	Longitudinal Dispersivity		
FRCOEFU	Freundlich Isotherm Coefficient	FRORGCAR	Fraction Organic Carbon		
FRCOEFU	Freundlich Isotherm Coefficient	ANGLEW	Angle of Well Off Plume Centerline		
FRCOEFU	Freundlich Isotherm Coefficient	XDIST	Longitudinal Distance to Well		
FRCOEFU	Freundlich Isotherm Coefficient	YDIST	Distance from Plume Centerline to Well		
FRCOEFU	Freundlich Isotherm Coefficient	ZDIST	Depth of Well Below Water Table		
FRCOEFU	Freundlich Isotherm Coefficient	FRCOEFA	Freundlich Isotherm Coefficient	Y	
FRCOEFU	Freundlich Isotherm Coefficient	GWAVTIM	Exposure Duration	Y	
FRCOEFU	Freundlich Isotherm Coefficient	LEACHCON	Leachate Concentration		
FRCOEFU	Freundlich Isotherm Coefficient	INFILRAT	Infiltration Rate	Y	
FRCOEFU	Freundlich Isotherm Coefficient	SATHYCON	Saturated Hydraulic Conductivity		
FRCOEFU	Freundlich Isotherm Coefficient	MOISTRPA	Moisture Rention Parameter (a)		
FRCOEFU	Freundlich Isotherm Coefficient	MOISTRPB	Moisture Rention Parameter (b)		
FRCOEFU	Freundlich Isotherm Coefficient	RESIDH2O	Residual Water Content	Y	
FRCOEFU	Freundlich Isotherm Coefficient	SATURH2O	Saturated Water Content		
FRCOEFU	Freundlich Isotherm Coefficient	UNSATHIK	Unsaturated Zone Thickness		
FRCOEFU	Freundlich Isotherm Coefficient	PERORGM	Percent Organic Matter		
FRCOEFU	Freundlich Isotherm Coefficient	FRCOEFU	Freundlich Isotherm Coefficient	Y	

Table E-14. Ranking of Parameters According to Percentage of Risk for Arsenic

Variable Description	Reduced Sums of Square	Variable Sums of Square	Variable Degrees of Freedom	% Risk Variation	Mean Square Variable	F VALUE	P VALUE
Freundlich Isotherm Coefficient {Aquifer} (cm3/g)	67752.6	309616.86	39	24186421.0%	57381.37	30233.03	1.16E+01
Freundlich Isotherm Coefficient {Unsaturated} (cm3/g)	272267.4	309616.86	39	3734944.0%	57381.37	7469.89	1.16E+01
Longitudinal Hydraulic Conductivity (m/yr)	283190.3	309616.86	39	2642657.0%	57381.37	3775.22	1.16E+01
Hydraulic Gradient (m/m)	291682.7	309616.86	39	1793418.0%	57381.37	2562.03	1.16E+01
Longitudinal Distance to Well (m)	293358.9	309616.86	39	1625800.0%	57381.37	2709.67	1.16E+01
Distance from Plume Centerline to Well (m)	294636.5	309616.86	39	1498035.0%	57381.37	2496.72	1.16E+01
Longitudinal Dispersivity {Aquifer} (m)	298410.1	309616.86	39	1120675.0%	57381.37	1600.96	1.16E+01
Exposure Duration (yr)	307585.1	309616.86	39	203172.0%	57381.37	2031.72	1.16E+01
Consumption of Drinking Water (ml/kg-day)	307982.5	309616.86	39	163440.0%	57381.37	1634.40	1.16E+01
Infiltration Rate (m/yr)	309447.0	309616.86	39	16981.0%	57381.37	169.81	1.16E+01
Groundwater Averaging Time (yr)	309456.4	309616.86	39	16042.0%	57381.37	80.21	1.16E+01
Leachate Concentration (mg/l)	309466.8	309616.86	39	15007.0%	57381.37	150.07	1.16E+01
Residual Water Content	309478.2	309616.86	39	13869.0%	57381.37	69.34	1.16E+01
Angle of Well Off Plume Centerline (degrees)	309508.2	309616.86	39	10862.0%	57381.37	54.31	1.16E+01
Depth of Well Below Water Table (m)	309514.1	309616.86	39	10280.0%	57381.37	102.80	1.16E+01

Constants

Full Model SS	31
Error SS	8
Error DF	1
MS Error	4960

Table E-15. Summary of Parameters Considered in Sensitivity Analysis for Boron

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
OBS					
ACIDCAT	Acid Catalyzed Hydrolysis Rate Constant	C			
ANGLEW	Angle of Well Off Plume Centerline	anglew			
ANISORAT	Anisotropy Ratio	C			
AQUTHIK	Aquifer Thickness	aquthik**-0.8	Y		
AVGPDIAM	Avg. Particle Diameter	C			
BASECAT	Base Catalyzed Hydrolysis Rate Constant	C			
BIODRATA	Biodegradation Rate	C			
BIODRATU	Biodegradation Rate	C			
BULKDENS	Bulk Density	C			
CHEMDRA	Chemical Decay Rate	C			
CHEMDRU	Chemical Decay Rate	C			
CONSH2OA	Consump of drinking water	log(consh2oa)			Y
ZDIST	Depth of Well Below Water Table	log(zdist+40)		Y	Y
DISHYD	Dissolved Hydrolysis Rate	C			
YDIST	Distance from Plume Centerline to Well	log(ydist+10)		Y	Y
DURLEACH	Duration of Leaching Period	durleach**0.5	Y		
GWAVTIM	Exposure Duration	C			
FRORGCAR	Fraction Organic Carbon	log(frorgcar)			
FRCOEFA	Freundlich Isotherm Coefficient	log(frcoefa+1)		Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	log(frcoefu+1)		Y	Y
FREXPA	Freundlich Isotherm Exponent	C			
FREXPU	Freundlich Isotherm Exponent	C			
GWPH	Groundwater pH	gwph	Y		
GWSEEPV	Groundwater Seepage Velocity	log(gwseepv+20)	Y		
GWTEMP	Groundwater Temperature	C			
HYDGRAD	Hydraulic Gradient	log(hydgrad+0.01)		Y	Y
INFILRAT	Infiltration Rate	infilrat**4		Y	Y
LANDEPTH	Landfill Depth	log(landepth+0.0007)	Y		
LEACHCON	Leachate Concentration	leachcon		Y	Y
LFFRACT	LF Fraction	C			
LONDISPA	Longitudinal Dispersivity	log(londispa+3)		Y	Y
LONDISPU	Longitudinal Dispersivity	londispu**2.5	Y		

Table E-15. Summary of Parameters Considered in Sensitivity Analysis for Boron

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
XDIST	Longitudinal Distance to Well	log(xdist+700)		Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity	log(lonhycon+500)			
MLLA	ml/L	C			
MOISTRPA	Moisture Rention Parameter (a)	log(moistrpa+7)		Y	
MOISTRPB	Moisture Rention Parameter (b)	log(moistrpb+20)			
MOLDIFF	Molecular Diffusion Coefficient	C			
NEUTHYD	Neutral Hydrolysis Rate Constant	C			
ORGCDIS	Organic Carbon Distribution Coefficient	C			
PERORGM	Percent Organic Matter	log(perorgm+0.005)			
POROSITY	Porosity	C			
RADISTW	Radial Distance to Well	log(radistw+350)	Y		
RECHARAT	Recharge Rate	recharat	Y		
RESIDH2O	Residual Water Content	residh2o**1.4		Y	
RETCOEF	Retardation Coefficient	log(retcoef+5)	Y		
RFDA	RfD (mg/kg/day)	C			
SATHYCON	Saturated Hydraulic Conductivity	log(sathycon+20)			
SATURH2O	Saturated Water Content	saturh2o		Y	
SOILBDEN	Soil Bulk Density	soilbden	Y		
SORBHYD	Sorbed Hydrolysis Rate	C			
TRANDISP	Transverse Dispersivity	log(trandisp+0.3)	Y		
UNSATHIK	Unsaturated Zone Thickness	unsathik**2.5		Y	Y
VERTDISP	Vertical Dispersivity	log(vertdisp+0.01)	Y		
WASTDENS	Waste Density	wastdens	Y		
WASTEVOL	Waste Volume	wastevol	Y		
WMUAREA	WMU Area	C			
WMULEN	WMU Length	C			
WMUWIDTH	WMU Width	C			

Table E-16. Summary of Correlated Parameters for Boron

Variable 1		Variable 2		Correlation Coefficient
Code	**Description**	**Code**	**Description**	
UNSATHIK	Unsaturated Zone Thickness	AQUTHIK	Aquifer Thickness	0.99936
LONHYCON	Longitundinal Hydraulic Conductivi	GWSEEPV	Groundwater Seepage Velocity	0.70455
FRCOEFA	Freundlich Isotherm Coefficient	RETCOEF	Retardation Coefficient	0.9998
LONDISPA	Longitudinal Dispersivity	TRANDISP	Transverse Dispersivity	0.99988
LONDISPA	Longitudinal Dispersivity	VERTDISP	Vertical Dispersivity	0.99935
XDIST	Longitudinal Distance to Well	RADISTW	Radial Distance to Well	0.99822
INFILRAT	Infiltration Rate	RECHARAT	Recharge Rate	0.98653
LEACHCON	Leachate Concentration	LANDEPTH	Landfill Depth	-1
WASTDENS	Waste Density	LANDEPTH	Landfill Depth	-1
LEACHCON	Leachate Concentration	WASTEVOL	Waste Volume	-1
WASTDENS	Waste Density	WASTEVOL	Waste Volume	-1
DURLEACH	Duration of Leaching Period	WASTEVOL	Waste Volume	0.986
LANDEPTH	Landfill Depth	WASTDENS	Waste Density	-1
WASTEVOL	Waste Volume	WASTDENS	Waste Density	-1
DURLEACH	Duration of Leaching Period	WASTDENS	Waste Density	-0.986
LEACHCON	Leachate Concentration	DURLEACH	Duration of Leaching Period	-0.986
LANDEPTH	Landfill Depth	DURLEACH	Duration of Leaching Period	0.986
WASTEVOL	Waste Volume	DURLEACH	Duration of Leaching Period	0.986
WASTDENS	Waste Density	DURLEACH	Duration of Leaching Period	-0.986
AQUTHIK	Aquifer Thickness	LONDISPU	Longitudinal Dispersivity	0.99939
UNSATHIK	Unsaturated Zone Thickness	LONDISPU	Longitudinal Dispersivity	0.99999

Note: Parameters in the variable 2 column were removed from the analysis.

Table E-17. Summary of Crosspairs Analysis for Boron

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
				Y	Y
HYDGRAD	Hydraulic Gradient			Y	Y
LONDISPA	Longitudinal Dispersivity			Y	Y
FRORGCAR	Fraction Organic Carbon				
ANGLEW	Angle of Well Off Plume Centerline				
XDIST	Longitudinal Distance to Well			Y	Y
YDIST	Distance from Plume Centerline to Well			Y	Y
ZDIST	Depth of Well Below Water Table			Y	Y
FRCOEFA	Freundlich Isotherm Coefficient			Y	Y
LEACHCON	Leachate Concentration			Y	Y
INFILRAT	Infiltration Rate			Y	Y
SATHYCON	Saturated Hydraulic Conductivity				
MOISTRPA	Moisture Rention Parameter (a)				
MOISTRPB	Moisture Rention Parameter (b)				
RESIDH2O	Residual Water Content				
SATURH2O	Saturated Water Content				
UNSATHIK	Unsaturated Zone Thickness			Y	Y
PERORGM	Percent Organic Matter				
FRCOEFU	Freundlich Isotherm Coefficient			Y	Y
				Y	
HYDGRAD	Hydraulic Gradient			Y	
HYDGRAD	Hydraulic Gradient	HYDGRAD	Hydraulic Gradient	Y	
LONDISPA	Longitudinal Dispersivity			Y	
LONDISPA	Longitudinal Dispersivity	HYDGRAD	Hydraulic Gradient	Y	
LONDISPA	Longitudinal Dispersivity	LONDISPA	Longitudinal Dispersivity	Y	
FRORGCAR	Fraction Organic Carbon				
FRORGCAR	Fraction Organic Carbon	HYDGRAD	Hydraulic Gradient		
FRORGCAR	Fraction Organic Carbon	LONDISPA	Longitudinal Dispersivity		
FRORGCAR	Fraction Organic Carbon	FRORGCAR	Fraction Organic Carbon		
ANGLEW	Angle of Well Off Plume Centerline				
ANGLEW	Angle of Well Off Plume Centerline	HYDGRAD	Hydraulic Gradient		
ANGLEW	Angle of Well Off Plume Centerline	LONDISPA	Longitudinal Dispersivity		
ANGLEW	Angle of Well Off Plume Centerline	FRORGCAR	Fraction Organic Carbon		
ANGLEW	Angle of Well Off Plume Centerline	ANGLEW	Angle of Well Off Plume Centerline		
XDIST	Longitudinal Distance to Well			Y	
XDIST	Longitudinal Distance to Well	HYDGRAD	Hydraulic Gradient	Y	
XDIST	Longitudinal Distance to Well	LONDISPA	Longitudinal Dispersivity	Y	
XDIST	Longitudinal Distance to Well	FRORGCAR	Fraction Organic Carbon		
XDIST	Longitudinal Distance to Well	ANGLEW	Angle of Well Off Plume Centerline		
XDIST	Longitudinal Distance to Well	XDIST	Longitudinal Distance to Well	Y	
YDIST	Distance from Plume Centerline to Well			Y	
YDIST	Distance from Plume Centerline to Well	HYDGRAD	Hydraulic Gradient	Y	
YDIST	Distance from Plume Centerline to Well	LONDISPA	Longitudinal Dispersivity	Y	
YDIST	Distance from Plume Centerline to Well	FRORGCAR	Fraction Organic Carbon		
YDIST	Distance from Plume Centerline to Well	ANGLEW	Angle of Well Off Plume Centerline		
YDIST	Distance from Plume Centerline to Well	XDIST	Longitudinal Distance to Well	Y	
YDIST	Distance from Plume Centerline to Well	YDIST	Distance from Plume Centerline to Well	Y	
ZDIST	Depth of Well Below Water Table			Y	
ZDIST	Depth of Well Below Water Table	HYDGRAD	Hydraulic Gradient	Y	

Table E-17. Summary of Crosspairs Analysis for Boron

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
ZDIST	Depth of Well Below Water Table	LONDISPA	Longitudinal Dispersivity	Y	
ZDIST	Depth of Well Below Water Table	FRORGCAR	Fraction Organic Carbon		
ZDIST	Depth of Well Below Water Table	ANGLEW	Angle of Well Off Plume Centerline		
ZDIST	Depth of Well Below Water Table	XDIST	Longitudinal Distance to Well	Y	
ZDIST	Depth of Well Below Water Table	YDIST	Distance from Plume Centerline to Well		
ZDIST	Depth of Well Below Water Table	ZDIST	Depth of Well Below Water Table	Y	
FRCOEFA	Freundlich Isotherm Coefficient			Y	
FRCOEFA	Freundlich Isotherm Coefficient	HYDGRAD	Hydraulic Gradient	Y	
FRCOEFA	Freundlich Isotherm Coefficient	LONDISPA	Longitudinal Dispersivity		
FRCOEFA	Freundlich Isotherm Coefficient	FRORGCAR	Fraction Organic Carbon		
FRCOEFA	Freundlich Isotherm Coefficient	ANGLEW	Angle of Well Off Plume Centerline		
FRCOEFA	Freundlich Isotherm Coefficient	XDIST	Longitudinal Distance to Well		
FRCOEFA	Freundlich Isotherm Coefficient	YDIST	Distance from Plume Centerline to Well		
FRCOEFA	Freundlich Isotherm Coefficient	ZDIST	Depth of Well Below Water Table		
FRCOEFA	Freundlich Isotherm Coefficient	FRCOEFA	Freundlich Isotherm Coefficient		
LEACHCON	Leachate Concentration				
LEACHCON	Leachate Concentration	HYDGRAD	Hydraulic Gradient		
LEACHCON	Leachate Concentration	LONDISPA	Longitudinal Dispersivity	Y	
LEACHCON	Leachate Concentration	FRORGCAR	Fraction Organic Carbon		
LEACHCON	Leachate Concentration	ANGLEW	Angle of Well Off Plume Centerline		
LEACHCON	Leachate Concentration	XDIST	Longitudinal Distance to Well		
LEACHCON	Leachate Concentration	YDIST	Distance from Plume Centerline to Well	Y	
LEACHCON	Leachate Concentration	ZDIST	Depth of Well Below Water Table		
LEACHCON	Leachate Concentration	FRCOEFA	Freundlich Isotherm Coefficient		
LEACHCON	Leachate Concentration	LEACHCON	Leachate Concentration		
INFILRAT	Infiltration Rate				
INFILRAT	Infiltration Rate	HYDGRAD	Hydraulic Gradient		
INFILRAT	Infiltration Rate	LONDISPA	Longitudinal Dispersivity		
INFILRAT	Infiltration Rate	FRORGCAR	Fraction Organic Carbon		
INFILRAT	Infiltration Rate	ANGLEW	Angle of Well Off Plume Centerline		
INFILRAT	Infiltration Rate	XDIST	Longitudinal Distance to Well		
INFILRAT	Infiltration Rate	YDIST	Distance from Plume Centerline to Well		
INFILRAT	Infiltration Rate	ZDIST	Depth of Well Below Water Table		
INFILRAT	Infiltration Rate	FRCOEFA	Freundlich Isotherm Coefficient		
INFILRAT	Infiltration Rate	LEACHCON	Leachate Concentration	Y	
INFILRAT	Infiltration Rate	INFILRAT	Infiltration Rate	Y	
SATHYCON	Saturated Hydraulic Conductivity				
SATHYCON	Saturated Hydraulic Conductivity	HYDGRAD	Hydraulic Gradient		
SATHYCON	Saturated Hydraulic Conductivity	LONDISPA	Longitudinal Dispersivity		
SATHYCON	Saturated Hydraulic Conductivity	FRORGCAR	Fraction Organic Carbon		
SATHYCON	Saturated Hydraulic Conductivity	ANGLEW	Angle of Well Off Plume Centerline		
SATHYCON	Saturated Hydraulic Conductivity	XDIST	Longitudinal Distance to Well		
SATHYCON	Saturated Hydraulic Conductivity	YDIST	Distance from Plume Centerline to Well		
SATHYCON	Saturated Hydraulic Conductivity	ZDIST	Depth of Well Below Water Table		
SATHYCON	Saturated Hydraulic Conductivity	FRCOEFA	Freundlich Isotherm Coefficient		
SATHYCON	Saturated Hydraulic Conductivity	LEACHCON	Leachate Concentration		
SATHYCON	Saturated Hydraulic Conductivity	INFILRAT	Infiltration Rate		
SATHYCON	Saturated Hydraulic Conductivity	SATHYCON	Saturated Hydraulic Conductivity		
MOISTRPA	Moisture Rention Parameter (a)				

Table E-17. Summary of Crosspairs Analysis for Boron

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
MOISTRPA	Moisture Rention Parameter (a)	HYDGRAD	Hydraulic Gradient		
MOISTRPA	Moisture Rention Parameter (a)	LONDISPA	Longitudinal Dispersivity		
MOISTRPA	Moisture Rention Parameter (a)	FRORGCAR	Fraction Organic Carbon		
MOISTRPA	Moisture Rention Parameter (a)	ANGLEW	Angle of Well Off Plume Centerline		
MOISTRPA	Moisture Rention Parameter (a)	XDIST	Longitudinal Distance to Well		
MOISTRPA	Moisture Rention Parameter (a)	YDIST	Distance from Plume Centerline to Well		
MOISTRPA	Moisture Rention Parameter (a)	ZDIST	Depth of Well Below Water Table		
MOISTRPA	Moisture Rention Parameter (a)	FRCOEFA	Freundlich Isotherm Coefficient	Y	
MOISTRPA	Moisture Rention Parameter (a)	LEACHCON	Leachate Concentration		
MOISTRPA	Moisture Rention Parameter (a)	INFILRAT	Infiltration Rate		
MOISTRPA	Moisture Rention Parameter (a)	SATHYCON	Saturated Hydraulic Conductivity		
MOISTRPA	Moisture Rention Parameter (a)	MOISTRPA	Moisture Rention Parameter (a)		
MOISTRPB	Moisture Rention Parameter (b)				
MOISTRPB	Moisture Rention Parameter (b)	HYDGRAD	Hydraulic Gradient		
MOISTRPB	Moisture Rention Parameter (b)	LONDISPA	Longitudinal Dispersivity		
MOISTRPB	Moisture Rention Parameter (b)	FRORGCAR	Fraction Organic Carbon		
MOISTRPB	Moisture Rention Parameter (b)	ANGLEW	Angle of Well Off Plume Centerline		
MOISTRPB	Moisture Rention Parameter (b)	XDIST	Longitudinal Distance to Well		
MOISTRPB	Moisture Rention Parameter (b)	YDIST	Distance from Plume Centerline to Well		
MOISTRPB	Moisture Rention Parameter (b)	ZDIST	Depth of Well Below Water Table		
MOISTRPB	Moisture Rention Parameter (b)	FRCOEFA	Freundlich Isotherm Coefficient		
MOISTRPB	Moisture Rention Parameter (b)	LEACHCON	Leachate Concentration		
MOISTRPB	Moisture Rention Parameter (b)	INFILRAT	Infiltration Rate		
MOISTRPB	Moisture Rention Parameter (b)	SATHYCON	Saturated Hydraulic Conductivity		
MOISTRPB	Moisture Rention Parameter (b)	MOISTRPA	Moisture Rention Parameter (a)		
MOISTRPB	Moisture Rention Parameter (b)	MOISTRPB	Moisture Rention Parameter (b)		
RESIDH2O	Residual Water Content				
RESIDH2O	Residual Water Content	HYDGRAD	Hydraulic Gradient	Y	
RESIDH2O	Residual Water Content	LONDISPA	Longitudinal Dispersivity		
RESIDH2O	Residual Water Content	FRORGCAR	Fraction Organic Carbon		
RESIDH2O	Residual Water Content	ANGLEW	Angle of Well Off Plume Centerline		
RESIDH2O	Residual Water Content	XDIST	Longitudinal Distance to Well		
RESIDH2O	Residual Water Content	YDIST	Distance from Plume Centerline to Well		
RESIDH2O	Residual Water Content	ZDIST	Depth of Well Below Water Table		
RESIDH2O	Residual Water Content	FRCOEFA	Freundlich Isotherm Coefficient		
RESIDH2O	Residual Water Content	LEACHCON	Leachate Concentration		
RESIDH2O	Residual Water Content	INFILRAT	Infiltration Rate		
RESIDH2O	Residual Water Content	SATHYCON	Saturated Hydraulic Conductivity		
RESIDH2O	Residual Water Content	MOISTRPA	Moisture Rention Parameter (a)		
RESIDH2O	Residual Water Content	MOISTRPB	Moisture Rention Parameter (b)		
RESIDH2O	Residual Water Content	RESIDH2O	Residual Water Content		
SATURH2O	Saturated Water Content				
SATURH2O	Saturated Water Content	HYDGRAD	Hydraulic Gradient		
SATURH2O	Saturated Water Content	LONDISPA	Longitudinal Dispersivity		
SATURH2O	Saturated Water Content	FRORGCAR	Fraction Organic Carbon		
SATURH2O	Saturated Water Content	ANGLEW	Angle of Well Off Plume Centerline		
SATURH2O	Saturated Water Content	XDIST	Longitudinal Distance to Well		
SATURH2O	Saturated Water Content	YDIST	Distance from Plume Centerline to Well		
SATURH2O	Saturated Water Content	ZDIST	Depth of Well Below Water Table		

Table E-17. Summary of Crosspairs Analysis for Boron

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
SATURH2O	Saturated Water Content	FRCOEFA	Freundlich Isotherm Coefficient		
SATURH2O	Saturated Water Content	LEACHCON	Leachate Concentration		
SATURH2O	Saturated Water Content	INFILRAT	Infiltration Rate		
SATURH2O	Saturated Water Content	SATHYCON	Saturated Hydraulic Conductivity		
SATURH2O	Saturated Water Content	MOISTRPA	Moisture Rention Parameter (a)		
SATURH2O	Saturated Water Content	MOISTRPB	Moisture Rention Parameter (b)		
SATURH2O	Saturated Water Content	RESIDH2O	Residual Water Content	Y	
SATURH2O	Saturated Water Content	SATURH2O	Saturated Water Content		
UNSATHIK	Unsaturated Zone Thickness				
UNSATHIK	Unsaturated Zone Thickness	HYDGRAD	Hydraulic Gradient		
UNSATHIK	Unsaturated Zone Thickness	LONDISPA	Longitudinal Dispersivity	Y	
UNSATHIK	Unsaturated Zone Thickness	FRORGCAR	Fraction Organic Carbon		
UNSATHIK	Unsaturated Zone Thickness	ANGLEW	Angle of Well Off Plume Centerline		
UNSATHIK	Unsaturated Zone Thickness	XDIST	Longitudinal Distance to Well		
UNSATHIK	Unsaturated Zone Thickness	YDIST	Distance from Plume Centerline to Well	Y	
UNSATHIK	Unsaturated Zone Thickness	ZDIST	Depth of Well Below Water Table		
UNSATHIK	Unsaturated Zone Thickness	FRCOEFA	Freundlich Isotherm Coefficient		
UNSATHIK	Unsaturated Zone Thickness	LEACHCON	Leachate Concentration	Y	
UNSATHIK	Unsaturated Zone Thickness	INFILRAT	Infiltration Rate		
UNSATHIK	Unsaturated Zone Thickness	SATHYCON	Saturated Hydraulic Conductivity		
UNSATHIK	Unsaturated Zone Thickness	MOISTRPA	Moisture Rention Parameter (a)		
UNSATHIK	Unsaturated Zone Thickness	MOISTRPB	Moisture Rention Parameter (b)		
UNSATHIK	Unsaturated Zone Thickness	RESIDH2O	Residual Water Content		
UNSATHIK	Unsaturated Zone Thickness	SATURH2O	Saturated Water Content		
UNSATHIK	Unsaturated Zone Thickness	UNSATHIK	Unsaturated Zone Thickness		
PERORGM	Percent Organic Matter				
PERORGM	Percent Organic Matter	HYDGRAD	Hydraulic Gradient		
PERORGM	Percent Organic Matter	LONDISPA	Longitudinal Dispersivity		
PERORGM	Percent Organic Matter	FRORGCAR	Fraction Organic Carbon		
PERORGM	Percent Organic Matter	ANGLEW	Angle of Well Off Plume Centerline		
PERORGM	Percent Organic Matter	XDIST	Longitudinal Distance to Well		
PERORGM	Percent Organic Matter	YDIST	Distance from Plume Centerline to Well		
PERORGM	Percent Organic Matter	ZDIST	Depth of Well Below Water Table		
PERORGM	Percent Organic Matter	FRCOEFA	Freundlich Isotherm Coefficient		
PERORGM	Percent Organic Matter	LEACHCON	Leachate Concentration		
PERORGM	Percent Organic Matter	INFILRAT	Infiltration Rate		
PERORGM	Percent Organic Matter	SATHYCON	Saturated Hydraulic Conductivity		
PERORGM	Percent Organic Matter	MOISTRPA	Moisture Rention Parameter (a)		
PERORGM	Percent Organic Matter	MOISTRPB	Moisture Rention Parameter (b)		
PERORGM	Percent Organic Matter	RESIDH2O	Residual Water Content		
PERORGM	Percent Organic Matter	SATURH2O	Saturated Water Content		
PERORGM	Percent Organic Matter	UNSATHIK	Unsaturated Zone Thickness		
PERORGM	Percent Organic Matter	PERORGM	Percent Organic Matter		
FRCOEFU	Freundlich Isotherm Coefficient				
FRCOEFU	Freundlich Isotherm Coefficient	HYDGRAD	Hydraulic Gradient		
FRCOEFU	Freundlich Isotherm Coefficient	LONDISPA	Longitudinal Dispersivity	Y	
FRCOEFU	Freundlich Isotherm Coefficient	FRORGCAR	Fraction Organic Carbon		
FRCOEFU	Freundlich Isotherm Coefficient	ANGLEW	Angle of Well Off Plume Centerline		
FRCOEFU	Freundlich Isotherm Coefficient	XDIST	Longitudinal Distance to Well		

Table E-17. Summary of Crosspairs Analysis for Boron

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
FRCOEFU	Freundlich Isotherm Coefficient	YDIST	Distance from Plume Centerline to Well	Y	
FRCOEFU	Freundlich Isotherm Coefficient	ZDIST	Depth of Well Below Water Table		
FRCOEFU	Freundlich Isotherm Coefficient	FRCOEFA	Freundlich Isotherm Coefficient	Y	
FRCOEFU	Freundlich Isotherm Coefficient	LEACHCON	Leachate Concentration	Y	
FRCOEFU	Freundlich Isotherm Coefficient	INFILRAT	Infiltration Rate	Y	
FRCOEFU	Freundlich Isotherm Coefficient	SATHYCON	Saturated Hydraulic Conductivity		
FRCOEFU	Freundlich Isotherm Coefficient	MOISTRPA	Moisture Rention Parameter (a)		
FRCOEFU	Freundlich Isotherm Coefficient	MOISTRPB	Moisture Rention Parameter (b)		
FRCOEFU	Freundlich Isotherm Coefficient	RESIDH2O	Residual Water Content		
FRCOEFU	Freundlich Isotherm Coefficient	SATURH2O	Saturated Water Content		
FRCOEFU	Freundlich Isotherm Coefficient	UNSATHIK	Unsaturated Zone Thickness		
FRCOEFU	Freundlich Isotherm Coefficient	PERORGM	Percent Organic Matter		
FRCOEFU	Freundlich Isotherm Coefficient	FRCOEFU	Freundlich Isotherm Coefficient	Y	

Table E-18. Ranking of Parameters According to Percentage of Risk for Boron

Variable Description	Reduced Sums of Square	Variable Sums of Square	Variable Degrees of Freedom	% Risk Variation	Mean Square Variable	F VALUE	P VALUE
Distance from Plume Centerline to Well (m)	2208.9	4105.47	45	189661.0%	502.44	210.73	1.01E-01
Longitudinal Hydraulic Conductivity (m/yr)	3059.4	4105.47	45	104602.0%	502.44	130.75	1.01E-01
Hydraulic Gradient (m/m)	3236.8	4105.47	45	86872.0%	502.44	108.59	1.01E-01
Consumption of Drinking Water (ml/kg-day)	3370.7	4105.47	45	73481.0%	502.44	734.81	1.01E-01
Longitudinal Dispersivity {Aquifer} (m)	3442.9	4105.47	45	66260.0%	502.44	73.62	1.01E-01
Leachate Concentration (mg/l)	3830.2	4105.47	45	27528.0%	502.44	45.88	1.01E-01
Longitudinal Distance to Well (m)	3974.2	4105.47	45	13132.0%	502.44	18.76	1.01E-01
Freundlich Isotherm Coefficient {Unsaturated} (cm3/g)	4043.1	4105.47	45	6241.0%	502.44	12.48	1.01E-01
Depth of Well Below Water Table (m)	4074.2	4105.47	45	3132.0%	502.44	5.22	1.01E-01
Infiltration Rate (m/yr)	4088.0	4105.47	45	1747.0%	502.44	4.37	1.01E-01
Freundlich Isotherm Coefficient {Aquifer} (cm3/g)	4096.8	4105.47	45	864.0%	502.44	2.88	1.01E-01
Unsaturated Zone Thickness (m)	4098.2	4105.47	45	731.0%	502.44	1.83	1.01E-01

Constants

Full Model SS	36
Error SS	9
Error DF	0
MS Error	4954

Table E-19. Summary of Parameters Considered in Sensitivity Analysis for Selenium

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
OBS					
ACIDCAT	Acid Catalyzed Hydrolysis Rate Constant	C			
ANGLEW	Angle of Well Off Plume Centerline	anglew			
ANISORAT	Anisotropy Ratio	C			
AQUTHIK	Aquifer Thickness	aquthik**-0.8	Y		
AVGPDIAM	Avg. Particle Diameter	C			
BASECAT	Base Catalyzed Hydrolysis Rate Constant	C			
BIODRATA	Biodegradation Rate	C			
BIODRATU	Biodegradation Rate	C			
BULKDENS	Bulk Density	C			
CHEMDRA	Chemical Decay Rate	C			
CHEMDRU	Chemical Decay Rate	C			
CONSH2OA	Consump of drinking water	log(consh2oa)			
ZDIST	Depth of Well Below Water Table	log(zdist+40)		Y	Y
DISHYD	Dissolved Hydrolysis Rate	C			
YDIST	Distance from Plume Centerline to Well	log(ydist+10)		Y	Y
DURLEACH	Duration of Leaching Period	durleach**0.5	Y		
GWAVTIM	Exposure Duration	C			
FRORGCAR	Fraction Organic Carbon	log(frorgcar)		Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	log(frcoefa+70)		Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	log(frcoefu+60)		Y	Y
FREXPA	Freundlich Isotherm Exponent	C			
FREXPU	Freundlich Isotherm Exponent	C			
GWPH	Groundwater pH	gwph	Y		
GWSEEPV	Groundwater Seepage Velocity	log(gwseepv+20)	Y		
GWTEMP	Groundwater Temperature	C			
HYDGRAD	Hydraulic Gradient	log(hydgrad+0.01)		Y	Y
INFILRAT	Infiltration Rate	infilrat**4		Y	Y
LANDEPTH	Landfill Depth	log(landepth+0.0007)	Y		
LEACHCON	Leachate Concentration	leachcon		Y	Y
LFFRACT	LF Fraction	C			
LONDISPA	Longitudinal Dispersivity	log(londispa+3)		Y	Y
LONDISPU	Longitudinal Dispersivity	londispu**1.5	Y		

Table E-19. Summary of Parameters Considered in Sensitivity Analysis for Selenium

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
XDIST	Longitudinal Distance to Well	log(xdist+700)		Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity	log(lonhycon)		Y	Y
MLLA	ml/L	C			
MOISTRPA	Moisture Rention Parameter (a)	log(moistrpa+5)		Y	
MOISTRPB	Moisture Rention Parameter (b)	log(moistrpb+20)		Y	
MOLDIFF	Molecular Diffusion Coefficient	C			
NEUTHYD	Neutral Hydrolysis Rate Constant	C			
ORGCDIS	Organic Carbon Distribution Coefficient	C			
PERORGM	Percent Organic Matter	log(perorgm+0.003)		Y	Y
POROSITY	Porosity	C			
RADISTW	Radial Distance to Well	log(radistw+350)	Y		
RECHARAT	Recharge Rate	recharat	Y		
RESIDH2O	Residual Water Content	residh2o**1.4		Y	
RETCOEF	Retardation Coefficient	log(retcoef+500)	Y		
RFDA	RfD (mg/kg/day)	C			
SATHYCON	Saturated Hydraulic Conductivity	log(sathycon+20)		Y	Y
SATURH2O	Saturated Water Content	saturh2o		Y	
SOILBDEN	Soil Bulk Density	soilbden	Y		
SORBHYD	Sorbed Hydrolysis Rate	C			
TRANDISP	Transverse Dispersivity	log(trandisp+0.3)	Y		
UNSATHIK	Unsaturated Zone Thickness	unsathik**1.5		Y	Y
VERTDISP	Vertical Dispersivity	log(vertdisp+0.01)	Y		
WASTDENS	Waste Density	wastdens	Y		
WASTEVOL	Waste Volume	wastevol	Y		
WMUAREA	WMU Area	C			
WMULEN	WMU Length	C			
WMUWIDTH	WMU Width	C			

Table E-20. Summary of Correlated Parameters for Selenium

Variable 1		Variable 2		Correlation Coefficient
Code	**Description**	**Code**	**Description**	
UNSATHIK	Unsaturated Zone Thickness	AQUTHIK	Aquifer Thickness	0.99914
LONHYCON	Longitundinal Hydraulic Conductivi	GWSEEPV	Groundwater Seepage Velocity	0.71241
LONDISPA	Longitudinal Dispersivity	TRANDISP	Transverse Dispersivity	0.99988
LONDISPA	Longitudinal Dispersivity	VERTDISP	Vertical Dispersivity	0.99932
XDIST	Longitudinal Distance to Well	RADISTW	Radial Distance to Well	0.99829
INFILRAT	Infiltration Rate	RECHARAT	Recharge Rate	0.98657
LEACHCON	Leachate Concentration	LANDEPTH	Landfill Depth	-1
WASTDENS	Waste Density	LANDEPTH	Landfill Depth	-1
LEACHCON	Leachate Concentration	WASTEVOL	Waste Volume	-1
WASTDENS	Waste Density	WASTEVOL	Waste Volume	-1
DURLEACH	Duration of Leaching Period	WASTEVOL	Waste Volume	0.9882
LANDEPTH	Landfill Depth	WASTDENS	Waste Density	-1
WASTEVOL	Waste Volume	WASTDENS	Waste Density	-1
DURLEACH	Duration of Leaching Period	WASTDENS	Waste Density	-0.9882
LEACHCON	Leachate Concentration	DURLEACH	Duration of Leaching Period	-0.9882
LANDEPTH	Landfill Depth	DURLEACH	Duration of Leaching Period	0.9882
WASTEVOL	Waste Volume	DURLEACH	Duration of Leaching Period	0.9882
WASTDENS	Waste Density	DURLEACH	Duration of Leaching Period	-0.9882
AQUTHIK	Aquifer Thickness	LONDISPU	Longitudinal Dispersivity	0.9991

Note: Parameters in the variable 2 column were removed from the analysis.

Table E-21. Summary of Crosspairs Analysis for Selenium

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
LONHYCON	Longitundinal Hydraulic Conductivity			Y	Y
HYDGRAD	Hydraulic Gradient			Y	Y
LONDISPA	Longitudinal Dispersivity			Y	Y
FRORGCAR	Fraction Organic Carbon			Y	
ANGLEW	Angle of Well Off Plume Centerline				
XDIST	Longitudinal Distance to Well			Y	Y
YDIST	Distance from Plume Centerline to Well			Y	Y
ZDIST	Depth of Well Below Water Table			Y	Y
FRCOEFA	Freundlich Isotherm Coefficient			Y	Y
LEACHCON	Leachate Concentration			Y	Y
INFILRAT	Infiltration Rate			Y	Y
SATHYCON	Saturated Hydraulic Conductivity				
MOISTRPA	Moisture Rention Parameter (a)				
MOISTRPB	Moisture Rention Parameter (b)				
RESIDH2O	Residual Water Content				
SATURH2O	Saturated Water Content				
UNSATHIK	Unsaturated Zone Thickness				
PERORGM	Percent Organic Matter				
FRCOEFU	Freundlich Isotherm Coefficient			Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity	LONHYCON	Longitundinal Hydraulic Conductivity	Y	
HYDGRAD	Hydraulic Gradient	LONHYCON	Longitundinal Hydraulic Conductivity	Y	
HYDGRAD	Hydraulic Gradient	HYDGRAD	Hydraulic Gradient	Y	
LONDISPA	Longitudinal Dispersivity	LONHYCON	Longitundinal Hydraulic Conductivity	Y	
LONDISPA	Longitudinal Dispersivity	HYDGRAD	Hydraulic Gradient	Y	
LONDISPA	Longitudinal Dispersivity	LONDISPA	Longitudinal Dispersivity	Y	
FRORGCAR	Fraction Organic Carbon	LONHYCON	Longitundinal Hydraulic Conductivity	Y	
FRORGCAR	Fraction Organic Carbon	HYDGRAD	Hydraulic Gradient		
FRORGCAR	Fraction Organic Carbon	LONDISPA	Longitudinal Dispersivity	Y	
FRORGCAR	Fraction Organic Carbon	FRORGCAR	Fraction Organic Carbon		
ANGLEW	Angle of Well Off Plume Centerline	LONHYCON	Longitundinal Hydraulic Conductivity		
ANGLEW	Angle of Well Off Plume Centerline	HYDGRAD	Hydraulic Gradient		
ANGLEW	Angle of Well Off Plume Centerline	LONDISPA	Longitudinal Dispersivity		
ANGLEW	Angle of Well Off Plume Centerline	FRORGCAR	Fraction Organic Carbon		
ANGLEW	Angle of Well Off Plume Centerline	ANGLEW	Angle of Well Off Plume Centerline		
XDIST	Longitudinal Distance to Well	LONHYCON	Longitundinal Hydraulic Conductivity	Y	
XDIST	Longitudinal Distance to Well	HYDGRAD	Hydraulic Gradient	Y	
XDIST	Longitudinal Distance to Well	LONDISPA	Longitudinal Dispersivity	Y	
XDIST	Longitudinal Distance to Well	FRORGCAR	Fraction Organic Carbon		
XDIST	Longitudinal Distance to Well	ANGLEW	Angle of Well Off Plume Centerline		
XDIST	Longitudinal Distance to Well	XDIST	Longitudinal Distance to Well	Y	
YDIST	Distance from Plume Centerline to Well	LONHYCON	Longitundinal Hydraulic Conductivity	Y	
YDIST	Distance from Plume Centerline to Well	HYDGRAD	Hydraulic Gradient	Y	
YDIST	Distance from Plume Centerline to Well	LONDISPA	Longitudinal Dispersivity	Y	
YDIST	Distance from Plume Centerline to Well	FRORGCAR	Fraction Organic Carbon		
YDIST	Distance from Plume Centerline to Well	ANGLEW	Angle of Well Off Plume Centerline		
YDIST	Distance from Plume Centerline to Well	XDIST	Longitudinal Distance to Well	Y	
YDIST	Distance from Plume Centerline to Well	YDIST	Distance from Plume Centerline to Well	Y	
ZDIST	Depth of Well Below Water Table	LONHYCON	Longitundinal Hydraulic Conductivity	Y	
ZDIST	Depth of Well Below Water Table	HYDGRAD	Hydraulic Gradient	Y	

Table E-21. Summary of Crosspairs Analysis for Selenium

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
ZDIST	Depth of Well Below Water Table	LONDISPA	Longitudinal Dispersivity	Y	
ZDIST	Depth of Well Below Water Table	FRORGCAR	Fraction Organic Carbon		
ZDIST	Depth of Well Below Water Table	ANGLEW	Angle of Well Off Plume Centerline		
ZDIST	Depth of Well Below Water Table	XDIST	Longitudinal Distance to Well	Y	
ZDIST	Depth of Well Below Water Table	YDIST	Distance from Plume Centerline to Well		
ZDIST	Depth of Well Below Water Table	ZDIST	Depth of Well Below Water Table	Y	
FRCOEFA	Freundlich Isotherm Coefficient	LONHYCON	Longitundinal Hydraulic Conductivity	Y	
FRCOEFA	Freundlich Isotherm Coefficient	HYDGRAD	Hydraulic Gradient	Y	
FRCOEFA	Freundlich Isotherm Coefficient	LONDISPA	Longitudinal Dispersivity	Y	
FRCOEFA	Freundlich Isotherm Coefficient	FRORGCAR	Fraction Organic Carbon		
FRCOEFA	Freundlich Isotherm Coefficient	ANGLEW	Angle of Well Off Plume Centerline		
FRCOEFA	Freundlich Isotherm Coefficient	XDIST	Longitudinal Distance to Well	Y	
FRCOEFA	Freundlich Isotherm Coefficient	YDIST	Distance from Plume Centerline to Well		
FRCOEFA	Freundlich Isotherm Coefficient	ZDIST	Depth of Well Below Water Table		
FRCOEFA	Freundlich Isotherm Coefficient	FRCOEFA	Freundlich Isotherm Coefficient		
LEACHCON	Leachate Concentration	LONHYCON	Longitundinal Hydraulic Conductivity	Y	
LEACHCON	Leachate Concentration	HYDGRAD	Hydraulic Gradient	Y	
LEACHCON	Leachate Concentration	LONDISPA	Longitudinal Dispersivity	Y	
LEACHCON	Leachate Concentration	FRORGCAR	Fraction Organic Carbon		
LEACHCON	Leachate Concentration	ANGLEW	Angle of Well Off Plume Centerline		
LEACHCON	Leachate Concentration	XDIST	Longitudinal Distance to Well	Y	
LEACHCON	Leachate Concentration	YDIST	Distance from Plume Centerline to Well	Y	
LEACHCON	Leachate Concentration	ZDIST	Depth of Well Below Water Table		
LEACHCON	Leachate Concentration	FRCOEFA	Freundlich Isotherm Coefficient	Y	
LEACHCON	Leachate Concentration	LEACHCON	Leachate Concentration		
INFILRAT	Infiltration Rate	LONHYCON	Longitundinal Hydraulic Conductivity	Y	
INFILRAT	Infiltration Rate	HYDGRAD	Hydraulic Gradient	Y	
INFILRAT	Infiltration Rate	LONDISPA	Longitudinal Dispersivity		
INFILRAT	Infiltration Rate	FRORGCAR	Fraction Organic Carbon		
INFILRAT	Infiltration Rate	ANGLEW	Angle of Well Off Plume Centerline		
INFILRAT	Infiltration Rate	XDIST	Longitudinal Distance to Well		
INFILRAT	Infiltration Rate	YDIST	Distance from Plume Centerline to Well	Y	
INFILRAT	Infiltration Rate	ZDIST	Depth of Well Below Water Table		
INFILRAT	Infiltration Rate	FRCOEFA	Freundlich Isotherm Coefficient		
INFILRAT	Infiltration Rate	LEACHCON	Leachate Concentration		
INFILRAT	Infiltration Rate	INFILRAT	Infiltration Rate	Y	
SATHYCON	Saturated Hydraulic Conductivity	LONHYCON	Longitundinal Hydraulic Conductivity		
SATHYCON	Saturated Hydraulic Conductivity	HYDGRAD	Hydraulic Gradient		
SATHYCON	Saturated Hydraulic Conductivity	LONDISPA	Longitudinal Dispersivity	Y	
SATHYCON	Saturated Hydraulic Conductivity	FRORGCAR	Fraction Organic Carbon		
SATHYCON	Saturated Hydraulic Conductivity	ANGLEW	Angle of Well Off Plume Centerline		
SATHYCON	Saturated Hydraulic Conductivity	XDIST	Longitudinal Distance to Well		
SATHYCON	Saturated Hydraulic Conductivity	YDIST	Distance from Plume Centerline to Well	Y	
SATHYCON	Saturated Hydraulic Conductivity	ZDIST	Depth of Well Below Water Table		
SATHYCON	Saturated Hydraulic Conductivity	FRCOEFA	Freundlich Isotherm Coefficient		
SATHYCON	Saturated Hydraulic Conductivity	LEACHCON	Leachate Concentration		
SATHYCON	Saturated Hydraulic Conductivity	INFILRAT	Infiltration Rate		
SATHYCON	Saturated Hydraulic Conductivity	SATHYCON	Saturated Hydraulic Conductivity	Y	
MOISTRPA	Moisture Rention Parameter (a)	LONHYCON	Longitundinal Hydraulic Conductivity		

Table E-21. Summary of Crosspairs Analysis for Selenium

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
MOISTRPA	Moisture Rention Parameter (a)	HYDGRAD	Hydraulic Gradient		
MOISTRPA	Moisture Rention Parameter (a)	LONDISPA	Longitudinal Dispersivity		
MOISTRPA	Moisture Rention Parameter (a)	FRORGCAR	Fraction Organic Carbon		
MOISTRPA	Moisture Rention Parameter (a)	ANGLEW	Angle of Well Off Plume Centerline		
MOISTRPA	Moisture Rention Parameter (a)	XDIST	Longitudinal Distance to Well		
MOISTRPA	Moisture Rention Parameter (a)	YDIST	Distance from Plume Centerline to Well		
MOISTRPA	Moisture Rention Parameter (a)	ZDIST	Depth of Well Below Water Table		
MOISTRPA	Moisture Rention Parameter (a)	FRCOEFA	Freundlich Isotherm Coefficient	Y	
MOISTRPA	Moisture Rention Parameter (a)	LEACHCON	Leachate Concentration		
MOISTRPA	Moisture Rention Parameter (a)	INFILRAT	Infiltration Rate		
MOISTRPA	Moisture Rention Parameter (a)	SATHYCON	Saturated Hydraulic Conductivity		
MOISTRPA	Moisture Rention Parameter (a)	MOISTRPA	Moisture Rention Parameter (a)		
MOISTRPB	Moisture Rention Parameter (b)	LONHYCON	Longitundinal Hydraulic Conductivity		
MOISTRPB	Moisture Rention Parameter (b)	HYDGRAD	Hydraulic Gradient		
MOISTRPB	Moisture Rention Parameter (b)	LONDISPA	Longitudinal Dispersivity		
MOISTRPB	Moisture Rention Parameter (b)	FRORGCAR	Fraction Organic Carbon		
MOISTRPB	Moisture Rention Parameter (b)	ANGLEW	Angle of Well Off Plume Centerline		
MOISTRPB	Moisture Rention Parameter (b)	XDIST	Longitudinal Distance to Well		
MOISTRPB	Moisture Rention Parameter (b)	YDIST	Distance from Plume Centerline to Well		
MOISTRPB	Moisture Rention Parameter (b)	ZDIST	Depth of Well Below Water Table		
MOISTRPB	Moisture Rention Parameter (b)	FRCOEFA	Freundlich Isotherm Coefficient		
MOISTRPB	Moisture Rention Parameter (b)	LEACHCON	Leachate Concentration		
MOISTRPB	Moisture Rention Parameter (b)	INFILRAT	Infiltration Rate		
MOISTRPB	Moisture Rention Parameter (b)	SATHYCON	Saturated Hydraulic Conductivity		
MOISTRPB	Moisture Rention Parameter (b)	MOISTRPA	Moisture Rention Parameter (a)		
MOISTRPB	Moisture Rention Parameter (b)	MOISTRPB	Moisture Rention Parameter (b)	Y	
RESIDH2O	Residual Water Content	LONHYCON	Longitundinal Hydraulic Conductivity		
RESIDH2O	Residual Water Content	HYDGRAD	Hydraulic Gradient	Y	
RESIDH2O	Residual Water Content	LONDISPA	Longitudinal Dispersivity		
RESIDH2O	Residual Water Content	FRORGCAR	Fraction Organic Carbon		
RESIDH2O	Residual Water Content	ANGLEW	Angle of Well Off Plume Centerline		
RESIDH2O	Residual Water Content	XDIST	Longitudinal Distance to Well		
RESIDH2O	Residual Water Content	YDIST	Distance from Plume Centerline to Well		
RESIDH2O	Residual Water Content	ZDIST	Depth of Well Below Water Table		
RESIDH2O	Residual Water Content	FRCOEFA	Freundlich Isotherm Coefficient		
RESIDH2O	Residual Water Content	LEACHCON	Leachate Concentration		
RESIDH2O	Residual Water Content	INFILRAT	Infiltration Rate		
RESIDH2O	Residual Water Content	SATHYCON	Saturated Hydraulic Conductivity		
RESIDH2O	Residual Water Content	MOISTRPA	Moisture Rention Parameter (a)		
RESIDH2O	Residual Water Content	MOISTRPB	Moisture Rention Parameter (b)		
RESIDH2O	Residual Water Content	RESIDH2O	Residual Water Content		
SATURH2O	Saturated Water Content	LONHYCON	Longitundinal Hydraulic Conductivity		
SATURH2O	Saturated Water Content	HYDGRAD	Hydraulic Gradient		
SATURH2O	Saturated Water Content	LONDISPA	Longitudinal Dispersivity		
SATURH2O	Saturated Water Content	FRORGCAR	Fraction Organic Carbon		
SATURH2O	Saturated Water Content	ANGLEW	Angle of Well Off Plume Centerline		
SATURH2O	Saturated Water Content	XDIST	Longitudinal Distance to Well		
SATURH2O	Saturated Water Content	YDIST	Distance from Plume Centerline to Well		
SATURH2O	Saturated Water Content	ZDIST	Depth of Well Below Water Table		

Table E-21. Summary of Crosspairs Analysis for Selenium

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
SATURH2O	Saturated Water Content	FRCOEFA	Freundlich Isotherm Coefficient		
SATURH2O	Saturated Water Content	LEACHCON	Leachate Concentration		
SATURH2O	Saturated Water Content	INFILRAT	Infiltration Rate		
SATURH2O	Saturated Water Content	SATHYCON	Saturated Hydraulic Conductivity		
SATURH2O	Saturated Water Content	MOISTRPA	Moisture Rention Parameter (a)		
SATURH2O	Saturated Water Content	MOISTRPB	Moisture Rention Parameter (b)		
SATURH2O	Saturated Water Content	RESIDH2O	Residual Water Content	Y	
SATURH2O	Saturated Water Content	SATURH2O	Saturated Water Content		
UNSATHIK	Unsaturated Zone Thickness	LONHYCON	Longitundinal Hydraulic Conductivity		
UNSATHIK	Unsaturated Zone Thickness	HYDGRAD	Hydraulic Gradient		
UNSATHIK	Unsaturated Zone Thickness	LONDISPA	Longitudinal Dispersivity	Y	
UNSATHIK	Unsaturated Zone Thickness	FRORGCAR	Fraction Organic Carbon		
UNSATHIK	Unsaturated Zone Thickness	ANGLEW	Angle of Well Off Plume Centerline		
UNSATHIK	Unsaturated Zone Thickness	XDIST	Longitudinal Distance to Well		
UNSATHIK	Unsaturated Zone Thickness	YDIST	Distance from Plume Centerline to Well	Y	
UNSATHIK	Unsaturated Zone Thickness	ZDIST	Depth of Well Below Water Table		
UNSATHIK	Unsaturated Zone Thickness	FRCOEFA	Freundlich Isotherm Coefficient		
UNSATHIK	Unsaturated Zone Thickness	LEACHCON	Leachate Concentration		
UNSATHIK	Unsaturated Zone Thickness	INFILRAT	Infiltration Rate		
UNSATHIK	Unsaturated Zone Thickness	SATHYCON	Saturated Hydraulic Conductivity		
UNSATHIK	Unsaturated Zone Thickness	MOISTRPA	Moisture Rention Parameter (a)		
UNSATHIK	Unsaturated Zone Thickness	MOISTRPB	Moisture Rention Parameter (b)		
UNSATHIK	Unsaturated Zone Thickness	RESIDH2O	Residual Water Content		
UNSATHIK	Unsaturated Zone Thickness	SATURH2O	Saturated Water Content		
UNSATHIK	Unsaturated Zone Thickness	UNSATHIK	Unsaturated Zone Thickness		
PERORGM	Percent Organic Matter	LONHYCON	Longitundinal Hydraulic Conductivity		
PERORGM	Percent Organic Matter	HYDGRAD	Hydraulic Gradient		
PERORGM	Percent Organic Matter	LONDISPA	Longitudinal Dispersivity	Y	
PERORGM	Percent Organic Matter	FRORGCAR	Fraction Organic Carbon		
PERORGM	Percent Organic Matter	ANGLEW	Angle of Well Off Plume Centerline		
PERORGM	Percent Organic Matter	XDIST	Longitudinal Distance to Well		
PERORGM	Percent Organic Matter	YDIST	Distance from Plume Centerline to Well		
PERORGM	Percent Organic Matter	ZDIST	Depth of Well Below Water Table		
PERORGM	Percent Organic Matter	FRCOEFA	Freundlich Isotherm Coefficient		
PERORGM	Percent Organic Matter	LEACHCON	Leachate Concentration		
PERORGM	Percent Organic Matter	INFILRAT	Infiltration Rate		
PERORGM	Percent Organic Matter	SATHYCON	Saturated Hydraulic Conductivity		
PERORGM	Percent Organic Matter	MOISTRPA	Moisture Rention Parameter (a)	Y	
PERORGM	Percent Organic Matter	MOISTRPB	Moisture Rention Parameter (b)		
PERORGM	Percent Organic Matter	RESIDH2O	Residual Water Content		
PERORGM	Percent Organic Matter	SATURH2O	Saturated Water Content		
PERORGM	Percent Organic Matter	UNSATHIK	Unsaturated Zone Thickness		
PERORGM	Percent Organic Matter	PERORGM	Percent Organic Matter		
FRCOEFU	Freundlich Isotherm Coefficient	LONHYCON	Longitundinal Hydraulic Conductivity	Y	
FRCOEFU	Freundlich Isotherm Coefficient	HYDGRAD	Hydraulic Gradient	Y	
FRCOEFU	Freundlich Isotherm Coefficient	LONDISPA	Longitudinal Dispersivity		
FRCOEFU	Freundlich Isotherm Coefficient	FRORGCAR	Fraction Organic Carbon	Y	
FRCOEFU	Freundlich Isotherm Coefficient	ANGLEW	Angle of Well Off Plume Centerline		
FRCOEFU	Freundlich Isotherm Coefficient	XDIST	Longitudinal Distance to Well	Y	

Table E-21. Summary of Crosspairs Analysis for Selenium

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
FRCOEFU	Freundlich Isotherm Coefficient	YDIST	Distance from Plume Centerline to Well		
FRCOEFU	Freundlich Isotherm Coefficient	ZDIST	Depth of Well Below Water Table		
FRCOEFU	Freundlich Isotherm Coefficient	FRCOEFA	Freundlich Isotherm Coefficient	Y	
FRCOEFU	Freundlich Isotherm Coefficient	LEACHCON	Leachate Concentration	Y	
FRCOEFU	Freundlich Isotherm Coefficient	INFILRAT	Infiltration Rate		
FRCOEFU	Freundlich Isotherm Coefficient	SATHYCON	Saturated Hydraulic Conductivity		
FRCOEFU	Freundlich Isotherm Coefficient	MOISTRPA	Moisture Rention Parameter (a)		
FRCOEFU	Freundlich Isotherm Coefficient	MOISTRPB	Moisture Rention Parameter (b)		
FRCOEFU	Freundlich Isotherm Coefficient	RESIDH2O	Residual Water Content		
FRCOEFU	Freundlich Isotherm Coefficient	SATURH2O	Saturated Water Content		
FRCOEFU	Freundlich Isotherm Coefficient	UNSATHIK	Unsaturated Zone Thickness	Y	
FRCOEFU	Freundlich Isotherm Coefficient	PERORGM	Percent Organic Matter		
FRCOEFU	Freundlich Isotherm Coefficient	FRCOEFU	Freundlich Isotherm Coefficient	Y	

Table E-22. Ranking of Parameters According to Percentage of Risk for Selenium

Variable Description	Reduced Sums of Square	Variable Sums of Square	Variable Degrees of Freedom	% Risk Variation	Mean Square Variable	F VALUE	P VALUE
Distance from Plume Centerline to Well (m)	2310.5	4310.94	59	200043.0%	532.93	222.27	1.08E-01
Longitudinal Hydraulic Conductivity (m/yr)	3486.2	4310.94	59	82474.0%	532.93	74.98	1.08E-01
Consumption of Drinking Water (ml/kg-day)	3562.3	4310.94	59	74866.0%	532.93	748.66	1.08E-01
Longitudinal Dispersivity {Aquifer} (m)	3598.8	4310.94	59	71217.0%	532.93	54.78	1.08E-01
Leachate Concentration (mg/l)	3646.4	4310.94	59	66450.0%	532.93	83.06	1.08E-01
Hydraulic Gradient (m/m)	3656.1	4310.94	59	65489.0%	532.93	59.53	1.08E-01
Longitudinal Distance to Well (m)	4122.1	4310.94	59	18879.0%	532.93	18.88	1.08E-01
Freundlich Isotherm Coefficient {Unsaturated} (cm3/g)	4136.4	4310.94	59	17449.0%	532.93	29.08	1.08E-01
Freundlich Isotherm Coefficient {Aquifer} (cm3/g)	4223.1	4310.94	59	8789.0%	532.93	12.56	1.08E-01
Depth of Well Below Water Table (m)	4276.0	4310.94	59	3490.0%	532.93	5.82	1.08E-01
Infiltration Rate (m/yr)	4287.2	4310.94	59	2376.0%	532.93	4.75	1.08E-01
Saturated Hydraulic Conductivity (m/yr)	4308.9	4310.94	59	201.0%	532.93	0.67	1.08E-01
Unsaturated Zone Thickness (m)	4308.9	4310.94	59	199.0%	532.93	1.00	1.08E-01
Fraction Organic Carbon (g/g)	4309.5	4310.94	59	145.0%	532.93	0.72	1.08E-01
Percent Organic Matter	4309.5	4310.94	59	144.0%	532.93	0.72	1.08E-01

Constants

Full Model SS	50
Error SS	9
Error DF	0
MS Error	4940

Table E-23. Summary of Parameters Considered in Sensitivity Analysis for Vanadium

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
OBS					
ACIDCAT	Acid Catalyzed Hydrolysis Rate Constant	C			
ANGLEW	Angle of Well Off Plume Centerline	anglew		Y	Y
ANISORAT	Anisotropy Ratio	C			
AQUTHIK	Aquifer Thickness	aquthik**-0.8	Y		
AVGPDIAM	Avg. Particle Diameter	C			
BASECAT	Base Catalyzed Hydrolysis Rate Constant	C			
BIODRATA	Biodegradation Rate	C			
BIODRATU	Biodegradation Rate	C			
BULKDENS	Bulk Density	C			
CHEMDRA	Chemical Decay Rate	C			
CHEMDRU	Chemical Decay Rate	C			
CONSH2OA	Consump of drinking water	log(consh2oa)			Y
ZDIST	Depth of Well Below Water Table	log(zdist+80)		Y	Y
DISHYD	Dissolved Hydrolysis Rate	C			
YDIST	Distance from Plume Centerline to Well	log(ydist+30)		Y	Y
DURLEACH	Duration of Leaching Period	durleach**0.2	Y		
GWAVTIM	Exposure Duration	C			
FRORGCAR	Fraction Organic Carbon	log(frorgcar-0.000003)		Y	Y
FRCOEFA	Freundlich Isotherm Coefficient	log(frcoefa-4)		Y	Y
FRCOEFU	Freundlich Isotherm Coefficient	log(frcoefu-3.5)		Y	Y
FREXPA	Freundlich Isotherm Exponent	C			
FREXPU	Freundlich Isotherm Exponent	C			
GWPH	Groundwater pH	gwph	Y		
GWSEEPV	Groundwater Seepage Velocity	log(gwseepv+30)	Y		
GWTEMP	Groundwater Temperature	C			
HYDGRAD	Hydraulic Gradient	log(hydgrad+100)		Y	Y
INFILRAT	Infiltration Rate	infilrat**4		Y	Y
LANDEPTH	Landfill Depth	log(landepth+0.0007)	Y		
LEACHCON	Leachate Concentration	leachcon		Y	Y
LFFRACT	LF Fraction	C			
LONDISPA	Longitudinal Dispersivity	log(londispa+30)		Y	Y
LONDISPU	Longitudinal Dispersivity	log(londispu+10)	Y		

Table E-23. Summary of Parameters Considered in Sensitivity Analysis for Vanadium

Parameter Code	Parameter Description	Transformation	Correlated	P<0.05	P<0.01
XDIST	Longitudinal Distance to Well	log(xdist+1500)		Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity	log(lonhycon+5)		Y	Y
MLLA	ml/L	C			
MOISTRPA	Moisture Rention Parameter (a)	log(moistrpa+5)		Y	Y
MOISTRPB	Moisture Rention Parameter (b)	log(moistrpb+10)		Y	
MOLDIFF	Molecular Diffusion Coefficient	C			
NEUTHYD	Neutral Hydrolysis Rate Constant	C			
ORGCDIS	Organic Carbon Distribution Coefficient	C			
PERORGM	Percent Organic Matter	log(perorgm+0.003)		Y	Y
POROSITY	Porosity	C			
RADISTW	Radial Distance to Well	log(radistw+1000)	Y		
RECHARAT	Recharge Rate	recharat	Y		
RESIDH2O	Residual Water Content	residh2o**1.5			
RETCOEF	Retardation Coefficient	log(retcoef-27)	Y		
RFDA	RfD (mg/kg/day)	C			
SATHYCON	Saturated Hydraulic Conductivity	log(sathycon+17)			
SATURH2O	Saturated Water Content	saturh2o			
SOILBDEN	Soil Bulk Density	soilbden	Y		
SORBHYD	Sorbed Hydrolysis Rate	C			
TRANDISP	Transverse Dispersivity	log(trandisp+3)	Y		
UNSATHIK	Unsaturated Zone Thickness	log(unsathik+50)		Y	Y
VERTDISP	Vertical Dispersivity	log(vertdisp+0.2)	Y		
WASTDENS	Waste Density	wastdens	Y		
WASTEVOL	Waste Volume	wastevol	Y		
WMUAREA	WMU Area	C			
WMULEN	WMU Length	C			
WMUWIDTH	WMU Width	C			

Table E-24. Summary of Correlated Parameters for Vanadium

Variable 1		Variable 2		Correlation Coefficient
Code	**Description**	**Code**	**Description**	
UNSATHIK	Unsaturated Zone Thickness	AQUTHIK	Aquifer Thickness	0.99827
LONHYCON	Longitundinal Hydraulic Conductivi	GWSEEPV	Groundwater Seepage Velocity	0.77226
FRCOEFA	Freundlich Isotherm Coefficient	RETCOEF	Retardation Coefficient	0.99988
LONDISPA	Longitudinal Dispersivity	TRANDISP	Transverse Dispersivity	0.99982
LONDISPA	Longitudinal Dispersivity	VERTDISP	Vertical Dispersivity	0.99998
XDIST	Longitudinal Distance to Well	RADISTW	Radial Distance to Well	0.99302
INFILRAT	Infiltration Rate	RECHARAT	Recharge Rate	0.98684
LEACHCON	Leachate Concentration	LANDEPTH	Landfill Depth	-1
WASTDENS	Waste Density	LANDEPTH	Landfill Depth	-1
LEACHCON	Leachate Concentration	WASTEVOL	Waste Volume	-1
WASTDENS	Waste Density	WASTEVOL	Waste Volume	-1
DURLEACH	Duration of Leaching Period	WASTEVOL	Waste Volume	0.98939
LANDEPTH	Landfill Depth	WASTDENS	Waste Density	-1
WASTEVOL	Waste Volume	WASTDENS	Waste Density	-1
DURLEACH	Duration of Leaching Period	WASTDENS	Waste Density	-0.98939
LEACHCON	Leachate Concentration	DURLEACH	Duration of Leaching Period	-0.98939
LANDEPTH	Landfill Depth	DURLEACH	Duration of Leaching Period	0.98939
WASTEVOL	Waste Volume	DURLEACH	Duration of Leaching Period	0.98939
WASTDENS	Waste Density	DURLEACH	Duration of Leaching Period	-0.98939
AQUTHIK	Aquifer Thickness	LONDISPU	Longitudinal Dispersivity	0.99851
UNSATHIK	Unsaturated Zone Thickness	LONDISPU	Longitudinal Dispersivity	0.99998

Note: Parameters in the variable 2 column were removed from the analysis.

Table E-25. Summary of Crosspairs Analysis for Vanadium

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
LONHYCON	Longitundinal Hydraulic Conductivity			Y	Y
HYDGRAD	Hydraulic Gradient			Y	Y
LONDISPA	Longitudinal Dispersivity			Y	Y
FRORGCAR	Fraction Organic Carbon				
ANGLEW	Angle of Well Off Plume Centerline			Y	
XDIST	Longitudinal Distance to Well				
YDIST	Distance from Plume Centerline to Well			Y	Y
ZDIST	Depth of Well Below Water Table			Y	Y
FRCOEFA	Freundlich Isotherm Coefficient			Y	Y
LEACHCON	Leachate Concentration			Y	Y
INFILRAT	Infiltration Rate			Y	Y
SATHYCON	Saturated Hydraulic Conductivity				
MOISTRPA	Moisture Rention Parameter (a)				
MOISTRPB	Moisture Rention Parameter (b)				
RESIDH2O	Residual Water Content				
SATURH2O	Saturated Water Content				
UNSATHIK	Unsaturated Zone Thickness			Y	Y
PERORGM	Percent Organic Matter				
FRCOEFU	Freundlich Isotherm Coefficient			Y	Y
LONHYCON	Longitundinal Hydraulic Conductivity	LONHYCON	Longitundinal Hydraulic Conductivity	Y	
HYDGRAD	Hydraulic Gradient	LONHYCON	Longitundinal Hydraulic Conductivity	Y	
HYDGRAD	Hydraulic Gradient	HYDGRAD	Hydraulic Gradient		
LONDISPA	Longitudinal Dispersivity	LONHYCON	Longitundinal Hydraulic Conductivity		
LONDISPA	Longitudinal Dispersivity	HYDGRAD	Hydraulic Gradient		
LONDISPA	Longitudinal Dispersivity	LONDISPA	Longitudinal Dispersivity	Y	
FRORGCAR	Fraction Organic Carbon	LONHYCON	Longitundinal Hydraulic Conductivity		
FRORGCAR	Fraction Organic Carbon	HYDGRAD	Hydraulic Gradient		
FRORGCAR	Fraction Organic Carbon	LONDISPA	Longitudinal Dispersivity		
FRORGCAR	Fraction Organic Carbon	FRORGCAR	Fraction Organic Carbon		
ANGLEW	Angle of Well Off Plume Centerline	LONHYCON	Longitundinal Hydraulic Conductivity	Y	
ANGLEW	Angle of Well Off Plume Centerline	HYDGRAD	Hydraulic Gradient		
ANGLEW	Angle of Well Off Plume Centerline	LONDISPA	Longitudinal Dispersivity		
ANGLEW	Angle of Well Off Plume Centerline	FRORGCAR	Fraction Organic Carbon		
ANGLEW	Angle of Well Off Plume Centerline	ANGLEW	Angle of Well Off Plume Centerline		
XDIST	Longitudinal Distance to Well	LONHYCON	Longitundinal Hydraulic Conductivity	Y	
XDIST	Longitudinal Distance to Well	HYDGRAD	Hydraulic Gradient	Y	
XDIST	Longitudinal Distance to Well	LONDISPA	Longitudinal Dispersivity	Y	
XDIST	Longitudinal Distance to Well	FRORGCAR	Fraction Organic Carbon	Y	
XDIST	Longitudinal Distance to Well	ANGLEW	Angle of Well Off Plume Centerline		
XDIST	Longitudinal Distance to Well	XDIST	Longitudinal Distance to Well	Y	
YDIST	Distance from Plume Centerline to Well	LONHYCON	Longitundinal Hydraulic Conductivity		
YDIST	Distance from Plume Centerline to Well	HYDGRAD	Hydraulic Gradient		
YDIST	Distance from Plume Centerline to Well	LONDISPA	Longitudinal Dispersivity	Y	
YDIST	Distance from Plume Centerline to Well	FRORGCAR	Fraction Organic Carbon		
YDIST	Distance from Plume Centerline to Well	ANGLEW	Angle of Well Off Plume Centerline		
YDIST	Distance from Plume Centerline to Well	XDIST	Longitudinal Distance to Well	Y	
YDIST	Distance from Plume Centerline to Well	YDIST	Distance from Plume Centerline to Well	Y	
ZDIST	Depth of Well Below Water Table	LONHYCON	Longitundinal Hydraulic Conductivity	Y	
ZDIST	Depth of Well Below Water Table	HYDGRAD	Hydraulic Gradient	Y	

Table E-25. Summary of Crosspairs Analysis for Vanadium

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
ZDIST	Depth of Well Below Water Table	LONDISPA	Longitudinal Dispersivity	Y	
ZDIST	Depth of Well Below Water Table	FRORGCAR	Fraction Organic Carbon		
ZDIST	Depth of Well Below Water Table	ANGLEW	Angle of Well Off Plume Centerline	Y	
ZDIST	Depth of Well Below Water Table	XDIST	Longitudinal Distance to Well	Y	
ZDIST	Depth of Well Below Water Table	YDIST	Distance from Plume Centerline to Well		
ZDIST	Depth of Well Below Water Table	ZDIST	Depth of Well Below Water Table		
FRCOEFA	Freundlich Isotherm Coefficient	LONHYCON	Longitundinal Hydraulic Conductivity	Y	
FRCOEFA	Freundlich Isotherm Coefficient	HYDGRAD	Hydraulic Gradient	Y	
FRCOEFA	Freundlich Isotherm Coefficient	LONDISPA	Longitudinal Dispersivity		
FRCOEFA	Freundlich Isotherm Coefficient	FRORGCAR	Fraction Organic Carbon		
FRCOEFA	Freundlich Isotherm Coefficient	ANGLEW	Angle of Well Off Plume Centerline		
FRCOEFA	Freundlich Isotherm Coefficient	XDIST	Longitudinal Distance to Well	Y	
FRCOEFA	Freundlich Isotherm Coefficient	YDIST	Distance from Plume Centerline to Well	Y	
FRCOEFA	Freundlich Isotherm Coefficient	ZDIST	Depth of Well Below Water Table		
FRCOEFA	Freundlich Isotherm Coefficient	FRCOEFA	Freundlich Isotherm Coefficient	Y	
LEACHCON	Leachate Concentration	LONHYCON	Longitundinal Hydraulic Conductivity		
LEACHCON	Leachate Concentration	HYDGRAD	Hydraulic Gradient		
LEACHCON	Leachate Concentration	LONDISPA	Longitudinal Dispersivity		
LEACHCON	Leachate Concentration	FRORGCAR	Fraction Organic Carbon		
LEACHCON	Leachate Concentration	ANGLEW	Angle of Well Off Plume Centerline	Y	
LEACHCON	Leachate Concentration	XDIST	Longitudinal Distance to Well		
LEACHCON	Leachate Concentration	YDIST	Distance from Plume Centerline to Well	Y	
LEACHCON	Leachate Concentration	ZDIST	Depth of Well Below Water Table	Y	
LEACHCON	Leachate Concentration	FRCOEFA	Freundlich Isotherm Coefficient	Y	
LEACHCON	Leachate Concentration	LEACHCON	Leachate Concentration		
INFILRAT	Infiltration Rate	LONHYCON	Longitundinal Hydraulic Conductivity		
INFILRAT	Infiltration Rate	HYDGRAD	Hydraulic Gradient		
INFILRAT	Infiltration Rate	LONDISPA	Longitudinal Dispersivity		
INFILRAT	Infiltration Rate	FRORGCAR	Fraction Organic Carbon		
INFILRAT	Infiltration Rate	ANGLEW	Angle of Well Off Plume Centerline	Y	
INFILRAT	Infiltration Rate	XDIST	Longitudinal Distance to Well		
INFILRAT	Infiltration Rate	YDIST	Distance from Plume Centerline to Well		
INFILRAT	Infiltration Rate	ZDIST	Depth of Well Below Water Table		
INFILRAT	Infiltration Rate	FRCOEFA	Freundlich Isotherm Coefficient		
INFILRAT	Infiltration Rate	LEACHCON	Leachate Concentration		
INFILRAT	Infiltration Rate	INFILRAT	Infiltration Rate	Y	
SATHYCON	Saturated Hydraulic Conductivity	LONHYCON	Longitundinal Hydraulic Conductivity		
SATHYCON	Saturated Hydraulic Conductivity	HYDGRAD	Hydraulic Gradient		
SATHYCON	Saturated Hydraulic Conductivity	LONDISPA	Longitudinal Dispersivity		
SATHYCON	Saturated Hydraulic Conductivity	FRORGCAR	Fraction Organic Carbon		
SATHYCON	Saturated Hydraulic Conductivity	ANGLEW	Angle of Well Off Plume Centerline		
SATHYCON	Saturated Hydraulic Conductivity	XDIST	Longitudinal Distance to Well		
SATHYCON	Saturated Hydraulic Conductivity	YDIST	Distance from Plume Centerline to Well		
SATHYCON	Saturated Hydraulic Conductivity	ZDIST	Depth of Well Below Water Table		
SATHYCON	Saturated Hydraulic Conductivity	FRCOEFA	Freundlich Isotherm Coefficient		
SATHYCON	Saturated Hydraulic Conductivity	LEACHCON	Leachate Concentration		
SATHYCON	Saturated Hydraulic Conductivity	INFILRAT	Infiltration Rate		
SATHYCON	Saturated Hydraulic Conductivity	SATHYCON	Saturated Hydraulic Conductivity		
MOISTRPA	Moisture Rention Parameter (a)	LONHYCON	Longitundinal Hydraulic Conductivity		

Table E-25. Summary of Crosspairs Analysis for Vanadium

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
MOISTRPA	Moisture Rention Parameter (a)	HYDGRAD	Hydraulic Gradient	Y	
MOISTRPA	Moisture Rention Parameter (a)	LONDISPA	Longitudinal Dispersivity		
MOISTRPA	Moisture Rention Parameter (a)	FRORGCAR	Fraction Organic Carbon		
MOISTRPA	Moisture Rention Parameter (a)	ANGLEW	Angle of Well Off Plume Centerline	Y	
MOISTRPA	Moisture Rention Parameter (a)	XDIST	Longitudinal Distance to Well		
MOISTRPA	Moisture Rention Parameter (a)	YDIST	Distance from Plume Centerline to Well		
MOISTRPA	Moisture Rention Parameter (a)	ZDIST	Depth of Well Below Water Table	Y	
MOISTRPA	Moisture Rention Parameter (a)	FRCOEFA	Freundlich Isotherm Coefficient		
MOISTRPA	Moisture Rention Parameter (a)	LEACHCON	Leachate Concentration		
MOISTRPA	Moisture Rention Parameter (a)	INFILRAT	Infiltration Rate		
MOISTRPA	Moisture Rention Parameter (a)	SATHYCON	Saturated Hydraulic Conductivity		
MOISTRPA	Moisture Rention Parameter (a)	MOISTRPA	Moisture Rention Parameter (a)		
MOISTRPB	Moisture Rention Parameter (b)	LONHYCON	Longitundinal Hydraulic Conductivity		
MOISTRPB	Moisture Rention Parameter (b)	HYDGRAD	Hydraulic Gradient		
MOISTRPB	Moisture Rention Parameter (b)	LONDISPA	Longitudinal Dispersivity		
MOISTRPB	Moisture Rention Parameter (b)	FRORGCAR	Fraction Organic Carbon		
MOISTRPB	Moisture Rention Parameter (b)	ANGLEW	Angle of Well Off Plume Centerline		
MOISTRPB	Moisture Rention Parameter (b)	XDIST	Longitudinal Distance to Well		
MOISTRPB	Moisture Rention Parameter (b)	YDIST	Distance from Plume Centerline to Well		
MOISTRPB	Moisture Rention Parameter (b)	ZDIST	Depth of Well Below Water Table		
MOISTRPB	Moisture Rention Parameter (b)	FRCOEFA	Freundlich Isotherm Coefficient		
MOISTRPB	Moisture Rention Parameter (b)	LEACHCON	Leachate Concentration		
MOISTRPB	Moisture Rention Parameter (b)	INFILRAT	Infiltration Rate		
MOISTRPB	Moisture Rention Parameter (b)	SATHYCON	Saturated Hydraulic Conductivity		
MOISTRPB	Moisture Rention Parameter (b)	MOISTRPA	Moisture Rention Parameter (a)		
MOISTRPB	Moisture Rention Parameter (b)	MOISTRPB	Moisture Rention Parameter (b)	Y	
RESIDH2O	Residual Water Content	LONHYCON	Longitundinal Hydraulic Conductivity		
RESIDH2O	Residual Water Content	HYDGRAD	Hydraulic Gradient		
RESIDH2O	Residual Water Content	LONDISPA	Longitudinal Dispersivity		
RESIDH2O	Residual Water Content	FRORGCAR	Fraction Organic Carbon		
RESIDH2O	Residual Water Content	ANGLEW	Angle of Well Off Plume Centerline		
RESIDH2O	Residual Water Content	XDIST	Longitudinal Distance to Well		
RESIDH2O	Residual Water Content	YDIST	Distance from Plume Centerline to Well		
RESIDH2O	Residual Water Content	ZDIST	Depth of Well Below Water Table		
RESIDH2O	Residual Water Content	FRCOEFA	Freundlich Isotherm Coefficient		
RESIDH2O	Residual Water Content	LEACHCON	Leachate Concentration		
RESIDH2O	Residual Water Content	INFILRAT	Infiltration Rate		
RESIDH2O	Residual Water Content	SATHYCON	Saturated Hydraulic Conductivity		
RESIDH2O	Residual Water Content	MOISTRPA	Moisture Rention Parameter (a)		
RESIDH2O	Residual Water Content	MOISTRPB	Moisture Rention Parameter (b)		
RESIDH2O	Residual Water Content	RESIDH2O	Residual Water Content		
SATURH2O	Saturated Water Content	LONHYCON	Longitundinal Hydraulic Conductivity		
SATURH2O	Saturated Water Content	HYDGRAD	Hydraulic Gradient		
SATURH2O	Saturated Water Content	LONDISPA	Longitudinal Dispersivity		
SATURH2O	Saturated Water Content	FRORGCAR	Fraction Organic Carbon		
SATURH2O	Saturated Water Content	ANGLEW	Angle of Well Off Plume Centerline		
SATURH2O	Saturated Water Content	XDIST	Longitudinal Distance to Well		
SATURH2O	Saturated Water Content	YDIST	Distance from Plume Centerline to Well		
SATURH2O	Saturated Water Content	ZDIST	Depth of Well Below Water Table		

Table E-25. Summary of Crosspairs Analysis for Vanadium

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
SATURH2O	Saturated Water Content	FRCOEFA	Freundlich Isotherm Coefficient		
SATURH2O	Saturated Water Content	LEACHCON	Leachate Concentration		
SATURH2O	Saturated Water Content	INFILRAT	Infiltration Rate		
SATURH2O	Saturated Water Content	SATHYCON	Saturated Hydraulic Conductivity		
SATURH2O	Saturated Water Content	MOISTRPA	Moisture Rention Parameter (a)		
SATURH2O	Saturated Water Content	MOISTRPB	Moisture Rention Parameter (b)		
SATURH2O	Saturated Water Content	RESIDH2O	Residual Water Content		
SATURH2O	Saturated Water Content	SATURH2O	Saturated Water Content		
UNSATHIK	Unsaturated Zone Thickness	LONHYCON	Longitundinal Hydraulic Conductivity	Y	
UNSATHIK	Unsaturated Zone Thickness	HYDGRAD	Hydraulic Gradient		
UNSATHIK	Unsaturated Zone Thickness	LONDISPA	Longitudinal Dispersivity		
UNSATHIK	Unsaturated Zone Thickness	FRORGCAR	Fraction Organic Carbon		
UNSATHIK	Unsaturated Zone Thickness	ANGLEW	Angle of Well Off Plume Centerline		
UNSATHIK	Unsaturated Zone Thickness	XDIST	Longitudinal Distance to Well		
UNSATHIK	Unsaturated Zone Thickness	YDIST	Distance from Plume Centerline to Well		
UNSATHIK	Unsaturated Zone Thickness	ZDIST	Depth of Well Below Water Table		
UNSATHIK	Unsaturated Zone Thickness	FRCOEFA	Freundlich Isotherm Coefficient		
UNSATHIK	Unsaturated Zone Thickness	LEACHCON	Leachate Concentration		
UNSATHIK	Unsaturated Zone Thickness	INFILRAT	Infiltration Rate		
UNSATHIK	Unsaturated Zone Thickness	SATHYCON	Saturated Hydraulic Conductivity		
UNSATHIK	Unsaturated Zone Thickness	MOISTRPA	Moisture Rention Parameter (a)		
UNSATHIK	Unsaturated Zone Thickness	MOISTRPB	Moisture Rention Parameter (b)		
UNSATHIK	Unsaturated Zone Thickness	RESIDH2O	Residual Water Content		
UNSATHIK	Unsaturated Zone Thickness	SATURH2O	Saturated Water Content		
UNSATHIK	Unsaturated Zone Thickness	UNSATHIK	Unsaturated Zone Thickness		
PERORGM	Percent Organic Matter	LONHYCON	Longitundinal Hydraulic Conductivity		
PERORGM	Percent Organic Matter	HYDGRAD	Hydraulic Gradient		
PERORGM	Percent Organic Matter	LONDISPA	Longitudinal Dispersivity	Y	
PERORGM	Percent Organic Matter	FRORGCAR	Fraction Organic Carbon		
PERORGM	Percent Organic Matter	ANGLEW	Angle of Well Off Plume Centerline		
PERORGM	Percent Organic Matter	XDIST	Longitudinal Distance to Well		
PERORGM	Percent Organic Matter	YDIST	Distance from Plume Centerline to Well		
PERORGM	Percent Organic Matter	ZDIST	Depth of Well Below Water Table		
PERORGM	Percent Organic Matter	FRCOEFA	Freundlich Isotherm Coefficient		
PERORGM	Percent Organic Matter	LEACHCON	Leachate Concentration		
PERORGM	Percent Organic Matter	INFILRAT	Infiltration Rate	Y	
PERORGM	Percent Organic Matter	SATHYCON	Saturated Hydraulic Conductivity		
PERORGM	Percent Organic Matter	MOISTRPA	Moisture Rention Parameter (a)		
PERORGM	Percent Organic Matter	MOISTRPB	Moisture Rention Parameter (b)		
PERORGM	Percent Organic Matter	RESIDH2O	Residual Water Content		
PERORGM	Percent Organic Matter	SATURH2O	Saturated Water Content		
PERORGM	Percent Organic Matter	UNSATHIK	Unsaturated Zone Thickness		
PERORGM	Percent Organic Matter	PERORGM	Percent Organic Matter		
FRCOEFU	Freundlich Isotherm Coefficient	LONHYCON	Longitundinal Hydraulic Conductivity	Y	
FRCOEFU	Freundlich Isotherm Coefficient	HYDGRAD	Hydraulic Gradient	Y	
FRCOEFU	Freundlich Isotherm Coefficient	LONDISPA	Longitudinal Dispersivity		
FRCOEFU	Freundlich Isotherm Coefficient	FRORGCAR	Fraction Organic Carbon		
FRCOEFU	Freundlich Isotherm Coefficient	ANGLEW	Angle of Well Off Plume Centerline		
FRCOEFU	Freundlich Isotherm Coefficient	XDIST	Longitudinal Distance to Well		

Table E-25. Summary of Crosspairs Analysis for Vanadium

Variable 1		Variable 2			
Code	**Description**	**Code**	**Description**	**P<0.05**	**P<0.01**
FRCOEFU	Freundlich Isotherm Coefficient	YDIST	Distance from Plume Centerline to Well	Y	
FRCOEFU	Freundlich Isotherm Coefficient	ZDIST	Depth of Well Below Water Table		
FRCOEFU	Freundlich Isotherm Coefficient	FRCOEFA	Freundlich Isotherm Coefficient	Y	
FRCOEFU	Freundlich Isotherm Coefficient	LEACHCON	Leachate Concentration		
FRCOEFU	Freundlich Isotherm Coefficient	INFILRAT	Infiltration Rate	Y	
FRCOEFU	Freundlich Isotherm Coefficient	SATHYCON	Saturated Hydraulic Conductivity		
FRCOEFU	Freundlich Isotherm Coefficient	MOISTRPA	Moisture Rention Parameter (a)		
FRCOEFU	Freundlich Isotherm Coefficient	MOISTRPB	Moisture Rention Parameter (b)		
FRCOEFU	Freundlich Isotherm Coefficient	RESIDH2O	Residual Water Content		
FRCOEFU	Freundlich Isotherm Coefficient	SATURH2O	Saturated Water Content		
FRCOEFU	Freundlich Isotherm Coefficient	UNSATHIK	Unsaturated Zone Thickness	Y	
FRCOEFU	Freundlich Isotherm Coefficient	PERORGM	Percent Organic Matter		
FRCOEFU	Freundlich Isotherm Coefficient	FRCOEFU	Freundlich Isotherm Coefficient	Y	

Table E-26. Ranking of Parameters According to Percentage of Risk for Vanadium

Variable Description	Reduced Sums of Square	Variable Sums of Square	Variable Degrees of Freedom	% Risk Variation	Mean Square Variable	F VALUE	P VALUE
Freundlich Isotherm Coefficient {Aquifer} (cm3/g)	14520.1	22646.55	46	812644.0%	3809.54	1160.92	7.69E-01
Distance from Plume Centerline to Well (m)	15861.8	22646.55	46	678475.0%	3809.54	1130.79	7.69E-01
Freundlich Isotherm Coefficient {Unsaturated} (cm3/g)	16694.4	22646.55	46	595214.0%	3809.54	850.31	7.69E-01
Leachage Concentration (mg/l)	20727.0	22646.55	46	191952.0%	3809.54	639.84	7.69E-01
Longitudinal Dispersivity {Aquifer} (m)	21382.0	22646.55	46	126458.0%	3809.54	252.92	7.69E-01
Consumption of Drinking Water (ml/kg-day)	21550.6	22646.55	46	109594.0%	3809.54	1095.94	7.69E-01
Longitudinal Hydraulic Conductivity (m/yr)	21679.5	22646.55	46	96700.0%	3809.54	138.14	7.69E-01
Hydraulic Gradient (m/m)	22027.1	22646.55	46	61945.0%	3809.54	154.86	7.69E-01
Longitudinal Distance to Well (m)	22125.8	22646.55	46	52071.0%	3809.54	57.86	7.69E-01
Infiltration Rate (m/yr)	22545.6	22646.55	46	10091.0%	3809.54	20.18	7.69E-01
Unsaturated Zone Thickness (m)	22619.7	22646.55	46	2689.0%	3809.54	13.45	7.69E-01
Depth of Well Below Water Table (m)	22619.8	22646.55	46	2674.0%	3809.54	6.68	7.69E-01
Angle of Well Off Plume Centerline (degrees)	22629.8	22646.55	46	1672.0%	3809.54	5.57	7.69E-01
Percent Organic Matter	22636.9	22646.55	46	969.0%	3809.54	4.84	7.69E-01
Fraction Organic Carbon (g/g)	22640.5	22646.55	46	600.0%	3809.54	3.00	7.69E-01
Moisture Retention Parameter a (1/m)	22641.4	22646.55	46	518.0%	3809.54	2.59	7.69E-01

Constants

Full Model SS	39
Error SS	7
Error DF	0
MS Error	4953

Appendix F

Development of Health-Based Levels for Household Water for Screening Volatile Constituents for Inhalation Risk

Appendix F

Development of Health-Based Levels for Household Water for Screening Volatile Constituents for Inhalation Risk

F.1 Introduction

Pathways for human exposure to contaminated residential well water are not limited to ingestion as drinking water. There is the potential for exposure to volatile constituents through the inhalation pathway during household water use, especially daily showering. To determine if it is possible for constituents to enter the residence in concentrations high enough to cause excess risk through inhalation, screening levels were estimated for comparison with concentrations in the landfill leachate. The leachate concentrations were estimated using either the toxicity characteristic leaching procedure (TCLP) for wastes managed in municipal landfills or the synthetic precipitation leaching procedure (SPLP) levels for wastes managed in industrial D landfills or the SPLP filtrate, or total waste concentration for onsite surface impoundments. For wastes managed in solid waste management units (SWMUs) that are assumed to discharge to surface waterbodies, the bounding surface water concentrations are used for comparison.

The risks estimated by this model are primarily from exposures during daily showering; however, additional exposures during additional time in the bathroom were considered. For noncarcinogens, the household factors and the physical and chemical properties of the volatile constituent determine the air concentration of each constituent. The air concentration is compared to the reference concentration (RfC) to yield the hazard quotient (HQ). If the target HQ is set at 1, a water concentration that corresponds to this air concentration can be estimated. This water concentration is the health-based level (HBL) and is protective of all adults and children. Table F-1 presents the inhalation HBLs, the corresponding RfCs, and the physical and chemical properties used in the analysis for constituents with noncancer endpoints, and Table F-2 presents the same data for constituents with cancer endpoints.

Table F-1. HBLs, RfCs, and Physical and Chemical Properties for Constituents Evaluated for Noncancer Endpoints

Constituent	HBL (mg/L)	RfC (mg/m^3)	Henry's Law Constant ($atm\text{-}m^3/mol$)	Diffusion Coefficient in Water (cm^2/s)	Diffusion Coefficient in Air (cm^2/s)
Acetonitrile	0.036	0.06	3.5E-05	1.7E-05	1.7E-5
Acrylonitrile	0.00045	0.002	1.0E-4	1.3E-5	1.2E-1
Chloroform	0.0025	0.081	3.7E-03	1.0E-05	1.0E-01
Hydrogen cyanide	0.00052	0.003	1.3E-04	1.8E-05	2.0E-01
Methylene chloride	0.13	3.0	2.2E-3	1.2E-5	1.0E-1

Table F-2. HBLs, CSF_is, and Physical and Chemical Properties for Constituents Evaluated for Cancer as an Endpoint

Constituent	HBL (mg/L)	CSF_is $(mg/kg/d)^{-1}$	Henry's Law Constant ($atm\text{-}m^3/mol$)	Diffusion Coefficient in Air (cm^2/s)	Diffusion Coefficient in Water (cm^2/s)
Acrylamide	20	4.5	1.0E-9	1.1E-05	9.7E-02
Acrylonitrile	0.00045	0.24	1.0E-04	1.3E-05	1.2E-01
Carbon tetrachloride	0.0035	0.053	3.0E-02	8.8E-06	7.8E-02
Chlorodibromomethane	0.0035	0.084	7.8E-4	1.1E-5	2.0E-2
Chloroform	0.0025	0.081	3.7E-03	1.0E-05	1.0E-01
Methylene chloride	0.13	0.0016	2.2E-03	1.2E-05	1.0E-01
Methyl chloride	0.035	6.3E-3	8.8E-3	6.5E-6	1.3E-1
Vinyl chloride	0.011	0.015	2.7-02	1.2E-05	1.1E-01

F.1.1 Shower Inhalation Exposure Algorithms

Shower inhalation exposures are calculated for residential receptors that have groundwater wells. The shower model includes inhalation exposures both during a shower and immediately after a shower while an individual is still in the bathroom. Thus, two concentrations are calculated: one for the shower and one for the bathroom after showering. The sets of equations used for these calculations are presented below.

$$InhShower = \frac{Csb \times 1000 \times IR \times Tsb \times BF}{BW \times 24 \times 60} \quad \text{(F-1)}$$

where

InhShower	=	average daily intake for showering inhalation (mg/kg-d)
1,000	=	units conversion factor (L/m^3)
IR	=	inhalation rate (m^3/d) for age cohort
Tsb	=	time in shower and bathroom (min/event), calculated as Tshower + Tbathroom
BF	=	event frequency (events/d)
BW	=	body weight (kg)
24	=	unit conversion factor (h/d)
60	=	unit conversion factor (min/h)
Csb	=	average air concentration in bathroom and shower (mg/L), calculated as (Csb is used for carcinogenic and noncarcinogenic effects).

$$Csb = Cshower \times \left(\frac{Tshower}{Tsb}\right) + Cbath \times \left(\frac{Tbathroom}{Tsb}\right) \quad \text{(F-2)}$$

where

Cshower	=	average air concentration in shower (mg/m^3)
Tshower	=	shower time (min)
Tbathroom	=	time spent in bathroom after showering (min)
Cbath	=	average air concentration in the bathroom (mg/m^3).

Cshower and Cbath are calculated as

$$Cshower = \sum_{t1=0}^{Tshower/60} ys(t1) \qquad \text{(F-3)}$$

$$Cbath = \sum_{t1=Tshower/60}^{Tsb/60} yb(t1) \qquad \text{(F-4)}$$

where

ys (t1) = gas-phase constituent concentration in shower at time t1 (mg/L)
yb (t1) = gas-phase constituent concentration in bathroom at time t1 (mg/L)
t1 = time index during shower/bathing activity.

Variables ys(t1) and yb(t1) are determined by solving a system of two coupled, differential equations that describe the time-varying changes in average concentration in the shower and the bathroom over the duration of a shower when the shower water is contaminated with a chemical. (Note that the dynamic response is not related to changes in the inputs to the system, e.g., chemical concentration in the tap water [which is constant within a year time period], but to changes in the shower and bathroom air concentrations resulting from injecting contaminated spray into an initially clean air environment.) Using a finite difference approximation to the time derivatives, the time series solutions (over the time duration of the shower) for ys(t1) and yb(t1) are determined from a joint solution to Equations F-5 and F-6:

$$yb(t1+dt1) = yb(t1) + \frac{\left(VRsb \times \left[ys(t1) - yb(t1)\right] - VRbh \times yb(t1)\right) \times dt1}{Vbath \times 60 \times 1000} \qquad \text{(F-5)}$$

where

$$ys(t1+dt1) = ys(t1) + \frac{VRsb \times \left[yb(t1) - ys(t1)\right] \times \left(\frac{dt1}{60}\right) + Es(t1)}{Vshower \times 1000} \qquad \text{(F-6)}$$

yb (t1+dt1) = gas-phase constituent concentration in bathroom at end of time step starting at time t (mg/L)

ys(t1+dt1) = gas-phase constituent concentration in shower at end of time step starting at time t (mg/L)

dt1 = calculation time step (= 20 s)

VRsb = volumetric gas exchange rate between shower and bathroom (L/min)

VRbh = volumetric gas exchange rate between bathroom and house (L/min)

Vbath = volume of bathroom (m^3)

Vshower = shower volume (m^3)

60 = unit conversion factor (s/min)

1000 = unit conversion factor (L/m^3)

Es(t1) = mass of constituent emitted from shower during time step starting at time t1 (mg), calculated as

$$Es(t1) = 0 \qquad If\ t1 > Tshower \times 60 \tag{F-7}$$

$$Es(t1) = \min(E1(t1), Emax(t1)) \qquad If\ t1 \leq Tshower \times 60 \tag{F-8}$$

where

E1(t1) = potential mass of constituent emitted from shower during time step beginning at time t1 (mg)

Emax(t1) = maximum mass of constituent available to be emitted from shower during time step starting at time t1 (mg).

E1(t1) and Emax(t1) are calculated as

$$E1(t1) = Cgw \times Rshower \times \left(\frac{dt1}{60}\right) \times (1 - f_{sat}(t1))\left[1 - \exp\left(-\frac{6 \times K_{ol} \times Hh}{DD \times Vn}\right)\right] \tag{F-9}$$

$$Emax(t1) = [41 \times H \times Cgw_t - ys(t1)] \times Vshower \times 1000 \tag{F-10}$$

where

Cgw	=	concentration in showering water (mg/L)
Rshower	=	shower rate (L/min)
Hh	=	nozzle height (cm)
DD	=	droplet diameter (cm)
Vn	=	terminal velocity of droplet (cm/s)
41	=	factor that converts H into its dimensionless form
H	=	Henry's law constant (atm-m^3/mol)
1,000	=	conversion factor (L/m^3)
$f_{sat}(t1)$	=	fraction of gas-phase saturation at time t1 (unitless), calculated as

$$f_{sat}(t1) = \frac{ys(t1)}{41 \times H \times Cgw}$$

K_{ol}	=	overall mass transfer coefficient (cm/s), calculated as

$$K_{ol} = 216 \times \left(\frac{2.5}{D_w^{2/3}} + \frac{1}{D_a^{2/3} \times 41 \times H} \right)^{-1}$$

where

216	=	proportionality constant β $(cm/s)^{-1/3}$
D_w	=	diffusivity in water (cm^2/s)
D_a	=	diffusivity in air (cm^2/s).

F.1.2 Shower Model Parameters

The shower algorithm was adapted from McKone (1987). This model requires several inputs specific to the dimensions and characteristics of the shower and bathroom, as well as ventilation rates between the shower and bathroom and bathroom and house. These variables are shown in Table F-3, along with the values used and the data sources.

These shower-related variables were not varied. *Shower volume* and *bathroom volume (Vshower and Vbath)* were obtained from McKone (1987). Shower temperature (HumRcpTemp) represents a typical value reported in Foster and Chrostowski (1987). The remaining variables were specified based on best professional judgment.

The exposure parameters used in calculating the HBLs are presented in Table F-4.

Table F-3. Shower-Related Variables

Description	Code	Units	Value	Data Source
Shower temperature (typical)	HumRcpTemp	°Celsius	43	Foster & Chrostowski (1987)
Shower volume	Vshower	m^3	2	McKone (1987)
Bathroom volume	Vbath	m^3	10	McKone (1987)
Shower rate	Rshower	L/min	5.5	Calculated based on droplet diameter and nozzle velocity
Shower-to-bathroom ventilation rate	VRsb	L/min	100	Best professional judgment
Bathroom-to-house ventilation rate	VRbh	L/min	300	Best professional judgment
Droplet terminal velocity	Vn	cm/s	400	Best professional judgment
Nozzle height	Hn	cm	180	Best professional judgment
Droplet diameter	DD	cm	0.1	Best professional judgment

Table F-4. Exposure Input Parameters for Inhalation of Carcinogens

Parameter	Adult	
	CT	High End
Event frequency (event/d)	1	1
Exposure frequency (d/yr)	350	350
Exposure duration(yr)	13	31
Body weight (kg)	70	89
Inhalation rate (m^3/d)	12.7	18.6

CT = Central tendency.

F.2 References

Foster,S.A., and P.C.Chrostowski. 1987. Inhalation exposures to volatile organic contaminants in the shower. In: *The 80th Annual Meeting of the Air Pollution Control Association (APCA)*, June 21-26, 1987, New York.

Little,J.C. (John C. Little). 1992. Applying the two-resistance theory to contaminant volatilization in showers. *Environmental Science & Technology*, 26(No. 7):1341-1349.

McKone,T.E. 1987. Human exposure to volatile organic compounds in household tap water: the indoor inhalation pathway. *Environmental Science and Technology*, 21(12):1194-1201.

U.S.EPA (Environmental Protection Agency). 1997. *Exposure Factors Handbook*. EPA/600/P-95/002Fa. Office of Research and Development, Washington, DC. August.

Appendix G

Approach for Performing Sensitivity Analyses

Appendix G

Approach for Performing Sensitivity Analyses

G.1 Introduction

Sensitivity analyses were conducted for previous listings by evaluating how much change in risk occurred as a result of varying an individual input parameter from a median or mean value to a 90th percentile or high end value. When the risk depends on a number of input parameters, however, such an approach may not necessarily identify the most important input variables. This may occur for several reasons:

- The ranges chosen for the various input parameters may not be defined consistently.
- Various input parameters may interact with one another (i.e., the effect of input X_1 on an outcome Y depends on the level of other inputs X_2, X_3, etc., so that the observed effect of X_1 depends on what values were chosen for the other variables as well).
- Nonlinear effects may obscure the effect of the input parameter (e.g., if only low and high levels of an input variable are examined, but the relationship between the risk and the input variable is of a quadratic nature, then the importance of the input parameter may be overlooked).

To address such issues, statistical regression methods were used to perform the sensitivity analyses. Although regression methods have distinct advantages over previous approaches, certain limitations remain. Regression methods are not capable of determining the sensitivity of model results to input parameters that are not varied in the analysis (e.g., assumptions) or are not otherwise included within the scope of the analysis (e.g., model derived parameters). If, for some reason, the most important parameters are not varied or their variability is improperly characterized, the sensitivity analysis may not identify them as being the most important parameters.

The sensitivity analysis was conducted on a data set generated during groundwater pathway modeling. For example, a set of input parameters (X_1, X_2, ..., X_p) was used in the modeling simulation.

Two different situations can be distinguished:

- The result of interest is the groundwater concentration of some contaminant; in this case, the Xs are all associated with site and environmental conditions.

- The result of interest is the risk associated with human exposures to the groundwater concentration of the contaminant; in this case, additional Xs associated with the intake rates, contact durations, etc., are also involved.

The regression approach uses the various combinations of X values that were used during the simulation and the resulting groundwater concentration and risk values as input data to a regression model. Functions of the results variables (denoted as Ys) were treated as dependent variables; for example, Y denoted the logarithm of the groundwater contaminant concentration or of the risk. Functions of the Xs were treated as independent variables. The goals of the approach were (1) to determine a fairly simple polynomial approximation to the simulation results that expressed the Ys as functions of the Xs, (2) to optimize this "response surface" and assess the importance of the various Xs by performing statistical tests on the model parameters and (3) to rank the Xs based on their relative contribution (in terms of risk) to the final response surface regression model.

These goals were realized using a second-order regression model. Such a model takes the following form:

$$\hat{Y} = \hat{\beta}_0 + \sum_{k=1}^{p} \hat{\beta}_k x_k + \sum_{k=1}^{p} \hat{\beta}_{kk} x_k^2 + \sum_{k=1}^{p-1} \sum_{j=k+1}^{p} \hat{\beta}_{kj} x_k x_j \qquad \text{(G-1)}$$

where the $\hat{\beta}$s are the least squares regression estimates of the model parameters.

The statistical significance of the parameters associated with the first-order, squared, and cross product terms were tested and all nonsignificant terms were removed from the model. The parameters in this reduced model were then reestimated and the process of testing was repeated. This was done to capture the most important independent variables (Xs) that influence the dependent variables (Ys).

This is called a response surface regression approach because it uses model characteristics like those used in a response surface experiment—i.e., a situation in which the input variables are all of a continuous nature and for which a low-order polynomial model is used to approximate the relationship between Y and the Xs.[1] Response surface methodology involves a statistical approach to designing experiments and an associated model estimation methodology. The design involves deciding on the number of trials to be performed and on the particular trials to be

[1] Use of low-order polynomial models is based on the idea that any function can be approximated (over some range of X values) by a Taylor series expansion (Casella, G. and Berger, R. L. Statistical Inference, Duxbury Press, Belmont, CA, 1990, p328-331). The truncation of the series after second-order terms yields a second-degree polynomial, for instance.

performed, i.e., the various sets of X values (X_{i1}, X_{i2}, ..., X_{ip}) for i = 1, 2, ..., n. The experiment yields n observations Y_i (i = 1, 2, ..., n). When used in experimental design, the particular trials chosen are designed to provide coverage of the relevant ranges of the Xs and to allow the model to be estimated with high precision. The terminology "response surface" derives from the fact that a regression model involving p continuous independent variables can be viewed as providing an estimated surface of the Ys (in a [p+1]-dimensional space). For example, suppose p=2, and suppose that X_1 and X_2 represent east-west and north-south geographical coordinates, respectively, relative to some fixed origin. Then the n design points (X_{i1}, X_{i2}) can be viewed as a set of n points on a map (i.e., a horizontal plane). The corresponding observed Y_i values can be viewed as altitudes above this plane. By fitting the model that relates Y to the Xs, one obtains a surface that gives the predicted Y value (altitude) for any combination of X values (geographic location); such a surface is often represented by producing contours of constant response (i.e., a contour map). The complexity of the model (e.g., whether it contains only first- and second-order terms or terms of higher degree) determines the general shape of the contours and the degree to which the "true" surface can be approximated.

The various X variables represent different attributes and are often measured in different units. Hence, before fitting the models that are used to relate Y to the Xs, transformations of the Xs are made to standardize them to unitless quantities. Such transformations seek to make the ranges of the various X variables similar to one another, to center the X values at zero, and to achieve approximate balance (symmetry) in the levels on some scale in order to eliminate the effect of the magnitude of the X values on the Y variable.

G.2 Application of Response Surface Methodology

The analogy of the existing Monte Carlo data to the response surface experiment is clear. The simulation involves n=10,000 "design points" for which we know the X values, and it has produced 10,000 observed Ys that correspond to these points. The goal, therefore, was to mimic the response surface methods to arrive at a reasonable model for characterizing Y as a function of the Xs; i.e., to obtain an estimated "response surface." Despite the analogy, it is noted that several aspects of the current context differed from the standard response surface situation:

- The "design points"(i.e., Monte Carlo data) were obviously not chosen to reflect the response surface; thus, some difficulties in the estimation of the model could be encountered and the precision of the estimation adversely affected.

- Although the goal of the usual response surface application is to provide a useful model for predicting and optimizing the response, methods were used here to identify the Xs that have the most important effects on Y. The final model is not intended to be adequate for providing an accurate prediction of risk. However, the major influences of the Xs should be captured by the approach, which is described in detail below.

The basic approach includes the following steps:

- The distributions of all input variables in the data set were checked to assess the number of unique values and the degree of symmetry.

- Transformations (log, square root, etc.) were performed to any input variables with asymmetric distributions so that all input variables for the sensitivity analysis had approximately symmetric distributions.

- Correlations of the transformed input variables were checked to ascertain whether major estimation difficulties may occur due to collinearities in the input variables.

- The transformed variables were standardized (i.e., subtract the mean and divide by the standard deviation). The transformed, standardized variables were denoted by (x_{i1}, x_{i1}, x_{i1}, ..., x_{ip}).

- The model parameters were used to estimate by least squares regression the logarithm of the groundwater concentration[2] as the dependent variable Y, using a second-order response surface model as an initial model. Such a prediction model is represented as

$$\hat{Y} = \hat{\beta}_0 + \sum_{k=1}^{p} \hat{\beta}_k x_k + \sum_{k=1}^{p} \hat{\beta}_{kk} x_k^2 + \sum_{k=1}^{p-1} \sum_{j=k+1}^{p} \hat{\beta}_{kj} x_k x_j \qquad \text{(G-2)}$$

  where the βs are the model parameters to be estimated and the $\hat{\beta}$s denote their estimates. Such a model involves p(p+1)+1 unknown parameters—one associated with an intercept, p first-order (main-effect) terms, p pure second-order terms (squares), and p(p-1) mixed second-order (interaction or cross-product) terms.

- The statistical significance of parameters associated with the squared terms and the cross product terms in model 1 were tested. All the nonsignificant second-order terms were removed from the model. If no second-order terms involving a given factor, say x_u, remained in the model and the corresponding first-order coefficient, β_u, was also not statistically significant, then the first-order term was also removed.

- The parameters in this reduced model were reestimated and the process of testing indicated in the prior step was repeated. After a few such iterations, this approach should yield a final second-order model that captures the most important independent variables that influence the (log) concentrations.

[2] The logarithm is recommended since the (amount of) uncertainty in the "observed" concentrations is assumed to be related to the concentration level. If that relationship is strictly proportional (i.e., a constant coefficient of variation), then the log transformation will yield a variable with homogeneous error variance (i.e., variance is constant for all values of Y), which is compatible with the assumptions underlying the least squares estimation method. If zero concentrations are "observed" for some cases, then the dependent variable is taken to be Y = log(concentration+C), where C is a small constant (relative to the smallest positive concentration observed).

- The logarithm of the risk was used as the dependent variable Y and the first- and second-order terms that appear in the final model above, plus any intake and exposure-related Xs as an initial model for log(risk). (This is described more fully in Section 6.3.2.2.)

- The effects of various factors were tested using F-tests, and the p-values from the tests were used to rank the importance of the effects of the variables on (log)risk. (This is described more fully in Section 6.3.2.3.)

G.3 Log Risk Model

The basic equation relating risk to concentration is multiplicative. Taking logs of both sides of the risk equation yields the following additive equation:

$$\log(risk) = \log(environmental\ \ concentration) + c_1 \log(risk\ \ factor) + c_2 \log\left(\sum_j exposure\ \ duration_j * intake\ \ rate_j\right) \quad \text{(G-3)}$$

where j equals 1 to n pathways and where the constants c_1 and c_2 are theoretically equal to 1. NOTE: For noncarcinogens, there is no exposure duration term.

To model the log(risk), we substitute for the log(environmental concentration) term in the above equation by using the independent variables of the log(concentration) model (i.e., the first- and second-order terms in the final model). The model thus includes the same terms as those appearing in the final model previously determined plus two other terms (the c_s are treated as unknown and are to be estimated along with the coefficients on the Xs. Using log(risk) (or log(risk+K), where K is a small constant) as a dependent variable, we then estimate the regression model and use F-tests to determine if the coefficients C_1 and C_2 are equal to 1. This is used to determine whether the relationship between log(risk) and the last two terms in the above equation still hold. Once the log(risk) model has been estimated, the testing and ranking methods are used to assess which input variables have the most effect on log(risk).

G.4. Testing and Ranking of Factors

If only first-order main effect terms appear in the final log(risk) model, then a clear conclusion can be made regarding the importance of an individual continuous variable's effect by examining the significance (p-value) of its associated regression coefficient. More likely, however, the final model will involve several terms involving the same variable (e.g., a linear term, a quadratic term, and one or more cross-product terms); the effect of that factor can then be assessed by using an F-test that tests whether all those terms involving the factor simultaneously have zero regression coefficients. The F-tests to test the effect of factor x_u are of the form

$$F = \frac{[FMSS - RMSS]\ /\ [FMDF - RMDF]}{FRSS\ /\ FRDF} \quad \text{(G-4)}$$

where

FMSS = model sum of squares for the final model

RMSS = model sum of squares for a model in which all terms involving x_u are removed (i.e., a reduced model)

FMDF = model degrees of freedom for the final model

RMDF = model degrees of freedom for the reduced model

FRSS = residual sum of squares for the final model

FRDF = residual degrees of freedom for the final model.

If a substantial increase in the residuals results from ignoring terms involving the variable x_u, then F will be "large," implying that these factors can be considered important in the sense that they require nonzero regression coefficients for the terms involving x_u. The p-value associated with the test, which is computed as the probability of observing a value as large as F or larger under the assumption that the statistic has an F distribution with FMDF-RMDF and FRDF degrees of freedom, thus provides an indication of the strength of association of Y with those model terms.

This strategy was used for each factor, and an ordering of the p-values from such tests was then used to rank the importance of the various factors on the risk.

Once the final regression model was developed, the input parameters (Xs) were ranked based on percentage of risk accounted for by that parameter. The percent risk was calculated using the following equation:

$$PercentRisk = \frac{[FMSS - RMSS]}{[FMSS + FRSS]} \quad \text{(G-5)}$$

where

FMSS = model sum of squares for the final model

RMSS = model sum of squares for a model in which all terms involving x_u are removed (i.e., a reduced model)

FRSS = residual sum of squares for the final model.

The two parameters responsible for the largest percentage of the risk were the two parameters set to high-end values in the deterministic analysis. This was used to order the variables when the p-values were equal to zero.

At the outset of this risk analysis, the entire distribution of 10,000 iterations was used in the sensitivity analysis. However, as the analysis proceeded, it was noted that, in some instances, when the two high-end parameters determined by the sensitivity analysis were set to high-end values, little variation from the central tendency risk value was observed. Because there were 2nd order terms in the final model, the variation between the risk and the two parameters is not a linear relationship, and the complete effect of the parameter does not show up in the deterministic analysis. At this point, the methodology of the sensitivity analysis was reexamined, and it was decided that the analysis should focus on the 50th percentile risk and above, given that the primary purpose of the sensitivity analysis was to determine what parameters were most important in predicting high-end risk, rather than the entire range of risk, across all percentiles. Thus, for the waste streams in the titanium dioxide sector and all waste streams evaluated after the titanium dioxide wastes, the sensitivity analysis was performed using the 5,000 iterations resulting in the highest risk. Thus, the parameters having the greatest effect on the higher range of risk were identified by the sensitivity analysis. In cases where the analysis was performed on the full 10,000 iterations and the top 5,000 iterations, the results of the sensitivity analysis were frequently different, but not in all cases.

Sensitivity analyses were performed for all combinations of WS/SWMU/CoCs for the inorganic chemical manufacturing risk analysis. Of these analyses, 14 were performed on the entire 10,000 iterations only. The remaining analyses were performed either only on the top half of the distribution or on the top half and the whole distribution. The results of the sensitivity analysis were variable from waste stream to waste stream and from constituent to constituent. However, several parameters reappeared frequently as one of the two most influential parameters.

The most common parameters identified as risk drivers were the K_d in the aquifer and the K_d in the unsaturated zone. In the small volume waste streams where the analysis was performed on the full 10,000 iterations, the second most common high-end parameter was the unsaturated zone thickness. Only one case showed infiltration rate as a high- end variable.[3] In the higher volume waste streams common in the titanium dioxide sector, the most common high- end parameters are K_ds in the saturated zone and the unsaturated zone and the distance from the plume center line to the well (y-well). The only exceptions to these parameters are two occurrences each of the longitudinal distance to the well (X-well) and the consumption of drinking water and one occurrence of waste management unit size. For the wastewaters managed in surface impoundments, the most frequently occurring high-end parameters are again K_ds in the saturated zone and the unsaturated zone and the distance from the plume center line (y-well).[4] The sensitivity analysis for each WS/SWMU/CoC, including the F-test results, is documented in Appendixes A through D.

[3] This case was for arsenic in sodium chlorate sludge and occurred because this waste stream is managed in areas with variable climates and one of the sites is very dry; thus, in this case, infiltration rate is a factor associated with greater risk.

[4] In addition, in a single case, leachate concentration appeared as one of the two high-end parameters.

G.5 Reference

Casella, G., and R.L. Berger. 1990. Chapter 7: Point Estimation. In: *Statistical Inference*, Wadsworth Publishing Company, Belmont, CA. pp. 328-331.

Appendix H

Surface Impoundment Infiltration Model

Appendix H

Surface Impoundment Infiltration Model

Surface impoundments are onsite solid waste management units (SWMUs) in the inorganic chemical manufacturing industry. Modeling these surface impoundments requires calculating an infiltration rate from the impoundment. For this analysis, infiltration was estimated using a portion of the SI source model developed for the HWIR99 analysis. The following sections describe the algorithms used in this model, which calculate the infiltration rate through the accumulated sediment at the bottom of the impoundment. These algorithms allow the sediment layer to change over time, and also limit infiltration through natural processes such as clogging of the native soil materials underlying the impoundment or mounding due to flow-limiting aquifer characteristics.

H.1 Effective Hydraulic Conductivity of Consolidatable Sediment Layer

As sediment accumulates at the base of the impoundment, the weight of the liquid and upper sediments tends to compress (or consolidate) the lower sediments. This consolidated sediment acts as a filter cake, and its hydraulic conductivity may be much lower than the nonconsolidated sediment. Figure H-1 illustrates a compartmentalized surface impoundment with stratified sediment. Shown in the figure are, in descending order: the liquid compartment, the sediment compartment (with loose and compacted sediments), and the vadose zone (with clogged and unaffected native materials). The model assumes that the system has attained a pseudo-steady-state condition and all sediment layer thicknesses are near stationary and approximately constant. The initial depth of the sediment layer for the surface impoundment is set at 20 cm to account for sediment and compaction created during the excavation of the impoundment.

Assume that initially the effective stress in the sediment is nonexistent. The final stress in the consolidatable sediment after the deformation and dissipation of fluid pressure is given by

$$\sigma_{vf} = (H - D_s - D_{fc})\rho_w g + (1-\theta)\rho_s g D_s + \theta \rho_w g D_s + (1-\theta)\rho_s g z + \theta \rho_w g z - [(H - D_{fc})\rho_w g - \frac{z}{D_{fc}}(H - D_{fc})\rho_w g] \quad \text{(H-1)}$$

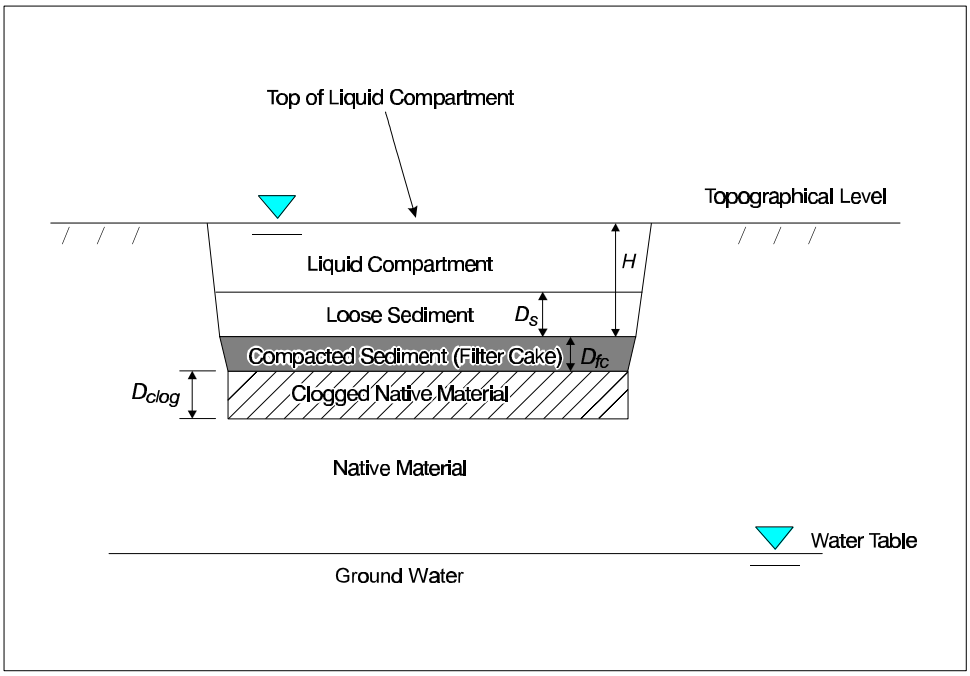

Figure H-1. Filter cake and clogged native material components of the surface impoundment infiltration rate module.

where

σ_{vf}	=	vertical effective stress in the z-direction, Mg/m-s^2
H	=	total depth of a given SI unit (height from bottom) (m)
D_s	=	thickness of unconsolidatable sediment (m)
D_{fc}	=	thickness of filter cake or consolidatable sediment (height from bottom) (m)
ρ_w	=	water density (Mg/m^3)
g	=	gravitational acceleration (m/s^2)
ρ_s	=	sediment grain density (Mg/m^3)
θ	=	porosity, volume fraction
z	=	vertically downward distance from the top of the consolidatable sediment (m).

The following limits are imposed on the filter cake thickness

$$D_{fcMin} \le D_{fc} = f_D(D_s + D_{fc}) \le D_{fcMax} \le H \qquad \text{(H-2)}$$

where

D_{fcMin}	=	minimum permissible thickness of filter cake, m = 0.1 m
f_D	=	fraction of total sediment depth that is consolidatable = 0.5
D_{fcMax}	=	maximum permissible thickness of filter cake, m = 0.6 m.

The compressibility of the consolidatable sediment is determined from

$$a_v = \frac{0.435 C_c}{\frac{1}{2}\sigma_{vf}\big|_{z=\frac{1}{2}D_{fc}}} \qquad \text{(H-3)}$$

where

C_c = compression index = 1.02

From

$$\Delta e = -a_v \Delta\sigma_{vf} \qquad \text{(H-4)}$$

where

e = void ratio

we can determine the change in void ratio by

$$e' = e_0 + \Delta e \qquad \text{(H-5)}$$

where

e_0 = initial void ratio (based on initial hydraulic conductivity at no stress condition)
= 2.0

or

$$e' = e_0 - a_v \Delta\sigma_{vf} \quad . \qquad \text{(H-6)}$$

From a number of laboratory observations (see Lambe and Whitman, 1969), we can express hydraulic conductivity, K, of the sediment as a function of void ratio, thus:

$$\log(e) = \log(A) + b \ \log(K) \qquad \text{(H-7)}$$

or

$$\left(\frac{e}{A}\right)^{\frac{1}{b}} = K \qquad \text{(H-8)}$$

where A, b are constants and

A = 1,120
b = 0.337

Using Equations H-1, H-3, H-6, and H-8, we can write:

$$K(e') = [(e_0 - a_v((H - D_s - D_{fc})\rho_w g + (1-\theta)\rho_s g D_s + \theta\rho_w g D_s + (1-\theta)\rho_s g z + \theta\rho_w g z - [(H - D_{fc})\rho_w g - \frac{z}{D_{fc}}(H - D_{fc})\rho_w g])\frac{1}{A}]^{\frac{1}{b}} \quad \text{(H-9)}$$

or simply

$$K(e') = (C_1 + C_2 z)^{\frac{1}{b}} \quad \text{(H-10)}$$

where

C_1, C_2 = constants.

The effective hydraulic conductivity of the consolidatable sediment is

$$\frac{1}{K_{FcEff}} = \frac{1}{D_{fc}} \int_0^{D_{fc}} \frac{1}{(C_1 + C_2 z)^{\frac{1}{b}}} dz \quad \text{(H-11)}$$

Integrating Equation H-11, one obtains:

$$\frac{1}{K_{FcEff}} = \frac{1}{D_{fc}(1 - \frac{1}{b})C_2} \left((C_1 + C_2 D_{fc})^{1-\frac{1}{b}} - (C_1)^{1-\frac{1}{b}} \right) \quad \text{(H-12)}$$

H.2 Effective Hydraulic Conductivity of Clogged Native Material

The values of saturated hydraulic conductivity of the clogged zone are commonly lower than that of the pristine native material, or

$$K_{clogged} = C_{fact} K_{sat} \quad \text{(H-13)}$$

where

C_{fact} = clogging factor = 0.1
K_{sat} = saturated hydraulic conductivity of the native vadose zone material (m/d).

The following conditions are imposed on the hydraulic conductivity of the clogged native material:

$$K_{fc} \leq K_{Clogged} \leq K_{sat} \quad \text{(H-14)}$$

Penetration depth of up to about 0.45 m has been observed; the depth of the clogged layer is assumed to be fixed at 0.5 m.

H.3 Limitations on Maximum Infiltration Rate

If the infiltration rate calculated using the equations in Section H.2 exceed the rate at which the saturated zone can transport the groundwater, the groundwater level will rise into the unsaturated zone and the assumption of zero pressure head at the base of the unsaturated zone is violated. This groundwater "mounding" will reduce the effective infiltration rate. The maximum infiltration rate is estimated as the rate that does not cause the groundwater mound to rise to the bottom elevation of the SI unit. The maximum allowable infiltration rate may be approximated by:

$$I_{Max} \leq \frac{2K_{aqsat}D_{aqsat}(D_{vadose} - H)}{R_0^2 \ln\frac{R_\infty}{R_0}} \quad \text{(H-15)}$$

where

I_{Max} = infiltration rate (m/d)

K_{aqsat} = hydraulic conductivity of the saturated zone (m/d)

D_{aqsat} = depth of the saturated zone (m)

D_{vadose} = vadose zone thickness (m)

R_0 = equivalent source radius (m)

R_∞ = length between the center of the source and the nearest downgradient boundary where the boundary location has no perceptible effects on the heads near the source (m). The nearest downgradient boundary location is normally

the nearest surface water body located along one of the streamlines traversing the surface impoundment.

The equivalent source radius may be calculated from:

$$R_0 = \sqrt{\frac{A}{\pi}} \quad \text{(H-16)}$$

where

A = source area, m^2.

If Equation H-15 is used to limit the infiltration (leachate flow) rate, the program will output a warning message stating that the infiltration rate is being capped to prevent groundwater mounding.

Under certain conditions of high soil-saturated hydraulic conductivity and long residence time in the SI, the leachate flow rate may exceed the influent flow rate. That is, given a porous underlying soil layer and high WMU residence time, the steady-state water depth may be less than the assumed depth of the liquid compartment as calculated or $d_{wmu} - d_2$. Rather than reiterating the infiltration rate calculation with liquid depth as a variable, the leachate rate is set equal to 99 percent of the influent flow rate as follows:

$$Q_{leach} = 0.99\ Q_{infl} \quad \text{(H-17)}$$

This equation is based on a volumetric balance on the WMU and an assumption that Q_{out} equals 1 percent of Q_{in}. If Equation H-17 is used to calculate the leachate flow rate, the program will output a warning message stating that the infiltration (leachate flow) rate is being capped by the influent flow rate.

The hydrogen cyanide (HCN) sector includes one waste stream (commingled wastewaters) managed in an onsite surface impoundment. The data used to describe the surface impoundment in the evaluation of this waste stream/WMU combination are presented in Table H-1 as an example of the data used for estimating infiltration from an onsite surface impoundment.

Table H-1. Surface Impoundment Parameters for Commingled Wastewaters, HCN Sector

Parameter	Value
Surface area	11,200 m^2
Ponding depth Normal range Maximum	 30-55 in 62 in
Depth of sludge layer	12 in
Liner	None
Nearest surface waterbody	Loosahatchie River
Distance to surface waterbody	800 ft
Mean flow of surface waterbody	51.7 Mgal/d
Underlying soil Clayey silt	 25-30 ft

NA = Not applicable.

Appendix I

Distribution Coefficients

Appendix I

Distribution Coefficients

The development and use of partition coefficients is common to two ongoing EPA studies: paints manufacturing waste listing determination and inorganics chemical manufacturing waste listing determination. Accordingly, the work documented in this appendix covers metals that are common to both studies. Not all of these metals were evaluated in the risk assessment for the inorganics chemical manufacturing waste listing determination.

Metal speciation and partitioning is an important factor in assessing the fate and mobility of metals in the environment. Because metals behavior is affected by such a large number of simultaneously occurring processes, predicting metal speciation and partitioning is complex. Yet, the ability to understand and ultimately predict the fate and mobility of metals is fundamental to any risk assessment involving the release of metals to the environment. One approach to the problem has been to use distribution coefficient (K_d) values to describe metal partitioning between environmental substrates and aqueous phases. Within the context of this risk assessment, K_d values are required as constituent-specific inputs for EPA's Composite Model with Transformation Products (EPACMTP) vadose zone and aquifer modules. They are also required as constituent-specific inputs for source partition models and for aboveground fate and transport modeling of constituent concentrations in soils, watersheds, and waterbodies.

The K_d is metal-specific as well as system-specific. Depending on the metal and the system parameters, the K_d can vary over as many as six or seven orders of magnitude. Ranges of this size present a challenge in the estimation of a single generic K_d value for use in risk assessment models. Methods that have been used to estimate K_d values for risk assessment include

- The use of aqueous speciation models such as MINTEQA2, which predict metal partitioning between a specified substrate and aqueous phase based on the thermodynamics of the defined system.

- Review and compilation of measured data reported in the scientific literature.

In response to concerns raised about the adequacy of the MINTEQA2 aqueous speciation model to estimate K_d values for use in risk assessment studies, EPA opted to use K_d measurements compiled from the scientific literature for this risk assessment. For this work,

EPA expanded on previous efforts that used empirical K_d values, including *Partitioning Coefficients for Metals in Surface Water, Soil, and Waste for HWIR99* (U.S. EPA, 1999a) and *Understanding Variation in Partition Coefficient, K_d, Values* (U.S. EPA, 1999b).

I.1 Literature Review

A literature review was undertaken to compile experimentally derived K_d values for soil and aquifer materials. The metals of interest included: antimony (Sb), arsenic (As), barium (Ba), beryllium (Be), boron (B), cadmium (Cd), chromium (Cr), cobalt (Co), copper (Cu), lead (Pb), manganese (Mn), molybdenum (Mo), mercury (Hg), nickel (Ni), selenium (Se), silver (Ag), thallium (Tl), tin (Sn), vanadium (V), and zinc (Zn). Cyanide (CN) was also likely to be of interest and was included in the literature search.

The general approach was to review and expand, as appropriate, upon two recent EPA efforts to identify and compile measured K_d values from literature sources. Specifically, these were the K_d data collection effort for the Hazardous Waste Identification Rule (HWIR; U.S. EPA, 1999a) and work conducted by EPA's Office of Air and Radiation (OAR) and the U.S. Department of Energy (DOE) (U.S. EPA, 1999b). The approach was designed to ensure that all relevant data were compiled and that the compiled data accurately reflected that reported in the scientific literature. Specific steps conducted as part of this literature review are described in the following subsections.

I.1.1 Step 1. Review and Comparison of Recent K_d Surveys

The HWIR and OAR databases were reviewed to determine which of the metals of interest to this study were represented in the two databases. The HWIR database contained a greater subset of target metals and became the starting foundation for this current effort. The OAR database was used to provide supplementary data for three metals common to both datasets (i.e., cadmium, chromium, and lead).

Distribution coefficient values representing soil/soil-water systems collected as part of the HWIR effort were compared to K_d values collected by the EPA/OAR study. The purpose of the comparison was to check for reasonable agreement in the values common to both studies and to identify gaps in the datasets. The comparison was limited to metals common to both studies and included cadmium, chromium, and lead. As shown in Figures I-1 through I-3, the median and lower limits of the two studies were similar. Differences in the two datasets were chiefly attributed to differences in the literature reviewed. The HWIR survey relied on information reported in the open literature whereas the OAR study included values from the open literature as well as from institutional reports such as those published by the Electric Power Research Institute and DOE. Where the studies used common references, the compiled data agreed well between the two reports.

On the basis of this comparison, it was concluded that, for the metals addressed, the HWIR and OAR surveys provide a solid data foundation for soil systems. However, because the HWIR survey did not address groundwater systems, K_d values for aquifer systems were lacking. Furthermore, the HWIR survey did not include aquifer or soil system data for three constituents

of concern (boron, manganese, and hydrogen cyanide). Hence, a supplemental literature search was designed and implemented to fill in these data gaps (see Step 3).

I.1.2 Step 2. Database Design

A simple database was designed and constructed to compile all K_d values collected under this effort as well as those collected as part of the HWIR and OAR surveys. Data collected as part of the HWIR survey were transferred electronically into the database. Random checks of the data were performed to confirm that the transfer was successful. Data from the OAR survey were keyed in and a 100 percent check of the keyed data was performed to ensure that all values were entered accurately.

The data dictionary is presented in Figure I-4. As shown, the database was designed to allow collection of all pertinent geochemical parameters reported in the references reviewed.

I.1.3 Step 3. Literature Survey

A literature survey was designed to identify measured K_d values that have been reported in the scientific literature. This survey was adopted from the HWIR survey plan and included the collection of published K_d values for the metals of interest in the environmental media of interest, estimation of K_d values from reported metal concentration data when feasible, and review of established relationships between K_d values and other variables, (U.S. EPA, 1999b, citing, for example, Strenge and Peterson, 1989, and Whelan et al., 1992). Relevant geochemical parameters (e.g., pH, metal concentration, sorbent content) were collected along with the K_d values when available. To the extent possible, the notation and procedure for collecting and calculating K_d values followed that in Lyon et al. (U.S. EPA, 1999b, citing Lyon et al., 1997).

Data sources included the scientific literature, EPA reports, and reports from other government and university sources. Electronic searches were conducted using the following databases:

- AGRICOLA (1970 - present)
- Analytical Abstracts (1980 - present)
- Applied Science and Technology Abstracts
- Aquatic Sciences and Fisheries Abstract Set (1981 - present)
- CAB Abstracts (1987 - present)
- Current Contents (1992 - present)
- Dissertation Abstracts (1981 - present)
- EI Compendex (1970 - present)
- Enviroline (1975 - present)
- Environmental Bibliography (1973 - present)
- GEOBASE (1980 - present)
- GEOREF (1985 - present)
- National Technical Information Service
- Pollution Abstracts (1970 - present)
- TOXLINE (1982 - present)

- WATERNET (1971 - present)
- Water Resources Abstracts (1987 - present).

Two separate searches were conducted. The first search focused on groundwater systems and included the entire suite of constituents of concern. Specifically, the literature was searched electronically for K_d values measured in groundwater systems for antimony, arsenic, barium, beryllium, boron, cadmium, chromium, cobalt, copper, lead, manganese, molybdenum, mercury, nickel, selenium, silver, thallium, tin, vanadium, zinc, hydrogen cyanide, and methylated mercury. The search string read as follows:

> *"partition coefficient" or "distribution coefficient" or "retardation factor" or "Kd" or "Kp" or "R" or "Rf" or "sorption" and "metal" and "ground water" or "ground water" or "aquifer" or "saturated zone"*

For each of these metals, the chemical name as well as the chemical symbol was included in the search string. For metals that are characterized by multiple oxidation states (e.g., arsenic and chromium), the important oxidation states were also added to the search string.

The second search focused on the three constituents not previously considered in the HWIR survey (i.e., boron, manganese, and hydrogen cyanide). The literature was searched electronically for K_d values measured in soil systems for boron, manganese, and hydrogen cyanide. The second search string read as follows:

> *"partition coefficient" or "distribution coefficient" or "Kd" or "Kp" or "sorption" and "constituent" and "soil" or "vadose zone" or "unsaturated zone"*

These strings were specifically designed to generate many citations, thereby decreasing the probability that relevant articles would be missed. However, the generality of the search strings also guaranteed that a significant number of the articles identified in the search would not contain relevant information. Because resources and schedule constraints prevented review of every single article in detail, a strategy was developed to expedite the review process.

Each of the titles returned in the literature search was reviewed for key words suggesting that the article might contain measured K_d values for one or more of the constituents of concern. For those titles that held promise, an electronic copy of the abstract was obtained and reviewed. Because it was frequently difficult to ascertain the contents of an article based solely on the title, all likely candidate abstracts were ordered. Each of the abstracts was then reviewed for information pertaining to the type and purpose of the study. The complete article was ordered if it seemed a likely candidate to contain experimentally measured K_d values for either groundwater or soil systems for the constituents of concern. Articles were reviewed and K_d values entered into the database.

The geochemical and measurement parameters most likely to influence the K_d were also entered into the database if specified in the article or report. Examples of these included media type, extractant, pH, total metal concentrations, dissolved organic carbon content, weight fraction of particulate organic matter, clay content, cation exchange capacity, and test method.

I.1.4 Step 4. Quality Assurance/Quality Control

Quality control activities included the following:

- Definition and documentation of criteria to judge the quality of the data and their relevance for use in modeling
- Comparison of data sources included in the HWIR and OAR datasets to ensure comprehensiveness and appropriateness of literature search criteria
- One hundred percent checks of all hand-entered data against the original sources
- Manual or parallel spreadsheet calculation checks of all automated data processing (e.g., data conversions, statistical analyses).

Quality control activities were performed by senior scientists with extensive experience in the field of geochemistry, and in evaluation of K_d data in particular. Each of the articles was reviewed by two individuals and the extracted data cross checked.

I.2 Criteria For Selection of K_d Values

A set of criteria were defined for selection of K_d values from the literature. The criteria included:

- Natural soil or aquifer media as opposed to pure mineral phases or treated soils
- Aqueous solutions (extractants) with low ionic strength ($\leq$ 0.1 M), low humic material concentrations (< 5 mg/L), and dilute metal concentrations
- Absence of organic chelates (e.g., EDTA)
- pH values in the range of 4 to 10.

Batch leach tests were considered to represent systems closer to equilibrium and were preferred over column tests (when both were available for the same study and soil). Langmuir isotherm data were not used. Freundlich isotherm data were used and converted to K_d by assuming 1 part per million. For some field studies, measured retardation factors (Rf) were also used to calculate K_d. In these cases, the following equation was used:

$$(Rf - 1)/(\text{bulk density}/\text{effective porosity}) = K_d.$$

If multiple K_d values were reported for the same soil type within a single reference, only one K_d was selected to avoid biasing the data in favor of any one researcher. The value selected was that most closely approximating natural conditions (i.e., unadjusted values on untreated samples using natural extractants).

I.4 Results of the Literature Search

A total of 57 articles were obtained and reviewed for this project. Distribution coefficient values were compiled and entered into the database along with those values collected during the HWIR and EPA/OAR studies (U.S. EPA, 1999a and U.S. EPA, 1999b, respectively). The HWIR effort was broader in its scope and resulted in review of approximately 245 articles and reports pertaining to metal partitioning between soil and soil-water, between suspended matter and surface water, between sediment and sediment-pore water, and between dissolved organic carbon and the dissolved inorganic phase in natural waters. Although all the HWIR data were imported into the database, only those data specific to soil and groundwater systems were used in this risk assessment.

Table I-1 presents summary statistics for the dataset. As expected, references were not obtained for the full suite of constituents of concern. There was a preponderance of data for arsenic, boron, cadmium, cobalt, copper, lead, nickel, and zinc. Although one of the objectives of the literature search was to determine separate K_d values for all metals that occur in multiple environmentally relevant oxidation states, this proved possible only for chromium. Other metals such as arsenic, selenium, and antimony are known to occur in multiple oxidation states, but the retrieved data were not adequate to clearly differentiate K_d values among different oxidation states for these metals. Hence, results are presented for arsenic, selenium, and antimony without specifying oxidation state. Chromium is the exception and results are reported for Cr(III) and Cr(VI).

Molybdenum and vanadium are known to exhibit multiple oxidation states as well. For these metals, it was assumed that the K_d values reported in the literature correspond to those expected for molybdate and vanadate, respectively.

I.5 Analysis of Retrieved Data and Development of K_d Ranges

Once the literature search and data compilation were complete it was necessary to prepare K_d values for use as input parameters for the soil and groundwater fate and transport models. Because K_d varies by several orders of magnitude for most metals, and because these models are known to be sensitive to K_d (in the context of calculating a retardation coefficient, R), it is appropriate to represent K_d as a distributed variable in the Monte Carlo runs. Two approaches were used to generate these distributions, depending on the availability of data: (1) a rank-order percentile approach was used to formulate empirical probability distributions from available measurements for metals with six or more literature K_d values, or (2) a log uniform distribution was used to represent variability when empirical K_d data were limited to five or fewer samples.

Empirical distributions were used because, although the literature review captured most, if not all, available measured K_d values, the data were judged to be inadequate to definitively fit a distribution type. Specifically, the sample represented by a collection of literature-derived data is not a random sample of all possible K_d values. There is the potential for bias in which soil or groundwater systems were selected for a study, and distribution fitting and parameterizing generally require a random sample. In addition, the number of values compiled for many metals was not adequate to apply routines to determine distribution type. In summary, the empirical

distribution approach offers the following advantages to assuming a distribution type like lognormal, gamma, or Weibull.

- # It honors the measured values collected for the study.
- # It is simple to apply and explain.
- # It captures the measured range and variability of K_d values in soil and groundwater.

The development of these empirical distributions is described in Section I.5.1. For metals for which the number of variables was not adequate to represent the data empirically, a loguniform distribution was assumed as described in Section I.5.2. Section I.5.3 describes the raw database of K_d values collected from the literature.

I.5.1 Empirical Distributions

An empirical distribution was developed for each metal represented by six or more literature K_d values (As, B, Cd, Cr(III), Cr(VI), Co, Cu, Pb, Mn, Hg, Ni, Se, Ag, and Zn). For each of these metals, the literature K_d values were listed in ascending order and ranked from 1 to N (N being the number of literature values). The cumulative distribution function (CDF) value for each K_d value was then calculated using the following formula:

$$CDF = rank/(1 + N);$$ where N is the total number of literature K_d values.

To account for uncertainty regarding whether the highest and lowest values in a dataset are the true maximum and minimum, the measured value range was extended as follows. The interval between the first two literature values was subtracted from the first to get a K_d value for CDF = 0. If this resulted in a negative value, then the CDF = 0 value was half of the first K_d value. The interval between the last two literature values was then added to the last to get a K_d value for CDF = 1.

Tables I-2 through I-15 show the empirical CDF distributions developed from the collected literature K_d values for each of these metals.

I.5.2 Loguniform Distributions

For all of the metals with five or fewer literature K_d values (Ba, Be, Tl, Mo, Sb, Sn, and V), a loguniform distribution was assumed. The loguniform shape was selected because, in general, K_d distributions are skewed with a long right tail, but distribution type cannot be definitively determined. The range of this distribution (three log units or three orders of magnitude) was based on the observation that, for the empirical distributions, the average range of measured values was about three log units.

To develop the loguniform distribution for a metal, the logarithms of the literature K_d values were averaged. Using the average logarithm value, a value of 1.5 was added to get a

maximum value for the distribution, and 1.5 was subtracted to get a minimum value. The inverse logarithms of the minimum and the maximum were then taken to get the final minimum and maximum K_d values for the loguniform distribution.

This approach could not be applied in the case of Tl. There were no measured K_d values found for Tl in the open scientific literature. Loux et al. (1990) presented K_d values determined from aquifer material/groundwater samples obtained from six states (WI, OR, FL, TX, UT, and NJ). The samples were subjected to acid-base additions so that K_d values were obtained at various pH values ranging from 2 to 11. The range in log K_d measured in these samples was from 0 to about 3 L/kg. Because this was the only instance of measured K_d values found for Tl, the range observed by Loux et al. (1990) was used to define a loguniform distribution—the log K_d was assumed to vary from 0 to 3 L/kg. This approach is consistent with the methodology used to treat the other metals for which there was a paucity of data.

Table I-16 lists the parameters of the loguniform distributions for metals with few (five or less) measured values. No values are presented for CN because no measured K_d values were found in the scientific literature. In a recent review of the behavior of CN in soil and groundwater, Kjeldsen (1999) suggests that retardation of CN transport due to sorption is expected to be of minor importance in most soils. To ensure conservatism, the K_d for CN was set equal to zero.

I.5.3 The Database of Literature K_d Values

The K_d values collected from the literature and used to create the distributions are listed in Tables I-17 and I-18. Each table provides, by metal, the K_d and log K_d values and corresponding reference information (reference index). The reference index consists of the first two or three letters of the first author's surname and the year of publication. Each reference index corresponds with a fully cited reference listed in Section I.8 the reference index is listed at the end of each citation. The "Study" heading in the tables indicates the EPA study that collected each value, with "Listing" indicating this study, "HWIR" indicating values collected by the Office of Solid Waste (OSW) for the Hazardous Waste Identification Rule (HWIR) risk modeling effort (U.S. EPA, 1999a), and "OAR" indicating values recently collected by EPA's Office of Air and Radiation (U.S. EPA, 1999b). Note that HWIR and OAR values were collected directly from those study reports and are, therefore, secondary values and citations.

Table I-17 also includes a description of the type of soil or aquifer material, the location of the study, and data on environmental conditions for the K_d determination, including (as available) pH, particulate (solid) organic carbon content (POC), dissolved organic carbon content (DOC), iron oxide (FeOx) and aluminum oxide (AlOx) content, percent clay, and cation exchange capacity (CEC). Data for these properties were collected from the cited references when available and entered into the database. Blank entries indicate that the information was not available. Table I-18 provides, for the identical list of metals, an indication of whether the value is relevant to soil or to aquifer material, the pH, extraction fluid (extractant), and experimental method (e.g., batch, column, field study). Comments are provided that describe how data were extracted or processed and special aspects of the study.

I.6 Uncertainty in K_d Values

Partition coefficients reported in the literature and presented in this K_d database are subject to numerous sources of uncertainty. Many previous studies have demonstrated that, in a variety of soils and for a variety of metals, partition coefficients vary with pH and with the concentration of sorbing phases in the soil matrix (e.g., weight percent organic matter content, weight percent hydrous ferric oxides, and corresponding oxides of aluminum and manganese) (Janssen et al., 1997; Hassan and Garrison, 1996; Bangash and Hanif, 1992; Anderson and Christensen, 1988). It is well known that dissolved ligands present in soil porewater (e.g., dissolved organic matter, anthropogenic organic acids) may complex with metals, reducing their propensity for sorption in proportion to the concentration of the ligands (Christensen et al., 1996). Within the population of soils, the natural variability in soil pH and in the composition of soil and its associated porewater results in variation in K_d over orders of magnitude, even for a single metal. For this reason, any comprehensive compilation of K_d values selected from the literature should present values that define a distribution. In fact, for a particular metal, K_d depends on these and other characteristics of the soil/porewater system, and, in a nationwide risk assessment, it is desirable to sample the national population of soil/porewater systems to obtain a frequency distribution of K_d.

Unfortunately, the collection of soil/porewater systems chosen for study by various researchers and reported in the literature almost certainly does not represent the national population of such systems, and collections of K_d values obtained from the literature almost certainly do not represent the true national frequency distribution of K_d for a particular metal. Furthermore, the degree to which the soil systems reported in the literature adequately represent the population of soils varies greatly among the different metals for which K_d values have been obtained. The development of frequency distributions of K_d for this analysis is described in Section I.5. For the empirical treatment, the collected K_d values were simply assumed to represent the true frequency distribution. In the loguniform treatment, the average of the collected log K_d values was assumed to define a central tendency value, and the minimum and maximum were established as 1.5 log units below and above this value. For any particular metal, the degree to which either method of establishing the frequency distribution of K_d is faithful to the true national frequency distribution of K_d, as it reflects the population of soil/porewater systems, is unknown. Qualitatively, it may be supposed that the frequency distributions for K_d represented by the empirical method are more nearly representative of the true frequency distributions, because they include more sampled K_d values.

Apart from uncertainties in representing the expected variation in K_d that arise from variation in soil/aquifer properties, there are significant uncertainties associated with individual K_d values. Sources of uncertainty in individual literature K_d values include:

- Detection limits in measuring metal concentrations may result in limiting the observed maximum K_d value.

- Equilibrium conditions may not have prevailed in the experiment for measuring media concentrations. Most batch experiments are carried out over a time span of

one or two days. Equilibrium may or may not have been attained, and unaccounted for nonequilibrium processes may have occurred.

- Some variability in collected K_d values may reflect variability in the different methods of measurement (e.g., batch experiments, measurements from natural soil and associated porewater, calculation from tracer/retardation studies).

- Some variability in collected K_d values may reflect variability in extractants used in batch tests. Some researchers used soil porewater or groundwater as the extractant. Others used distilled water or a solution of electrolyte. The modeling in which these K_d values are to be used may implicitly prescribe an extractant that is dissimilar to any used in literature studies (e.g., landfill leachate).

- Some uncertainty in the reported K_d values is associated with uncontrolled or unknown redox conditions during the course of experimental measurements, especially for redox-sensitive metals (e.g., Cr, As, Se).

- There is uncertainty in the K_d values due to neglecting the impact of total system concentration of metal on the magnitude of K_d. Numerous studies have documented the dependence of K_d on total metal concentration—K_d tends to decrease as the total metal concentration increases. No attempt has been made in this compilation of literature values to investigate or represent the dependence of K_d on metal concentration. Instances in cited references of the use of Freundlich isotherms to represent such a dependence have been treated by computing the K_d appropriate for a dissolved metal concentration of 1 ppm. The K_d values compiled here are likely to be more representative of those in systems with low metal concentration than systems with high metal concentration.

Finally, the magnitude of the uncertainty in K_d values presented in this database of literature values should be viewed as having a significant metal-dependent component. As noted already, several metals have been more widely studied (e.g., Cd, As, Pb). For some of the metals of interest in this study, most notably Tl and Sb, there is very little partitioning data available for soil and groundwater systems. In addition, some sources of uncertainty listed above are associated with metal-specific phenomena (e.g., detection limits, redox transformations, propensity for dependence of K_d on metal concentration).

I.7 Summary

The information presented herein represents K_d values compiled from the scientific literature for aquifer and saturated soil systems. As expected, not all metals were equally represented in the scientific literature. There was a preponderance of data for arsenic, boron, cadmium, cobalt, copper, lead, nickel, and zinc, and there was little to no data for barium, beryllium, molybdenum, antimony, tin, thallium, and vanadium.

Two approaches were used to prepare K_d distributions for use as input parameters for the soil and groundwater fate and transport models. The approach used was dependent upon the

availability of data. A rank-order percentile approach was used to formulate empirical probability distributions for metals having six or more available measurements. A loguniform distribution was used to represent variability when empirical data were limited to five or fewer values. A value of 0 was used for the K_d of CN.

Tables I-2 through I-16 present the frequency distributions used in the modeling effort to characterize variability and uncertainty in K_d values at a given site. A K_d value was picked at random from these distributions for each realization in probabilistic (Monte Carlo) EPACMTP model runs. Depending on model sensitivity to K_d, central tendency (50^{th} percentile) or high-end (90^{th} percentile) values were used for deterministic runs.

	OAR	HWIR
Number of values	174	3,737
Number of references	7	6
Common references	2	2
Minimum value	0.5	12
Median	122	710
Mean	227	1,881
Maximum value	4,360	18,263
Standard deviation	587	3,355
Coefficient of variation	2.6	1.8

HWIR = Hazardous Waste Identification Rule.
OAR = Office of Air and Radiation.

References Common to Both Studies

Allen, H. E., Y. Chen, Y. Li, C. P. Huang, and P. F. Sanders, 1995. Soil partition coefficients by column desorption and comparison to batch adsorption measurements. *Environmental Science & Technology*, 29(8):1887-1891. [Al95]

Anderson, P. R. and T. H. Christensen, 1988. Distribution coefficients of Cd, Co, Ni, and Zn in soils. *Journal of Soil Science*, 39:15-22. [An88] (cited but not used in HWIR)

HWIR Unique References

Christensen, T. H., 1985. Cadmium sorption at low concentrations. IV. Effect of waste leachates on distribution coefficients. *Water, Air, and Soil Pollution*, 26:265-274. [Ch85]

Janssen, R. P. T., W. J. G. M. Peijnenburg, L. Posthuma, and M. A. G. T. van Den Hoop, 1997. Equilibrium partitioning of heavy metals in Dutch field soils. I. Relationship between metal partition coefficients and soil characteristics. *Environmental Toxicology and Chemistry*, 16(12):2470-2478. [Ja97]

Kuo, S. and E. J. Jellum, 1991. Affinity and behavior of Cd sorption in some acid soils. *Water, Air, and Soil Pollution*, 57-58:369-376. [Ku91]

Merrington, G. and B. J. Alloway, 1994. The flux of Cd, Cu, Pb, and Zn in mining polluted soils. *Water, Air, and Soil Pollution*, 73:333-344. [Me94]

Schimmack, W., K. Bunzl, and H. Bachhuber, 1987. Variability of the sorption of Cs, Zn, Sr, Co, Cd, Ru, Tc, and I at trace concentrations by a forest soil along a transect. *Environment International*, 13:427-436. [Sc88]

Figure I-1. K_d Comparison for Cadmium (L/kg)

(continued)

OAR Unique References

Buchter, B., B. Davidoff, M. C. Amacher, C. Hinz, I. K. Iskandar, and H. M. Selim. 1989. "Correlation of Freundlich K_d and n Retention Parameters with Soils and Element." *Soil Science*, 148:370-379.

Del Debbio, J. A. 1991. "Sorption of Strontium, Selenium, Cadmium, and Mercury in Soil." *Radiochimica Acta*, 52/53:181-186.

Garcia-Miragaya, J. 1980. "Specific Sorption of Trace Amounts of Cadmium by Soils." *Communications in Soil Science and Plant Analysis*, 11:1157-1166.

Madrid, L., and E. Diz-Barrientos. 1992. "Influence of Carbonate on the Reaction of Heavy Metals in Soils." *Journal of Soil Science*, 43:709-721.

Navrot, J., A. Singer, and A. Banin. 1978. "Adsorption of Cadmium and its Exchange Characteristics in Some Israeli Soils." *Journal of Soil Science*, 29:205-511.

Figure I-1. (continued)

	OAR	HWIR
Number of values	22	3
Number of references	6	1
Common references	0	0
Minimum value	0.25	0.5
Median	44	27
Mean	346	25
Maximum value	2,905	47
Standard deviation	716	23
Coefficient of variation	2.1	0.9

HWIR = Hazardous Waste Identification Rule.
OAR = Office of Air and Radiation.

References Common to Both

[NONE]

HWIR Unique References

Hassan, S. M. and A. W. Garrison, 1996. Distribution of chromium species between soil and porewater. *Chemical Speciation and Bioavailability*, 8(3/4):85-103. [Ha96b]

OAR Unique References

Rai, D., J. M. Zachara, L. E. Eary, C. C. Ainsworth, J. E. Amonette, C. E. Cowan, R. W. Szelmeczka, C.T. Resch, R. L. Schmidt, D. C. Girvin, and S. C. Smith. 1988. *Chromium Reactions in Geological Materials*. EPRI-EA-5741. Electric Power Research Institute, Palo Alto, California.

Ramirez, L. M., J. B. Rodriguez and F. Barba. 1985. "Heavy Metal Concentration in Sludge-Soil Systems as a result of Water Infiltration." In *Tropical Hydrology and Caribbean Island Water Resources Congress*, F. Quinones and A. N. Sanchez (eds.), pp. 20-25, American Water Resources Association, Bethesda, Maryland.

Sheppard, M. I., D. H. Thibault, and J. H. Mitchell. 1987. "Element Leaching and Capillary Rise in Sandy Soil Cores: Experimental Results." *Journal of Environmental Quality*, 16:273-284.

Sheppard, M. I., and S. C. Sheppard. 1987. "A Solute Transport Model Evaluated on Two Experimental Systems." *Ecological Modeling*, 37:191-206.

Stollenwerk, K. G., and D. B. Grove. 1985. "Adsorption and Desorption of Hexavalent Chromium in an Alluvial Aquifer Near Telluride, Colorado." *Journal of Environmental Quality*, 14:150-155.

Wong, K. V., S. Sengupta, D. Dasgupta, E. L. Daly, N. Nemerow, and H. P. Gerrish. 1983. "Heavy Metal Migration in Soil-Leachate Systems." *Biocycle*, 24:30-33.

Figure I-2. K_d Comparison for Chromium (L/kg)

	OAR	HWIR
Number of values	14	31
Number of references	4	4
Common references	2	2
Minimum value	19	14
Median	3,500	12,514
Mean	15,444	21,572
Maximum value	79,000	67,856
Standard deviation	24,710	22,789
Coefficient of variation	1.6	1.1

HWIR = Hazardous Waste Identification Rule.
OAR = Office of Air and Radiation.

References Cited in Both Documents

Gerritse, R. G., R. Vriesema, J. W. Dalenberg, and H. P. De Roos, 1982. Effect of sewage sludge on trace element mobility in soils. *Journal of Environmental Quality*, 11:359-364. [Ge82] (cited but not used in HWIR)

Sheppard, S. C., W. G. Evenden, and R. J. Pollock, 1989. Uptake of natural radionuclides by field and garden crops. *Canadian Journal of Soil Science*, 69:751-767. [Sh89b]

HWIR Unique References

Janssen, R. P. T., W. J. G. M. Peijnenburg, L. Posthuma, and M. A. G. T. van Den Hoop, 1997. Equilibrium partitioning of heavy metals in Dutch field soils. I. Relationship between metal partition coefficients and soil characteristics. *Environmental Toxicology and Chemistry*, 16(12):2470-2478. [Ja97]

Merrington, G. and B. J. Alloway, 1994. The flux of Cd, Cu, Pb, and Zn in mining polluted soils. *Water, Air, and Soil Pollution*, 73:333-344. [Me94]

Sheppard, S. C. and M. I. Sheppard, 1991. Lead in boreal soils and food plants. *Water, Air, and Soil Pollution*, 57-58:79-91. [Sh91b]

OAR Unique References

Haji-Djafari, S., P. E. Antommaria, and H. L. Crouse. 1981. "Attenuation of Radionuclides and Toxic Elements by In Situ Soils at a Uranium Tailings Pond in central Wyoming." In *Permeability and Groundwater Contaminant Transport*, T. F. Zimmie, and C. O. Riggs (eds.), pp 221-242. ASTM STP 746. American Society of Testing Materials. Washington, D.C.

Rhoads, K., B. N. Bjornstad, R. E. Lewis, S. S. Teel, K. J. Cantrell, R. J. Serne, J. L. Smoot, C. T. Kincaid, and S. K. Wurstner. 1992. *Estimation of the Release and Migration of Lead Through Soils and Groundwater at the Hanford Site 218-E-12B Burial Ground. Volume 1: Final Report.* PNL-8356 Volume 1, Pacific Northwest Laboratory, Richland, Washington.

Figure I-3. K_d Comparison for Lead (L/kg)

Table: Export
Description: Soil Kd table

Field Name	Type	Size	Description
ID	Long Integer	4	unique identifier (key field)
Metal	Text	255	metal (elemental symbol)
Species	Text	255	metal identification (elemental symbol plus oxidation state)
RefIndex	Text	255	unique reference index
Medium	Text	255	substrate medium (soil, aquifer, waste)
MediaDescription	Text	255	description for medium (optional)
Depth(m)	Text	255	depth below ground surface in meters (optional)
Location	Text	255	location (city, state or country if foreign)
Kd_L/kg	Double	8	selected Kd measurement in liters per kilogram
LogKd	Double	8	logarithm (base 10) of Kd value
Uncertainty_(L/kg)	Text	255	standard deviation on Kd (optional)
Cd(mg_w/L_w)	Double	8	dissolved metal concentration in milligrams per liter (optional)
Cs(mg_s/kg_s)	Double	8	sorbed metal concentration in milligrams per liter (optional)
Ctot(mg/L)	Double	8	total metal concentration in milligrams per liter (optional)
Ctot(mg/kg)	Double	8	total metal concentration in milligrams per kilogram (optional)
pH	Double	8	pH for measured value (optional)
POC_wt%	Double	8	solid or total organic carbon for medium in weight percent optional
DOC	Double	8	dissolved organic carbon for extractant solution (optional)
DOC_units	Text	255	units for DOC (mg/L, mmol/L, etc.) (required only when DOC is filled)
FeOx	Double	8	hydrous iron oxides / hydroxides for medium (optional)
FeOx_units	Text	255	units for FeOx (wt%, mmol/kg, etc.) (required only when FeOx is filled)
AlOx	Double	8	hydrous aluminum oxides / hydroxides for medium (optional)
AlOx_units	Text	255	units for AlOx (wt%, mmol/kg, etc.) (required only when AlOx is filled)
Clay_wt%	Double	8	clay content of medium (weight percent) (optional)
CEC	Double	8	cation exchange capacity of medium (optional)
CECunits	Text	255	units for CEC (required only when CEC is filled)
Extractant	Text	255	extraction solution used for measurements (groundwater, 0.1N NaNO3, etc.)
Method	Text	255	method used to measure Kd (batch, column, field, etc.)
Comments	Memo	0	comments on any of the above (highlight selection criteria and any unusual or unique situations)

Figure I-4. Data Dictionary

Table I-1. K_d Data Statistics

Metal	No. of Kd values used	No. of References	Mean	Std. Dev.	Median	Min.	Max.
Ag	9	4	1,805.24	2,144.93	1,200	26.8	6,700
As	35	10	2,363.82	4,022.42	225	0.005	20,412
B	34	6	1.39	1.07	1.165	0.06	3.99
Ba	2	1	698.75	928.08	698.75	42.5	1,355
Be	2	1	5,186.25	6,807.67	5,186.25	372.5	10,000
Cd	102	19	935.50	2,196.15	202.85	2	18,263
Co	20	8	2,123.15	3,259.10	935	19	14,000
Cr(III)	25	4	7,696.44	7,038.37	5,977	25	24,217
Cr(VI)	21	11	305.78	571.59	26.9	0.2	1,729
Cu	22	2	669.68	919.08	476	25	4,318
Hg	9	5	4,542.54	4,185.96	4,500	0.22	10,526.7
Mn	12	4	536.33	1,155.32	113	34	4,100
Mo	5	4	66.10	81.59	10.56	2.75	162.5
Ni	40	4	1,444.46	1,816.82	445	3	7,250
Pb	39	8	18,599.21	22,163.92	5,310	14	67,856
Sb	2	1	12.50	2.12	12.5	11	14
Se	14	6	23.09	12.36	24.76	2.17	46.7
Sn	2	1	4,950.00	3,959.80	4,950	2,150	7,750
V	2	1	202.50	180.31	202.5	75	330
Zn	40	7	3,584.54	5,324.70	2,019.5	2.7	28,000

Table I-2. Empirical K_d Distributions for Silver

Metal	Kd_L/kg	Rank	CDF
Ag	13.4		0
Ag	26.8	1	0.1
Ag	137.1	2	0.2
Ag	390	3	0.3
Ag	650	4	0.4
Ag	1200	5	0.5
Ag	1250	6	0.6
Ag	2570	7	0.7
Ag	3323	8	0.8
Ag	6700	9	0.9
Ag	10077		1

Table I-3. Empirical K_d Distributions for Arsenic

Metal	Kd_L/kg	Rank	CDF
As	0.0025		0
As	0.005	1	0.03
As	1.13	2	0.06
As	1.86	3	0.08
As	2.97	4	0.11
As	10.4	5	0.14
As	12	6	0.17
As	13	7	0.19
As	18.8	8	0.22
As	19.4	9	0.25
As	33.2	10	0.28
As	45	11	0.31
As	67	12	0.33
As	90	13	0.36
As	97	14	0.39
As	120	15	0.42
As	125	16	0.44
As	158	17	0.47
As	225	18	0.5
As	804	19	0.53
As	1362	20	0.56
As	1502	21	0.58
As	2015	22	0.61
As	2109	23	0.64
As	2289	24	0.67
As	2521	25	0.69
As	2905	26	0.72
As	3127	27	0.75
As	3794	28	0.78
As	3829	29	0.81
As	5313	30	0.83
As	6075	31	0.86
As	6649	32	0.89
As	7243	33	0.92
As	9745	34	0.94
As	20412	35	0.97
As	31079		1

Table I-4. Empirical K_d Distributions for Boron

Metal	Kd_L/kg	Rank	CDF
B	0.033		0
B	0.06	1	0.03
B	0.087	2	0.06
B	0.125	3	0.09
B	0.162	4	0.11
B	0.32	5	0.14
B	0.35	6	0.17
B	0.409	7	0.2
B	0.421	8	0.23
B	0.62	9	0.26
B	0.86	10	0.29
B	0.89	11	0.31
B	0.93	12	0.34
B	0.94	13	0.37
B	0.97	14	0.4
B	1.08	15	0.43
B	1.14	16	0.46
B	1.15	17	0.49
B	1.18	18	0.51
B	1.24	19	0.54
B	1.29	20	0.57
B	1.35	21	0.6
B	1.37	22	0.63
B	1.4	23	0.66
B	1.52	24	0.69
B	1.53	25	0.71
B	1.93	26	0.74
B	1.93	27	0.77
B	2.16	28	0.8
B	2.34	29	0.83
B	2.53	30	0.86
B	3.33	31	0.89
B	3.58	32	0.91
B	3.92	33	0.94
B	3.99	34	0.97
B	4.06		1

Table I-5. Empirical K_d Distributions for Cadmium

Metal	Kd_L/kg	Rank	CDF
Cd	1		0
Cd	2	1	0.01
Cd	5.5	2	0.02
Cd	6	3	0.03
Cd	10.47	4	0.04
Cd	11	5	0.05
Cd	12	6	0.06
Cd	12	7	0.07
Cd	13.9	8	0.08
Cd	14	9	0.09
Cd	14	10	0.1
Cd	14	11	0.11
Cd	14.4	12	0.12
Cd	15	13	0.13
Cd	16.82	14	0.14
Cd	19.3	15	0.15
Cd	20.42	16	0.16
Cd	21	17	0.17
Cd	22.1	18	0.17
Cd	23.9	19	0.18
Cd	25	20	0.19
Cd	26.3	21	0.2
Cd	28.8	22	0.21
Cd	30.1	23	0.22
Cd	32	24	0.23
Cd	33.88	25	0.24
Cd	38	26	0.25

(continued)

Table I-5. (continued)

Metal	Kd_L/kg	Rank	CDF
Cd	40	27	0.26
Cd	46.8	28	0.27
Cd	52.5	29	0.28
Cd	52.7	30	0.29
Cd	62.8	31	0.3
Cd	69	32	0.31
Cd	80	33	0.32
Cd	84.3	34	0.33
Cd	87.1	35	0.34
Cd	91.2	36	0.35
Cd	97	37	0.36
Cd	97.9	38	0.37
Cd	102	39	0.38
Cd	113.2	40	0.39
Cd	133.3	41	0.4
Cd	144	42	0.41
Cd	152.1	43	0.42
Cd	159	44	0.43
Cd	175	45	0.44
Cd	180	46	0.45
Cd	181.8	47	0.46
Cd	186.6	48	0.47
Cd	200	49	0.48
Cd	200	50	0.49
Cd	201.5	51	0.5
Cd	204.2	52	0.5
Cd	225	53	0.51

(continued)

Table I-5. (continued)

Metal	Kd_L/kg	Rank	CDF
Cd	250	54	0.52
Cd	255	55	0.53
Cd	266.7	56	0.54
Cd	274.2	57	0.55
Cd	288.4	58	0.56
Cd	300	59	0.57
Cd	303.2	60	0.58
Cd	368.1	61	0.59
Cd	461.8	62	0.6
Cd	475	63	0.61
Cd	488.4	64	0.62
Cd	494.3	65	0.63
Cd	500	66	0.64
Cd	532	67	0.65
Cd	560	68	0.66
Cd	603	69	0.67
Cd	640	70	0.68
Cd	660	71	0.69
Cd	670	72	0.7
Cd	710	73	0.71
Cd	720	74	0.72
Cd	755	75	0.73
Cd	755.1	76	0.74
Cd	769.1	77	0.75
Cd	770	78	0.76
Cd	780	79	0.77
Cd	948	80	0.78

(continued)

Table I-5. (continued)

Metal	Kd_L/kg	Rank	CDF
Cd	974	81	0.79
Cd	1000	82	0.8
Cd	1010	83	0.81
Cd	1078	84	0.82
Cd	1378	85	0.83
Cd	1386.8	86	0.83
Cd	1594.9	87	0.84
Cd	1610	88	0.85
Cd	1700	89	0.86
Cd	1770	90	0.87
Cd	2000	91	0.88
Cd	2175	92	0.89
Cd	2200	93	0.9
Cd	2600	94	0.91
Cd	3549	95	0.92
Cd	4360	96	0.93
Cd	4653	97	0.94
Cd	5049	98	0.95
Cd	5828	99	0.96
Cd	6298	100	0.97
Cd	6446	101	0.98
Cd	18263	102	0.99
Cd	30080		1

Table I-6. Empirical K_d Distributions for Cobalt

Metal	Kd_L/kg	Rank	CDF
Co	9.5		0
Co	19	1	0.05
Co	41	2	0.1
Co	120	3	0.14
Co	136	4	0.19
Co	140	5	0.24
Co	160	6	0.29
Co	232	7	0.33
Co	400	8	0.38
Co	410	9	0.43
Co	880	10	0.48
Co	990	11	0.52
Co	1430	12	0.57
Co	1735	13	0.62
Co	1800	14	0.67
Co	2200	15	0.71
Co	3700	16	0.76
Co	4120	17	0.81
Co	4500	18	0.86
Co	5450	19	0.9
Co	14000	20	0.95
Co	22550		1

Table I-7. Empirical K_d Distributions for Chromium (III)

Metal	Kd_L/kg	Rank	CDF
Cr(III)	12.5		0
Cr(III)	25	1	0.04
Cr(III)	360	2	0.08
Cr(III)	524	3	0.12
Cr(III)	536	4	0.15
Cr(III)	711	5	0.19
Cr(III)	2364	6	0.23
Cr(III)	2418	7	0.27
Cr(III)	2747	8	0.31
Cr(III)	3799	9	0.35
Cr(III)	4219	10	0.38
Cr(III)	4711	11	0.42
Cr(III)	5075	12	0.46
Cr(III)	5977	13	0.5
Cr(III)	6746	14	0.54
Cr(III)	7933	15	0.58
Cr(III)	8116	16	0.62
Cr(III)	8906	17	0.65
Cr(III)	9159	18	0.69
Cr(III)	9519	19	0.73
Cr(III)	11063	20	0.77
Cr(III)	11992	21	0.81
Cr(III)	19796	22	0.85
Cr(III)	20665	23	0.88
Cr(III)	20833	24	0.92
Cr(III)	24217	25	0.96
Cr(III)	27601		1

Table I-8. Empirical K_d Distributions for Chromium (VI)

Metal	Kd_L/kg	Rank	CDF
Cr(VI)	0.1		0
Cr(VI)	0.2	1	0.05
Cr(VI)	0.5	2	0.09
Cr(VI)	1	3	0.14
Cr(VI)	2	4	0.18
Cr(VI)	5.3	5	0.23
Cr(VI)	6	6	0.27
Cr(VI)	7	7	0.32
Cr(VI)	8	8	0.36
Cr(VI)	10	9	0.41
Cr(VI)	22	10	0.45
Cr(VI)	26.9	11	0.5
Cr(VI)	46.5	12	0.55
Cr(VI)	50	13	0.59
Cr(VI)	52	14	0.64
Cr(VI)	100	15	0.68
Cr(VI)	110	16	0.73
Cr(VI)	288	17	0.77
Cr(VI)	1000	18	0.82
Cr(VI)	1372	19	0.86
Cr(VI)	1585	20	0.91
Cr(VI)	1729	21	0.95
Cr(VI)	1873		1

Table I-9. Empirical K_d Distributions for Copper

Metal	Kd_L/kg	Rank	CDF
Cu	15		0
Cu	25	1	0.04
Cu	35	2	0.09
Cu	38	3	0.13
Cu	67	4	0.17
Cu	88	5	0.22
Cu	92	6	0.26
Cu	109	7	0.3
Cu	135	8	0.35
Cu	155	9	0.39
Cu	322	10	0.43
Cu	452	11	0.48
Cu	500	12	0.52
Cu	529	13	0.57
Cu	701	14	0.61
Cu	838	15	0.65
Cu	874	16	0.7
Cu	874	17	0.74
Cu	986	18	0.78
Cu	1033	19	0.83
Cu	1253	20	0.87
Cu	1309	21	0.91
Cu	4318	22	0.96
Cu	7327		1

Table I-10 . Empirical K_d Distributions for Mercury

Metal	Kd_L/kg	Rank	CDF
Hg	0.11		0
Hg	0.22	1	0.1
Hg	0.78	2	0.2
Hg	2.2	3	0.3
Hg	1924.4	4	0.4
Hg	4500	5	0.5
Hg	7600	6	0.6
Hg	8000	7	0.7
Hg	8328.6	8	0.8
Hg	10526.7	9	0.9
Hg	12724.8		1

Table I-11. Empirical K_d Distributions for Manganese

Metal	Kd_L/kg	Rank	CDF
Mn	32		0
Mn	34	1	0.08
Mn	36	2	0.15
Mn	44	3	0.23
Mn	49	4	0.31
Mn	86	5	0.38
Mn	96	6	0.46
Mn	130	7	0.54
Mn	160	8	0.62
Mn	271	9	0.69
Mn	430	10	0.77
Mn	1000	11	0.85
Mn	4100	12	0.92
Mn	7200		1

Table I-12. Empirical K_d Distributions for Nickel

Metal	Kd_L/kg	Rank	CDF
Ni	1.5		0
Ni	3	1	0.02
Ni	7	2	0.05
Ni	12	3	0.07
Ni	18	4	0.1
Ni	24	5	0.12
Ni	40	6	0.15
Ni	40	7	0.17
Ni	49.5	8	0.2
Ni	115	9	0.22
Ni	130	10	0.24
Ni	185	11	0.27
Ni	236	12	0.29
Ni	243	13	0.32
Ni	250	14	0.34
Ni	292	15	0.37
Ni	310	16	0.39
Ni	350	17	0.41
Ni	376	18	0.44
Ni	420	19	0.46
Ni	440	20	0.49
Ni	450	21	0.51
Ni	744	22	0.54
Ni	1088	23	0.56
Ni	1255	24	0.59
Ni	1285	25	0.61
Ni	1430	26	0.63
Ni	1510	27	0.66
Ni	1660	28	0.68
Ni	1843	29	0.71
Ni	1857	30	0.73
Ni	2163	31	0.76
Ni	2310	32	0.78
Ni	2750	33	0.8
Ni	3151	34	0.83
Ni	4113	35	0.85
Ni	4370	36	0.88
Ni	4510	37	0.9
Ni	4750	38	0.93
Ni	5749	39	0.95
Ni	7250	40	0.98
Ni	8751		1

Table I-13. Empirical K_d Distributions for Lead

Metal	Kd_L/kg	Rank	CDF
Pb	9		0
Pb	14	1	0.025
Pb	19	2	0.05
Pb	19.8	3	0.075
Pb	20	4	0.1
Pb	24.4	5	0.125
Pb	93	6	0.15
Pb	96	7	0.175
Pb	100	8	0.2
Pb	126	9	0.225
Pb	750	10	0.25
Pb	916	11	0.275
Pb	1159	12	0.3
Pb	1326	13	0.325
Pb	1500	14	0.35
Pb	2637	15	0.375
Pb	3428	16	0.4
Pb	3550	17	0.425
Pb	4000	18	0.45
Pb	4250	19	0.475
Pb	5310	20	0.5
Pb	5923	21	0.525
Pb	9000	22	0.55
Pb	12514	23	0.575
Pb	16973	24	0.6
Pb	21000	25	0.625
Pb	22944	26	0.65
Pb	27722	27	0.675
Pb	30000	28	0.7
Pb	34727	29	0.725
Pb	36930	30	0.75
Pb	37379	31	0.775
Pb	42250	32	0.8
Pb	45502	33	0.825
Pb	46000	34	0.85
Pb	59000	35	0.875
Pb	60000	36	0.9
Pb	60000	37	0.925
Pb	60311	38	0.95
Pb	67856	39	0.975
Pb	75401		1

Table I-14. Empirical K_d Distributions for Selenium

Metal	Kd_L/kg	Rank	CDF
Se	1.085		0
Se	2.17	1	0.07
Se	9.25	2	0.13
Se	10.5	3	0.2
Se	10.7	4	0.27
Se	16.5	5	0.33
Se	18.9	6	0.4
Se	23.5	7	0.47
Se	26	8	0.53
Se	27.5	9	0.6
Se	30	10	0.67
Se	32	11	0.73
Se	34.5	12	0.8
Se	35	13	0.87
Se	46.7	14	0.93
Se	58.4		1

Table I-15. Empirical K_d Distributions for Zinc

Metal	Kd_L/kg	Rank	CDF
Zn	1.35		0
Zn	2.7	1	0.02
Zn	6	2	0.05
Zn	23	3	0.07
Zn	33.8	4	0.1
Zn	34	5	0.12
Zn	38	6	0.15
Zn	41	7	0.17
Zn	41	8	0.2
Zn	55.5	9	0.22
Zn	72.5	10	0.24
Zn	73	11	0.27
Zn	154	12	0.29
Zn	422	13	0.32
Zn	604	14	0.34
Zn	994.9	15	0.37
Zn	1278	16	0.39
Zn	1294	17	0.41
Zn	1299	18	0.44
Zn	1756	19	0.46
Zn	1989	20	0.49
Zn	2050	21	0.51
Zn	2245	22	0.54
Zn	2438	23	0.56
Zn	2700	24	0.59
Zn	2800	25	0.61
Zn	3000	26	0.63
Zn	3200	27	0.66
Zn	3698	28	0.68
Zn	5000	29	0.71
Zn	5100	30	0.73
Zn	5112	31	0.76
Zn	5472	32	0.78
Zn	5600	33	0.8
Zn	5667	34	0.83
Zn	6226	35	0.85
Zn	6762	36	0.88
Zn	9100	37	0.9
Zn	14000	38	0.93
Zn	15000	39	0.95
Zn	28000	40	0.98
Zn	41000		1

Table I-16. Loguniform K_d Distributions Used in Model Runs

Metal	Count	Distribution Type	Min Kd	Max Kd
Ba	2	loguniform	7.6	7586
Be	2	loguniform	61	60954
Mo	5	loguniform	0.68	682
Sb	2	loguniform	0.39	393
Sn	2	loguniform	129	128825
V	2	loguniform	5.0	5012

Table I-17. Measured Kd Values: Experimental Conditions

ID	Species	Study	RefIndex	Medium	Kd_L/kg	Log Kd	pH	Extractant	Method	Comments
9	Ag	Listing	Ba92	aquifer	6700	3.83	8	groundwater	batch (L:S not specified)	mean of three 0.45um-filtered replicates (Table 6); Total_Ag=3e-07 M; mean pH of replicates
3	Ag	HWIR	Jo86	soil	3323	3.52	5.8	dist. water	batch (10 mL : 1 g)	contaminated soil from silver mining area
8	Ag	Listing	Ba92	aquifer	2570	3.41	7.8	synthesized groundwater	batch (L:S not specified)	mean of three 0.45um-filtered replicates (Table 6); Total_Ag=2e-06 M; mean pH of replicates
5	Ag	Listing	Ge82	soil	1250	3.1	7.8	various: dist. water; 0.0035 M and 0.035 M CaCl2, NaCl, or KCl	batch (25 mL:5 g)	middle (7.8) of pH range (7.5 - 8.0) reported for a sandy loam soil
4	Ag	HWIR	Sz95	soil	1200	3.08		0.05M NaNO3	batch (40 mL: 1 g) using radiosilver	"eyeballed" from graph of Kd vs pH; plotted Kd's varied little with pH range 4 to 8
6	Ag	Listing	Ge82	soil	650	2.81	4.8	various: dist. water; 0.0035 M and 0.035 M CaCl2, NaCl, or KCl	batch (25 mL:5 g)	middle (4.8) of pH range (4.5 - 5.0) reported for a sandy soil
7	Ag	HWIR	Jo86	soil	390	2.59	4.2	dist. water	batch (10 mL : 1 g)	uncontaminated soil from silver mining area
1	Ag	HWIR	Jo86	soil	137	2.14	6	dist. water	batch (10 mL : 1 g)	contaminated soil from silver mining area
2	Ag	HWIR	Jo86	soil	26.8	1.43	5.9	dist. water	batch (10 mL : 1 g)	contaminated soil from silver mining area
39	As(V)	HWIR	Ja97	soil	20412	4.31	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
42	As(V)	HWIR	Ja97	soil	9745	3.99	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
27	As(V)	HWIR	Ja97	soil	7243	3.86	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
31	As(V)	HWIR	Ja97	soil	6649	3.82	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
26	As(V)	HWIR	Ja97	soil	6075	3.78	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
34	As(V)	HWIR	Ja97	soil	5313	3.73	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils

(continued)

Table I-17. (continued)

ID	Species	Study	RefIndex	Medium	Kd_L/kg	Log Kd	pH	Extractant	Method	Comments
28	As(V)	HWIR	Ja97	soil	3829	3.58	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
30	As(V)	HWIR	Ja97	soil	3794	3.58	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
41	As(V)	HWIR	Ja97	soil	3127	3.5	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
29	As(V)	HWIR	Ja97	soil	2905	3.46	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
43	As(V)	HWIR	Ja97	soil	2521	3.4	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
44	As(V)	HWIR	Ja97	soil	2289	3.36	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
37	As(V)	HWIR	Ja97	soil	2109	3.32	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
40	As(V)	HWIR	Ja97	soil	2015	3.3	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
36	As(V)	HWIR	Ja97	soil	1502	3.18	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
25	As(V)	HWIR	Ja97	soil	1362	3.13	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
38	As(V)	HWIR	Ja97	soil	804	2.91	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
10	As	Listing	On96	aquifer	225	2.35		water (NOS)	batch (23:5)	calculated from %sorbed and solid:liquid ratio for total As of 6.6 mg/L; more sorption (implying higher Kd) was observed for experiments with lower total As, but values could not be determined
35	As(V)	HWIR	Ja97	soil	158	2.2	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils

(continued)

Table I-17. (continued)

ID	Species	Study	RefIndex	Medium	Kd_L/kg	Log Kd	pH	Extractant	Method	Comments
23	As(V)	Listing	Ge82	soil	125	2.1	7.8	various: dist. water; 0.0035 M and 0.035 M CaCl2, NaCl, or KCl	batch (25 mL:5 g)	middle (7.8) of pH range (7.5 - 8.0) reported for a sandy loam soil
12	As	Listing	Ku97a	soil	120	2.08	11	groundwater	column desorption	selected long term experiment & stabilized value (25 void volumes); note alkaline pH
33	As(V)	HWIR	Ja97	soil	97	1.99	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
32	As(V)	HWIR	Ja97	soil	90	1.95	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
22	As(V)	HWIR	Is93	soil	67	1.83	5.3	0.01M NaCl	batch (5 mL: 1 g)	calculated from sorbed conc data plotted against solution conc for two soil horizons of one soil; mean Kd, pH, POC values
24	As(V)	Listing	Ge82	soil	45	1.65	4.8	various: dist. water; 0.0035 M and 0.035 M CaCl2, NaCl, or KCl	batch (25 mL:5 g)	middle (4.8) of pH range (4.5 - 5.0) reported for a sandy soil
18	As	Listing	Jo99	soil	33.2	1.52	8	0.01 M KCl	batch (20 mL:10 g)	from Table 1 (p. 1317); [Kd = 0.015 (AOE Fe) + 0.038 (AOE Mn) - 0.62 (Olsen P) + 3.3]; mean soil properties
14	As	Listing	DOE93	aquifer	19.4	1.29	7.2	groundwater	batch (L:S varies)	obtained from Freundlich isotherm parameters (Fig. 4.4) using 1 mg/l for dissolved conc; range of solid:liquid ratios (1g:1mL to 1g:40mL) were used to generate Freundlich isotherm points
16	As	Listing	Jo99	soil	18.8	1.27	8	0.01 M KCl	batch (20 mL:10 g)	median of two reported values (Table 1, p. 1317); [Kd = 0.015 (AOE Fe) + 0.038 (AOE Mn) - 0.62 (Olsen P) + 3.3]; mean soil properties
19	As	Listing	Jo99	soil	13	1.11	8	0.01 M KCl	batch (20 mL:10 g)	from Table 1 (p. 1317); [Kd = 0.015 (AOE Fe) + 0.038 (AOE Mn) - 0.62 (Olsen P) + 3.3];mean soil properties
21	As(III)	HWIR	Is93	soil	12	1.08	5.3	0.01M NaCl	batch (5 mL: 1 g)	calculated from sorbed conc data plotted against solution conc for two soil horizons of one soil; mean Kd, pH, POC values
15	As	Listing	Jo99	soil	10.4	1.02	8	0.01 M KCl	batch (20 mL:10 g)	median of two reported values (Table 1, p. 1317); [Kd = 0.015 (AOE Fe) + 0.038 (AOE Mn) - 0.62 (Olsen P) + 3.3]; mean soil properties
13	As	Listing	Ku97b	aquifer	2.97	0.47	7	groundwater	column adsorption	average values for two columns from same aquifer (different depths)
17	As	Listing	Ca98	aquifer	1.86	0.27	7	0.1 M & 0.01 M NaNO3	batch (L:S varies)	from Figure 5 (p. 255); no units reported, but value of retardation factor in Table 3 is consistent with L/kg.

(continued)

Table I-17. (continued)

ID	Species	Study	RefIndex	Medium	Kd_L/kg	Log Kd	pH	Extractant	Method	Comments
20	As(III)	HWIR	Is93	soil	1.13	0.05	5.3	0.01M NaCl	batch (5 mL: 1 g)	calculated from sorbed conc data plotted against solution conc for two soil horizons of one soil; mean Kd, pH, POC values
11	As	Listing	Za92	aquifer	0.005	-2.3	7.4	groundwater	field study	Kd estimated from Rf, assume effective posity = total porosity = 0.26;assumed bulk density = 2.0, As2O3 tracer; mean Rf, 10 and 20 m
52	B	Listing	El82	soil	3.99	0.6	7.57	0.01 M CaCl2	batch (20 mL:20 g)	"adsorption" value from Table 4, K for Freundlich, assumes C = 1 ppm
46	B	Listing	Go91	soil	3.92	0.59		0.1 M NaCl	batch (25 mL:5 g)	avg. of two "untreated" values from Table 1 for Freundlich "nonlinear" case, assumes C = 1ppm in Freundlich eq.; average value multiplied by 100 to get L/kg
50	B	Listing	Sa97	soil	3.58	0.55	8.15	0.03 M KNO3	batch (20 mL:5 g)	Freundlich adsorption constants (did not use desorption constants)
58	B	Listing	El82	soil	3.33	0.52	7.54	0.01 M CaCl2	batch (20 mL:20 g)	"adsorption" value from Table 4, K for Freundlich, assumes C = 1 ppm
54	B	Listing	El82	soil	2.53	0.4	7.62	0.01 M CaCl2	batch (20 mL:20 g)	"adsorption" value from Table 4, K for Freundlich, assumes C = 1 ppm
49	B	Listing	Sa97	soil	2.34	0.37	7.15	0.03 M KNO3	batch (20 mL:5 g)	Freundlich adsorption constants (did not use desorption constants)
53	B	Listing	El82	soil	2.16	0.33	7.42	0.01 M CaCl2	batch (20 mL:20 g)	"adsorption" value from Table 4, K for Freundlich, assumes C = 1 ppm
45	B	Listing	El82	soil	1.93	0.29	6.02	0.01 M CaCl2	batch (20 mL:20 g)	"adsorption" value from Table 4, K for Freundlich, assumes C = 1 ppm
48	B	Listing	Sa97	soil	1.93	0.29	5	0.03 M KNO3	batch (20 mL:5 g)	Freundlich adsorption constants (did not use desorption constants)
71	B	Listing	Mo93	soil	1.53	0.18		0.03 M KNO3	batch (20 mL:10 g)	recalculated from "Freundlich" isotherm (Table 2) assuming C = 1 ppm; soil properties given as ranges
63	B	Listing	Mo93	soil	1.52	0.18		0.03 M KNO3	batch (20 mL:10 g)	recalculated from "Freundlich" isotherm (Table 2) assuming C = 1 ppm; soil properties given as ranges
67	B	Listing	Mo93	soil	1.4	0.15		0.03 M KNO3	batch (20 mL:10 g)	recalculated from "Freundlich" isotherm (Table 2) assuming C = 1 ppm; soil properties given as ranges
65	B	Listing	Mo93	soil	1.37	0.14		0.03 M KNO3	batch (20 mL:10 g)	recalculated from "Freundlich" isotherm (Table 2) assuming C = 1 ppm; soil properties given as ranges
47	B	Listing	Sa97	soil	1.35	0.13	7.52	0.03 M KNO3	batch (20 mL:5 g)	Freundlich adsorption constants (did not use desorption constants)
68	B	Listing	Mo93	soil	1.29	0.11		0.03 M KNO3	batch (20 mL:10 g)	recalculated from "Freundlich" isotherm (Table 2) assuming C = 1 ppm; soil properties given as ranges

(continued)

Table I-17. (continued)

ID	Species	Study	RefIndex	Medium	Kd_L/kg	Log Kd	pH	Extractant	Method	Comments
62	B	Listing	Mo93	soil	1.24	0.09		0.03 M KNO3	batch (20 mL:10 g)	recalculated from "Freundlich" isotherm (Table 2) assuming C = 1 ppm; soil properties given as ranges
70	B	Listing	Mo93	soil	1.18	0.07		0.03 M KNO3	batch (20 mL:10 g)	recalculated from "Freundlich" isotherm (Table 2) assuming C = 1 ppm; soil properties given as ranges
66	B	Listing	Mo93	soil	1.15	0.06		0.03 M KNO3	batch (20 mL:10 g)	recalculated from "Freundlich" isotherm (Table 2) assuming C = 1 ppm; soil properties given as ranges
74	B	Listing	Mo93	soil	1.14	0.06		0.03 M KNO3	batch (20 mL:10 g)	recalculated from "Freundlich" isotherm (Table 2) assuming C = 1 ppm; soil properties given as ranges
75	B	Listing	Mo93	soil	1.08	0.03		0.03 M KNO3	batch (20 mL:10 g)	recalculated from "Freundlich" isotherm (Table 2) assuming C = 1 ppm; soil properties given as ranges
76	B	Listing	Mo93	soil	0.97	-0.01		0.03 M KNO3	batch (20 mL:10 g)	recalculated from "Freundlich" isotherm (Table 2) assuming C = 1 ppm; soil properties given as ranges
77	B	Listing	Mo93	soil	0.94	-0.03		0.03 M KNO3	batch (20 mL:10 g)	recalculated from "Freundlich" isotherm (Table 2) assuming C = 1 ppm; soil properties given as ranges
72	B	Listing	Mo93	soil	0.93	-0.03		0.03 M KNO3	batch (20 mL:10 g)	recalculated from "Freundlich" isotherm (Table 2) assuming C = 1 ppm; soil properties given as ranges
64	B	Listing	Mo93	soil	0.89	-0.05		0.03 M KNO3	batch (20 mL:10 g)	recalculated from "Freundlich" isotherm (Table 2) assuming C = 1 ppm; soil properties given as ranges
73	B	Listing	Mo93	soil	0.86	-0.07		0.03 M KNO3	batch (20 mL:10 g)	recalculated from "Freundlich" isotherm (Table 2) assuming C = 1 ppm; soil properties given as ranges
78	B	Listing	Ye95	soil	0.62	-0.21	7.5	0.005 M CaCl2	batch (20 mL:5 g)	from Fig 1 with no added composted OM, pH 7.5 (closest to natural pH of 7.8)
56	B	Listing	El82	soil	0.421	-0.38	7.89	0.01 M CaCl2	batch (20 mL:20 g)	"adsorption" value from Table 4, K for Freundlich, assumes C = 1 ppm
55	B	Listing	El82	soil	0.409	-0.39	6.02	0.01 M CaCl2	batch (20 mL:20 g)	"adsorption" value from Table 4, K for Freundlich, assumes C = 1 ppm
60	B	Listing	Go91	soil	0.35	-0.46		0.1 M NaCl	batch (25 mL:5 g)	avg. of two "untreated" values from Table 1 for Freundlich "nonlinear" case, assumes C = 1ppm in Freundlich eq.; average value multiplied by 100 to get L/kg
69	B	Listing	Mo93	soil	0.32	-0.49		0.03 M KNO3	batch (20 mL:10 g)	recalculated from "Freundlich" isotherm (Table 2) assuming C = 1 ppm; soil properties given as ranges
57	B	Listing	El82	soil	0.162	-0.79	7.82	0.01 M CaCl2	batch (20 mL:20 g)	"adsorption" value from Table 4, K for Freundlich, assumes C = 1 ppm
51	B	Listing	El82	soil	0.125	-0.9	8	0.01 M CaCl2	batch (20 mL:20 g)	"adsorption" value from Table 4, K for Freundlich, assumes C = 1 ppm
59	B	Listing	El82	soil	0.087	-1.06	7.03	0.01 M CaCl2	batch (20 mL:20 g)	"adsorption" value from Table 4, K for Freundlich, assumes C = 1 ppm

(continued)

Table I-17. (continued)

ID	Species	Study	RefIndex	Medium	Kd_L/kg	Log Kd	pH	Extractant	Method	Comments
61	B	Listing	Br97	aquifer	0.06	-1.22	7.57	groundwater	field tracer	median of calculated values based on in situ observations from 5 sampling points vertically, radially disposed.
79	Ba(II)	Listing	Ge82	soil	1355	3.13	7.8	various: dist. water; 0.0035 M and 0.035 M CaCl2, NaCl, or KCl	batch (25 mL:5 g)	middle (7.8) of pH range (7.5 - 8.0) reported for a sandy loam soil
80	Ba(II)	Listing	Ge82	soil	42.5	1.63	4.8	various: dist. water; 0.0035 M and 0.035 M CaCl2, NaCl, or KCl	batch (25 mL:5 g)	middle (4.8) of pH range (4.5 - 5.0) reported for a sandy soil
81	Be(II)	Listing	Ge82	soil	10000	4	7.8	various: dist. water; 0.0035 M and 0.035 M CaCl2, NaCl, or KCl	batch (25 mL:5 g)	middle (7.8) of pH range (7.5 - 8.0) reported for a sandy loam soil
82	Be(II)	Listing	Ge82	soil	372.5	2.57	4.8	various: dist. water; 0.0035 M and 0.035 M CaCl2, NaCl, or KCl	batch (25 mL:5 g)	middle (4.8) of pH range (4.5 - 5.0) reported for a sandy soil
167	Cd(II)	HWIR	Ja97	soil	18263	4.26	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
166	Cd(II)	HWIR	Ja97	soil	6446	3.81	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
165	Cd(II)	HWIR	Ja97	soil	6298	3.8	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
153	Cd(II)	HWIR	Ja97	soil	5828	3.77	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
155	Cd(II)	HWIR	Ja97	soil	5049	3.7	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
163	Cd(II)	HWIR	Ja97	soil	4653	3.67	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
147	Cd(II)	OAR	De91	soil	4360	3.64	8	groundwater (carbonate)	batch (20:1)	adsorption study; groundwater pH
156	Cd(II)	HWIR	Ja97	soil	3549	3.55	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
173	Cd(II)	HWIR	Ku91	soil	2600	3.41	6	0.01M NaNO3	batch (10 mL : 1 g)	

(continued)

Table I-17. (continued)

ID	Species	Study	RefIndex	Medium	Kd_L/kg	Log Kd	pH	Extractant	Method	Comments
174	Cd(II)	HWIR	Ku91	soil	2200	3.34	6	0.01M NaNO3	batch (10 mL : 1 g)	
178	Cd(II)	HWIR	Ku91	soil	2175	3.34	6.5	0.01M NaNO3	batch (10 mL : 1 g)	
145	Cd(II)	Listing	Ge82	soil	2000	3.3	7.8	various: dist. water; 0.0035 M and 0.035 M CaCl2, NaCl, or KCl	batch (25 mL:5 g)	middle (7.8) of pH range (7.5 - 8.0) reported for a sandy loam soil
134	Cd(II)	Listing	Ch96	aquifer	1770	3.25	8.83	0.001 M CaCl2	batch (50 mL:10 g)	data from Table 2 (p. 79): log Kd = 0.67pH - 2.74
183	Cd(II)	HWIR	Ch85	soil	1700	3.23	6.65	0.001 M CaCl2	batch (various L:S ratios)	
124	Cd(II)	Listing	Ch96	aquifer	1610	3.21	8.75	0.001 M CaCl2	batch (50 mL:10 g)	data from Table 2 (p. 79): log Kd = 0.67pH - 2.74
172	Cd(II)	Listing	Le98	soil	1595	3.2	6.51	0.01 N NaNO3	batch (100:1)	values at soil pH from Table 3 (Kd at other pH's also presented)
105	Cd(II)	HWIR	An88	soil	1386.8	3.14	7.3	0.001M CaCl2	batch (most at 100 mL: 1g; some at 100 mL: 5 g)	Co = 0.7 to 12.6 ppb
154	Cd(II)	HWIR	Ja97	soil	1378	3.14	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
151	Cd(II)	HWIR	Ja97	soil	1078	3.03	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
123	Cd(II)	Listing	Ch96	aquifer	1010	3	8.87	0.001 M CaCl2	batch (50 mL:10 g)	data from Table 2 (p. 79): log Kd = 0.67pH - 2.74
148	Cd(II)	OAR	De91	soil	1000	3	8	groundwater (carbonate)	batch (20:1)	adsorption study; groundwater pH
162	Cd(II)	HWIR	Ja97	soil	974	2.99	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
164	Cd(II)	HWIR	Ja97	soil	948	2.98	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
181	Cd(II)	HWIR	Ch85	soil	780	2.89	6.65	0.001 M CaCl2	batch (various L:S ratios)	
175	Cd(II)	HWIR	Ku91	soil	770	2.89	6	0.01M NaNO3	batch (10 mL : 1 g)	
104	Cd(II)	HWIR	An88	soil	769.1	2.89	6.9	0.001M CaCl2	batch (most at 100 mL: 1g; some at 100 mL: 5 g)	Co = 0.7 to 12.6 ppb
119	Cd(II)	OAR	Bu89	soil	755.1	2.88	7.6	0.005 M CaNO3	batch (10:1)	adsorption; converted Freund. to Kd using 1ppm
152	Cd(II)	HWIR	Ja97	soil	755	2.88	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
122	Cd(II)	Listing	Ch96	aquifer	720	2.86	7.96	0.001 M CaCl2	batch (50 mL:10 g)	data from Table 2 (p. 79): log Kd = 0.67pH - 2.74
176	Cd(II)	HWIR	Ku91	soil	710	2.85	6	0.01M NaNO3	batch (10 mL : 1 g)	

(continued)

Table I-17. (continued)

ID	Species	Study	RefIndex	Medium	Kd_L/kg	Log Kd	pH	Extractant	Method	Comments
127	Cd(II)	Listing	Ch96	aquifer	670	2.83	8.51	0.001 M CaCl2	batch (50 mL:10 g)	data from Table 2 (p. 79): log Kd = 0.67pH - 2.74
131	Cd(II)	Listing	Ch96	aquifer	660	2.82	8.46	0.001 M CaCl2	batch (50 mL:10 g)	data from Table 2 (p. 79): log Kd = 0.67pH - 2.74
128	Cd(II)	Listing	Ch96	aquifer	640	2.81	8.01	0.001 M CaCl2	batch (50 mL:10 g)	data from Table 2 (p. 79): log Kd = 0.67pH - 2.74
150	Cd(II)	HWIR	Ja97	soil	603	2.78	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
135	Cd(II)	Listing	Ch96	aquifer	560	2.75	8.47	0.001 M CaCl2	batch (50 mL:10 g)	data from Table 2 (p. 79): log Kd = 0.67pH - 2.74
159	Cd(II)	HWIR	Ja97	soil	532	2.73	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
125	Cd(II)	Listing	Ch96	aquifer	500	2.7	7.85	0.001 M CaCl2	batch (50 mL:10 g)	data from Table 2 (p. 79): log Kd = 0.67pH - 2.74
103	Cd(II)	HWIR	An88	soil	494.3	2.69	6.6	0.001M CaCl2	batch (most at 100 mL: 1g; some at 100 mL: 5 g)	Co = 0.7 to 12.6 ppb
138	Cd(II)	OAR	Ma92	soil	488.4	2.69	6.8	0.01 M NaCl	batch (100:1)	desorption (average of 2 measurements)
177	Cd(II)	HWIR	Ku91	soil	475	2.68	6	0.01M NaNO3	batch (10 mL : 1 g)	
168	Cd(II)	Listing	Le98	soil	461.8	2.66	6.89	0.01 N NaNO3	batch (100:1)	values at soil pH from Table 3 (Kd at other pH's also presented)
102	Cd(II)	HWIR	An88	soil	368.1	2.57	6.4	0.001M CaCl2	batch (most at 100 mL: 1g; some at 100 mL: 5 g)	Co = 0.7 to 12.6 ppb
170	Cd(II)	Listing	Le98	soil	303.2	2.48	6.38	0.01 N NaNO3	batch (100:1)	values at soil pH from Table 3 (Kd at other pH's also presented)
179	Cd(II)	HWIR	Ku91	soil	300	2.48	5	0.01M NaNO3	batch (10 mL : 1 g)	
108	Cd(II)	OAR	Bu89	soil	288.4	2.46	5.7	0.005 M CaNO3	batch (10:1)	adsorption; converted Freund. to Kd using 1ppm
101	Cd(II)	HWIR	An88	soil	274.2	2.44	6.2	0.001M CaCl2	batch (most at 100 mL: 1g; some at 100 mL: 5 g)	Co = 0.7 to 12.6 ppb
90	Cd(II)	OAR	Na78	soil	266.7	2.43	7.9	0.01 M NaCl	batch (25:1)	calculated from Figure 1
142	Cd(II)	Listing	Za92	aquifer	255	2.41	7.4	groundwater	field study	Kd estimated from Rf, assume effective posity = total porosity = 0.26; assumed bulk density = 2.0, CdCl2 tracer; mean Rf, 10 and 20 m
182	Cd(II)	HWIR	Ch85	soil	250	2.4	5.5	0.001 M CaCl2	batch (various L:S ratios)	
184	Cd(II)	HWIR	Ch85	soil	225	2.35	5.5	0.001 M CaCl2	batch (various L:S ratios)	
100	Cd(II)	HWIR	An88	soil	204.2	2.31	6	0.001M CaCl2	batch (most at 100 mL: 1g; some at 100 mL: 5 g)	Co = 0.7 to 12.6 ppb
146	Cd(II)	Listing	Ge82	soil	201.5	2.3	4.8	various: dist. water; 0.0035 M and 0.035 M CaCl2, NaCl, or KCl	batch (25 mL:5 g)	middle (4.8) of pH range (4.5 - 5.0) reported for a sandy soil

(continued)

Table I-17. (continued)

ID	Species	Study	RefIndex	Medium	Kd_L/kg	Log Kd	pH	Extractant	Method	Comments
140	Cd(II)	HWIR	Al95	soil	200	2.3	5.12	0.01 N NaNO3	batch (100 mL:1 g)	adsoption study; Kd estimated from Kd-pH relation using natural system pH (5.12)
87	Cd(II)	OAR	Na78	soil	200	2.3	7.8	0.01 M NaCl	batch (25:1)	calculated from Figure 1
110	Cd(II)	OAR	Bu89	soil	186.6	2.27	5.9	0.005 M CaNO3	batch (10:1)	adsorption; converted Freund. to Kd using 1ppm
91	Cd(II)	OAR	Na78	soil	181.8	2.26	7.6	0.01 M NaCl	batch (25:1)	calculated from Figure 1
130	Cd(II)	Listing	Ch96	aquifer	180	2.26	6.77	0.001 M CaCl2	batch (50 mL:10 g)	data from Table 2 (p. 79): log Kd = 0.67pH - 2.74
180	Cd(II)	HWIR	Ku91	soil	175	2.24	4.5	0.01M NaNO3	batch (10 mL : 1 g)	
158	Cd(II)	HWIR	Ja97	soil	159	2.2	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
99	Cd(II)	HWIR	An88	soil	152.1	2.18	5.8	0.001M CaCl2	batch (most at 100 mL: 1g; some at 100 mL: 5 g)	Co = 0.7 to 12.6 ppb
157	Cd(II)	HWIR	Ja97	soil	144	2.16	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
89	Cd(II)	OAR	Na78	soil	133.3	2.12	8.3	0.01 M NaCl	batch (25:1)	calculated from Figure 1
98	Cd(II)	HWIR	An88	soil	113.2	2.05	5.6	0.001M CaCl2	batch (most at 100 mL: 1g; some at 100 mL: 5 g)	Co = 0.7 to 12.6 ppb
160	Cd(II)	HWIR	Ja97	soil	102	2.01	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
114	Cd(II)	OAR	Bu89	soil	97.9	1.99	6.6	0.005 M CaNO3	batch (10:1)	adsorption; converted Freund. to Kd using 1ppm
133	Cd(II)	HWIR	Sc88	soil	97	1.99	3.7	dist. water	batch (25 mL: 10g) spiked with radiotracer metal	data from a single forest soil; reported "mean" Kd; Kd reported to exhibit a log-normal distrib
112	Cd(II)	OAR	Bu89	soil	91.2	1.96	6	0.005 M CaNO3	batch (10:1)	adsorption; converted Freund. to Kd using 1ppm
118	Cd(II)	OAR	Ga80	soil	87.1	1.94	8.4	water NOS	batch (800:1)	adsorption study; converted Freund. to Kd using 1ppm
97	Cd(II)	HWIR	An88	soil	84.3	1.93	5.4	0.001M CaCl2	batch (most at 100 mL: 1g; some at 100 mL: 5 g)	Co = 0.7 to 12.6 ppb
88	Cd(II)	OAR	Na78	soil	80	1.9	8.2	0.01 M NaCl	batch (25:1)	calculated from Figure 1
83	Cd(II)	HWIR	Me94	soil	69	1.84	4.6	0.002M Ca(ClO4)2	batch (25 mL:1 g)	acidic soil polluted with mine waste in England
96	Cd(II)	HWIR	An88	soil	62.8	1.8	5.2	0.001M CaCl2	batch (most at 100 mL: 1g; some at 100 mL: 5 g)	Co = 0.7 to 12.6 ppb
111	Cd(II)	OAR	Bu89	soil	52.7	1.72	3.9	0.005 M CaNO3	batch (10:1)	adsorption; converted Freund. to Kd using 1ppm
106	Cd(II)	OAR	Bu89	soil	52.5	1.72	4.8	0.005 M CaNO3	batch (10:1)	adsorption; converted Freund. to Kd using 1ppm

(continued)

Table I-17. (continued)

ID	Species	Study	RefIndex	Medium	Kd_L/kg	Log Kd	pH	Extractant	Method	Comments
95	Cd(II)	HWIR	An88	soil	46.8	1.67	5	0.001M CaCl2	batch (most at 100 mL: 1g; some at 100 mL: 5 g)	Co = 0.7 to 12.6 ppb
132	Cd(II)	Listing	Ch96	aquifer	40	1.6	5.83	0.001 M CaCl2	batch (50 mL:10 g)	data from Table 2 (p. 79): log Kd = 0.67pH - 2.74
149	Cd(II)	Listing	St86	soil	38	1.58		not specified	batch-single point (L:S not specified)	selected two values for bulk soil under ambient conditions; did not use values for organic-rich root channel macropores; no units given, assumed L/kg.
115	Cd(II)	OAR	Ga80	soil	33.88	1.53	5.2	water NOS	batch (800:1)	adsorption study; converted Freund. to Kd using 1ppm
86	Cd(II)	HWIR	Me94	soil	32	1.51	3.4	0.002M Ca(ClO4)2	batch (25 mL:1 g)	acidic soil polluted with mine waste in England
94	Cd(II)	HWIR	An88	soil	30.1	1.48	4.7	0.001M CaCl2	batch (most at 100 mL: 1g; some at 100 mL: 5 g)	Co = 0.7 to 12.6 ppb
113	Cd(II)	OAR	Bu89	soil	28.8	1.46	6.9	0.005 M CaNO3	batch (10:1)	adsorption; converted Freund. to Kd using 1ppm
92	Cd(II)	Listing	Vu98	aquifer	26.3	1.42	5.8	not specified	column	median value for the three fresh samples
143	Cd(II)	HWIR	Al95	soil	25	1.4	4.7	0.01 N NaNO3	batch (100 mL:1 g)	adsoption study; Kd measured at pH (4.7) closest to natural system pH (4.69)
171	Cd(II)	Listing	Le98	soil	23.9	1.38	4.81	0.01 N NaNO3	batch (100:1)	values at soil pH from Table 3 (Kd at other pH's also presented)
169	Cd(II)	Listing	Le98	soil	22.1	1.34	3.96	0.01 N NaNO3	batch (100:1)	values at soil pH from Table 3 (Kd at other pH's also presented)
161	Cd(II)	HWIR	Ja97	soil	21	1.32	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
107	Cd(II)	OAR	Ga80	soil	20.42	1.31	5.8	water NOS	batch (800:1)	adsorption study; converted Freund. to Kd using 1ppm
93	Cd(II)	HWIR	An88	soil	19.3	1.29	4.4	0.001M CaCl2	batch (most at 100 mL: 1g; some at 100 mL: 5 g)	Co = 0.7 to 12.6 ppb
139	Cd(II)	Listing	Pa99	aquifer	16.82	1.23	7.3	tap water (domestic well)	batch-static (150 mL:1400 g)	Freundlich constant (p. 194, batch tests)
85	Cd(II)	HWIR	Me94	soil	15	1.18	4.1	0.002M Ca(ClO4)2	batch (25 mL:1 g)	acidic soil polluted with mine waste in England
120	Cd(II)	OAR	Bu89	soil	14.4	1.16	5.3	0.005 M CaNO3	batch (10:1)	adsorption; converted Freund. to Kd using 1ppm
121	Cd(II)	Listing	Ch96	aquifer	14	1.15	6.19	0.001 M CaCl2	batch (50 mL:10 g)	data from Table 2 (p. 79): log Kd = 0.67pH - 2.74
141	Cd(II)	HWIR	Al95	soil	14	1.15	5.22	0.01 N NaNO3	batch (100 mL:1 g)	adsoption study; Kd estimated from Kd-pH relation using natural system pH (5.22)
129	Cd(II)	Listing	Ch96	aquifer	14	1.15	5.66	0.001 M CaCl2	batch (50 mL:10 g)	data from Table 2 (p. 79): log Kd = 0.67pH - 2.74
109	Cd(II)	OAR	Bu89	soil	13.9	1.14	5.4	0.005 M CaNO3	batch (10:1)	adsorption; converted Freund. to Kd using 1ppm
84	Cd(II)	HWIR	Me94	soil	12	1.08	4	0.002M Ca(ClO4)2	batch (25 mL:1 g)	acidic soil polluted with mine waste in England

(continued)

Table I-17. (continued)

ID	Species	Study	RefIndex	Medium	Kd_L/kg	Log Kd	pH	Extractant	Method	Comments
144	Cd(II)	HWIR	Al95	soil	12	1.08	4.8	0.01 N NaNO3	batch (100 mL:1 g)	adsoption study; Kd measured at pH (4.8) closest to natural system pH (4.74)
136	Cd(II)	Listing	Ch96	aquifer	11	1.04	5.86	0.001 M CaCl2	batch (50 mL:10 g)	data from Table 2 (p. 79): log Kd = 0.67pH - 2.74
117	Cd(II)	OAR	Ga80	soil	10.47	1.02	6	water NOS	batch (800:1)	adsorption study; converted Freund. to Kd using 1ppm
137	Cd(II)	Listing	Ch96	aquifer	6	0.78	5.28	0.001 M CaCl2	batch (50 mL:10 g)	data from Table 2 (p. 79): log Kd = 0.67pH - 2.74
116	Cd(II)	OAR	Bu89	soil	5.5	0.74	4.3	0.005 M CaNO3	batch (10:1)	adsorption; converted Freund. to Kd using 1ppm
126	Cd(II)	Listing	Ch96	aquifer	2	0.3	4.91	0.001 M CaCl2	batch (50 mL:10 g)	data from Table 2 (p. 79): log Kd = 0.67pH - 2.74
197	Co(II)	Listing	Mi82	aquifer	14000	4.15	8	groundwater	batch-radioisotope (10:1)	from Table II; trace concentration of metal (less than or equal to 1umol/L)
204	Co(II)	Listing	Ta94	soil	5450	3.74	7.5	groundwater	batch (10 mL:1 g)	median of 16 soil samples, calculated from data in Table 3; average pH (range: 7.07 - 8.00)
198	Co(II)	Listing	Mi82	aquifer	4500	3.65	7	groundwater	batch-radioisotope (10:1)	from Table II; trace concentration of metal (less than or equal to 1umol/L)
187	Co(II)	HWIR	Ban92	soil	4120	3.61	8	dist. water	batch (20 mL: 1 g) using cobalt radioisotope	0.05 kg/L soil solid concentration is low for a soil system; PCE observed above soil solid conc of 0.05 kg/L; single experiment seemed to show that the Kd would be halved at Cs = 0.1 kg/L
189	Co(II)	Listing	Ge82	soil	3700	3.57	7.8	various: dist. water; 0.0035 M and 0.035 M CaCl2, NaCl, or KCl	batch (25 mL:5 g)	middle (7.8) of pH range (7.5 - 8.0) reported for a sandy loam soil
192	Co(II)	Listing	Mi82	aquifer	2200	3.34	8.2	groundwater	batch-radioisotope (10:1)	from Table II; trace concentration of metal (less than or equal to 1umol/L)
194	Co(II)	Listing	Mi82	aquifer	1800	3.26	8.2	groundwater	batch-radioisotope (10:1)	from Table II; trace concentration of metal (less than or equal to 1umol/L)
188	Co(II)	Listing	Ya95	soil	1735	3.24	5.85	rainwater	batch (30 mL:3 g)	median value from Table III (36 soils)
203	Co(II)	Listing	Ba92	aquifer	1430	3.16		groundwater	batch (L:S not specified)	mean of three 0.45um filtered replicates for Total_Co=4e-10 M; pH not specified; used Table 7 entries w/o added DOC.
195	Co(II)	Listing	Mi82	aquifer	990	3	8.4	groundwater	batch-radioisotope (10:1)	from Table II; trace concentration of metal (less than or equal to 1umol/L)
193	Co(II)	Listing	Mi82	aquifer	880	2.94	6.2	groundwater	batch-radioisotope (10:1)	from Table II; trace concentration of metal (less than or equal to 1umol/L)
196	Co(II)	Listing	Mi82	aquifer	410	2.61	8.3	groundwater	batch-radioisotope (10:1)	from Table II; trace concentration of metal (less than or equal to 1umol/L)
201	Co(II)	Listing	Mi82	aquifer	400	2.6	6.8	groundwater	batch-radioisotope (10:1)	from Table II; trace concentration of metal (less than or equal to 1umol/L)

(continued)

Table I-17. (continued)

ID	Species	Study	RefIndex	Medium	Kd_L/kg	Log Kd	pH	Extractant	Method	Comments
202	Co(II)	Listing	Ha88	aquifer	232	2.37	7.3	groundwater	batch (9 mL:1 g)	avg. of two values from Table 4 for natural ground water.
199	Co(II)	Listing	Mi82	aquifer	160	2.2	6.4	groundwater	batch-radioisotope (10:1)	from Table II; trace concentration of metal (less than or equal to 1umol/L)
200	Co(II)	Listing	Mi82	aquifer	140	2.15	6.4	groundwater	batch-radioisotope (10:1)	from Table II; trace concentration of metal (less than or equal to 1umol/L)
185	Co(II)	HWIR	Ra96	soil	136	2.13	8.5	dist. water	batch (20 mL: 1 g)	soil: 15% sand, 49% silt, 36% clay
191	Co(II)	HWIR	Ra96	soil	120	2.08	6.3	dist. water	batch (20 mL: 1 g)	soil: 50% sand, 39% silt, 11% clay
186	Co(II)	HWIR	Sc88	soil	41	1.61	3.7	dist. water	batch (25 mL: 10g) spiked with radiotracer metal	data from a single forest soil; reported "mean" Kd; Kd reported to exhibit a log-normal distrib
190	Co(II)	Listing	Ge82	soil	19	1.28	4.8	various: dist. water; 0.0035 M and 0.035 M CaCl2, NaCl, or KCl	batch (25 mL:5 g)	middle (4.8) of pH range (4.5 - 5.0) reported for a sandy soil
228	Cr(III)	HWIR	Ja97	soil	24217	4.38	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
209	Cr(III)	HWIR	Ha96b	soil	20833	4.32	6.2	dist. water	batch (31 mL: 0.15 g)	
219	Cr(III)	HWIR	Ja97	soil	20665	4.32	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
226	Cr(III)	HWIR	Ja97	soil	19796	4.3	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
214	Cr(III)	HWIR	Ja97	soil	11992	4.08	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
227	Cr(III)	HWIR	Ja97	soil	11063	4.04	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
229	Cr(III)	HWIR	Ja97	soil	9519	3.98	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
230	Cr(III)	HWIR	Ja97	soil	9159	3.96	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
225	Cr(III)	HWIR	Ja97	soil	8906	3.95	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils

(continued)

Table I-17. (continued)

ID	Species	Study	RefIndex	Medium	Kd_L/kg	Log Kd	pH	Extractant	Method	Comments
215	Cr(III)	HWIR	Ja97	soil	8116	3.91	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
216	Cr(III)	HWIR	Ja97	soil	7933	3.9	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
218	Cr(III)	HWIR	Ja97	soil	6746	3.83	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
217	Cr(III)	HWIR	Ja97	soil	5977	3.78	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
208	Cr(III)	HWIR	Ha96b	soil	5075	3.71	6.52	dist. water	batch (31 mL: 0.15 g)	glacially derived Zahl loam
212	Cr(III)	HWIR	Ja97	soil	4711	3.67	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
222	Cr(III)	HWIR	Ja97	soil	4219	3.63	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
220	Cr(III)	HWIR	Ja97	soil	3799	3.58	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
213	Cr(III)	HWIR	Ja97	soil	2747	3.44	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
221	Cr(III)	HWIR	Ja97	soil	2418	3.38	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
224	Cr(III)	HWIR	Ja97	soil	2364	3.37	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
206	Cr(III)	HWIR	Sh91a	soil	711	2.85	5.7	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	4-year study of a sandy soil originally spiked with Cr(III); the paper mentioned an associated "a" value as in the exponent for
207	Cr(III)	HWIR	Ha96b	soil	536	2.73	4.03	dist. water	batch (31 mL: 0.15 g)	high clay lens in a soil taken near a river
223	Cr(III)	HWIR	Ja97	soil	524	2.72	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils

(continued)

Table I-17. (continued)

ID	Species	Study	RefIndex	Medium	Kd_L/kg	Log Kd	pH	Extractant	Method	Comments
211	Cr(III)	Listing	Ge82	soil	360	2.56	4.8	various: dist. water; 0.0035 M and 0.035 M CaCl2, NaCl, or KCl	batch (25 mL:5 g)	middle (4.8) of pH range (4.5 - 5.0) reported for a sandy soil
210	Cr(III)	Listing	Ge82	soil	25	1.4	7.8	various: dist. water; 0.0035 M and 0.035 M CaCl2, NaCl, or KCl	batch (25 mL:5 g)	middle (7.8) of pH range (7.5 - 8.0) reported for a sandy loam soil
238	Cr(VI)	OAR	Wo83	soil	1729	3.24	8.2	sludge filtrate (WWT)	batch (10:1)	OAR (Table E-1)
244	Cr(VI)	OAR	Ra88	soil	1585	3.2	4.45	0.1 NaNO3	NA	value measured closest to soil pH (4.38); Cr: 1000000 M
234	Cr(VI)	OAR	Wo83	soil	1372	3.14	7.2	sludge filtrate (WWT)	batch (10:1)	depth-average of 3 layers, assuming equal thickness; (OAR, Table E-1)
248	Cr(VI)	OAR	Sh87	soil	1000	3		rainwater	lysimeters (outdoor)	OAR (Table E.1); little information provided
245	Cr(VI)	OAR	Ra88	soil	288	2.46	5.46	0.1 NaNO3	NA	value measured closest to soil pH (5.33); Cr: 1000000 M
250	Cr(VI)	OAR	Ra85	soil	110	2.04		NA	NA	tabulated data; little background information provided
249	Cr(VI)	OAR	Sh87	soil	100	2		rainwater	lysimeters (outdoor)	OAR (Table E.1); little information provided
242	Cr(VI)	Listing	St85	aquifer	52	1.72	6.8	artficial groundwater	batch (15 mL:3 g)	upper end of Kd range (52 to 1.7 L/kg) from batch tests for a equilibrium CrO4-2 concentrations from 0.4 to 1400 umol/L; corresponding column test at 960 umol/L equil CrO4, gave Kd of 2.3 L/kg
241	Cr(VI)	OAR	Sh87b	soil	50	1.7	5.425	groundwater	column lysimeter	selected groundwater extractant (OAR, Table E-1, has leachate also); depth-weighted average assuming equal layer thickness
237	Cr(VI)	HWIR	Ha96b	soil	46.5	1.67	2.52	dist. water	batch (31 mL: 1.5 g)	
235	Cr(VI)	HWIR	Ha96b	soil	26.9	1.43	2.29	dist. water	batch (31 mL: 1.5 g)	high clay lens in a soil taken near a river
205	Cr(VI)	Listing	Ni94	aquifer	22	1.34	4.7	groundwater	field (in-situ measurements)	"apparent" partition coefficient estimated from mean %sorbed (99%), mean dry bulk density (1.6 g/cm3), and mean porosity (0.35) (p. 155); POC wt% value recorded was referred to as "organic content" in paper (may be wt% OM)
233	Cr(VI)	OAR	Se88	soil	10	1	5.1	0.005 M CaNO3	column	initial Cr 1 - 100 mg/L; OAR report gives range (9-10; Table E-1).
247	Cr(VI)	OAR	Ra85	soil	8	0.9		NA	NA	tabulated data; little background information provided
246	Cr(VI)	OAR	Ra88	soil	7	0.85	6.92	0.1 NaNO3	NA	value measured closest to soil pH (6.94); Cr: 1000000 M
232	Cr(VI)	OAR	Se88	soil	6	0.78	5.4	0.005 M CaNO3	column	initial Cr 1 - 100 mg/L; OAR report gives range (2-10; Table E-1).

(continued)

Table I-17. (continued)

ID	Species	Study	RefIndex	Medium	Kd_L/kg	Log Kd	pH	Extractant	Method	Comments
240	Cr(VI)	Listing	St85	aquifer	5.3	0.72	6.8	artficial groundwater	batch (15 mL:3 g)	selected batch measurement closest to natural conditions
231	Cr(VI)	OAR	Se88	soil	2	0.3	6.4	0.005 M CaNO3	column	initial Cr 1 - 100 mg/L; OAR report gives range (1-3; Table E-1).
243	Cr(VI)	OAR	Ra88	soil	1	0	9.4	0.1 NaNO3	NA	value measured closest to soil pH (10.7); Cr: 1000000 M
236	Cr(VI)	HWIR	Ha96b	soil	0.5	-0.3	11.1	dist. water	batch (31 mL: 1.5 g)	glacially derived Zahl loam
239	Cr(VI)	Listing	Me91	soil	0.2	-0.7		not specified	batch (L:S not specified)	report geared toward remediation options; Kd value on page 6; batch and column results agree
270	Cu(II)	HWIR	Ja97	soil	4318	3.64	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
267	Cu(II)	HWIR	Ja97	soil	1309	3.12	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
271	Cu(II)	HWIR	Ja97	soil	1253	3.1	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
260	Cu(II)	HWIR	Ja97	soil	1033	3.01	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
269	Cu(II)	HWIR	Ja97	soil	986	2.99	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
263	Cu(II)	HWIR	Ja97	soil	874	2.94	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
272	Cu(II)	HWIR	Ja97	soil	874	2.94	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
268	Cu(II)	HWIR	Ja97	soil	838	2.92	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
256	Cu(II)	HWIR	Ja97	soil	701	2.85	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
258	Cu(II)	HWIR	Ja97	soil	529	2.72	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils

(continued)

Table I-17. (continued)

ID	Species	Study	RefIndex	Medium	Kd_L/kg	Log Kd	pH	Extractant	Method	Comments
251	Cu(II)	Listing	Ge82	soil	500	2.7	7.8	various: dist. water; 0.0035 M and 0.035 M CaCl2, NaCl, or KCl	batch (25 mL:5 g)	middle (7.8) of pH range (7.5 - 8.0) reported for a sandy loam soil
259	Cu(II)	HWIR	Ja97	soil	452	2.66	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
257	Cu(II)	HWIR	Ja97	soil	322	2.51	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
252	Cu(II)	Listing	Ge82	soil	155	2.19	4.8	various: dist. water; 0.0035 M and 0.035 M CaCl2, NaCl, or KCl	batch (25 mL:5 g)	middle (4.8) of pH range (4.5 - 5.0) reported for a sandy soil
265	Cu(II)	HWIR	Ja97	soil	135	2.13	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
253	Cu(II)	HWIR	Ja97	soil	109	2.04	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
255	Cu(II)	HWIR	Ja97	soil	92	1.96	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
266	Cu(II)	HWIR	Ja97	soil	88	1.94	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
264	Cu(II)	HWIR	Ja97	soil	67	1.83	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
262	Cu(II)	HWIR	Ja97	soil	38	1.58	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
254	Cu(II)	HWIR	Ja97	soil	35	1.54	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
261	Cu(II)	HWIR	Ja97	soil	25	1.4	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
275	Hg(II)	HWIR	Ly97	soil	10526	4.02		soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	data from Table 1 (depth-weighted average) computed as "mean" values within a depth interval as the ratio of mean soil conc over mean water conc.

(continued)

Table I-17. (continued)

ID	Species	Study	RefIndex	Medium	Kd_L/kg	Log Kd	pH	Extractant	Method	Comments
277	Hg(II)	HWIR	Ly97	soil	8328	3.92		soil porewater	field (conc in soil solid phase (mg/kg) / conc in soil porewater (mg/L))	data from Table 2 (depth-weighted average)
276	Hg(II)	HWIR	Ly97	soil	8000	3.9		soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	data from Table 2
279	Hg(II)	Listing	Ge82	soil	7600	3.88	7.8	various: dist. water; 0.0035 M and 0.035 M CaCl2, NaCl, or KCl	batch (25 mL:5 g)	middle (7.8) of pH range (7.5 - 8.0) reported for a sandy loam soil
280	Hg(II)	Listing	Ge82	soil	4500	3.65	4.8	various: dist. water; 0.0035 M and 0.035 M CaCl2, NaCl, or KCl	batch (25 mL:5 g)	middle (4.8) of pH range (4.5 - 5.0) reported for a sandy soil
278	Hg(II)	HWIR	Sc97	soil	1924	3.28	4.5	artificial rainwater	batch (250 mL: 25 g or 250 mL: 100 g)	estimated depth-weighted average from a plot of Kd vs depth for a single soil type (iron-humus podozol).
281	Hg(II)	Listing	Bi91	aquifer	2.2	0.34		0.01 M NaCl	column	result for the lowest total Hg concentration listed in Table 3
273	Hg(II)	Listing	Mac93	soil	0.78	-0.11	4.5	not specified	batch (L:S not specified)	average value; no units reported
274	Hg(II)	Listing	Mac93	aquifer	0.22	-0.66	4.5	not specified	batch (L:S not specified)	average value; no units reported
288	Mn	Listing	Mi82	aquifer	4100	3.61	8	groundwater	batch-radioisotope (10:1)	from Table II; trace concentration of metal (less than or equal to 1umol/L)
284	Mn	Listing	Mi82	aquifer	1000	3	8.2	groundwater	batch-radioisotope (10:1)	from Table II; trace concentration of metal (less than or equal to 1umol/L)
289	Mn	Listing	Mi82	aquifer	430	2.63	7	groundwater	batch-radioisotope (10:1)	from Table II; trace concentration of metal (less than or equal to 1umol/L)
282	Mn	Listing	Ya95	soil	271	2.43	5.85	rainwater	batch (30 mL:3 g)	median value from Table III (36 soils)
292	Mn	Listing	Mi82	aquifer	160	2.2	6.8	groundwater	batch-radioisotope (10:1)	from Table II; trace concentration of metal (less than or equal to 1umol/L)
285	Mn	Listing	Mi82	aquifer	130	2.11	6.2	groundwater	batch-radioisotope (10:1)	from Table II; trace concentration of metal (less than or equal to 1umol/L)
286	Mn	Listing	Mi82	aquifer	96	1.98	8.4	groundwater	batch-radioisotope (10:1)	from Table II; trace concentration of metal (less than or equal to 1umol/L)
290	Mn	Listing	Mi82	aquifer	86	1.93	6.4	groundwater	batch-radioisotope (10:1)	from Table II; trace concentration of metal (less than or equal to 1umol/L)
291	Mn	Listing	Mi82	aquifer	49	1.69	6.4	groundwater	batch-radioisotope (10:1)	from Table II; trace concentration of metal (less than or equal to 1umol/L)
293	Mn	Listing	Sh89	soil	44	1.64	6.7	0.1 M ammonium acetate	batch-radioisotope (50 mL: 2.5 cc)	geometric mean from table 2, pH and soil properties recorded are mean values; paper presents evidence of log-normal distribution for Kd in these soils

(continued)

Table I-17. (continued)

ID	Species	Study	RefIndex	Medium	Kd_L/kg	Log Kd	pH	Extractant	Method	Comments
283	Mn	Listing	St86	soil	36	1.56		not specified	batch-single point (L:S not specified)	selected only the two values for bulk soil under ambient conditions; did not use values for organic-rich root channel macropores; no units given, assumed L/kg.
287	Mn	Listing	Mi82	aquifer	34	1.53	8.3	groundwater	batch-radioisotope (10:1)	from Table II; trace concentration of metal (less than or equal to 1umol/L)
297	Mo(VI)	Listing	Ge82	soil	162.5	2.21	4.8	various: dist. water; 0.0035 M and 0.035 M CaCl2, NaCl, or KCl	batch (25 mL:5 g)	middle (4.8) of pH range (4.5 - 5.0) reported for a sandy soil
294	Mo(VI)	HWIR	Is93	soil	148	2.17	5.3	0.01M NaCl	batch (5 mL: 1 g)	calculated from sorbed conc data plotted against solution conc for two soil horizons of one soil; values recorded are mean Kd, pH, POC
295	Mo(VI)	HWIR	Sh91a	soil	10.6	1.02	5.7	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	depth-weighted average from 4-year study of a sandy soil originally spiked with Mo(VI)
298	Mo(VI)	Listing	St95	aquifer	6.7	0.83	5.7	groundwater	batch (30 mL:30 g)	estimated from % sorbed in Fig. 5 at ambient pH (5.7) for uncontaminated well (Sample F347-20); solid conc = 1kg/L, total MoO4 = 5E-05 M
296	Mo(VI)	Listing	Ge82	soil	2.75	0.44	7.8	various: dist. water; 0.0035 M and 0.035 M CaCl2, NaCl, or KCl	batch (25 mL:5 g)	middle (7.8) of pH range (7.5 - 8.0) reported for a sandy loam soil
302	Ni(II)	Listing	Ch96	aquifer	7250	3.86	8.75	0.001 M CaCl2	batch (50 mL:10 g)	data from Table 2 (p. 79): log Kd = 0.72pH - 3.03
335	Ni(II)	HWIR	Ja97	soil	5749	3.76	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
338	Ni(II)	Listing	Ba92	aquifer	4750	3.68		groundwater	batch (L:S not specified)	mean of two 0.45um filtered replicates; Total_Ni=9e-09 M; pH not specified; used Table 7 entries w/o added DOC.
301	Ni(II)	Listing	Ch96	aquifer	4510	3.65	8.87	0.001 M CaCl2	batch (50 mL:10 g)	data from Table 2 (p. 79): log Kd = 0.72pH - 3.03
313	Ni(II)	Listing	Ch96	aquifer	4370	3.64	8.83	0.001 M CaCl2	batch (50 mL:10 g)	data from Table 2 (p. 79): log Kd = 0.72pH - 3.03
336	Ni(II)	HWIR	Ja97	soil	4113	3.61	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
326	Ni(II)	HWIR	Ja97	soil	3151	3.5	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
308	Ni(II)	Listing	Ch96	aquifer	2750	3.44	8.87	0.001 M CaCl2	batch (50 mL:10 g)	data from Table 2 (p. 79): log Kd = 0.72pH - 3.03

(continued)

Table I-17. (continued)

ID	Species	Study	RefIndex	Medium	Kd_L/kg	Log Kd	pH	Extractant	Method	Comments
337	Ni(II)	HWIR	Ja97	soil	2310	3.36	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
334	Ni(II)	HWIR	Ja97	soil	2163	3.34	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
333	Ni(II)	HWIR	Ja97	soil	1857	3.27	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
324	Ni(II)	HWIR	Ja97	soil	1843	3.27	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
321	Ni(II)	HWIR	Ja97	soil	1660	3.22	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
314	Ni(II)	Listing	Ch96	aquifer	1510	3.18	8.47	0.001 M CaCl2	batch (50 mL:10 g)	data from Table 2 (p. 79): log Kd = 0.72pH - 3.03
305	Ni(II)	Listing	Ch96	aquifer	1430	3.16	8.51	0.001 M CaCl2	batch (50 mL:10 g)	data from Table 2 (p. 79): log Kd = 0.72pH - 3.03
325	Ni(II)	HWIR	Ja97	soil	1285	3.11	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
322	Ni(II)	HWIR	Ja97	soil	1255	3.1	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
319	Ni(II)	HWIR	Ja97	soil	1088	3.04	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
332	Ni(II)	HWIR	Ja97	soil	744	2.87	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
300	Ni(II)	Listing	Ch96	aquifer	450	2.65	7.96	0.001 M CaCl2	batch (50 mL:10 g)	data from Table 2 (p. 79): log Kd = 0.72pH - 3.03
307	Ni(II)	Listing	Ch96	aquifer	440	2.64	8.01	0.001 M CaCl2	batch (50 mL:10 g)	data from Table 2 (p. 79): log Kd = 0.72pH - 3.03
311	Ni(II)	Listing	Ch96	aquifer	420	2.62	8.46	0.001 M CaCl2	batch (50 mL:10 g)	data from Table 2 (p. 79): log Kd = 0.72pH - 3.03
331	Ni(II)	HWIR	Ja97	soil	376	2.58	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
317	Ni(II)	Listing	Ge82	soil	350	2.54	7.8	various: dist. water; 0.0035 M and 0.035 M CaCl2, NaCl, or KCl	batch (25 mL:5 g)	middle (7.8) of pH range (7.5 - 8.0) reported for a sandy loam soil

(continued)

Table I-17. (continued)

ID	Species	Study	RefIndex	Medium	Kd_L/kg	Log Kd	pH	Extractant	Method	Comments
306	Ni(II)	Listing	Ch96	aquifer	310	2.49	8.41	0.001 M CaCl2	batch (50 mL:10 g)	data from Table 2 (p. 79): log Kd = 0.72pH - 3.03
320	Ni(II)	HWIR	Ja97	soil	292	2.47	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
303	Ni(II)	Listing	Ch96	aquifer	250	2.4	7.85	0.001 M CaCl2	batch (50 mL:10 g)	data from Table 2 (p. 79): log Kd = 0.72pH - 3.03
323	Ni(II)	HWIR	Ja97	soil	243	2.39	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
329	Ni(II)	HWIR	Ja97	soil	236	2.37	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
330	Ni(II)	HWIR	Ja97	soil	185	2.27	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
328	Ni(II)	HWIR	Ja97	soil	130	2.11	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
327	Ni(II)	HWIR	Ja97	soil	115	2.06	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
318	Ni(II)	Listing	Ge82	soil	49.5	1.69	4.8	various: dist. water; 0.0035 M and 0.035 M CaCl2, NaCl, or KCl	batch (25 mL:5 g)	middle (4.8) of pH range (4.5 - 5.0) reported for a sandy soil
310	Ni(II)	Listing	Ch96	aquifer	40	1.6	6.77	0.001 M CaCl2	batch (50 mL:10 g)	data from Table 2 (p. 79): log Kd = 0.72pH - 3.03
312	Ni(II)	Listing	Ch96	aquifer	40	1.6	5.83	0.001 M CaCl2	batch (50 mL:10 g)	data from Table 2 (p. 79): log Kd = 0.72pH - 3.03
315	Ni(II)	Listing	Ch96	aquifer	24	1.38	5.86	0.001 M CaCl2	batch (50 mL:10 g)	data from Table 2 (p. 79): log Kd = 0.72pH - 3.03
299	Ni(II)	Listing	Ch96	aquifer	18	1.26	6.19	0.001 M CaCl2	batch (50 mL:10 g)	data from Table 2 (p. 79): log Kd = 0.72pH - 3.03
309	Ni(II)	Listing	Ch96	aquifer	12	1.08	5.66	0.001 M CaCl2	batch (50 mL:10 g)	data from Table 2 (p. 79): log Kd = 0.72pH - 3.03
316	Ni(II)	Listing	Ch96	aquifer	7	0.85	5.28	0.001 M CaCl2	batch (50 mL:10 g)	data from Table 2 (p. 79): log Kd = 0.72pH - 3.03
304	Ni(II)	Listing	Ch96	aquifer	3	0.48	4.91	0.001 M CaCl2	batch (50 mL:10 g)	data from Table 2 (p. 79): log Kd = 0.72pH - 3.03
371	Pb(II)	HWIR	Ja97	soil	67856	4.83	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
360	Pb(II)	HWIR	Ja97	soil	60311	4.78	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils

(continued)

Table I-17. (continued)

ID	Species	Study	RefIndex	Medium	Kd_L/kg	Log Kd	pH	Extractant	Method	Comments
345	Pb(II)	HWIR	Sh91b	soil	60000	4.78	7	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	agricultural soil: loam
343	Pb(II)	HWIR	Sh91b	soil	60000	4.78	7	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	agricultural soil: clay loam
349	Pb(II)	HWIR	Sh89b	soil	59000	4.77	7.4	dist. water	batch (L:S ratio such as to wet soil to field capacity)	
373	Pb(II)	OAR	Rh92	soil	46000	4.66	8.35	NA	batch	mid-point of range, batch tracer studies (Initial activities 2.38 23.4 μCi/1; <0.01 OC))
369	Pb(II)	HWIR	Ja97	soil	45502	4.66	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
357	Pb(II)	HWIR	Ja97	soil	42250	4.63	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
367	Pb(II)	HWIR	Ja97	soil	37379	4.57	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
366	Pb(II)	HWIR	Ja97	soil	36930	4.57	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
356	Pb(II)	HWIR	Ja97	soil	34727	4.54	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
346	Pb(II)	HWIR	Sh91b	soil	30000	4.48	5.5	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	boreal acidic organic soil: sedge peat
368	Pb(II)	HWIR	Ja97	soil	27722	4.44	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
353	Pb(II)	HWIR	Ja97	soil	22944	4.36	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
344	Pb(II)	HWIR	Sh91b	soil	21000	4.32	7.3	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	agricultural soil: gleysol loam

(continued)

Table I-17. (continued)

ID	Species	Study	RefIndex	Medium	Kd_L/kg	Log Kd	pH	Extractant	Method	Comments
370	Pb(II)	HWIR	Ja97	soil	16973	4.23	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
359	Pb(II)	HWIR	Ja97	soil	12514	4.1	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
347	Pb(II)	HWIR	Sh91b	soil	9000	3.95	4.8	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	boreal acidic organic soil: sphagnum peat
363	Pb(II)	HWIR	Ja97	soil	5923	3.77	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
358	Pb(II)	HWIR	Ja97	soil	5310	3.73	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
351	Pb(II)	Listing	Ge82	soil	4250	3.63	7.8	various: dist. water; 0.0035 M and 0.035 M CaCl2, NaCl, or KCl	batch (25 mL:5 g)	middle (7.8) of pH range (7.5 - 8.0) reported for a sandy loam soil
377	Pb(II)	OAR	Ha81	aquifer	4000	3.6	7	NA	NA	OAR (Table F.!); little information provided
365	Pb(II)	HWIR	Ja97	soil	3550	3.55	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
354	Pb(II)	HWIR	Ja97	soil	3428	3.54	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
355	Pb(II)	HWIR	Ja97	soil	2637	3.42	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
376	Pb(II)	OAR	Ha81	aquifer	1500	3.18	5.75	NA	NA	OAR (Table F.!); little information provided
361	Pb(II)	HWIR	Ja97	soil	1326	3.12	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
362	Pb(II)	HWIR	Ja97	soil	1159	3.06	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
364	Pb(II)	HWIR	Ja97	soil	916	2.96	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils

(continued)

Table I-17. (continued)

ID	Species	Study	RefIndex	Medium	Kd_L/kg	Log Kd	pH	Extractant	Method	Comments
352	Pb(II)	Listing	Ge82	soil	750	2.88	4.8	various: dist. water; 0.0035 M and 0.035 M CaCl2, NaCl, or KCl	batch (25 mL:5 g)	middle (4.8) of pH range (4.5 - 5.0) reported for a sandy soil
341	Pb(II)	HWIR	Me94	soil	126	2.1	4.1	0.002M Ca(ClO4)2	batch (25 mL:1 g)	acidic soil polluted with mine waste in England
375	Pb(II)	OAR	Ha81	aquifer	100	2	4.5	NA	NA	OAR (Table F.!); little information provided
342	Pb(II)	HWIR	Me94	soil	96	1.98	3.4	0.002M Ca(ClO4)2	batch (25 mL:1 g)	acidic soil polluted with mine waste in England
339	Pb(II)	HWIR	Me94	soil	93	1.97	4.6	0.002M Ca(ClO4)2	batch (25 mL:1 g)	acidic soil polluted with mine waste in England
372	Pb(II)	Listing	Fu96	aquifer	24.4	1.39	5.3	artificial groundwater	batch (20:1)	mean sorbed from multiple cores sampled; Fig 2 and Tbl 4 in Da93; Fe, Al, Mn anal. avail. (Tbl. 1); total Pb is 20 umol/L
374	Pb(II)	OAR	Ha81	aquifer	20	1.3	2	NA	NA	OAR (Table F.!); little information provided
348	Pb(II)	HWIR	Sh91b	soil	19.8	1.3	4.9	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	boreal acidic sandy soil: brunisol sand
350	Pb(II)	HWIR	Sh89b	soil	19	1.28	4.9	dist. water	batch (L:S ratio such as to wet soil to field capacity)	
340	Pb(II)	HWIR	Me94	soil	14	1.15	4	0.002M Ca(ClO4)2	batch (25 mL:1 g)	acidic soil polluted with mine waste in England
378	Sb(III)	Listing	Ge82	soil	14	1.15	7.8	various: dist. water; 0.0035 M and 0.035 M CaCl2, NaCl, or KCl	batch (25 mL:5 g)	middle (7.8) of pH range (7.5 - 8.0) reported for a sandy loam soil
379	Sb(III)	Listing	Ge82	soil	11	1.04	4.8	various: dist. water; 0.0035 M and 0.035 M CaCl2, NaCl, or KCl	batch (25 mL:5 g)	middle (4.8) of pH range (4.5 - 5.0) reported for a sandy soil
387	Se(IV)	HWIR	Fi91	soil	46.7	1.67	8.3	0.005M CaSO4	batch (150 mL: 7.5 g)	Kd from plot of %sorbed vs time (Fig 2); used longest time interval for Soil CS in 0.005M CaSO4 solution
389	Se(IV)	HWIR	Sa94	soil	35	1.54	5	0.1M NaCl	batch (25 mL: 1 g)	Kd from plot of sorbed vs dissolved for metal titration (Fig 1); value is for low added Se for Mukaiyama whole soil
382	Se(IV)	HWIR	Ne87	soil	34.5	1.54	5.5	0.05M NaCl	batch (25 mL: 1g)	Kd from plot of %sorbed vs pH (Fig 2); 3 points selected for this soil to describe the Kd vs pH response
385	Se(IV)	HWIR	Ch89	soil	31	1.5	6.5	dist. water	batch (50 mL: 1g) with Se radioisotope	Kd from plot of %sorbed vs time (Fig 1); used longest time interval for Ronhave whole soil
386	Se(IV)	HWIR	Fi91	soil	30	1.48	8.3	0.1M NaCl	batch (150 mL: 7.5 g)	Kd from plot of %sorbed vs time (Fig 2); used longest time interval for Site 3 soil in 0.1M NaCl
392	Se(IV)	Listing	Ge82	soil	27.5	1.44	7.8	various: dist. water; 0.0035 M and 0.035 M CaCl2, NaCl, or KCl	batch (25 mL:5 g)	middle (7.8) of pH range (7.5 - 8.0) reported for a sandy loam soil

(continued)

Table I-17. (continued)

ID	Species	Study	RefIndex	Medium	Kd_L/kg	Log Kd	pH	Extractant	Method	Comments
393	Se(IV)	Listing	Ge82	soil	26	1.41	4.8	various: dist. water; 0.0035 M and 0.035 M CaCl2, NaCl, or KCl	batch (25 mL:5 g)	middle (4.8) of pH range (4.5 - 5.0) reported for a sandy soil
388	Se(IV)	HWIR	Ch89	soil	23.5	1.37	6.6	dist. water	batch (50 mL: 1g) with Se radioisotope	Kd from plot of %sorbed vs time (Fig 2); used longest time interval for Studsgaard whole soil
381	Se(IV)	HWIR	Ne87	soil	18.9	1.28	4.2	0.05M NaCl	batch (25 mL: 1g)	Kd from plot of %sorbed vs pH (Fig 2); 3 points selected for this soil to describe the Kd vs pH response
390	Se(IV)	HWIR	Sa94	soil	16.5	1.22	5	0.1M NaCl	batch (25 mL: 1 g)	Kd from plot of sorbed vs dissolved for metal titration (Fig 1); value is for low added Se for Tanashi whole soil
383	Se(IV)	HWIR	Ne87	soil	10.7	1.03	5.9	0.05M NaCl	batch (25 mL: 1g)	Kd from plot of %sorbed vs pH (Fig 2); 3 points selected for this soil to describe the Kd vs pH response
391	Se(IV)	Listing	Fi90	soil	10.5	1.02	8.3	0.1 M NaCl	batch (150 mL:7.5 g)	median value of three Freundlich values from Table 1
384	Se(IV)	HWIR	Ne87	soil	9.2	0.97	6	0.05M NaCl	batch (25 mL: 1g)	Kd from plot of %sorbed vs pH (Fig 2); 3 points selected for this soil to describe the Kd vs pH response
380	Se(IV)	HWIR	Ne87	soil	2.17	0.34	8.1	0.05M NaCl	batch (25 mL: 1g)	Kd from plot of %sorbed vs pH (Fig 2); 3 points selected for this soil to describe the Kd vs pH response
394	Sn	Listing	Ge82	soil	7750	3.89	7.8	various: dist. water; 0.0035 M and 0.035 M CaCl2, NaCl, or KCl	batch (25 mL:5 g)	middle (7.8) of pH range (7.5 - 8.0) reported for a sandy loam soil
395	Sn	Listing	Ge82	soil	2150	3.33	4.8	various: dist. water; 0.0035 M and 0.035 M CaCl2, NaCl, or KCl	batch (25 mL:5 g)	middle (4.8) of pH range (4.5 - 5.0) reported for a sandy soil
396	V(IV)	Listing	Ge82	soil	330	2.52	7.8	various: dist. water; 0.0035 M and 0.035 M CaCl2, NaCl, or KCl	batch (25 mL:5 g)	middle (7.8) of pH range (7.5 - 8.0) reported for a sandy loam soil
397	V(IV)	Listing	Ge82	soil	75	1.88	4.8	various: dist. water; 0.0035 M and 0.035 M CaCl2, NaCl, or KCl	batch (25 mL:5 g)	middle (4.8) of pH range (4.5 - 5.0) reported for a sandy soil
427	Zn(II)	Listing	Mi82	aquifer	28000	4.45	8	groundwater	batch-radioisotope (10:1)	from Table II; trace concentration of metal (less than or equal to 1umol/L)
422	Zn(II)	Listing	Mi82	aquifer	15000	4.18	8.2	groundwater	batch-radioisotope (10:1)	from Table II; trace concentration of metal (less than or equal to 1umol/L)
424	Zn(II)	Listing	Mi82	aquifer	14000	4.15	8.2	groundwater	batch-radioisotope (10:1)	from Table II; trace concentration of metal (less than or equal to 1umol/L)

(continued)

Table I-17. (continued)

ID	Species	Study	RefIndex	Medium	Kd_L/kg	Log Kd	pH	Extractant	Method	Comments
428	Zn(II)	Listing	Mi82	aquifer	9100	3.96	7	groundwater	batch-radioisotope (10:1)	from Table II; trace concentration of metal (less than or equal to 1umol/L)
420	Zn(II)	HWIR	Ja97	soil	6762	3.83	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
409	Zn(II)	HWIR	Ja97	soil	6226	3.79	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
437	Zn(II)	Listing	Le98	soil	5667	3.75	6.51	0.01 N NaNO3	batch (100:1)	values at soil pH from Table 3 (Kd at other pH's also presented)
425	Zn(II)	Listing	Mi82	aquifer	5600	3.75	8.4	groundwater	batch-radioisotope (10:1)	from Table II; trace concentration of metal (less than or equal to 1umol/L)
421	Zn(II)	HWIR	Ja97	soil	5472	3.74	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
419	Zn(II)	HWIR	Ja97	soil	5112	3.71	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
429	Zn(II)	Listing	Mi82	aquifer	5100	3.71	6.4	groundwater	batch-radioisotope (10:1)	from Table II; trace concentration of metal (less than or equal to 1umol/L)
430	Zn(II)	Listing	Mi82	aquifer	5000	3.7	6.4	groundwater	batch-radioisotope (10:1)	from Table II; trace concentration of metal (less than or equal to 1umol/L)
417	Zn(II)	HWIR	Ja97	soil	3698	3.57	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
423	Zn(II)	Listing	Mi82	aquifer	3200	3.51	6.2	groundwater	batch-radioisotope (10:1)	from Table II; trace concentration of metal (less than or equal to 1umol/L)
426	Zn(II)	Listing	Mi82	aquifer	3000	3.48	8.3	groundwater	batch-radioisotope (10:1)	from Table II; trace concentration of metal (less than or equal to 1umol/L)
406	Zn(II)	HWIR	Ja97	soil	2800	3.45	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
431	Zn(II)	Listing	Mi82	aquifer	2700	3.43	6.8	groundwater	batch-radioisotope (10:1)	from Table II; trace concentration of metal (less than or equal to 1umol/L)
407	Zn(II)	HWIR	Ja97	soil	2438	3.39	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils

(continued)

Table I-17. (continued)

ID	Species	Study	RefIndex	Medium	Kd_L/kg	Log Kd	pH	Extractant	Method	Comments
405	Zn(II)	HWIR	Ja97	soil	2245	3.35	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
400	Zn(II)	Listing	Ge82	soil	2050	3.31	7.8	various: dist. water; 0.0035 M and 0.035 M CaCl2, NaCl, or KCl	batch (25 mL:5 g)	middle (7.8) of pH range (7.5 - 8.0) reported for a sandy loam soil
433	Zn(II)	Listing	Le98	soil	1989	3.3	6.89	0.01 N NaNO3	batch (100:1)	values at soil pH from Table 3 (Kd at other pH's also presented)
399	Zn(II)	Listing	Ya95	soil	1756	3.24	5.85	rainwater	batch (30 mL:3 g)	median value from Table III (36 soils)
408	Zn(II)	HWIR	Ja97	soil	1299	3.11	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
402	Zn(II)	HWIR	Ja97	soil	1294	3.11	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
418	Zn(II)	HWIR	Ja97	soil	1278	3.11	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
435	Zn(II)	Listing	Le98	soil	995	3	6.38	0.01 N NaNO3	batch (100:1)	values at soil pH from Table 3 (Kd at other pH's also presented)
404	Zn(II)	HWIR	Ja97	soil	604	2.78	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
416	Zn(II)	HWIR	Ja97	soil	422	2.63	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
412	Zn(II)	HWIR	Ja97	soil	154	2.19	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
403	Zn(II)	HWIR	Ja97	soil	73	1.86	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
436	Zn(II)	Listing	Le98	soil	72.5	1.86	4.81	0.01 N NaNO3	batch (100:1)	values at soil pH from Table 3 (Kd at other pH's also presented)
401	Zn(II)	Listing	Ge82	soil	55.5	1.74	4.8	various: dist. water; 0.0035 M and 0.035 M CaCl2, NaCl, or KCl	batch (25 mL:5 g)	middle (4.8) of pH range (4.5 - 5.0) reported for a sandy soil
398	Zn(II)	HWIR	Sc88	soil	41	1.61	3.7	dist. water	batch (25 mL: 10g) spiked with radiotracer metal	data from a single forest soil; reported "mean" Kd; Kd reported to exhibit a log-normal distrib

(continued)

Table I-17. (continued)

ID	Species	Study	RefIndex	Medium	Kd_L/kg	Log Kd	pH	Extractant	Method	Comments
411	Zn(II)	HWIR	Ja97	soil	41	1.61	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
414	Zn(II)	HWIR	Ja97	soil	38	1.58	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
413	Zn(II)	HWIR	Ja97	soil	34	1.53	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
434	Zn(II)	Listing	Le98	soil	33.8	1.53	3.96	0.01 N NaNO3	batch (100:1)	values at soil pH from Table 3 (Kd at other pH's also presented)
410	Zn(II)	HWIR	Ja97	soil	23	1.36	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
415	Zn(II)	HWIR	Ja97	soil	6	0.78	6.4	soil porewater	field (soil solid conc (mg/kg) /soil porewater conc (mg/L))	pH, POC, DOC, etc., are median values for the collection of 20 soils
432	Zn(II)	Listing	Fu96	aquifer	2.7	0.43	5.3	artificial groundwater	batch (20:1)	mean sorbed from multiple cores sampled; Fig 2 and Tbl 4 in Da93; Fe, Al, Mn anal. avail. (Tbl 1); total Zn is 5 umol/L

Table I-18. Kd Values: Soil and Aquifer Material Characterisitics

ID	Species	RefIndex	Study	Media Type	Location	Kd (L/kg)	Log Kd	pH	POC (wt%)	DOC	DOC units	FeOx	FeOx units	AlOx	AlOx units	Clay (wt%)	CEC	CEC units
9	Ag	Ba92	Listing	London clay	England	6700	3.83	8		6	mg/L							
3	Ag	Jo86	HWIR	shallow soil	Wales	3323	3.52	5.8	7.5									
8	Ag	Ba92	Listing	gravel	England	2570	3.41	7.8										
5	Ag	Ge82	Listing	sandy loam	Netherlands	1250	3.1	7.8	2.25									
4	Ag	Sz95	HWIR	soil	Paks, Hungary	1200	3.08											
6	Ag	Ge82	Listing	sand	Netherlands	650	2.81	4.8	1.75									
7	Ag	Jo86	HWIR	peaty soil	Wales	390	2.59	4.2	39									
1	Ag	Jo86	HWIR	gleyed silty clay	Wales	137	2.14	6	3.6									
2	Ag	Jo86	HWIR	sandy loam	Wales	26.8	1.43	5.9	6.5									
39	As(V)	Ja97	HWIR	Soil O	Netherlands (location not impacted by agricultural)	20412	4.31	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
42	As(V)	Ja97	HWIR	Soil R	Netherlands (location not impacted by agricultural)	9745	3.99	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
27	As(V)	Ja97	HWIR	Soil C	Netherlands (location not impacted by agricultural)	7243	3.86	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
31	As(V)	Ja97	HWIR	Soil G	Netherlands (location not impacted by agricultural)	6649	3.82	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
26	As(V)	Ja97	HWIR	Soil B	Netherlands (location not impacted by agricultural)	6075	3.78	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
34	As(V)	Ja97	HWIR	Soil J	Netherlands (location not impacted by agricultural)	5313	3.73	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
28	As(V)	Ja97	HWIR	Soil D	Netherlands (location not impacted by agricultural)	3829	3.58	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		

(continued)

Table I-18. (continued)

ID	Species	RefIndex	Study	Media Type	Location	Kd (L/kg)	Log Kd	pH	POC (wt%)	DOC	DOC units	FeOx	FeOx units	AlOx	AlOx units	Clay (wt%)	CEC	CEC units
30	As(V)	Ja97	HWIR	Soil F	Netherlands (location not impacted by agricultural)	3794	3.58	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
41	As(V)	Ja97	HWIR	Soil Q	Netherlands (location not impacted by agricultural)	3127	3.5	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
29	As(V)	Ja97	HWIR	Soil E	Netherlands (location not impacted by agricultural)	2905	3.46	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
43	As(V)	Ja97	HWIR	Soil S	Netherlands (location not impacted by agricultural)	2521	3.4	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
44	As(V)	Ja97	HWIR	Soil T	Netherlands (location not impacted by agricultural)	2289	3.36	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
37	As(V)	Ja97	HWIR	Soil M	Netherlands (location not impacted by agricultural)	2109	3.32	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
40	As(V)	Ja97	HWIR	Soil P	Netherlands (location not impacted by agricultural)	2015	3.3	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
36	As(V)	Ja97	HWIR	Soil L	Netherlands (location not impacted by agricultural)	1502	3.18	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
25	As(V)	Ja97	HWIR	Soil A	Netherlands (location not impacted by agricultural)	1362	3.13	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
38	As(V)	Ja97	HWIR	Soil N	Netherlands (location not impacted by agricultural)	804	2.91	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
10	As	On96	Listing	glacio-deltaic sediment	Auburn, ME	225	2.35											

(continued)

Table I-18. (continued)

ID	Species	RefIndex	Study	Media Type	Location	Kd (L/kg)	Log Kd	pH	POC (wt%)	DOC	DOC units	FeOx	FeOx units	AlOx	AlOx units	Clay (wt%)	CEC	CEC units
35	As(V)	Ja97	HWIR	Soil K	Netherlands (location not impacted by agricultural)	158	2.2	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
23	As(V)	Ge82	Listing	sandy loam	Netherlands	125	2.1	7.8	2.25									
12	As	Ku97a	Listing	clayey silt	Houston, TX	120	2.08	11	0.66	40	mg/L	0.6	wt%	0.5	wt%			
33	As(V)	Ja97	HWIR	Soil I	Netherlands (location not impacted by agricultural)	97	1.99	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
32	As(V)	Ja97	HWIR	Soil H	Netherlands (location not impacted by agricultural)	90	1.95	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
22	As(V)	Is93	HWIR	two soil horizons	Oconee Co, GA	67	1.83	5.3	0.34			1.09	wt%					
24	As(V)	Ge82	Listing	sand	Netherlands	45	1.65	4.8	1.75									
18	As	Jo99	Listing	nonirrigated Madison R. valley soil A1	MT	33.2	1.52	8	2.8									
14	As	DOE93	Listing	aquifer sediments	Rifle, CO	19.4	1.29	7.2										
16	As	Jo99	Listing	nonirrigated Madison R. valley soil C	MT	18.8	1.27	8	2.8									
19	As	Jo99	Listing	nonirrigated Madison R. valley soil D1	MT	13	1.11	8	2.8									
21	As(III)	Is93	HWIR	one soil horizon	Oconee Co, GA	12	1.08	5.3	0.34			1.09	wt%					
15	As	Jo99	Listing	nonirrigated Madison R. valley soil B	MT	10.4	1.02	8	2.8									
13	As	Ku97b	Listing	silty sand	Houston, TX	2.97	0.47	7	0.015			0.14	wt%	0.04	wt%			
17	As	Ca98	Listing	monitoring well sediment	Mexico	1.86	0.27	7										
20	As(III)	Is93	HWIR	one soil horizon	Oconee Co, GA	1.13	0.05	5.3	0.34			1.09	wt%					
11	As	Za92	Listing	gravel; carbonate & dolomite	Munich, GDR	0.005	-2.3	7.4										
52	B	El82	Listing	Glendale clay	NM	3.99	0.6	7.57	0.97			0.42	wt%	0.08	wt%	57	35.2	meq/100g
46	B	Go91	Listing	calcareous	Imperial Valley, CA	3.92	0.59		0.83									

(continued)

Table I-18. (continued)

ID	Species	RefIndex	Study	Media Type	Location	Kd (L/kg)	Log Kd	pH	POC (wt%)	DOC	DOC units	FeOx	FeOx units	AlOx	AlOx units	Clay (wt%)	CEC	CEC units
50	B	Sa97	Listing	Ustochrept	India	3.58	0.55	8.15	0.53			0.31	%			14		
58	B	El82	Listing	Reagan clay loam	NM	3.33	0.52	7.54	1.1			0.18	wt%	0.09	wt%	27.3	18.5	meq/100g
54	B	El82	Listing	Lea sandy loam	NM	2.53	0.4	7.62	0.57			0.03	wt%	0.07	wt%	14.5	14.1	meq/100g
49	B	Sa97	Listing	Haplustert	India	2.34	0.37	7.15	0.49			0.866	%			45		
53	B	El82	Listing	Harvey sandy loam	NM	2.16	0.33	7.42	0.43			0.09	wt%	0.12	wt%	13.7	14	meq/100g
48	B	Sa97	Listing	Haplustalf	India	1.93	0.29	5	0.46			0.624	%			21		
45	B	El82	Listing	Carjo silt loam	NM	1.93	0.29	6.02	1			0.38	wt%	0.27	wt%	25	16.2	meq/100g
71	B	Mo93	Listing	Soil 3	W. Bengal, India	1.53	0.18											
63	B	Mo93	Listing	Soil 10	W. Bengal, India	1.52	0.18											
67	B	Mo93	Listing	Soil 14	W. Bengal, India	1.4	0.15											
65	B	Mo93	Listing	Soil 12	W. Bengal, India	1.37	0.14											
47	B	Sa97	Listing	Calciorthent	India	1.35	0.13	7.52	0.34			0.106	%			50		
68	B	Mo93	Listing	Soil 15	W. Bengal, India	1.29	0.11											
62	B	Mo93	Listing	Soil 1	W. Bengal, India	1.24	0.09											
70	B	Mo93	Listing	Soil 2	W. Bengal, India	1.18	0.07											
66	B	Mo93	Listing	Soil 13	W. Bengal, India	1.15	0.06											
74	B	Mo93	Listing	Soil 6	W. Bengal, India	1.14	0.06											
75	B	Mo93	Listing	Soil 7	W. Bengal, India	1.08	0.03											
76	B	Mo93	Listing	Soil 8	W. Bengal, India	0.97	-0.01											
77	B	Mo93	Listing	Soil 9	W. Bengal, India	0.94	-0.03											
72	B	Mo93	Listing	Soil 4	W. Bengal, India	0.93	-0.03											
64	B	Mo93	Listing	Soil 11	W. Bengal, India	0.89	-0.05											
73	B	Mo93	Listing	Soil 5	W. Bengal, India	0.86	-0.07											
78	B	Ye95	Listing	loess	Israel	0.62	-0.21	7.5	0.55								168	mmol/kg
56	B	El82	Listing	R-28 sand	NM	0.421	-0.38	7.89	0.04			0.21	wt%	0.08	wt%	7.7	8.1	meq/100g
55	B	El82	Listing	Puye sandy loam	NM	0.409	-0.39	6.02	0.45			0.27	wt%	0.14	wt%	10	5.5	meq/100g
60	B	Go91	Listing	clayey loam	Imperial Valley, CA	0.35	-0.46		0.1									
69	B	Mo93	Listing	Soil 16	W. Bengal, India	0.32	-0.49											
57	B	El82	Listing	R-30 sand	NM	0.162	-0.79	7.82	0.04			0.1	wt%	0.07	wt%	5.6	7.8	meq/100g
51	B	El82	Listing	Chem B sand	NM	0.125	-0.9	8	0.02			0.17	wt%	0.06	wt%	5	6.2	meq/100g
59	B	El82	Listing	Tuff loamy sand	NM	0.087	-1.06	7.03	0.17			0.21	wt%	0.08	wt%	3.4	1.6	meq/100g

(continued)

Table I-18. (continued)

ID	Species	RefIndex	Study	Media Type	Location	Kd (L/kg)	Log Kd	pH	POC (wt%)	DOC	DOC units	FeOx	FeOx units	AlOx	AlOx units	Clay (wt%)	CEC	CEC units
61	B	Br97	Listing	unconsolidated, conglomerate	Stanton, TX	0.06	-1.22	7.57										
79	Ba(II)	Ge82	Listing	sandy loam	Netherlands	1355	3.13	7.8	2.25									
80	Ba(II)	Ge82	Listing	sand	Netherlands	42.5	1.63	4.8	1.75									
81	Be(II)	Ge82	Listing	sandy loam	Netherlands	10000	4	7.8	2.25									
82	Be(II)	Ge82	Listing	sand	Netherlands	372.5	2.57	4.8	1.75									
167	Cd(II)	Ja97	HWIR	Soil T	Netherlands (location not impacted by agricultural)	18263	4.26	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
166	Cd(II)	Ja97	HWIR	Soil S	Netherlands (location not impacted by agricultural)	6446	3.81	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
165	Cd(II)	Ja97	HWIR	Soil R	Netherlands (location not impacted by agricultural)	6298	3.8	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
153	Cd(II)	Ja97	HWIR	Soil D	Netherlands (location not impacted by agricultural)	5828	3.77	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
155	Cd(II)	Ja97	HWIR	Soil F	Netherlands (location not impacted by agricultural)	5049	3.7	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
163	Cd(II)	Ja97	HWIR	Soil P	Netherlands (location not impacted by agricultural)	4653	3.67	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
147	Cd(II)	De91	OAR	alluvium	ID; INEL	4360	3.64	8				2.5	wt%			12.4		
156	Cd(II)	Ja97	HWIR	Soil G	Netherlands (location not impacted by agricultural)	3549	3.55	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
173	Cd(II)	Ku91	HWIR	coastal soil	Washington state	2600	3.41	6	5.4			1.27	wt% Fe					
174	Cd(II)	Ku91	HWIR	coastal soil	Washington state	2200	3.34	6	7			0.55	wt% Fe					
178	Cd(II)	Ku91	HWIR	coastal soil	Washington state	2175	3.34	6.5	1.8			1.45	wt% Fe					
145	Cd(II)	Ge82	Listing	sandy loam	Netherlands	2000	3.3	7.8	2.25									
134	Cd(II)	Ch96	Listing	Allerod 1 sand	Denmark	1770	3.25	8.83	0.133							2		

(continued)

Table I-18. (continued)

ID	Species	RefIndex	Study	Media Type	Location	Kd (L/kg)	Log Kd	pH	POC (wt%)	DOC	DOC units	FeOx	FeOx units	AlOx	AlOx units	Clay (wt%)	CEC	CEC units
183	Cd(II)	Ch85	HWIR	sandy loam	Denmark, agricultural exp. station soil	1700	3.23	6.65	0.15			1.65	wt% Fe					
124	Cd(II)	Ch96	Listing	Gunderup 2 sand	Denmark	1610	3.21	8.75	0.292							0		
172	Cd(II)	Le98	Listing	Wan-li loam	Taiwan	1595	3.2	6.51	1.9							11.5	1	meq/100g
105	Cd(II)	An88	HWIR	agricultural Danish soil	Denmark, agricultural exp. station soil	1386.8	3.14	7.3										
154	Cd(II)	Ja97	HWIR	Soil E	Netherlands (location not impacted by agricultural)	1378	3.14	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
151	Cd(II)	Ja97	HWIR	Soil B	Netherlands (location not impacted by agricultural)	1078	3.03	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
123	Cd(II)	Ch96	Listing	Gunderup 1 sand	Denmark	1010	3	8.87	0.032							1		
148	Cd(II)	De91	OAR	interbed sediments	ID; INEL	1000	3	8				3.7	wt%			12		
162	Cd(II)	Ja97	HWIR	Soil O	Netherlands (location not impacted by agricultural)	974	2.99	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
164	Cd(II)	Ja97	HWIR	Soil Q	Netherlands (location not impacted by agricultural)	948	2.98	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
181	Cd(II)	Ch85	HWIR	sand	Denmark, agricultural exp. station soil	780	2.89	6.65	0.2			0.38	wt% Fe					
175	Cd(II)	Ku91	HWIR	coastal soil	Washington state	770	2.89	6	1.8			1.45	wt% Fe					
104	Cd(II)	An88	HWIR	agricultural Danish soil	Denmark, agricultural exp. station soil	769.1	2.89	6.9										
119	Cd(II)	Bu89	OAR	Webster Ap	USA	755.1	2.88	7.6	4.39			0.19	wt%			23.9	48.1	meq/100g
152	Cd(II)	Ja97	HWIR	Soil C	Netherlands (location not impacted by agricultural)	755	2.88	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
122	Cd(II)	Ch96	Listing	Finderup 2 sand	Denmark	720	2.86	7.96	0.108							0		
176	Cd(II)	Ku91	HWIR	coastal soil	Washington state	710	2.85	6	2			0.87	wt% Fe					

(continued)

Table I-18. (continued)

ID	Species	RefIndex	Study	Media Type	Location	Kd (L/kg)	Log Kd	pH	POC (wt%)	DOC	DOC units	FeOx	FeOx units	AlOx	AlOx units	Clay (wt%)	CEC	CEC units
127	Cd(II)	Ch96	Listing	Tirstrup 1 sand	Denmark	670	2.83	8.51	0.306							3		
131	Cd(II)	Ch96	Listing	Vorbasse 2 sand	Denmark	660	2.82	8.46	0.01							0		
128	Cd(II)	Ch96	Listing	Tylstrup sand	Denmark	640	2.81	8.01	0.167							4		
150	Cd(II)	Ja97	HWIR	Soil L	Netherlands (location not impacted by agricultural)	603	2.78	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
135	Cd(II)	Ch96	Listing	Allerod 2 sand	Denmark	560	2.75	8.47	0.083							0		
159	Cd(II)	Ja97	HWIR	Soil J	Netherlands (location not impacted by agricultural)	532	2.73	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
125	Cd(II)	Ch96	Listing	Herborg sand	Denmark	500	2.7	7.85	0.213							0		
103	Cd(II)	An88	HWIR	agricultural Danish soil	Denmark, agricultural exp. station soil	494.3	2.69	6.6										
138	Cd(II)	Ma92	OAR	Soil A	Spain (SW)	488.4	2.69	6.8								25.2	27.5	meq/100g
177	Cd(II)	Ku91	HWIR	coastal soil	Washington state	475	2.68	6	1.6			0.35	wt% Fe					
168	Cd(II)	Le98	Listing	Hu-shan farm sand	Taiwan	461.8	2.66	6.89	0.55							6.5	7.3	meq/100g
102	Cd(II)	An88	HWIR	agricultural Danish soil	Denmark, agricultural exp. station soil	368.1	2.57	6.4										
170	Cd(II)	Le98	Listing	Kuei-jen loam	Taiwan	303.2	2.48	6.38	0.45							9	8.1	meq/100g
179	Cd(II)	Ku91	HWIR	coastal soil	Washington state	300	2.48	5	1.8			1.45	wt% Fe					
108	Cd(II)	Bu89	OAR	Cecil Ap	USA	288.4	2.46	5.7	0.61			0.1	wt%			8.3	2	meq/100g
101	Cd(II)	An88	HWIR	agricultural Danish soil	Denmark, agricultural exp. station soil	274.2	2.44	6.2										
90	Cd(II)	Na78	OAR	Hahoterim	Israel	266.7	2.43	7.9	0.86								37	meq/100g
142	Cd(II)	Za92	Listing	gravel; carbonate & dolomite	Munich, GDR	255	2.41	7.4										
182	Cd(II)	Ch85	HWIR	sand	Denmark, agricultural exp. station soil	250	2.4	5.5	0.2			0.38	wt% Fe					
184	Cd(II)	Ch85	HWIR	sandy loam	Denmark, agricultural exp. station soil	225	2.35	5.5	0.15			1.65	wt% Fe					

(continued)

Table I-18. (continued)

ID	Species	RefIndex	Study	Media Type	Location	Kd (L/kg)	Log Kd	pH	POC (wt%)	DOC	DOC units	FeOx	FeOx units	AlOx	AlOx units	Clay (wt%)	CEC	CEC units
100	Cd(II)	An88	HWIR	agricultural Danish soil	Denmark, agricultural exp. station soil	204.2	2.31	6										
146	Cd(II)	Ge82	Listing	sand	Netherlands	201.5	2.3	4.8	1.75									
87	Cd(II)	Na78	OAR	Bet Yizhaq	Israel	200	2.3	7.8	0.83								15.4	meq/100g
140	Cd(II)	Al95	HWIR	Boonton loam	New Jersey	200	2.3	5.12	8.6							6		
110	Cd(II)	Bu89	OAR	Kula Ap1	USA	186.6	2.27	5.9	6.62			1.68	wt%			0.9	22.54	meq/100g
91	Cd(II)	Na78	OAR	Maaban Michael	Israel	181.8	2.26	7.6	0.79								31.8	meq/100g
130	Cd(II)	Ch96	Listing	Vorbasse 1 sand	Denmark	180	2.26	6.77	0.011							1		
180	Cd(II)	Ku91	HWIR	coastal soil	Washington state	175	2.24	4.5	1.8			1.45	wt% Fe					
158	Cd(II)	Ja97	HWIR	Soil I	Netherlands (location not impacted by agricultural)	159	2.2	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
99	Cd(II)	An88	HWIR	agricultural Danish soil	Denmark, agricultural exp. station soil	152.1	2.18	5.8										
157	Cd(II)	Ja97	HWIR	Soil H	Netherlands (location not impacted by agricultural)	144	2.16	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
89	Cd(II)	Na78	OAR	Gilat	Israel	133.3	2.12	8.3	0.23								18.9	meq/100g
98	Cd(II)	An88	HWIR	agricultural Danish soil	Denmark, agricultural exp. station soil	113.2	2.05	5.6										
160	Cd(II)	Ja97	HWIR	Soil K	Netherlands (location not impacted by agricultural)	102	2.01	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
114	Cd(II)	Bu89	OAR	Olivier Ap	USA	97.9	1.99	6.6	0.83			0.3	wt%			6.2	8.6	meq/100g
133	Cd(II)	Sc88	HWIR	forest soil	Northern Bavaria	97	1.99	3.7								3		
112	Cd(II)	Bu89	OAR	Molokai Ap	USA	91.2	1.96	6	1.67			0.19	wt%			28.2	11	meq/100g
118	Cd(II)	Ga80	OAR	Imperial, Vertic Torrifluvent	CA	87.1	1.94	8.4	1.44			1.07	wt%				60	meq/100g
97	Cd(II)	An88	HWIR	agricultural Danish soil	Denmark, agricultural exp. station soil	84.3	1.93	5.4										
88	Cd(II)	Na78	OAR	Gevulot	Israel	80	1.9	8.2	0.21								8.2	meq/100g
83	Cd(II)	Me94	HWIR	acidic soil	England	69	1.84	4.6	10.5									

(continued)

Table I-18. (continued)

ID	Species	RefIndex	Study	Media Type	Location	Kd (L/kg)	Log Kd	pH	POC (wt%)	DOC	DOC units	FeOx	FeOx units	AlOx	AlOx units	Clay (wt%)	CEC	CEC units
96	Cd(II)	An88	HWIR	agricultural Danish soil	Denmark, agricultural exp. station soil	62.8	1.8	5.2										
111	Cd(II)	Bu89	OAR	Lafitte Ap	USA	52.7	1.72	3.9	11.6			1.19	wt%			17.6	26.9	meq/100g
106	Cd(II)	Bu89	OAR	Alligator Ap	USA	52.5	1.72	4.8	1.54			0.33	wt%			54.7	30.2	meq/100g
95	Cd(II)	An88	HWIR	agricultural Danish soil	Denmark, agricultural exp. station soil	46.8	1.67	5										
132	Cd(II)	Ch96	Listing	Vorbasse 3 sand	Denmark	40	1.6	5.83	0.072							1		
149	Cd(II)	St86	Listing	Shelocta silt loam	TN	38	1.58											
115	Cd(II)	Ga80	OAR	organic	CA	33.88	1.53	5.2	32.6								33.8	meq/100g
86	Cd(II)	Me94	HWIR	acidic soil	England	32	1.51	3.4	13.3									
94	Cd(II)	An88	HWIR	agricultural Danish soil	Denmark, agricultural exp. station soil	30.1	1.48	4.7										
113	Cd(II)	Bu89	OAR	Norwood Ap	USA	28.8	1.46	6.9	0.21			0.06	wt%			2.8	4.1	meq/100g
92	Cd(II)	Vu98	Listing	Sava R. alluvial sediment	Croatia	26.3	1.42	5.8	0.5									
143	Cd(II)	Al95	HWIR	Rockaway stony loam	New Jersey	25	1.4	4.7	0.2							16		
171	Cd(II)	Le98	Listing	Niu-chou-pu sandy loam	Taiwan	23.9	1.38	4.81	0.15							12	8.5	meq/100g
169	Cd(II)	Le98	Listing	Hu-tou-pi sandy loam	Taiwan	22.1	1.34	3.96	0.4							10	8.1	meq/100g
161	Cd(II)	Ja97	HWIR	Soil M	Netherlands (location not impacted by agricultural)	21	1.32	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
107	Cd(II)	Ga80	OAR	Boomer, Ultic Haploxeralf	CA	20.42	1.31	5.8	3			8.29	wt%				23.8	meq/100g
93	Cd(II)	An88	HWIR	agricultural Danish soil	Denmark, agricultural exp. station soil	19.3	1.29	4.4										
139	Cd(II)	Pa99	Listing	fluvioglacial outwash gravels	Burnham, New Zealand	16.82	1.23	7.3	0.23								0.053	me/g
85	Cd(II)	Me94	HWIR	acidic soil	England	15	1.18	4.1	7.9									
120	Cd(II)	Bu89	OAR	Windsor Ap	USA	14.4	1.16	5.3	2.03			0.42	wt%			2.8	2	meq/100g
121	Cd(II)	Ch96	Listing	Finderup 1 sand	Denmark	14	1.15	6.19	0.007							1		
129	Cd(II)	Ch96	Listing	Vejen sand	Denmark	14	1.15	5.66	0.034							1		

(continued)

Table I-18. (continued)

ID	Species	RefIndex	Study	Media Type	Location	Kd (L/kg)	Log Kd	pH	POC (wt%)	DOC	DOC units	FeOx	FeOx units	AlOx	AlOx units	Clay (wt%)	CEC	CEC units
141	Cd(II)	Al95	HWIR	Freehold sandy loam	New Jersey	14	1.15	5.22	0.2							13		
109	Cd(II)	Bu89	OAR	Cecil B	USA	13.9	1.14	5.4	0.26			0.08	wt%			51.2	2.4	meq/100g
144	Cd(II)	Al95	HWIR	Downer loamy sand	New Jersey	12	1.08	4.8	0.8							8		
84	Cd(II)	Me94	HWIR	acidic soil	England	12	1.08	4	5.7									
136	Cd(II)	Ch96	Listing	Borris sand	Denmark	11	1.04	5.86	0.032							0		
117	Cd(II)	Ga80	OAR	Olivenheim, Ultic Palexeral	CA	10.47	1.02	6	3.2			1.07	wt%				25	meq/100g
137	Cd(II)	Ch96	Listing	Brande sand	Denmark	6	0.78	5.28	0.028							1		
116	Cd(II)	Bu89	OAR	Spodisol	USA	5.5	0.74	4.3	1.98			0	wt%			3.8	2.7	meq/100g
126	Cd(II)	Ch96	Listing	Rabis Baek sand	Denmark	2	0.3	4.91	0.482							1		
197	Co(II)	Mi82	Listing	Soil 5: heavy clay	Finland	14000	4.15	8									25	meq/100g
204	Co(II)	Ta94	Listing	loess	China	5450	3.74	7.5										
198	Co(II)	Mi82	Listing	Soil 6: silty clay	Finland	4500	3.65	7									17	meq/100g
187	Co(II)	Ban92	HWIR	illitic soil	Islamabad	4120	3.61	8	0.25									
189	Co(II)	Ge82	Listing	sandy loam	Netherlands	3700	3.57	7.8	2.25									
192	Co(II)	Mi82	Listing	Soil 1: heavy clay	Finland	2200	3.34	8.2									26	meq/100g
194	Co(II)	Mi82	Listing	Soil 2: heavy clay	Finland	1800	3.26	8.2										meq/100g
188	Co(II)	Ya95	Listing	paddy and upland agricultural soils	Japan	1735	3.24	5.85									107	mmol/kg
203	Co(II)	Ba92	Listing	London clay	England	1430	3.16			6	mg/L							
195	Co(II)	Mi82	Listing	Soil 3: heavy clay	Finland	990	3	8.4									21	meq/100g
193	Co(II)	Mi82	Listing	Soil 10: sandy till	Finland	880	2.94	6.2										meq/100g
196	Co(II)	Mi82	Listing	Soil 4: heavy clay	Finland	410	2.61	8.3									5.7	meq/100g
201	Co(II)	Mi82	Listing	Soil 9: sandy till	Finland	400	2.6	6.8										meq/100g
202	Co(II)	Ha88	Listing	glacial sand	Cumbria, UK	232	2.37	7.3		6.9	mg/L						2.8	meq/100g
199	Co(II)	Mi82	Listing	Soil 7: sandy till	Finland	160	2.2	6.4									2.8	meq/100g
200	Co(II)	Mi82	Listing	Soil 8: sandy till	Finland	140	2.15	6.4									3.2	meq/100g
185	Co(II)	Ra96	HWIR		Bhopal, India	136	2.13	8.5	0.57							36		
191	Co(II)	Ra96	HWIR		Tehri, India	120	2.08	6.3	0.69							11		
186	Co(II)	Sc88	HWIR	forest soil	Northern Bavaria	41	1.61	3.7								3		
190	Co(II)	Ge82	Listing	sand	Netherlands	19	1.28	4.8	1.75									

(continued)

Table I-18. (continued)

ID	Species	RefIndex	Study	Media Type	Location	Kd (L/kg)	Log Kd	pH	POC (wt%)	DOC	DOC units	FeOx	FeOx units	AlOx	AlOx units	Clay (wt%)	CEC	CEC units
228	Cr(III)	Ja97	HWIR	Soil R	Netherlands (location not impacted by agricultural)	24217	4.38	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
209	Cr(III)	Ha96b	HWIR	loess	U.S various locations	20833	4.32	6.2	0.11			9717	mg/kg					
219	Cr(III)	Ja97	HWIR	Soil G	Netherlands (location not impacted by agricultural)	20665	4.32	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
226	Cr(III)	Ja97	HWIR	Soil P	Netherlands (location not impacted by agricultural)	19796	4.3	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
214	Cr(III)	Ja97	HWIR	Soil B	Netherlands (location not impacted by agricultural)	11992	4.08	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
227	Cr(III)	Ja97	HWIR	Soil Q	Netherlands (location not impacted by agricultural)	11063	4.04	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
229	Cr(III)	Ja97	HWIR	Soil S	Netherlands (location not impacted by agricultural)	9519	3.98	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
230	Cr(III)	Ja97	HWIR	Soil T	Netherlands (location not impacted by agricultural)	9159	3.96	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
225	Cr(III)	Ja97	HWIR	Soil O	Netherlands (location not impacted by agricultural)	8906	3.95	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
215	Cr(III)	Ja97	HWIR	Soil C	Netherlands (location not impacted by agricultural)	8116	3.91	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
216	Cr(III)	Ja97	HWIR	Soil D	Netherlands (location not impacted by agricultural)	7933	3.9	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		

(continued)

Table I-18. (continued)

ID	Species	RefIndex	Study	Media Type	Location	Kd (L/kg)	Log Kd	pH	POC (wt%)	DOC	DOC units	FeOx	FeOx units	AlOx	AlOx units	Clay (wt%)	CEC	CEC units
218	Cr(III)	Ja97	HWIR	Soil F	Netherlands (location not impacted by agricultural)	6746	3.83	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
217	Cr(III)	Ja97	HWIR	Soil E	Netherlands (location not impacted by agricultural)	5977	3.78	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
208	Cr(III)	Ha96b	HWIR	Zahl loam	U.S various locations	5075	3.71	6.52	1.92			7182	mg/kg					
212	Cr(III)	Ja97	HWIR	Soil L	Netherlands (location not impacted by agricultural)	4711	3.67	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
222	Cr(III)	Ja97	HWIR	Soil J	Netherlands (location not impacted by agricultural)	4219	3.63	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
220	Cr(III)	Ja97	HWIR	Soil H	Netherlands (location not impacted by agricultural)	3799	3.58	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
213	Cr(III)	Ja97	HWIR	Soil A	Netherlands (location not impacted by agricultural)	2747	3.44	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
221	Cr(III)	Ja97	HWIR	Soil I	Netherlands (location not impacted by agricultural)	2418	3.38	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
224	Cr(III)	Ja97	HWIR	Soil M	Netherlands (location not impacted by agricultural)	2364	3.37	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
206	Cr(III)	Sh91a	HWIR	sandy soil	Canada	711	2.85	5.7	0.313			4646	mg/kg					
207	Cr(III)	Ha96b	HWIR	clay	U.S various locations	536	2.73	4.03	3.75			19217	mg/kg					
223	Cr(III)	Ja97	HWIR	Soil K	Netherlands (location not impacted by agricultural)	524	2.72	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
211	Cr(III)	Ge82	Listing	sand	Netherlands	360	2.56	4.8	1.75									
210	Cr(III)	Ge82	Listing	sandy loam	Netherlands	25	1.4	7.8	2.25									

(continued)

Table I-18. (continued)

ID	Species	RefIndex	Study	Media Type	Location	Kd (L/kg)	Log Kd	pH	POC (wt%)	DOC	DOC units	FeOx	FeOx units	AlOx	AlOx units	Clay (wt%)	CEC	CEC units
238	Cr(VI)	Wo83	OAR	Hallandale fine sand	Pompano Beach, FL	1729	3.24	8.2	1.45								0.113	meq/100g
244	Cr(VI)	Ra88	OAR	Holton/Cloudland Series (Bx horizon)	TN	1585	3.2	4.45	0.05			0.435	mmol/g			34	7.3	meq/100g
234	Cr(VI)	Wo83	OAR	organic soil (muck); all layers	FL	1372	3.14	7.2	5.52								0.34	meq/100g
248	Cr(VI)	Sh87	OAR	loam (Chernozem)	Canada	1000	3										60	meq/100g
245	Cr(VI)	Ra88	OAR	Cecil/Pacolet Series (Be horizon)	NC	288	2.46	5.46	0.07			0.266	mmol/g			28	4.4	meq/100g
250	Cr(VI)	Ra85	OAR	Toa Series	PR	110	2.04											
249	Cr(VI)	Sh87	OAR	sand (Regosol)	Canada	100	2										1.6	meq/100g
242	Cr(VI)	St85	Listing	alluvium	Telluride, CO	52	1.72	6.8								0.3		
241	Cr(VI)	Sh87b	OAR	sand (Brunisol) all layers	Manitoba (SE)	50	1.7	5.425									2.19	meq/100g
237	Cr(VI)	Ha96b	HWIR	loess	U.S various locations	46.5	1.67	2.52	0.11			9717	mg/kg					
235	Cr(VI)	Ha96b	HWIR	clay	U.S various locations	26.9	1.43	2.29	3.75			19217	mg/kg					
205	Cr(VI)	Ni94	Listing	fine to silty sands	Woodstock, CN	22	1.34	4.7	1.2									
233	Cr(VI)	Se88	OAR	Cecil Series	USA	10	1	5.1	0.24			10.2	wt%				3.72	meq/100g
247	Cr(VI)	Ra85	OAR	Bayamon Series	PR	8	0.9											
246	Cr(VI)	Ra88	OAR	Kenoma Series (Be+C horizon)	KS	7	0.85	6.92	0.32			0.162	mmol/g			46	28.4	meq/100g
232	Cr(VI)	Se88	OAR	Windsor Series	USA	6	0.78	5.4	0.94			2.2	wt%				1.2	meq/100g
240	Cr(VI)	St85	Listing	alluvium	Telluride, CO	5.3	0.72	6.8										
231	Cr(VI)	Se88	OAR	Olivier Series	USA	2	0.3	6.4	0.99			1.14	wt%				8.31	meq/100g
243	Cr(VI)	Ra88	OAR	Ocala Series (C4 horizon)	NV	1	0	9.4	0.14			0.009	mmol/g			31	35.7	meq/100g
236	Cr(VI)	Ha96b	HWIR	Zahl loam	U.S various locations	0.5	-0.3	11.1	1.92			7182	mg/kg					
239	Cr(VI)	Me91	Listing	vadose zone	USA	0.2	-0.7											
270	Cu(II)	Ja97	HWIR	Soil R	Netherlands (location not impacted by agricultural)	4318	3.64	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		

(continued)

Table I-18. (continued)

ID	Species	RefIndex	Study	Media Type	Location	Kd (L/kg)	Log Kd	pH	POC (wt%)	DOC	DOC units	FeOx	FeOx units	AlOx	AlOx units	Clay (wt%)	CEC	CEC units
267	Cu(II)	Ja97	HWIR	Soil O	Netherlands (location not impacted by agricultural)	1309	3.12	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
271	Cu(II)	Ja97	HWIR	Soil S	Netherlands (location not impacted by agricultural)	1253	3.1	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
260	Cu(II)	Ja97	HWIR	Soil G	Netherlands (location not impacted by agricultural)	1033	3.01	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
269	Cu(II)	Ja97	HWIR	Soil Q	Netherlands (location not impacted by agricultural)	986	2.99	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
263	Cu(II)	Ja97	HWIR	Soil J	Netherlands (location not impacted by agricultural)	874	2.94	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
272	Cu(II)	Ja97	HWIR	Soil T	Netherlands (location not impacted by agricultural)	874	2.94	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
268	Cu(II)	Ja97	HWIR	Soil P	Netherlands (location not impacted by agricultural)	838	2.92	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
256	Cu(II)	Ja97	HWIR	Soil C	Netherlands (location not impacted by agricultural)	701	2.85	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
258	Cu(II)	Ja97	HWIR	Soil E	Netherlands (location not impacted by agricultural)	529	2.72	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
251	Cu(II)	Ge82	Listing	sandy loam	Netherlands	500	2.7	7.8	2.25									
259	Cu(II)	Ja97	HWIR	Soil F	Netherlands (location not impacted by agricultural)	452	2.66	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		

(continued)

Table I-18. (continued)

ID	Species	RefIndex	Study	Media Type	Location	Kd (L/kg)	Log Kd	pH	POC (wt%)	DOC	DOC units	FeOx	FeOx units	AlOx	AlOx units	Clay (wt%)	CEC	CEC units
257	Cu(II)	Ja97	HWIR	Soil D	Netherlands (location not impacted by agricultural)	322	2.51	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
252	Cu(II)	Ge82	Listing	sand	Netherlands	155	2.19	4.8	1.75									
265	Cu(II)	Ja97	HWIR	Soil M	Netherlands (location not impacted by agricultural)	135	2.13	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
253	Cu(II)	Ja97	HWIR	Soil L	Netherlands (location not impacted by agricultural)	109	2.04	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
255	Cu(II)	Ja97	HWIR	Soil B	Netherlands (location not impacted by agricultural)	92	1.96	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
266	Cu(II)	Ja97	HWIR	Soil N	Netherlands (location not impacted by agricultural)	88	1.94	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
264	Cu(II)	Ja97	HWIR	Soil K	Netherlands (location not impacted by agricultural)	67	1.83	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
262	Cu(II)	Ja97	HWIR	Soil I	Netherlands (location not impacted by agricultural)	38	1.58	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
254	Cu(II)	Ja97	HWIR	Soil A	Netherlands (location not impacted by agricultural)	35	1.54	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
261	Cu(II)	Ja97	HWIR	Soil H	Netherlands (location not impacted by agricultural)	25	1.4	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
275	Hg(II)	Ly97	HWIR	soil (from Aa91)	Sweden	10526	4.02											
277	Hg(II)	Ly97	HWIR	soil (from Le94)	Sweden (near Lake Gardsjon)	8328	3.92											
276	Hg(II)	Ly97	HWIR	soil (from Le95)	Sweden (near Lake Gardsjon)	8000	3.9											
279	Hg(II)	Ge82	Listing	sandy loam	Netherlands	7600	3.88	7.8	2.25									

(continued)

Table I-18. (continued)

ID	Species	RefIndex	Study	Media Type	Location	Kd (L/kg)	Log Kd	pH	POC (wt%)	DOC	DOC units	FeOx	FeOx units	AlOx	AlOx units	Clay (wt%)	CEC	CEC units
280	Hg(II)	Ge82	Listing	sand	Netherlands	4500	3.65	4.8	1.75									
278	Hg(II)	Sc97	HWIR	iron-humus podozol	Norway	1924	3.28	4.5	2.3									
281	Hg(II)	Bi91	Listing	Rhine aquifer sand	France	2.2	0.34									0.1		
273	Hg(II)	Mac93	Listing	coastal plain	NJ	0.78	-0.11	4.5	1.55									
274	Hg(II)	Mac93	Listing	Bridgeton Fmt./Cohansey Sand	NJ	0.22	-0.66	4.5										
288	Mn	Mi82	Listing	Soil 5: heavy clay	Finland	4100	3.61	8									25	meq/100g
284	Mn	Mi82	Listing	Soil 1: heavy clay	Finland	1000	3	8.2									26	meq/100g
289	Mn	Mi82	Listing	Soil 6: silty clay	Finland	430	2.63	7									17	meq/100g
282	Mn	Ya95	Listing	paddy and upland agricultural soils	Japan	271	2.43	5.85									107	mmol/kg
292	Mn	Mi82	Listing	Soil 9: sandy till	Finland	160	2.2	6.8										meq/100g
285	Mn	Mi82	Listing	Soil 10: sandy till	Finland	130	2.11	6.2										meq/100g
286	Mn	Mi82	Listing	Soil 3: heavy clay	Finland	96	1.98	8.4									21	meq/100g
290	Mn	Mi82	Listing	Soil 7: sandy till	Finland	86	1.93	6.4									2.8	meq/100g
291	Mn	Mi82	Listing	Soil 8: sandy till	Finland	49	1.69	6.4									3.2	meq/100g
293	Mn	Sh89	Listing	69 different soils	Ontario (SW)	44	1.64	6.7	2.05							14		
283	Mn	St86	Listing	Shelocta silt loam	TN	36	1.56											
287	Mn	Mi82	Listing	Soil 4: heavy clay	Finland	34	1.53	8.3									5.7	meq/100g
297	Mo(VI)	Ge82	Listing	sand	Netherlands	162.5	2.21	4.8	1.75									
294	Mo(VI)	Is93	HWIR	two soil horizons	Oconee Co, Georgia	148	2.17	5.3	0.34			1.09	wt%					
295	Mo(VI)	Sh91a	HWIR	sandy soil	Canada	10.6	1.02	5.7	0.313			4646	mg/kg					
298	Mo(VI)	St95	Listing	sand/gravel alluvium	Cape Cod, MA	6.7	0.83	5.7		0.31	mg/L							
296	Mo(VI)	Ge82	Listing	sandy loam	Netherlands	2.75	0.44	7.8	2.25									
302	Ni(II)	Ch96	Listing	Gunderup 2 sand	Denmark	7250	3.86	8.75	0.292							0		
335	Ni(II)	Ja97	HWIR	Soil R	Netherlands (location not impacted by agricultural)	5749	3.76	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
338	Ni(II)	Ba92	Listing	London clay	England	4750	3.68			6	mg/L							
301	Ni(II)	Ch96	Listing	Gunderup 1 sand	Denmark	4510	3.65	8.87	0.032							1		

(continued)

Table I-18. (continued)

ID	Species	RefIndex	Study	Media Type	Location	Kd (L/kg)	Log Kd	pH	POC (wt%)	DOC	DOC units	FeOx	FeOx units	AlOx	AlOx units	Clay (wt%)	CEC	CEC units
313	Ni(II)	Ch96	Listing	Allerod 1 sand	Denmark	4370	3.64	8.83	0.133							2		
336	Ni(II)	Ja97	HWIR	Soil S	Netherlands (location not impacted by agricultural)	4113	3.61	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
326	Ni(II)	Ja97	HWIR	Soil G	Netherlands (location not impacted by agricultural)	3151	3.5	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
308	Ni(II)	Ch96	Listing	Vasby sand	Denmark	2750	3.44	8.87	0.113							1		
337	Ni(II)	Ja97	HWIR	Soil T	Netherlands (location not impacted by agricultural)	2310	3.36	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
334	Ni(II)	Ja97	HWIR	Soil Q	Netherlands (location not impacted by agricultural)	2163	3.34	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
333	Ni(II)	Ja97	HWIR	Soil P	Netherlands (location not impacted by agricultural)	1857	3.27	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
324	Ni(II)	Ja97	HWIR	Soil E	Netherlands (location not impacted by agricultural)	1843	3.27	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
321	Ni(II)	Ja97	HWIR	Soil B	Netherlands (location not impacted by agricultural)	1660	3.22	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
314	Ni(II)	Ch96	Listing	Allerod 2 sand	Denmark	1510	3.18	8.47	0.083							0		
305	Ni(II)	Ch96	Listing	Tirstrup 1 sand	Denmark	1430	3.16	8.51	0.306							3		
325	Ni(II)	Ja97	HWIR	Soil F	Netherlands (location not impacted by agricultural)	1285	3.11	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
322	Ni(II)	Ja97	HWIR	Soil C	Netherlands (location not impacted by agricultural)	1255	3.1	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		

(continued)

Table I-18. (continued)

ID	Species	RefIndex	Study	Media Type	Location	Kd (L/kg)	Log Kd	pH	POC (wt%)	DOC	DOC units	FeOx	FeOx units	AlOx	AlOx units	Clay (wt%)	CEC	CEC units
319	Ni(II)	Ja97	HWIR	Soil L	Netherlands (location not impacted by agricultural)	1088	3.04	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
332	Ni(II)	Ja97	HWIR	Soil O	Netherlands (location not impacted by agricultural)	744	2.87	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
300	Ni(II)	Ch96	Listing	Finderup 2 sand	Denmark	450	2.65	7.96	0.108							0		
307	Ni(II)	Ch96	Listing	Tylstrup sand	Denmark	440	2.64	8.01	0.167							4		
311	Ni(II)	Ch96	Listing	Vorbasse 2 sand	Denmark	420	2.62	8.46	0.01							0		
331	Ni(II)	Ja97	HWIR	Soil M	Netherlands (location not impacted by agricultural)	376	2.58	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
317	Ni(II)	Ge82	Listing	sandy loam	Netherlands	350	2.54	7.8	2.25									
306	Ni(II)	Ch96	Listing	Tirstrup 2 sand	Denmark	310	2.49	8.41	0.046							2		
320	Ni(II)	Ja97	HWIR	Soil A	Netherlands (location not impacted by agricultural)	292	2.47	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
303	Ni(II)	Ch96	Listing	Herborg sand	Denmark	250	2.4	7.85	0.213							0		
323	Ni(II)	Ja97	HWIR	Soil D	Netherlands (location not impacted by agricultural)	243	2.39	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
329	Ni(II)	Ja97	HWIR	Soil J	Netherlands (location not impacted by agricultural)	236	2.37	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
330	Ni(II)	Ja97	HWIR	Soil K	Netherlands (location not impacted by agricultural)	185	2.27	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
328	Ni(II)	Ja97	HWIR	Soil I	Netherlands (location not impacted by agricultural)	130	2.11	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
327	Ni(II)	Ja97	HWIR	Soil H	Netherlands (location not impacted by agricultural)	115	2.06	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		

(continued)

Table I-18. (continued)

ID	Species	RefIndex	Study	Media Type	Location	Kd (L/kg)	Log Kd	pH	POC (wt%)	DOC	DOC units	FeOx	FeOx units	AlOx	AlOx units	Clay (wt%)	CEC	CEC units
318	Ni(II)	Ge82	Listing	sand	Netherlands	49.5	1.69	4.8	1.75									
312	Ni(II)	Ch96	Listing	Vorbasse 3 sand	Denmark	40	1.6	5.83	0.072							1		
310	Ni(II)	Ch96	Listing	Vorbasse 1 sand	Denmark	40	1.6	6.77	0.011							1		
315	Ni(II)	Ch96	Listing	Borris sand	Denmark	24	1.38	5.86	0.032							0		
299	Ni(II)	Ch96	Listing	Finderup 1 sand	Denmark	18	1.26	6.19	0.007							1		
309	Ni(II)	Ch96	Listing	Vejen sand	Denmark	12	1.08	5.66	0.034							1		
316	Ni(II)	Ch96	Listing	Brande sand	Denmark	7	0.85	5.28	0.028							1		
304	Ni(II)	Ch96	Listing	Rabis Baek sand	Denmark	3	0.48	4.91	0.482							1		
371	Pb(II)	Ja97	HWIR	Soil T	Netherlands (location not impacted by agricultural)	67856	4.83	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
360	Pb(II)	Ja97	HWIR	Soil G	Netherlands (location not impacted by agricultural)	60311	4.78	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
345	Pb(II)	Sh91b	HWIR	loam	Canada	60000	4.78	7										
343	Pb(II)	Sh91b	HWIR	clay loam	Canada	60000	4.78	7										
349	Pb(II)	Sh89b	HWIR	fine sandy loam	Canada	59000	4.77	7.4								11		
373	Pb(II)	Rh92	OAR	sand	Hanford, WA	46000	4.66	8.35				0.41	wt%			0.06	5.27	meq/100g
369	Pb(II)	Ja97	HWIR	Soil R	Netherlands (location not impacted by agricultural)	45502	4.66	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
357	Pb(II)	Ja97	HWIR	Soil D	Netherlands (location not impacted by agricultural)	42250	4.63	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
367	Pb(II)	Ja97	HWIR	Soil P	Netherlands (location not impacted by agricultural)	37379	4.57	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
366	Pb(II)	Ja97	HWIR	Soil O	Netherlands (location not impacted by agricultural)	36930	4.57	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
356	Pb(II)	Ja97	HWIR	Soil C	Netherlands (location not impacted by agricultural)	34727	4.54	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		

(continued)

Table I-18. (continued)

ID	Species	RefIndex	Study	Media Type	Location	Kd (L/kg)	Log Kd	pH	POC (wt%)	DOC	DOC units	FeOx	FeOx units	AlOx	AlOx units	Clay (wt%)	CEC	CEC units
346	Pb(II)	Sh91b	HWIR	sedge peat	Canada	30000	4.48	5.5										
368	Pb(II)	Ja97	HWIR	Soil Q	Netherlands (location not impacted by agricultural)	27722	4.44	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
353	Pb(II)	Ja97	HWIR	Soil L	Netherlands (location not impacted by agricultural)	22944	4.36	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
344	Pb(II)	Sh91b	HWIR	gleysol loam	Canada	21000	4.32	7.3										
370	Pb(II)	Ja97	HWIR	Soil S	Netherlands (location not impacted by agricultural)	16973	4.23	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
359	Pb(II)	Ja97	HWIR	Soil F	Netherlands (location not impacted by agricultural)	12514	4.1	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
347	Pb(II)	Sh91b	HWIR	spaghnum peat	Canada	9000	3.95	4.8										
363	Pb(II)	Ja97	HWIR	Soil J	Netherlands (location not impacted by agricultural)	5923	3.77	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
358	Pb(II)	Ja97	HWIR	Soil E	Netherlands (location not impacted by agricultural)	5310	3.73	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
351	Pb(II)	Ge82	Listing	sandy loam	Netherlands	4250	3.63	7.8	2.25									
377	Pb(II)	Ha81	OAR	Split Rock Fmt.	WY	4000	3.6	7										
365	Pb(II)	Ja97	HWIR	Soil M	Netherlands (location not impacted by agricultural)	3550	3.55	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
354	Pb(II)	Ja97	HWIR	Soil A	Netherlands (location not impacted by agricultural)	3428	3.54	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
355	Pb(II)	Ja97	HWIR	Soil B	Netherlands (location not impacted by agricultural)	2637	3.42	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
376	Pb(II)	Ha81	OAR	Split Rock Fmt.	WY	1500	3.18	5.75										

(continued)

Table I-18. (continued)

ID	Species	RefIndex	Study	Media Type	Location	Kd (L/kg)	Log Kd	pH	POC (wt%)	DOC	DOC units	FeOx	FeOx units	AlOx	AlOx units	Clay (wt%)	CEC	CEC units
361	Pb(II)	Ja97	HWIR	Soil H	Netherlands (location not impacted by agricultural)	1326	3.12	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
362	Pb(II)	Ja97	HWIR	Soil I	Netherlands (location not impacted by agricultural)	1159	3.06	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
364	Pb(II)	Ja97	HWIR	Soil K	Netherlands (location not impacted by agricultural)	916	2.96	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
352	Pb(II)	Ge82	Listing	sand	Netherlands	750	2.88	4.8	1.75									
341	Pb(II)	Me94	HWIR	acidic soil	England	126	2.1	4.1	7.9									
375	Pb(II)	Ha81	OAR	Split Rock Fmt.	WY	100	2	4.5										
342	Pb(II)	Me94	HWIR	acidic soil	England	96	1.98	3.4	13.3									
339	Pb(II)	Me94	HWIR	acidic soil	England	93	1.97	4.6	10.5									
372	Pb(II)	Fu96	Listing	sandy glacial outwash	Cape Cod, MA	24.4	1.39	5.3										
374	Pb(II)	Ha81	OAR	Split Rock Fmt.	WY	20	1.3	2										
348	Pb(II)	Sh91b	HWIR	Brunisol sand	Canada	19.8	1.3	4.9										
350	Pb(II)	Sh89b	HWIR	medium sand	Canada	19	1.28	4.9								2		
340	Pb(II)	Me94	HWIR	acidic soil	England	14	1.15	4	5.7									
378	Sb(III)	Ge82	Listing	sandy loam	Netherlands	14	1.15	7.8	2.25									
379	Sb(III)	Ge82	Listing	sand	Netherlands	11	1.04	4.8	1.75									
387	Se(IV)	Fi91	HWIR	Soil CS	San Joaquin Valley, California	46.7	1.67	8.3										
389	Se(IV)	Sa94	HWIR	Mukaiyama	Japan	35	1.54	5	13.44			1.23	wt%					
382	Se(IV)	Ne87	HWIR	Los Banos	San Joaquin Valley, California	34.5	1.54	5.5	1.02			0.09	wt%					
385	Se(IV)	Ch89	HWIR	Ronhave soil	Denmark	31	1.5	6.5	1.21			0.608	wt%					
386	Se(IV)	Fi91	HWIR	Site 3 soil	San Joaquin Valley, California	30	1.48	8.3										
392	Se(IV)	Ge82	Listing	sandy loam	Netherlands	27.5	1.44	7.8	2.25									
393	Se(IV)	Ge82	Listing	sand	Netherlands	26	1.41	4.8	1.75									
388	Se(IV)	Ch89	HWIR	Studsgaard	Denmark	23.5	1.37	6.6	2.37			0.686	wt%					
381	Se(IV)	Ne87	HWIR	Ciervo	San Joaquin Valley, California	18.9	1.28	4.2	0.69			0.11	wt%					

(continued)

Table I-18. (continued)

ID	Species	RefIndex	Study	Media Type	Location	Kd (L/kg)	Log Kd	pH	POC (wt%)	DOC	DOC units	FeOx	FeOx units	AlOx	AlOx units	Clay (wt%)	CEC	CEC units
390	Se(IV)	Sa94	HWIR	Tanashi	Japan	16.5	1.22	5	8.25			1.75	wt%					
383	Se(IV)	Ne87	HWIR	Pan Hill	San Joaquin Valley, California	10.7	1.03	5.9	0.53			0.1	wt%					
391	Se(IV)	Fi90	Listing	Ciervo silty clay series	CA	10.5	1.02	8.3										
384	Se(IV)	Ne87	HWIR	Panoche	San Joaquin Valley, California	9.2	0.97	6	0.73			0.06	wt%					
380	Se(IV)	Ne87	HWIR	Altamont	San Joaquin Valley, California	2.17	0.34	8.1	2.9									
394	Sn	Ge82	Listing	sandy loam	Netherlands	7750	3.89	7.8	2.25									
395	Sn	Ge82	Listing	sand	Netherlands	2150	3.33	4.8	1.75									
396	V(IV)	Ge82	Listing	sandy loam	Netherlands	330	2.52	7.8	2.25									
397	V(IV)	Ge82	Listing	sand	Netherlands	75	1.88	4.8	1.75									
427	Zn(II)	Mi82	Listing	Soil 5: heavy clay	Finland	28000	4.45	8									25	meq/100g
422	Zn(II)	Mi82	Listing	Soil 1: heavy clay	Finland	15000	4.18	8.2									26	meq/100g
424	Zn(II)	Mi82	Listing	Soil 2: heavy clay	Finland	14000	4.15	8.2										meq/100g
428	Zn(II)	Mi82	Listing	Soil 6: silty clay	Finland	9100	3.96	7									17	meq/100g
420	Zn(II)	Ja97	HWIR	Soil S	Netherlands (location not impacted by agricultural)	6762	3.83	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
409	Zn(II)	Ja97	HWIR	Soil G	Netherlands (location not impacted by agricultural)	6226	3.79	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
437	Zn(II)	Le98	Listing	Wan-li loam	Taiwan	5667	3.75	6.51	1.9							11.5	1	meq/100g
425	Zn(II)	Mi82	Listing	Soil 3: heavy clay	Finland	5600	3.75	8.4									21	meq/100g
421	Zn(II)	Ja97	HWIR	Soil T	Netherlands (location not impacted by agricultural)	5472	3.74	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
419	Zn(II)	Ja97	HWIR	Soil R	Netherlands (location not impacted by agricultural)	5112	3.71	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
429	Zn(II)	Mi82	Listing	Soil 7: sandy till	Finland	5100	3.71	6.4									2.8	meq/100g
430	Zn(II)	Mi82	Listing	Soil 8: sandy till	Finland	5000	3.7	6.4									3.2	meq/100g

(continued)

Table I-18. (continued)

ID	Species	RefIndex	Study	Media Type	Location	Kd (L/kg)	Log Kd	pH	POC (wt%)	DOC	DOC units	FeOx	FeOx units	AlOx	AlOx units	Clay (wt%)	CEC	CEC units
417	Zn(II)	Ja97	HWIR	Soil P	Netherlands (location not impacted by agricultural)	3698	3.57	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
423	Zn(II)	Mi82	Listing	Soil 10: sandy till	Finland	3200	3.51	6.2										meq/100g
426	Zn(II)	Mi82	Listing	Soil 4: heavy clay	Finland	3000	3.48	8.3									5.7	meq/100g
406	Zn(II)	Ja97	HWIR	Soil D	Netherlands (location not impacted by agricultural)	2800	3.45	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
431	Zn(II)	Mi82	Listing	Soil 9: sandy till	Finland	2700	3.43	6.8										meq/100g
407	Zn(II)	Ja97	HWIR	Soil E	Netherlands (location not impacted by agricultural)	2438	3.39	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
405	Zn(II)	Ja97	HWIR	Soil C	Netherlands (location not impacted by agricultural)	2245	3.35	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
400	Zn(II)	Ge82	Listing	sandy loam	Netherlands	2050	3.31	7.8	2.25									
433	Zn(II)	Le98	Listing	Hu-shan farm sand	Taiwan	1989	3.3	6.89	0.55							6.5	7.3	meq/100g
399	Zn(II)	Ya95	Listing	paddy and upland agricultural soils	Japan	1756	3.24	5.85									107	mmol/kg
408	Zn(II)	Ja97	HWIR	Soil F	Netherlands (location not impacted by agricultural)	1299	3.11	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
402	Zn(II)	Ja97	HWIR	Soil L	Netherlands (location not impacted by agricultural)	1294	3.11	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
418	Zn(II)	Ja97	HWIR	Soil Q	Netherlands (location not impacted by agricultural)	1278	3.11	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
435	Zn(II)	Le98	Listing	Kuei-jen loam	Taiwan	995	3	6.38	0.45							9	8.1	meq/100g
404	Zn(II)	Ja97	HWIR	Soil B	Netherlands (location not impacted by agricultural)	604	2.78	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		

(continued)

Table I-18. (continued)

ID	Species	RefIndex	Study	Media Type	Location	Kd (L/kg)	Log Kd	pH	POC (wt%)	DOC	DOC units	FeOx	FeOx units	AlOx	AlOx units	Clay (wt%)	CEC	CEC units
416	Zn(II)	Ja97	HWIR	Soil O	Netherlands (location not impacted by agricultural)	422	2.63	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
412	Zn(II)	Ja97	HWIR	Soil J	Netherlands (location not impacted by agricultural)	154	2.19	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
403	Zn(II)	Ja97	HWIR	Soil A	Netherlands (location not impacted by agricultural)	73	1.86	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
436	Zn(II)	Le98	Listing	Niu-chou-pu sandy loam	Taiwan	72.5	1.86	4.81	0.15							12	8.5	meq/100g
401	Zn(II)	Ge82	Listing	sand	Netherlands	55.5	1.74	4.8	1.75									
398	Zn(II)	Sc88	HWIR	forest soil	Northern Bavaria	41	1.61	3.7								3		
411	Zn(II)	Ja97	HWIR	Soil I	Netherlands (location not impacted by agricultural)	41	1.61	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
414	Zn(II)	Ja97	HWIR	Soil N	Netherlands (location not impacted by agricultural)	38	1.58	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
413	Zn(II)	Ja97	HWIR	Soil K	Netherlands (location not impacted by agricultural)	34	1.53	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
434	Zn(II)	Le98	Listing	Hu-tou-pi sandy loam	Taiwan	33.8	1.53	3.96	0.4							10	8.1	meq/100g
410	Zn(II)	Ja97	HWIR	Soil H	Netherlands (location not impacted by agricultural)	23	1.36	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
415	Zn(II)	Ja97	HWIR	Soil M	Netherlands (location not impacted by agricultural)	6	0.78	6.4	2.8	5.4	mmol/L	88.6	mmol/kg	26.1	mmol/kg	6.5		
432	Zn(II)	Fu96	Listing	sandy glacial outwash	Cape Cod, MA	2.7	0.43	5.3										

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Appendix J

Human Health Benchmarks

Appendix J

Human Health Benchmarks

J.1 Acetonitrile

J.1.1 Introduction

Acetonitrile is also known as cyanomethane and methyl cyanide. It is a volatile, colorless liquid with an ether-like odor. It is one of the most stable nitriles. Although nitriles are widely used to synthesize amines, ketones, aldehydes, and other compounds, acetonitrile is primarily used as a solvent. Sources of acetonitrile emissions to the air include manufacturing and industrial facilities, car exhaust, and volatilization from water (U.S. EPA, 1985, 1999).

J.1.2 Noncancer Effects

Human data on acetonitrile are limited to case reports, which have reported nausea, shallow and irregular breathing, and impaired motor activity from occupational exposure to acetonitrile. Children or adults who ingested large amounts of acetonitrile showed symptoms including vomiting, respiratory distress, confusion, convulsions, seizures, and pulmonary edema. In subchronic studies in animals, lethality occurs. In 2-year studies, at lower concentrations, no adverse effects have been noted. The lethal effects of acetonitrile exposure are believed to be associated with the production of cyanide, leading to respiratory paralysis and inhibition of central nervous system processes (U.S. EPA, 1999).

Acetonitrile		
Benchmark	**Value**	**Source**
RfD	NA	
RfC	6.0E-02 mg/m^3	U.S. EPA, 1999, 2000
oral CSF	NA	
inh URF	NA	
inh CSF	NA	

J.1.2.1 Reference Dose. EPA has not established an RfD for acetonitrile (U.S. EPA, 1999, 2000).

J.1.2.2 Reference Concentration. The RfC for acetonitrile is 6.0E-02 mg/m^3, based on a NOAEL of 336 mg/m^3 (200 ppm), an uncertainty factor of 100, and a modifying factor of 10. The RfC was based on a 13-week study in which mice inhaled acetonitrile at concentrations of 0, 100, 200, 400, 800, or 1,600 ppm (0, 168, 336, 672, 1,343, or 2,686 mg/m^3), respectively, for 6 h/d, 5 d/wk (U.S. EPA, 1999, 2000, citing NTP, 1996a). Mortality was observed at concentrations of 400 ppm and greater. There were no effects reported for the lungs. Males exhibited a significant concentration-related increase in absolute and relative liver weight. Females had a significant increase in absolute liver wight at 800 ppm and in relative liver wight at 400 ppm and above. Incidences of forestomach squamous epithelial hyperplasia were significantly increased in males at 800 ppm and in females at 200 ppm and greater. A NOAEL of 200 ppm (336 mg/m^3) was identified from this study, based on mortality as an endpoint. This NOAEL was adjusted as follows: NOAEL (ADJ) = NOAEL (mg/m^3) × 6 h/24 h × 5/7 d = 60 mg/m^3. The NOAEL (human equivalent concentration or HEC) was calculated for a category 2 gas and extrarespiratory (systemic) effects assuming periodicity was attained. Acetonitrile is considered to be a category 2 gas because it has high water solubility, is metabolized to reactive cyanide in the liver but may be detoxified rapidly to thiocyanate, and does not react directly with respiratory tract tissues. The RGDR for a category 2 gas is assumed to be 1. Thus, NOAEL (HEC) = NOAEL (ADJ) × 1 = 60 mg/m^3 (U.S. EPA, 1999, 2000).

An uncertainty factor of 100 was applied based on a threefold factor for extrapolation from animals to humans, a tenfold factor to protect sensitive human subpopulations, and a threefold factor for database deficiencies (e.g., reproductive endpoints, hematology in mice). Because two factors of 3 coalesce to a 10, a total uncertainty factor of 100 results. A modifying factor of 10 was applied because of the uncertain role that inhalation may have played in the development of the concentration-related increase in the incidence of forestomach lesions in both male and female mice (U.S. EPA, 1999, 2000).

EPA assigns confidence rankings to the noncancer benchmarks contained in IRIS. Confidence rankings are assigned to the study on which the RfC was based, the database supporting the RfC, and to the RfC itself. For acetonitrile, EPA has

- Medium confidence in the study on which the RfC was based because, although the sample sizes were appropriate, histopathology was extensive, and data were reported in detail, hematology was not measured in mice and was measured only at the 15-month interim evaluation in rats

- Medium confidence in the database because of the uncertain role of inhalation in the development of forestomach lesions in the mouse study; the lack of evaluation of possible effects of acetonitrile on heart rate, ventilatory parameters, and blood pressure; and the absence of two-generation studies. Although acceptable developmental studies involving the F_1 generation were carried out (via the inhalation route) in two species, with evidence of developmental effects occurring

at maternally toxic concentrations, there is a lack of information on reproductive endpoints in animals exposed prior to and during mating through parturition.

Consequently, EPA has assigned a ranking of medium confidence to the RfC (U.S. EPA, 2000).

J.1.3 Cancer Effects

No human data are available on the carcinogenicity of acetonitrile. In a 2-year study in rats and mice, there was no evidence of carcinogenicity in female rats or in male or female mice. In male rats, there was a statistically significant positive trend in the incidence of hepatocellular adenomas, carcinomas, and adenomas and carcinomas combined. However, the incidences were not statistically significant by pairwise comparison or by life table analysis. The NTP concluded that the evidence for carcinogenicity of acetonitrile in rats was equivocal (U.S. EPA, 1999, 2000, citing NTP, 1996a).

EPA has classified acetonitrile as Group D, not classifiable as to human carcinogenicity. EPA has not calculated an oral CSF or an inhalation unit risk estimate for acetonitrile (U.S. EPA, 2000).

J.2 Antimony

J.2.1 Introduction

Antimony is found at very low levels throughout the environment. Soil usually contains very low concentrations of antimony (less than 1 ppm). However, higher concentrations have been detected at hazardous waste sites and at antimony processing sites. Food contains small amounts of antimony; the average concentration of antimony in meats, vegetables, and seafood is 0.2 to 1.1 ppb. There are many different antimony compounds that occur naturally or are manufactured chemicals. Antimony trioxide is one example; it is found naturally in the environment and may also be produced by oxidizing antimony sulfide ore or antimony metal in air at 600 to 800°C. The most common industrial use of antimony compounds is to produce antimony trioxide for fire retardation. Persons who work in industries that process antimony ore and metal or manufacture antimony trioxide may be exposed to antimony by breathing dust or by skin contact (ATSDR, 1992a).

J.2.2 Noncancer Effects

The primary effects from chronic inhalation exposure to antimony in humans are respiratory effects that include antimony pneumoconiosis (inflammation of the lungs due to irritation caused by the inhalation of dust), alterations in pulmonary function, chronic bronchitis, chronic emphysema, inactive tuberculosis, pleural adhesions, and irritation. Other effects noted in humans chronically exposed to antimony by inhalation are cardiovascular effects (increased blood pressure, altered EKG readings, and heart muscle damage) and gastrointestinal disorders (ATSDR, 1992a).

Antimony		
Benchmark	**Value**	**Source**
RfD	4.0E-04 mg/kg-d	U.S. EPA, 2000
RfC	2.0E-04 mg/m^3	U.S. EPA, 2000
Oral CSF	NA	
inh URF	NA	
inh CSF	NA	

Animal studies have reported lung, cardiovascular, liver, and kidney damage from exposure to high levels of antimony by inhalation. Exposure to lower levels has resulted in eye irritation, lung damage, hair loss, and cardiovascular effects (changes in EKGs). Reproductive effects, including failure to conceive, were reported in rats exposed to antimony trioxide by inhalation (ATSDR, 1992a).

J.2.2.1 Reference Dose. The RfD for antimony is 4.0E-04 mg/kg-d based on a LOAEL of 0.35 mg/kg-d, an uncertainty factor of 1,000, and a modifying factor of 1 (U.S. EPA, 2000). The RfD was based on a study in which 50 male and 50 female rats were administered 0 or 5 ppm potassium antimony tartrate in water (U.S. EPA, 2000, citing Schroeder et al., 1970). Over the period of the study, growth rates of treated animals were not affected, but male and female rats survived 106 and 107 fewer days, respectively, than did controls at median lifespans. Nonfasting blood glucose levels were decreased in treated males, and cholesterol levels were altered in both sexes. A decrease in mean heart weight for the males was noted and no increase in tumors was seen as a result of treatment. Because only one level of antimony was administered, a NOAEL could not be established in the study. The concentration of 5 ppm antimony was expressed as an exposure of 0.35 mg/kg-d by the authors. The critical effects identified for this study are decreased longevity and blood glucose levels and altered cholesterol levels (U.S. EPA, 2000).

An uncertainty factor of 1,000 was applied based on a tenfold factor for extrapolation from animals to humans, a tenfold factor to protect sensitive individuals, and an additional tenfold factor for use of a LOAEL (U.S. EPA, 2000).

EPA assigns confidence rankings to the noncancer benchmarks contained in IRIS. Confidence rankings are assigned to the study on which the RfD was based, the database supporting the RfD, and to the RfD itself. For antimony, EPA has

- Low confidence in the study on which the RfD was based because only one species and one dose level were used, a NOAEL was not determined, and gross pathology and histopathology were not well described

- **#** Low confidence in the database due to lack of adequate oral exposure investigations.

Consequently, EPA has assigned a ranking of low confidence to the RfD (U.S. EPA, 2000).

J.2.2.2 <u>Reference Concentration</u>. EPA has not established an RfC for antimony (U.S. EPA, 2000). However, EPA has established an RfC for antimony trioxide of 2.0E-04 mg/m^3 based on a benchmark concentration (BMC) (adjusted) of 0.074 mg/m^3, an uncertainty factor of 300, and a modifying factor of 1 (U.S. EPA, 2000). This RfC was based on a study in which groups of 65 rats/sex/group were exposed to actual concentrations of 0, 0.06, 0.51, or 4.50 mg/m^3 antimony trioxide for 6 h/d, 5 d/wk for 1 year (U.S. EPA, 2000, citing Newton et al., 1994). No significant changes in hematological parameters were observed that were concentration related. An increase in cataracts was noted but a dose-response relationship was not observed. Microscopic lesions of the lungs revealed interstitial inflammation in control and exposure groups at the end of 6, 12, 18, and 24 months. This incidence was analyzed to determine a BMC. The concentrations associated with 1, 5, and 10 percent relative increases in the probability of response were estimated using both the Weibull and linear models. The lower 95 percent confidence limit for the 10 percent relative increase in probability of response was determined to be 0.87 mg/m^3 (U.S. EPA, 2000). Similar analyses indicate that more serious respiratory lesions occur at slightly higher concentrations.

The BMC of 0.87 mg/m^3 was adjusted for intermittent exposure (6 h/d, 5 d/wk) (BMC_{ADJ} = 0.16 mg/m^3). A regional deposited dose ratio (RDDR) factor was incorporated to account for differences in the deposition pattern of inhaled particles in the respiratory tract of humans and the rat test animals (U.S. EPA, 2000, citing Jarabek et al., 1990). The RDDR of 0.46 for respiratory effects in the thoracic region was determined based on a mass median aerodynamic diameter (MMAD) of 3.7 µm and a geometric standard deviation of 1.7 (U.S. EPA, 2000); based on this RDDR, a human equivalent concentration BMC (BMC_{HEC}) of 0.074 mg/m^3 was calculated.

An uncertainty factor of 300 was applied based on a tenfold factor for the protection of sensitive human subpopulations, a threefold factor for extrapolation from animals to humans because the dosimetric adjustments account for part of this area of uncertainty, a threefold uncertainty factor for lack of reproductive and developmental bioassays, and an additional threefold uncertainty factor to account for less-than-lifetime exposure duration, since there is no evidence that, at the lowest exposure level tested in the Newton et al. (1994) study, the levels of antimony in the rat reached a steady-state concentration (U.S. EPA, 2000).

EPA has

- **#** Medium confidence in the study on which the RfC was based because it was not a chronic, lifetime study

- **#** Medium confidence in the database because adequate developmental or reproductive studies are not available.

Consequently, EPA has assigned a ranking of medium confidence to the RfC (U.S. EPA, 2000).

J.2.2 Cancer Effects

Limited data are available on the carcinogenic effects of antimony. One study in humans did not report an increased incidence of cancer in workers exposed to antimony oxide in the workplace for 9 to 31 years. Animal studies have shown conflicting results. Several studies have reported an increase in lung tumors in rats exposed by inhalation to antimony trioxide and antimony trisulfide, while other studies did not report an increase in these tumors (ATSDR, 1992a).

EPA has not classified antimony or antimony trioxide for carcinogenicity and has not calculated an oral CSF or an inhalation unit risk estimate for antimony (U.S. EPA, 2000).

J.3 Arsenic

J.3.1 Introduction

Arsenic occurs naturally in the earth's crust at an average concentration of 2 to 5 mg/kg and is mainly associated with igneous and sedimentary rocks in the form of inorganic arsenic. Inorganic arsenic may be released into the air by volcanoes, the weathering of arsenic-containing minerals and ores, and by commercial or industrial processes. For most people, food is the largest source of arsenic exposure (about 25 to 50 µg/d), with lower amounts coming from drinking water and air. Among foods, some of the highest levels are in fish and shellfish; however, this arsenic exists primarily as organic compounds, which are essentially nontoxic. Elevated levels of inorganic arsenic may be present in soil, either from natural mineral deposits or contamination from human activities. Human activities that may lead to substantial environmental contamination include metal smelting, chemical production and use, fossil fuel combustion, and waste disposal (ATSDR, 1998a).

J.3.2 Noncancer Effects

Arsenic has long been known as a human poison, and large oral doses of arsenic (above 60,000 parts per billion (ppb) in food or water) can produce death. Chronic inhalation exposure to inorganic arsenic in humans is associated with irritation of the skin and mucous membranes (dermatitis, conjunctivitis, pharyngitis, and rhinitis). Chronic oral exposure to inorganic arsenic in humans has resulted in gastrointestinal effects, anemia, peripheral neuropathy, skin lesions, hyperpigmentation, gangrene of the extremities, vascular lesions, and liver or kidney damage (ATSDR, 1998a). Some studies have suggested that inorganic arsenic is an essential dietary nutrient in goats, chickens, and rats. However, no comparable data are available for humans. EPA has concluded that essentiality, although not rigorously established, is plausible (U.S. EPA, 2000).

Arsenic		
Benchmark	**Value**	**Source**
RfD	3.0E-04 mg/kg-d	U.S. EPA, 2000
RfC	NA	
oral CSF	1.5 $(mg/kg\text{-}d)^{-1}$	U.S. EPA, 2000
inh URF	4.3E-03 $(\mu g/m^3)^{-1}$	U.S. EPA, 2000
inh CSF	NA	

J.3.2.1 Reference Dose. The RfD for arsenic is 3.0E-04 mg/kg-d based on a NOAEL of 0.009 mg/L converted to 0.0008 mg/kg-d, an uncertainty factor of 3, and a modifying factor of 1 (U.S. EPA, 2000). The RfD was based on two studies that showed that the prevalence of blackfoot disease increased with age and dose for individuals exposed to high levels of arsenic in drinking water. This same population also displayed a greater incidence of hyperpigmentation and skin lesions (U.S. EPA, 2000, citing Tseng, 1977, and Tseng et al., 1968). The control group showed no evidence of skin lesions and, presumably, blackfoot disease, although this latter point is not explicitly stated. The exposure level for this group is considered a NOAEL. The arithmetic mean of the arsenic concentration in the wells used by the individuals in the control group was 9 μg/L, and the arithmetic mean of the arsenic concentration in the wells used by those in the LOAEL group was 170 μg/L. The NOAEL and LOAEL doses for both food and water were calculated as follows: LOAEL - [170 μg/L × 4.5 L/d + 2 μg/d (contribution from food)] × (1/55 kg) = 14 μg/kg-d; NOAEL - [9 μg/L × 4.5 L/d + 2 μg/d (contribution from food)] × (1/55 kg) = 0.8 μg/kg-d (U.S. EPA, 2000).

An uncertainty factor of 3 was applied to account for the lack of data to preclude reproductive toxicity as a critical effect and to account for some uncertainty in whether the NOAEL of the critical study accounts for all sensitive individuals (U.S. EPA, 2000).

EPA assigns confidence rankings to the noncancer benchmarks contained in IRIS. Confidence rankings are assigned to the study on which the RfD was based, the database supporting the RfD, and to the RfD itself. For arsenic, EPA has

- **#** Medium confidence in the study on which the RfD was based because an extremely large number of people were included in the assessment but the doses were not well characterized and other contaminants were present

- **#** Medium confidence in the database because it is extensive but somewhat flawed, since problems exist with all of the epidemiological studies.

Consequently, EPA has assigned a ranking of medium confidence to the RfD (U.S. EPA, 2000).

J.3.2.2 Reference Concentration. EPA has not established an RfC for arsenic (U.S. EPA, 2000).

J.3.3 Cancer Effects

Inhalation studies in humans have reported inorganic arsenic exposure to be strongly associated with lung cancer. Ingestion of inorganic arsenic from drinking water in humans has been associated with an increased risk of nonmelanoma skin cancer and to an increased risk of bladder, liver, kidney, and lung cancer. Animal studies have not associated inorganic arsenic exposure via the oral route with cancer, and no cancer inhalation studies have been performed in animals for inorganic arsenic (ATSDR, 1998a).

EPA has classified inorganic arsenic as a Group A, Human Carcinogen, based on increased lung cancer mortality in multiple human populations exposed primarily through inhalation and increased incidence of skin cancer in populations consuming drinking water with high levels of inorganic arsenic (U.S. EPA, 2000).

J.3.3.1 Oral Cancer Risk. EPA used a time- and dose-related formulation of the multistage model based on data from Tseng et al. 1968 and Tseng 1977 studies (as cited in U.S. EPA, 2000) on persons exposed to arsenic in drinking water to calculate the oral CSF and unit risk estimate. EPA calculated an oral unit risk estimate of 5.0E-05 $(\mu g/L)^{-1}$ and an oral CSF of 1.5 $(mg/kg\text{-}d)^{-1}$ based on an increase in skin cancer in the populations in Taiwan exposed to arsenic in drinking water (U.S. EPA, 2000).

EPA has identified several sources of uncertainty in the risk estimate, including the following:

- An underestimation of the risk of skin cancer because of competing mortality from Blackfoot disease in the endemic area of Taiwan
- Other sources of inorganic arsenic, particularly in food, have not been considered because of lack of reliable information
- Uncertainty on the amount of water consumed per day by Taiwanese males and the temporal variability of arsenic concentrations in specific wells (U.S. EPA, 2000).

J.3.3.2 Inhalation Cancer Risk. EPA used an absolute-risk linear model based on data from occupational studies on lung cancer and arsenic exposure to estimate the inhalation unit risk estimate for arsenic. EPA established an inhalation URF of 4.3E-03 $(\mu g/m^3)^{-1}$ based on lung cancer in occupationally exposed humans (U.S. EPA, 2000).

EPA has confidence in the risk estimate because a large study population was observed, exposure assessments included air and urinary measurements, and observed lung cancer incidence was significantly increaed over expected values (U.S. EPA, 2000).

J.4 Boron

J.4.1 Introduction

Boron is an element found naturally in the environment, mainly as an inorganic compound in sediments and sedimentary rock. It is mainly released to the environment from natural weathering processes. Natural sources of releases of boron to the air include oceans, volcanoes, and geothermal steam. Industrial sources of release include power plants, chemical plants, and manufacturing facilities producing fiberglass and other products. Boron is widely distributed in surface water and groundwater. It is also found in soil where it is an essential nutrient for plants. The general population is likely to be exposed to boron mainly through the ingestion of food and water (ATSDR, 1992b).

J.4.2 Noncancer Effects

Acute and chronic exposure to boron through inhalation has resulted in irritation of the upper respiratory tract and eye irritation. Oral exposure to high doses of boron has resulted in gastrointestinal disorders, such as vomiting and diarrhea. Infants appear to be particularly susceptible to gastrointestinal effects from boron exposure, possibly because of immature detoxifying enzyme systems and greater gastrointestinal absorption. Developmental effects and testicular atrophy have been noted in several studies where animals were exposed to high levels of boron in the feed (ATSDR, 1992b).

Boron		
Benchmark	**Value**	**Source**
RfD	9.0E-02 mg/kg-d	U.S. EPA, 2000
RfC	2.0E-02 mg/m^3	U.S. EPA, 1997a
oral CSF	NA	
inh URF	NA	
inh CSF	NA	

J.4.2.1 Reference Dose. The RfD for boron is 9.0E-02 mg/kg-d, based on a NOAEL of 350 ppm (8.8 mg/kg-d), an uncertainty factor of 100, and a modifying factor of 1 (U.S. EPA, 2000). The RfD was based on a study in which dogs were fed borax and boric acid in the diet for 2 years (U.S. EPA, 2000, citing Weir and Fisher, 1972). A NOAEL of 350 ppm was selected, which was the highest dose tested. In an additional study, dogs were fed 1,170 (29 mg/kg-d) for 38 weeks. At this dose, severe testicular atrophy and spermatogenic arrest occurred (U.S. EPA, 2000).

An uncertainty factor of 100 was applied to account for use of a NOAEL from a lifetime animal study (U.S. EPA, 2000).

EPA assigns confidence rankings to the noncancer benchmarks contained in IRIS. Confidence rankings are assigned to the study on which the RfD was based, the database supporting the RfD, and to the RfD itself. For boron, EPA has

- **#** Medium confidence in the study on which the RfD was based because it provides both a NOAEL and LOAEL and examines many biological endpoints, but has a limited number of experimental animals

- **#** Medium confidence in the database because several subchronic, chronic, and reproductive studies provide supportive data and developmental data do not exist.

Consequently, EPA has assigned a ranking of medium confidence to the RfD (U.S. EPA, 2000).

J.4.2.2 <u>Reference Concentration</u>. The RfC for boron is 2.0E-02 mg/m^3, based on a LOAEL of 4.5 mg/m^3, an uncertainty factor of 100, and a modifying factor of 1. The RfC was based on a human study in which respiratory tract irritation was noted (U.S. EPA, 1997a, citing Garabrant et al., 1985). The RfC is specifically for anydrous borax (U.S. EPA, 1997a).

J.4.3 Cancer Effects

No studies are available on the carcinogenic effects of boron in humans. In a life-time study in which mice were fed boric acid in the diet, there was no evidence of carcinogenicity (ATSDR, 1992b).

EPA has not classified boron for human carcinogenicity and has not calculated an oral CSF or an inhalation unit risk estimate for boron (U.S. EPA, 2000).

J.5 Cadmium

J.5.1 Introduction

Cadmium is a soft, silver-white metal that occurs naturally in the earth's crust and is usually found in combination with other elements such as oxygen, chlorine, or sulfur. The major uses of cadmium are in the manufacture of pigments and batteries and in the metal-plating and plastics industries. Most of the cadmium used in this country is obtained as a byproduct from the smelting of zinc, lead, or copper ores (ATSDR, 1999a).

Cadmium		
Benchmark	**Value**	**Source**
RfD	5.0E-04 mg/kg-d (water) 1.0E-03 mg/kg-d (food)	U.S. EPA, 2000
RfC	2.0E-05 mg/m^3	CalEPA, 1999b
oral CSF	1.5E+01 $(mg/kg\text{-}d)^{-1}$	CalEPA, 1999a
inh URF	1.8E-03 $(\mu g/m^3)^{-1}$	U.S. EPA, 2000
inh CSF	6.3E+00 $(mg/kg\text{-}d)^{-1}$	Calculated

J.5.2 Noncancer Effects

The kidney appears to be the main target organ in humans following chronic inhalation exposure to cadmium. Abnormal kidney function, indicated by proteinuria and a decrease in glomerular filtration rate, and an increased frequency of kidney stone formation are some of the effects that have been observed. Respiratory effects, such as bronchitis and emphysema, have also been noted in humans chronically exposed to cadmium through inhalation. Oral exposure to cadmium in humans also results in effects on the kidney, with effects similar to those seen following inhalation exposure. In humans, dermal exposure to cadmium does not appear to cause allergic reactions (ATSDR, 1999a).

Animal studies have reported effects on the kidney, liver, lung, and blood from chronic inhalation exposure to cadmium. Chronic oral exposure to cadmium in animals results in effects on the kidney, bone, immune system, blood, and nervous system. No information is available on chronic dermal exposure to cadmium in animals (ATSDR, 1999a).

J.5.2.1 Reference Dose. EPA has established two RfDs for cadmium: one for cadmium ingested in drinking water and one for cadmium ingested in food. The RfD for cadmium in drinking water is 5.0E-04 mg/kg-d and the RfD for dietary exposure to cadmium is 1.0E-03 mg/kg-d (U.S. EPA, 2000). These RfDs were based on a number of human studies that showed kidney effects (significant proteinuria) from chronic exposure to cadmium. Both RfDs were calculated based on the highest level of cadmium in the human renal cortex (200 µg/g) that was not associated with the critical effect, i.e., significant proteinuria (U.S. EPA, 2000, citing U.S. EPA, 1985b). A toxicokinetic model was then used to determine the NOAEL. This model took into account the difference in absorption between drinking water and food. The NOAELs for water and food were calculated to be 0.005 mg/kg-d and 0.01 mg/kg-d, respectively. The RfDs were calculated by applying an uncertainty factor of 10 and a modifying factor of 1 to each NOAEL (U.S. EPA, 2000). An uncertainty factor of 10 was applied to account for intrahuman variability to the toxicity of cadmium in the absence of data on sensitive individuals (U.S. EPA, 2000).

EPA has high confidence in the studies and the database on which the RfDs for cadmium were based. The RfDs were not based on a single study, but rather on data obtained from many

studies on the toxicity of cadmium in humans and animals. These data permit calculation of pharmacokinetic parameters of cadmium absorption, distribution, metabolism, and elimination. High confidence in the RfDs results (U.S. EPA, 2000).

J.5.2.2 Reference Concentration. EPA has not established an RfC for cadmium. However, CalEPA (1999b) derived a chronic inhalation reference exposure level (REL) of 2.0E-05 mg/m^3 based on kidney (proteinuria) and respiratory effects (reduction in forced vital capacity and reduction in peak expiratory flow rate) in occupationally exposed humans (CalEPA, 1999b, citing Lauwerys et al., 1974). Workers had been exposed to cadmium for periods of 1 to over 20 years and the exposed group was matched to a control group in terms of age, body size, cigarettes smoked per day, duration of smoking, and duration of employment. A NOAEL of 0.0014 mg/m^3 was identified and then adjusted for intermittent exposure (8 h/d, 5 d/wk). An uncertainty factor of 30 was applied: a threefold factor for extrapolation from subchronic to chronic exposure and a tenfold factor for intrahuman variation (CalEPA, 1999b).

J.5.3 Cancer Effects

Several occupational studies have reported an excess risk of lung cancer from exposure to inhaled cadmium. However, the evidence is limited rather than conclusive due to confounding factors such as the presence of other carcinogens and smoking. Studies of human ingestion to cadmium are inadequate to assess its carcinogenicity (U.S. EPA, 2000). Animal studies have reported lung cancer resulting from inhalation exposure to several forms of cadmium, while animal ingestion studies have not reported cancer from exposure to cadmium compounds (U.S. EPA, 2000).

EPA has classified cadmium as Group B1, Probable Human Carcinogen, based on human studies showing a possible association between cadmium exposure and lung cancer and animal studies showing an increased incidence of lung cancer (U.S. EPA, 2000).

J.5.3.1 Oral Cancer Risk. EPA has not calculated an oral unit risk estimate for cadmium (U.S. EPA, 2000). However, CalEPA has calculated an oral CSF of 1.5E+01 $(mg/kg\text{-}d)^{-1}$ based on the same data that EPA used (Thun et al., 1985) to derive an inhalation cancer risk estimate (see below); data were fitted with a Poisson regression model (CalEPA, 1999a).

J.5.3.2 Inhalation Cancer Risk. EPA used the two-stage extrapolation model based on data from an occupational study of workers exposed to cadmium (U.S. EPA, 2000, citing Thun et al., 1985) to estimate the inhalation risk estimate for cadmium. EPA calculated an inhalation unit risk estimate of 1.8E-03 $(\mu g/m^3)^{-1}$ (U.S. EPA, 2000). An inhalation CSF of 6.3 $(mg/kg\text{-}d)^{-1}$ was calculated from the inhalation URF as follows:

$$\text{inh CSF} = 0.0018\ (\mu g/m^3)^{-1} \times 70\ kg \div 20\ m^3/d \times 1{,}000\ \mu g/mg = 6.3\ (mg/kg\text{-}d)^{-1}$$

EPA used human data to develop the risk estimate for cadmium because the data were derived from a relatively large cohort, and the effects of arsenic and smoking were accounted for in the quantitative analysis of cadmium's effects. EPA also calculated an inhalation unit risk of

9.2E-02 $(\mu g/m^3)^{-1}$ for cadmium based on animal data (U.S. EPA, 2000, citing Takenda et al., 1983). This estimate was higher than that derived from human data and thus more conservative. However, EPA felt that the use of the available human data was more reliable because of species variations in response and the type of exposure (U.S. EPA, 2000).

J.6 Chromium

J.6.1 Introduction

Chromium is a metallic element that occurs in the environment in two major valence states: trivalent chromium (chromium III) and hexavalent chromium (chromium VI). Chromium (VI) compounds are much more toxic than chromium (III) compounds. Chromium (III) is an essential element in humans (it potentiates insulin production and is essential for lipid, protein, and fat metabolism); a daily intake of 50 to 200 µg/d is recommended for an adult. Chromium (VI) is quite toxic; however, the human body can detoxify some amount of chromium (VI) to chromium (III). The metallurgical, refractory, and chemical industries are the fundamental users of chromium. In the chemical industry, chromium is used primarily in pigments (III and VI), metal finishing (VI), leather tanning (III), and wood preservatives (VI) (ATSDR, 1998b).

Chromium		
Benchmark	**Value**	**Source**
RfD	3.0E-03 mg/kg-d (Cr VI) 1.5E+00 mg/kg-d (Cr III)	U.S. EPA, 2000
RfC	1.0E-04 mg/m^3 (Cr VI particulates)	U.S. EPA, 2000
oral CSF	NA	
inh URF	1.2E-02 $(\mu g/m^3)^{-1}$ (Cr VI)	U.S. EPA, 2000
inh CSF	4.1E+01 $(mg/kg\text{-}d)^{-1}$ (Cr VI)	U.S. EPA, 1997a

J.6.2 Noncancer Effects

Chronic inhalation exposure to chromium (VI) in humans results in effects on the respiratory tract, with perforations and ulcerations of the septum, bronchitis, decreased pulmonary function, pneumonia, asthma, and nasal itching and soreness reported. Chronic exposure to high levels of chromium (VI) by inhalation or ingestion may also produce effects on the liver, kidney, gastrointestinal and immune systems, and possibly the blood. Dermal exposure to chromium (VI) may cause contact dermatitis, sensitivity, and ulceration of the skin (ATSDR, 1998b).

Limited information is available on the chronic effects of chromium in animals. The available data indicate that, following inhalation exposure, the lung and kidney have the highest tissue levels of chromium. Respiratory effects have been reported in animals exposed to chromium (VI) by inhalation. No effects were noted in several oral animal studies with chromium (VI) and chromium (III) (ATSDR, 1998b). High levels of chromium (VI) administered orally have resulted in developmental effects in rats and mice (U.S. EPA, 1998a, 2000).

J.6.2.1 Reference Dose. EPA has established an RfD for chromium (VI) of 3.0E-03 mg/kg-d, based on a NOAEL (adjusted) of 2.5 mg/kg-d, an uncertainty factor of 300, and a modifying factor of 3 (U.S. EPA, 1998a, 2000). This was based on a study in rats (U.S. EPA, 1998a, 2000, citing MacKenzie et al., 1958) that reported no adverse effects after exposure to chromium (VI) in the drinking water for 1 year. A study in dogs supports these findings; no significant effects were observed in female dogs given chromium (VI) in the drinking water for 4 years (U.S. EPA, 1998a, 2000).

An uncertainty factor of 300 was applied based on two tenfold factors to account for both the expected intrahuman and interspecies variability in the toxicity of the chemical in lieu of specific data and an additional threefold factor to compensate for the less-than-lifetime exposure duration of the principal study. The modifying factor of 3 is to account for uncertainties related to reports of gastrointestinal effects following drinking water exposure in a residential population in China (U.S. EPA, 1998a, 2000).

EPA has assigned a ranking of low confidence in the study on which the RfD for chromium (VI) was based, in the database, and in the RfD. Confidence in the key study was ranked low due to the small number of animals tested, the small number of parameters measured, and the lack of toxic effects at the highest dose tested. Confidence in the database was also ranked low by EPA because the supporting studies are of equally low quality and developmental toxicity endpoints are not well studied, thus a low confidence in the RfD follows (U.S. EPA, 1998a, 2000).

The RfD for chromium (III) is 1.5E+00 mg/kg-d, based on a NOAEL (adjusted) of 1,468 mg/kg-d, an uncertainty factor of 100, and a modifying factor of 10 (U.S. EPA, 1998b, 2000). This was based on no effects observed in rats fed chromium (III) in the diet for 2 years (U.S. EPA, 1998b, 2000, citing Ivankovic and Preussman, 1975). In this study, groups of 60 male and female rats were fed chromic oxide in the diet for 600 feedings. All major organs were examined histologically, and no effects due to chromium treatment were observed at any dose level. This study also included a 90-day study, where the only effects observed were reductions in the absolute weights of the livers and spleens in animals in the high-dose group (U.S. EPA, 1998b, 2000).

An uncertainty factor of 100 was applied based on two tenfold factors to account for both the expected interhuman and interspecies variability in the toxicity of the chemical in lieu of specific data. An additional tenfold modifying factor was applied to reflect database deficiencies including the lack of a study in a nonrodent mammal and uncertainties regarding potential reproductive effects. Additional uncertainties are related to the NOAEL because the effects

observed in the 90-day study were not explicitly addressed in the 2-year study, the effect of the vehicle on absorption of chromium is unclear, the animals were allowed to die naturally after feeding stopped (2 years), and only then was histology performed (U.S. EPA, 1998b, 2000).

EPA has assigned a ranking of low confidence in the study on which the RfD was based, in the database, and in the RfD. The low confidence in the key study was due to the lack of explicit detail on study protocol and results, the low ranking of the database was due to the lack of supporting data, and the low confidence of the RfD was due to the lack of an observed effect level in the key study (U.S. EPA, 1998b, 2000).

J.6.2.2 Reference Concentration. EPA has established an RfC for chromium (VI) particulates of 1.0E-04 mg/m^3, based on a benchmark dose of 0.016 mg/m^3, an uncertainty factor of 300, and a modifying factor of 1 (U.S. EPA, 1998a, 2000). This was based on lower respiratory effects reported in rats (U.S. EPA, 1998a, 2000, citing Glaser et al., 1990 and Malsch et al., 1994). Chronic respiratory dyspnea, reduced body weight, increased lung weight, accumulation of macrophages, focal inflammation in the upper airways, and increased albumin and lactate dehydrogenase in bronchioalveolar lavage fluid were observed (U.S. EPA, 1998a, 2000, citing Glaser et al., 1990).

The dose-effects data were adjusted to account for discontinuous exposure (22 h/d). An RDDR factor was incorporated to account for differences in the deposition pattern of inhaled chromium (VI) dusts in the respiratory tract of humans and the rat test animals (U.S. EPA, 2000, citing Jarabek et al., 1990). The RDDR of 2.1576 was determined based on a mass median aerodynamic diameter (MMAD) (0.28 µm for dose levels of 0.05 to 0.1 mg/m^3 and 0.39 for dose levels of 0.1 to 0.4 mg/m^3) and a geometric standard deviation (1.63 for dose levels of 0.05 to 0.1 mg/m^3 and 1.72 for dose levels of 0.1 to 0.4 mg/m^3) of the particulates reported in Glaser et al. (U.S. EPA, 2000, citing Glaser et al., 1990); based on this RDDR, a BMC_{HEC} of 0.34 mg/m^3 was calculated.

An uncertainty factor of 300 was applied based on a threefold factor to account for the pharmacodynamic differences not accounted for by the RDDR, a tenfold uncertainty factor to account for the less-than-lifetime exposure, and a tenfold uncertainty factor to account for variation in the human population (U.S. EPA, 1998a, 2000).

EPA has medium confidence in the principal study because of uncertainties regarding upper respiratory, reproductive, and renal effects resulting from the exposures. The overall confidence in this RfC assessment for chromium (VI) particulates is medium (U.S. EPA, 1998a, 2000).

EPA has also established an RfC for chromium (VI) acid mists and dissolved aerosols of 8.0E-06 mg/m^3, based on a LOAEL of 0.002 mg/m^3, an uncertainty factor of 90, and a modifying factor of 1 (U.S. EPA, 1998a, 2000). The critical effect was nasal septum atrophy in occupationally exposed humans. The LOAEL was adjusted for intermittent exposure (8 h/d, 5 d/wk). An uncertainty factor of 3 for extrapolation from subchronic to chronic exposure, 3 for extrapolation from a LOAEL to a NOAEL, and 10 for interhuman variation were applied (U.S. EPA, 1998a, 2000).

There is uncertainty regarding the relevance of occupational exposures to chromic acid mists and dissolved aerosols to exposures to chromium (VI) dusts in the environment (U.S. EPA, 1998a, 2000). Chromium is present in the atmosphere primarily in particulate form (ATSDR, 1998b). Therefore, the RfC for chromium (VI) particulates is used in this risk assessment.

EPA has not established an RfC for chromium (III) (U.S. EPA, 1998b, 2000).

J.6.3 Cancer Effects

Epidemiological studies of workers have clearly established that inhaled chromium is a human carcinogen, resulting in an increased risk of lung cancer. These studies were not able to differentiate between exposure to chromium (III) and chromium (VI) compounds. No information is available on cancer in humans from oral or dermal exposure to chromium (ATSDR, 1998b; U.S. EPA 1998a, 1998b, 2000).

Animal studies have shown chromium (VI) to cause lung tumors via inhalation exposure. No studies are available that investigated cancer in animals from oral or dermal exposure to chromium (VI). Chromium (III) has been tested in mice and rats by the oral route, with several studies reporting no increase in tumor incidence. No studies are available on cancer in animals from inhalation or dermal exposure to chromium (III) (ATSDR, 1998b; U.S. EPA, 1998a, 1998b, 2000).

EPA has classified chromium (VI) as Group A, Known Human Carcinogen, by the inhalation route of exposure because results of occupational epidemiologic studies show a dose-response relationship for chromium exposure and lung cancer. Because the human studies could not differentiate between chromium (III) and chromium (VI) exposure and only chromium (VI) was found to be carcinogenic in animal studies, EPA concluded that only chromium (VI) should be classified as a human carcinogen (U.S. EPA, 1998a, 2000). EPA has classified chromium (III) as Group D, Not Classifiable as to Human Carcinogenicity (U.S. EPA, 1998b, 2000).

J.6.3.1 <u>Oral Cancer Risk</u>. EPA has not calculated a risk estimate from oral exposure to chromium (VI) or chromium (III) (U.S. EPA, 1998a, 1998b, 2000).

J.6.3.2 <u>Inhalation Cancer Risk</u>. EPA used the multistage extrapolation model, based on data from an occupational study of chromate production workers (U.S. EPA, 1998a, 2000, citing Mancuso, 1975) to estimate the unit cancer risk for chromium (VI). EPA calculated an inhalation unit risk estimate of 1.2E-02 $(\mu g/m^3)^{-1}$ (U.S. EPA, 1998a, 2000). An inhalation CSF of 4.1E+01 $(mg/kg\text{-}d)^{-1}$ was calculated from the URF for chromium (VI) (U.S. EPA, 1997a). EPA has not calculated a risk estimate from inhalation exposure to chromium (III) (U.S. EPA, 1998b, 2000).

EPA has confidence in the risk estimate for chromium (VI) because results of studies of chromium exposure are consistent across investigators and countries, and a dose-response for lung tumors has been established. However, an overestimation of risk may be due to the implicit assumption that the smoking habits of chromate workers were similar to those of the general white male population, since it is generally accepted that the proportion of smokers is higher for

industrial workers than for the general population. An underestimation of risk may result from the assumption that the ratio of chromium (III) to chromium (VI) is 6:1 (U.S. EPA, 2000).

J.7 Copper

J.7.1 Introduction

Copper occurs naturally in rock, soil, water, sediment, and air and is an essential element for humans. It is extensively mined and processed in the United States and is primarily used as the metal or alloy in the manufacture of wire and sheet metal, in agriculture to treat plant diseases, and as a preservative for wood, leather, and fabrics (ATSDR, 1990).

Copper		
Benchmark	**Value**	**Source**
RfD	NA	
RfC	2.0E-05 mg/m^3	CalEPA, 1997
oral CSF	NA	
inh URF	NA	
inh CSF	NA	

J.7.2 Noncancer Effects

The majority of information on copper toxicity in humans involves the consumption of water contaminated with high levels of copper or suicide attempts using copper sulfate. Effects observed in humans include gastrointestinal (nausea, vomiting, abdominal pains), hepatic, and renal effects from oral exposure, respiratory irritation from inhalation exposure, and allergic contact dermatitis from dermal exposure. An example of significant (but rare) copper toxicity in humans is Wilson's Disease, an autosomal recessive disorder that affects normal copper homeostasis. The disease is characterized by excessive retention of hepatic copper, decreased concentration of plasma ceruloplasmin, and impaired biliary excretion; hepatic and renal lesions and hemolytic anemia are symptoms (ATSDR, 1990).

Longer-term or chronic human exposure to copper has been associated with a number of effects including metal fume fever and enlarged livers. Metal fume fever is characterized by chills, fever, aching muscles, dryness in the mouth and throat, and headaches that last for 1 or 2 days. Anorexia, nausea, and occasional diarrhea in factory workers exposed to high concentrations of airborne copper have also been reported (ATSDR, 1990).

The effects observed in animals from oral exposure to high levels of copper include hepatic, renal, hematologic, gastrointestinal, immunologic, and developmental effects. Respiratory effects have been reported in animals following inhalation exposure (ATSDR, 1990).

Copper is an essential dietary nutrient for which a recommended daily allowance (RDA) has been developed. Copper is needed for human hemoglobin formation, carbohydrate metabolism, catecholamine biosynthesis, and cross-linking of collagen, elastin, and hair keratin. Copper is also essential for incorporation into copper-dependent enzymes. An RDA of 2 to 3 mg copper/day is recommended by the National Academy of Sciences (ATSDR, 1990).

J.7.2.1 Reference Dose. EPA has not established an RfD for copper (U.S. EPA, 2000).

J.7.2.2 Reference Concentration. EPA has not established an RfC for copper (U.S. EPA, 2000). However, CalEPA has established a chronic inhalation reference exposure level for copper of 2.0E-05 mg/m^3 based on a NOAEL of 0.008 mg/m^3 for respiratory effects in humans (CalEPA, 1997, citing Gleason, 1968) and an uncertainty factor of 100 (CalEPA, 1997). Cold-like symptoms (warmth or chills and head stuffiness), the classic signs of metal fume fever, were reported among workers exposed to copper dust. The NOAEL was adjusted for intermittent exposure (8 h/d, 5 d/wk). An uncertainty factor of 100 was applied based on a tenfold factor to account for human variability and a tenfold factor to account for extrapolation from subchronic to chronic exposure duration (CalEPA, 1997).

J.7.3 Cancer Effects

An increased incidence of cancer has not been observed in humans or animals exposed to copper via inhalation, oral, or dermal routes (ATSDR, 1990). In laboratory animal studies, two strains of mice administered copper for 53 weeks failed to show any evidence of statistically significant increases in tumor incidence (U.S. EPA, 2000).

EPA has classified copper as Group D, Not Classifiable as to Human Carcinogenicity, based on no human data, inadequate animal data, and equivocal mutagenicity data (U.S. EPA, 2000).

J.8 Cyanide

J.8.1 Introduction

Cyanides are naturally occurring substances found in a number of foods and plants and produced by certain bacteria, fungi, and algae. Cyanide is present in a number of compounds such as hydrogen cyanide, sodium cyanide, and potassium cyanide. The primary source of cyanide in the air is from car exhaust. Other airborne sources include emissions from chemical processing, other industries, and municipal waste incinerators. Smoking is another important source of cyanide. Cyanide may be found in water from discharges from organic chemical industries, iron and steel works, and wastewater treatment facilities. Hydrogen cyanide may be used as an intermediate in the production of chemicals and as an insecticide. Other cyanide compounds have been used in metal treatment and electropolating (ATSDR, 1997a).

J.8.2 Noncancer Effects

Cyanide is extremely toxic to humans. Inhalation exposure to 100 mg/m^3 or more of hydrogen cyanide will cause death in humans. Exposure to lower concentrations (6 to 49 mg/m^3) of hydrogen cyanide will cause a variety of effects, such as weakness, headache, nausea, increased rate of respiration, and eye and skin irritation. Chronic exposure to cyanide in humans via inhalation results in effects on the central nervous system, such as headaches, dizziness, numbness, tremor, and loss of visual acuity. Other effects in humans include cardiovascular and respiratory effects, an enlarged thyroid gland, and irritation to the eyes and skin. Animal studies have reported effects on the nervous, cardiovascular, and respiratory systems and have suggested that oral exposure to cassava (a cyanide-containing vegetable) may be associated with malformations in the fetus and low fetal body weight (ATSDR, 1997a).

Cyanide		
Benchmark	**Value**	**Source**
RfD	2.0E-02 mg/kg-d	U.S. EPA, 2000
RfC	3.0E-03 mg/m^3	U.S. EPA, 2000
oral CSF	NA	
inh URF	NA	
inh CSF	NA	

J.8.2.1 <u>Reference Dose</u>. The RfD for cyanide and hydrogen cyanide is 2.0E-02 mg/kg-d based on a NOAEL of 10.8 mg/kg-d (converted to 11.2 mg/kg-d for hydrogen cyanide), an uncertainty factor of 100, and a modifying factor of 5 (U.S. EPA, 2000). The RfD was based on a study in which rats were administered food fumigated with hydrogen cyanide for 2 years (U.S. EPA, 2000, citing Howard and Hanzel, 1955). Daily estimated doses were 4.3 mg and 10.8 mg/kg body weight. There were no treatment-related effects on growth rate, no gross signs of toxicity and no histopathologic lesions (U.S. EPA, 2000).

An uncertainty factor of 100 was applied based on a tenfold factor for extrapolation from animals to humans and a tenfold factor to protect sensitive individuals (U.S. EPA, 2000).

EPA assigns confidence rankings to the noncancer benchmarks contained in IRIS. Confidence rankings are assigned to the study on which the RfD was based, the database supporting the RfD, and to the RfD itself. For cyanide, EPA has

- Medium confidence in the study on which the RfD was based because adequate records of food consumption and body weight were maintained, and animals of both sexes were tested at doses for 2 years

- **#** Medium confidence in the database because a small but sufficient number of studies support the chosen study.

Consequently, EPA has assigned a ranking of medium confidence to the RfD (U.S. EPA, 2000).

J.8.2.2 <u>Reference Concentration</u>. EPA has established an RfC of 3.0E-03 mg/m^3 for hydrogen cyanide based on a lowest observed adverse effects level (LOAEL) (human equivalent concentration) of 2.5 mg/m^3, an uncertainty factor of 1,000, and a modifying factor of 1 (U.S. EPA, 2000). The RfC was based on a study in which 36 male workers employed in the electroplating sections of three factories in Egypt were studied (U.S. EPA, 2000, citing El Ghawabi et al., 1975). Cyanide exposure was from a plating bath that contained 3 percent copper cyanide, 3 percent sodium cyanide, and 1 percent sodium carbonate. Breathing zone air samples were taken to determine the levels of airborne cyanide to which the men were exposed (mean of 6.4 to 10.4 ppm [7.07 to 11.45 mg/m^3]) in the three factories. Twenty normal male volunteers of the same age group and socioeconomic status who had no exposure to cyanide were chosen as controls. Symptoms reported more frequently in the exposed workers included headache, weakness, and changes in the senses of taste and smell. Lacrimation, abdominal colic, lower stomach pain, salivation, and nervous instability occurred less frequently. A correlation was found to exist between urinary excretion of thiocyanates and breathing zone concentrations of cyanides. The lowest mean concentration recorded in the three factories, 6.4 ppm (7.07 mg/m^3), was selected as the LOAEL. The LOAEL is an extrarespiratory effect of a gas exposure and was based on an 8-h time-weighted average occupational exposure. The LOAEL (human equivalent concentration) was calculated as follows:

$$7.07 \text{ mg/m}^3 \times 5\text{d}/7\text{d} = 2.5 \text{ mg/m}^3.$$

An uncertainty factor of 1,000 was applied based on a tenfold factor for the lack of a NOAEL, a tenfold factor to protect sensitive human subpopulations, and two partial factors of 3 for deficiencies in the database (lack of chronic and multigenerational reproduction studies) and for less than chronic duration studies (U.S. EPA, 2000).

EPA has

- **#** Low confidence in the study on which the RfC was based because the principal study gives evidence for toxic chronic effects of inhaled cyanide in humans, and, although the symptomatology was mostly subjective and self-reported among a small population of workers, the data in the report were consistent with that reported in other occupational studies; however, only a LOAEL was reported

- **#** Low confidence in the database because there are no chronic inhalation studies and no multigenerational studies.

Consequently, EPA has assigned a ranking of low confidence to the RfC (U.S. EPA, 2000).

J.8.3 Cancer Effects

No studies are available on the carcinogenic effects of cyanide to humans or animals (ATSDR, 1997a).

EPA has classified cyanide as a Group D, Not Classifiable as to Human Carcinogenicity. EPA has not calculated an oral CSF or an inhalation unit risk estimate for cyanide (U.S. EPA, 2000).

J.9 Lead

J.9.1 Introduction

Lead is a naturally occurring, bluish-gray metal that is found in small quantities in the earth's crust. It is present in a variety of compounds such as lead acetate, lead chloride, lead chromate, lead nitrate, and lead oxide (ATSDR, 1999c).

Exposure to lead can occur through the air, drinking water, food, and soil. Most lead exposure occurs through a combination of the inhalation and oral routes, with inhalation generally contributing a greater proportion of the dose for occupationally exposed groups and the oral route generally contributing a greater proportion for the general population. The effects of lead are the same regardless of the route of exposure (inhalation or oral) and are correlated with internal exposure as blood lead levels. For this reason, this summary discusses lead exposure in terms of blood lead levels rather than route (ATSDR, 1999c).

Children are at particular risk to lead exposure because they commonly put hands, toys, and other items that may come in contact with lead-containing dust and dirt in their mouths. In addition, lead-based paints were commonly used for many years and flaking paint, paint chips, and weathered paint powder may be a major source of lead exposure, particularly for children. Lead continues to be used in pigments for paints (ATSDR, 1999c).

J.9.2 Noncancer Effects

The primary effects in humans from chronic exposure to lead are to the nervous system. Neurological symptoms have been reported in workers with blood lead levels of 40 to 60 µg/dL, and slowed nerve conduction in peripheral nerves in adults occurs at blood lead levels of 30 to 40 µg/dL. Children are particularly sensitive to the neurotoxic effects of lead. There is evidence that blood lead levels of 10 to 30 µg/dL or lower may affect the hearing threshold and growth in children. Neurobehavioral impairment, including IQ deficits, has been been associated with blood lead levels of 50 to 70 µg/dL in children. Chronic exposure to lead in humans can also affect the blood. Anemia has been reported in adults at blood lead levels of 50 to 80 µg/dL and in children at blood lead levels of 40 to 70 µg/dL. Other effects from chronic lead exposure in humans include effects on blood pressure and kidney function, interference with vitamin D metabolism, and reproductive effects (ATSDR, 1999c).

Animal studies have reported effects similar to those found in humans, with effects on the blood, kidneys, and nervous, immune, reproductive, and cardiovascular systems noted (ATSDR, 1999c).

EPA has not established an RfD or RfC for lead. Although, by comparison to most other environmental toxicants, there is a low degree of uncertainty about the health effects of lead, EPA believes that it is inappropriate to develop an RfD for lead. In addition, "it appears that some of these effects, particularly children's neurobehavioral development, may occur at blood lead levels so low as to be essentially without a threshold" (U.S. EPA, 2000).

The Centers for Disease Control and Prevention (CDC) has set an "intervention level" for childhood lead poisoning of 10 μg/dL. This level was reduced in 1991 from the previous threshold level of 25 μg/dL based on scientific evidence that adverse health effects can occur at levels as low as 10 μg/dL (CDC, 1991). However, the CDC does not recommend environmental or medical intervention at 10 μg/dL. They recommend medical evaluation at or above 20 μg/dL or if blood lead levels of 15 to 19 μg/dL persist. Various counseling, monitoring, and communitywide prevention activities are recommended at levels between 10 and 19 μg/dL (CDC, 1991).

J.9.3 Cancer Effects

Human studies are inconclusive regarding lead and an increased cancer risk. Four major human studies of workers exposed to lead have been carried out; two studies did not find an association between lead exposure and cancer, one study found an increased incidence of respiratory tract and kidney cancers, and one study found excesses for lung and stomach cancers. However, all of these studies are limited in usefulness because the levels of lead to which the workers were exposed and information on smoking were not reported. In addition, exposure to other metals probably occurred (U.S. EPA, 2000).

Animal studies have reported kidney tumors in rats and mice exposed to soluble lead salts via the oral route. No studies are available on cancer in animals exposed to lead via the inhalation or dermal routes (U.S. EPA, 2000).

EPA has classified lead as Group B2, Probable Human Carcinogen. This classification was based on animal studies showing an increased risk of kidney tumors and inadequate human evidence (U.S. EPA, 2000).

EPA has not calculated a cancer risk estimate for lead due to the number of uncertainties that are unique to lead. Age, health, nutritional state, body burden, and exposure duration influence the absorption, release, and excretion of lead. In addition, EPA believes that "the current knowledge of lead pharmacokinetics indicates that an estimate derived by standard procedures would not truly describe the potential risk" (U.S. EPA, 2000).

J.10 Manganese

J.10.1 Introduction

Manganese is a silver-colored metal that forms compounds in the environment with chemicals such as oxygen, sulfur, and chlorine. It is found in many types of rock and soil; it is ubiquitous in the environment and found in low levels in water air, soil, and food. Manganese can also be released into the air by iron and steel production plants, power plants, and coke ovens. Metallic manganese is used primarily in steel production to improve hardness, stiffness, and strength. It is also used in carbon steel, stainless steel, and high-temperature steel, along with cast iron and superalloys. Manganese compounds have a variety of uses. Manganese dioxide is used in the production of dry-cell batteries, matches, fireworks, and the production of other manganese compounds. Manganese chloride is used as a catalyst in the chlorination of organic compounds, in animal feed, and in dry-cell batteries, while manganese sulfate is used as a fertilizer, livestock nutritional supplement, in glazes and varnishes, and in ceramics (ATSDR, 1997b).

J.10.2 Noncancer Effects

Manganese is an essential element in humans, with an estimated safe and adequate daily dietary intake of 2 to 5 mg/d for adults and adolescents. No cases of manganese deficiency have been observed in the general population; however, in animals, manganese deficiency has been associated with impaired growth, skeletal abnormalities, and reproductive effects. Chronic inhalation exposure of humans to manganese results primarily in effects on the central nervous system, such as slower visual reaction time, poorer hand steadiness, and impaired eye-hand coordination. Chronic inhalation exposure of humans to high levels may result in a syndrome called manganism and typically begins with feelings of weakness and lethargy and progresses to other symptoms such as gait disturbances, clumsiness, tremors, speech disturbances, a mask-like facial expression, and psychological disturbances. Impaired reproductive function and impaired fertility have been associated with inhalation exposure of workers to manganese dust (ATSDR, 1997b).

Manganese		
Benchmark	**Value**	**Source**
RfD	1.4E-01 mg/kg-d	U.S. EPA, 2000
RfC	5.0E-05 mg/m^3	U.S. EPA, 2000
oral CSF	NA	
inh URF	NA	
inh CSF	NA	

J.10.2.1 Reference Dose. The RfD for manganese is is 1.40E-01 mg/kg-d, based on a NOAEL of 0.14 mg/kg-d, an uncertainty factor of 1, and a modifying factor of 1 (U.S. EPA, 2000). The RfD was based on many studies of daily consumption of manganese in the human population (U.S. EPA, 2000, citing Freeland-Graves et al. 1987, NRC, 1989, and WHO, 1973). According to EPA, the National Research Council (U.S. EPA, 2000, citing NRC, 1989) determined an estimated safe and adequate daily intake (ESADDI) of manganese to be 2 to 5 mg/d for adults. The range of the ESADDI also includes an "extra margin of safety" from the level of 10 mg/d, which the NRC considered to be safe for an occasional intake. Some nutritionists feel that the range of 2 to 5 mg/d may be too low. Freeland-Graves et al. (U. S. EPA, 2000 citing Freeland-Graves et al., 1987) suggested a range of 3.5 to 7 mg/d for adults based on a review of human studies. The World Health Organization (U.S. EPA, 2000, citing WHO, 1973) reviewed several studies of adult diets and reported the average daily consumption of manganese to range from 2.0 to 8.8 mg/d. The WHO concluded that 2 to 3 mg/d is adequate for adults and 8 to 9 mg/d is "perfectly safe." From this information taken together, EPA concluded that an appropriate reference dose for manganese is 0.14 mg/kg-d (10 mg/d) (U.S. EPA, 2000).

An uncertainty factor of 1 was applied because the information was taken from many large populations consuming normal diets over an extended period of time with no adverse health effects and manganese is an essential element. A modifying factor of 1 was applied for assessing exposure to manganese from food; however, a modifying factor of 3 is recommended when assessing exposure from drinking water or soil. There is some degree of increased uptake of manganese from water in fasted individuals (versus in food). A study by Kondakis et al. (U.S. EPA, 2000 citing Kondakis et al., 1989) raised some concern for possible adverse health effects associated with lifetime consumption of drinking water containing about 2 mg/L of manganese. There is concern for infants fed formula that typically has a much higher concentration of manganese than does human milk. There is some evidence that neonates absorb more manganese from the gastrointestinal tract, that neonates are less able to excrete absorbed manganese, and that in the neonate the absorbed manganese more easily passes the blood-brain barrier (U.S. EPA, 2000).

EPA assigns confidence rankings to the noncancer benchmarks contained in IRIS. Confidence rankings are assigned to the study on which the RfD was based, to the database supporting the RfD, and to the RfD itself. For manganese, EPA has

- Medium confidence in the studies on which the RfD was based because many studies have reported similar findings with regard to the normal dietary intake of manganese in humans

- Medium confidence in the database because there is no single study used to derive the RfD for manganese; however, no quantitative information is available to indicate toxic levels of manganese in the diet of humans.

Consequently, EPA has assigned a ranking of medium confidence to the RfD (U.S. EPA, 2000).

J.10.2.2 <u>Reference Concentration</u>. EPA has established an RfC of 5.0E-05 mg/m^3 for manganese based on a LOAEL (human equivalent concentration) of 0.05 mg/m^3, an uncertainty factor of 1,000, and a modifying factor of 1 (U.S. EPA, 2000). The RfC was based on two studies of workers exposed to manganese dioxide (U.S. EPA, 2000, citing Roels et al. 1992, 1987). The first study consisted of 92 male workers who were exposed to manganese dioxide dust in a Belgian alkaline battery plant (U.S. EPA, 2000, citing Roels et al., 1992). This group had been exposed to manganese dioxide for an average of 5.3 years. The mean of the workers' airborne manganese concentrations were 0.215 mg/m^3 for respirable dust and 0.948 mg/m^3 for total dust, with a geometric mean occupational-lifetime integrated respirable dust concentration of 0.793 mg/m^3. A control group was selected of 101 male workers. Manganese workers performed worse than controls on several measures of neurobehavioral function, including visual reaction time and eye-hand coordination. A LOAEL was derived by dividing the geometric mean occupational-lifetime integrated respirable dust concentration (0.793 mg/m^3) by the average duration of the workers' exposure to manganese dioxide (5.13 yr), resulting in a value of 0.15 mg/m^3. The LOAEL (human equivalent concentration) was calculated as 0.15 mg/m^3 × 5d/7d = 0.5 mg/m^3. The second study examined 141 male workers exposed to a geometric mean airborne manganese dust concentration of 0.94 mg/m^3 (U.S. EPA, 2000 citing Roels et al., 1987). A control group of 104 male workers was selected. Significant differences in mean scores between manganese-exposed workers and the control group were found for objective measures of visual reaction time, eye-hand coordination, hand steadiness, and audio-verbal short-term memory. A significantly greater prevalence of coughs during the cold season, dyspnea during exercise, and recent episodes of acute bronchitis was reported in the manganese-exposed group. A LOAEL of 0.97 mg/m^3 was identified with a LOAEL (human equivalent concentration) of 0.34 mg/m^3.

An uncertainty factor of 1,000 was applied based on a tenfold factor for the use of a LOAEL, a tenfold factor to protect sensitive human subpopulations, and a tenfold factor for database limitations reflecting both the less-than-chronic periods of exposure and the lack of developmental data as well as potential but unquantified differences in the toxicity of different forms of manganese (U.S. EPA, 2000).

EPA has

- Medium confidence in the principal studies because neither of the studies identified a NOAEL for neurobehavioral effects, nor did either study directly measure particle size or provide information on the particle size distribution. These limitations are mitigated by the fact that the principal studies found similar indications of neurobehavioral dysfunction and these findings are consistent with the results of other human studies.

- Medium confidence in the database because the duration of exposure was relatively limited in all of the studies and the workers were relatively young, raising concerns that longer durations of exposure and/or interactions with aging might result in the detection of effects at lower concentrations.

Consequently, EPA has assigned a ranking of medium confidence to the RfC (U.S. EPA, 2000).

J.10.3 Cancer Effects

No studies are available regarding carcinogenic effects in humans or animals from inhalation exposure to manganese. No studies are available regarding cancer in humans from oral exposure to manganese. Several oral animal studies reported negative results, one study reporting an increased incidence of thyroid gland follicular cell adenomas and hyperplasia and one study noting an increased incidence of pancreatic tumors, all from exposure to manganese sulfate (ATSDR, 1997b).

EPA has classified manganese as a Group D, Not Classifiable as to Human Carcinogenicity. EPA has not calculated an oral CSF or an inhalation unit risk estimate for manganese (U.S. EPA, 2000).

J.11 Mercury

J.11.1 Introduction

Elemental mercury is a shiny, silver-white, odorless liquid. Elemental mercury is released to the air by natural and industrial processes. A major route of exposure to elemental mercury is inhalation in occupational settings, such as chlorine-alkaline manufacturing facilities. Exposure may also occur from dental and medical treatments; dental amalgams may contain between 43 and 54 percent elemental liquid mercury (ATSDR, 1999d).

Mercury		
Benchmark	**Value**	**Source**
RfD	NA	
RfC	3.0E-04 mg/m^3	U.S. EPA, 2000
oral CSF	NA	
inh URF	NA	
inh CSF	NA	

J.11.2 Noncancer Effects

Nervous system effects are the most sensitive toxicologic endpoint observed following exposure to elemental mercury. Symptoms associated with elemental mercury neurological toxicity include tremors, irritability, excessive shyness, nervousness, insomnia, headaches, polyneuropathy, and memory loss. At higher concentrations, kidney and respiratory effects have been observed (U.S. EPA, 1997b).

J.11.2.1 Reference Dose. EPA has not calculated an RfD for elemental mercury; however, RfDs for inorganic and organic mercury are available (U.S. EPA, 2000).

J.11.2.2 Reference Concentration. EPA has calculated an RfC for elemental mercury of 3.0E-04 mg/m^3, based on a LOAEL (adjusted) of 0.009 mg/m^3, an uncertainty factor of 30, and a modifying factor of 1. A human occupational study was used as the basis for the RfC and the LOAEL (U.S. EPA, 2000, citing Fawer et al., 1983) and several other human occupational studies were used to corroborate this LOAEL. These studies investigated neurological effects in humans exposed to elemental mercury in the workplace; hand tremors, increases in memory disturbances, and evidence of autonomic dysfunction were observed and were the basis for the LOAEL (U.S. EPA, 2000).

An uncertainty factor of 30 was applied based on a tenfold factor for the protection of sensitive human subpopulations and an additional threefold factor for database deficiencies, particularly developmental and reproductive studies. The LOAEL of 0.025 mg/m^3 was adjusted to account for occupational ventilation rate ([10 m^3/8 h]/[20 m^3/24 h]) and intermittent exposure (5/7 d) to result in an adjusted LOAEL of 0.009 mg/m^3 (U.S. EPA, 2000).

EPA has

- Medium confidence in the studies on which the RfC was based because there were a sufficient number of human subjects, an appropriate control group, and the exposure levels in a number of studies had to be extrapolated from blood mercury levels

- Medium confidence in the database; although the LOAEL is corroborated by several human studies, there are a lack of human or multispecies reproductive/developmental studies and inadequate quantification of exposure levels.

EPA has assigned a ranking of medium confidence in the RfC (U.S. EPA, 2000).

J.11.3 Cancer Effects

There are a number of epidemiological studies that have examined cancer mortality and morbidity among workers occupationally exposed to elemental mercury. All of these studies have limitations, including small sample sizes, probable exposure to other lung carcinogens, failure to consider confounding factors such as smoking, and failure to observe correlations between estimated exposure and cancer incidence (U.S. EPA, 1997b).

One available animal study identified cancer incidence in animals exposed to elemental mercury by injection. Tumors were found at the contact sites; however, the study was incompletely reported as to controls and statistics (U.S. EPA, 1997b).

EPA has classified elemental mercury as Group D, Not Classifiable as to Human Carcinogenicity, based on inadequate human and animal data. EPA has not calculated a unit risk estimate for elemental mercury (U.S. EPA, 2000).

J.12 Inorganic Mercury (Mercuric Chloride; Divalent Mercury)

J.12.1 Introduction

Inorganic mercury compounds are usually white powders of crystals. Until 30 years ago, inorganic mercury compounds were used extensively as pharmaceuticals, such as components of antiseptics, diuretics, skin lightening creams, and laxatives. Since then, more effective and less harmful alternatives have replaced most pharmaceutical uses of mercury. Today, most exposure to inorganic mercury compounds occurs through dental treatments (ATSDR, 1999d).

Inorganic Mercury		
Benchmark	**Value**	**Source**
RfD	3.0E-04 mg/kg-d	U.S. EPA, 2000
RfC	NA	
oral CSF	NA	
inh URF	NA	
inh CSF	NA	

J.12.2 Noncancer Effects

The primary effect from chronic exposure to inorganic mercury is kidney damage, primarily due to mercury-induced autoimmune glomerulonephritis (induction of an immune response to the body's kidney tissue). In addition, several animal studies have reported developmental effects from exposure to inorganic mercury (U.S. EPA, 1997b).

J.12.2.1 Reference Dose. EPA has established an RfD of 3.0E-04 mg/kg-d for mercuric chloride. This was based on a consensus decision of a panel of mercury experts who used several LOAELs ranging from 0.23 to 0.63 mg/kg-d (U.S. EPA, 1987a), an uncertainty factor of 1,000, and a modifying factor of 1. The LOAELs were derived from several rat feeding, gavage, and subcutaneous injection studies in which autoimmune glomerulonephritis was observed (U.S. EPA, 2000).

An uncertainty factor of 1,000 was applied based a tenfold factor for use of a LOAEL, a tenfold factor for use of subchronic studies, and an additional tenfold factor for extrapolating from animals to humans and for sensitive human subpopulations (U.S. EPA, 2000).

The studies on which the RfD was based were not given a confidence ranking; the RfD and database were given a high confidence ranking based on the weight of evidence from several studies using Brown Norway rats and the entirety of the mercuric mercury database (U.S. EPA, 2000).

J.12.2.2 Reference Concentration. EPA has not established an RfC for inorganic mercury (U.S. EPA, 2000).

J.12.3 Cancer Effects

There are no data concerning the carcinogenic effects of mercuric chloride in humans (U.S. EPA, 1997b). Limited animal data are available on the carcinogenic effects of inorganic mercury. Cancer of the forestomach and thyroid were seen in rats exposed to mercuric chloride by gavage, and evidence of cancer of the forestomach and kidneys was considered equivocal in mice (U.S. EPA, 1997b).

EPA has classified mercuric chloride as Group C, Possible Human Carcinogen, based on the absence of data in humans and limited evidence in rats and mice. EPA has not calculated a unit risk estimate for mercuric chloride (U.S. EPA, 2000).

J.13 Organic Mercury (Methylmercury)

J.13.1 Introduction

Organic mercury compounds are white crystalline solids. The most common organic mercury compound in the environment is methylmercury. Most exposure to organic mercury occurs through the diet, with fish and fish products as the dominant source. Sources of past exposure to organic mercury include fungicide-treated grains and meat from animals fed such grain. However, fungicides containing mercury are banned in the United States today and this source of exposure is now negligible (ATSDR, 1999d).

Methylmercury		
Benchmark	**Value**	**Source**
RfD	1.0E-04 mg/kg-d	U.S. EPA, 2000
RfC	NA	
oral CSF	NA	
inh URF	NA	
inh CSF	NA	

J.13.2 Noncancer Effects

A large number of human studies are available on the systemic effects of methylmercury. This database is the result of two large-scale poisoning episodes in Japan and Iraq, as well as several epidemiologic studies investigating populations that consume large quantities of fish. Methylmercury mainly affects the central nervous system. Early symptoms from chronic exposure to low levels of methylmercury are prickling on the skin, blurred vision, and malaise. At higher doses, deafness, speech difficulties, and constriction of the visual field are seen. The fetus is at particular risk from methylmercury exposure. Offspring born to women exposed to methylmercury during pregnancy have exhibited a number of developmental abnormalities including delayed onset of walking and talking, cerebral palsy, altered muscle tone, and reduced neurological test scores (U.S. EPA, 1997b).

J.13.2.1 Reference Dose. EPA has established an RfD of 1.0E-04 mg/kg-d for methylmercury based on a benchmark dose of 0.0011 mg/kg-d, an uncertainty factor of 10, and a modifying factor of 1 (U.S. EPA, 2000). This was based on developmental neurologic abnormalities in infants born to mothers exposed to methylmercury in contaminated grain in Iraq (U.S. EPA, 2000, citing Marsh et al., 1987, and Ahmed, 1991). EPA used a benchmark dose, the lower 95 percent confidence level for a 10 percent incidence rate of neurologic changes, based on modeling of all effects in children. This lower bound was 11 ppm methylmercury in maternal hair. A dose conversion was used to estimate a daily intake of 1.1 µg methylmercury/kg body weight/d that, when ingested by a 60-kg individual, will maintain a concentration of approximately 44 µg/L of blood or a hair concentration of 11 µg mercury/g hair (11 ppm) (U.S. EPA, 1997b, 2000).

EPA applied an uncertainty factor of 10, based on a threefold factor for variability in the human population and an additional threefold factor for the lack of a two-generation reproductive study and lack of data for the effect of exposure duration on developmental neurotoxicity effects and on adult paresthesia (U.S. EPA, 2000).

EPA has assigned a ranking of medium confidence in the studies on which the RfD was based, in the database, and in the RfD for methylmercury. These rankings are based on the fact that the benchmark dose approach allowed use of the entire dose-response assessment with a resulting value that is consistent with the traditional NOAEL/LOAEL approach. However, EPA has some concerns related to the applicability of a dose-response estimate based on a grain-consuming population when the actual application is likely to help characterize risk for fish-consuming segments of the population (U.S. EPA, 2000).

It is also important to consider the fact that the RfD represents a "no-effect" level that is presumed to be without appreciable risk. As discussed above, EPA used an uncertainty factor of 10 to derive the RfD for methylmercury. An uncertainty factor of 100 to 1,000 is usually applied when the RfD is based on animal data; however, because this RfD was based on human data, an uncertainty factor of 10 was deemed appropriate. In addition, the RfD was based on a benchmark dose that itself was derived as the lower 95 percent confidence level for the 10 percent incidence rate of neurologic abnormalities in children. Therefore, there is a margin of

safety between the RfD and the level corresponding to the threshold for adverse effects, as indicated by the human data.

Considerable new data on the health effects of methylmercury are becoming available. Large studies of fish- and marine-mammal-consuming populations in the Seychelles and Faroe Islands have been carried out. Smaller-scale studies also describe effects in populations around the U.S. Great Lakes. However, EPA has decided "that it is premature to make a change in the methylmercury RfD at this time" (U.S. EPA, 1997b). In November 1998, EPA and other federal agencies participated in an interagency review of available human neurodevelopmental data on methylmercury, including the most recent studies from the Seychelles and Faroe Islands. Preliminary review of the Seychellois and Faroese data supports the current RfD as scientifically valid and protective of human health. The National Academy of Sciences (NAS) is currently independently assessing EPA's RfD for methylmercury. Pending the completion of the NAS study, EPA will reevaluate the RfD for methylmercury following careful review of the results of the NAS study.

J.13.2.2 Reference Concentration. EPA has not established an RfC for methylmercury (U.S. EPA, 2000).

J.13.3 Cancer Effects

Three human studies have examined the relationship between methylmercury and cancer incidence. However, these studies were considered extremely limited because of study design or incomplete data reporting (U.S. EPA, 1997b).

Several animal studies have shown an increased incidence of kidney tumors in mice exposed orally to methylmercury. However, these tumors were observed only at a single site (kidney), in a single species (mice), and in a single sex (males) (U.S. EPA, 1997b).

EPA has classified methylmercury as Group C - Possible Human Carcinogen, based on the absence of adequate data in humans and limited evidence in animals. EPA has not calculated a unit risk estimate for methylmercury (U.S. EPA, 2000).

J.14 Molybdenum

J.14.1 Introduction

Molybdenum occurs naturally in the environment in rocks and soil. It is found in various minerals such as molydenite, wulfenite, ferrimolybdate, and jordisite. Geological factors cause widely varying environmental concentrations of molybdenum. The available molybdenum in soil is dependent on pH and other factors, which affects the amount of molybdenum in vegetable crops (NRC, 1980).

J.14.2 Noncancer Effects. Molybdenum is an essential dietary element in humans. It is a constituent of several mammalian enzymes including xanthine oxidase, sulfite oxidase, and aldehyde oxidase. An estimated safe and adequate daily intake range of 0.075-0.250 mg/d has

been established for molybdenum, based on the reported molybdenum intakes of adults and older children with average American diets (U.S. EPA, 2000, citing NRC, 1989). In areas with very high levels of molybdenum, higher than average levels of gout and gout-like symptoms (arthralgia in the knees, hands, and feet) have been reported. Animal studies have reported body weight loss, bone deformities, and depigmentation of the hair from exposure to high levels of molybdenum. Animal studies have also demonstrated that the effects of molydenum on growth and melanin synthesis are more pronounced when dietary copper intake is low (U.S. EPA, 2000).

Molybdenum		
Benchmark	**Value**	**Source**
RfD	5.0E-03 mg/kg-d	U.S. EPA, 2000
RfC	NA	
oral CSF	NA	
inh URF	NA	
inh CSF	NA	

J.14.2.1 Reference Dose. The RfD for molybdenum is is 5.0E-03 mg/kg-d, based on a LOAEL of 0.14 mg/kg-d, an uncertainty factor of 30, and a modifying factor of 1 (U.S. EPA, 2000). The RfD was based on a study in Armenia with high levels of molybdenum and low levels of copper in the soil and plants (U.S. EPA, 2000, citing Koval'skiy et al, 1961). The average adult received 10 to 15 mg of molybdenum (0.21 mg/kg-d) and 5 to 10 mg of copper through the diet. A control area was selected with dietary intake levels of 1 to 2 mg of molybdenum and 5 to 10 mg of copper. Of the highly exposed population, 31 percent had gout-like symptoms as compared to 17.9 percent of the control group. Above-normal blood uric acid content was found in 29 of 52 adults examined; at least 17 of the 29 had gout-like symptoms. A molybdenum intake of 0.14 mg/kg-d was determined to result in serum uric acid levels elevated above the average range of the adult population, and this level was selected as a LOAEL (U.S. EPA, 2000).

An uncertainty factor of 30 was applied based on a threefold factor for protection of sensitive human populations and a tenfold factor for the use of a LOAEL rather than a NOAEL (U.S. EPA, 2000).

EPA assigns confidence rankings to the noncancer benchmarks contained in IRIS. Confidence rankings are assigned to the study on which the RfD was based, the database supporting the RfD, and to the RfD itself. For molybdenum, EPA has

- Medium confidence in the study on which the RfD was based because the study examined only gross physical effects of a gout-like disease and an exhaustive analysis of blood chemistry and individualized dietary habits was not done

- **#** Medium confidence in the database because the proposed RfD satisfies nutrient requirements for all healthy members of the population.

Consequently, EPA has assigned a ranking of medium confidence to the RfD (U.S. EPA, 2000).

J.14.2.2 Reference Concentration. EPA has not established an RfC for molybdenum (U.S. EPA, 2000).

J.14.3 Cancer Effects

No information is available on the carcinogenic effects of molybdenum. EPA has not classified manganese for human carcinogenicity and has not calculated an oral CSF or an inhalation unit risk estimate for manganese (U.S. EPA, 2000).

J.15 Nickel

J.15.1 Introduction

Nickel is a silvery-white metal that is usually found in nature as a component of silicate, sulfide, or arsenide ores. The predominant forms of nickel in the atmosphere are nickel sulfate, nickel oxides, metallic nickel, and the complex oxides of nickel. Each form of nickel exhibits different physical properties. Most nickel is used to make stainless steel; other uses include the manufacture of batteries, electroplating baths, textile dyes, coins, sparkplugs, and machinery parts (ATSDR, 1997c).

Nickel		
Benchmark	**Value**	**Source**
RfD	2.0E-02 mg/kg-d	U.S. EPA, 2000
RfC	8.0E-05 mg/m^3 (salt) 1.5E-04 mg/m^3 (oxide)	Developed
oral CSF	NA	
inh URF	NA	
inh CSF	NA	

J.15.2 Noncancer Effects

Contact dermatitis is the most common effect in humans from exposure to nickel via inhalation, oral, or dermal exposure. Cases of nickel-contact dermatitis have been reported following occupational and nonoccupational exposure, with symptoms of itching of the fingers, wrists, and forearms. Chronic inhalation exposure to nickel in humans also results in respiratory

effects. These effects include direct respiratory effects such as asthma due to primary irritation or an allergic response and an increased risk of chronic respiratory tract infections (ATSDR, 1997c).

Animal studies have reported effects on the lungs, kidneys, and immune system from inhalation exposure to nickel and effects on the respiratory and gastrointestinal systems, heart, blood, liver, kidney, and decreased body weight from oral exposure to nickel. Fetotoxicity has been reported in animals orally exposed to nickel (soluble salts). Dermal animal studies have reported effects on the skin (ATSDR, 1997c).

Significant differences in inhalation toxicity among the various forms of nickel have been documented; different mechanisms of action between soluble and insoluble nickel compounds and different dose-response levels have been reported. Soluble nickel compounds are more toxic to the respiratory tract than less soluble compounds (e.g., nickel oxide) (ATSDR, 1997c; CalEPA, 1999b).

J.15.2.1 Reference Dose. EPA has established an RfD for nickel (soluble salts) of 2.0E-02 mg/kg-d, based on a NOAEL of 5 mg/kg-d, an uncertainty factor of 300, and a modifying factor of 1 (U.S. EPA, 2000). This was based on a study in rats (U.S. EPA, 2000, citing Ambrose et al., 1976) that showed decreased body and organ weights from chronic (2-year) exposure to nickel in the diet. Several other studies showed similar results, with decreased body and organ weights after exposure to nickel chloride via gavage and through the drinking water (U.S. EPA, 2000).

An uncertainty factor of 300 was applied, based on a tenfold factor for interspecies extrapolation, a tenfold factor to protect sensitive subpopulations, and a threefold factor for inadequacies in the reproductive studies (U.S. EPA, 2000).

EPA has

- Low confidence in the study on which the RfD was based because, although it was properly designed and provided adequate toxicological endpoints, high mortality occurred in the controls

- Medium confidence in the database because it provided adequate supporting subchronic studies.

EPA assigned a ranking of medium confidence level in the RfD (U.S. EPA, 2000).

J.15.2.2 Reference Concentration. EPA has not established an RfC for any nickel compound (U.S. EPA, 2000).

Substantive differences in toxicity warrant the derivation of separate RfCs for soluble nickel salts and nickel oxide. A provisional chronic RfC for soluble nickel salts of 8.0E-05 mg/m^3 is based on a NOAEL of 0.03 mg/m^3 for respiratory effects in rats (NTP, 1996b) and an uncertainty factor of 30. Groups of male and female rats were exposed via inhalation to 0, 0.03, 0.06, or 0.11 mg Ni/m^3 as nickel sulfate hexahydrate for 6 h/d, 5 d/wk for 104 weeks. The

incidences of inflammatory lesions in the lung, chronic active inflammation, macrophage hyperplasia, alveolar proteinosis, and fibrosis were markedly increased in rats exposed to 0.06 or 0.11 mg Ni/m^3. Increased incidences of bronchial lymph node hyperplasia and olfactory epithelial atrophy were observed in male and female rats exposed to 0.11 mg Ni/m^3 (NTP, 1996b). A NOAEL of 0.03 mg/m^3 was identified.

The NOAEL was adjusted for intermittent exposure (6 h/d, 5 d/wk), resulting in a $NOAEL_{ADJ}$ of 0.0054 mg/m^3. To account for species-specific differences in inhalation dosimetry, a $NOAEL_{HEC}$ of 0.0024 µg/m^3 was calculated based on an RDDR of 0.445 (MMAD = 2.5, sigma g = 2.4, male F344 rat default body weight = 380 g). An uncertainty factor of 30 was applied based on a tenfold factor to account for human variability and a threefold factor to account for extrapolation from animals to humans.

A provisional chronic RfC for nickel oxide of 1.5E-04 mg/m^3 is based on a LOAEL of 0.5 mg/m^3 for respiratory effects in rats (NTP, 1996c) and an uncertainty factor of 300. Groups of male and female rats were exposed via inhalation to 0, 0.5, 1.0, or 2.0 mg Ni/m^3 as nickel oxide for 6 h/d, 5 d/wk for 104 weeks. Atypical alveolar hyperplasia and chronic inflammation of the lungs were observed in all exposed groups. The incidence of inflammatory pigmentation in the alveoli was significantly greater in all exposed groups compared to controls. The severity of the lesions increased with increasing exposure. Lymphoid hyperplasia in the bronchial lymph nodes was observed and the incidence generally increased with increasing concentration at the end of the 2-year study. Females had an increased incidence of adrenal medullary hyperplasia at the highest concentration of nickel oxide (NTP, 1996c). A LOAEL of 0.5 mg/m^3 was identified.

The LOAEL was adjusted for intermittent exposure (6 h/d, 5 d/wk), resulting in a $LOAEL_{ADJ}$ of 0.0895 mg/m^3. To account for species-specific differences in inhalation dosimetry, a $LOAEL_{HEC}$ of 0.0438 µg/m^3 was calculated based on an RDDR of 0.489 (MMAD = 2.21, sigma g = 1.97, male F344 rat default body weight = 380 g). An uncertainty factor of 300 was applied based on a tenfold factor for use of a LOAEL, a threefold factor to account for interspecies extrapolation, and a tenfold factor to account for human variability.

J.15.3 Cancer Effects

No significant increases in tumor incidences were observed in male or female rats or mice chronically exposed to nickel sulfate hexahydrate (a soluble nickel salt) via inhalation in a study by the NTP; NTP concluded that there was no evidence of carcinogenic activity in rats or mice (NTP, 1996b).

In a chronic inhalation study, NTP concluded that there was some evidence of carcinogenic activity of nickel oxide in male and female rats based on increased incidences of alveolar/ bronchiolar adenoma or carcinoma (combined) and increased incidences of benign or malignant pheochromocytoma of the adrenal medulla, no evidence in male mice, and equivocal evidence in female mice based on marginally increased incidences of alveolar/bronchiolar adenoma or carcinoma (NTP, 1996c).

Neither soluble nickel salts nor nickel oxide has been classified for carcinogenicity by EPA. EPA has not calculated a unit risk estimate for soluble nickel salts or nickel oxide (U.S. EPA, 2000).

Nickel refinery dust and nickel subsulfide (a primary component of refinery dust) have been classified as Class A, known human carcinogens, based on increased risk of lung and nasal cancer in humans and increased lung tumor incidences in animals (U.S. EPA, 2000). However, nickel refinery dust and nickel subsulfide are not anticipated to be in paint waste streams and will not be used as surrogates for nickel soluble salts or nickel oxide.

J.16 Selenium

J.16.1 Introduction

Selenium is a naturally occurring substance in the earth's crust and is commonly found in sedimentary rock combined with other substances, such as sulfide minerals, or with silver, copper, lead, and nickel minerals. Selenium is an essential element for humans and animals and exposure occurs daily through food intake. It is used in the electronics industry; the glass industry; in pigments used in plastics, paints, enamels, inks, and rubber; in pharmaceuticals manufacturing; and as a constituent of fungicides (ATSDR, 1996).

Selenium		
Benchmark	**Value**	**Source**
RfD	5.0E-03 mg/kg-d	U.S. EPA, 2000
RfC	2.0E-02 mg/m^3	CalEPA, 1999b
oral CSF	NA	
inh URF	NA	
inh CSF	NA	

J.16.2 Noncancer Effects

No information is available on the chronic effects of selenium in humans from inhalation exposure. Acute inhalation of high concentrations of selenium has resulted in respiratory effects in occupationally exposed workers. Ingestion of high levels of selenium in food and water has led to selenosis, which is characterized by discoloration of the skin, deformation and loss of nails, hair loss, excessive tooth decay and discoloration, lack of mental alertness, and listlessness. Dermal exposure has resulted in skin rashes and contact dermatitis (ATSDR, 1996).

No data are available on the chronic effects in animals from inhalation exposure. Livestock exposed through consumption of high levels of selenium develop "alkali disease." (ATSDR, 1996).

J.16.2.1 Reference Dose. EPA has established an RfD for selenium of 5.0E-03 mg/kg-d based on a NOAEL of 0.015 mg/kg-d, an uncertainty factor of 3, and a modifying factor of 1 (U.S. EPA, 2000). The RfD is based on an epidemiological study (U.S. EPA, 2000, citing Yang et al., 1989), which reported selenosis in a population in China. Clinical signs observed included “garlic odor” of the breath and urine, thickened and brittle nails, hair and nail loss, lowered hemoglobin levels, mottled teeth, skin lesions, and central nervous system abnormalities (U.S. EPA, 2000).

EPA applied an uncertainty factor of 3 to account for sensitive individuals. A full factor of 10 was not deemed necessary because similar NOAELs were identified in two moderate-sized populations exposed to selenium in excess of the recommended daily allowance without apparent signs of selenosis (U.S. EPA, 2000).

EPA has medium confidence in the study on which the RfD was based because, although it was a study in which a sizable population with sensitive subpopulations was studied, there were still several possible interactions that were not fully accounted for. EPA has assigned a ranking of high confidence in the database because many animal studies and epidemiologic studies support the principal study and, consequently, high confidence in the RfD (U.S. EPA, 2000).

J.16.2.2 Reference Concentration. EPA has not established an RfC for selenium (U.S. EPA, 2000). However, CalEPA has established a chronic inhalation REL for selenium of 2.0E-02 mg/m^3; a route-to-route extrapolation of the EPA RfD (0.005 mg/kg-d) was performed, assuming a body weight of 70 kg and an inhalation rate of 20 m^3/d (CalEPA, 1999b).

J.16.3 Cancer Effects

Several epidemiological studies have examined the relationship between cancer death rates in humans and selenium levels in forage crops. These studies have reported an increased incidence of colon, gastrointestinal, breast, prostate, and other forms of cancer in areas where selenium is deficient and a lowered cancer incidence in areas with higher selenium concentrations. Other studies have reported that blood serum levels in patients with cancer had significantly lower selenium levels than healthy patients (U.S. EPA, 2000).

Several animal studies have investigated the carcinogenicity of selenium. However, the data are conflicting and difficult to interpret because of apparent anticarcinogenicity and high toxicity of some selenium compounds (U.S. EPA, 2000).

EPA has classified selenium as Group D, Not Classifiable as to Carcinogenicity in Humans, because of inadequate human data and inadequate evidence of carcinogenicity in animals (U.S. EPA, 2000). EPA has not calculated a unit risk estimate for selenium.

J.17 Thallium

J.17.1 Introduction

Thallium is a bluish-white metal that is found in the earth's crust. It is found combined with other elements such as oxygen, sulfur, and chloride. It is quite stable in the environment, since it is neither transformed nor biodegraded in the environment. Thallium compounds are generally soluble in water and may attach to soils and sediment. Major releases of thallium to the environment are from processes such as coal-burning and smelting, in which thallium is a trace contaminant of the raw materials. Thallium is used in the semiconductor and pharmaceutical industries and to manufacture highly refractive optical glass (ATSDR, 1992c).

J.17.2 Noncancer Effects

Studies on workers exposed to high levels of thallium by inhalation indicate that it may affect the central nervous system, with effects such as paresthesia, numbness of toes and fingers, "burning feet," and muscle cramps. Ingestion of thallium has been associated with hair loss in humans. Hair loss was reported to be temporary, and no skin changes were reported. Peripheral neuropathy was reported in cases of thallium poisoning in China. In animal studies, hair loss, nervous system effects, and abnormalities in testicular morphology have been reported from thallium exposure (ATSDR, 1992c).

Thallium		
Benchmark	**Value**	**Source**
RfD	8.0 E-05 mg/kg-d[a] 9.0 E-05 mg/kg-d[b]	U.S. EPA, 2000 U.S. EPA, 2000
RfC	NA	
oral CSF	NA	
inh URF	NA	
inh CSF	NA	

[a]This RfD is for thallium carbonate, thallium chloride, and thallium sulfate.
[b]This RfD is for thallium acetate, and thallium nitrate.

J.17.2.1 Reference Dose. The RfD for thallium carbonate, thallium chloride, and thallium sulfate is 8.0 E-05mg/kg-d and the RfD for thallium acetate and thallium nitrate is 9.0E-05 mg/kg-d, based on a NOAEL of 0.25 mg/kg-d, an uncertainty factor of 3,000, and a modifying factor of 1.The RfDs were based on a 90-day study in which rats were treated by gavage with thallium sulfate at doses of 0, 0.01, 0.05, or 0.25 mg/kg-d (0, 0.004, 0.02, or 0.10 mg thallium/kg-d) (U.S. EPA, 2000, citing U.S. EPA, 1986). No differences between the control groups and the exposed groups were observed in body weights, body weight gain, food consumption, or organ weights. Moderate dose-related changes were observed in some blood

chemistry parameters. The only grossly observed finding was alopecia; however, microscopic evaluation did not reveal any histopathologic alterations. The highest dose (0.25 mg/kg-d thallium sulfate, 0.10 mg/kg-d thallium) was selected as a NOAEL. Using the molecular weight ratios, the NOAEL was converted for the other thallium compounds as follows: thallium carbonate and thallium chloride = 0.23 mg/kg-d; thallium acetate and thallium nitrate = 0.26 mg/kg-d (U.S. EPA, 2000).

An uncertainty factor of 3,000 was applied based on a tenfold factor to extrapolate from subchronic to chronic data, a tenfold factor for extrapolating from animals to humans, a tenfold factor for sensitive human subpopulations, and a threefold factor to account for lack of reproductive and chronic toxicity data (U.S. EPA, 2000).

EPA assigns confidence rankings to the noncancer benchmarks contained in IRIS. Confidence rankings are assigned to the study on which the RfD was based, the database supporting the RfD, and to the RfD itself. For thallium, EPA has

- Low confidence in the study on which the RfD was based because of uncertainties in the results and because supporting studies show adverse health effects at doses slightly higher than the NOAEL

- Low confidence in the database because is provides only one subchronic study and some anecdotal human data.

Consequently, EPA has assigned a ranking of low confidence to the RfD (U.S. EPA, 2000).

J.17.2.2 <u>Reference Concentration</u>. EPA has not established an RfC for any thallium compound (U.S. EPA, 2000).

J.17.3 Cancer Effects

A study on the carcinogenic effects of thallium in workers did not report an increase in cancer. However, this study was inadequate due to lack of exposure quantification, examination of medical records only, and unknown length of observation. EPA has classified thallium as a Group D, Not Classifiable as to Human Carcinogenicity. EPA has not calculated an oral CSF or an inhalation unit risk estimate for thallium (U.S. EPA, 2000).

J.18 Vanadium

J.18.1 Introduction

Vanadium is a white to grey metal that is widely distributed at low concentrations in the earth's crust. It is generally bound to oxygen when it occurs in the environment; the most common compound is vanadium pentoxide. It is released naturally to air through volcanic emissions and continental dust. The weathering of rocks and soil erosion release most of the vanadium to water and soils. Industrial sources of vanadium include fossil fuel combustion, leachates from mining tailings, and municipal sewage sludge. The major use of vanadium is as an

alloying agent in the steel industry, where it is used in automobile parts, springs, ball bearings, and other products (ATSDR, 1992d).

J.18.2 Noncancer Effects

The most significant effect from exposure to vanadium in humans is mild to moderate respiratory distress and mucosal irritation. Vanadium workers have reported coughs, wheezing, chest pain, sore throats, or eye irritation, which can last for several days after exposure. Studies in animals support the finding that vanadium primarily affects the respiratory system (ATSDR, 1992d).

Vanadium		
Benchmark	**Value**	**Source**
RfD	9.0E-03 mg/kg-d	U.S. EPA, 2000
RfC	NA	
oral CSF	NA	
inh URF	NA	
inh CSF	NA	

J.18.2.1 Reference Dose. The RfD for vanadium pentoxide is is 9.0E-03 mg/kg-d, based on a NOAEL of 0.89 mg/kg-d, an uncertainty factor of 100, and a modifying factor of 1 (U.S. EPA, 2000). The RfD was based on a study in which rats were exposed to dietary levels of 10 or 1,000 ppm vanadium (17.9 or 179 ppm vanadium pentoxide) for 2.5 years (U.S. EPA, 2000, citing Stokinger et al., 1953). The criteria used to evaluate vanadium toxicity were growth rate, survival, and hair cystine content. The only significant change reported was a decrease in the amount of cystine in the hair of animals ingesting vanadium. A LOAEL of 17.9 ppm was selected and converted to 0.89 mg/kg-d, assuming an adult rat food consumption rate of 5 percent body weight per day (U.S. EPA, 2000).

An uncertainty factor of 100 was applied based on a tenfold factor for extrapolating from animals to humans and a tenfold factor for protecting sensitive subpopulations (U.S. EPA, 2000).

EPA assigns confidence rankings to the noncancer benchmarks contained in IRIS. Confidence rankings are assigned to the study on which the RfD was based, the database supporting the RfD, and to the RfD itself. For vanadium, EPA has

- Low confidence in the study on which the RfD was based because the study provided few details
- Low confidence in the database because of the scarcity of data available on vanadium pentoxide.

Consequently, EPA has assigned a ranking of low confidence to the RfD (U.S. EPA, 2000).

J.18.2.2 Reference Concentration. EPA has not established an RfC for vanadium (U.S. EPA, 2000).

J.18.3 Cancer Effects

No information is available on the carcinogenic effects of vanadium. The National Toxicology Program (NTP) has carried out a 2-year inhalation study in rats and mice on vanadium pentoxide and a pathology quality assessment is currently in progress (http://ntp-server.niehs.nih.gov/Main_Pages/MSRPage1.html). EPA has not classified vanadium for human carcinogenicity and has not calculated an oral CSF or an inhalation unit risk estimate for vanadium (U.S. EPA, 2000).

J.19 Zinc

J.19.1 Introduction

Zinc is an element commonly found in the earth's crust. It is mined in the United States, and secondary zinc metal is produced at plants from scrap metal. Zinc is used most commonly as a protective coating of other metals. It is also used in alloys such as bronze and brass, for the electrical apparatus in many common goods, and in organic chemical extractions and reductions (ATSDR, 1994). The primary uses of zinc oxide are in paint pigments, cosmetics, and cements (CalEPA, 1997).

Zinc		
Benchmark	**Value**	**Source**
RfD	3.0E-01 mg/kg-d	U.S. EPA, 2000
RfC	9.0E-04 mg/m^3	CalEPA, 1997
oral CSF	NA	
inh URF	NA	
inh CSF	NA	

J.19.2 Noncancer Effects

Zinc is an essential element in humans, with a Recommended Daily Allowance (RDA) of 15 mg/d for men and 12 mg/d for women (U.S. EPA, 1989a, 2000, citing NRC, 1989). Acute inhalation exposure to high levels of zinc has resulted in metal fume fever, a disease characterized by dryness of the throat, coughing, chest pain, cough, and dyspnea. The respiratory symptoms generally disappear within a few days. Respiratory effects (changes in pulmonary

function and morphological changes) have also been reported in guinea pigs exposed to zinc oxide via inhalation. Acute oral exposure to high concentrations of zinc has resulted in gastrointestinal irritation and pancreatic damage in humans. Chronic oral exposure has resulted in effects on the blood, including decreased levels of hemoglobin and hematocrit, which is believed to be the result of zinc-induced copper deficiency (ATSDR, 1994).

J.19.2.1 Reference Dose. The RfD for zinc is 3.0E-01 mg/kg-d based on a LOAEL of 59.72 mg/d (1.0 mg/kg-d), an uncertainty factor of 3, and a modifying factor of 1 (U.S. EPA, 2000). The RfD was based on a clinical study in which 18 healthy women were given zinc gluconate supplements twice daily (50 mg/d or 1.0 mg/kg-d) for 10 weeks (U.S. EPA, 2000, citing Yadrick et al., 1989). Erythrocyte superoxide dismutase (ESOD) levels declined over the 10-wk supplementation period and at 10 weeks were significantly different from values during the pretreatment period. By 10 weeks, ESOD levels had declined to 53 percent of pretreatment levels (U.S, EPA, 2000). A LOAEL of 1.0 mg/kg-d was calculated from estimations of the FDA Total Diet Study for 1982-1986, plus the reported supplemental dose, divided by the assumed body weight (60 kg), as follows:

$$50 \text{ mg/d} + 9.72 \text{ mg/d} = 60 \text{ mg/d} \div 60 \text{ kg} = 1.0 \text{ mg/kg-d}$$

An uncertainty factor of 3 was applied based on the use of a minimal LOAEL from a moderate duration study of the most sensitive humans and consideration of a substance that is an essential dietary nutrient (U.S. EPA, 2000).

The RfD is expected to be without adverse health effects when consumed on a daily basis over an extended period of time. It neither induces a nutritional deficiency in healthy, non-pregnant, adult women consuming the average American diet nor causes undesirable inhibition of normal lipid transport. EPA assigned a ranking of medium confidence in the RfD based on

- Medium confidence in the studies because they are well-conducted clinical studies with many parameters investigated but only a few humans tested
- Medium confidence in the database because the studies were all of short duration (U.S. EPA, 2000).

J.19.2.2 Reference Concentration. EPA has not established an RfC for zinc. However, CalEPA (1997) derived a chronic inhalation reference exposure level of 9.0E-04 mg/m^3 based on a LOAEL of 0.26 mg/m^3 and an uncertainty factor of 100. The RfC was based on a case report in which development of occupational asthma was seen in a worker exposed to zinc from galvanization processes over a 2-year period (CalEPA, 1997, citing Malo et al., 1993). Environmental monitoring resulted in estimated exposure levels of 0.26 to 0.29 mg/m^3 zinc. The worker experienced increasing shortness of breath, chest tightness, wheezing, sneezing, and burning of the eyes. Symptoms disappeared when he left work for 7 months, but reappeared when he returned to work (CalEPA, 1997).

The worker's exposure was determined to be 7 h/d (assumed inhalation rate of 10 m^3/d), 5 d/wk. The LOAEL was adjusted for intermittent occupational exposure and resulted in a

$LOAEL_{ADJ}$ of 0.093 mg/m^3 (0.26 mg/m^3 × 10/20 m^3/d × 5/7 d). An uncertainty factor of 100 was applied based on a tenfold factor to account for the use of a LOAEL and a tenfold factor to account for extrapolating from subchronic to chronic exposure duration (CalEPA, 1997).

J.19.3 Cancer Effects

Inadequate human carcinogenicity data are available for zinc. In a study in mice, no statistically significant increase in tumor incidence was observed in animals exposed to zinc sulfate in drinking water for 1 year (ATSDR, 1994). EPA has classified zinc as Group D, Not Classifiable as to Human Carcinogenicity, and has not calculated an oral CSF or inhalation unit risk estimate for zinc (U.S. EPA, 2000).

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