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North Carolina Protocol for Performing Indirect Exposure Risk Assessments for Hazardous Waste Combustion Units

Prepared for

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APPENDIX A

CONSTITUENT-SPECIFIC PROPERTIES

For the chemical compounds most likely to be emitted and to be of concern, this appendix presents chemical-specific properties. Included in this appendix are physical and chemical properties needed to conduct indirect exposure modeling and chemical-specific health effect criteria or benchmarks.

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Table A-1 Constituents with Carcinogen Slope Factors for Oral Ingestion

CAS Number	Chemical Name
50328	Benzo(a)pyrene
53703	Dibenz(a,h)anthracene
56235	Carbon tetrachloride
56553	Benz(a)anthracene
57749	Chlordane
62500	Ethyl methanesulfonate
62533	Aniline
67663	Chloroform
67721	Hexachloroethane
71432	Benzene
72559	DDE
74873	Methyl chloride (Chloromethane)
75014	Vinyl chloride
75092	Methylene chloride
75218	Ethylene oxide
75252	Bromoform (Tribromomethane)
75274	Bromodichloromethane
75343	Dichloroethane, 1,1-
75354	Dichloroethylene, 1,1-
76448	Heptachlor
78875	Dichloropropane, 1,2-
79005	Trichloroethane, 1,1,2-
79016	Trichloroethylene
79345	Tetrachloroethane, 1,1,2,2-
82688	Pentachloronitrobenzene (PCNB)
87683	Hexachloro-1,3-butadiene
87865	Pentachlorophenol*
88062	Trichlorophenol, 2,4,6-
91225	Quinoline
91941	Dichlorobenzidine, 3,3'-
92875	Benzidine*
94597	Safrole
95534	Toluidine, o- *
96128	Dibromo-3-chloropropane, 1,2-
96457	Ethylene thiourea
98077	Benzotrichloride
100447	Benzyl chloride
103333	Azobenzene
106467	Dichlorobenzene, 1,4-
106490	Toluidine, p- *
106898	Epichlorohydrin
106934	Ethylene Dibromide
107062	Dichloroethane, 1,2-
107131	Acrylonitrile
111444	Bis(2-chlorethyl)ether
117817	Bis(2-ethylhexyl)phthalate
118741	Hexachlorobenzene
119904	Dimethyoxybenzidine, 3,3'- *
122667	1,2-Diphenylhydrazine
123739	Crotonaldehyde
123911	Dioxane, 1,4- **
193395	Indeno(1,2,3-cd) pyrene
205992	Benzo(b)fluoranthene
207089	Benzo(k)fluoranthene
218019	Chrysene
319846	Hexachlorocyclohexane, alpha- (alpha-BHC)
319857	Hexachlorocyclohexane, beta- (beta-BHC)
510156	Chlorobenzilate
542756	Dichloropropene, 1,3-
542881	Bis (chloromethyl)ether
621647	N-Nitrosodi-n-propylamine
630206	Tetrachloroethane, 1,1,1,2-
924163	Nitrosodi-n-butylamine
1336363	Polychlorinated biphenyls
1746016	TCDD, 2,3,7,8-
7487-94-7	Mercuric chloride
7440382	Arsenic
7440417	Beryllium

*Known to ionize under environmental conditions

** Completely miscible; solubility estimated from Henry's Law Constant and Vapor Pressure.

Table A-2 Target Organs and Critical Effect for Constituents with RfDs

Constituent Name	CAS No.	Target Organ	Critical Effect
Formaldehyde	50-00-0	Body weight	Reduced weight gain, histopathology in rats
2,4-Dinitrophenol	51-28-5	Eye	Cataract formation
Tetrachloromethane (carbon tetrachloride)	56-23-5	Liver	Liver lesions
Strychnine and salts	57-24-9	General	Toxicity/histopathology
Chlordane	57-74-9	Liver	Regional liver hypertrophy in females
2,3,4,6-Tetrachlorophenol	58-90-2	Liver	Increased liver weights and centrilobular hypertrophy
Formic acid	64-18-6	Body weight	Decreased rate of growth
Chloroform	67-66-3	Liver	Fatty cyst formation in liver
Hexachloroethane	67-72-1	Kidney	Atrophy and degeneration of the renal tubules
Methoxychlor	72-43-5	Reproductive	Excessive loss of litters
Methyl bromide	74-83-9	GI	Epithelial hyperplasia of the forestomach
Methylene bromide (R-R)	74-95-3	Blood	Increased carboxyhemoglobin (route-to-route)
Methylene chloride	75-09-2	Liver	Liver toxicity
Carbon disulfide	75-15-0	Reproductive	Fetal toxicity / malformations
Bromoform	75-25-2	Liver	Hepatic lesions
Dichlorobromomethane	75-27-4	Kidney	Renal cytomegaly
1,1-Dichloroethane	75-34-3	No effects	No observed adverse effects (route-to-route extrapolation)
1,1-Dichloroethene	75-35-4	Liver	Hepatic lesions
CFC-11	75-69-4	General	Survival and histopatology
Dichlorodifluoromethane [CFC-12]	75-71-8	Body weight	Reduced body weight
Freon 113	76-13-1	neurotoxicity	Psychomotor impairment
Heptachlor	76-44-8	Liver	Liver weight increases in males only
Hexachlorocyclopentadiene	77-47-4	GI	Stomach lesions
Methyl ethyl ketone	78-93-3	Reproductive	Decreased fetal birth weight
1,1,2-Trichloroethane	79-00-5	Blood	Clinical serum chemistry
Pentachloronitrobenzene	82-68-8	Liver	Liver toxicity
Diethyl hexyl phthalate	84-66-2	Body weight	Decreased growth rate, food consumption and altered organ weights
Diethyl hexyl phthalate	84-66-2	Organ weight	Decresed growth rate, food consumption and altered organ weights
Di-n-butyl phthalate	84-74-2	Death	Increased mortality
Phthalic anhydride	85-44-9	Kidney	Lung and histopathology
Phthalic anhydride	85-44-9	Respiratory	Lung and histopathology
Butyl benzyl phthalate	85-68-7	Liver	Significantly increased liver-to-body weight and liver-to-brain weight ratios
Hexachlorobutadiene	87-68-3	Kidney	Renal tubules regeneration
Pentachlorophenol	87-86-5	Kidney	Liver and kidney pathology
Pentachlorophenol	87-86-5	Liver	Liver and kidney pathology
beta-Chloronaphthalene	91-58-7	Respiratory	Dyspnea, abnormal appearance, liver enlargement
1,1-Biphenyl	92-52-4	Kidney	Kidney damage

Table A-2 Target Organs and Critical Effect for Constituents with RfDs

Constituent Name	CAS No.	Target Organ	Critical Effect
2,4-D Acid	94-75-7	Blood	Hematologic, hepatic and renal toxicity
2,4-D Acid	94-75-7	Kidney	Hematologic, hepatic and renal toxicity
2,4-D Acid	94-75-7	Liver	Hematologic, hepatic and renal toxicity
o-Xylene	95-47-6	Neurotoxicity	Hyperactivity
o-Cresol (2-Methylphenol)	95-48-7	Body weight	Decreased body weights and neurotoxicity
o-Cresol (2-Methylphenol)	95-48-7	Neurotoxicity	Decreased body weights and neurotoxicity
o-Chlorotoluene	95-49-8	Body weight	Decrease in body weight gain
o-Dichlorobenzene	95-50-1	No effects	No adverse effects observed
2-Chlorophenol	95-57-8	Reproductive	Reproductive effects
1,2,4,5-Tetrachlorobenzene	95-94-3	Kidney	Kidney lesions
2,4,5-Trichlorophenol	95-95-4	Kidney	Liver and kidney pathology
2,4,5-Trichlorophenol	95-95-4	Liver	Liver and kidney pathology
1,2,3-Trichloropropane	96-18-4	Blood	Alterations in clinical chemisty and reduction in red cell mass
Ethylene thiourea	96-45-7	Thyroid	Increased incidence of thyroid hyperplasia
Ethyl methacrylate	97-63-2	Kidney	Incresed relative weight of hte kidney
Furfural	98-01-1	Liver	Mild hepatocellular vacuolization
Cumene	98-82-8	Kidney	Increased average kidney weight
Acetophenone	98-86-2	General	General toxicity
Nitrobenzene	98-95-3	Adrenal	Hematologic, adrenal, renal and hepatic lesions
Nitrobenzene	98-95-3	Blood	Hematologic, adrenal, renal and hepatic lesions
Nitrobenzene	98-95-3	Liver	Hematologic, adrenal, renal and hepatic lesions
Nitrobenzene	98-95-3	Renal	Hematologic, adrenal, renal and hepatic lesions
sym-Trinitrobenzene	99-35-4	Spleen	Increased splenic weight
1,3-Dinitrobenzene	99-65-0	Spleen	Increased splenic weight
1,4-Dinitrobenzene	100-25-4	Spleen	Increased spleen weight
Ethylbenzene	100-41-4	Kidney	Liver and kidney toxicity
Ethylbenzene	100-41-4	Liver	Liver and kidney toxicity
Styrene	100-42-5	Blood	Red blood cell and liver effects
Styrene	100-42-5	Liver	Red blood cell and liver effects
Benzaldehyde	100-52-7	GI	Forestomach lesions, kidney toxicity
Benzaldehyde	100-52-7	Kidney	Forestomach lesions, kidney toxicity
Dimethylphenol, 2,4-	105-67-9	Neurotoxicity	Nervous system effects
Dimethylphenol, 2,4-	105-67-9	Blood	Blood alterations
p-Cresol	106-44-5	Eye	Ocular discharge
p-Cresol	106-44-5	Neurotoxicity	Hypoactivity
p-Cresol	106-44-5	Respiratory	Respiratory distress
4-Chloroaniline	106-47-8	Spleen	Nonneoplastic lesions of the splenic capsule
Epichlorohydrin	106-89-8	Kidney	Kidney lesions (route-to-route)
1,2-Dibromoethane	106-93-4		
Acrolein	107-02-8	No effects	No adverse effects observed
Acrylonitrile	107-13-1	Reproductive	Decreased sperm counts, seminiferous tubule degeneration

Table A-2 Target Organs and Critical Effect for Constituents with RfDs

Constituent Name	CAS No.	Target Organ	Critical Effect
Propargyl alcohol	107-19-7	Kidney	Renal and hepatotoxicity
Propargyl alcohol	107-19-7	Liver	Renal and hepatotoxicity
Ethylene glycol	107-21-1	Kidney	Kidney toxicity
Propylene glycol monomethyl ether	107-98-2	Kidney	Histopathologic changes of the kidney
Propylene glycol monomethyl ether	107-98-2	Liver	Histopathologic changes of the liver
Vinyl acetate	108-05-4	Body weight	Decreased body weight
Vinyl acetate	108-05-4	Kidney	Altered weight
Methyl isobutyl ketone	108-10-1	Kidney	Increased relative and absolute weight of the kidney and increased urinary protein
Methyl isobutyl ketone	108-10-1	Liver	Increased absolute and relative weights of the liver
Methyl isobutyl ketone	108-10-1	Neurotoxicity	Lethargy
m-Xylene	108-38-3	Body weight	Decreased body weight
m-Xylene	108-38-3	Neurotoxicity	Hyperactivity
3-Methylphenol (m-Cresol)	108-39-4	Body weight	Decreased body weights and neurotoxicity
3-Methylphenol (m-Cresol)	108-39-4	Neurotoxicity	Decreased body weights and neurotoxicity
Toluene	108-88-3	Kidney	Changes in liver and kidney weights
Toluene	108-88-3	Liver	Changes in liver and kidney weights
Chlorobenzene	108-90-7	Liver	Histopathologic changes in liver
Phenol	108-95-2	Reproductive	Reduced fetal body weight in rats
Malononitrile	109-77-3	Liver	Liver effects
Malononitrile	109-77-3	Spleen	Spleen effects
2-Methoxyethanol	109-86-4	Reproductive	Testicular effects (route-to-route)
Furan	110-00-9	Liver	Hepatic lesions
n-Hexane	110-54-3	Neurotoxicity	Neuropathy
n-Hexane	110-54-3	Reproductive	Atrophy of the testis
2-Ethoxyethanol	110-80-5	Body weight	Decreased body weight
Pyridine	110-86-1	Liver	Increased liver weight
Bis(2-ethylhexyl)phthalate	117-81-7	Liver	Increased relative liver weight
Di-N-octyl phthalate	117-84-0	Kidney	Increased kidney weight
Di-N-octyl phthalate	117-84-0	Liver	Increased liver weight; increased SGOT and SGPT activity
Hexachlorobenzene	118-74-1	Liver	Liver effects
Anthracene	120-12-7	No effects	No observed effects
1,2,4-Trichlorobenzene	120-82-1	Adrenal	Increased adrenal weights; vacuolation of zona fasciculata in the cortex
2,4-Dichlorophenol	120-83-2	Immunotoxicity	Decreased delayed hypersensitivity response
2,4-Dinitrotoluene	121-14-2	GI	Neurotoxicity, Heinze bodies and biliary tract hyperplasia

Table A-2 Target Organs and Critical Effect for Constituents with RfDs

Constituent Name	CAS No.	Target Organ	Critical Effect
2,4-Dinitrotoluene	121-14-2	Neurotoxicity	Neurotoxicity, Heinze bodies and biliary tract hyperplasia
Diphenylamine	122-39-4	Body weight	Decreased body weight gain, and increased liver and kidney weights
Diphenylamine	122-39-4	Kidney	Decreased body weight gain, and increased liver and kidney weights
Diphenylamine	122-39-4	Liver	Decreased body weight gain, and increased liver and kidney weights
Malaic hydrazide	123-33-1	Kidney	Renal dysfunction
Methacrylonitrile	126-98-7	Liver	Increased SGOT and SGPT levels
Tetrachloroethene	127-18-4	Liver	Hepatotoxicity in mice, weight gain in rats
Dimethylphthalate	131-11-3	Kidney	Kidney effects
4,6--Dinitro-o-cyclohexyl phenol	131-89-5	Eye	Cataract formation
Endothall	145-73-3	GI	Increased absolute and relative weights fo stomach and small intestine
trans-1,2-Dichloroethene	156-60-5	Blood	Increased serum alkaline phosphatase in male mice
Fluoranthene	206-44-0	Blood	Nephropathy, increased liver weights, hematological alterations and clinical effects
Fluoranthene	206-44-0	Kidney	Nephropathy, increased liver weights, hematological alterations and clinical effects
Fluoranthene	206-44-0	Liver	Nephropathy, increased liver weights, hematological alterations and clinical effects
Cyanogen	460-19-5	Body weight	Weight loss, thyroid effects and myelin degeneration
Cyanogen	460-19-5	Neurotoxicity	Weight loss, thyroid effects and myelin degeneration
Cyanogen	460-19-5	Thyroid	Weight loss, thyroid effects and myelin degeneration
Cyanogen bromide	506-68-3	Body weight	Weight loss, thyroid effects and myelin degeneration
Cyanogen bromide	506-68-3	Neurotoxicity	Weight loss, thyroid effects and myelin degeneration
Cyanogen bromide	506-68-3	Thyroid	Weight loss, thyroid effects and myelin degeneration
Cyanogen chloride	506-77-4	Body weight	Weight loss, thyroid effects and myelin degeneration
Cyanogen chloride	506-77-4	Neurotoxicity	Weight loss, thyroid effects and myelin degeneration
Cyanogen chloride	506-77-4	Thyroid	Weight loss, thyroid effects and myelin degeneration
Chlorobenzilate	510-15-6	GI	Decreased stool quantity, food consumption and body weight gains; hyperirritability
Chlorobenzilate	510-15-6	Neurotoxicity	Decreased stool quantity, food consumption and body weight gains; hyperirritability

Table A-2 Target Organs and Critical Effect for Constituents with RfDs

Constituent Name	CAS No.	Target Organ	Critical Effect
1,2-Dinitrobenzene	528-29-0	Spleen	Increased spleen weight
1,3-Dichloropropene	542-75-6		
Bis (chloromethyl)ether	542-88-1	Organ weights	Increased organ weights
2,6-Dinitrotoluene	606-20-2	Blood	Heinze bodies, methemoglobinemia
2,6-Dinitrotoluene	606-20-2	GI	Hyperplasia of the bile duct
2,6-Dinitrotoluene	606-20-2	Kidney	Histopathologic changes in the kidney
2,6-Dinitrotoluene	606-20-2	Neurotoxicity	Neurotoxic effects
Pentachlorobenzene	608-93-5	Kidney	Liver and kidney toxicity
Pentachlorobenzene	608-93-5	Liver	Liver and kidney toxicity
N-Nitrosodi-n-propylamine	621-64-7		
Tetrachloroethane, 1,1,1,2-	630-20-6	Kidney	Mineralization of the kidneys in males, Hepatic clear cell change in females
Tetrachloroethane, 1,1,1,2-	630-20-6	Liver	Mineralization of the kidneys in males, Hepatic clear cell change in females
Glycidaldehyde	765-34-4	Adrenal	Weght gain retardation, enlarged adrenals, hydropic renal pelvis and hematropoietic effects
Glycidaldehyde	765-34-4	Blood	Weght gain retardation, enlarged adrenals, hydropic renal pelvis and hematropoietic effects
Glycidaldehyde	765-34-4	Body weight	Weight gain retardation, enlarged adrenals, hydropic renal pelvis and hematropoietic effects
Toluene-2,6-diamine	823-40-5	No effects	No adverse effects observed
Xylenes	1330-20-7	Body weight	Hyperactivity, decreased body weight and increased mortality
Xylenes	1330-20-7	Neurotoxicity	Hyperactivity, decreased body weight and increased mortality
Nickel, soluble salts	7440-02-0	Body weight	Decreased body weight and organ weights
Nickel, soluble salts	7440-02-0	Organ weights	Decreased body weight and organ weights
Silver	7440-22-4	Skin	Argyria
Antimony	7440-36-0	Blood	Blood glucose and cholesterol, longevity
Arsenic, inorganic	7440-38-2	Skin	Hyperpigmentation, keratosis and possible vascular complications
Barium	7440-39-3	Blood pressure	Increased blood pressure
Beryllium	7440-41-7	No effects	No adverse effects observed
Cadmium	7440-43-9	Kidney	Significant proteinuria
Mercury chloride (divalent)	7439-97-6	Kidney	Kidney effects
Zinc	7440-66-6	Blood	Decrease ESOD concentration
Ammonia	7664-41-7	Sensory	Taste threshold
Selenium	7782-49-2	Respiratory	Clinical selenosis
Chlorine	7782-50-5	No effects	No observed effects
Methyl mercury	22967-92-6	Neurotoxicity	CNS effects

Table A-3 Physical and Chemical Properties Data

CAS Number	Chemical Name	Chemical Type	Physical-Chemical Properties: Koc (mL/g)	Kds *** (mL/g)	Kow (unitless)	Ambient Vapor Pressure (atm)	Fv values (unitless)	Solubility (mg/L)	Molecular weight (g/mol)	Henry's Law constant (atm-m3/mol)	Diffusion coefficient in water (cm2/s)	Diffusion coefficient in air (cm2/s)
50-00-0	Formaldehyde	Organic	8.9E-01	varies	8.9E-01	6.9E+00	1.00	5.5E+05	30.03	3.4E-07	2.0E-05	1.8E-01
50-32-8	Benzo(a)pyrene	Organic	1.0E+06	varies	1.3E+06	7.2E-12	0.37	1.6E-03	252.32	1.1E-06	9.0E-06	4.3E-02
51-28-5	Dinitrophenol, 2,4-	Organic	3.3E+01	varies	3.5E+01	6.7E-06	1.00	2.8E+03	184.11	4.4E-07	9.1E-06	2.7E-02
53-70-3	Dibenz(a,h)anthracene	Organic	3.8E+06	varies	4.9E+06	1.3E-13	0.10	2.5E-03	278.35	1.5E-08	5.2E-06	2.0E-02
56-23-5	Carbon tetrachloride	Organic	4.8E+02	varies	5.4E+02	1.5E-01	1.00	7.9E+02	153.82	3.0E-02	8.8E-06	7.8E-02
56-55-3	Benz(a)anthracene	Organic	4.0E+05	varies	5.0E+05	1.4E-10	0.55	9.4E-03	228.29	3.4E-06	9.0E-06	6.1E-02
57-74-9	Chlordane	Organic	1.6E+06	varies	2.1E+06	1.3E-08	1.00	5.6E-02	409.78	4.9E-05	4.4E-06	1.2E-02
58-90-2	Tetrachlorophenol, 2,3,4,6-	Organic	2.3E+04	varies	2.8E+04	1.9E-06	1.00	1.0E+02	231.89	4.4E-06	7.1E-06	2.2E-02
62-50-0	Ethyl methanesulfonate	Organic	1.1E+00	varies	1.1E+00	2.7E-04	1.00	6.3E+03	124.16	5.3E-06	8.0E-06	8.0E-02
62-53-3	Aniline	Organic	9.2E+00	varies	9.5E+00	6.4E-04	1.00	3.6E+04	93.13	1.9E-06	8.3E-06	7.0E-02
64-18-6	Formic Acid*	Organic	2.9E-01	varies	2.9E-01	5.6E-02	1.00	1.0E+06	46.03	1.7E-07	1.4E-06	7.9E-02
67-66-3	Chloroform	Organic	7.7E+01	varies	8.3E+01	2.6E-01	1.00	7.9E+03	119.38	3.7E-03	1.0E-05	1.0E-01
67-72-1	Hexachloroethane	Organic	8.6E+03	varies	1.0E+04	2.8E-04	1.00	5.0E+01	236.74	3.9E-03	6.8E-06	2.5E-03
70-30-4	Hexachlorophene*	Organic	2.6E+07	varies	3.5E+07	2.0E-13	0.01	1.4E+02	406.91	5.5E-13	8.0E-06	8.0E-02
71-43-2	Benzene	Organic	1.2E+02	varies	1.3E+02	1.3E-01	1.00	1.8E+03	78.11	5.6E-03	9.8E-06	8.8E-02
72-43-5	Methoxychlor	Organic	9.9E+04	varies	1.2E+05	7.9E-10	0.89	4.5E-02	345.65	1.6E-05	4.5E-06	1.6E-02
72-55-9	DDE	Organic	4.4E+06	varies	5.8E+06	7.9E-09	0.99	1.2E-01	318.03	2.1E-05	5.9E-06	1.4E-02
74-83-9	Methyl bromide (Bromomethane)	Organic	1.5E+01	varies	1.5E+01	2.1E+00	1.00	1.5E+04	94.94	6.2E-03	1.2E-05	7.3E-02
74-87-3	Methyl chloride (Chloromethane)	Organic	7.8E+00	varies	8.1E+00	5.7E+00	1.00	5.3E+03	50.49	8.8E-03	6.5E-06	1.3E-01
74-95-3	Methylene bromide	Organic	3.9E+01	varies	4.2E+01	5.8E-02	1.00	1.2E+04	173.83	8.6E-04	8.4E-06	3.2E-02
75-01-4	Vinyl chloride	Organic	3.0E+01	varies	3.2E+01	3.9E+00	1.00	2.8E+03	62.5	2.7E-02	1.2E-05	1.1E-01
75-09-2	Methylene chloride	Organic	1.7E+01	varies	1.8E+01	5.7E-01	1.00	1.3E+04	84.93	2.2E-03	1.2E-05	1.0E-01
75-15-0	Carbon disulfide	Organic	9.3E+01	varies	1.0E+02	4.7E-01	1.00	1.2E+03	76.14	3.0E-02	1.0E-05	1.0E-01
75-21-8	Ethylene oxide	Organic	5.1E-01	varies	5.0E-01	1.4E+00	1.00	3.8E+05	44.06	1.2E-04	1.5E-05	1.0E-01
75-25-2	Bromoform (Tribromomethane)	Organic	2.0E+02	varies	2.2E+02	7.3E-03	1.00	3.1E+03	252.73	6.5E+00	1.0E-05	1.5E-02
75-27-4	Bromodichloromethane	Organic	1.2E+02	varies	1.3E+02	6.6E-02	1.00	6.7E+03	163.83	1.6E-03	1.1E-05	3.0E-02
75-29-6	2-Chloropropane	Organic	NA	varies	NA	6.9E-01	1.00	3.1E+03	78.54	1.7E-02	1.0E-05	1.2E-01
75-34-3	Dichloroethane, 1,1-	Organic	5.8E+01	varies	6.2E+01	3.0E-01	1.00	5.1E+03	98.96	5.6E-03	1.1E-05	7.4E-02
75-35-4	Dichloroethylene, 1,1- (Vinylidene chloride)	Organic	1.2E+02	varies	1.3E+02	7.9E-01	1.00	2.3E+03	96.94	2.6E-02	1.0E-05	9.0E-02
75-69-4	Trichlorofluoromethane	Organic	3.1E+02	varies	3.4E+02	1.1E+00	1.00	1.1E+03	137.37	9.7E-02	9.7E-06	8.7E-02
75-71-8	Dichlorodifluoromethane	Organic	1.3E+02	varies	1.4E+02	6.4E+00	1.00	2.8E+02	120.91	3.4E-01	8.0E-06	8.0E-02
76-13-1	Trichloro-1,2,2-trifluoroethane, 1,1,2-	Organic	1.3E+03	varies	1.4E+03	4.4E-01	1.00	1.7E+02	187.38	4.8E-01	8.2E-06	7.8E-02
76-44-8	Heptachlor	Organic	1.4E+06	varies	1.8E+06	5.3E-07	1.00	1.8E-01	373.32	1.5E+00	5.7E-06	1.1E-02
77-47-4	Hexachlorocyclopentadiene	Organic	2.0E+05	varies	2.5E+05	1.1E-04	1.00	1.8E+00	272.77	2.7E-02	6.2E-06	5.6E-02

*Known to ionize under environmental conditions

** Completely miscible; solubility estimated from HLC and Vapor Pressure.

*** See App. A Reference No. 2, 3, and 4 to calc. Kds, Kdsw, Kdbs.

Table A-3 Physical and Chemical Properties Data

CAS Number	Chemical Name	Physical-Chemical Properties: Chemical Type	Koc (mL/g)	Kds *** (mL/g)	Kow (unitless)	Ambient Vapor Pressure (atm)	Fv values (unitless)	Solubility (mg/L)	Molecular weight (g/mol)	Henry's Law constant (atm-m3/mol)	Diffusion coefficient in water (cm2/s)	Diffusion coefficient in air (cm2/s)
78-87-5	Dichloropropane, 1,2-	Organic	8.6E+01	varies	9.3E+01	6.8E-02	1.00	2.8E+03	112.99	2.8E-03	8.7E-06	7.8E-02
78-93-3	Methyl ethyl ketone	Organic	1.9E+00	varies	1.9E+00	1.3E-01	1.00	2.2E+05	72.11	5.6E-05	9.8E-06	8.1E-02
79-00-5	Trichloroethane, 1,1,2-	Organic	1.0E+02	varies	1.1E+02	3.1E-02	1.00	4.4E+03	133.4	9.1E-04	8.8E-06	7.8E-02
79-01-6	Trichloroethylene	Organic	4.6E+02	varies	5.1E+02	9.7E-02	1.00	1.1E+03	131.39	1.0E-02	9.1E-06	7.9E-02
79-34-5	Tetrachloroethane, 1,1,2,2-	Organic	2.2E+02	varies	2.5E+02	6.1E-03	1.00	3.0E+03	167.85	3.5E-04	7.9E-06	7.1E-02
82-68-8	Pentachloronitrobenzene (PCNB)	Organic	3.6E+04	varies	4.4E+04	1.5E-07	1.00	5.5E-01	295.34	3.8E-04	6.1E-06	1.6E-02
84-66-2	Diethyl phthalate	Organic	2.9E+02	varies	3.2E+02	2.2E-06	1.00	1.1E+03	222.24	4.5E-07	6.4E-06	2.6E-02
84-74-2	Di-n-butyl phthalate	Organic	3.4E+04	varies	4.1E+04	9.6E-08	0.99	1.1E+01	278.35	9.4E-10	7.9E-06	4.4E-02
85-44-9	Phthalic anhydride	Organic	2.5E-01	varies	2.4E-01	6.8E-07	1.00	6.2E+03	148.12	1.6E-08	9.6E-06	7.1E-02
85-68-7	Butylbenzylphthalate	Organic	5.7E+04	varies	6.9E+04	1.1E-08	0.95	2.7E+00	312.37	1.3E-06	4.9E-06	1.7E-02
87-68-3	Hexachloro-1,3-butadiene	Organic	5.4E+04	varies	6.5E+04	2.9E-04	1.00	3.2E+00	260.76	8.2E-03	6.2E-06	5.6E-02
87-86-5	Pentachlorophenol*	Organic	1.0E+05	varies	1.2E+05	4.2E-08	1.00	2.0E+03	266.34	2.4E-08	6.1E-06	5.6E-02
88-06-2	Trichlorophenol, 2,4,6-	Organic	4.3E+03	varies	5.0E+03	3.2E-05	1.00	8.0E+02	197.45	7.8E-06	6.4E-06	3.1E-02
91-20-3	Naphthalene	Organic	2.0E+03	varies	2.3E+03	1.1E-04	1.00	3.1E+01	128.17	4.8E-04	7.5E-06	5.9E-02
91-22-5	Quinoline	Organic	1.0E+02	varies	1.1E+02	1.3E-04	1.00	6.1E+03	129.16	2.7E-06	8.3E-06	5.5E-02
91-58-7	2-chloronaphthalene	Organic	1.2E+04	varies	1.4E+04	1.1E-05	1.00	1.2E+01	162.62	3.1E-04	8.8E-06	3.5E-02
91-94-1	Dichlorobenzidine, 3,3'-	Organic	2.8E+03	varies	3.2E+03	4.9E-11	0.59	3.1E+00	253.13	4.0E-09	6.7E-06	1.9E-02
92-52-4	1,1-Biphenyl	Organic	7.8E+03	varies	9.1E+03	1.3E-05	1.00	6.0E+00	154.21	3.0E-04	8.2E-06	4.0E-02
94-59-7	Safrole	Organic	4.1E+02	varies	4.6E+02	9.3E-05	1.00	8.1E+02	162.19	1.9E-05	7.2E-06	4.1E-02
94-75-7	Dichlorophenoxyacetic acid, 2,4- (2,4 D)*	Organic	4.5E+02	varies	5.0E+02	7.9E-10	0.96	6.8E+02	221.04	1.0E-08	6.5E-06	5.9E-02
95-47-6	o-Xylene	Organic	1.2E+03	varies	1.3E+03	8.7E-03	1.00	1.8E+02	106.17	5.2E-03	1.0E-05	8.7E-02
95-48-7	Cresol, o-	Organic	9.0E+01	varies	9.8E+01	3.9E-04	1.00	2.6E+04	108.14	1.2E-06	8.3E-06	7.4E-02
95-50-1	Dichlorobenzene, 1,2-	Organic	2.4E+03	varies	2.7E+03	1.8E-03	1.00	1.6E+02	147	1.9E-03	7.9E-06	6.9E-02
95-53-4	Toluidine, o- *	Organic	2.1E+01	varies	2.2E+01	4.2E-04	1.00	1.7E+04	107.16	2.7E-06	9.1E-06	7.1E-02
95-57-8	Chlorophenol, 2-	Organic	1.3E+02	varies	1.4E+02	3.1E-03	1.00	2.2E+04	128.56	3.9E-04	9.5E-06	5.0E-02
95-94-3	Tetrachlorobenzene, 1,2,4,5-	Organic	3.6E+04	varies	4.4E+04	7.1E-06	1.00	6.0E-01	215.89	2.6E-03	8.8E-06	2.1E-02
95-95-4	Trichlorophenol, 2,4,5-	Organic	6.8E+03	varies	7.9E+03	2.6E-05	1.00	1.2E+03	197.45	4.3E-06	7.0E-06	2.9E-02
96-12-8	Dibromo-3-chloropropane, 1,2-	Organic	2.0E+02	varies	2.2E+02	7.6E-04	1.00	1.2E+03	236.33	1.5E-04	7.0E-06	2.1E-02
96-18-4	Trichloropropane, 1,2,3-	Organic	1.6E+02	varies	1.8E+02	4.9E-03	1.00	1.8E+03	147.43	4.1E-04	7.9E-06	7.1E-02
96-45-7	Ethylene thiourea	Organic	2.2E-01	varies	2.2E-01	1.8E-07	1.00	6.2E+04	102.16	3.1E-10	1.0E-05	7.2E-02
97-63-2	Ethyl methacrylate	Organic	3.7E+01	varies	3.9E+01	2.7E-02	1.00	3.7E+03	114.14	8.4E-04	8.0E-06	8.0E-02
98-01-1	Furfural	Organic	2.5E+00	varies	2.6E+00	2.9E-03	1.00	1.1E+05	96.09	4.0E-06	1.0E-05	6.7E-02
98-07-7	Benzotrichloride	Organic	7.4E+02	varies	8.3E+02	3.0E-04	1.00	1.7E+01	195.48	3.6E-03	7.8E-06	2.8E-02
98-82-8	Cumene	Organic	3.3E+03	varies	3.8E+03	5.9E-03	1.00	6.1E+01	120.19	1.2E+00	7.1E-06	8.6E-02
98-86-2	Acetophenone	Organic	4.1E+01	varies	4.4E+01	5.2E-04	1.00	6.1E+03	120.15	1.1E-05	8.7E-06	6.0E-02

*Known to ionize under environmental conditions

** Completely miscible; solubility estimated from HLC and Vapor Pressure.

*** See App. A Reference No. 2, 3, and 4 to calc. Kds, Kdsw, Kdbs.

Table A-3 Physical and Chemical Properties Data

CAS Number	Chemical Name	Physical-Chemical Properties										
		Chemical Type	Koc (mL/g)	Kds *** (mL/g)	Kow (unitless)	Ambient Vapor Pressure (atm)	Fv values (unitless)	Solubility (mg/L)	Molecular weight (g/mol)	Henry's Law constant (atm-m3/mol)	Diffusion coefficient in water (cm2/s)	Diffusion coefficient in air (cm2/s)
98-95-3	Nitrobenzene	Organic	6.4E+01	varies	6.9E+01	3.2E-04	1.00	2.1E+03	123.11	2.4E-05	8.6E-06	7.6E-02
99-35-4	Trinitrobenzene, sym-	Organic	1.4E+01	varies	1.5E+01	2.6E-08	1.00	3.5E+02	213.11	1.6E-08	6.2E-06	2.8E-02
99-65-0	Dinitrobenzene, 1,3-	Organic	3.0E+01	varies	3.2E+01	1.2E-06	1.00	8.6E+02	168.11	2.3E-07	7.6E-06	2.8E-01
100-25-4	1,4-Dinitrobenzene	Organic	NA	varies	NA	NA	1.00	NA	168.111	NA	7.6E-06	2.8E-01
100-41-4	Ethylbenzene	Organic	1.2E+03	varies	1.4E+03	1.3E-02	1.00	1.7E+02	106.17	7.9E-03	7.8E-06	7.5E-02
100-42-5	Stryene	Organic	7.8E+02	varies	8.7E+02	8.1E-03	1.00	3.1E+02	104.15	2.8E-03	8.0E-06	7.1E-02
100-44-7	Benzyl chloride	Organic	1.8E+02	varies	2.0E+02	1.7E-03	1.00	5.3E+02	126.59	4.2E-04	7.8E-06	7.5E-02
100-52-7	Benzaldehyde	Organic	2.6E+01	varies	3.0E+01	1.3E-03	1.00	3.3E+03	106.13	4.2E-05	9.1E-06	7.3E-02
105-67-9	Dimethylphenol, 2,4-	Organic	2.1E+02	varies	2.3E+02	1.6E-04	1.00	NA	122.16	3.3E-06	8.0E-06	8.0E-02
106-44-5	Cresol, p-	Organic	8.3E+01	varies	8.9E+01	1.4E-04	1.00	2.2E+04	108.14	7.9E-07	1.0E-05	7.4E-02
106-46-7	Dichlorobenzene, 1,4-	Organic	2.3E+03	varies	2.6E+03	1.3E-03	1.00	7.4E+01	147	2.4E-03	7.9E-06	6.9E-02
106-47-8	Chloroaniline, p-	Organic	6.6E+01	varies	7.1E+01	1.6E-05	1.00	5.3E+03	127.57	3.3E-07	1.0E-05	4.8E-02
106-49-0	Toluidine, p- *	Organic	2.4E+01	varies	2.5E+01	2.3E-04	1.00	7.8E+02	107.16	NA	9.4E-06	7.0E-02
106-51-4	Quinone	Organic	1.3E+00	varies	1.6E+00	1.2E-04	1.00	NA	108.09	NA	8.0E-06	8.0E-02
106-89-8	Epichlorohydrin	Organic	1.8E+00	varies	1.8E+00	2.2E-02	1.00	6.6E+04	92.53	3.0E-05	9.8E-06	8.6E-02
106-93-4	Ethylene Dibromide	Organic	8.5E+01	varies	9.1E+01	1.8E-02	1.00	4.2E+03	187.86	7.4E-04	1.2E-05	2.2E-02
107-02-8	Acrolein	Organic	9.8E-01	varies	9.8E-01	3.6E-01	1.00	2.1E+05	56.06	1.2E-04	1.2E-05	1.1E-01
107-06-2	Dichloroethane, 1,2-	Organic	2.8E+01	varies	3.0E+01	1.0E-01	1.00	8.5E+03	98.96	9.8E-04	9.9E-06	1.0E-01
107-13-1	Acrylonitrile	Organic	1.8E+00	varies	1.8E+00	1.4E-01	1.00	7.4E+04	53.06	1.0E-04	1.3E-05	1.2E-01
107-19-7	Propargyl alcohol	Organic	NA	varies	NA	4.2E-02	1.00	5.6E+06	56.0646	4.2E-07	1.3E-05	1.8E-01
107-21-1	Ethylene glycol	Organic	4.6E-02	varies	4.4E-02	1.2E-04	1.00	1.0E+06	62.07	6.0E-08	1.2E-05	1.1E-01
107-98-2	Propylene glycol monomethyl ether	Organic	NA	varies	NA	NA	1.00	NA	90.123	NA	8.0E-06	8.0E-02
108-05-4	vinyl acetate	Organic	5.2E+00	varies	5.4E+00	1.2E-01	1.00	2.0E+04	86.09	5.1E-04	8.5E-02	9.2E-06
108-10-1	Methyl isobutyl ketone	Organic	1.5E+01	varies	1.5E+01	2.6E-02	1.00	1.9E+04	100.16	1.4E-04	7.8E-06	7.5E-02
108-38-3	m-Xylene	Organic	1.4E+03	varies	1.6E+03	1.1E-02	1.00	1.6E+02	106.17	7.3E-03	7.8E-06	7.0E-02
108-39-4	Cresol, m-	Organic	8.6E+01	varies	9.3E+01	1.8E-04	1.00	2.3E+04	108.14	8.7E-07	1.0E-05	7.4E-02
108-88-3	Toluene	Organic	5.1E+02	varies	5.6E+02	3.7E-02	1.00	5.3E+02	92.14	6.6E-03	8.6E-06	8.7E-02
108-90-7	Chlorobenzene	Organic	6.5E+02	varies	7.2E+02	1.6E-02	1.00	4.7E+02	112.56	3.7E-03	8.7E-06	7.3E-02
108-95-2	Phenol	Organic	2.9E+01	varies	3.0E+01	3.6E-04	1.00	8.3E+04	94.11	4.0E-07	9.1E-06	8.2E-02
109-77-3	Malononitrile	Organic	3.2E-01	varies	3.2E-01	6.0E-04	1.00	NA	66.06	NA	8.0E-06	8.0E-02
109-86-4	2-Methoxyethanol	Organic	1.8E-01	varies	1.7E-01	8.2E-03	1.00	1.0E+06	76.09	2.9E-03	8.0E-06	8.0E-02
110-54-3	n-Hexane	Organic	8.6E+03	varies	1.0E+04	2.0E-01	1.00	1.2E+01	86.18	1.4E-02	7.8E-06	2.0E-01
110-80-5	Ethoxyethanol, 2- **	Organic	8.0E-01	varies	7.9E-01	7.0E-03	1.00	1.0E+06	90.12	1.2E-07	9.6E-06	9.5E-02
110-86-1	Pyridine**	Organic	4.6E+00	varies	4.7E+00	2.7E-02	1.00	1.0E+06	79.1	8.9E-06	7.6E-06	9.1E-02
111-44-4	Bis(2-chlorethyl)ether	Organic	1.5E+01	varies	1.6E+01	2.0E-03	1.00	1.7E+04	143.01	1.8E-05	7.5E-06	6.9E-02
117-81-7	Bis(2-ethylhexyl)phthalate	Organic	1.5E+07	varies	2.0E+07	8.5E-09	0.93	3.3E-01	390.56	1.0E-07	3.7E-06	3.5E-02

*Known to ionize under environmental conditions

** Completely miscible; solubility estimated from HLC and Vapor Pressure.

*** See App. A Reference No. 2, 3, and 4 to calc. Kds, Kdsw, Kdbs.

Table A-3 Physical and Chemical Properties Data

CAS Number	Chemical Name	Physical-Chemical Properties: Chemical Type	Koc (mL/g)	Kds *** (mL/g)	Kow (unitless)	Ambient Vapor Pressure (atm)	Fv values (unitless)	Solubility (mg/L)	Molecular weight (g/mol)	Henry's Law constant (atm-m3/mol)	Diffusion coefficient in water (cm2/s)	Diffusion coefficient in air (cm2/s)
117-84-0	Di-n-octyl phthalate	Organic	8.4E+07	varies	1.1E+08	3.4E-09	0.85	2.0E-02	390.56	6.7E-05	3.6E-06	1.5E-02
118-74-1	Hexachlorobenzene	Organic	6.2E+05	varies	7.8E+05	2.4E-08	1.00	6.2E+00	284.78	1.3E-03	5.9E-06	6.4E-02
119-90-4	Dimethyoxybenzidine, 3,3'- *	Organic	6.0E+01	varies	6.5E+01	2.8E-10	0.98	6.0E+01	244.29	1.8E-13	5.5E-06	2.4E-02
120-12-7	Anthracene	Organic	3.0E+04	varies	3.5E+04	3.5E-09	1.00	4.3E-02	178.23	6.5E-05	7.7E-06	3.2E-02
120-82-1	Trichlorobenzene, 1,2,4-	Organic	8.8E+03	varies	1.0E+04	5.7E-04	1.00	3.0E+02	181.45	1.4E-03	8.2E-06	3.0E-02
120-83-2	Dichlorophenol, 2,4-	Organic	1.1E+03	varies	1.2E+03	8.8E-05	1.00	4.5E+03	163	3.2E-06	8.8E-06	3.5E-02
121-14-2	Dinitrotoluene, 2,4-	Organic	9.5E+01	varies	1.0E+02	1.9E-07	1.00	2.7E+02	182.14	9.3E-08	7.1E-06	2.0E-01
122-39-4	Diphenylamine*	Organic	2.6E+03	varies	3.0E+03	8.8E-07	1.00	3.6E+01	169.23	5.0E-07	6.3E-06	6.8E-02
122-66-7	1,2-Diphenylhydrazine	Organic	7.8E+02	varies	8.7E+02	5.7E-07	1.00	6.8E+01	184.24	1.5E-06	7.4E-06	3.2E-02
123-33-1	Malaic hydrazide	Organic	1.9E-01	varies	1.8E-01	6.2E+01	1.00	6.0E+03	112.09	6.6E-03	8.0E-06	8.0E-02
123-73-9	Crotonaldehyde	Organic	NA	varies	NA	2.5E-02	1.00	1.5E+05	70.0842	1.2E-05	1.0E-05	2.0E-02
123-91-1	Dioxane, 1,4- **	Organic	4.1E-01	varies	4.1E-01	5.0E-02	1.00	1.0E+06	88.11	4.8E-06	1.0E-05	2.3E-01
126-98-7	Methacrylonitrile	Organic	3.4E+00	varies	3.5E+00	9.4E-02	1.00	2.5E+04	67.09	2.5E-04	8.0E-06	8.0E-02
127-18-4	Tetrachloroethylene	Organic	4.2E+02	varies	4.7E+02	2.4E-02	1.00	2.0E+02	165.83	1.8E-02	8.2E-06	7.2E-02
131-11-3	Dimethyl phthalate	Organic	3.5E+01	varies	3.7E+01	2.2E-06	1.00	4.0E+03	194.19	1.1E-07	6.3E-06	6.7E-02
131-89-5	4,6--Dinitro-o-cyclohexyl phenol	Organic	NA	varies	NA	NA	1.00	NA	194.177	NA	5.9E-06	2.0E-02
145-73-3	Endothall	Organic	2.9E-01	varies	2.8E-01	2.3E-07	1.00	2.1E+04	232.14	2.6E-10	8.0E-06	8.0E-02
156-60-5	Dichloroethylene, trans-1,2-	Organic	1.1E+02	varies	1.2E+02	4.4E-01	1.00	6.3E+03	96.94	9.4E-03	1.2E-05	7.0E-02
193-39-5	Indeno(1,2,3-cd) pyrene	Organic	3.4E+06	varies	4.5E+06	1.3E-13	0.01	2.2E-05	276.34	1.6E-06	5.7E-06	2.0E-02
205-99-2	Benzo(b)fluoranthene	Organic	1.2E+06	varies	1.6E+06	6.6E-10	0.98	1.5E-03	252.32	1.1E-04	5.6E-06	2.3E-02
206-44-0	Fluoranthene	Organic	1.1E+05	varies	1.3E+05	1.0E-08	0.99	2.1E-01	202.26	1.6E-05	6.4E-06	3.0E-02
207-08-9	Benzo(k)fluoranthene	Organic	1.2E+06	varies	1.6E+06	2.6E-12	0.37	8.0E-04	252.32	8.3E-07	5.6E-06	2.3E-02
218-01-9	Chrysene	Organic	4.0E+05	varies	5.0E+05	8.2E-12	0.83	1.6E-03	228.29	9.5E-05	6.2E-06	2.5E-02
319-84-6	Hexachlorocyclohexane, alpha- (alpha-BHC)	Organic	5.4E+03	varies	6.3E+03	5.9E-08	1.00	2.0E+00	290.83	1.1E-05	5.6E-06	1.8E-02
319-85-7	Hexachlorocyclohexane, beta- (beta-BHC)	Organic	5.6E+03	varies	6.5E+03	6.1E-10	1.00	2.4E-01	290.83	7.4E-07	5.6E-06	1.8E-02
460-19-5	Cyanogen	Non-metal	1.2E+00	varies	1.2E+00	5.7E+00	1.00	8.5E+03	52.04	NA	1.4E-05	2.0E-01
506-68-3	Cyanogen bromide	Non-metal	NA	varies	NA	2.4E-01	1.00	NA	105.92	NA	1.1E-05	6.2E-02
506-77-4	Cyanogen chloride	Non-metal	NA	varies	NA	1.6E+00	1.00	NA	61.47	NA	1.6E-05	1.4E-01
510-15-6	Chlorobenzilate	Organic	2.0E+04	varies	2.4E+04	2.6E-09	0.81	1.1E+01	325.19	NA	5.8E-06	1.4E-02
528-29-0	1,2-Dinitrobenzene	Organic	4.6E+01	varies	4.9E+01	NA	1.00	NA	168.1062	NA	8.0E-06	8.0E-02
542-75-6	Dichloropropene, 1,3-	Organic	9.3E+01	varies	1.0E+02	4.5E-02	1.00	2.8E+03	110.98	1.8E-02	1.0E-05	6.3E-02
542-88-1	Bis (chloromethyl)ether	Organic	1.1E+01	varies	1.1E+01	3.9E-02	1.00	NA	114.96	1.2E-04	9.4E-06	6.0E-02
606-20-2	Dinitrotoluene, 2,6-	Organic	6.9E+01	varies	7.4E+01	7.5E-07	1.00	1.8E+02	182.14	7.5E-07	7.3E-06	3.3E-02
608-93-5	Pentachlorobenzene	Organic	1.5E+05	varies	1.8E+05	2.9E-06	1.00	1.3E+00	250.34	7.1E-04	6.3E-06	6.7E-02

*Known to ionize under environmental conditions

** Completely miscible; solubility estimated from HLC and Vapor Pressure.

*** See App. A Reference No. 2, 3, and 4 to calc. Kds, Kdsw, Kdbs.

Table A-3 Physical and Chemical Properties Data

CAS Number	Chemical Name	Physical-Chemical Properties										
		Chemical Type	Koc (mL/g)	Kds *** (mL/g)	Kow (unitless)	Ambient Vapor Pressure (atm)	Fv values (unitless)	Solubility (mg/L)	Molecular weight (g/mol)	Henry's Law constant (atm-m3/mol)	Diffusion coefficient in water (cm2/s)	Diffusion coefficient in air (cm2/s)
621-64-7	N-Nitrosodi-n-propylamine	Organic	2.4E+01	varies	2.5E+01	1.7E-04	1.00	9.9E+03	130.19	2.3E-06	8.9E-06	5.1E-02
630-20-6	Tetrachloroethane, 1,1,1,2-	Organic	3.9E+02	varies	4.3E+02	1.6E-02	1.00	1.1E+03	167.85	2.4E-03	7.9E-06	7.1E-02
765-34-4	Glycidaldehyde	Organic	1.9E-01	varies	1.9E-01	3.6E-02	1.00	1.0E+06	72.06	5.1E-07	8.0E-06	8.0E-02
823-40-5	Toluene-2,6-diamine	Organic	NA	varies	NA	NA	1.00	NA	122.17	NA	9.2E-06	5.5E-02
924-16-3	Nitrosodi-n-butylamine	Organic	2.3E+02	varies	2.6E+02	3.9E-05	1.00	1.3E+03	158.24	3.2E-04	8.0E-06	8.0E-02
1330-20-7	Xylenes (total)	Organic	1.3E+03	varies	1.5E+03	1.1E-02	1.00	1.9E+02	106.17	6.0E-03	9.3E-06	7.1E-02
1336-36-3	Polychlorinated biphenyls (Total)	Organic	3.1E+05	varies	3.8E+05	4.9E-04	1.00	7.0E-01	328	2.3E-01	1.0E-05	8.0E-02
1746-01-6	TCDD, 2,3,7,8- TEQ	Organic	1.4E+07	varies	3.4E+06	2.0E-12	0.27	7.9E-06	321.96	7.9E-05	5.8E-06	1.4E-02
7439-92-1	Lead *	Metal	NA	2.8E+05	NA	0.0E+00	0.00	0.0E+00	207.21	NA	NA	NA
7439-97-6	Mercury (elemental)	Hg	NA	9.5E+04	NA	2.6E-06	1.00	6.0E-02	200.59	7.1E-02	6.3E-06	3.1E-02
7440-02-0	Nickel	Metal	NA	8.2E+01	NA	0.0E+00	0.00	0.0E+00	58.69	NA	NA	NA
7440-22-4	Silver	Metal	NA	4.0E-01	NA	0.0E+00	0.00	NA	107.87	NA	NA	NA
7440-28-0	Thallium (I)	Metal	NA	7.4E+01	NA	0.0E+00	0.00	0.0E+00	204.38	NA	NA	NA
7440-36-0	Antimony	Metal	NA	2.0E+00	NA	0.0E+00	0.00	NA	121.75	NA	NA	NA
7440-38-2	Arsenic	Metal	NA	2.9E+01	NA	0.0E+00	0.00	0.0E+00	74.92	NA	NA	NA
7440-39-3	Barium	Metal	NA	5.3E+02	NA	0.0E+00	0.00	NA	137.33	NA	NA	NA
7440-41-7	Beryllium	Metal	NA	7.0E+01	NA	0.0E+00	0.00	NA	9.01	NA	NA	NA
7440-43-9	Cadmium	Metal	NA	1.6E+02	NA	0.0E+00	0.00	0.0E+00	112.41	NA	NA	NA
7440-47-3	Chromium VI	Metal	NA	1.8E+01	NA	0.0E+00	0.00	0.0E+00	52.00	NA	NA	NA
7440-66-6	Zinc	Metal	NA	4.0E+01	NA	NA	0.00	NA	65.38	NA	NA	NA
7487-94-7	Mercuric chloride (divalent)	Hg	NA	1.5E+02	6.0E-01	1.6E-07	1.00	6.9E+04	271.52	7.1E-10	NA	NA
7647-01-0	Hydrogen chloride	Non-metal	NA	NA	NA	4.7E+01	1.00	NA	36.46	NA	NA	NA
7664-41-7	Ammonia	Non-metal	NA	NA	NA	1.0E+01	1.00	5.3E+05	17.03	3.2E-04	6.9E-05	2.6E-01
7782-49-2	Selenium	Metal	NA	4.3E+00	NA	0.0E+00	0.00	0.0E+00	78.96	NA	NA	NA
7782-50-5	Chlorine	Non-metal	NA	NA	NA	NA	1.00	6.5E+03	8.0E+01	NA	NA	NA
22967-92-6	Methyl mercury (organic mercury)	Hg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

*Known to ionize under environmental conditions

** Completely miscible; solubility estimated from HLC and Vapor Pressure.

*** See App. A Reference No. 2, 3, and 4 to calc. Kds, Kdsw, Kdbs.

Table A-4 Biotransfer Factors for Plants

CAS Number	Chemical Name	Biotransfer Factors for Plants				
		RCF (ug/g WW plant)/ (ug/mL soil water)	Br - abovegrnd. veg. (ug/g DW plant)/ (ug/g soil)	Br - forage/ silage / grain (ug/g DW plant) /(ug/g soil)	Bv - abovegrnd. veg. (ug/g DW plant)/ (ug/g air)	Bv - forage / silage (ug/g DW plant)/ (ug/g air)
50-00-0	Formaldehyde	8.5E-01	4.1E+01	4.1E+01	1.5E+01	1.5E+01
50-32-8	Benzo(a)pyrene	1.5E+03	1.1E-02	1.1E-02	4.7E+04	4.7E+04
51-28-5	Dinitrophenol, 2,4-	1.3E+00	4.9E+00	4.9E+00	5.6E+02	5.6E+02
53-70-3	Dibenz(a,h)anthracene	4.3E+03	5.3E-03	5.3E-03	1.3E+08	1.3E+08
56-23-5	Carbon tetrachloride	4.6E+00	1.0E+00	1.0E+00	1.5E-01	1.5E-01
56-55-3	Benz(a)anthracene	7.4E+02	2.0E-02	2.0E-02	2.7E+04	2.7E+04
57-74-9	Chlordane	2.2E+03	8.6E-03	8.6E-03	6.2E+05	6.2E+05
58-90-2	Tetrachlorophenol, 2,3,4,6-	8.0E+01	1.1E-01	1.1E-01	1.7E+03	1.7E+03
62-50-0	Ethyl methanesulfonate	8.5E-01	3.6E+01	3.6E+01	1.2E+00	1.2E+00
62-53-3	Aniline	9.9E-01	1.1E+01	1.1E+01	3.3E+01	3.3E+01
64-18-6	Formic Acid*	8.3E-01	7.9E+01	7.9E+01	8.9E+00	8.9E+00
67-66-3	Chloroform	1.7E+00	3.0E+00	3.0E+00	1.7E-01	1.7E-01
67-72-1	Hexachloroethane	3.7E+01	1.9E-01	1.9E-01	2.6E+01	2.6E+01
70-30-4	Hexachlorophene*	1.9E+04	1.7E-03	1.7E-03	1.1E+15	1.1E+15
71-43-2	Benzene	2.1E+00	2.3E+00	2.3E+00	1.9E-01	1.9E-01
72-43-5	Methoxychlor	2.5E+02	4.5E-02	4.5E-02	9.1E+04	9.1E+04
72-55-9	DDE	4.8E+03	4.8E-03	4.8E-03	4.2E+06	4.2E+06
74-83-9	Methyl bromide (Bromomethane)	1.1E+00	7.9E+00	7.9E+00	1.7E-02	1.7E-02
74-87-3	Methyl chloride (Chloromethane)	9.7E-01	1.2E+01	1.2E+01	5.9E-03	5.9E-03
74-95-3	Methylene bromide	1.4E+00	4.5E+00	4.5E+00	3.4E-01	3.4E-01
75-01-4	Vinyl chloride	1.3E+00	5.3E+00	5.3E+00	8.2E-03	8.2E-03
75-09-2	Methylene chloride	1.1E+00	7.3E+00	7.3E+00	5.5E-02	5.5E-02
75-15-0	Carbon disulfide	1.9E+00	2.7E+00	2.7E+00	2.5E-02	2.5E-02
75-21-8	Ethylene oxide	8.4E-01	5.8E+01	5.8E+01	2.2E-02	2.2E-02
75-25-2	Bromoform (Tribromomethane)	2.8E+00	1.7E+00	1.7E+00	2.7E-04	2.7E-04
75-27-4	Bromodichloromethane	2.1E+00	2.4E+00	2.4E+00	6.0E-01	6.0E-01
75-29-6	2-Chloropropane	NA	NA	NA	NA	NA
75-34-3	Dichloroethane, 1,1-	1.5E+00	3.6E+00	3.6E+00	8.0E-02	8.0E-02
75-35-4	Dichloroethylene, 1,1-	2.1E+00	2.3E+00	2.3E+00	4.0E-02	4.0E-02
75-69-4	Trichlorofluoromethane	3.5E+00	1.3E+00	1.3E+00	2.9E-02	2.9E-02
75-71-8	Dichlorodifluoromethane	2.2E+00	2.2E+00	2.2E+00	3.3E-03	3.3E-03
76-13-1	Trichloro-1,2,2-trifluoroethane, 1,1,2-	9.0E+00	5.8E-01	5.8E-01	2.7E-02	2.7E-02
76-44-8	Heptachlor	2.0E+03	9.3E-03	9.3E-03	1.8E+01	1.8E+01
77-47-4	Hexachlorocyclopentadiene	4.3E+02	3.0E-02	3.0E-02	1.1E+02	1.1E+02

*Known to ionize under environmental conditions

** Completely miscible; solubility estimated from Henry's Law Constant and Vapor Pressure.

Table A-4 Biotransfer Factors for Plants

CAS Number	Chemical Name	Biotransfer Factors for Plants: RCF (ug/g WW plant)/ (ug/mL soil water)	Br - abovegrnd. veg. (ug/g DW plant)/ (ug/g soil)	Br - forage/ silage / grain (ug/g DW plant) /(ug/g soil)	Bv - abovegrnd. veg. (ug/g DW plant)/ (ug/g air)	Bv - forage / silage (ug/g DW plant)/ (ug/g air)
78-87-5	Dichloropropane, 1,2-	1.8E+00	2.8E+00	2.8E+00	2.5E-01	2.5E-01
78-93-3	Methyl ethyl ketone	8.7E-01	2.7E+01	2.7E+01	2.0E-01	2.0E-01
79-00-5	Trichloroethane, 1,1,2-	2.0E+00	2.5E+00	2.5E+00	9.3E-01	9.3E-01
79-01-6	Trichloroethylene	4.5E+00	1.1E+00	1.1E+00	4.2E-01	4.2E-01
79-34-5	Tetrachloroethane, 1,1,2,2-	2.9E+00	1.6E+00	1.6E+00	5.7E+00	5.7E+00
82-68-8	Pentachloronitrobenzene (PCNB)	1.1E+02	8.1E-02	8.1E-02	1.3E+03	1.3E+03
84-66-2	Diethyl phthalate	3.4E+00	1.4E+00	1.4E+00	5.7E+03	5.7E+03
84-74-2	Di-n-butyl phthalate	1.1E+02	8.4E-02	8.4E-02	4.8E+08	4.8E+08
85-44-9	Phthalic anhydride	8.3E-01	8.8E+01	8.8E+01	1.9E+00	1.9E+00
85-68-7	Butylbenzylphthalate	1.6E+02	6.2E-02	6.2E-02	6.3E+05	6.3E+05
87-68-3	Hexachloro-1,3-butadiene	1.5E+02	6.4E-02	6.4E-02	9.1E+01	9.1E+01
87-86-5	Pentachlorophenol*	2.5E+02	4.4E-02	4.4E-02	1.5E+06	1.5E+06
88-06-2	Trichlorophenol, 2,4,6-	2.2E+01	2.8E-01	2.8E-01	6.3E+03	6.3E+03
91-20-3	Naphthalene	1.2E+01	4.4E-01	4.4E-01	4.4E+01	4.4E+01
91-22-5	Quinoline	2.0E+00	2.5E+00	2.5E+00	8.0E+00	8.0E+00
91-58-7	2-chloronaphthalene	4.7E+01	1.6E-01	1.6E-01	4.6E+02	4.6E+02
91-94-1	Dichlorobenzidine, 3,3'-	1.6E+01	3.6E-01	3.6E-01	7.6E+06	7.6E+06
92-52-4	1,1-Biphenyl	3.5E+01	2.0E-01	2.0E-01	7.7E+00	7.7E+00
94-59-7	Safrole	4.2E+00	1.1E+00	1.1E+00	2.0E+02	2.0E+02
94-75-7	Dichlorophenoxyacetic acid, 2,4- (2,4-D)*	4.4E+00	1.1E+00	1.1E+00	4.1E+05	4.1E+05
95-47-6	o-Xylene	8.6E+00	6.0E-01	6.0E-01	5.8E-02	5.8E-02
95-48-7	Cresol, o-	1.8E+00	2.7E+00	2.7E+00	6.1E+02	6.1E+02
95-50-1	Dichlorobenzene, 1,2-	1.4E+01	4.0E-01	4.0E-01	1.3E+01	1.3E+01
95-53-4	Toluidine, o- *	1.1E+00	6.5E+00	6.5E+00	5.5E+01	5.5E+01
95-57-8	Chlorophenol, 2-	2.2E+00	2.2E+00	2.2E+00	2.8E+00	2.8E+00
95-94-3	Tetrachlorobenzene, 1,2,4,5-	1.1E+02	8.1E-02	8.1E-02	1.9E+02	1.9E+02
95-95-4	Trichlorophenol, 2,4,5-	3.1E+01	2.2E-01	2.2E-01	1.8E+04	1.8E+04
96-12-8	Dibromo-3-chloropropane, 1,2-	2.7E+00	1.7E+00	1.7E+00	1.2E+01	1.2E+01
96-18-4	Trichloropropane, 1,2,3-	2.5E+00	1.9E+00	1.9E+00	3.4E+00	3.4E+00
96-45-7	Ethylene thiourea	8.3E-01	9.3E+01	9.3E+01	3.6E+03	3.6E+03
97-63-2	Ethyl methacrylate	1.3E+00	4.7E+00	4.7E+00	3.3E-01	3.3E-01
98-01-1	Furfural	8.8E-01	2.2E+01	2.2E+01	9.5E-02	9.5E-02
98-07-7	Benzotrichloride	6.2E+00	7.9E-01	7.9E-01	NA	NA

*Known to ionize under environmental conditions

** Completely miscible; solubility estimated from Henry's Law Constant and Vapor Pressure.

Table A-4 Biotransfer Factors for Plants

CAS Number	Chemical Name	Biotransfer Factors for Plants: RCF (ug/g WW plant)/ (ug/mL soil water)	Br - abovegrnd. veg. (ug/g DW plant)/ (ug/g soil)	Br - forage/ silage / grain (ug/g DW plant) /(ug/g soil)	Bv - abovegrnd. veg. (ug/g DW plant)/ (ug/g air)	Bv - forage / silage (ug/g DW plant)/ (ug/g air)
98-82-8	Cumene	1.8E+01	3.3E-01	3.3E-01	3.1E-02	3.1E-02
98-86-2	Acetophenone	1.4E+00	4.4E+00	4.4E+00	2.9E+01	2.9E+01
98-95-3	Nitrobenzene	1.6E+00	3.3E+00	3.3E+00	2.1E+01	2.1E+01
99-35-4	Trinitrobenzene, sym-	1.1E+00	8.1E+00	8.1E+00	6.3E+03	6.3E+03
99-65-0	Dinitrobenzene, 1,3-	1.3E+00	5.3E+00	5.3E+00	9.6E+02	9.6E+02
100-25-4	1,4-Dinitrobenzene	NA	NA	NA	NA	NA
100-41-4	Ethylbenzene	8.7E+00	5.9E-01	5.9E-01	1.6E+00	1.6E+00
100-42-5	Stryene	6.4E+00	7.7E-01	7.7E-01	2.7E+00	2.7E+00
100-44-7	Benzyl chloride	2.6E+00	1.8E+00	1.8E+00	3.8E+00	3.8E+00
100-52-7	Benzaldehyde	1.2E+00	5.4E+00	5.4E+00	1.2E-01	1.2E-01
105-67-9	Dimethylphenol, 2,4-	9.5E+00				
106-44-5	Cresol, p-	1.8E+00	2.9E+00	2.9E+00	8.4E+02	8.4E+02
106-46-7	Dichlorobenzene, 1,4-	1.4E+01	4.1E-01	4.1E-01	1.0E+01	1.0E+01
106-47-8	Chloroaniline, p-	1.6E+00	3.3E+00	3.3E+00	1.6E+03	1.6E+03
106-49-0	Toluidine, p- *	1.2E+00	6.0E+00	6.0E+00	NA	NA
106-51-4	Quinone	8.6E-01	3.0E+01	0.0E+00	NA	NA
106-89-8	Epichlorohydrin	8.7E-01	2.8E+01	2.8E+01	3.4E-01	3.4E-01
106-93-4	Ethylene Dibromide	1.8E+00	2.9E+00	2.9E+00	9.2E-01	9.2E-01
107-02-8	Acrolein	8.5E-01	3.9E+01	3.9E+01	4.5E-02	4.5E-02
107-06-2	Dichloroethane, 1,2-	1.2E+00	5.5E+00	5.5E+00	2.1E-01	2.1E-01
107-13-1	Acrylonitrile	8.7E-01	2.8E+01	2.8E+01	1.0E-01	1.0E-01
107-19-7	Propargyl alcohol	NA	NA	NA	NA	NA
107-21-1	Ethylene glycol	8.2E-01	2.4E+02	2.4E+02	8.3E-02	8.3E-02
107-98-2	Propylene glycol monomethyl ether	NA	NA	NA	NA	NA
108-05-4	vinyl acetate	9.3E-01	1.5E+01	1.5E+01	6.6E-02	6.6E-02
108-10-1	Methyl isobutyl ketone	1.1E+00	7.9E+00	7.9E+00	7.5E-01	7.5E-01
108-38-3	m-Xylene	9.6E+00	5.5E-01	5.5E-01	4.9E-02	4.9E-02
108-39-4	Cresol, m-	1.8E+00	2.8E+00	2.8E+00	8.1E+02	8.1E+02
108-88-3	Toluene	4.8E+00	1.0E+00	1.0E+00	7.1E-01	7.1E-01
108-90-7	Chlorobenzene	5.6E+00	8.6E-01	8.6E-01	1.7E+00	1.7E+00
108-95-2	Phenol	1.2E+00	5.4E+00	5.4E+00	5.3E+02	5.3E+02
109-77-3	Malononitrile	8.3E-01	7.5E+01	7.5E+01	NA	NA
109-86-4	2-Methoxyethanol	8.3E-01	1.1E+02	1.1E+02	7.3E-06	7.3E-06
110-54-3	n-Hexane	3.7E+01	1.9E-01	1.9E-01	1.8E-01	1.8E-01

*Known to ionize under environmental conditions

** Completely miscible; solubility estimated from Henry's Law Constant and Vapor Pressure.

Table A-4 Biotransfer Factors for Plants

CAS Number	Chemical Name	Biotransfer Factors for Plants				
		RCF (ug/g WW plant)/ (ug/mL soil water)	Br - abovegrnd. veg. (ug/g DW plant)/ (ug/g soil)	Br - forage/ silage / grain (ug/g DW plant) /(ug/g soil)	Bv - abovegrnd. veg. (ug/g DW plant)/ (ug/g air)	Bv - forage / silage (ug/g DW plant)/ (ug/g air)
110-80-5	Ethoxyethanol, 2- **	8.5E-01	4.4E+01	4.4E+01	3.6E+01	3.6E+01
110-86-1	Pyridine**	9.2E-01	1.6E+01	1.6E+01	3.3E+00	3.3E+00
111-44-4	Bis(2-chlorethyl)ether	1.1E+00	7.7E+00	7.7E+00	6.0E+00	6.0E+00
117-81-7	Bis(2-ethylhexyl)phthalate	1.3E+04	2.3E-03	2.3E-03	8.2E+07	8.2E+07
117-84-0	Di-n-octyl phthalate	4.9E+04	8.5E-04	8.5E-04	8.0E+05	8.0E+05
118-74-1	Hexachlorobenzene	1.0E+03	1.5E-02	1.5E-02	2.0E+02	2.0E+02
119-90-4	Dimethyoxybenzidine, 3,3'- *	1.6E+00	3.5E+00	3.5E+00	2.6E+09	2.6E+09
120-12-7	Anthracene	9.7E+01	9.1E-02	9.1E-02	1.5E+02	1.5E+02
120-82-1	Trichlorobenzene, 1,2,4-	3.8E+01	1.9E-01	1.9E-01	7.3E+01	7.3E+01
120-83-2	Dichlorophenol, 2,4-	7.9E+00	6.4E-01	6.4E-01	3.4E+03	3.4E+03
121-14-2	Dinitrotoluene, 2,4-	1.9E+00	2.7E+00	2.7E+00	8.3E+03	8.3E+03
122-39-4	Diphenylamine*	1.5E+01	3.8E-01	3.8E-01	5.7E+04	5.7E+04
122-66-7	1,2-Diphenylhydrazine	6.4E+00	7.7E-01	7.7E-01	1.2E+02	1.2E+02
123-33-1	Malaic hydrazide	8.3E-01	1.0E+02	1.0E+02	3.5E-06	3.5E-06
123-73-9	Crotonaldehyde	9.1E-01	1.7E+01	1.7E+01	5.5E-02	5.5E-02
123-91-1	Dioxane, 1,4- **	8.4E-01	6.5E+01	6.5E+01	4.5E-01	4.5E-01
126-98-7	Methacrylonitrile	9.0E-01	1.9E+01	1.9E+01	8.5E-02	8.5E-02
127-18-4	Tetrachloroethylene	4.3E+00	1.1E+00	1.1E+00	2.1E-01	2.1E-01
131-11-3	Dimethyl phthalate	1.3E+00	4.8E+00	4.8E+00	2.5E+03	2.5E+03
131-89-5	4,6--Dinitro-o-cyclohexyl phenol	NA	NA	NA	NA	NA
145-73-3	Endothall	8.3E-01	8.1E+01	8.1E+01	1.4E+02	1.4E+02
156-60-5	Dichloroethylene, trans-1,2-	2.0E+00	2.5E+00	2.5E+00	9.5E-02	9.5E-02
193-39-5	Indeno(1,2,3-cd) pyrene	4.0E+03	5.6E-03	5.6E-03	5.4E+04	5.4E+04
205-99-2	Benzo(b)fluoranthene	1.8E+03	1.0E-02	1.0E-02	5.1E+03	5.1E+03
206-44-0	Fluoranthene	2.7E+02	4.3E-02	4.3E-02	3.5E+03	3.5E+03
207-08-9	Benzo(k)fluoranthene	1.8E+03	1.0E-02	1.0E-02	6.7E+05	6.7E+05
218-01-9	Chrysene	7.4E+02	2.0E-02	2.0E-02	2.5E+04	2.5E+04
319-84-6	Hexachlorocyclohexane, alpha- (alpha-BHC)	2.6E+01	2.5E-01	2.5E-01	5.9E+03	5.9E+03
319-85-7	Hexachlorocyclohexane, beta- (beta-BHC)	2.7E+01	2.4E-01	2.4E-01	8.6E+04	8.6E+04
460-19-5	Cyanogen	8.5E-01	3.5E+01	3.5E+01	NA	NA
506-68-3	Cyanogen bromide	NA	NA	NA	NA	NA
506-77-4	Cyanogen chloride	NA	NA	NA	NA	NA

*Known to ionize under environmental conditions

** Completely miscible; solubility estimated from Henry's Law Constant and Vapor Pressure.

Table A-4 Biotransfer Factors for Plants

CAS Number	Chemical Name	Biotransfer Factors for Plants				
		RCF (ug/g WW plant)/ (ug/mL soil water)	Br - abovegrnd. veg. (ug/g DW plant)/ (ug/g soil)	Br - forage/ silage / grain (ug/g DW plant) /(ug/g soil)	Bv - abovegrnd. veg. (ug/g DW plant)/ (ug/g air)	Bv - forage / silage (ug/g DW plant)/ (ug/g air)
510-15-6	Chlorobenzilate	7.2E+01	1.1E-01	1.1E-01	NA	NA
528-29-0	1,2-Dinitrobenzene	9.2E-01	1.5E+01	1.5E+01	NA	NA
542-75-6	Dichloropropene, 1,3-	1.9E+00	2.7E+00	2.7E+00	4.3E-02	4.3E-02
542-88-1	Bis (chloromethyl)ether	1.0E+00	9.7E+00	9.7E+00	1.5E-02	1.5E-02
606-20-2	Dinitrotoluene, 2,6-	1.7E+00	3.2E+00	3.2E+00	7.3E+02	7.3E+02
608-93-5	Pentachlorobenzene	3.4E+02	3.5E-02	3.5E-02	3.1E+03	3.1E+03
621-64-7	N-Nitrosodi-n-propylamine	1.2E+00	6.0E+00	6.0E+00	7.7E+01	7.7E+01
630-20-6	Tetrachloroethane, 1,1,1,2-	4.0E+00	1.2E+00	1.2E+00	1.5E+00	1.5E+00
765-34-4	Glycidaldehyde	8.3E-01	1.0E+02	1.0E+02	4.6E-02	4.6E-02
823-40-5	Toluene-2,6-diamine	NA	NA	NA	NA	NA
924-16-3	Nitrosodi-n-butylamine	3.0E+00	1.6E+00	1.6E+00	6.5E+00	6.5E+00
1330-20-7	Xylenes (total)	9.2E+00	5.7E-01	5.7E-01	2.2E+00	2.2E+00
1336-36-3	Polychlorinated biphenyls	6.0E+02	2.3E-02	2.3E-02	5.3E-01	5.3E-01
1746-01-6	TCDD, 2,3,7,8-	1.2E+04	6.5E-03	6.5E-03	4.6E+05	4.6E+05
7439-92-1	Lead *	9.0E-03	1.3E-05	1.3E-05	0.0E+00	0.0E+00
7439-97-6	Mercury (elemental)	NA	NA	NA	NA	NA
7440-02-0	Nickel	8.0E-03	3.2E-02	1.1E-01	NA	NA
7440-22-4	Silver	1.0E-01	4.0E-01	4.0E-01	NA	NA
7440-28-0	Thallium (I)	4.0E-04	4.0E-03	4.0E-03	NA	NA
7440-36-0	Antimony	3.0E-02	2.0E-01	2.0E-01	NA	NA
7440-38-2	Arsenic	8.0E-03	3.6E-02	6.0E-02	NA	NA
7440-39-3	Barium	1.5E-02	1.5E-01	1.5E-01	NA	NA
7440-41-7	Beryllium	1.5E-03	1.0E-02	1.0E-02	NA	NA
7440-43-9	Cadmium	6.4E-02	3.6E-01	1.4E-01	NA	NA
7440-47-3	Chromium VI	4.5E-03	7.5E-03	7.5E-03	NA	NA
7440-66-6	Zinc	NA	2.5E-01	9.6E-02	NA	NA
7487-94-7	Mercuric chloride (divalent)	1.4E-02	8.0E-03	2.0E-03	2.3E-04	2.3E-04
7647-01-0	Hydrogen chloride	NA	NA	NA	NA	NA
7664-41-7	Ammonia	NA	NA	NA	NA	NA
7782-49-2	Selenium	2.2E-02	1.6E-02	6.0E-03	NA	NA
7782-50-5	Chlorine	NA	NA	NA	NA	NA
22967-92-6	Methyl mercury	NA	NA	NA	NA	NA

*Known to ionize under environmental conditions

** Completely miscible; solubility estimated from Henry's Law Constant and Vapor Pressure.

Table B.2.1. Soil Concentration Due to Deposition Continued

Parameter	Definition	Default Value
0.31536	Units conversion factor (m-g-s/cm-µg-yr)	
Vdv	Dry deposition velocity (cm/s)	3
Q	Stack emissions (g/sec)	site-specific
F_v	Fraction of air concentration in vapor phase (dimensionless)	chemical-specific (see Appendix A)
Dywv	Normalized yearly wet deposition from vapor phase (s/m^2-yr)	modeled (see Section 5.2.1)
Dydp	Normalized yearly dry deposition from particle phase (s/m^2-yr)	modeled (see Section 5.2.1)
Dywp	Normalized yearly wet deposition from particle phase (s/m^2-yr)	modeled (see Section 5.2.1)
100	Units conversion factor ($[mg\text{-}m^2]/[kg\text{-}cm^2]$)	

Description

These equations calculate an average soil concentration over the exposure duration as a result of wet and dry deposition of particles and vapors to soil. Contaminants are assumed to be incorporated only to a finite depth (the mixing depth, Z).

The soil concentration averaged over the exposure duration should be used for carcinogenic chemicals, where the risk is averaged over the lifetime of an individual. Since the hazard quotient associated with noncarcinogenic chemicals is based on a reference dose and not on a lifetime exposure, the highest annual average soil concentration occurring within the exposure duration period should be used for noncarcinogenic chemicals. The highest annual average soil concentration would occur at the end of the time period of combustion and is represented by Sc_{TC}.

Table B.2.2. Soil Loss Constant

Equation
$ks = ksl + kse + ksr + ksg + ksv$

Parameter	Definition	Default Value
ks	Soil loss constant due to all processes (yr^{-1})	
ksl	Loss constant due to leaching (yr^{-1})	calculated (see Table B.2.3)
kse	Loss constant due to soil erosion (yr^{-1})	0
ksr	Loss constant due to surface runoff (yr^{-1})	calculated (see Table B.2.4)
ksg	Loss constant due to degradation (yr^{-1})	0
ksv	Loss constant due to volatilization (yr^{-1})	calculated (see Table B.2.5)

Description
This equation calculates the soil loss constant, which accounts for the loss of contaminant from soil by several mechanisms. The loss term for erosion is assumed to be zero due to contaminated soil eroding onto the site as well as off.

Table B.2.3. Loss Constant Due to Leaching

Equation

$$ksl = \frac{q}{\theta_s \cdot z \cdot [1.0 + (BD \cdot Kd_s / \theta_s)]}$$

Parameter	Definition	Default Value
ksl	Loss constant due to leaching (yr^{-1})	
q	Average annual recharge (cm/yr)	site-specific
θ_s	Soil volumetric water content (mL/cm^3)	0.2
z	Soil depth from which leaching removal occurs (cm)	20
Kd_s	Soil-water partition coefficient (cm^3/g)	chemical-specific (see Appendix A)
BD	Soil bulk density (g/cm^3)	1.5

Description

This equation calculates the contaminant loss constant due to leaching from soil.

Table B.2.4. Loss Constant Due to Runoff

Equation

$$ksr = \frac{R}{\theta_s \cdot z} \cdot \left(\frac{1}{1 + (Kd_s \cdot BD / \theta_s)} \right)$$

Parameter	Definition	Default Value
ksr	Loss constant due to runoff (yr^{-1})	
R	Average annual runoff (cm/yr)	site-specific
θ_s	Soil volumetric water content (mL/cm^3)	0.2
z	Soil mixing depth (cm)	20
Kd_s	Soil-water partition coefficient (cm^3/g)	chemical-specific (see Appendix A)
BD	Soil bulk density (g/cm^3)	1.5

Description

This equation calculates the contaminant loss constant due to runoff from soil.

Table B.2.5. Loss Constant Due to Volatilization

Equation

$$ksv = \left[\frac{3.1536x10^{7} \cdot H}{z \cdot Kd_s \cdot R \cdot T \cdot BD}\right] \cdot \left[0.482 \cdot u^{0.78} \cdot \left(\frac{\mu_a}{\rho_a \cdot D_a}\right)^{-0.67} \cdot \left(\sqrt{\frac{4 \cdot A}{\pi}}\right)^{-0.11}\right]$$

Parameter	Definition	Default Value
ksv	Loss constant due to volatilization (yr^{-1})	
$3.1536x10^{7}$	Conversion constant (s/yr)	
H	Henry's Law constant (atm-m^3/mol)	chemical-specific (see Appendix A)
z	Soil mixing depth (cm)	20
Kd_s	Soil-water partition coefficient (cm^3/g)	chemical-specific (see Appendix A)
R	Universal gas constant (atm-m^3/mol-K)	$8.205x10^{-5}$
BD	Soil bulk density (g/cm^3)	1.5
T	Ambient air temperature (K)	site-specific
u	Average annual wind speed (m/s)	site-specific
μ_a	Viscosity of air (g/cm-s)	$1.81x10^{-4}$
ρ_a	Density of air (g/cm^3)	$1.2x10^{-3}$
D_a	Diffusivity of contaminant in air (cm^2/s)	chemical-specific (see Appendix A)
A	Surface area of contaminated area (m^2)	site-specific

Description

This equation calculates the contaminant loss constant due to volatilization from soil.

Table B.2.6. Aboveground Produce Concentration Due to Direct Deposition

Equation

$$Pd = \frac{1000 \cdot Q \cdot (1 - F_v) \cdot [Dydp + (Fw \cdot Dywp)] \cdot Rp \cdot [(1.0 - exp(-kp \cdot Tp)]}{Yp \cdot kp}$$

Parameter	Definition	Default Value
Pd	Concentration in plant due to direct deposition (mg/kg DW)	
1000	Units conversion factor (mg/g)	
Q	Stack emissions (g/sec)	site-specific
F_v	Fraction of air concentration in vapor phase (dimensionless)	chemical-specific (see Appendix A)
Dydp	Normalized yearly dry deposition from particle phase (s/m^2-yr)	modeled (see Section 5.2.1)
Fw	Fraction of wet deposition that adheres to plant (dimensionless)	0.6 for Cations 0.2 for Anions
Dywp	Normalized yearly wet deposition from particle phase (s/m^2/yr)	modeled (see Section 5.2.1)
Rp	Interception fraction of edible portion of plant (dimensionless)	0.04
kp	Plant surface loss coefficient (yr^{-1})	18
Tp	Length of plant's exposure to deposition per harvest of edible portion of plant (yrs)	0.16
Yp	Yield or standing crop biomass of the edible portion of the plant (kg DW/m^2)	1.6

Description

This equation calculates the contaminant concentration in aboveground vegetation due to wet and dry deposition of contaminant on the plant surface.

Table B.2.7. Aboveground Produce Concentration Due to Air-to-Plant Transfer

Exposure Scenarios

$$Pv = Q \cdot F_v \cdot \frac{Cyv \cdot Bv \cdot VG_{ag}}{\rho_a}$$

Parameter	Definition	Default Value
Pv	Concentration of pollutant in the plant due to air-to-plant transfer (mg/kg)	
Q	Stack emissions (g/sec)	site-specific
F_v	Fraction of air concentration in vapor phase (dimensionless)	chemical-specific (see Appendix A)
Cyv	Normalized vapor phase air concentration (µg-sec/g-m^3)	modeled (see Section 5.2.1)
Bv	Air-to-plant biotransfer factor ([mg pollutant/kg plant tissue DW]/[µg pollutant/g air])	chemical-specific (see Appendix A)
Vg_{ag}	Empirical correction factor for aboveground vegetation (dimensionless)	Organics 0.1 for human aboveground produce consumption Metals 1.0 for aboveground produce
ρ_a	Density of air (g/m^3)	1.2×10^3

Description

This equation calculates the contaminant concentration in aboveground vegetation due to direct uptake of vapor phase contaminants into the plant leaves.

Table B.2.8. Aboveground Produce Concentration Due to Root Uptake

Equation
$Pr = Sc \cdot Br$

Parameter	Definition	Default Value
Pr	Concentration of pollutant in the plant due to direct uptake from soil (mg/kg)	
Sc	Average soil concentration of pollutant over exposure duration (mg/kg)	calculated (see Table B.2.1)
Br	Plant-soil bioconcentration factor for aboveground produce [µg/g DW]/[µg/g soil]	chemical-specific (see Appendix A)

Description
This equation calculates the contaminant concentration in aboveground vegetation due to direct uptake of contaminants from soil.

B.3 Consumption of Animal Products

The equations in this section are used to calculate contaminant concentrations in the animal products, which include beef, pork, milk, poultry, and eggs. The consumption of animal products is dependant on scenario and tier. For Tiers 1 and 2, only the subsistence farmer is considered to eat beef and milk. For Tier 3, all scenarios are assumed to eat beef and milk; and pork, eggs, and poultry should also be considered if appropriate to site-specific circumstances. Therefore, equations for determining the concentration in all of these types of animal products are included here.

Animal tissue (beef, pork, poultry, eggs, and milk) may be contaminated through ingestion of contaminated forage, grain, silage and soil by livestock. Beef and dairy cattle ingest grain, silage, forage, and soil. Hogs ingest grain, silage, and soil. Chickens raised by the subsistence farmer are assumed to consume 10% of their diet as contaminated soil. Chickens raised by the typical farmer are assumed not to be free range. These chickens consume contaminated grain but no soil.

The contamination of plant matter consumed by livestock differs depending on the type of plant. Forage (pasture grass and hay) and silage may be contaminated by combustion emissions through direct deposition of contaminants onto the plant, direct uptake of vapor phase contaminants, and root uptake of contaminants deposited on the soil. Grain is assumed to be protected, and thus are only contaminated by root uptake of contaminants in soil. Direct deposition and root uptake of contaminants are calculated at the location of the given scenario.

The site-specific parameters required for this pathway are:

- Total time of deposition (Tc): This should be set to the expected lifetime of the combustion source (e.g., 30 years.)

- Average annual recharge (q): Appropriate recharge values

- Average annual surface runoff (R): Surface runoff, R, can be estimated using the Water Atlas. This reference provides maps with isolines of annual average surface water runoff, which are defined as all flow contributions to surface water bodies, including direct runoff, shallow interflow, and ground water recharge. The range of values shown for North Carolina is 10 to 40 in/yr, with the lowest values occurring in the coastal region and increasing to the highest values in the mountains. Since these values are total contributions and not just surface runoff, they need to be reduced to estimate surface runoff. A reduction of 50 percent, or one half, should suffice if using the Water Atlas for the R term. More detailed, site-specific procedures for estimating the amount of surface runoff, such as those based on the U.S. Soil Conservation Service curve number equation (CNE), may also be used (see, for example, U.S. EPA, 1985). (Note that all values must be converted to cm/yr.)

Table B.3.1. Soil Concentration Due to Deposition

Equation

Soil Concentration Averaged over Exposure Duration

$$Sc = \frac{\left(\frac{Ds \cdot Tc - Sc_{Tc}}{ks}\right) + \left(\frac{Sc_{Tc}}{ks} \cdot [1 - exp(-ks \cdot (T_2 - Tc)]\right)}{(T_2 - T_1)}$$

Highest Annual Average Soil Concentration

$$Sc_{Tc} = \frac{Ds \cdot (1 - exp(-ks \cdot Tc))}{ks}$$

$$Ds = \frac{100 \cdot Q}{z \cdot BD} \cdot [F_v (0.31536 \cdot Vdv \cdot Cyv + Dywv) + (Dydp + Dywp) \cdot (1 - F_v)]$$

Parameter	Definition	Default Value
Sc	Average soil concentration of pollutant over exposure duration (mg/kg)	
Ds	Deposition term (mg/kg-yr)	
Tc	Time period over which deposition occurs (yr)	site-specific
Sc_{Tc}	Soil concentration at time Tc (mg/kg)	
ks	Soil loss constant (yr^{-1})	calculated (see Table B.1.2)
T_2	Exposure duration (yr)	scenario-specific (see Section 5.1)
Z	Soil mixing depth (cm)	20-grain & silage from tilled field 1.0-forage & soil
BD	Soil bulk density (g/cm^3)	1.5
0.31536	Units conversion factor (m-g-s/cm-µg-yr)	

Table B.3.1 Soil Concentration Due to Deposition Continued

Parameter	Definition	Default Value
Vdv	Dry deposition velocity (cm/s)	3
Q	Stack emission (g/s)	site-specific
F_v	Fraction of air concentration in vapor phase (dimensionless)	chemical-specific (see Appendix A)
Cyv	Normalized vapor phase air concentration (μg-s/g-m^3)	modeled (see Section 5.2.1)
Dywv	Normalized yearly wet deposition from vapor phase (s/m^2-yr)	modeled (see Section 5.2.1)
Dydp	Normalized yearly dry deposition from particle phase (3/m^2-yr)	modeled (see Section 5.2.1)
Dywp	Normalized yearly wet deposition from particle phase (s/m^2-yr)	modeled (see Section 5.2.1)
100	Units conversion factor ([mg-m^2]/[kg-cm^2])	

Description

These equations calculate an average soil concentration over the exposure duration as a result of wet and dry deposition of particles and vapors to soil. Contaminants are assumed to be incorporated only to a finite depth (the mixing depth, Z).

The soil concentration averaged over the exposure duration should be used for carcinogenic chemicals, where the risk is averaged over the lifetime of an individual. Since the hazard quotient associated with noncarcinogenic chemicals is based on a reference dose and not on a lifetime exposure, the highest annual average soil concentration occurring within the exposure duration period should be used for noncarcinogenic chemicals. The highest annual average soil concentration would occur at the end of the time period of combustion and is represented by Sc_{TC}.

Table B.3.2. Soil Loss Constant

Equation
$ks = ksl + kse + ksr + ksg + ksv$

Parameter	Definition	Default Value
ks	Soil loss constant due to all processes (yr^{-1})	
ksl	Loss constant due to leaching (yr^{-1})	calculated (see Table B.3.3)
kse	Loss constant due to soil erosion (yr^{-1})	0
ksr	Loss constant due to surface runoff (yr^{-1})	calculated (see Table B.3.4)
ksg	Loss constant due to degradation (yr^{-1})	0
ksv	Loss constant due to volatilization (yr^{-1})	calculated (see Table B.3.5)

Description
This equation calculates the soil loss constant, which accounts for the loss of contaminant from soil by several mechanisms. The loss term for erosion is assumed to be zero due to contaminated soil eroding onto the site as well as off.

Table B.3.3. Loss Constant Due to Leaching

Equation

$$ksl = \frac{q}{\theta_s \cdot z \cdot [1.0 + (BD \cdot Kd_s / \theta_s)]}$$

Parameter	Definition	Default Value
ksl	Loss constant due to leaching (yr^{-1})	
q	Average annual recharge (cm/yr)	site-specific
θ_s	Soil volumetric water content (mL/cm^3)	0.2
z	Soil depth from which leaching removal occurs (cm)	20-grain & silage from tilled field 1.0-forage & soil
Kd_s	Soil-water partition coefficient (cm^3/g)	chemical-specific (see Appendix A)
BD	Soil bulk density (g/cm^3)	1.5

Description

This equation calculates the contaminant loss constant due to leaching from soil.

Table B.3.4. Loss Constant Due to Runoff

Equation

$$ksr = \frac{R}{\theta_s \cdot z} \cdot \left(\frac{1}{1 + (Kd_s \cdot BD / \theta_s)} \right)$$

Parameter	Definition	Default Value
ksr	Loss constant due to runoff (yr^{-1})	
R	Average annual runoff (cm/yr)	site-specific
θ_s	Soil volumetric water content (mL/cm^3)	0.2
z	Soil mixing depth (cm)	20-grain & silage from tilled field 1.0-forage & soil
Kd_s	Soil-water partition coefficient (cm^3/g)	chemical-specific (see Appendix A)
BD	Soil bulk density (g/cm^3)	1.5

Description

This equation calculates the contaminant loss constant due to runoff from soil.

Table B.3.5. Loss Constant Due to Volatilization

Equation

$$ksv = \left[\frac{3.1536x10^{7} \cdot H}{z \cdot Kd_s \cdot R \cdot T \cdot BD}\right] \cdot \left[0.482 \cdot u^{0.78} \cdot \left(\frac{\mu_a}{\rho_a \cdot D_a}\right)^{-0.67} \cdot \left(\sqrt{\frac{4 \cdot A}{\pi}}\right)^{-0.11}\right]$$

Parameter	Definition	Default Value
ksv	Loss constant due to volatilization (yr^{-1})	
$3.1536x10^{7}$	Conversion constant (s/yr)	
H	Henry's Law constant ($atm\text{-}m^3/mol$)	chemical-specific (see Appendix A)
z	Soil mixing depth (cm)	20-grain & silage from tilled field 1.0-forage & soil
Kd_s	Soil-water partition coefficient (cm^3/g)	chemical-specific (see Appendix A)
R	Universal gas constant ($atm\text{-}m^3/mol\text{-}K$)	$8.205x10^{-5}$
BD	Soil bulk density (g/cm^3)	1.5
T	Ambient air temperature (K)	site-specific
u	Average annual wind speed (m/s)	site-specific
μ_a	Viscosity of air (g/cm-s)	$1.81x10^{-4}$
ρ_a	Density of air (g/cm^3)	$1.2x10^{-3}$
D_a	Diffusivity of contaminant in air (cm^2/s)	chemical-specific (see Appendix A)
A	Surface area of contaminated area (m^2)	site-specific

Description

This equation calculates the contaminant loss constant due to volatilization from soil.

Table B.3.6. Forage and Silage Concentration Due to Direct Deposition

Equation

$$Pd = \frac{1000 \cdot Q \cdot (1 - F_v)[Dydp + (Fw \cdot Dywp)] \cdot Rp \cdot [(1.0 - exp(-kp \cdot Tp)]}{Yp \cdot kp}$$

Parameter	Definition	Default Value
Pd	Concentration in plant due to direct deposition (mg/kg DW)	
1000	Units conversion factor (mg/g)	
Q	Stack emissions (g/s)	site-specific
Dydp	Normalized yearly dry deposition from particle phase (s/m^2-yr)	modeled (see Section 5.2.1)
Fw	Fraction of wet deposition that adheres to plant surfaces (dimensionless)	0.6 for Cations 0.2 for Anions
F_v	Fraction of air concentration in vapor phase (dimensionless)	chemical-specific (see Appendix A)
Dywp	Yearly particle phase wet deposition rate ($g/m^2/yr$)	modeled (see Section 5.2.1)
Rp	Interception fraction of the edible portion of the plant tissue (dimensionless)	forage - 0.5 silage - 0.46
kp	Plant surface loss coefficient (yr^{-1})	18
Tp	Length of the plant's exposure to deposition per harvest of the edible portion of the plant (yrs)	forage - 0.12 silage - 0.16
Yp	Yield or standing crop biomass of the edible portion of the plant ($kg\ DW/m^2$)	forage - 0.24 silage - 0.8

Description

This equation calculates the contaminant concentration in aboveground vegetation due to wet and dry deposition of contaminant on the plant surface.

Table B.3.7. Forage and Silage Concentration Due to Air-to-Plant Transfer

Equation

$$Pv = Q \bullet F_v \bullet \frac{Cyv \cdot Bv \cdot VG_{ag}}{\rho_a}$$

Parameter	Definition	Default Value
Pv	Concentration of pollutant in the plant due to air-to-plant transfer (mg/kg)	
Q	Stack emissions (g/s)	site-specific
F_v	Fraction of air concentration in vapor phase (dimensionless)	chemical-specific (see Appendix A)
Cyv	Normalized vapor phase air concentration (µg-s/g-m^3)	modeled (see Section 5.2.1)
Bv	Air-to-plant biotransfer factor ([mg pollutant/kg plant tissue DW]/[µg pollutant/g air])	chemical-specific (see Appendix A)
Vg_{ag}	Empirical correction factor for above ground vegetation (unitless)	Organics forage - 1.0 silage - 0.5 Metals 1.0 for aboveground produce
ρ_a	Density of air (g/m^3)	1.2×10^3

Description

This equation calculates the contaminant concentration in aboveground vegetation due to direct uptake of vapor phase contaminants into the plant leaves.

Table B.3.8. Forage/Silage/Grain Concentration Due to Root Uptake

Equation		
$Pr = Sc \cdot Br$		
Parameter	**Definition**	**Default Value**
Pr	Concentration of pollutant in the plant due to direct uptake from soil (mg/kg)	
Sc	Average soil concentration of pollutant over exposure duration (mg/kg)	calculated (see Table B.3.1)
Br_i	Plant-soil bioconcentration factor for plant [µg/g DW]/[µg/g soil]	chemical-specific (see Appendix A)

Description
This equation calculates the contaminant concentration in aboveground vegetation due to direct uptake of contaminants from soil.

Table B.3.9. Beef Concentration Due to Plant and Soil Ingestion

Equation

$$A_{beef} = (\Sigma(F_i \cdot Qp_i \cdot P_i) + Qs \cdot Sc) \cdot Ba_{beef}$$

Parameter	Definition	Default Value
A_{beef}	Concentration of pollutant in beef (mg/kg)	
F_i	Fraction of plant grown on contaminated soil and eaten by the animal (dimensionless) for each plant type	1
Qp_i	Quantity of plant eaten by the animal each day (kg plant tissue DW/day)	forage - 8.8 silage - 2.5 grain - 0.47
P_i	Total concentration of pollutant in the plant eaten by the animal (mg/kg DW) P = Pd + Pv + Pr Pd and Pv are not used for grain.	calculated (see Tables B.3.6, B.3.7, B.3.8)
Qs	Quantity of soil eaten by the animal (kg soil/day)	0.5
Sc	Average soil concentration of pollutant over exposure duration (mg/kg)	calculated (see Table B.3.1)
Ba_{beef}	Biotransfer factor for beef (d/kg)	chemical-specific (see Appendix A)

Description

This equation calculates the concentration of contaminant in beef from ingestion of forage, grain, silage, and soil. The consumption rates given in the table reflect default values for cattle raised by subsistence farmers.

Table B.3.10. Milk Concentration Due to Plant and Soil Ingestion

Equation

$$A_{milk} = (\Sigma(F_i \cdot Qp_i \cdot P_i) + Qs \cdot Sc) \cdot Ba_{milk}$$

Parameter	Definition	Default Value
A_{milk}	Concentration of pollutant in milk (mg/kg)	
F_i	Fraction of plant grown on contaminated soil and eaten by the animal (dimensionless) for each plant group	1
Qp_i	Quantity of plant eaten by the animal each day (kg plant tissue DW/day) for each plant type	forage - 13.2 silage - 4.1 grain - 3.0
P_i	Total concentration of pollutant in each plant eaten by the animal (mg/kg) = Pd + Pv + Pr	calculated (see Tables B.3.6, B.3.7, B.3.8)
Qs	Quantity of soil eaten by the animal (kg soil/day)	0.4
Sc	Average soil concentration of pollutant over exposure duration (mg/kg)	calculated (see Table B.3.1)
Ba_{milk}	Biotransfer factor for milk (day/kg)	chemical-specific (see Appendix A)

Description

This equation calculates the concentration of contaminant in milk from ingestion of forage, silage, grain, and soil. The consumption rates given in the table reflect default values for cattle raised by subsistence farmers.

Table B.3.11 Pork Concentration Due to Plant and Soil Ingestion

Equation

$$A_{pork} = \left(\sum(F_i \bullet Qp_i \bullet P_i) + Qs \bullet Sc\right) \bullet Ba_{pork}$$

Parameter	Definition	Values
A_{pork}	Concentration of pollutant in pork (mg/kg Fw)[1]	
F_i	Fraction of plant grown on contaminated soil and eaten by the animal (dimensionless) for each plant type.	1
Qp_i	Quantity of plant matter eaten by the animal each day (kg plant tissue DW/d) for each plant type	grain - 3 silage - 1.3
P_i	Total concentration of pollutant due to root uptake in grain and silage eaten by the animal (mg/kg Dw). P = Pd + Pv + Pr. Pd and Pv are not used for grain.	calculated (see Tables B.3.6, B.3.7, B.3.8)
Qs	Quantity of soil eaten by the animal (kg soil/d)	0.37
Sc	Average soil concentration of pollutant over exposure duration (mg/kg)	calculated (see Table B.3.1)
Ba_{pork}	Biotransfer factor for pork (d/kg)	chemical-specific (see Appendix A)

Description

This equation calculates the concentration of contaminant in pork from ingestion of grain, silage, and soil. Forage ingestion was not used because hogs are not grazing animals. The consumption rates given in the table reflect default values for hogs raised by subsistence farmers.

[1] For the chemicals mercury, selenium, and cadmium, the concentration in pork is in (mg/kg Dw).

Table B.3.12 Concentration in Eggs

Equation

$$A_{eggs} = \left(S_c \bullet Fd + Pr \bullet (1 - Fd)\right) \bullet BCF_{eggs}$$

Parameter	Definition	Values
A_{eggs}	Concentration of pollutant in eggs (mg/kg Fw)	
Sc	Average soil concentration of pollutant over exposure duration (mg/kg)	calculated (see Table B.3.1)
Fd	Fraction of diet that is soil (dimensionless)	0.1
Pr	Concentration of congener in grain (mg/kg). Pd and Pv are not used for grain	calculated (see Table B.3.8)
BCF_{egg}	Bioconcentration factor for congener in eggs (unitless)	chemical-specific (see Appendix A)

Description

This equation calculates the concentration in eggs due to ingestion of contaminated soil and grain by the chickens raised by a subsistence farmer. Chickens raised by typical farmers are not assumed to consume soil, and Fd for this case would be set to zero.

Table B.3.13 Concentration in Poultry Meat

Equation

$$A_{poultry} = \left(S_c \bullet Fd + Pr \bullet (1 - Fd)\right) \bullet BCF_{chick}$$

Parameter	Definition	Values
$A_{poultry}$	Concentration of pollutant in poultry meat (mg/kg Fw)	
Sc	Average soil concentration of pollutant over exposure duration (mg/kg)	calculated (see Table B.3.1)
Fd	Fraction of diet that is soil (dimensionless)	0.1
Pr	Concentration of congener in grain (mg/kg). Pd and Pv are not used for grain	calculated (see Table B.3.8)
BCF_{chick}	Bioconcentration factor for congener in thigh meat	chemical-specific (see Appendix A)

Description

This equation calculates the concentration in poultry meat due to ingestion of contaminated soil and grain by the chickens raised by the subsistence farmer. Chickens raised by typical farmers are not assumed to consume soil, and Fd for this case would be set to zero.

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B.4 Consumption of Drinking Water and Fish

The equations in this section calculate the contaminant concentration in the waterbody partitioned between dissolved phase, suspended sediment, and benthic sediment. Contaminant concentrations in fish are calculated from the contaminant concentrations in the waterbody, either dissolved or total water column concentrations or sediment concentrations. This is done in several steps.

The first step is to calculate the soil concentration resulting from deposition of particle phase and wet vapor phase contaminants onto soils and diffusion of dry vapor phase contaminant into soils at the location of maximum combined (wet and dry) deposition. The calculation of soil concentration includes a loss term which can account for loss of contaminant from the soil after deposition by several mechanisms, including leaching, erosion, runoff, degradation, and volatilization. These loss mechanisms all lower the soil concentration associated with a specific deposition rate. The degradation term is chemical-specific. However, the degradation term is also set to zero for all contaminants.

The second step is to calculate the load of contaminant to the waterbody (Tables B.4.7 through B.4.12) at the location of maximum combined (wet and dry) deposition. Five pathways cause contaminant loading of the waterbody: 1) direct deposition; 2) runoff from impervious surfaces within the watershed; 3) runoff from pervious surfaces within the watershed; 4) soil erosion from the watershed; and 5) direct diffusion of dry vapor phase contaminant into the surface water. Other pathways have been omitted or their contributions would be negligible compared with the pathways being evaluated. Internal transformation may be considered as a waterbody loading pathway but this pathway has also been omitted from the analysis. Instead, the effects of transformation processes for constituents which are transformed (e.g., inorganic mercury to methyl mercury) are implicit in the waterbody to fish tissue partitioning factor (e.g., the bioaccumulation factor for mercury). For each chemical, only the most important pathways are used.

The third step is to calculate the total waterbody concentration (in the water column and sediments) from the waterbody load (Table B.4.15) and to partition the total concentration into a dissolved water concentration, a total water column concentration, and a bed sediment concentration (Tables B.4.23 through B.4.25). Only one of these three concentrations is calculated for each chemical. Chemical dissipation from within the waterbody is also considered in this analysis, specifically the dissipation due to volatilization and burial in benthic sediment.

At this point the dissolved water concentration can be used to calculate the exposure due to drinking water ingestion (see Appendix C for equations). The dissolved water concentration is used because it is assumed that the drinking water is treated to remove suspended particles.

The final step is to calculate the concentration in fish from the total water column concentration, the dissolved water concentration, or the bed sediment concentration using a bioconcentration factor, a bioaccumulation factor, or a sediment bioaccumulation factor, as appropriate (Tables B.4.26 through B.4.28).

There are a number of site-specific parameters in the fish consumption pathway, including total time of deposition (Tc), meteorologic data, and the various parameters characterizing the waterbody. The total

time of deposition should be set to the expected lifetime of the combustion source (e.g., 30 years). The following guidance is provided on the waterbody parameters:

- Average annual recharge (q): Appropriate recharge values

- Average annual surface runoff (R): Surface runoff, R, can be estimated using the Water Atlas. This reference provides maps with isolines of annual average surface water runoff, which are defined as all flow contributions to surface water bodies, including direct runoff, shallow interflow, and ground water recharge. The range of values shown for North Carolina is 10 to 40 in/yr, with the lowest values occurring in the coastal region and increasing to the highest values in the mountains. Since these values are total contributions and not just surface runoff, they need to be reduced to estimate surface runoff. A reduction of 50 percent, or one half, should suffice if using the Water Atlas for the R term. More detailed, site-specific procedures for estimating the amount of surface runoff, such as those based on the U.S. Soil Conservation Service curve number equation (CNE), may also be used (see, for example, U.S. EPA, 1985). (Note that all values must be converted to cm/yr.)

- Waterbody surface area (WA_w): this should be estimated from local maps.

- Average volumetric flow (Vfx): average flows can be obtained from river and stream gauging stations. If data from gauging stations are not available, the average flow can be estimated based on the total upstream watershed area and the average runoff. The total upstream watershed area (in length squared units) is multiplied by a unit area surface water runoff (in length per time). The *Water Atlas of the United States* (Geraghty, et al., 1973) provides maps with isolines of annual average surface water runoff, which is defined as all flow contributions to surface water bodies, including direct runoff, shallow interflow, and groundwater recharge. Flows may vary from 10^5 m^3/yr in small streams or ponds draining less than a square kilometer to 10^9 m^3/yr or more in large rivers.

- Depth of the water column (d_w): depths can be obtained from gauging stations or be estimated based on other local data. Depths should represent the average depth of the water column, so far as is possible.

- Total watershed area (WA_L): see Section 5.2.1 for guidance on estimating the watershed area. This area should be the same as the effective drainage area.

- Impervious watershed area (WA_I): this is the portion of the total effective watershed area that is impervious to rainfall (e.g., roofs, driveways, streets, parking lots, etc.) and drains to the waterbody through a conveyance such as a gutter, storm sewer, ditch, or canal. It can be estimated based on land use and other local information.

- USLE rainfall factor (RF): The RF term represents the influence of precipitation on erosion, and is derived from data on the frequency and intensity of storms. This value is typically derived on a storm-by-storm basis, but average annual values have been compiled by county for North Carolina (U.S. Department of Agriculture, 1991) and range from 170 to 350. Values by county are provided in Table B.4.0.

Table B.4.0. Values of the USLE Rainfall Factor "R" for North Carolina by County

Alamance	230	Cumberland	300	Johnston	290	Randolph	240
Alexander	230	Currituck	320	Jones	340	Richmond	270
Alleghany	180	Dare	350	Lee	270	Robeson	310
Anson	260	Davidson	240	Lenoir	330	Rockingham	190
Ashe	180	Davie	230	Lincoln	260	Rowan	240
Avery	190	Duplin	330	McDowell	230	Rutherford	270
Beaufort	350	Durham	240	Macon	290	Sampson	320
Bertie	310	Edgecombe	290	Madison	170	Scotland	290
Bladen	320	Forsyth	210	Martin	310	Stanly	250
Brunswick	350	Franklin	260	Mecklinburg	250	Stokes	190
Buncombe	200	Gaston	260	Mitchell	170	Surry	200
Burke	250	Gates	300	Montgomery	260	Swain	230
Cabarrus	250	Graham	240	Moore	260	Transylvania	300
Caldwell	230	Granville	240	Nash	280	Tyrell	340
Camden	320	Greene	310	New Hanover	350	Union	250
Carteret	350	Guilford	220	Northampton	270	Vance	240
Caswell	200	Halifax	280	Onslow	350	Wake	270
Catawba	260	Harnett	280	Orange	240	Warren	250
Chatham	260	Haywood	200	Pamlico	350	Washington	330
Cherokee	260	Henderson	300	Pasquotank	320	Watauga	200
Chowan	320	Hertford	290	Pender	340	Wayne	310
Clay	270	Hoke	290	Perquimans	320	Wilkes	220
Cleveland	270	Hyde	350	Person	220	Wilson	290
Columbus	330	Iredell	240	Pitt	320	Yadkin	210
Craven	350	Jackson	290	Polk	270	Yancey	180

Table B.4.1. Watershed Soil Concentration Due to Deposition

Equation

Soil Concentration Averaged over Exposure Duration

$$Sc = \frac{\left(\frac{Ds \cdot Tc - Sc_{Tc}}{ks}\right) + \left(\frac{Sc_{Tc}}{ks} \cdot [1 - exp(-ks \cdot (T_2 - Tc)]\right)}{(T_2 - T_1)}$$

Highest Annual Average Soil Concentration

$$Sc_{Tc} = \frac{Ds \cdot (1 - exp(-ks \cdot Tc))}{ks}$$

$$Ds = \frac{100 \cdot Q}{z \cdot BD} \cdot [F_v \cdot (0.31536 \cdot Vdv \cdot Cywv + Dywwv) + (1 - F_v) \cdot Dytwp]$$

Parameter	Definition	Default Value
Sc	Average soil concentration of pollutant over exposure duration (mg/kg)	
Ds	Deposition term (mg/kg-yr)	
Tc	Time period over which deposition occurs (yr)	site-specific
Sc_{Tc}	Soil concentration at time Tc (mg/kg)	
ks	Soil loss constant (yr^{-1})	calculated (see Table B.1.2)
T_2	Exposure duration (yr)	scenario-specific (see Section 5.1)
Z	Soil mixing depth (cm)	1
BD	Soil bulk density (g/cm^3)	1.5
0.31536	Units conversion factor (m-g-s/cm-µg-yr)	

Table B.4.1. Soil Concentration Due to Deposition Continued

Parameter	Definition	Default Value
Vdv	Dry deposition velocity (cm/s)	3
Cywv	Normalized yearly watershed average vapor phase air concentration (μg-s/g-m^3)	modeled (see Section 5.2.1)
Q	Stack emissions (g/s)	site-specific
F_v	Fraction of air concentration in vapor phase (dimensionless)	chemical-specific (see Appendix A)
Dywwv	Normalized yearly watershed average wet deposition from vapor phase (s/m^2-yr)	modeled (see Section 5.2.1)
Dytwp	Normalized yearly watershed average total (wet and dry) deposition from particle phase (s/m^2-yr)	modeled (see Section 5.2.1)
100	Units conversion factor ([mg-m^2]/[kg-cm^2])	

Description

These equations calculate an average soil concentration over the exposure duration as a result of wet and dry deposition of particles and vapors to soil. Contaminants are assumed to be incorporated only to a finite depth (the mixing depth, Z).

The soil concentration averaged over the exposure duration should be used for carcinogenic chemicals, where the risk is averaged over the lifetime of an individual. Since the hazard quotient associated with noncarcinogenic chemicals is based on a reference dose and not on a lifetime exposure, the highest annual average soil concentration occurring within the exposure duration period should be used for noncarcinogenic chemicals. The highest annual average soil concentration would occur at the end of the time period of combustion and is represented by Sc_{TC}.

Table B.4.2. Soil Loss Constant

Equation
$ks = ksl + kse + ksr + ksg + ksv$

Parameter	Definition	Default Value
ks	Soil loss constant due to all processes (yr^{-1})	
ksl	Loss constant due to leaching (yr^{-1})	calculated (see Table B.4.3)
kse	Loss constant due to soil erosion (yr^{-1})	calculated (see Table B.4.4)
ksr	Loss constant due to surface runoff (yr^{-1})	calculated (see Table B.4.5)
ksg	Loss constant due to degradation (yr^{-1})	0
ksv	Loss constant due to volatilization (yr^{-1})	calculated (see Table B.4.6)

Description
This equation calculates the soil loss constant, which accounts for the loss of contaminant from soil by several mechanisms.

Table B.4.3. Loss Constant Due to Leaching

Equation

$$ksl = \frac{q}{\theta_s \cdot z \cdot [1.0 + (BD \cdot Kd_s / \theta_s)]}$$

Parameter	Definition	Default Value
ksl	Loss constant due to leaching (yr^{-1})	
q	Average annual recharge (cm/yr)	site-specific
θ_s	Soil volumetric water content (mL/cm^3)	0.2
z	Soil depth from which leaching removal occurs (cm)	1
Kd_s	Soil-water partition coefficient (cm^3/g)	chemical-specific (see Appendix A)
BD	Soil bulk density (g/cm^3)	1.5

Description

This equation calculates the contaminant loss constant due to leaching from soil.

Table B.4.4. Loss Constant Due to Erosion

Equation

$$kse = \frac{0.1 \cdot X_e \cdot SD \cdot ER}{BD \cdot z} \cdot \left(\frac{Kd_s \cdot BD}{\theta_s + (Kd_s \cdot BD)} \right)$$

Parameter	Definition	Default Value
kse	Loss constant due to erosion (yr^{-1})	
X_e	Unit soil loss ($kg/m^2/yr$)	calculated (see Table B.4.13)
SD	Sediment delivery ratio (unitless)	calculated (see Table B.4.14)
ER	Soil enrichment ratio (unitless)	3
z	Soil mixing depth (cm)	1
θ_s	Soil volumetric water content (mL/cm^3)	0.2
Kd_s	Soil-water partition coefficient (cm^3/g)	chemical-specific (see Appendix A)
BD	Soil bulk density (g/cm^3)	1.5

Description

This equation calculates the contaminant loss constant due to runoff from soil.

Table B.4.5. Loss Constant Due to Runoff

Equation

$$ksr = \frac{R}{\theta_s \cdot z} \cdot \left(\frac{1}{1 + (Kd_s \cdot BD / \theta_s)} \right)$$

Parameter	Definition	Default Value
ksr	Loss constant due to runoff (yr^{-1})	
R	Average annual runoff (cm/yr)	site-specific
θ_s	Soil volumetric water content (mL/cm^3)	0.2
z	Soil mixing depth (cm)	1
Kd_s	Soil-water partition coefficient (cm^3/g)	chemical-specific (see Appendix A)
BD	Soil bulk density (g/cm^3)	1.5

Description

This equation calculates the contaminant loss constant due to runoff from soil.

Table B.4.6. Loss Constant Due to Volatilization

Equation

$$ksv = \left[\frac{3.1536x10^{7} \cdot H}{z \cdot Kd_s \cdot R \cdot T \cdot BD}\right] \cdot \left[0.482 \cdot u^{0.78} \cdot \left(\frac{\mu_a}{\rho_a \cdot D_a}\right)^{-0.67} \cdot \left(\sqrt{\frac{4 \cdot A}{\pi}}\right)^{-0.11}\right]$$

Parameter	Definition	Default Value
ksv	Loss constant due to volatilization (yr^{-1})	
$3.1536x10^{7}$	Units conversion constant (s/yr)	
H	Henry's Law constant (atm-m^3/mol)	chemical-specific (see Appendix A)
z	Soil mixing depth (cm)	1
Kd_s	Soil-water partition coefficient (cm^3/g)	chemical-specific (see Appendix A)
R	Universal gas constant (atm-m^3/mol-K)	$8.205x10^{-5}$
BD	Soil bulk density (g/cm^3)	1.5
T	Ambient air temperature (K)	site-specific
u	Average annual wind speed (m/s)	site-specific
μ_a	Viscosity of air (g/cm-s)	$1.81x10^{-4}$
ρ_a	Density of air (g/cm^3)	$1.2x10^{-3}$
D_a	Diffusivity of contaminant in air (cm^2/s)	chemical-specific (see Appendix A)
A	Surface area of contaminated area (m^2)	site-specific

Description

This equation calculates the contaminant loss constant due to volatilization from soil.

Table B.4.7. Total Waterbody Load

Equation

$$L_T = L_{Dep} + L_{Df} + L_{RI} + L_R + L_E$$

Parameter	Definition	Default Value
L_T	Total contaminant load to the water body (g/yr)	
L_{Dep}	Total (wet and dry) particle phase and wet vapor phase contaminant direct deposition load to waterbody (g/yr)	calculated (see Table B.4.8)
L_{Dif}	Vapor phase contaminant diffusion (dry deposition) load to waterbody (g/yr)	calculated (see Table B.4.12)
L_{RI}	Runoff load from impervious surfaces (g/yr)	calculated (see Table B.4.9)
L_R	Runoff load from pervious surfaces (g/yr)	calculated (see Table B.4.10)
L_E	Soil erosion load (g/yr)	calculated (see Table B.4.11)

Description

This equation calculates the total average waterbody load from wet and dry vapor and particle deposition, runoff, and erosion loads.

Table B.4.8. Deposition to Waterbody

Equation

$$L_{Dep} = Q \cdot [\, F_v \cdot Dywwv + (1 - F_v) \cdot Dytwp \,] \cdot WA_w$$

Parameter	Definition	Default Value
L_{Dep}	Total (wet and dry) particle phase and wet vapor phase contaminant direct deposition load to waterbody (g/yr)	
Q	Stack emissions (g/s)	site-specific
F_v	Fraction of air concentration in vapor phase (dimensionless)	chemical-specific (see Appendix A)
Dywwv	Normalized yearly watershed average wet deposition from vapor phase (s/m^2-yr)	modeled (see Section 5.2.1)
Dytwp	Normalized yearly watershed average total (wet and dry) deposition from particle phase (s/m^2-yr)	modeled (see Section 5.2.1)
WA_w	Water body area (m^2)	site-specific

Description

This equation calculates the average load to the waterbody from direct deposition of wet and dry particles and wet vapors onto the surface of the waterbody.

Table B.4.9. Impervious Runoff Load to Waterbody

Equation

$$L_{RI} = Q \cdot [\, F_v \cdot Dywwv + (1.0 - F_v) \cdot Dytwp \,] \cdot WA_I$$

Parameter	Definition	Default Value
L_{RI}	Impervious surface runoff load (g/yr)	
WA_I	Impervious watershed area receiving pollutant deposition (m^2)	site-specific
Q	Stack emissions (g/s)	site-specific
F_v	Fraction of air concentration in vapor phase (dimensionless)	chemical-specific (see Appendix A)
Dywwv	Normalized yearly watershed average wet deposition from vapor phase (s/m^2-yr)	modeled (see Section 5.2.1)
Dytwp	Normalized yearly watershed average total (wet and dry) deposition from particle phase (s/m^2-yr)	modeled (see Section 5.2.1)

Description

This equation calculates the average runoff load to the waterbody from impervious surfaces in the watershed from which runoff is conveyed directly to the waterbody.

Table B.4.10. Pervious Runoff Load to Waterbody

Equation

$$L_R = R \cdot (WA_L - WA_I) \cdot \frac{Sc \cdot BD}{\theta_s + Kd_s \cdot BD} \cdot 0.01$$

Parameter	Definition	Default Value
L_R	Pervious surface runoff load (g/yr)	
R	Average annual surface runoff (cm/yr)	site-specific
Sc	Average soil concentration of pollutant over exposure duration in watershed soils (mg/kg)	calculated (see Table B.4.1)
BD	Soil bulk density (g/cm^3)	1.5
Kd_s	Soil-water partition coefficient (L/kg)	chemical-specific (see Appendix A)
WA_L	Total watershed area receiving pollutant deposition (m^2)	site-specific
WA_I	Impervious watershed area receiving pollutant deposition (m^2)	site-specific
0.01	Units conversion factor ($kg\text{-}cm^2/mg\text{-}m^2$)	
θ_s	Volumetric soil water content (cm^3/cm^3)	0.2

Description

This equation calculates the average runoff load to the waterbody from pervious soil surfaces in the watershed.

Table B.4.11. Erosion Load to Waterbody

Equation

$$L_E = X_e \cdot (WA_L - WA_I) \cdot SD \cdot ER \cdot \frac{Sc \cdot Kd_s \cdot BD}{\theta_s + Kd_s \cdot BD} \cdot 0.001$$

Parameter	Definition	Default Value
L_E	Soil erosion load (g/yr)	
X_e	Unit soil loss (kg/m^2/yr)	calculated (see Table B.4.13)
Sc	Average soil concentration of pollutant over exposure duration in watershed soils (mg/kg)	calculated (see Table B.4.1)
BD	Soil bulk density (g/cm^3)	1.5
θ_s	Volumetric soil water content (cm^3/cm^3)	0.2
Kd_s	Soil-water partition coefficient (L/kg)	chemical-specific (see Appendix A)
WA_L	Total watershed area receiving pollutant deposition (m^2)	site-specific
WA_I	Impervious watershed area receiving pollutant deposition (m^2)	site-specific
SD	Watershed sediment delivery ratio (unitless)	calculated (see Table B.4.14)
ER	Soil enrichment ratio (unitless)	3
0.001	Units conversion factor ([g/kg]/[mg/kg])	

Description

This equation calculates the load to the waterbody from soil erosion.

Table B.4.12. Diffusion Load to Waterbody

Equation

$$L_{Df} = \frac{Kv \cdot Q \cdot F_v \cdot Cywv \cdot WA_w \cdot 10^{-6}}{\frac{H}{R \cdot T_w}}$$

Parameter	Definition	Default Value
L_{Dif}	Dry vapor phase contaminant diffusion load to waterbody (g/yr)	
Q	Stack emissions (g/s)	site-specific
F_v	Fraction of air concentration in vapor phase (dimensionless)	chemical-specific (see Appendix A)
Kv	Diffusive mass transfer coefficient (m/yr)	calculated (see Table B.4.19)
Cywv	Normalized yearly watershed average vapor phase air concentration (µg-s/g-m^3)	modeled (see Section 5.2.1)
WA_w	Waterbody surface area (m^2)	site-specific
H	Henry's Law constant (atm-m^3/mol)	chemical-specific (see Appendix A)
R	Universal gas constant (atm-m^3/mol-K)	8.205×10^{-5}
T_w	Waterbody temperature (K)	298
10^{-6}	Units conversion factor (g/µg)	

Description

This equation calculates the load to the waterbody from soil erosion.

Table B.4.13. Universal Soil Loss Equation (USLE)

Equation

$$X_e = RF \cdot K \cdot LS \cdot C \cdot P \cdot \frac{907.18}{4047}$$

Parameter	Definition	Default Value
X_e	Unit soil loss ($kg/m^2/yr$)	
RF	USLE rainfall (or erosivity) factor (yr^{-1})	site-specific
K	USLE erodibility factor (ton/acre)	0.36
LS	USLE length-slope factor (unitless)	1.5
C	USLE cover management factor (unitless)	0.1
P	USLE supporting practice factor (unitless)	1
907.18	Conversion factor (kg/ton)	
4047	Conversion factor (m^2/acre)	

Description

This equation calculates the soil loss rate from the watershed, using the Universal Soil Loss Equation; the result is used in the soil erosion load equation.

Table B.4.14. Sediment Delivery Ratio

Equation
$SD = a \cdot (WA_L)^{-b}$

Parameter	Definition	Default Value
SD	Watershed sediment delivery ratio (unitless)	
WA_L	Total watershed area receiving pollutant deposition (m^2)	site-specific
b	Empirical slope coefficient	0.125
a	Empirical intercept coefficient	depends on watershed area; see table below

Description
This equation calculates the sediment delivery ratio for the watershed; the result is used in the soil erosion load equation.

Values for Empirical Intercept Coefficient, a

Watershed area (sq. miles)	"a" coefficient (unitless)
≤ 0.1	2.1
1	1.9
10	1.4
100	1.2
1,000	0.6
1 sq. mile = 2.59×10^6 m^2	

Table B.4.15. Total Waterbody Concentration

Equation

$$C_{wtot} = \frac{L_T}{Vf_x \cdot f_{water} + kwt \cdot WA_w \cdot (d_w + d_b)}$$

Parameter	Definition	Default Value
C_{wtot}	Total water body concentration, including water column and bed sediment (mg/L)	
L_T	Total chemical load into water body, including deposition, runoff, and erosion (g/yr)	calculated (see Table B.4.7)
Vf_x	Average volumetric flow rate through water body (m^3/yr)	site-specific
f_{water}	Fraction of total water body contaminant concentration that occurs in the water column (unitless)	calculated (see Table B.4.16)
kwt	Overall total waterbody dissipation rate constant (unitless)	calculated (see Table B.4.17)
WA_w	Water body surface area (m^2)	site-specific
d_w	Depth of water column (m)	site-specific
d_b	Depth of upper benthic layer (m)	0.03

Description

This equation calculates the total waterbody concentration, including both the water column and the bed sediment.

Table B.4.16. Fraction in Water Column and Benthic Sediment

Equation

$$f_{water} = \frac{(1 + Kd_{sw} \cdot TSS \cdot 10^{-6}) \cdot d_w/d_z}{(1 + Kd_{sw} \cdot TSS \cdot 10^{-6}) \cdot d_w/d_z + (\theta_{bs} + Kd_{bs} \cdot BS) \cdot d_b/d_z}$$

$$f_{benth} = 1 - f_{water}$$

Parameter	Definition	Default Value
f_{water}	Fraction of total water body contaminant concentration that occurs in the water column (unitless)	
Kd_{sw}	Suspended sediment/surface water partition coefficient (L/kg)	chemical-specific (see Appendix A)
TSS	Total suspended solids (mg/L)	10
10^{-6}	Conversion factor (kg/mg)	
d_w	Depth of water column (m)	site-specific
d_b	Depth of upper benthic layer (m)	0.03
d_z	Total waterbody depth (m)	calculated (d_w+d_b)
θ_{bs}	Bed sediment porosity (L_{water}/L)	0.6
Kd_{bs}	Bed sediment/sediment pore water partition coefficient (L/kg)	chemical-specific (see Appendix A)
BS	Bed sediment concentration (g/cm^3)	1.0
f_{benth}	Fraction of total water body contaminant concentration that occurs in the benthic sediment (unitless)	

Description

These equations calculate the fraction of total waterbody concentration occurring in the water column and the bed sediments.

Table B.4.17. Overall Total Waterbody Dissipation Rate Constant

Equation

$$k_{wt} = f_{water} \cdot k_v + f_{benth} \cdot k_b$$

Parameter	Definition	Default Value
k_{wt}	Overall total waterbody dissipation rate constant (yr^{-1})	
f_{water}	Fraction of total waterbody contaminant concentration that occurs in the water column (unitless)	calculated (see Table B.4.16)
k_v	Water column volatilization rate constant (yr^{-1})	calculated (see Table B.4.18)
f_{benth}	Fraction of total waterbody contaminant concentration that occurs in the benthic sediment (unitless)	calculated (see Table B.4.16)
k_b	Benthic burial rate constant (yr^{-1})	calculated (see Table B.4.22)

Description

This equation calculates the overall dissipation rate of contaminant in surface water due to volatilization and benthic burial.

Table B.4.18. Water Column Volatilization Loss Rate Constant

Equation

$$k_v = \frac{K_v}{d_z \cdot (1 + Kd_{sw} \cdot TSS \cdot 10^{-6})}$$

Parameter	Definition	Default Value
k_v	Water column volatilization rate constant (yr^{-1})	
K_v	Overall transfer rate (m/yr)	calculated (see Table B.4.19)
d_z	Total waterbody depth (m)	calculated (d_w+d_b)
Kd_{sw}	Suspended sediment/surface water partition coefficient (L/kg)	chemical-specific (see Appendix A)
TSS	Total suspended solids (mg/L)	10
10^{-6}	Conversion factor (kg/mg)	

Description

This equation calculates the water column contaminant loss due to volatilization.

Table B.4.19. Overall Transfer Rate

Equation

$$K_v = \left[K_L^{-1} + \left(K_G \frac{H}{R \cdot T_k} \right)^{-1} \right]^{-1} \cdot \theta^{(T_k - 293)}$$

Parameter	Definition	Default Value
K_v	Overall transfer rate (m/yr)	
K_L	Liquid phase transfer coefficient (m/yr)	calculated (see Table B.4.20)
K_G	Gas phase transfer coefficient (m/yr)	calculated (see Table B.4.21)
H	Henry's Law constant (atm-m^3/mol)	chemical-specific (see Appendix A)
R	Universal gas constant (atm-m^3/mol-K)	8.205×10^{-5}
T_k	Waterbody temperature (K)	298
θ	Temperature correction factor (unitless)	1.026

Description

This equation calculates the overall transfer rate of contaminant from the liquid and gas phases in surface water.

Table B.4.20. Liquid Phase Transfer Coefficient

Equation

- Flowing stream or river

$$K_L = \sqrt{\frac{10^{-4} \cdot D_w \cdot u}{d_z}} \cdot 3.15x10^7$$

- Quiescent lake or pond

$$K_L = (C_d^{0.5} \cdot W) \cdot \left(\frac{\rho_a}{\rho_w}\right)^{0.5} \cdot \left(\frac{k^{0.33}}{\lambda_2}\right) \cdot \left(\frac{\mu_w}{\rho_w \cdot D_w}\right)^{-0.67} \cdot 3.15x10^7$$

Parameter	Definition	Default Value
K_L	Liquid phase transfer coefficient (m/yr)	
D_w	Diffusivity of chemical in water (cm^2/s)	chemical-specific (see Appendix A)
u	Current velocity (m/s)	site-specific
d_z	Total waterbody depth (m)	calculated (d_w+d_b)
C_d	Drag coefficient	0.0011
W	Wind velocity,10m above water surface (m/s)	site-specific
ρ_a	Density of air corresponding to water temperature (g/cm^3)	1.2×10^{-3}
ρ_w	Density of water corresponding to water temperature (g/cm^3)	1
k	von Karman's constant	0.4
λ_2	Dimensionless viscous sublayer thickness	4
μ_w	Viscosity of water corresponding to water temperature (g/cm-s)	1.69×10^{-2}
$3.15x10^7$	Conversion constant (s/yr)	

Description

This equation calculates the transfer rate of contaminant from the liquid phase for a flowing or quiescent system.

Table B.4.21. Gas Phase Transfer Coefficient

Equation

- Flowing stream or river

$$K_G = 36500\ m/yr$$

- Quiescent lake or pond

$$K_G = (C_d^{0.5} \cdot W) \cdot \left(\frac{k^{0.33}}{\lambda_2} \right) \cdot \left(\frac{\mu_a}{\rho_a \cdot D_a} \right)^{-0.67} \cdot 3.15x10^7$$

Parameter	Definition	Default Value
K_G	Gas phase transfer coefficient (m/yr)	
C_d	Drag coefficient	0.0011
W	Wind velocity,10m above water surface (m/s)	site-specific
k	von Karman's constant	0.4
λ_2	Dimensionless viscous sublayer thickness	4
μ_a	Viscosity of air corresponding to the air temperature (g/cm-s)	1.81×10^{-4}
ρ_a	Density of air corresponding to water temperature (g/cm^3)	1.2×10^{-3}
D_a	Diffusivity of chemical in air (cm^2/s)	chemical-specific (see Appendix A)
$3.15x10^7$	Conversion constant (s/yr)	

Description

This equation calculates the transfer rate of contaminant from the gas phase for a flowing or quiescent system.

Table B.4.22. Benthic Burial Rate Constant

Equation

$$k_b = \left(\frac{X_e \cdot WA_L \cdot SD \cdot 10^3 - Vf_x \cdot TSS}{WA_w \cdot TSS} \right) \left(\frac{TSS \cdot 10^{-6}}{BS \cdot d_b} \right)$$

Parameter	Definition	Default Value
k_b	Benthic burial rate constant (yr^{-1})	
X_e	Unit soil loss ($kg/m^2/yr$)	calculated (see Table B.4.13)
WA_L	Watershed area receiving fallout (m^2)	site-specific
SD	Watershed sediment delivery ratio (unitless)	calculated (see Table B.4.14)
10^3	Conversion factor (g/kg)	
Vf_x	Average volumetric flow rate through waterbody (m^3/yr)	site-specific
TSS	Total suspended solids (mg/L) or (g/m^3)	10
WA_w	Water body surface area (m^2)	site-specific
BS	Benthic solids concentration (kg/L)	1
d_b	Depth of upper benthic layer (m)	0.03
10^{-6}	Conversion factor (kg/mg)	

Description

This equation calculates the water column contaminant loss due to burial in benthic sediment.

Table B.4.23. Total Water Column Concentration

Equation

$$C_{wt} = f_{water} \cdot C_{wtot} \cdot \frac{d_w + d_b}{d_w}$$

Parameter	Definition	Default Value
C_{wt}	Total concentration in water column (mg/L)	
f_{water}	Fraction of total water body contaminant concentration that occurs in the water column (unitless)	calculated (see Table B.4.16)
C_{wtot}	Total water concentration in surface water system, including water column and bed sediment (mg/L)	calculated (see Table B.4.15)
d_b	Depth of upper benthic layer (m)	0.03
d_w	Depth of water column (m)	site-specific

Description

This equation calculates the total water column concentration of contaminant; this includes both dissolved contaminant and contaminant sorbed to suspended solids.

Table B.4.24. Dissolved Water Concentration

Equation

$$C_{dw} = \frac{C_{wt}}{1 + Kd_{sw} \cdot TSS \cdot 10^{-6}}$$

Parameter	Definition	Default Value
C_{dw}	Dissolved phase water concentration (mg/L)	
C_{wt}	Total water column concentration (mg/L)	calculated (see Table B.4.23)
Kd_{sw}	Suspended sediment/surface water partition coefficient (L/kg)	chemical-specific (see Appendix A)
TSS	Total suspended solids (mg/L)	10

Description

This equation calculates the concentration of contaminant dissolved in the water column.

Table B.4.25. Concentration Sorbed to Bed Sediment

Equation

$$C_{sb} = f_{benth} \cdot C_{wtot} \cdot \frac{Kd_{bs}}{\theta_{bs} + Kd_{bs} \cdot BS} \cdot \frac{d_w + d_b}{d_b}$$

Parameter	Definition	Default Value
C_{sb}	Concentration sorbed to bed sediments (mg/kg)	
f_{benth}	Fraction of total water body contaminant concentration that occurs in the bed sediment (unitless)	calculated (see Table B.4.16)
C_{wtot}	Total water body concentration, including water column and bed sediment (mg/L)	calculated (see Table B.4.15)
d_w	Depth of water column (m)	site-specific
d_b	Depth of the upper benthic layer (m)	0.03
θ_{bs}	Bed sediment porosity (unitless)	0.6
Kd_{bs}	Bed sediment/sediment pore water partition coefficient (L/kg)	chemical-specific (see Appendix A)
BS	Bed sediment concentration (kg/L)	1.0

Description

This equation calculates the concentration of contaminant sorbed to bed sediments.

Table B.4.26. Fish Concentration from Dissolved Water Concentration

Equation
$C_{fish} = C_{dw} \cdot BCF$

Parameter	Definition	Default Value
C_{fish}	Fish concentration (mg/kg)	
C_{dw}	Dissolved phase water concentration (mg/L)	calculated (see Table B.4.24)
BCF	Bioconcentration factor (L/kg)	chemical-specific (see Appendix A)

Description
This equation calculates fish concentration from dissolved water concentration, using a bioconcentration factor.

Table B.4.27. Fish Concentration from Total Water Column Concentration

Equation
$C_{fish} = C_{wt} \cdot BAF$

Parameter	Definition	Default Value
C_{fish}	Fish concentration (mg/kg)	
C_{wt}	Total water column concentration (mg/L)	calculated (see Table B.4.23)
BAF	Bioaccumulation factor (L/kg)	chemical-specific (see Appendix A)

Description
This equation calculates fish concentration from total water column concentration, using a bioaccumulation factor.

Table B.4.28. Fish Concentration from Bed Sediments

Equation

$$C_{fish} = \frac{C_{sb} \cdot f_{lipid} \cdot BSAF}{OC_{sed}}$$

Parameter	Definition	Default Value
C_{fish}	Fish concentration (mg/kg)	
C_{sb}	Concentration sorbed to bed sediment (mg/kg)	calculated (see Table B.4.25)
f_{lipid}	Fish lipid content (fraction)	0.07
BSAF	Biota to sediment accumulation factor (unitless)	chemical-specific (see Appendix A)
OC_{sed}	Fraction organic carbon in bottom sediment (unitless)	0.04

Description

This equation calculates fish concentration from bed sediment concentration, using a biota-to-sediment accumulation factor.

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B.5 Direct Inhalation

The following equation is used to calculate the air concentration of a pollutant based on separate air modeling runs for the vapor phase and particle phase described in Section 5.2.1. It should be noted that this equation applies to a much larger group of constituents than those used for the indirect pathways. Direct inhalation calculations should be completed for all emissions from the stack that have inhalation health benchmarks such as a Reference Concentration (RfC) or inhalation slope factor or unit risk estimate. The *"Implementation Guidance for Conducting Indirect Exposure Analysis at RCRA Combustion Units"* provides guidance on the particles of incomplete combustion (PICs) that should be included in an assessment and the health benchmarks available for each.

Table B.5.1 Air Concentration

Equation
$C_a = Q \cdot [F_v \cdot Cyv + (1.0 - F_v) \cdot Cyp]$

Parameter	Definition	Default Value
C_a	Total air concentration (µg/m^3)	
Q	Stack emissions (g/s)	site-specific
F_v	Fraction of air concentration in vapor phase (dimensionless)	chemical-specific (see Appendix A)
Cyv	Normalized vapor phase air concentration (µg - s/g - m^3)	modeled (see Section 5.2.1)
Cyp	Normalized particle phase air concentration (µg - s/g - m^3)	modeled (see Section 5.2.1)

Description
This equation calculates the total air concentration of a constituent based on the fraction in vapor phase and the fraction in particle phase.

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APPENDIX C

RISK CHARACTERIZATION EQUATIONS

This appendix presents the equations needed to calculate dose estimates and risk assessment endpoints. Attachment C provides examples of the types of tables that would be presented in this appendix.

APPENDIX C. RISK CHARACTERIZATION

Characterization of risk is the final step of the risk assessment. In this step, for each exposure scenario the health effects criteria or benchmarks are used in conjunction with dose estimates which are calculated for each exposure pathway to arrive at the risk assessment endpoints. The assessment endpoints of the risk assessment are as follows: a) the increased probability of cancer in an individual over a lifetime, referred to as the excess lifetime individual cancer risk (or simply, individual cancer risk) arising from both oral and inhalation routes of exposure; b) for oral exposures, a measure of an individual's exposure to chemicals with noncancer health effects relative to the reference dose (RfD), referred to as the hazard quotient; c) for inhalation exposures, a hazard quotient relative to the reference concentration (RfC) in air; and d) where appropriate, a hazard index which represents the combined hazard quotients for those chemicals with the same noncancer health effects. Although oral and inhalation routes of exposure are handled separately in the assessment, the individual risks associated with exposures to carcinogenic chemicals are combined for the oral and inhalation routes of exposure.

Indirect Exposures

In the indirect exposure equations, an estimate is made of the dose (or intake) of each contaminant from all oral routes of exposure (Tables C.1.1 to C.1.5). Exposure parameters listed in the equations (the consumption rates, body weights, and exposure durations) will vary for different scenarios. The total daily oral intake is calculated by summing the intake from each pathway, as appropriate for the tier and the scenario (Table C.1.6). For the carcinogens, cancer risks are added across chemicals (Table C.1.9). For noncancer health effects, hazard quotients are added across chemicals only when they target the same organ. Therefore, the hazard quotients from chemicals that target the same organ are added together to calculate an overall hazard index for each organ effect (Table C.1.10).

Infant Exposure Through Breast Milk

The dioxin exposure assessment document released by the Office of Research and Development in April 1994, presents procedures for calculating infant exposures to dioxins and other lipophilic compounds through ingestion of human breast milk. The procedures are based on the intake of the contaminant by the mother. The exposure to an infant from breast feeding can be presented as an average daily dose (ADD) or a lifetime average daily dose (LADD). The ADD to the infant over a one year averaging time is predicted to be much higher (e.g. 30 to 60 times higher) than the ADD for the mother. However, if a 70 year averaging time is used, then the LADD to the infant is below the lower end of the range for the mother's LADD. Research is incomplete however in the area of calculating risk for infant exposures to dioxin-like compounds in breast milk. One method of risk characterization, and the method used in this document, is comparison of the ADD to the average adult background level for dioxin exposure, 50 pg/kg/day. Algorithms for calculating the ADD for infant exposure are presented as Equations C.3.1 and C.3.2.

The remainder of this section is organized as follows. The tables for characterizing risk from indirect exposures are given in Section C.1. Characterizing risk from direct inhalation exposures is covered in Section C.2. Characterizing the risk to breast-fed infants is discussed for adult exposure scenarios in Section C.3.

The overall cancer risk for an individual is calculated by the following equation:

$$\text{Overall Cancer Risk} = \sum \text{Cancer Risk}_{\text{inhalation}} + \sum \text{Cancer Risk}_{\text{oral}}$$

The overall hazard index for noncancer health effects is calculated by the following equation:

$$\text{Overall Hazard Index} = \text{Hazard Index}_{\text{inhalation}} + \text{Hazard Index}_{\text{oral}}$$

Table C.1.1. Contaminant Intake from Soil

$$I_{soil} = Sc \cdot CR_{soil} \cdot F_{soil}$$

Parameter	Description	Values
I_{soil}	Daily intake of contaminant from soil (mg/d)	
Sc	Average soil concentration of pollutant over exposure duration (mg/kg)	calculated (see Appendix B)
CR_{soil}	Consumption rate of soil (kg/d)	varies (see Section 5.1 or Appendix D)
F_{soil}	Fraction of consumed soil contaminated (unitless)	1

Description

This equation calculates the daily intake of contaminant from soil consumption. The soil concentration will vary with each scenario, and the soil consumption rate varies for children and adults.

Table C.1.2. Contaminant Intake from Aboveground Produce

$$I_{ag} = (Pd + Pv + Pr) \cdot CR_{ag} \cdot F_{ag}$$

Parameter	Description	Values
I_{ag}	Daily intake of contaminant from aboveground produce (mg/day)	
Pd	Concentration in above-ground produce due to deposition (mg/kg Dw)	calculated (see Appendix B)
Pv	Concentration in above-ground produce due to air-to-plant transfer (mg/kg Dw)	calculated (see Appendix B)
Pr	Concentration in aboveground produce due to root uptake (mg/kg Dw)	calculated (see Appendix B)
CR_{ag}	Consumption rate of aboveground produce for dioxins (kg Fw/d); metals (kg Dw/d)	varies (see Section 5.1 or Appendix D)
F_{ag}	Fraction of above-ground produce contaminated (unitless)	varies (see Section 5.1)

Description

This equation calculates the daily intake of contaminant from ingestion of aboveground produce. The consumption rate varies for children and adults and for the type of produce. The contaminated fraction and the concentration in aboveground produce will also vary with each scenario.

Table C.1.3. Contaminant Intake from Beef, Milk, Pork, Poultry and Eggs

$$I_i = A_i \bullet CR_i \bullet F_i$$

Parameter	Description	Values
I_i	Daily intake of contaminant from animal tissue i (mg/d)	
A_i	Concentration in animal tissue i (mg/kg Fw)[1]	calculated (see Appendix B)
CR_i	Consumption rate of animal tissue i (kg Fw/d)[6]	varies (see Section 5.1 or Appendix D)
F_i	Fraction of animal tissue i contaminated (unitless)	varies (see Section 5.1)

Description

This equation calculates the daily intake of contaminant from ingestion of animal tissue (where the "*i*" in the above equation refers to beef, milk, pork, poultry, or eggs). Intake of poultry and eggs is only applicable to dioxins. The consumption rate varies for children and adults and for the type of animal tissue. The contaminated fraction and the concentration in the animal tissue will also vary with each scenario.

1 For the metals mercury, selenium, and cadmium, the concentration in beef, milk, and pork and the consumption rate are in kilograms dry weight per day. Wet weight to dry weight conversion factors for beef and milk are 0.4 and 0.1, respectively. The pork conversion factor is assumed equal to the beef conversion factor.

Table C.1.4. Contaminant Intake from Fish

$$I_{fish} = C_{fish} \bullet CR_{fish} \bullet F_{fish}$$

Parameter	Description	Values
I_{fish}	Daily intake of contaminant from fish (mg/d)	
C_{fish}	Fish concentration (mg/kg)	calculated (see Appendix B)
CR_{fish}	Consumption rate of fish (kg/d)	varies (see Section 5.1 or Appendix D)
F_{fish}	Fraction of fish contaminated (unitless)	varies (see Section 5.1)

Description

This equation calculates the daily intake of contaminant from ingestion of fish. The contaminant concentration in fish will vary for each waterbody. The consumption rate varies for children and adults and for scenario. The contaminated fraction will also vary with each scenario, with the subsistence and recreational fisher contaminated fraction equal to 1.

Table C.1.5. Contaminant Intake from Drinking Water

$$I_{dw} = C_{dw} \cdot CR_{dw} \cdot F_d$$

Parameter	Description	Values
I_{dw}	Daily intake of contaminant from drinking water (mg/d)	
C_{dw}	Dissolved phase water concentration (mg/L)	calculated (see Appendix B)
CR_{dw}	Consumption rate of drinking water (L/d)	varies (see Section 5.1 or Appendix D)
F_{dw}	Fraction of drinking water contaminated (unitless)	1

Description

This equation calculates the intake of contaminant from drinking water. The contaminant concentration will vary for each waterbody. The consumption rate varies for adult and children.

Table C.1.6. Total Daily Intake - Tier 1 and Tier 2

Adult and Child Home Gardener

$$I = I_{soil} + I_{ag} + I_{dw}$$

Subsistence Farmer

$$I = I_{soil} + I_{ag} + I_{beef} + I_{milk} + I_{dw}$$

Subsistence Fisher

$$I = I_{soil} + I_{ag} + I_{fish} + I_{dw}$$

Parameter	Description	Values
I	Total daily intake of contaminant (mg/d)	
I_{soil}	Daily intake of contaminant from soil (mg/d)	calculated (see Appendix C.1.1)
I_{ag}	Daily intake of contaminant from above-ground produce (mg/d)	calculated (see Appendix C.1.2)
I_{beef}, I_{milk}	Daily intake of contaminant from animal tissue (mg/d)	calculated (see Appendix C.1.3)
I_{fish}	Daily intake of contaminant from fish (mg/d)	calculated (see Appendix C.1.4)
I_{dw}	Daily intake of contaminant from drinking water (mg/d)	calculated (see Appendix C.1.5)

Description

This equation calculates the daily intake of contaminant via all indirect pathways for the Tier 1 and Tier 2 analysis. The intake of drinking water should be included only if a surface water body has been identified as a drinking water source.

Table C1.6. (Continued) Total Daily Intake - Tier 3 Analysis

$$I = I_{soil} + I_{ag} + I_{beef} + I_{milk} + I_{pork} + I_{poultry} + I_{eggs} + I_{fish} + I_{dw}$$

Parameter	Description	Values
I	Total daily intake of contaminant (mg/d)	
I_{soil}	Daily intake of contaminant from soil (mg/d)	calculated (see Table C.1.1)
I_{ag}	Daily intake of contaminant from above-ground produce (mg/d)	calculated (see Table C.1.2)
I_{beef}, I_{milk}, I_{pork}, $I_{poultry}$, I_{eggs}	Daily intake of contaminant from animal tissue (mg/d)	calculated (see Table C.1.3)
I_{fish}	Daily intake of contaminant from fish (mg/d)	calculated (see Table C.1.4)
I_{dw}	Daily intake of contaminant from drinking water (mg/d)	calculated (see Table C.1.5)

Description

This equation calculates the daily intake of contaminant via all indirect pathways. In the Tier 3 analysis, each scenario may be exposed through all of the pathways, as noted in the table, depending upon site-specific activity patterns. The intake of drinking water should be included only if a surface water body has been identified as a drinking water source. Ingestion of poultry and eggs is only applicable to dioxins.

A description of the scenarios recommended for the Tier 3 analysis is given in Section 5.1.

Table C.1.7. Individual Cancer Risk: Carcinogens

$$Cancer\ Risk = \frac{I \cdot ED \cdot EF \cdot CSF}{BW \cdot AT \cdot 365}$$

Parameter	Description	Values
Cancer Risk	Individual lifetime cancer risk (unitless)	
I	Total daily intake of contaminant (mg/d)	calculated (see Table C.1.6)
ED	Exposure duration (yr)	subsistence farmer: 40 subsistence fisher: 30 adult resident: 30 child resident: 6
EF	Exposure frequency (day/yr)	350
BW	Body weight (kg)	adult: 70 child: 15
AT	Averaging time (yr)	70
365	Units conversion factor (day/yr)	
CSF	Oral cancer slope factor (per mg/kg/d)	chemical-specific (see Appendix A)

Description

This equation calculates the individual cancer risk from indirect exposure to carcinogenic chemicals. The body weight varies for the child and the adult. The exposure duration varies for different scenarios.

Table C.1.8. Hazard Quotient : Noncarcinogens

$$HQ = \frac{I}{BW \cdot RfD}$$

Parameter	Description	Values
HQ	Hazard quotient (unitless)	
I	Total daily intake of contaminant (mg/d)	calculated (see Table C.1.6)
BW	Body weight (kg)	adult: 70 child: 15
RfD	Reference Dose (mg/kg/d)	chemical-specific (see Appendix A)

Description

This equation calculates the hazard quotient for indirect exposure to noncarcinogenic chemicals. The body weight varies for the child and the adult.

Table C.1.9. Total Cancer Risk for Subsistence Farmer Scenario: Carcinogens

$$Total\ Cancer\ Risk = \sum_i Cancer\ Risk_i$$

Parameter	Description	Value
Total Cancer Risk	Total individual lifetime cancer risk for all chemicals (unitless)	
Cancer Risk$_i$	Individual lifetime cancer risk for chemical carcinogen I (unitless)	calculated (see Table C.1.7)

Description

For carcinogens, cancer risks are added across all carcinogenic chemicals. See Appendix A for identification of carcinogens.

Table C.1.10. Hazard Index for Specific Organ Effects for Subsistence Farmer Scenario: Noncarcinogens

$$HI_j = \sum_i HQ_i$$

Parameter	Description	Value
HI_j	Hazard index for specific organ effect j (unitless)	
HQ_i	Hazard quotient for chemical I with specific organ effect j (unitless)	calculated (see Table C.1.8)

Description

For noncancer health effects, hazard quotients are added across chemicals when they target the same organ to calculate an overall hard index. See Appendix A for identification of noncarcinogens and their associated target organ.

C.2 Direct Inhalation Exposures

This section provides the equations needed for characterizing risk from direct inhalation exposures for all exposure scenarios. The following equation tables are included:

Table C.2.1. Inhalation Cancer Risk for Individual Chemicals from Unit Risk Factor: Carcinogens
Table C.2.2. Inhalation Cancer Risk for Individual Chemicals from Carcinogenic Slope Factor: Carcinogens
Table C.2.3. Inhalation Hazard Quotient for Individual Chemicals: Noncarcinogens
Table C.2.4. Total Inhalation Cancer Risk: Carcinogens
Table C.2.5. Hazard Index for Inhalation: Noncarcinogens

Table C.2.1. Inhalation Cancer Risk for Individual Chemicals from Unit Risk Factor: Carcinogens

$$Cancer\ Risk = C_a \cdot URF$$

Parameter	Description	Value
Cancer Risk	Individual Lifetime cancer risk (unitless)	
C_a	Concentration in air ($\mu g/m^3$)	calculated (see Appendix B)
URF	Inhalation Unit Risk Factor (per $\mu g/m^3$)	chemical-specific (see Appendix A)

Table C.2.2. Inhalation Cancer Risk for Individual Chemicals from Carcinogenic Slope Factor: Carcinogens

$$Cancer\ Risk = ADI \cdot CSF_{inh}$$

$$ADI = \frac{C_a \cdot IR \cdot ET \cdot EF \cdot ED \cdot 0.001\ mg/\mu g}{BW \cdot AT \cdot 365\ day/yr}$$

Parameter	Description	Value
Cancer Risk	Individual Lifetime cancer risk (unitless)	
ADI	Average daily intake via inhalation (mg/kg/day)	
C_a	Concentration in air (µg/m^3)	calculated (see Appendix B)
IR	Inhalation rate (m^3/hr)	adult: 0.83 child: 0.3
ET	Exposure time (hr/day)	24
EF	Exposure frequency (day/yr)	350
ED	Exposure duration (yr)	subsistence farmer: 40 subsistence fisher: 30 adult resident: 30 child resident: 6
BW	Body weight (kg)	adult: 70 child: 15
AT	Averaging time (yr)	70
CSF_{inh}	Inhalation Carcinogenic Slope Factor (per mg/kg/day)	chemical-specific (see Appendix A)

Table C.2.3. Inhalation Hazard Quotient for Individual Chemicals: Noncarcinogens

$$HQ = \frac{C_a \cdot 0.001\ mg/\mu g}{RfC}$$

Parameter	Description	Value
HQ	Hazard quotient (unitless)	
C_a	Concentration in air ($\mu g/m^3$)	calculated (see Appendix B)
RfC	Reference Concentration (mg/m^3)	chemical-specific (see Appendix A)

Table C.2.4. Total Inhalation Cancer Risk: Carcinogens

$$Total\ Cancer\ Risk = \sum_i Cancer\ Risk_i$$

Parameter	Description	Value
Total Cancer Risk	Total individual lifetime cancer risk for all chemicals (unitless)	
Cancer Risk$_i$	Individual lifetime cancer risk for chemical carcinogen I (unitless)	calculated (see Tables C.2.1, C.2.2)

Description

For carcinogens, cancer risks are added across all carcinogenic chemicals. See Appendix A for identification of carcinogens.

Table C.2.5. Hazard Index for Inhalation: Noncarcinogens

$$HI_{inh} = \sum_i HQ_i$$

Parameter	Description	Value
HI_{inh}	Hazard index for inhalation (unitless)	
HQ_i	Hazard quotient for chemical I (unitless)	calculated (see Table C.2.3)

Description

For noncancer health effects, hazard quotients are added across chemicals when they target the same organ to calculate an overall hazard index. See Appendix A for identification of noncarcinogens and their associated target organ.

C.3 Breast Milk Exposure for Dioxins

To determine the average daily dose for a breast-feeding infant, the concentration of dioxin in the mother's milk must first be determined. Table C.3.1 provides equations for calculating the concentration of dioxin in maternal milk. Once the contaminant concentration in maternal milk is determined, the equation in Table C.3.2 is used to determine the average daily dose for infant exposure in pg/kg/day.

Further research is required in the area of risk characterization of infant exposures. Many questions still exist about how to quantify a lifetime risk for exposure during this very short and developmentally critical period of time. The significance of the average daily dose calculation is unclear, especially considering that many dioxin-like compounds reach steady-state levels only during chronic exposures. As research provides new and better methods of characterizing breastmilk exposure they should be thoughtfully considered. Until that point, this guidance suggests that the average daily dose for one year of breastmilk exposure be compared to the average adult background exposure level for 2,3,7,8-TCDD-TEQ of 50 pg/kg/day, as suggested in the Dioxin Exposure Document.

Table C.3.1. Concentration in Maternal Milk

$$C_{(milkfat)} = \frac{I \cdot 10^9 \cdot h \cdot f_1}{0.693 \cdot f_2 \cdot BW_{adult}}$$

Parameter	Description	Value
$C_{(milkfat)}$	Concentration in maternal milk for a given exposure scenario (pg/kg of milkfat)	
I	Average maternal intake of dioxin for each adult exposure scenario (mg/day)	calculated (see Table C.1.6)
10^9	Conversion constant (pg/mg)	
h	Half-life of dioxin in adults (days)	2555
f_1	Proportion of ingested dioxin that is stored in fat (unitless)	0.9
f_2	Proportion of mother's weight that is fat (unitless)	0.3
BW (adult)	Adult Body Weight (kg)	70

Table C.3.2. Average Daily Dose to the Exposed Infant

$$ADD_{(infant)} = \frac{C_{(milkfat)} \cdot f_3 \cdot f_4 \cdot IR_{milk} \cdot ED}{BW_{infant} \cdot AT}$$

Parameter	Description	Value
$ADD_{(infant)}$	Average daily dose for infant exposed to contaminated breastmilk (pg/kg/day)	
$C_{(milkfat)}$	Concentration in maternal milk for a given exposure scenario (pg/kg of milkfat)	calculated (see Table C.3.1)
f_3	Fraction of fat in breastmilk (unitless)	0.04
f_4	Fraction ingested contaminant which is absorbed (unitless)	0.9
IR_{milk}	Ingestion rate of breastmilk (kg/d)	0.8
ED	Exposure duration (year)	1
BW_{infant}	Body weight of infant (kg)	10
AT	Averaging time (year)	1

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APPENDIX D

DATA SOURCES FOR FATE AND TRANSPORT AND EXPOSURE PARAMETERS

This appendix lists fate and transport and exposure parameters that can be used as default values for the tiered analysis.

APPENDIX D. DATA SOURCES FOR FATE AND TRANSPORT AND EXPOSURE PARAMETERS

Appendix D lists fate and transport and exposure parameters that can be used as default values for the tiered analysis. A complete reference list for the derivation of the default parameters is included at the end of this appendix.

The scenario exposure parameters and their data sources are listed in Table D.1. Exposure parameters include body weight, consumption rates, inhalation rates, and exposure durations. These parameters represent national averages and should be adjusted to reflect site-specific behaviors and activity patterns if necessary.

Table D.2 contains the references and values for the fate and transport parameters. The fate and transport parameters given in the table represent national averages and should be adjusted to reflect values more typical of North Carolina if necessary.

Table D.1. Summary of Exposure Inputs

Parameter	Exposure Factor		Reference
Inhalation of Air			
Intake rate of air (m^3/d)	adult child	20 12	US EPA (1990a)
Ingestion of Drinking Water			
Consumption rate of drinking water (L/d)	adult child	1.4 0.5	US EPA (1990a)
Ingestion of Soil			
Consumption rate of soil (kg/d)	adult child	0.1 0.2	US EPA (1990a)
Ingestion of Produce			
Consumption rate of aboveground produce (g DW/d)	adult child	19.7 14	Adult: US EPA (1990a) and US EPA (1994) Child: US EPA (1994b)
Ingestion of Animal Products			
Consumption rate of beef (g FW/d)[1]	adult child	57 32	USDA (1993)
Consumption rate of milk (g FW/d)[1]	adult child	181 353	USDA (1993)
Consumption rate of pork (g FW/d)[1]	adult child	17 9	USDA (1993)
Consumption rate of chicken (g FW/d)	adult child	34 17	USDA (1993)
Consumption rate of eggs (g FW/d)	adult child	23 11	USDA (1993)

[1] For the metals mercury, cadmium, and selenium, these consumption rates have to be multiplied by dry weight conversion factors before being used to calculate individual hazard quotients. The conversion factors are 0.4 and 0.1 for beef and milk, respectively (Memorandum, Lorber, 1995). The conversion factor for pork is assumed to equal that for beef.

Table D.1. Summary of Exposure Inputs

Parameter	Exposure Factor		Reference
Ingestion of Fish			
Consumption rate of fish (g/d)	Subsistence fisher Recreational fisher Other adults Child	60 30 1.64 0.35	Columbia River (1994) Murray and Burmaster (1994) FIMS (1993) USDA (1978)
Ingestion of Breastmilk by the Infant			
Ingestion rate of breastmilk (kg/d)	0.8		US EPA (1994a)
Miscellaneous			
Average body weight (kg)	adult child infant	70 15 10	US EPA (1990a) US EPA (1994a)
Lifetime/averaging time for carcinogens (yr)	70		Standard Value
Exposure frequency (d/yr)	350		US EPA (1991b)
Exposure duration (yr)	Sub. farmer Typ farmer other adults child infant	40 40 30 6 1	US EPA (1990a) US EPA (1994a)

Table D.2 Data Sources for Fate and Transport Equations

Parameter	Definition	Value	Derivation
Soil Concentration			
Z	Soil mixing depth for soil ingestion (cm)	1	Reflects untilled soil. *Addendum* (U.S. EPA, 1993)
BD	Soil bulk density (g/cm^3)	1.5	Based on mean for loam soil from Carsel et al. (1988). Also recommended as center of range of values in *Addendum* (U.S. EPA, 1993).
f_{oc}	Fraction of organic carbon in soil (unitless)	0.01	*Addendum* (U.S. EPA, 1993)
Vdv	Dry deposition velocity of vapors (cm/sec)	3	Based on median dry deposition velocity for HNO_3 from a U.S. EPA data base of dry deposition velocities for HNO_3, ozone, and SO_2. HNO_3 was considered the most similar to the constituents covered here, and the value should be applicable to any organic with a low Henry's Law Constant.
kse	Soil loss constant due to soil erosion (yr^{-1})	0	Assumption; soil erodes onto the site as well as off, and the two processes are assumed to balance each other.
θ_a	Soil volumetric water content (mL/cm^3)	0.2	*Addendum* (U.S. EPA, 1993)
R	Universal Gas Constant ($atm\text{-}m^3/mol\text{-}K$)	8.205e-5	Standard value
μ_a	Viscosity of air (g/cm-sec)	1.81e-4	*CRC Handbook* (Weast, 1980). Taken at standard conditions (temperature = 20 °C, pressure = 1 atm or 760 mm Hg).
ρ_a	Density of air (g/cm^3)	0.0012	*CRC Handbook* (Weast, 1980). Taken at standard conditions (temperature = 20 °C, pressure = 1 atm or 760 mm Hg).

Table D.2 Data Sources for Fate and Transport Equations

Parameter	Definition	Value	Derivation
Terrestrial Food Chain			
Z	Soil mixing depth (cm)	20 tilled 1 untilled	Reflects tilled soil. *Addendum* (U.S. EPA, 1993); Used in calculating concentrations in root vegetables and aboveground produce consumed by humans and in silage and grain consumed by livestock. Reflects untilled soil. *Addendum* (U.S. EPA, 1993); Used in calculating concentrations in forage and soil which is then consumed by livestock
kp	Plant surface loss coefficient (yr^{-1})	18	Corresponds to a half-life of 14 days, and reflects physical processes only, no chemical degradation. *Addendum* (U.S. EPA, 1993)
Tp	Length of the plant's exposure to deposition per harvest (yrs)	0.12 forage 0.16 other	*IED* (U.S. EPA, 1990b). 45 days; based on the average of average period between successive hay harvests (60 days) and average period between successive grazing (30 days) in Belcher and Travis (1989). Used in calculating concentration in forage feed to cattle. *IED* (U.S. EPA, 1990b). 60 days; based on average period between successive hay harvests in Belcher and Travis (1989). Used in calculating concentration in aboveground produce and root vegetables consumed by humans and silage consumed by animals

Table D.2 Data Sources for Fate and Transport Equations

Parameter	Definition	Value	Derivation
Yp	Yield or standing crop biomass aboveground fruits and vegetables (kg DW/m^2)	1.6	Yp may be estimated from dry harvest yield (Yh) and area harvested (Ah) (Shor et al., 1982): Here, Yp was estimated for fruits, fruiting vegetables, legumes, and leafy vegetables using U.S. average Yh and Ah values for a variety of fruits and vegetables for 1993 (USDA, 1994b and USDA, $$Yp \approx \frac{Yh}{Ah}$$ 1994c); Yh values were converted to dry weight using average conversion factors for fruits, fruiting vegetables, legumes, and leafy vegetables (Baes et al., 1984). The following fruits and vegetables were included in each category: Fruits: apple, apricot, berry, cherry, cranberry, grape, peach, pear, plum/prune, strawberry Fr. veg: asparagus, cucumber, eggplant, sweet pepper, tomato Legumes: snap beans Leafy: broccoli, brussels sprout, cabbage, cauliflower, celery, lettuce, and spinach The calculated Yp values for fruits, fruiting vegetables, legumes, and leafy vegetables were then weighted by relative ingestion of each group to determine the weighted average Yp given here. Unweighted Yp (kg DW/m^2) and the ingestion rates (kg DW/day) used for weighing were as follows: Fruits 2.5e-6 Yp 13.2 Intake Fr. veg. 10.5 4.2 Leafy 0.34 2.0 Legume 0.075 8.8 The ingestion rate for fruits was based on a whole weight intake of 88 g/day from the *Dioxin Document* (U.S. EPA, 1994a) and an average whole-weight to dry-weight conversion factor for fruits (excluding plums/prunes, which had an extreme value) of 0.15 from Baes, et al, 1984.

Table D.2 Data Sources for Fate and Transport Equations

Parameter	Definition	Value	Derivation
Terrestrial Food Chain			
Yp	Yield or standing crop biomass (kg DW/m^2)	0.24 forage	Weighted average of crop yields for pasture grass (forage) and hay. Weights were based on the fraction of a year cattle could be pastured; the weights used here were 0.75 for pasture grass and 0.25 for hay, based on 9 months/year in pasture and 3 months per year not in pasture (and fed hay). Unweighted Yp values were 0.15 kg DW/m^2 for pasture grass (*Dioxin Document*, U.S. EPA, 1994a) and 0.5 for hay. The Yp for hay was estimated from dry harvest yield (Yh) and area harvested (Ah) (Shor et al., 1982): $$Yp \approx \frac{Yh}{Ah}$$ Yh = 1.22e+11 kg DW: U.S. average Yh for hay for 1993 is 1.35e+11 kg (USDA, 1994a); this is converted to dry weight using a conversion factor of 0.9 (Fries, 1994). Ah = 2.45e+11 m^2: U.S. average Ah for hay for 1993 (USDA, 1994) Production weighted U.S. average for silage (Shor et al., 1982). Crop yield for grains was not used because it was considered a protected species.
		0.8 silage	

Table D.2 Data Sources for Fate and Transport Equations

Parameter	Definition	Value	Derivation
Terrestrial Food Chain			
Fw	Fraction of wet deposition that adheres to plant (dimensionless)	0.6- Cations 0.2- Anions	Memorandum, Lorber, 1995
Rp	Interception fraction for aboveground fruits and vegetables (dimensionless)	0.2	Calculated (Baes et al., 1984) based on a Yp in wet weight

Table D.2 Data Sources for Fate and Transport Equations

Parameter	Definition	Value	Derivation
Terrestrial Food Chain			
Rp	Interception fraction (dimensionless)	0.5 forage	Calculated (Chamberlain, 1970): $Rp = 1 - e^{-\gamma \cdot Yp}$ γ = empirical constant; Chamberlain (1970) gives range as 2.3-3.33; the midpoint of the range, 2.88 is used (Baes et al., 1984) Yp = 0.24 kg DW/m^2 (see above)
		0.46 silage	Calculated from Yp of 0.8 for silage Interception fractions were not used for grains because it was considered a protected species.
VG_{ag}	Empirical correction factor that reduces produce concentration because Bv was developed for azalea leaves	varies	For organic compounds, the VG_{ag} was assumed to be 0.01 for aboveground produce. The VG_{ag} termwas assumed to be 1for forage and 0.5 for silage intended for animal feed. For metals, VG_{ag} was assumed to be 1 for aboveground produce intended for either human or animal consumption. It should be noted that the VG_{ag} term is not applied for grains (animal feed) because they are considered protected species and are assumed not to be contaminated through air-to-plant transfer (see Table B.3.7).

Table D.2 Data Sources for Fate and Transport Equations

Parameter	Definition	Value	Derivation
Terrestrial Food Chain			
Qp	Quantity of plant matter eaten by cattle (kg plant tissue DW/day		
	Subsistence Beef Farmer	8.8 forage 0.47 grain 2.5 silage	Forage intake = 75% of total dry matter intake (DMI) for beef cattle on subsistence farms (i.e., unsupplemented) (Boone et al., 1981) Grain intake = 3.9% of total dry matter intake (DMI) for beef cattle on subsistence farms (i.e., unsupplemented) Silage intake = 21% of total dry matter intake (DMI) for beef cattle on subsistence farms (i.e., unsupplemented) DMI = 2% of body weight for beef cattle (NAS, 1987) Average body weight for beef cattle = 590 kg (NAS, 1987
	Typical Beef Farmer	3.8 forage 3.8 grain 1.0 silage	Rice, 1994. Values here include grain supplement during growing phase for beef cattle.
	Subsistence Dairy Farmer	13.2 forage 3.0 grain 4.1 silage	Forage intake = 65% of total dry matter intake (DMI) for dairy cattle on subsistence farms (Boone et al., 1981) Grain intake = 15% of total dry matter intake (DMI) for dairy cattle on subsistence farms Silage intake = 20% of total dry matter intake (DMI) for dairy cattle on subsistence farms DMI = 3.2% of body weight for dairy cattle (NAS, 1987) Average body weight for dairy cattle = 630 kg (NAS, 1987)
	Typical Dairy Farmer	6.2 forage 12.2 grain 1.9 silage	Rice, 1994.

Table D.2 Data Sources for Fate and Transport Equations

Parameter	Definition	Value	Derivation
Terrestrial Food Chain			
Qs	Quantity of soil eaten by cattle (kg soil/day)		
	Subsistence Beef Farmer	0.5	Soil intake = 4% of DMI for beef cattle on subsistence farms (Fries, 1994) DMI = 2% of body weight (NAS, 1987) Average body weight for beef cattle = 590 kg (NAS, 1987)
	Typical Beef Farmer	0.25	Rice, 1994.
	Subsistence Dairy Farmer	0.4	Soil intake = 2% of DMI for dairy cattle on subsistence farms (Fries, 1994) DMI = 3.2% of body weight (NAS, 1987) Average body weight for dairy cattle = 630 kg (NAS, 1987)
	Typical Dairy Farmer	0.2	Rice, 1994.

Table D.2 Data Sources for Fate and Transport Equations

Parameter	Definition	Value	Derivation
Terrestrial Food Chain			
Qp	Quantity of plant matter eaten by hog (kg plant tissue DW/day)	3.0 grain 1.3 silage	Grain intake = 70% of average daily intake *IED* (U.S. EPA, 1990b). Silage intake = 30% of average daily intake *IED* (U.S. EPA, 1990b). Hogs are not grazing animals and are not assumed to eat forage.
Qs	Quantity of soil eaten by hogs (kg soil /day)	0.37	Soil intake = 8% of DMI for hogs - *Addendum* (U.S. EPA, 1993)
F_d	Fraction of chicken diet that is soil (unitless)	0.1	Biotransfer factors for poultry were calculated for chickens consuming 10% of their diet as contaminated soil. (Stephens et al. 1992). Only chickens raised by subsistence poultry farmers were assumed to eat soil. These chickens consumed no contaminated grain. Chickens raised by the typical farmer were assumed to consume no contaminated soil. However, all the grain consumed by these chickens was assumed to be contaminated. No consumption rate of soil or grain is used in the calculation of dioxin concentration in poultry because the bioconcentration factor for poultry is unitless. (See Appendix C for equations used to calculate the concentration of dioxins in poultry.)

Table D.2 Data Sources for Fate and Transport Equations

Parameter	Definition	Value	Derivation
Aquatic Food Chain			
Z	Soil mixing depth for watershed (cm)	1	Reflects untilled soil. *Addendum* (U.S. EPA, 1993)
ER	Soil enrichment ratio (unitless)	3	Applies to organics only; value should be 1 for metals. *Addendum* (U.S. EPA, 1993).
T_w (also T_k)	Waterbody temperature (K)	298	Assumption; equals 25 °C.
K	USLE erodability factor (ton/acre)	0.36	Based on 1% organic matter. Droppo et al. (1989). Value was chosen to be representative of a whole watershed, not just an agricultural field.
LS	USLE length-slope factor (unitless)	1.5	Reflects a variety of possible distance and slope conditions. *Superfund Exposure Assessment Manual* (U.S. EPA, 1988a) Value was chosen to be representative of a whole watershed, not just an agricultural field.
C	USLE cover management factor (unitless)	0.1	Values up to 0.1 reflect dense vegetative cover, as pasture grass; values from 0.1 to 0.7 reflect agricultural row crops; a value of 1 reflects bare soil. Value of 0.1 selected to cover both grass or agricultural crops. *Addendum* (U.S. EPA, 1993) Value was chosen to be representative of a whole watershed, not just an agricultural field.
P	USLE supporting practice factor (unitless)	1	Represents no erosion/runoff control measures. *Addendum* (U.S. EPA, 1993)
b	Empirical slope coefficient for sediment delivery ratio calculation	0.125	*Addendum* (U.S. EPA, 1993)

Table D.2 Data Sources for Fate and Transport Equations

Parameter	Definition	Value	Derivation
Aquatic Food Chain			
a	Empirical intercept coefficient for sediment delivery ratio calculation	0.6-2.1	Depends on watershed area; values are as follows (*Addendum*, U.S. EPA, 1993): (Note 1 sq. mile = 2.59×10^6 m^2) Watershed Area (sq. miles) — a ≤ 0.1 — 2.1 1 — 1.9 10 — 1.4 100 — 1.2 1,000 — 0.6
d_b	Depth of the upper benthic layer (m)	0.03	Based on center of range given in *Addendum* (U.S. EPA, 1993)
TSS	Total suspended solids (mg/L)	10	*Addendum* (U.S. EPA, 1993)
BS	Bed sediment concentration (g/cm^3)	1	*Addendum* (U.S. EPA, 1993)
θ_{bs}	Bed sediment porosity (L_{water}/L)	0.6	Calculated from bed sediment concentration (BS = 1, see above) and solids density (ρ_s = 2.65 g/cm^3) as follows (*Addendum*, U.S. EPA, 1993): $\theta_{bs} = 1 - \frac{BS}{\rho_s}$
θ	Temperature correction factor (unitless)	1.026	*Addendum* (U.S. EPA, 1993).
C_d	Drag coefficient (unitless)	0.0011	*Addendum* (U.S. EPA, 1993).

Table D.2 Data Sources for Fate and Transport Equations

Parameter	Definition	Value	Derivation
Aquatic Food Chain			
ρ_w	Density of water (g/cm^3)	1	*CRC Handbook* (Weast, 1980).
k	von Karman's constant	0.4	*Addendum* (U.S. EPA, 1993).
μ_w	Viscosity of water (g/cm-sec)	1.69e-2	*CRC Handbook* (Weast, 1980).
λ_2	Dimensionless viscous sublayer thickness (unitless)	4	*Addendum* (U.S. EPA, 1993).
f_{lipid}	Fish lipid content (fraction)	0.07	Cook et al. (1991); value used in *Dioxin document* (U.S. EPA, 1992)
OC_{ss}	Fraction of organic carbon in suspended solids (unitless)	0.075	Corresponds roughly to a surface soil fraction organic carbon of 0.01. Midpoint of range given in *Addendum* (U.S. EPA, 1993).
OC_{sed}	Fraction organic carbon in bottom sediment (unitless)	0.04	Corresponds roughly to a surface soil fraction organic carbon of 0.01. Midpoint of range given in *Addendum* (U.S. EPA, 1993).

Table D.2 Data Sources for Fate and Transport Equations

Parameter	Definition	Value	Derivation
Breast Milk Exposure for Dioxins			
h	Half-life of dioxin in adults (days)	2555	*Dioxin document* (U.S. EPA, 1994a)
f_1	Proportion of ingested dioxin that is stored in fat (unitless)	0.9	*Dioxin document* (U.S. EPA, 1994a)
f_2	Proportion of mother's weight that is fat (unitless)	0.3	*Dioxin document* (U.S. EPA, 1994a)
f_3	Fraction of fat in breastmilk (unitless)	0.04	*Dioxin document* (U.S. EPA, 1994a)
f_4	Fraction ingested contaminant which is adsorbed (unitless)	0.9	*Dioxin document* (U.S. EPA, 1994a)

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