

US EPA ARCHIVE DOCUMENT

**ATTACHMENT D: EXAMPLE CALCULATIONS**

Presents Example Calculations for Indirect Risks from Dioxin

Calculation of Adjusted Model Outputs

CONTAMINANT - TCDD		UNIT		UNIT	
SOURCE	EMISSION RATE g/sec	Fv Unitless	DRY PARTICLE DEPOSITION g/m2/yr	WET PARTICLE DEPOSITION g/m2/yr	UNIT
CS - Arc. F. A Fug.	0	0.27	58.83418	2.3244	2.3244
CS - Arc. F. B Fug.	0	0.27	58.83418	2.3244	2.3244
CS - Baghouse A	0	0.27	2.20388	0.0259	0.0259
CS - Baghouse B	0	0.27	0.03388	0.02154	0.02154
CS - BH C, Arc F. A	0	0.27	0.04855	0.01338	0.01338
CS - BH C, Arc F. B	0	0.27	0.04855	0.01338	0.01338
NTC	8.62E-10	0.27	0.00478	0.00071	0.00071
TXI	1.64E-08	0.27	0.00149	0.00959	0.00959
Holnam	9.88E-10	0.27	0.00085	0.0005	0.0005
TOTAL					
CONTAMINANT - TCDD		ACTUAL		ACTUAL	
SOURCE	EMISSION RATE g/sec	Fv Unitless	DRY PARTICLE DEPOSITION g/m2/yr	WET PARTICLE DEPOSITION g/m2/yr	UNIT
CS - Arc. F. A Fug.	0	0.27	0	0	0
CS - Arc. F. B Fug.	0	0.27	0	0	0
CS - Baghouse A	0	0.27	0	0	0
CS - Baghouse B	0	0.27	0	0	0
CS - BH C, Arc F. A	0	0.27	0	0	0
CS - BH C, Arc F. B	0	0.27	0	0	0
NTC	8.62E-10	0.27	3.0078628E-12	4.467746E-13	4.467746E-13
TXI	1.64E-08	0.27	1.783828E-11	1.1481148E-10	1.1481148E-10
Holnam	9.88E-10	0.27	6.13054E-13	3.6062E-13	3.6062E-13
TOTAL			2.15E-11	1.16E-10	1.16E-10

Cancer Risk for Individual Chemicals for Adult Resident Scenario

Chemical	CR	HQ
2,3,7,8-TCDDioxin TEQ	2E-08	NA

Cancer Risk for Individual Chemicals for Adult Resident Scenario  
 Table 5.3.5

$CR = (I \cdot ED \cdot EF \cdot CSF) / (BW \cdot AT \cdot 365)$	
CR	Individual lifetime cancer risk (unitless)
I	Total daily intake of contaminant (mg/day)
ED	Exposure duration (yr)
EF	Exposure frequency (day/yr)
BW	Body weight (kg)
AT	Averaging time (yr)
365	Units conversion factor (day/yr)

Table 5.3.4

Chemical	CR
2,3,7,8-TCDDioxin TEQ	1.8E-08

**Total Daily Intake for Adult Resident Scenario  
Table 5.3.4**

$I = I_{soil} + I_{ag} + I_{dw}$	
I	Total daily intake of contaminant (mg/day)
$I_{soil}$	Daily intake of contaminant from soil Table 5.3.1 (mg/day)
$I_{ag}$	Daily intake of contaminant from agove-ground produce Table 5.3.2 (mg/day)
$I_{dw}$	Daily intake of contaminant from drinking water Table 5.3.3 (mg/day)

**Chemical Name**      I      (mg/day)

**2,3,7,8-TCDDioxin TEQ**      2.0E-11

Soil Intake for Adult Resident Scenario  
Table 5.3.1

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

Isoil	Daily intake of soil	
Sc	Soil concentration	Table 4.1.1 (mg/kg)
CRsoil	Consumption rate of soil	0.0001 (kg/day)
Fsoil	Fraction of consumed soil contaminated	1 (unitless)

Chemical Name	Isoil	(mg/day)
2,3,7,8-TCDD/Dioxin TEQ	1.9E-11	

Soil Concentration due to Deposition  
Table 4.1.1

Average soil concentration over exposure duration	Sc	
$\frac{[(D_s \cdot T_c - S_{csc}) / k_s] + (S_{csc} / k_s) \cdot (1 - \exp(-k_s \cdot (T_2 - T_c)))}{(T_2 - T_1)}$		
Sc	Average soil concentration	(mg/kg)
Ds	Deposition term	(mg/kg-yr)
Tc	Time period over which deposition occurs	(yr)
S <sub>csc</sub>	Soil concentration at time T <sub>c</sub>	(mg/kg)
k <sub>s</sub>	Soil loss constant	(yr <sup>-1</sup> )
T <sub>2</sub>	Exposure duration	(yr)
	Site specific	IDETRAN
	Table 4.1.2	
	Scenario specific	30 yrs

Soil concentration at time T<sub>c</sub> S<sub>csc</sub>

$$[D_s \cdot (1 - \exp(-k_s \cdot T_c))] / k_s$$

Deposition term D<sub>s</sub>

$$[100 \cdot ((.31536 \cdot V_{dv} \cdot C_{yv} + D_{yww}) + (D_{ydp} + D_{ywp})) / (z \cdot BD)]$$

100	Units conversion factor	100 ((mg-m <sup>2</sup> )/(kg-cm <sup>2</sup> ))
z	Soil mixing depth	1 (cm)
BD	Soil bulk density	1.5 (g/cm <sup>3</sup> )
0.31536	Units conversion factor	0.31536 (m-g-s/cm-ug-yr)
V <sub>dv</sub>	Dry deposition velocity	3 (cm/s)
C <sub>yv</sub>	Normalized vapor phase air concentration	Modelled (ug-s/g-m <sup>2</sup> )
D <sub>yww</sub>	Normalized yearly wet deposition from vapor phase	Modelled (s/m <sup>2</sup> -yr)
D <sub>ydp</sub>	Normalized yearly dry deposition from particle phase	Modelled (s/m <sup>2</sup> -yr)
D <sub>ywp</sub>	Normalized yearly wet deposition from particle phase	Modelled (s/m <sup>2</sup> -yr)
		DISPC1-
		DISPC1-
		DISPC1-
		DISPC1-



Chemical Name	Sc (mg/kg)	Sctc (mg/kg)	Da (mg/m)
2,3,7,8-TCDDioxin TEQ	1.9E-07	2.9E-07	1.1E-04

Soil Loss Constant  
Table 4.1.2

$k_{sl} + k_{se} + k_{sr} + k_{sg} + k_{sv}$		
ks	Soil loss constant due to all processes	(yr <sup>-1</sup> )
ksl	Loss constant due to leaching	Table 4.1.3 (yr <sup>-1</sup> )
kse	Loss constant due to soil erosion	(yr <sup>-1</sup> )
ksr	Loss constant due to surface runoff	Table 4.1.4 (yr <sup>-1</sup> )
ksg	Loss constant due to degradation	Chemical specific (yr <sup>-1</sup> )
ksv	Loss constant due to volatilization	Table 4.1.5 (yr <sup>-1</sup> )

Chemical Name ks (yr<sup>-1</sup>)

2,3,7,8-TCDDioxin TEQ 1.8E-02

Loss Constant Due to Leaching  
Table 4.1.3

	$(P+I-R-Ev)/[Qs*z*(1+(BD*Kds/Qs))]$			
ksl	Loss constant due to leaching			
P	Average annual precipitation	Site specific	(yr <sup>-1</sup> )	IDETRAN
I	Average annual irrigation	Site specific	(cm/yr)	IDETRAN
R	Average annual runoff	Site specific	(cm/yr)	IDETRAN
Ev	Average annual evapo- transpiration	Site specific	(cm/yr)	IDETRAN
Qs	Soil volumetric water content		0.2 (mL/cm <sup>3</sup> )	
z	Soil depth from which leaching removal occurs		1 (cm)	
Kds	Soil-water partition coefficient	Chemical specific	(cm <sup>3</sup> /g)	IDECHE

Chemical Name ksl (yr<sup>-1</sup>)

2,3,7,8-TCDDioxin TEQ 9.0E-05

Loss constant due to Runoff  
Table 4.1.4

	$[R/(Qs*z)] * [1 + (Kds*BD)/Qs]$	
ksr	Loss constant due to runoff	(yr <sup>-1</sup> )
R	Average annual runoff	(cm/yr)
Qs	Soil volumetric water content	0.2 (g/cm <sup>3</sup> )
z	Soil mixing depth	1 (cm)
Kds	Soil-water partition coefficient	Chemical specific (cm <sup>3</sup> /g)
BD	Soil bulk density	1.5 (g/cm <sup>3</sup> )

Chemical Name ksr (yr<sup>-1</sup>)

2,3,7,8-TCDD Dioxin TEQ 3.0E-05

Loss Constant due to Volatilization  
Table 4.1.5

Parameter	Value	Units	Chemical Specific	Chemical Name
ksv	$[(3.1536e+7H)/(z*Kds*R*T*BD)]*[-.482*u^{.78}*(ua/(pa*Da))^{-.87}]*[(4*A/(Pi))^{.5})^{-.11}]$	(yr <sup>-1</sup> )		
Loss constant due to volatilization				
3.1536e7		(s/yr)		
H		(atm-m <sup>3</sup> /mol)		IDECHEM
Henry's Law constant				
z	1	(cm)		IDECHEM
Soil mixing depth				
Kds		(cm <sup>3</sup> /g)		
Soil-water partition coefficient				
R	8.1E-05	(atm-m <sup>3</sup> /mol-K)		
Universal gas constant				
BD	1.5	(g/cm <sup>3</sup> )		
Soil bulk density				
T		(K)		IDETRAN-Tc
Ambient air temperature				IDETRAN
u		(m/s)		
Average annual wind speed				
ua	1.8E-04	(g/cm-s)		
Viscosity of air				
pa	1.2E-03	(g/cm <sup>3</sup> )		
Density of air				
Da		(cm <sup>2</sup> /s)		IDECHEM
Diffusivity of contaminant in air				IDETRAN
A		(m <sup>2</sup> )		
Surface area of contaminated area				

Chemical Name ksv (yr<sup>-1</sup>)

2,3,7,8-TCDDioxin TEQ 1.8E-02

Above-Ground Produce Intake for Adult Resident Scenario  
 Table 5.3.2

		(Pd+Pv+Pr)*CRag*Fag	(mg/day)
Iag	Daily intake of contaminant from soil		
Pd	Concentration in above-ground produce due to deposition		Table 4.2.6 (mg/kg)
Pv	Concentration in above-ground produce due to air-to-plant transfer		Table 4.2.7 (mg/kg)
Pr	Concentration in above-ground produce due to root uptake		Table 4.2.8 (mg/kg)
CRag	Consumption rate of above-ground produce		0.0197 (kg/day)
Fag	Fraction of above-ground produce contaminated		0.25 (unitless)

Chemical Name Iag (mg/day)  
 2,3,7,8-TCDDioxin TEQ 3.5E-12

Above-Ground Produce Concentration Due to Direct Deposition  
Table 4.2.6

	$[[1000 * (Dydp + (Fw * Dywp)) * Rp * [(1 - \exp(-kp * Tp)) / (Yp * kp)]]$			
1000	Units conversion factor			
Dydp	Normalized yearly dry deposition from particle phase	Modelled	(unitless) (s/m <sup>2</sup> -yr)	DISPC1-
Fw	Fraction of wet deposition that adheres to plant	Chemical specific	(unitless)	CHEMIC
Dywp	Yearly particle phase wet deposition rate	Modelled	(g/m <sup>2</sup> /yr)	DISPC1-
Rp	Interception fraction of edible portion of plant		0.05 (unitless)	
kp	Plant surface loss coefficient		18 (yr <sup>-1</sup> )	
Tp	Length of plant exposure to deposition of edible portion of plant, per harvest		0.16 (yrs)	
Yp	Yield or standing crop biomass of the edible portion of the plant		1.6 (kgDW/M <sup>2</sup> )	

Chemical Name Pd (mg/kg)

2,3,7,8-TCDDioxin TEQ 1.2E-10

Above-Ground Produce Concentration Due to Air-to-Plant Transfer  
 Table 4.2.7

	(C <sub>yv</sub> *B <sub>v</sub> *V <sub>Gag</sub> )/p <sub>a</sub>	
P <sub>v</sub>	Concentration of pollutant in the plant due to air-to-plant transfer	(mg/kg)
C <sub>yv</sub>	Normalized vapor phase air concentration	(ug-sec/g-m <sup>3</sup> )
B <sub>v</sub>	Air-to-plant biotransfer factor	DISPC1-
V <sub>Gag</sub>	Empirical correction factor for above-ground produce	Chemical specific (mgplant/ugair) CHEMIC
p <sub>a</sub>	Density of air	0.01 (unitless)
		1.2E+03 (g/m <sup>3</sup> )

Chemical Name  
 2,3,7,8-TCDDioxin TEQ 7.0E-11



Above-Ground Produce Concentration Due to Root Uptake  
 Table 4.2.8

Sc*Br	Pr	Sc	Br
	Pr	Sc	Br
	Concentration of pollutant in the Average soil concentration of pollutant over exposure duration	(mg/kg)	(mg/kg)
	Plant-soil bioconcentration factor for above-ground produce	Chemical specific	(ug/gplant)/(ug/gsoil) CHEMIC

Chemical Name Pr (mg/kg)

2,3,7,8-TCDDioxin TEQ 5.2E-10

Soil Concentration due to Deposition  
Table 4.2.1

$$\frac{[(Ds \cdot Tc - Sc) / ks] + [(Sc / ks) \cdot (1 - \exp(-ks \cdot (T2 - Tc))) / (T2 - T1)]}{[(Ds \cdot (1 - \exp(-ks \cdot Tc))) / ks]$$

Sc	Average soil concentration	(mg/kg)
Ds	Deposition term	(mg/kg-yr)
Tc	Time period over which deposition occurs	(yr)
Sc/c	Soil concentration at time Tc	(mg/kg)
ks	Soil loss constant	(yr <sup>-1</sup> )
T2	Exposure duration	(yr)
T1	Exposure duration	(yr)

30 Site specific

Table 4.1.2

30 Scenario specific

0 Scenario specific

$$[(Ds \cdot (1 - \exp(-ks \cdot Tc))) / ks]$$

$$[100 \cdot ((.31536 \cdot Vdv \cdot Cyv + Dywv) + (Dydp + Dywp)) / (z \cdot BD)]$$

100	Units conversion factor	(mg-m <sup>2</sup> )/[kg-cm <sup>2</sup> ]
z	Soil mixing depth	1 (cm)
BD	Soil bulk density	1.5 (g/cm <sup>3</sup> )
0.31536	Units conversion factor	0.31536 (m-g-s/cm-ug-yr)
Vdv	Dry deposition velocity	3 (cm/s)
Cyv	Normalized vapor phase air concentration	(ug-s/g-m <sup>2</sup> )
Dywv	Normalized yearly wet deposition from vapor phase	(s/m <sup>2</sup> -yr)
Dydp	Normalized yearly dry deposition from particle phase	(s/m <sup>2</sup> -yr)
Dywp	Normalized yearly wet deposition from particle phase	(s/m <sup>2</sup> -yr)

Modelled

Modelled

Modelled

Modelled

Chemical Name  
2,3,7,8-TCDDioxin TEQ

Sc	(mg/kg)	Sc/c	(mg/kg)	Ds	(mg/kg-yr)
1.6E-07		2.9E-07			1.3E-08

Soil Loss Constant  
Table 4.2.2

$k_{sl}+k_{se}+k_{sr}+k_{sg}+k_{sv}$	
$k_s$	Soil constant due to leaching ( $yr^{-1}$ )
$k_{se}$	Loss constant due to soil erosion 0 ( $yr^{-1}$ )
$k_{sr}$	Loss constant due to surface runoff ( $yr^{-1}$ )
$k_{sg}$	Loss constant due to degradation Chemical specific ( $yr^{-1}$ )
$k_{sv}$	Loss constant due to volatilization Table 4.2.5 ( $yr^{-1}$ )

Chemical Name  $k_s$  ( $yr^{-1}$ )

2,3,7,8-TCDDioxin TEQ 1.8E-02

Loss Constant due to Degradation  
Appendix A

$k_{sg}$  0.0E+00

0.0E+00

Loss Constant Due to Leaching  
Table 4.2.3

$$(P+I-R-Ev)/(Qs*z*(1+(BD*Kds/Qs)))$$

ksl	Loss constant due to leaching	(yr <sup>-1</sup> )
P	Average annual precipitation	Site specific (cm/yr)
I	Average annual irrigation	Site specific (cm/yr)
R	Average annual runoff	Site specific (cm/yr)
Ev	Average annual evapo- transpiration	Site specific (cm/yr)
Qs	Soil volumetric water content	0.2 (mL/cm <sup>3</sup> )
z	Soil depth from which leaching removal occurs	1 (cm)
Kds	Soil-water partition coefficient	Chemical specific (cm <sup>3</sup> /g)

Chemical Name ksl (yr<sup>-1</sup>)

2,3,7,8-TCDDioxin TEQ 9.0E-05

Loss Constant due to Runoff  
Table 4.2.4

$$[R/(Qs*z)]*[1/(1+(Kds*BD)/Qs)]$$

ksr	Loss constant due to runoff	(yr <sup>-1</sup> )	
R	Average annual runoff	(cm/yr)	IDETTRAN
Qs	Soil volumetric water content	0.2 (cJ/cm <sup>3</sup> )	
z	Soil mixing depth	1 (cm)	
Kds	Soil-water partition coefficient	Chemical specific (cm <sup>3</sup> /g)	IDECEM
BD	Soil bulk density	1.5 (g/cm <sup>3</sup> )	

Chemical Name ksr (yr<sup>-1</sup>)

2,3,7,8-TCDDioxin TEQ 3.0E-05

Loss Constant due to Volatilization  
Table 4.2.5

$$[(3.1536e+7 \cdot H) / (z \cdot K_{ds} \cdot R \cdot T \cdot BD)] \cdot [4.82 \cdot u \cdot 7.8 \cdot (u a / (p a \cdot D a)) \cdot 67] \cdot [((4 \cdot A / (P \cdot I)) \cdot 5)^{\wedge} \cdot 1.11]$$

Parameter	Value	Units	Chemical
ksv		(yr <sup>-1</sup> )	
Loss constant due to volatilization			
3.1536e7		(s/yr)	
H		Chemical specific (atm-m <sup>3</sup> /IDECHE)	
Henry's Law constant			
z	1	(cm)	
Soil mixing depth			
K <sub>ds</sub>		Chemical specific (cm <sup>3</sup> /g) IDECHE	
Soil-water partition coefficient			
R	8.1E-05	(atm-m <sup>3</sup> /mol-K)	
Universal gas constant			
BD	1.5	(g/cm <sup>3</sup> )	
Soil bulk density			
T		(K)	IDECHAN
Ambient air temperature			
u		(m/s)	IDECHAN
Average annual wind speed			
ua	1.8E-04	(g/cm-s)	
Viscosity of air			
pa	1.2E-03	(g/cm <sup>3</sup> )	
Density of air			
Da		Chemical specific (cm <sup>2</sup> /s)	IDECHAN
Diffusivity of contaminant in air			
A		Site specific (m <sup>2</sup> )	IDECHAN
Surface area of contaminated area			

Chemical Name ksv (yr<sup>-1</sup>)

2,3,7,8-TCDDioxin TEQ 1.8E-02

Drinking Water Intake for Adult Resident Scenario  
 Table 5.3.3

$C_{dw} \cdot CR_{dw} \cdot F_{dw}$		
$I_{dw}$	Daily intake of contaminant from drinking water	(mg/day)
$C_{dw}$	Dissolved contaminant concentration in drinking water	(mg/L)
$CR_{dw}$	Consumption rate of drinking water	1.4 (L/day)
$F_{dw}$	Fraction of drinking water contaminated	1 (unitless)

Table 4.4.24

Chemical Name  $I_{dw}$  (mg/day)

2,3,7,8-TCDDioxin TEQ  $3.0E-13$

Dissolved Water Concentration  
Table 4.4.24

$$C_{dw}/(1+K_{dsw} \cdot TSS \cdot 10^{-6})$$

C <sub>dw</sub>	Dissolved phase water concentration	(mg/L)	
C <sub>w</sub>	Total concentration in water column	(mg/L)	Table 4.5.23
K <sub>dsw</sub>	Suspended sediment/surface water partition coefficient	(L/kg)	CHEMIC
TSS	Total suspended solids	10 (mg/L)	
1e-6	Conversion factor	1.0E-06 (kg/mg)	

Chemical Name (mg/L)

2,3,7,8-TCDDioxin TEQ 2.1E-13



Total Water Column Concentration  
Table 4.4.23

$$F_{water} \cdot C_{wtot} \cdot [(dw + db) / dw]$$

Cwr	Total concentration in water column	(mg/L)
Fwater	Fraction of total water body contaminant concentration that occurs in the water column	(unitless)
Cwtot	Total water concentration in surface water system, including water column and bed sediment	(mg/L)
db	Depth of upper benthic layer	0.03 (m)
dw	Depth of the water column	(m)

Table 4.4.16

Table 4.4.15

Site specific  
IDESW-G

Chemical Name Cwt (mg/L)

2,3,7,8-TCDDioxin TEQ 2.1E-12

Total Waterbody Concentration  
Table 4.4.15

$L/[(Vfx+Fwater)+Kwt*WAw*(dw+db)]$	
Cwtot	(mg/L)
Lt	Table 4.4.7 (g/yr)
Vfx	Site specific (m <sup>3</sup> /yr) IDESW-E
Fwater	Table 4.4.16 (unitless)
kwt	Table 4.4.17 (unitless)
WAw	Site specific (m <sup>3</sup> ) IDESW-B
dw	Site specific (m) IDESW-G
db	0.03 (m)

Chemical Name Cwtot (mg/L)

2,3,7,8-TCDDioxin TEQ 2.1E-10

Fraction in Water Column and Benthic Sediment  
Table 4.4.16

$$[(1+Kdsw \cdot TSS \cdot 1e-6) \cdot (dw/(dw+db))] / [(1+Kdsw \cdot TSS \cdot 1e-6) \cdot (dw/(dw+db)) + (Obs+Kdbs \cdot BS) \cdot db / (dw+db)]$$

Parameter	Description	Chemical specific (L/kg)	CHEMIC
Fwater	Fraction of total water body contaminant concentration that occurs in the water column	(unitless)	
Kdsw	Suspended sediment/surface partition coefficient		
TSS	Total suspended solids	10 (mg/L)	
1e-6	Conversion factor	1.0E-06 (kg/mg)	
dw	Depth of water column	Site specific (m)	IDESW-G
db	Depth of upper benthic layer	0.03 (m)	
dz	Total waterbody depth	(m)	16.53
Qbs	Bed sediment porosity	0.6 (L water/L)	
Kdbs	Bed sediment/sediment pore water partition coefficient	Chemical specific (L/kg)	CHEMIC
BS	Bed sediment concentration	1 (g/cm <sup>3</sup> )	

1-Fwater

Fbenth Fraction of total water body contaminant concentration that occurs in the benthic

Fwater (unitless)  
1.0E-02

Fwater (unitless)

1.0E-02

Chemical Name  
2,3,7,8-TCDDioxin TEQ

Total Waterbody Load  
Table 4.4.7

$L_{dep} + L_{dif} + L_{ri} + L_r + L_e$	
Lt	Total contaminant load to the water
Ldep	Total particle phase and wet phase contaminant direct deposition load to waterbody
Ldif	Vapor phase contaminant diffusion load to waterbody
Lri	Rnoff load from impervious surfaces
Lr	Runoff load from pervious surfaces
Le	Soil erosion load
	(g/yr)
	Table 4.4.8 (g/yr)
	Table 4.4.12 (g/yr)
	Table 4.4.9 (g/yr)
	Table 4.4.10 (g/yr)
	Table 4.4.11 (g/yr)

Chemical Name Lt (g/yr)

2,3,7,8-TCDDioxin TEQ 7.2E-01

Overall Total Waterbody Dissipation Rate Constant  
Table 4.4.17

$(F_{water} + kv) + (F_{benthic} * kb)$	
kwt	Overall total waterbody dissipation rate constant (yr <sup>-1</sup> ) Table 4.4.16
fwater	Fraction of total waterbody contaminant concentration that occurs in the water column
kv	Water column volatilization rate
fbenth	Fraction of total waterbody contaminant concentration that occurs in the benthic sediments
kb	Benthic burial rate constant Table 4.4.22 (yr <sup>-1</sup> )

Chemical Name Kwt (yr<sup>-1</sup>)

2,3,7,8-TCDDioxin TEQ 6.6E+00

Deposition to Waterbody  
Table 4.4.8

	(Dywww+Dytwp)*WAw	
Ldep	Total particle phase and wet phase contaminant direct load to waterbody	(g/yr)
Dywww	Normalized yearly watershed average wet deposition from vapor phase	Modeled (s/m <sup>2</sup> -Yr)
Dytwp	Normalized yearly watershed average total deposition from particle phase	Modeled (s/m <sup>2</sup> -Yr)
WAw	Water body area	Site-specific (m <sup>2</sup> )

Chemical Name Ldep (g/yr)

2,3,7,8-TCDDioxin TEQ 2.7E-03

Diffusion Load to Waterbody  
Table 4.4.12

	$(K_v \cdot C_{yww} \cdot W_{Aw} \cdot 1e-6) / (H \cdot (R \cdot T))$	
Ldif	Dry vapor phase contaminant diffusion load to waterbody	(g/yr)
Kv	Diffusive mass transfer coefficient	Table 4.4.19 Modeled
Cyww	Normalized yearly watershed average vapor phase air concentration	
WAw	Waterbody surface area	Site-specific (m <sup>2</sup> )
H	Henry's Law constant	Chemical-specific (atm-m <sup>3</sup> /mol)
R	Universal gas constant	8.1E-05 (atm-m <sup>3</sup> /mol-K)
Tw	Waterbody temperature	288 (K)
1e-6	Conversion factor	1.0E-06 (g/ug)

Chemical Name Ldif (g/yr)

2,3,7,8-TCDDioxin TEQ 6.6E-01

Impervious Runoff Load to Waterbody  
 Table 4.4.9

(Dywww+Dytwp)*WAI		Site-specific (g/yr)
Ln	Impervious surface runoff load	(g/yr)
WAI	Impervious watershed area receiving pollutant deposition	(m <sup>2</sup> )
Dywww	Normalized yearly watershed average wet deposition from vapor phase	(s/m <sup>2</sup> -yr)
Dytwp	Normalized yearly watershed average total deposition from particle phase	(s/m <sup>2</sup> -yr)

Chemical Name Ln (g/yr)

2,3,7,8-TCDDioxin TEQ 8.1E-04



Impervious Runoff Load to Waterbody  
Table 4.4.9

(Dywww+Dytwp)*WAI		Site-specific	(g/yr)
Lri	Impervious surface runoff load		(m <sup>2</sup> )
WAI	Impervious watershed area receiving pollutant deposition		
Dywww	Normalized yearly watershed average wet deposition from vapor phase	Modeled	(s/m <sup>2</sup> -yr)
Dytwp	Normalized yearly watershed average total deposition from particle phase	Modeled	(s/m <sup>2</sup> -yr)

Chemical Name Lri (g/yr)

2,3,7,8-TCDDioxin TEQ 8.1E-04

Pervious Runoff Load to Waterbody  
Table 4.4.10

$$R * (WAI - WAI) * [(Sc * 1.5 * 0.01) / (2 + (1.5 * 2.8e+5))] ]$$

Lr	Pervious surface runoff load	(g/yr)
R	Average annual surface runoff	(cm/yr)
Sc	Pollutant concentration in watershed soils	(mg/kg)
Bd	Soil bulk density	1.5 (g/cm <sup>3</sup> )
Kds	Soil-water partition coefficient	Chemical-specific (L/kg)
WAI	Total watershed area receiving pollutant deposition	Site-specific (m <sup>2</sup> )
WAI	Impervious watershed area receiving pollutant deposition	Site-specific (m <sup>2</sup> )
0.01	Conversion factor	0.01 (kg-cm <sup>2</sup> /mg-m <sup>2</sup> )
Qs	Volumetric soil water content	0.2 (cm <sup>3</sup> /cm <sup>3</sup> )

Chemical Name Lr (g/yr)

2,3,7,8-TCDDioxin TEQ 2.2E-05

Erosion Load to Waterbody  
Table 4.4.11

$$Xe*(WAI-WAI)*SD^3*((Sc^2.8e+5*1.5)/(2+2.8e+5*1.5))^*.001$$

Le	Soil erosion load	(g/yr)
Xe	Unit soil loss	(kg/m <sup>2</sup> /yr)
Sc	Pollutant concentration in watershed soils	(mg/kg)
BD	Soil bulk density	1.5 (g/cm <sup>3</sup> )
Qs	Volumetric soil water content	0.2 (cm <sup>3</sup> /cm <sup>3</sup> )
Kds	Soil-water partition coefficient	Chemical-specific (L/kg)
WAI	Total watershed area receiving pollutant deposition	Site-specific (m <sup>2</sup> )
WAI	Impervious watershed area receiving pollutant deposition	Site-specific (m <sup>2</sup> )
SD	Watershed sediment delivery ratio	Table 4.4.14 (unitless)
ER	Soil enrichment ratio	<sup>3</sup> (unitless)
0.001	Conversion factor	0.001 [(g/kg)/(mg/kg)]

Chemical Name Le (g/yr)

2,3,7,8-TCDDioxin TEQ 5.4E-02

Water Column Volatilization Loss Rate Constant  
Table 4.4.18

$K_v / [(d_w + 0.3) * (1 + 2.1e+6 * 10^{-6})]$	
$k_v$	Water column volatilization rate ( $yr^{-1}$ )
$K_v$	Overall transfer rate ( $m/yr$ )
$d_z$	Total waterbody depth (m)
$K_{dsw}$	Suspended sediments/surface water partition coefficient Chemical-specific
TSS 1e-6	10 (mg/L) 1.0E-06 (kg/mg)
Conversion factor	

Chemical Name  $k_v$  ( $yr^{-1}$ )

2,3,7,8-TCDDioxin TEQ 6.5E+02

Benthic Burial Rate Constant  
Table 4.4.22

$$[(X_e \cdot WAI \cdot SD^{1e-3} \cdot Vfx^{10}) / (WAW \cdot 10)] / [(10^{11} \cdot e^{-6}) / (1 \cdot .03)]$$

kb	Benthic burial rate constant	(yr <sup>-1</sup> )
Xe	Unit soil loss	Table 4.4.13 (kg/m <sup>2</sup> /yr)
WAI	Watershed area receiving fallo	Site-specific (m <sup>2</sup> )
SD	Watershed sediment delivery ratio	Table 4.4.14 (unitless)
1e3	Conversion factor	1.0E+03 (g/kg)
Vfx	Average volumetric flow rate through watershed	Site-specific (m <sup>3</sup> /yr)
TSS	Total suspended solids	10 (mg/L)
WAW	Waterbody surface area	Site-specific (m <sup>2</sup> )
BS	Benthic solids concentration	1 (kg/L)
db	Depth of upper benthic sedime layer	0.03 (m)
1e-6	Conversion factor	1.0E-06 (kg/mg)

Chemical Name kb (yr<sup>-1</sup>)  
2,3,7,8-TCDDioxin TEQ 1.4E-01 4.3E+02 3.3E-04

Overall Transfer Rate  
Table 4.4.18

$$[Kl^{1.1} + (Kg \cdot H) / (Rg \cdot Tw)]^{1.1} \cdot Q \cdot (Tw - 2)$$

Kv	Overall transfer rate	(m/yr)
Kl	Liquid phase transfer coefficient	Table 4.4.20 (m/yr)
Kg	Gas phase transfer coefficient	Table 4.4.21 (m/yr)
H	Henry's Law constant	Chemical-specific (atm-m <sup>3</sup> /mol)
Rg	Universal gas constant	8.1E-05 (atm-m <sup>3</sup> /mol-K)
Tw	Waterbody temperature	298 (K)
Q	Temperature correction factor	1.026 (unitless)

Chemical Name Kv (m/yr)

2,3,7,8-TCDDioxin TEQ 1.2E+05

Watershed Soil Concentration Due to Deposition  
Table 4.4.1

Parameter	Equation	Units	Source
Average soil concentration over exposure duration	$S_c$	(mg/kg)	Site-specific
Average soil concentration over exposure duration	$\frac{[(D_s \cdot T_c \cdot S_{ctc}) / k_s] + [(S_{ctc} / k_s) \cdot (1 - \exp(-k_s \cdot (T_2 - T_c)))]}{(T_2 - T_1)}$	(mg/kg-yr)	Table 4.4.2
Deposition term	$D_s$	(mg/kg-yr)	Table 4.4.2
Time period over which deposition occurs	$T_c$	(yr)	Scenario-specific
Soil concentration at time $T_c$	$S_{ctc}$	(mg/kg)	Table 4.4.2
Soil loss constant	$k_s$	(yr <sup>-1</sup> )	30
Exposure duration	$T_2$	(yr)	0
Time at beginning of exposure	$T_1$	(yr)	
Soil concentration at time $T_c$	$S_{ctc}$	(mg/kg)	
Soil concentration at time $T_c$	$[D_s \cdot (1 - \exp(-k_s \cdot T_c))] / k_s$	(mg/kg)	
Soil concentration at time $T_c$	$S_{ctc}$	(mg/kg-yr)	Table 4.4.2
Deposition term	$D_s$	(mg/kg-yr)	Scenario-specific
Soil loss constant	$k_s$	(yr <sup>-1</sup> )	
Exposure duration	$T_2$	(yr)	
Deposition term	$D_s$	(mg/kg-yr)	
Deposition term	$[100 \cdot [(31536 \cdot V_{dv} \cdot C_{yww}] + D_{ywww} + D_{ytwp})] / z \cdot BD$	(mg/kg-yr)	
Deposition term	$D_s$	(mg/kg-yr)	
Dry deposition velocity	$V_{dv}$	(cm/s)	3
Normalized yearly watershed average vapor phase air concentration	$C_{yww}$	(ug-s/g-m <sup>3</sup> )	DISPERS
Normalized yearly watershed concentration	$D_{ywww}$	(s/m <sup>2</sup> -yr)	DISPERS

Dytwp	average wet deposition from vapor phase	Modeled	(s/m <sup>2</sup> -yr)	DISPERS
BD	Normalized yearly watershed average total (wet and dry) deposition from particle phase		1.5 (g/cm <sup>3</sup> )	
Z	Soil bulk density		1 (cm)	
100	Soil mixing depth			
	Units conversion factor			[mg-m <sup>2</sup> ]/[kg-cm <sup>2</sup> ]

Sc	(mg/kg)	Sctc	(mg/kg)	Dst	(mg/kg-yr)
1.4E-07		1.9E-07			1.9E-08

Chemical Name  
2,3,7,8-TCDDioxin TEQ



Universal Soil Loss Equation (USLE)  
Table 4.4.13

$$(R^*K^*LS^*C^*PF^*907.18/4047)$$

Parameter	Unit soil loss	Site-specific	(kg/m <sup>2</sup> /yr)
Xe	USLE rainfall factor	0.36	(ton/acre)
RF	USLE erodibility factor	1.5	(unitless)
K	USLE length-slope factor	0.1	(unitless)
LS	USLE cover management factor	1	(unitless)
C	USLE supporting practice factor	907.18	(kg/ton)
PF	Conversion factor	4047	(m <sup>2</sup> /acre)

Chemical Name Xe (kg/m<sup>2</sup>/yr)

2,3,7,8-TCDDioxin TEQ 3.6E+00

Sediment Delivery Ratio  
Table 4.4.14

$$a*(WAI)^b \cdot 125$$

SD	Watershed sediment delivery ratio	(unitless)
WAI	Watershed area receiving fallout	Site-specific (m <sup>2</sup> )
a	Empirical intercept coefficient	Watershed-specific (unitless)
b	Empirical slope coefficient	0.125 (unitless)

Chemical Name SD

2,3,7,8-TCDDioxin TEQ 1.0E-01

Liquid Phase Transfer Coefficient (Quiescent lake or pond)  
Table 4.4.20

	$(Cd^{0.5}W)^*(pa/pw)^{0.5}*(vk^{0.33}/y2)*(uw/(pw*Dw))^{0.67}*31500000$	
Kl	Liquid phase transfer coefficient	(m/yr)
Dw	Diffusivity of chemical in water	Chemical-specific (cm <sup>2</sup> /s)
Cd	Drag coefficient	0.0011 (unitless)
W	Wind velocity, 10 m above water surface	Site-specific (m/s)
pa	Density of air corresponding to water temperature	1.2E-03 (g/cm <sup>3</sup> )
pw	Density of water corresponding to water temperature	1 (g/cm <sup>3</sup> )
vk	von Karman's constant	0.4 (unitless)
y2	Dimensionless viscous sublayer thickness	4 (unitless)
uw	Viscosity of water corresponding to the water temperature	1.7E-02 (g/cm-s)
3.15e7	Conversion constant	3.2E+07 (s/yr)

Chemical Name      Kl      (m/yr)  
2,3,7,8-TCDDioxin TEQ      2.0E+02

Gas Phase Transfer Coefficient (Quiescent lake or pond)  
Table 4.4.21

$$(Cd \cdot 5 \cdot W) \cdot (vk \cdot 33/y2) \cdot [ua / (pa \cdot Da)] \cdot 67 \cdot 3.15e+7$$

Kg	Gas phase transfer coefficient	(m/yr)
Cd	Drag coefficient	0.0011 (unitless)
W	Wind velocity, 10 m above water surface	Site-specific (m/s)
vk	van Karman's constant	0.4 (unitless)
y2	Dimensionless viscous sublayer thickness	4 (unitless)
ua	Viscosity of air corresponding to the air temperature	1.8E-04 (g/cm-s)
pa	Density of air corresponding to water temperature	1.2E-03 (g/cm^3)
Da	Diffusivity of chemical in air	Chemical-specific (cm^2/s)
3.15e7	Conversion constant	3.2E+07 (s/yr)

Chemical Name Kg (m/yr)

2,3,7,8-TCDDioxin TEQ 4.5E+05

Soil Loss Constant  
Table 4.4.2

Parameter	Units	Source
$k_{sl} + k_{se} + k_{sr} + k_{sg} + k_{sv}$	$(yr^{-1})$	
$k_s$	Soil loss constant due to all processes	
$k_{sl}$	Loss constant due to leaching	Table 4.4.3
$k_{se}$	Loss constant due to soil erosion	Table 4.4.4
$k_{sr}$	Loss constant due to surface runoff	Table 4.4.5
$k_{sg}$	Loss constant due to degradation	Chemical-specific
$k_{sv}$	Loss constant due to volatilization	Table 4.4.6

Chemical Name  $k_s$   $(yr^{-1})$

2,3,7,8-TCDDioxin TEQ 9.2E-02

Loss Constant Due to Leaching  
Table 4.4.3

		$(P+I-R-Ev)/[Qs*z*(1+(BD*Kds/BD))]$	
ksl	Loss constant due to leaching	Site-specific	(yr <sup>-1</sup> )
P	Average annual precipitation	Site-specific	(cm/yr)
I	Average annual irrigation	Site-specific	(cm/yr)
R	Average annual runoff	Site-specific	(cm/yr)
Ev	Average annual evapotranspiration	Site-specific	(cm/yr)
Qs	Soil volumetric water content		0.2 (mL/cm <sup>3</sup> )
z	Soil depth from which leaching removal occurs		1 (cm)
Kds	Soil-water partition coefficient	Chemical-specific	(cm <sup>3</sup> /g)
BD	Soil bulk density		1.5 (g/cm <sup>3</sup> )
ksl			(yr <sup>-1</sup> )
Chemical Name			
2,3,7,8-TCDD	TEQ		9.0E-05

Loss Constant due to Erosion  
Table 4.4.4

$$[(1 \cdot X_e \cdot S_D \cdot E_R) / (B D \cdot z)] \cdot [(K_{d s} \cdot B D) / (Q_s + (K_{d s} \cdot B D))]$$

k <sub>se</sub>	Loss constant due to erosion	(yr <sup>-1</sup> )
X <sub>e</sub>	Unit soil loss	(kg/m <sup>2</sup> /yr)
S <sub>D</sub>	Sediment delivery ration	(unitless)
E <sub>R</sub>	Contaminant enrichment ratio	3 (unitless)
z	Soil mixing depth	1 (cm)
Q <sub>s</sub>	Soil volumetric water content	0.2 (mL/cm <sup>3</sup> )
K <sub>ds</sub>	Soil-water partition coefficient	Chemical-specific (cm <sup>3</sup> /g)
B <sub>D</sub>	Soil bulk density	1.5 (g/cm <sup>3</sup> )

Chemical Name  
2,3,7,8-TCDDioxin TEQ

k<sub>se</sub> 7.4E-02 (yr<sup>-1</sup>)

Loss constant due to Runoff  
Table 4.4.5

$$[R/(Qs*z)]^{1/(1+(Kds*BD)/Qs)}$$

ksr	Loss constant due to runoff	(yr <sup>-1</sup> )	
R	Average annual runoff	(cm/yr)	IDETRAN
Qs	Soil volumetric water content	0.2 (mL/cm <sup>3</sup> )	
z	Soil mixing depth	1 (cm)	
Kds	Soil-water partition coefficient	Chemical specific (cm <sup>3</sup> /g)	IDECHE
BD	Soil bulk density	1.5 (g/cm <sup>3</sup> )	

Chemical Name

2,3,7,8-TCDDioxin TEQ

ksr 3.0E-05 (yr<sup>-1</sup>)



Loss Constant due to Volatilization  
Table 4.4.6

$$[(3.1536e+7 \cdot H) / (z \cdot Kds \cdot R \cdot T \cdot BD)] \cdot [ .462 \cdot u \wedge .78 \cdot (ua / (pa \cdot Da)) \wedge .67 ] \cdot [ ((4 \cdot A / (P)) \wedge .5) \wedge .11 ]$$

ksv	Loss constant due to volatilization	(yr <sup>-1</sup> )	
3.1536e7	Conversion constant	3.2E+07 (s/yr)	IDECHEM
H	Henry's Law constant	Chemical specific (atm-m <sup>3</sup> /mol)	IDECHEM
z	Soil mixing depth	1 (cm)	IDECHEM
Kds	Soil-water partition coefficient	Chemical specific (cm <sup>3</sup> /g)	IDECHEM
R	Universal Gas constant	8.1E-05 (atm-m <sup>3</sup> /mol-K)	IDECHEM
BD	Soil bulk density	1.5 (g/cm <sup>3</sup> )	IDETRAN-Tc
T	Ambient air temperature	Site specific (K)	IDETRAN
u	Average annual wind speed	Site specific (m/s)	IDECHEM
ua	Viscosity of air	1.8E-04 (g/cm-s)	IDESW
pa	Density of air	1.2E-03 (g/cm <sup>3</sup> )	
Da	Diffusivity of contaminant in air	Chemical specific (cm <sup>2</sup> /s)	
A	Surface area of contaminated area	Site specific (m <sup>2</sup> )	

Chemical Name ksv (yr<sup>-1</sup>)

2,3,7,8-TCDDioxin TEQ 1.8E-02

Cancer Risk for Individual Chemicals for Subsistence Farmer Scenario

Chemical	CR	HQ
2,3,7,8-TCDDioxin TEQ	1E-06	NA

Cancer Risk for Individual Chemicals for Subsistence Farmer Scenario  
 Table 5.1.6

$$CR = (I \cdot ED \cdot EF \cdot CSF) / (BW \cdot AT \cdot 365)$$

CR	Individual lifetime cancer risk	(unitless)
I	Total daily intake of contaminant	(mg/day)
ED	Exposure duration	40 (yr)
EF	Exposure frequency	350 (day/yr)
BW	Body weight	70 (kg)
AT	Averaging time	70 (yr)
365	Units conversion factor	365 (day/yr)

Chemical  
 2,3,7,8-TCDDioxin TEQ

CR  
 1.0E-06

Hazard Quotient for Individual Chemicals for Subsidiary  
 Table 5.1.7

HQ = I/(BW*RID)	
HQ	Hazard Quotient Total daily intake of contaminant Body weight Reference dose
I	Table 5.1.4 Chemical-specific 70 (kg) (mg/day) (mg/kg/da)
BW	
RI	
HQ	(unitless)
Chemical Name	
2,3,7,8-TCDDioxin TEQ	NA

Total Daily Intake for Subsistence Farmer Scenario  
Table 5.1.5

	I = I <sub>soil</sub> + I <sub>ag</sub> + I <sub>beef</sub> + I <sub>milk</sub> + I <sub>dw</sub>	
I	Total daily intake of contaminant	(mg/day)
I <sub>soil</sub>	Daily intake of contaminant from soil	Table 5.1.1 (mg/day)
I <sub>ag</sub>	Daily intake of contaminant agove-ground produce	Table 5.1.2 (mg/day)
I <sub>beef</sub>	Daily intake of contaminant from beef	Table 5.1.3 (mg/day)
I <sub>milk</sub>	Daily intake of contaminant from milk	Table 5.1.3 (mg/day)
I <sub>dw</sub>	Daily intake of contaminant from drinking water	Table 5.1.4 (mg/day)

Chemical Name I (mg/day)

2,3,7,8-TCDDioxin TEQ 8.4E-10

Soil Intake for Subsistence Farmer Scenario  
 Table 5.1.1

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

Isoil	Daily intake of soil	
Sc	Soil concentration	Table 4.1.1
CRsoil	Consumption rate of soil	0.0001 (kg/day)
Fsoil	Fraction of consumed soil contaminated	1 (unitless)

Chemical Name                      Isoil                      (mg/day)

2,3,7,8-TCDDioxin TEQ                      2.0E-11

Soil Concentration due to Deposition  
Table 4.1.1

Average soil concentration over exposure duration	Sc	
$\frac{[(Ds \cdot Tc - Sctc) / ks] + [(Sctc / ks) \cdot (1 - \exp(-ks \cdot (T2 - Tc))) / (T2 - T1)]}{(T2 - T1)}$		
Sc	Average soil concentration	(mg/kg)
Ds	Deposition term	(mg/kg-yr)
Tc	Time period over which deposition occurs	(yr)
Sctc	Soil concentration at time Tc	(mg/kg)
ks	Soil loss constant	(yr <sup>-1</sup> )
T2	Exposure duration	(yr)
	Site specific	IDETRAN
	Table 4.1.2	
	Scenario specific	30 yrs

Soil concentration at time Tc Sctc

$$[Ds \cdot (1 - \exp(-ks \cdot Tc))] / ks$$

Deposition term Ds

$$[100 \cdot [(0.31536 \cdot Vdv \cdot Cyv + Dywv) + (Dydp + Dywp)]] / (z \cdot BD)$$

100	Units conversion factor	100 ((mg-m <sup>2</sup> )/(kg-cm <sup>2</sup> ))
z	Soil mixing depth	1 (cm)
BD	Soil bulk density	1.5 (g/cm <sup>3</sup> )
0.31536	Units conversion factor	0.31536 (m-g-s/cm-ug-yr)
Vdv	Dry deposition velocity	3 (cm/s)
Cyv	Normalized vapor phase air concentration	(ug-s/g-m <sup>2</sup> )
Dywv	Normalized yearly wet deposition from vapor phase	(s/m <sup>2</sup> -yr)
Dydp	Normalized yearly dry deposition from particle phase	(s/m <sup>2</sup> -yr)
Dywp	Normalized yearly wet deposition from particle phase	(s/m <sup>2</sup> -yr)
	Modelled	DISPC1-
	Modelled	DISPC1-
	Modelled	DISPC1-
	Modelled	DISPC1-

Chemical Name	Stc (mg/kg)	Sdc (mg/kg)	Ds (mg/kg-yr)
2,3,7,8-TCDDioxin TEQ	2.0E-07	3.6E-07	1.3E-06



Soil Loss Constant  
Table 4.1.2

ksl+kse+ksr+ksg+ksv			
ks	Soil loss constant due to all processes		(yr <sup>-1</sup> )
ksl	Loss constant due to leaching	Table 4.1.3	(yr <sup>-1</sup> )
kse	Loss constant due to soil erosion	Table 4.1.4	(yr <sup>-1</sup> )
ksr	Loss constant due to surface runoff	Chemical specific	(yr <sup>-1</sup> )
ksg	Loss constant due to degradation	Table 4.1.5	(yr <sup>-1</sup> )
ksv	Loss constant due to volatilization		(yr <sup>-1</sup> )

Chemical Name ks (yr<sup>-1</sup>)

2,3,7,8-TCDDioxin TEQ 1.8E-02

Loss Constant Due to Leaching  
Table 4.1.3

ksl	(P+I-R-Ev)/[Qs*z*(1+(BD*Kds/Qs))]			
P	Loss constant due to leaching			
I	Average annual precipitation	Site specific	(yr <sup>-1</sup> )	IDETRAN
R	Average annual irrigation	Site specific	(cm/yr)	IDETRAN
Ev	Average annual runoff	Site specific	(cm/yr)	IDETRAN
	Average annual evapo- transpiration	Site specific	(cm/yr)	IDETRAN
Qs	Soil volumetric water content		0.2 (mL/cm <sup>3</sup> )	
z	Soil depth from which leaching removal occurs		1 (cm)	
Kds	Soil-water partition coefficient	Chemical specific	(cm <sup>3</sup> /g)	IDECHC

Chemical Name ksl (yr<sup>-1</sup>)

2,3,7,8-TCDDioxin TEQ 9.0E-05

Loss constant due to Runoff  
Table 4.1.4

	$[R/(Qs*z)]^{1/(1+(Kds*BD)/Qs)}$	
ksr	Loss constant due to runoff	(yr <sup>-1</sup> )
R	Average annual runoff	(cm/yr)
Qs	Soil volumetric water content	0.2 (cL/cm <sup>3</sup> )
z	Soil mixing depth	1 (cm)
Kds	Soil-water partition coefficient	Chemical specific (cm <sup>3</sup> /g)
BD	Soil bulk density	1.5 (g/cm <sup>3</sup> )

Site specific  
IDETRA

Chemical specific  
IDECE

Chemical Name ksr (yr<sup>-1</sup>)

2,3,7,8-TCDDioxin TEQ 3.0E-05

Loss Constant due to Volatilization  
Table 4.1.5

$$[(3.1536e+7^H)/(z^2 * Kds * R * T * BD)] * [4.62 * u^{.78} * (ua / (pa * Da))^{.67}] * [((4 * A / (Pi))^{.5})^{.11}]$$

ksv	Loss constant due to volatilization	(yr <sup>-1</sup> )	
3.1536e7	Conversion constant	(s/yr)	
H	Henry's Law constant	(atm-m <sup>3</sup> /mol)	IDECHEM
z	Soil mixing depth	(cm)	
Kds	Soil-water partition coefficient	(cm <sup>3</sup> /g)	IDECHEM
R	Universal gas constant	8.1E-05 (atm-m <sup>3</sup> /mol-K)	
BD	Soil bulk density	1.5E+00 (g/cm <sup>3</sup> )	
T	Ambient air temperature	(K)	IDETRA-Tc
u	Average annual wind speed	(m/s)	IDETRA
ua	Viscosity of air	1.8E-04 (g/cm-s)	
pa	Density of air	1.2E-03 (g/cm <sup>3</sup> )	
Da	Diffusivity of contaminant in air	Chemical specific (cm <sup>2</sup> /s)	IDECHEM
A	Surface area of contaminated area	Site specific (m <sup>2</sup> )	IDETRA

Chemical Name ksv (yr<sup>-1</sup>)

2,3,7,8-TCDDioxin TEQ 1.8E-02

Above-Ground Produce Intake for Subsistence Farmer Scenario  
 Table 5.1.2

	$(P_d + P_v + P_r) \cdot CR_{ag} \cdot F_{ag}$	(mg/day)
I <sub>ag</sub>	Daily intake of contaminant from soil	
P <sub>d</sub>	Concentration in above-ground produce due to deposition	Table 4.2.6 (mg/kg)
P <sub>v</sub>	Concentration in above-ground produce due to air-to-plant transfer	Table 4.2.7 (mg/kg)
P <sub>r</sub>	Concentration in above-ground produce due to root uptake	Table 4.2.8 (mg/kg)
CR <sub>ag</sub>	Consumption rate of above-ground produce	0.028 (kg/day)
F <sub>ag</sub>	Fraction of above-ground produce contaminated	1 (unitless)

Chemical Name I<sub>ag</sub> (mg/day)

2,3,7,8-TCDDioxin TEQ 2.0E-11

Above-Ground Produce Concentration Due to Direct Deposition  
Table 4.2.6

$$[[1000*(Dydp+(Fw*Dywp)]*Rp*{(1-exp(-kp*Tp))}/(Yp*kp)$$

1000 Dydp	Units conversion factor Normalized yearly dry deposition from particle phase	Modelled	(unitless) (s/m <sup>2</sup> -yr)	DISPC1-
Fw	Fraction of wet deposition that adheres to plant	Chemical specific	(unitless)	CHEMIC
Dywp	Yearly particle phase wet deposition rate	Modelled	(g/m <sup>2</sup> /yr)	DISPC1-
Rp	Interception fraction of edible portion of plant		0.04 (unitless)	
kp	Plant surface loss coefficient		18 (yr <sup>-1</sup> )	
Tp	Length of plant exposure to deposition of edible portion of plant, per harvest		0.16 (yrs)	
Yp	Yield or standing crop biomass of the edible portion of the plant		1.7 (kgDW/M <sup>2</sup> )	

Chemical Name Pd (mg/kg)

2,3,7,8-TCDDioxin TEQ 1.1E-10

Above-Ground Produce Concentration Due to Air-to-Plant Transfer  
 Table 4.2.7

	(C <sub>yv</sub> *B <sub>v</sub> *V <sub>Gg</sub> )/p <sub>a</sub>		
P <sub>v</sub>	Concentration of pollutant in the plant due to air-to-plant transfer		(mg/kg)
C <sub>yv</sub>	Normalized vapor phase air concentration	Modelled	(ug-sec/g-m <sup>3</sup> ) DISPC1-
B <sub>v</sub>	Air-to-plant biotransfer factor	Chemical specific	(mgplant/ugair) CHEMIC
V <sub>Gg</sub>	Empirical correction factor for above-ground produce	0.01	(unitless)
p <sub>a</sub>	Density of air	1.2E+03	(g/m <sup>3</sup> )

Chemical Name Pv (mg/kg)

2,3,7,8-TCDDioxin TEQ 7.0E-11

Above-Ground Produce Concentration Due to Root Uptake  
 Table 4.2.8

Sc*Br	Pr	Sc	Br
	Concentration of pollutant in the Average soil concentration of pollutant over exposure duration	(mg/kg)	(mg/kg)
	Plant-soil bioconcentration factor for above-ground produce		
		Table 4.2.1	Chemical specific (ug/gplant)/(ug/gsoil) CHEMIC

Chemical Name Pr (mg/kg)

2,3,7,8-TCDDioxin TEQ 5.2E-10



Soil Concentration due to Deposition  
Table 4.2.1

$$\frac{[(Ds \cdot Tc \cdot Sctc) / ks] + [(Sctc / ks) \cdot (1 - \exp(-ks \cdot (T2 - Tc)))] / (T2 - T1)}$$

Sc	Average soil concentration	(mg/kg)
Ds	Deposition term	(mg/kg-yr)
Tc	Time period over which deposition occurs	(yr)
Sctc	Soil concentration at time Tc	(mg/kg)
ks	Soil loss constant	(yr <sup>-1</sup> )
T2	Exposure duration	(yr)
T1	Exposure duration	(yr)

$$[Ds \cdot (1 - \exp(-ks \cdot Tc))] / ks$$

$$[100 \cdot [(0.31536 \cdot VdV \cdot Cyv + Dywv) \cdot (Dydp + Dywp)]] / (z \cdot BD)$$

100	Units conversion factor	(mg-m <sup>2</sup> )/(kg-cm <sup>2</sup> )
z	Soil mixing depth	1 (cm)
BD	Soil bulk density	1.5 (g/cm <sup>3</sup> )
0.31536	Units conversion factor	0.31536 (m-g-s/cm-ug-yr)
VdV	Dry deposition velocity	3 (cm/s)
Cyv	Normalized vapor phase air concentration	(ug-s/g-m <sup>2</sup> )
Dywv	Normalized yearly wet deposition from vapor phase	(s/m <sup>2</sup> -yr)
Dydp	Normalized yearly dry deposition from particle phase	(s/m <sup>2</sup> -yr)
Dywp	Normalized yearly wet deposition from particle phase	(s/m <sup>2</sup> -yr)

Chemical Name	Sc	(mg/kg)	Sctc	(mg/kg)	Ds	(mg/kg-yr)
2,3,7,8-TCDDioxin TEQ	1.6E-07		2.9E-07		1.3E-08	

Soil Loss Constant  
Table 4.2.2

$k_{sl} + k_{se} + k_{sr} + k_{sg} + k_{sv}$		
ks	Soil constant due to leaching	$(yr^{-1})$
kse	Loss constant due to soil erosion	0 $(yr^{-1})$
ksr	Loss constant due to surface runoff	$(yr^{-1})$
ksg	Loss constant due to degradation	Chemical specific $(yr^{-1})$
ksv	Loss constant due to volatilization	Table 4.2.5 $(yr^{-1})$

Chemical Name ks  $(yr^{-1})$

2,3,7,8-TCDDioxin TEQ 1.8E-02

Loss Constant due to Degradation  
Appendix A

ksg 0.0E+00

0.0E+00

Loss Constant Due to Leaching  
Table 4.2.3

	$(P+I+R-Ev)/(Qs+z*(1+(BD*Kds/Qs)))$	
ksl	Loss constant due to leaching	(yr <sup>-1</sup> )
P	Average annual precipitation	(cm/yr)
I	Average annual irrigation	(cm/yr)
R	Average annual runoff	(cm/yr)
Ev	Average annual evapo- transpiration	(cm/yr)
Qs	Soil volumetric water content	0.2 (mL/cm <sup>3</sup> )
z	Soil depth from which leaching removal occurs	1 (cm)
Kds	Soil-water partition coefficient	Chemical specific (cm <sup>3</sup> /g)

Chemical Name ksl (yr<sup>-1</sup>)

2,3,7,8-TCDDioxin TEQ 9.0E-05

Loss Constant due to Runoff  
Table 4.2.4

$$[R/(Qs*z)]^{1/(1+(Kds*BD)/Qs)}$$

ksr Loss constant due to runoff (yr<sup>-1</sup>)  
 R Average annual runoff (cm/yr)  
 Qs Soil volumetric water content 0.2 (CL/cm<sup>3</sup>)  
 z Soil mixing depth 1 (cm)  
 Kds Soil-water partition coefficient (cm<sup>3</sup>/g)  
 BD Soil bulk density 1.5 (g/cm<sup>3</sup>)

Site specific IDETRAN  
 Chemical specific IDECHEM

Chemical Name ksr (yr<sup>-1</sup>)

2,3,7,8-TCDDioxin TEQ 3.0E-05

Loss Constant due to Volatilization  
Table 4.2.5

$$[(3.1536e+7 \cdot H) / (z \cdot K_{ds} \cdot R \cdot T \cdot BD)] [1.482 \cdot u \cdot 7.9 \cdot (u a / (p a \cdot D a))^{\wedge} .67] \cdot [((t \cdot A / (P \cdot t))^{\wedge} .5)^{\wedge} .11]$$

ksv	Loss constant due to volatilization	(yr <sup>-1</sup> )
3.1536e7	Conversion constant	(s/yr)
H	Henry's Law constant	(atm·m <sup>3</sup> /IDECHE)
z	Soil mixing depth	<sub>1</sub> (cm)
K <sub>ds</sub>	Soil-water partition coefficient	(cm <sup>3</sup> /g) IDECHE
R	Universal gas constant	8.1E-05 (atm·m <sup>3</sup> /mol·K)
BD	Soil bulk density	1.5 (g/cm <sup>3</sup> )
T	Ambient air temperature	(K) IDETRAN
u	Average annual wind speed	(m/s) IDETRAN
ua	Viscosity of air	1.8E-04 (g/cm·s)
pa	Density of air	1.2E-03 (g/cm <sup>3</sup> )
Da	Diffusivity of contaminant in air	Chemical specific (cm <sup>2</sup> /s) IDECHE
A	Surface area of contaminated area	Site specific (m <sup>2</sup> ) IDETRAN

Chemical Name ksv (yr<sup>-1</sup>)

2,3,7,8-TCDDioxin TEQ 1.8E-02

Beef and Milk Intake for Subsistence Farmer Scenario  
 Table 5.1.3

$I_{beef} = T_{beef} * CR_{beef} * F_{beef}$

$I_{milk} = A_{milk} * CR_{milk} * F_{milk}$

Parameter	Value	Units
$I_{beef}$	Daily intake of contaminated beef	(mg/kg)
$A_{beef}$	Concentration in beef	(mg/kg)
$CR_{beef}$	Consumption rate of beef	0.057 (kg/day)
$F_{beef}$	Fraction of beef contaminated	1 (unitless)
$I_{milk}$	Daily intake of contaminated milk	(mg/kg)
$A_{milk}$	Concentration in milk	(mg/kg)
$CR_{milk}$	Consumption rate of milk	0.18 (kg/day)
$F_{milk}$	Fraction of milk contaminated	1 (unitless)

Chemical Name      Ibeef      (mg/kg)      Imilk      (mg/kg)

2,3,7,8-TCDDioxin TEQ      4.9E-10      3.1E-10

Beef Concentration due to Plant and Soil Ingestion  
Table 4.3.8

$$A_{\text{beef}} = (F * Q_p * P_e + Q_s * S_c) * B_{\text{beef}}$$

A <sub>beef</sub>	Concentration of pollutant in beef	(mg/kg)
F	Fraction of plant grown on contaminated soil and eaten by animal	1 (unitless)
Q <sub>p</sub>	Quantity of plant eaten by the animal each day	6.76 (kg/day)
P <sub>e</sub>	Total concentration of pollutant in the plant eaten by animal	Table 4.3.6, 4.3.7, 4.3.8 (mg/kg)
Q <sub>s</sub>	Quantity of soil eaten by animal	0.5 (kg/day)
S <sub>c</sub>	Soil concentration	Table 4.1.1 (mg/kg)
B <sub>beef</sub>	Biotransfer factor for beef	Chemical-specific (d/kg)

Chemical Name      A<sub>beef</sub>      (mg/kg)

2,3,7,8-TCDDioxin TEQ      8.6E-09

Total con

Pe = Pd + Pv + Pr

Chemical Name

1.7E-08

2,3,7,8-TCDDioxin TEQ

25-Jan-96

---



Above-Ground Produce Concentration Due to Direct Deposition  
Table 4.2.6

$$Pd = \frac{1000 \cdot (Dydp \cdot (Fw \cdot Dywp)) \cdot Rp \cdot [(1 - \exp(-kp \cdot Tp))] \cdot (Yp \cdot kp)}{\text{Units conversion factor}}$$

1000	Units conversion factor	(unitless)
Dydp	Normalized yearly dry deposition from particle phase	Modelled (s/m <sup>2</sup> -yr) DISPC1-
Fw	Fraction of wet deposition that adheres to plant	Chemical (unitless) CHEMIC
Dywp	Yearly particle phase wet deposition rate	Modelled (g/m <sup>2</sup> /yr) DISPC1-
Rp	Interception fraction of edible portion of plant	0.5 (unitless)
kp	Plant surface loss coefficient	18 (yr <sup>-1</sup> )
Tp	Length of plant exposure to deposition of edible portion of plant, per harvest	0.12 (yrs)
Yp	Yield or standing crop biomass of the edible portion of the plant	0.24 (kgDW/M <sup>2</sup> )

Chemical Name Pd (mg/kg)

2,3,7,8-TCDDioxin TEQ 9.3E-09

Forage (Pasture Grass/Hay) concentration due to Air-to-Plant Transf  
 Table 4.3.7

$$P_v = (C_{yv} \cdot B_v \cdot V_{Gag}) / p_a$$

P <sub>v</sub>	Concentration of pollutant in the plant due to air-to-plant transfer	(mg/kg)
C <sub>yv</sub>	Vapor phase air concentration of pollutant in air due to direct emissions	(ug/m <sup>2</sup> )
B <sub>v</sub>	Air-to-plant biotransfer factor	Chemical-specific
V <sub>Gag</sub>	Empirical correction factor that reduces produce concentration because B <sub>v</sub> was developed for azalea leaves	1 (unitless)
p <sub>a</sub>	Density of air	1.2E+03 (g/m <sup>3</sup> )

Chemical Name  
 2,3,7,8-TCDDioxin TEQ 7.0E-09

Forage/Silage/Grain concentration due to Root Uptake  
 Table 4.3.8

	Pr = Sc*Br		
Pr	concentration of pollutant in the plant due to direct uptake from soil	(mg/kg)	
Sc	Average soil concentration of pollutant overexposure duration	(mg/kg)	Table 4.1.1
Br	Plant-soil bioconcentration factor	Chemical-specific	(ug/g)/(ug)
Chemical Name	Pr (mg/kg)		
2,3,7,8-TCDDioxin TEQ	6.6E-10		

Milk concentration due to Plant and Soil Ingestion  
Table 4.3.10

$$A_{\text{milk}} = (F \cdot Q_p + P_e + Q_s \cdot S_c) \cdot B_{\text{milk}}$$

F	Fraction of plant grown on contaminated soil and eaten by animal	1 (unitless)
Qp	Quantity of plant eaten by the animal each day	9.63 (kg/day)
Pe	Total concentration of pollutant in the plant eaten by animal	Table 4.3.6, 4.3.7, 4.3.8 (mg/kg)
Qs	Quantity of soil eaten by animal	0.4 (kg/day)
Sc	Soil concentration	Table 4.1.1 (mg/kg)
B <sub>milk</sub>	Biotransfer factor for milk	Chemical-specific (d/kg)

Chemical Name (mg/kg)

2,3,7,8-TCDDioxin TEQ 1.7E-09

1.6E-07 8.0E-08

Drinking Water Intake for Adult Resident Scenario  
 Table 5.3.3

	$C_{dw} \cdot CR_{dw} \cdot F_{dw}$		
Idw	Daily intake of contaminant from drinking water		(mg/day)
Cdw	Dissolved contaminant concentration in drinking water	Table 4.4.24	(mg/L)
CRdw	Consumption rate of drinking water	1.4	(L/day)
Fdw	Fraction of drinking water contaminated	1	(unitless)

Chemical Name Idw (mg/day)

2,3,7,8-TCDDioxin TEQ 3.0E-13

Dissolved Water Concentration  
Table 4.4.24

	$C_w / (1 + K_{dsw} * TSS * 1e-6)$		
C <sub>dw</sub>	Dissolved phase water concentration	(mg/L)	
C <sub>w</sub>	Total concentration in water column	(mg/L)	Table 4.5.23
K <sub>dsw</sub>	Suspended sediment/surface water partition coefficient	(L/kg)	CHEMIC
TSS	Total suspended solids	10 (mg/L)	
1e-6	Conversion factor	1.0E-06 (kg/mg)	

Chemical Name C<sub>dw</sub> (mg/L)

2,3,7,8-TCDDioxin TEQ 2.2E-13

Total Water Column Concentration  
Table 4.4.23

$$F_{water} \cdot C_{wtot}^{*} [(dw+db)/dw]$$

Cwr	Total concentration in water column	(mg/L)	
Fwater	Fraction of total water body contaminant concentration that occurs in the water column	(unitless)	Table 4.4.16
Cwtot	Total water concentration in surface water system, including water column and bed sediment	(mg/L)	Table 4.4.15
db	Depth of upper benthic layer	0.03 (m)	
dw	Depth of the water column	(m)	Site specific IDESW-G

Chemical Name Cwf (mg/L)

2,3,7,8-TCDDioxin TEQ 2.2E-12

Total Waterbody Concentration  
Table 4.4.15

$$LW/[(Vfx*Fwater)+Kwt*WAw*(dw+db)]$$

Cwtot	Total water body concentration	(mg/L)	
Lt	Total chemical load into water body, including deposition, runoff and erosion	(g/yr)	Table 4.4.7
Vfx	Average volumetric flow rate through water body	(m <sup>3</sup> /yr)	Site specific IDESW-E
Fwater	Fraction of total water body contaminant concentration that occurs in the water column	(unitless)	Table 4.4.16
kwt	Overall total waterbody dissipation rate constant	(unitless)	Table 4.4.17
WAw	Waterbody surface area	(m <sup>2</sup> )	Site specific IDESW-B
dw	Depth of water column	(m)	Site specific IDESW-G
db	Depth of upper benthic layer	(m)	0.03

Chemical Name Cwtot (mg/L)

2,3,7,8-TCDDioxin TEQ 2.2E-10



Fraction in Water Column and Benthic Sediment  
Table 4.4.16

$$[(1+Kdsw \cdot TSS \cdot 10^{-6}) \cdot (dw/(dw+db))] / [(1+Kdsw \cdot TSS \cdot 10^{-6}) \cdot (dw/(dw+db)) + (Qbs + Kdbs \cdot BS) \cdot db / (dw+db)]$$

Parameter	Description	Units	Chemical Specific	Chemical
Fwater	Fraction of total water body contaminant concentration that occurs in the water column	(unitless)		
Kdsw	Suspended sediment/surface partition coefficient	(L/kg)		CHEMIC
TSS	Total suspended solids	10 (mg/L)		
1e-6	Conversion factor	1.0E-06 (kg/mg)		
dw	Depth of water column	(m)	Site specific	IDESW-G
db	Depth of upper benthic layer	0.03 (m)	(dw+db)	
dz	Total waterbody depth	(m)		16.53
Qbs	Bed sediment porosity	0.6 (Lwater/L)		
Kdbs	Bed sediment/sediment pore water partition coefficient	(L/kg)	Chemical specific	CHEMIC
BS	Bed sediment concentration	1 (g/cm <sup>3</sup> )		

1-Fwater

Fbenth Fraction of total water body contaminant concentration that occurs in the benthic

Fluvial (unitless)  
0.0E-01

Fwater (unitless)

1.0E-02

Chemical Name  
2,3,7,8-TCDDioxin TEQ

**Total Waterbody Load**  
**Table 4.4.7**

$L_{dep} + L_{diff} + L_{ri} + L_r + L_e$	
<b>Lt</b>	Total contaminant load to the water (g/yr)
<b>Ldep</b>	Total particle phase and wet phase contaminant direct deposition load to waterbody Table 4.4.8 (g/yr)
<b>Ldiff</b>	Vapor phase contaminant diffusion load to waterbody Table 4.4.12 (g/yr)
<b>Lri</b>	Runoff load from impervious surfaces Table 4.4.9 (g/yr)
<b>Lr</b>	Runoff load from pervious surfaces Table 4.4.10 (g/yr)
<b>Le</b>	Soil erosion load Table 4.4.11 (g/yr)

**Chemical Name**      **Lt**      **(g/yr)**

2,3,7,8-TCDDioxin TEQ      7.3E-01

Overall Total Waterbody Dissipation Rate Constant  
Table 4.4.17

	$(F_{water} + kv) + (F_{benthic} + kb)$	
kwt	Overall total waterbody dissipation rate constant	(yr <sup>-1</sup> )
fwater	Fraction of total waterbody contaminant concentration that occurs in the water column	Table 4.4.16
kv	Water column volatilization rate	Table 4.4.18 (yr <sup>-1</sup> )
fbenth	Fraction of total waterbody contaminant concentration that occurs in the benthic sediments	
kb	Benthic burial rate constant	Table 4.4.22 (yr <sup>-1</sup> )

Chemical Name      Kwt      (yr<sup>-1</sup>)

2,3,7,8-TCDD/dioxin TEQ      6.6E+00

Deposition to Waterbody  
Table 4.4.8

(Dywww+Dytwp)*WAW	
Ldep	Total particle phase and wet phase contaminant direct load to waterbody (g/yr)
Dywww	Normalized yearly watershed average wet deposition from vapor phase (s/m <sup>2</sup> -Yr)
Dytwp	Normalized yearly watershed average total deposition from particle phase (s/m <sup>2</sup> -Yr)
WAW	Water body area (m <sup>2</sup> )

Chemical Name Ldep (g/yr)

2,3,7,8-TCDDioxin TEQ 2.7E-03

Diffusion Load to Waterbody  
Table 4.4.12

	(Kv*C <sub>yww</sub> *WAW*1e-6)/[(H/(R*T))]	
Ldif	Dry vapor phase contaminant diffusion load to waterbody	(g/yr)
Kv	Diffusive mass transfer coefficient	(m/yr)
C <sub>yww</sub>	Normalized yearly watershed average vapor phase air concentration	(ug-s/g-m <sup>3</sup> )
WAW	Waterbody surface area	(m <sup>2</sup> )
H	Henry's Law constant	Chemical-specific (atm-m <sup>3</sup> /mol)
R	Universal gas constant	8.2E-05 (atm-m <sup>3</sup> /mol-K)
T <sub>w</sub>	Waterbody temperature	298 (K)
1e-6	Conversion factor	1.0E-06 (g/ug)

Table 4.4.18  
Modeled

Site-specific  
Chemical-specific

Chemical Name Ldif (g/yr)

2,3,7,8-TCDDioxin TEQ 6.7E-01

Impervious Runoff Load to Waterbody  
 Table 4.4.9

(Dywww+Dytwp)*WAI		Site-specific	(g/yr)
Lri	Impervious surface runoff load		(m <sup>2</sup> )
WAI	Impervious watershed area receiving pollutant deposition		
Dywww	Normalized yearly watershed average wet deposition from vapor phase	Modeled	(s/m <sup>2</sup> -yr)
Dytwp	Normalized yearly watershed average total deposition from particle phase	Modeled	(s/m <sup>2</sup> -yr)

Chemical Name Lri (g/yr)

2,3,7,8-TCDDioxin TEQ 8.1E-04

Pervious Runoff Load to Waterbody  
Table 4.4.10

$$R^*(WAI-WAI)^{1.5} / [(Sc^{1.5} * 0.1) / (.2 + (1.5 * 2.8e+5))]$$

Lr	Pervious surface runoff load	(g/yr)
R	Average annual surface runoff	(cm/yr)
Sc	Pollutant concentration in watershed soils	(mg/kg)
Bd	Soil bulk density	1.5 (g/cm <sup>3</sup> )
Kds	Soil-water partition coefficient	Chemical-specific (L/kg)
WAI	Total watershed area receiving pollutant deposition	Site-specific (m <sup>2</sup> )
WAI	Impervious watershed area receiving pollutant deposition	Site-specific (m <sup>2</sup> )
0.01	Conversion factor	0.01 (kg-cm <sup>2</sup> /mg-m <sup>2</sup> )
Qs	Volumetric soil water content	0.2 (cm <sup>3</sup> /cm <sup>3</sup> )

Chemical Name Lr (g/yr)

2,3,7,8-TCDDioxin TEQ 2.2E-05

Erosion Load to Waterbody  
Table 4.4.11

$$Xe*(WAI-WAI)*SD^3*((Sc*2.8e+5*1.5)/(2+2.8e+5*1.5))^*.001$$

Le	Soil erosion load	(g/yr)
Xe	Unit soil loss	(kg/m <sup>2</sup> /yr)
Sc	Pollutant concentration in watershed soils	(mg/kg)
BD	Soil bulk density	1.5 (g/cm <sup>3</sup> )
Qs	Volumetric soil water content	0.2 (cm <sup>3</sup> /cm <sup>3</sup> )
Kds	Soil-water partition coefficient	Chemical-specific (L/kg)
WAI	Total watershed area receiving pollutant deposition	Site-specific (m <sup>2</sup> )
WAI	Impervious watershed area receiving pollutant deposition	Site-specific (m <sup>2</sup> )
SD	Watershed sediment delivery ratio	Table 4.4.14 (unitless)
ER	Soil enrichment ratio	3 (unitless)
0.001	Conversion factor	0.001 [(g/kg)]/[(mg/kg)]

Chemical Name Le (g/yr)

2,3,7,8-TCDDioxin TEQ 5.4E-02



Water Column Volatilization Loss Rate Constant  
Table 4.4.18

$K_v / [(d_w + 0.03) * (1 + 2.1e+6 * 10^{-6})]$	
$k_v$	Water column volatilization rate ( $yr^{-1}$ )
$K_v$	Overall transfer rate ( $m/yr$ )
$d_z$	Total waterbody depth ( $m$ )
$K_{dsw}$	Suspended sediments/surface water partition coefficient ( $L/kg$ )
TSS $1e-6$	Total suspended solids Conversion factor $1.0E+01$ ( $mg/L$ ) $1.0E-08$ ( $kg/mg$ )

Chemical Name  $k_v$  ( $yr^{-1}$ )

2,3,7,8-TCDDioxin TEQ  $6.5E+02$

Benthic Burial Rate Constant  
Table 4.4.22

$$[(X_e * WAI * SD * 1e-3 - Vfx * 10) / (WAW * 10)] / [(10 * 1e-6) / (1 * 0.03)]$$

kb	Benthic burial rate constant	(yr <sup>-1</sup> )
Xe	Unit soil loss	Table 4.4.13 (kg/m <sup>2</sup> /yr)
WAI	Watershed area receiving fallout	Site-specific (m <sup>2</sup> )
SD	Watershed sediment delivery ratio	Table 4.4.14 (unitless)
1e3	Conversion factor	1.0E+03 (g/kg)
Vfx	Average volumetric flow rate through watershed	Site-specific (m <sup>3</sup> /yr)
TSS	Total suspended solids	10 (mg/L)
WAW	Waterbody surface area	Site-specific (m <sup>2</sup> )
BS	Benthic solids concentration	1 (kg/L)
db	Depth of upper benthic sediment layer	0.03 (m)
1e-6	Conversion factor	1.0E-06 (kg/mg)

Chemical Name kb (yr<sup>-1</sup>)

2,3,7,8-TCDDioxin TEQ 1.4E-01

4.3E+02 3.3E-04

Overall Transfer Rate  
Table 4.4.19

	$[Kl^{-1} + ((Kg \cdot H) / (Rg \cdot Tw))^{-1}]^{-1} \cdot Q \cdot (Tw - 2)$
Kv	Overall transfer rate (m/yr)
Kl	Liquid phase transfer coefficient Table 4.4.20 (m/yr)
Kg	Gas phase transfer coefficient Table 4.4.21 (m/yr)
H	Henry's Law constant Chemical-specific (atm-m <sup>3</sup> /mol)
Rg	Universal gas constant 8.1E-05 (atm-m <sup>3</sup> /mol-K)
Tw	Waterbody temperature 298 (K)
Q	Temperature correction factor 1.026 (unitless)

Chemical Name Kv (m/yr)

2,3,7,8-TCDDioxin TEQ 1.2E+05

Watershed soil Concentration Due to Deposition  
Table 4.4.1

Average soil concentration over exposure duration Sc

$$\frac{[(D_s \cdot T_c \cdot S_{d,c}) / k_s] + (S_{d,c} / k_s) \cdot (1 - \exp(-k_s \cdot (T_2 - T_c))) / (T_2 - T_1)}$$

Sc	Average soil concentration over exposure duration	(mg/kg)
Ds	Deposition term	(mg/kg-yr)
Tc	Time period over which deposition occurs	(yr)
Sdc	Soil concentration at time Tc	(mg/kg)
ks	Soil loss constant	(yr <sup>-1</sup> )
T2	Exposure duration	30 (yr)
T1	Time at beginning of exposure	0 (yr)

Site-specific

Table 4.1.2

Soil concentration at time Tc Sdc

$$[D_s \cdot (1 - \exp(-k_s \cdot T_c))] / k_s$$

Sdc	Soil concentration at time Tc	(mg/kg)
Ds	Deposition term	(mg/kg-yr)
ks	Soil loss constant	(yr <sup>-1</sup> )
T2	Exposure duration	(yr)

Table 4.1.2  
Scenario-specific

Deposition term Ds

$$[100 \cdot [(3.1536 \cdot V_d \cdot C_{yww}) + D_{yww} + D_{ywp}]] / z \cdot BD$$

Ds	Deposition term	(mg/kg-yr)
Vd	Dry deposition velocity	3 (cm/s)
Cyww	Normalized yearly watershed average vapor phase air concentration	(ug-s/g-m <sup>3</sup> ) DISPERS
Dyww	Normalized yearly watershed concentration	(s/m <sup>2</sup> -yr) DISPERS

Dytwp	average wet deposition from vapor phase	Modeled	DISPERS
	Normalized yearly watershed average total (wet and dry) deposition from particle phase		
BD	Soil bulk density	1.5	(g/cm <sup>3</sup> )
z	Soil mixing depth	1	(cm)
100	Units conversion factor		[mg-m <sup>2</sup> ]/[kg-cm <sup>2</sup> ]

Sc	(mg/kg)	Sdc	(mg/kg)	Dis	(mg/kg-yr)
1.4E-07		1.9E-07		1.9E-06	

Chemical Name  
2,3,7,8-TCDDioxin TEQ

Universal Soil Loss Equation (USLE)  
Table 4.4.13

$$(Rf \cdot K \cdot LS \cdot C \cdot PF) \cdot (907.18 / 4047)$$

Parameter	Unit	Value	Site-specific Value
Xe	Unit soil loss		(kg/m <sup>2</sup> /yr)
RF	USLE rainfall factor		0.36 (ton/acre)
K	USLE erodibility factor		1.5 (unitless)
LS	USLE length-slope factor		0.1 (unitless)
C	USLE cover management factor		1 (unitless)
PF	USLE supporting practice factor		907.18 (kg/ton)
907.18	Conversion factor		4047 (m <sup>2</sup> /acre)
4047	Conversion factor		

Chemical Name Xe (kg/m<sup>2</sup>/yr)

2,3,7,8-TCDDioxin TEQ 3.6E+00

Sediment Delivery Ratio  
Table 4.4.14

$a^*(WAI)^b$	0.125
SD	Watershed sediment delivery ratio (unitless)
WAI	Watershed area receiving fallout (m <sup>2</sup> )
a	Empirical intercept coefficient (unitless)
b	Empirical slope coefficient (unitless)
	0.125

Site-specific Watershed-specific IDESW

Chemical Name SD  
2,3,7,8-TCDDioxin TEQ 1.0E-01

Soil Loss Constant  
Table 4.4.2

$k_s + k_{se} + k_{sr} + k_{sg} + k_{sv}$			
$k_s$	Soil loss constant due to all processes		( $yr^{-1}$ )
$k_{sl}$	Loss constant due to leaching	Table 4.4.3	( $yr^{-1}$ )
$k_{se}$	Loss constant due to soil erosion	Table 4.4.4	( $yr^{-1}$ )
$k_{sr}$	Loss constant due to surface runoff	Table 4.4.5	( $yr^{-1}$ )
$k_{sg}$	Loss constant due to degradation	Chemical-specific	( $yr^{-1}$ )
$k_{sv}$	Loss constant due to volatilization	Table 4.4.6	( $yr^{-1}$ )

$k_s$  ( $yr^{-1}$ )

Chemical Name

9.2E-02

2,3,7,8-TCDDioxin TEQ



Liquid Phase Transfer Coefficient (Quiescent lake or pond)  
Table 4.4.20

$$(Cd^{*0.5} * W)^{(pa/pw)^{*0.5} * (vk^{*0.33}/y2)^{(uw/(pw^{*}Dw))^{*0.67} * 31500000)}$$

Parameter	Description	Chemical-specific	Site-specific
Kl	Liquid phase transfer coefficient	(m/yr)	
Dw	Diffusivity of chemical in water	(cm <sup>2</sup> /s)	
Cd	Drag coefficient	0.0011 (unitless)	
W	Wind velocity, 10 m above water surface	(m/s)	
pa	Density of air corresponding to water temperature	1.2E-03 (g/cm <sup>3</sup> )	
pw	Density of water corresponding to water temperature	1 (g/cm <sup>3</sup> )	
vk	von Karman's constant	0.4 (unitless)	
y2	Dimensionless viscous sublayer thickness	4 (unitless)	
uw	Viscosity of water corresponding to the water temperature	1.7E-02 (g/cm-s)	
3.15e7	Conversion constant	3.2E+07 (s/yr)	

Chemical Name Kl (m/yr)

2,3,7,8-TCDDioxin TEQ 2.0E+02

Gas Phase Transfer Coefficient (Quiescent lake or pond)  
Table 4.4.21

$$(Cd \cdot 5 \cdot W) \cdot (vk \cdot 33/y2) \cdot [ua / (pa \cdot Da)] \cdot 67 \cdot 3.15e+7$$

Kg	Gas phase transfer coefficient	(m/yr)
Cd	Drag coefficient	0.0011 (unitless)
W	Wind velocity, 10 m above water surface	Site-specific (m/s)
vk	van Kaman's constant	0.4 (unitless)
y2	Dimensionless viscous sublayer thickness	4 (unitless)
ua	Viscosity of air corresponding to the air temperature	1.9E-04 (g/cm-s)
pa	Density of air corresponding to water temperature	1.2E-03 (g/cm^3)
Da	Diffusivity of chemical in air	Chemical-specific (cm^2/s)
3.15e7	Conversion constaint	3.2E+07 (s/yr)

Chemical Name      Kg      (m/yr)

2,3,7,8-TCDDioxin TEQ      4.5E+05

Loss Constant Due to Leaching  
Table 4.4.3

	$(P+I-R-Ev)/[Qs*z*(1+(BD*Kds/BD))]$		
ksl	Loss constant due to leaching		(yr <sup>-1</sup> )
P	Average annual precipitation	Site-specific	(cm/yr)
I	Average annual irrigation	Site-specific	(cm/yr)
R	Average annual runoff	Site-specific	(cm/yr)
Ev	Average annual evapotranspiration	Site-specific	(cm/yr)
Qs	Soil volumetric water content		0.2 (mL/cm <sup>3</sup> )
z	Soil depth from which leaching removal occurs		1 (cm)
Kds	Soil-water partition coefficient	Chemical-specific	(cm <sup>3</sup> /g)
BD	Soil bulk density		1.5 (g/cm <sup>3</sup> )

Chemical Name ksl (yr<sup>-1</sup>)

2,3,7,8-TCDDioxin TEQ 9.0E-05

Loss Constant due to Erosion  
Table 4.4.4

$$[(.1 * X_e * S D * E R) / (B D * z)] * [(K_d s * B D) / (Q_s + (K_d s * B D))]$$

kse	Loss constant due to erosion	(yr <sup>-1</sup> )
Xe	Unit soil loss	(kg/m <sup>2</sup> /yr)
SD	Sediment delivery ration	(unitless)
ER	Contaminant enrichment ratio	3 (unitless)
z	Soil mixing depth	1 (cm)
Qs	Soil volumetric water content	0.2 (mL/cm <sup>3</sup> )
Kds	Soil-water partition coefficient	Chemical-specific (cm <sup>3</sup> /g)
BD	Soil bulk density	1.5 (g/cm <sup>3</sup> )

Chemical Name kse (yr<sup>-1</sup>)

2,3,7,8-TCDDioxin TEQ 7.4E-02

Loss constant due to Runoff  
Table 4.4.5

	$[R/(Qs*z)]^{1/(1+(Kds*BD)/Qs)}$		
ksr	Loss constant due to runoff	(yr <sup>-1</sup> )	
R	Average annual runoff	(cm/yr)	IDETRAN
Qs	Soil volumetric water content	0.2 (mL/cm <sup>3</sup> )	
z	Soil mixing depth	1 (cm)	
Kds	Soil-water partition coefficient	Chemical specific (cm <sup>3</sup> /g)	IDECHE
BD	Soil bulk density	1.5 (g/cm <sup>3</sup> )	

Chemical Name

2,3,7,8-TCDDioxin TEQ

ksr 3.0E-05 (yr<sup>-1</sup>)

Loss Constant due to Volatilization  
Table 4.4.6

Parameter	Value	Units	Chemical Name
ksv	$[(3.1536e+7 \cdot H) / (z \cdot Kds \cdot R \cdot T \cdot BD)] \cdot [1.482 \cdot u \wedge .78 \cdot (pa \cdot Da) \wedge -.67] \cdot [(4 \cdot A \cdot (Pi)) \wedge .5] \wedge -.11]$	(yr <sup>-1</sup> )	
Loss constant due to volatilization			
3.1536e7	Conversion constant	3.2E+07 (s/yr)	Chemical specific (atm-m <sup>3</sup> /mol)
H	Henry's Law constant	1 (cm)	IDECHEM
z	Soil mixing depth	Chemical specific (cm <sup>3</sup> /g)	IDECHEM
Kds	Soil-water partition coefficient	8.1E-05 (atm-m <sup>3</sup> /mol-K)	IDECHEM
R	Universal gas constant	1.5 (g/cm <sup>3</sup> )	
BD	Soil bulk density	Site specific (K)	IDETRAN-Tc
T	Ambient air temperature	Site specific (m/s)	IDETRAN
u	Average annual wind speed	1.8E-04 (g/cm-s)	
ua	Viscosity of air	1.2E-03 (g/cm <sup>3</sup> )	
pa	Density of air	Chemical specific (cm <sup>2</sup> /s)	IDECHEM
Da	Diffusivity of contaminant in air	Site specific (m <sup>2</sup> )	IDESW
A	Surface area of contaminated area		

Chemical Name ksv (yr<sup>-1</sup>)

2,3,7,8-TCDDioxin TEQ 1.8E-02

**Cancer Risk for Individual Chemicals for Subsistence Fisher Scenario**

Chemical	CR	HQ
2,3,7,8-TCDDioxin TEQ	8E-07	NA

Cancer Risk for Individual Chemicals for subsistence Fisher Scenario  
 Table 5.2.6

$$C R = (I * E D * E F * C S F) / (B W * A T * 365)$$

CR	Individual lifetime cancer risk	(unitless)
I	Total daily intake of contaminant	(mg/day)
ED	Exposure duration	30 (yr)
EF	Exposure frequency	350 (day/yr)
BW	Body weight	70 (kg)
AT	Averaging time	70 (yr)
365	Units conversion factor	365 (day/yr)

Chemical	CR
2,3,7,8-TCDDioxin TEQ	7.8E-07



Hazard Quotient for Individual Chemicals for Subsidiary  
Table 5.2.6

$$HQ = I/(BW \cdot RfD)$$

HQ	Hazard Quotient	HQ	(unitless)
1	Total daily intake of contaminant	Table 5.2.4	(mg/day)
BW	Body weight	70	(kg)
RfD	Reference dose	Chemical-specific	(mg/kg/day)

Chemical Name HQ (unitless)

2,3,7,8-TCDD/dioxin TEQ NA

Total Daily Intake for Subsistence Fisher Scenario  
Table 5.2.5

I = I <sub>soil</sub> + I <sub>ag</sub> + I <sub>fish</sub> + I <sub>dw</sub>	
I	Total daily intake of contaminant (mg/day)
I <sub>soil</sub>	Daily intake of contaminant from soil Table 5.2.1 (mg/day)
I <sub>ag</sub>	Daily intake of contaminant from agave-ground produce Table 5.2.2 (mg/day)
I <sub>fish</sub>	Daily intake of contaminant from fish Table 5.2.3 (mg/day)
I <sub>dw</sub>	Daily intake of contaminant from drinking water Table 5.2.4 (mg/day)

Chemical Name I (mg/day)

2,3,7,8-TCDDioxin TEQ 8.5E-10

Soil Intake for Subsistence Fisher Scenario  
 Table 5.2.1

$$I_{soil} = Sc * CR_{soil} * F_{soil}$$

Isoil	Daily intake of soil	
Sc	Soil concentration	Table 4.1.1 (mg/kg)
CR <sub>soil</sub>	Consumption rate of soil	0.0001 (kg/day)
F <sub>soil</sub>	Fraction of consumed soil contaminated	1 (unitless)

Chemical Name Isoil (mg/day)

2,3,7,8-TCDDioxin TEQ 1.6E-11

Soil Concentration due to Deposition  
Table 4.1.1

Average soil concentration over exposure duration  $S_c$

$$\frac{[(D_s \cdot T_c \cdot S_{dc}) / k_s] + [(S_{dc} / k_s) \cdot (1 - \exp(-k_s \cdot (T_2 - T_c)))]}{(T_2 - T_1)}$$

$S_c$	Average soil concentration	(mg/kg)	
$D_s$	Deposition term	(mg/kg-yr)	
$T_c$	Time period over which deposition occurs	(yr)	IDETRA
$S_{dc}$	Soil concentration at time $T_c$	(mg/kg)	
$k_s$	Soil loss constant	(yr <sup>-1</sup> )	Table 4.1.2
$T_2$	Exposure duration	(yr)	Senario specific 30 yrs

Soil concentration at time  $T_c$   $S_{dc}$

$$[D_s \cdot (1 - \exp(-k_s \cdot T_c))] / k_s$$

Deposition term  $D_s$

$$[100 \cdot ((.31536 \cdot V_{dv} \cdot C_{yv} + D_{yww}) + (D_{ydp} + D_{ywp}))] / (z \cdot BD)$$

100	Units conversion factor	100 (mg-m <sup>2</sup> /(kg-cm <sup>2</sup> ))	
$z$	Soil mixing depth	1 (cm)	
$BD$	Soil bulk density	1.5 (g/cm <sup>3</sup> )	
0.31536	Units conversion factor	0.31536 (m-g-s/cm-ug-yr)	
$V_{dv}$	Dry deposition velocity	3 (cm/s)	
$C_{yv}$	Normalized vapor phase air concentration	(ug-s/g-m <sup>2</sup> )	DISPC1-
$D_{yww}$	Normalized yearly wet deposition from vapor phase	(s/m <sup>2</sup> -yr)	DISPC1-
$D_{ydp}$	Normalized yearly dry deposition from particle phase	(s/m <sup>2</sup> -yr)	DISPC1-
$D_{ywp}$	Normalized yearly wet deposition from particle phase	(s/m <sup>2</sup> -yr)	DISPC1-

Chemical Name	Sc1 (mg/kg)	Sc2c (mg/kg)	Sc3 (mg/kg-yr)
2,3,7,8-TCDDioxin TEQ	1.0E-07	2.9E-07	1.2E-08

Soil Loss Constant  
Table 4.1.2

Parameter	Description	Reference	Units
$k_{sl} + k_{se} + k_{sr} + k_{sg} + k_{sv}$			
$k_s$	Soil loss constant due to all processes		$(yr^{-1})$
$k_{sl}$	Loss constant due to leaching	Table 4.1.3	$(yr^{-1})$
$k_{se}$	Loss constant due to soil erosion		$(yr^{-1})$
$k_{sr}$	Loss constant due to surface runoff	Table 4.1.4	$(yr^{-1})$
$k_{sg}$	Loss constant due to degradation	Chemical specific	$(yr^{-1})$
$k_{sv}$	Loss constant due to volatilization	Table 4.1.5	$(yr^{-1})$

Chemical Name  $k_s$   $(yr^{-1})$

2,3,7,8-TCDDioxin TEQ 1.8E-02

Loss Constant Due to Leaching  
Table 4.1.3

					$(P+I-R-Ev)/[Qs*z*(1+(BD*Kds/Qs))]$
ksl	Loss constant due to leaching				(yr <sup>-1</sup> )
P	Average annual precipitation	Site specific			IDETTRAN
I	Average annual irrigation	Site specific			IDETTRAN
R	Average annual runoff	Site specific			IDETTRAN
Ev	Average annual evapo- transpiration	Site specific			IDETTRAN
Qs	Soil volumetric water content		0.2	(mL/cm <sup>3</sup> )	
z	Soil depth from which leaching removal occurs		1	(cm)	
Kds	Soil-water partition coefficient	Chemical specific		(cm <sup>3</sup> /g)	IDECHE

Chemical Name ksl (yr<sup>-1</sup>)

2,3,7,8-TCDDioxin TEQ 9.0E-05

Loss constant due to Runoff  
Table 4.1.4

$$[R/(Qs*z)]*[1/(1+(Kds*BD)/Qs)]$$

ksr	Loss constant due to runoff	(yr <sup>-1</sup> )	
R	Average annual runoff	(cm/yr)	IDETAN
Qs	Soil volumetric water content	0.2 (cL/cm <sup>3</sup> )	
z	Soil mixing depth	1 (cm)	
Kds	Soil-water partition coefficient	Chemical specific (cm <sup>3</sup> /g)	IDECEH
BD	Soil bulk density	1.5 (g/cm <sup>3</sup> )	

Chemical Name ksr (yr<sup>-1</sup>)

2,3,7,8-TCDDioxin TEQ 3.0E-05



Loss Constant due to Volatilization  
Table 4.1.5

$$[(3.1536e+7H)/(z*Kds*R*T*BD)]*1.482*u^*.78*(ua/(pa*Da)^*.67)*(((4*A/(PI))^*.5)^*.11)$$

ksv	Loss constant: due to volatilization	(yr <sup>-1</sup> )	
3.1536e7	Conversion constant	(s/yr)	
H	Henry's Law constant	Chemical specific (atm-m <sup>3</sup> /mol)	IDECHEM
z	Soil mixing depth	1 (cm)	
Kds	Soil-water partition coefficient	Chemical specific (cm <sup>3</sup> /g)	IDECHEM
R	Universal gas constant	8.1E-05 (atm-m <sup>3</sup> /mol-K)	
BD	Soil bulk density	1.5E+00 (g/cm <sup>3</sup> )	
T	Ambient air temperature	Site specific (K)	IDETRAN-Tc
u	Average annual wind speed	Site specific (m/s)	IDETRAN
ua	Viscosity of air	1.8E-04 (g/cm-s)	
pa	Density of air	1.2E-03 (g/cm <sup>3</sup> )	
Da	Diffusivity of contaminant in air	Chemical specific (cm <sup>2</sup> /s)	IDECHEM
A	Surface area of contaminated area	Site specific (m <sup>2</sup> )	IDETRAN

Chemical Name ksv (yr<sup>-1</sup>)

2,3,7,8-TCDDioxin TEQ 1.8E-02

Above-Ground Produce Intake for Adult Resident Scenario  
 Table 5.2.2

	$(Pd+Pv+Pr)*CRag*Fag$	
Iag	Daily intake of contaminant from soil	(mg/day)
Pd	Concentration in above-ground produce due to deposition	Table 4.2.6 (mg/kg)
Pv	Concentration in above-ground produce due to air-to-plant transfer	Table 4.2.7 (mg/kg)
Pr	Concentration in above-ground produce due to root uptake	Table 4.2.8 (mg/kg)
CRag	Consumption rate of above-ground produce	0.028 (kg/day)
Fag	Fraction of above-ground produce contaminated	0.25 (unitless)

Chemical Name  
 2,3,7,8-TCDDioxin TEQ

Iag (mg/day)  
 5.0E-12

Above-Ground Produce Concentration Due to Direct Deposition  
Table 4.2.6

	$[(1000 \times (\text{Dydp} + (\text{Fw} \times \text{Dywp})) \times \text{Rp}) \times (1 - \exp(-\text{kp} \times \text{Tp}))] / (\text{Yp} \times \text{kp})$			
1000	Units conversion factor			(unitless)
Dydp	Normalized yearly dry deposition from particle phase	Modelled		(s/m <sup>2</sup> -yr)
Fw	Fraction of wet deposition that adheres to plant	Chemical specific	CHEMIC	(unitless)
Dywp	Yearly particle phase wet deposition rate	Modelled	DISPC1-	(g/m <sup>2</sup> /yr)
Rp	Interception fraction of edible portion of plant			0.05 (unitless)
kp	Plant surface loss coefficient			18 (yr <sup>-1</sup> )
Tp	Length of plant exposure to deposition of edible portion of plant, per harvest			0.16 (yrs)
Yp	Yield or standing crop biomass of the edible portion of the plant			1.6 (kgDW/M <sup>2</sup> )

Chemical Name Pd (mg/kg)

2,3,7,8-TCDDioxin TEQ 1.2E-10

Above-Ground Produce Concentration Due to Air-to-Plant Transfer  
 Table 4.2.7

	(C <sub>yv</sub> *B <sub>v</sub> *V <sub>Gag</sub> )/p <sub>a</sub>			
P <sub>v</sub>	Concentration of pollutant in the plant due to air-to-plant transfer			(mg/kg)
C <sub>yv</sub>	Normalized vapor phase air concentration		Modelled	(ug-sec/g-m <sup>3</sup> )
B <sub>v</sub>	Air-to-plant biotransfer factor		Chemical specific	(mgplant/ugair) CHEMIC
V <sub>Gag</sub>	Empirical correction factor for above-ground produce		0.01	(unitless)
p <sub>a</sub>	Density of air		1.2E+03	(g/m <sup>3</sup> )

Chemical Name  
 2,3,7,8-TCDDioxin TEQ      P<sub>v</sub>      (mg/kg)      7.0E-11

Above-Ground Produce Concentration Due to Root Uptake  
 Table 4.2.8

Sc*Br	Pr	Sc	Br
	Pr	Sc	Br
	Pr	Sc	Br
	Pr	Sc	Br

Concentration of pollutant in the  
 Average soil concentration of  
 pollutant over exposure duration  
 Plant-soil bioconcentration factor  
 for above-ground produce

(mg/kg)  
 (mg/kg)

Table 4.2.1

Chemical specific (ug/gplant)/(ug/gsoil) CHEMIC

Pr (mg/kg)

Chemical Name

2,3,7,8-TCDDioxin TEQ 5.2E-10

Soil Concentration due to Deposition  
Table 4.2.1

$$\frac{[(Ds \cdot Tc \cdot Sc) / ks] + [(Sc / ks) \cdot (1 - \exp(-ks \cdot (T2 - Tc)))] / (T2 - T1)}$$

Sc	Average soil concentration	(mg/kg)
Ds	Deposition term	(mg/kg-yr)
Tc	Time period over which deposition occurs	(yr)
Scic	Soil concentration at time Tc	(mg/kg)
ks	Soil loss constant	(yr <sup>-1</sup> )
T2	Exposure duration	(yr)
T1	Exposure duration	(yr)

$$[Ds \cdot (1 - \exp(-ks \cdot Tc))] / ks$$

$$[100 \cdot [(0.31536 \cdot Vdv \cdot Cyv + Dywv) + (Dydp + Dywp)] / (z \cdot BD)]$$

100	Units conversion factor	(mg-m <sup>2</sup> ) / (kg-cm <sup>2</sup> )
z	Soil mixing depth	1 (cm)
BD	Soil bulk density	1.5 (g/cm <sup>3</sup> )
0.31536	Units conversion factor	0.31536 (m-g-s/cm-ug-yr)
Vdv	Dry deposition velocity	3 (cm/s)
Cyv	Normalized vapor phase air concentration	(ug-s/g-m <sup>2</sup> )
Dywv	Normalized yearly wet deposition from vapor phase	(s/m <sup>2</sup> -yr)
Dydp	Normalized yearly dry deposition from particle phase	(s/m <sup>2</sup> -yr)
Dywp	Normalized yearly wet deposition from particle phase	(s/m <sup>2</sup> -yr)

Chemical Name	Sc	(mg/kg)	Sctc	(mg/kg)	Ds	(mg/kg-yr)
2,3,7,8-TCDDioxin TEQ	1.6E-07		2.9E-07			1.3E-08

Soil Loss Constant  
Table 4.2.2

$k_s + k_{se} + k_{sr} + k_{sg} + k_{sv}$	
$k_s$	Soil constant due to leaching ( $yr^{-1}$ )
$k_{se}$	Loss constant due to soil erosion 0 ( $yr^{-1}$ )
$k_{sr}$	Loss constant due to surface runoff ( $yr^{-1}$ )
$k_{sg}$	Loss constant due to degradation Chemical specific ( $yr^{-1}$ )
$k_{sv}$	Loss constant due to volatilization Table 4.2.5 ( $yr^{-1}$ )

Chemical Name  $k_s$  ( $yr^{-1}$ )

2,3,7,8-TCDDioxin TEQ 1.8E-02

Loss Constant due to Degradation  
Appendix A

0.0E+00 ksg 0.0E+00

Loss Constant Due to Leaching  
Table 4.2.3

	$(P+I-R-Ev)/(Qs*z*(1+(BD*Kds/Qs)))$	
ksl	Loss constant due to leaching	(yr <sup>-1</sup> )
P	Average annual precipitation	Site specific (cm/yr)
I	Average annual irrigation	Site specific (cm/yr)
R	Average annual runoff	Site specific (cm/yr)
Ev	Average annual evapo- transpiration	Site specific (cm/yr)
Qs	Soil volumetric water content	0.2 (mL/cm <sup>3</sup> )
z	Soil depth from which leaching removal occurs	1 (cm)
Kds	Soil-water partition coefficient	Chemical specific (cm <sup>3</sup> /g)

Chemical Name ksl (yr<sup>-1</sup>)

2,3,7,8-TCDDioxin TEQ 9.0E-05



Loss Constant due to Runoff  
Table 4.2.4

	$[R/(Qs^2)] \cdot [1/(1+(Kds \cdot BD)/Qs)]$	
ksr	Loss constant due to runoff	(yr <sup>-1</sup> )
R	Average annual runoff	(cm/yr)
Qs	Soil volumetric water content	0.2 (cL/cm <sup>3</sup> )
z	Soil mixing depth	1 (cm)
Kds	Soil-water partition coefficient	Chemical specific (cm <sup>3</sup> /g)
BD	Soil bulk density	1.5 (g/cm <sup>3</sup> )

Site specific  
IDETRAN

Chemical specific  
IDECHEM

Chemical Name      ksr      (yr<sup>-1</sup>)

2,3,7,8-TCDDioxin TEQ      3.0E-05

Loss Constant due to Volatilization  
Table 4.2.5

Parameter	Value	Units	Notes
ksv	$[(3.1536e+7 \cdot H) / (z \cdot Kds \cdot R \cdot T \cdot BD)] \cdot [1.482 \cdot u \cdot 78 \cdot (ua / (pa \cdot Da)) \cdot .67] \cdot [(4 \cdot A / (Pi) \cdot 5) \cdot ] \cdot 1.1]$	(yr <sup>-1</sup> )	
Loss constant due to volatilization			
3.1536e7		(s/yr)	Chemical specific (atm-m <sup>3</sup> / IDECHE)
H		1 (cm)	
Henry's Law constant			
z		(cm <sup>3</sup> /g)	IDECHE
Soil mixing depth		8.1E-05 (atm-m <sup>3</sup> /mol-K)	
Kds		1.5 (g/cm <sup>3</sup> )	
Soil-water partition coefficient		(K)	IDETRAN
R		(m/s)	IDETRAN
Universal gas constant		1.8E-04 (g/cm-s)	
BD		1.2E-03 (g/cm <sup>3</sup> )	
Soil bulk density			
T		(cm <sup>2</sup> /s)	IDECHE
Ambient air temperature		(m <sup>2</sup> )	IDETRAN
u			
ua			
Average annual wind speed			
viscosity of air			
pa			
Density of air			
Da			
Diffusivity of contaminant in air			
A			
Surface area of contaminated area			

Chemical Name ksv (yr<sup>-1</sup>)

2,3,7,8-TCDDioxin TEQ 1.8E-02

Fish Intake for Subsistence Fisher Scenario  
 Table 5.2.3

$$I_{fish} = C_{fish} * CR_{fish} * F_{fish}$$

$I_{fish}$	Daily intake of contaminant from fish	(mg/day)
$C_{fish}$	Fish concentration	Table $C_{fish}$
$CR_{fish}$	Consumption rate of fish	0.06 (kg/day)
$F_{fish}$	Fraction of fish contaminated	1 (unitless)

Chemical Name  $I_{fish}$  (mg/day)

2,3,7,8-TCDDioxin TEQ  $8.3E-10$

Fish Cone

Cfish=Cfish+Cfish+

Cfish (mg/kg)

1.4E-08

Chemical Name

2,3,7,8-TCDDioxin TEQ

Fish Concentration from Dissolved Water concentration  
 Table 4.4.26

	$C_{fish} = C_{dw} * BCF$		
C <sub>fish</sub>	fish concentration	(mg/kg)	
C <sub>dw</sub>	Dissolved water concentration	(mg/L)	Table 4.4.24
BCF	Bioconcentration	Chemical-specific	(L/kg)
Chemical Name	C <sub>fish</sub>	(mg/kg)	
2,3,7,8-TCDDioxin TEQ		0.0E+00	

Fish Concentration from Dissolved Water concentration  
 Table 4.4.26

$C_{fish} = C_{dw} * BCF$	
$C_{fish}$	fish concentration (mg/kg)
$C_{dw}$	Dissolved water concentration (mg/L)
BCF	Table 4.4.24 Chemical-specific Bioconcentration (L/kg)
$C_{fish}$	(mg/kg)
Chemical Name	
2,3,7,8-TCDDioxin TEQ	0.0E+00

Fish concentration from Total Water Column Concentration  
Table 4.4.27

Chemical Name	C <sub>fish</sub> (mg/kg)	C <sub>fish</sub> / C <sub>w</sub> (mg/kg) / (mg/L)	BAF (L/kg)
2,3,7,8-TCDDioxin TEQ	0.0E+00		

Fish Concentration from Bed Sediments  
Table 4.4.28

$$C_{fish} = (C_{sb} * \text{lipid} * \text{BSAF}) / \text{OC}_{sed}$$

$C_{fish}$	Fish concentration	(mg/kg)
$C_{sb}$	Concentration of contaminant sorbed to bed sediment	(mg/kg)
lipid	fish lipid content	0.07 (unitless)
BSAF	Biota to sediment accumulation factor	Chemical-specific (unitless)
$\text{OC}_{sed}$	Fraction organic carbon in bottom sediment	0.04 (unitless)

Chemical Name (mg/kg)

2,3,7,8-TCDDioxin TEQ 1.4E-08



Concentration Sorbed to Bed Sediment  
Table 4.4.25

$$C_{sb} = f_{benth} * C_{wtot} * [K_{dbs} / (Q_{bs} + K_{dbs} * BS)] * (dw + db) / db$$

Csb	Concentration sorbed to bed sediment	(mg/kg)
f <sub>benth</sub>	Fraction of total water body contaminant concentration that occurs in bed sediment	Table 4.4.16 (unitless)
C <sub>wtot</sub>	Total water concentration in surface water system, including water column	Table 4.4.15 (mg/L)
dw	Total depth of water column	Site-specific (m)
db	Depth of upper benthic layer	0.03 (m)
Q <sub>bs</sub>	Bed sediment porosity	0.6 (unitless)
K <sub>dbs</sub>	Bed sediment/sediment pore water partition coefficient	Chemical-specific
BS	Bedsediment concentration	1 (kg/L)

Chemical Name Csb (mg/kg)

2,3,7,8-TCDDioxin TEQ 1.2E-07

Drinking Water Intake for Subsistence Fisher Scenario  
 Table 5.2.4

Cdw*CRdw*Fdw	
Idw	Daily intake of contaminant from drinking water (mg/day)
Cdw	Dissolved contaminant concentration in drinking water (mg/L)
CRdw	Consumption rate of drinking water (L/day)
Fdw	Fraction of drinking water contaminated (unitless)

Table 4.4.24

Chemical Name Idw (mg/day)

2,3,7,8-TCDDioxin TEQ 3.0E-13