R 299.5711 Rescinded.

R 299.5712 Generic cleanup criteria for groundwater based on human dermal contact with groundwater.

Rule 712. (1) Exposure to groundwater by dermal contact shall be considered a relevant pathway, and the criteria derived under this rule shall apply when contaminated groundwater is, or will be as a result of migration of groundwater contamination, encountered at a depth where construction or maintenance of utilities or other subsurface activities may reasonably be expected to result in persons coming into contact with the groundwater. If utilities are not currently present at a facility, then the location and elevation of contaminated groundwater relative to the location and elevation of surrounding utilities shall be considered in determining whether it is likely that dermal contact with groundwater related to utility construction and maintenance is reasonably likely to occur in the future.

(2) If exposure to surface water in existing ponds or other existing surface water features is a reasonable and relevant pathway at a facility, then the criteria established under R 299.5716(6) shall apply unless the department approves of alternative criteria as being protective of the public health, safety, and welfare, and the environment under R 299.5716(8) or R 299.5716(11).

(3) Cleanup criteria for groundwater based on risks resulting from dermal contact with groundwater shall be calculated according to the algorithms set forth in this subrule, except as provided for in R 299.5734(3). The exposure assumptions for calculation of generic criteria shall be the same for all land use categories.

EQUATION FOR CARCINOGENS:

$$GCC = \frac{BW \times AT \times TR \times CF_1}{SF \times SA \times SP \times EV \times EF \times ED \times CF_2}$$

where,

GCC	(Groundwater contact criterion)	=	chemical-specific, ug/L or ppb
BW	(Body weight)	=	70 kg
AT	(Averaging time)	=	25,550 days (70 years x 365 days/year)
TR	(Target risk level)	=	10^{-5}
SF	(Oral cancer slope factor)	=	chemical-specific $(mg/kg\text{-}day)^{-1}$
SA	(Skin surface area – adult)	=	3,300 cm^2
SP	(Skin penetration per event)	=	chemical-specific, cm/event
EV	(Event frequency)	=	1 event/day
EF	(Exposure frequency)	=	20 days/year
ED	(Exposure duration)	=	21 years
CF_1	(Conversion factor 1)	=	1E+3 ug/mg

CF_2	(Conversion factor 2)	=	1E-3 L/cm^3

EQUATION FOR NONCARCINOGENS:

$$GCC = \frac{THQ \times RfD \times BW \times AT \times CF_1}{SA \times SP \times EV \times EF \times ED \times CF_2}$$

where,

GCC	(Groundwater contact criterion)	=	chemical-specific, ug/L or ppb
THQ	(Target hazard quotient)	=	1
RfD	(Oral reference dose)	=	chemical-specific, mg/kg-day
BW	(Body weight)	=	70 kg
AT	(Averaging time)	=	7,665 days (21 years x 365 days/year)
SA	(Skin surface area – adult)	=	3,300 cm^2
SP	(Skin penetration per event)	=	chemical-specific, cm/event
EV	(Event frequency)	=	1 event/day
EF	(Exposure frequency)	=	20 days/year
ED	(Exposure duration)	=	21 years
CF_1	(Conversion factor 1)	=	1E+3 ug/mg
CF_2	(Conversion factor 2)	=	1E-3 L/cm^3

Derivation of SP is performed differently for inorganic and organic hazardous substances. The steady-state method shall be used to estimate skin penetration for inorganic hazardous substances (SP_i) as shown in the following equation:

$$SP_i = K_p \times ET$$

where,

SP_i	(Skin penetration per event)	=	chemical-specific, cm/event
K_p	(Permeability coefficient)	=	chemical-specific, cm/hour, or default specified by the department
ET	(Exposure time)	=	2 hours/event

If the department does not specify a K_p for a particular inorganic hazardous substance, then a default value of 0.001 cm/hour shall be used.

A nonsteady-state method shall be used to calculate skin penetration for organic hazardous substances (SP_o) to account for absorption that occurs after the actual exposure event due to storage of the hazardous substance within skin lipids. The

algorithm below shall be used to determine chemical-specific K_p values for organic hazardous substances:

$$\log K_p = -2.80 + (0.67 \times \log K_{ow}) - (0.0056 \times MW)$$

where,

K_p	(Permeability coefficient)	=	chemical-specific, cm/hour
K_{ow}	(Octanol/water partition coefficient)	=	chemical-specific, L/L
MW	(Molecular weight)	=	chemical-specific, g/mole

The department shall specify chemical-specific values for K_{ow} and MW.

The equations used to estimate penetration of organic hazardous substances (SP_o) through the skin shall be as follows:

$$\text{If } ET \le t^*, \text{ then: } SP_o = 2 \times K_p \times \sqrt{\frac{6 \times \tau \times ET}{\pi}}$$

$$\text{If } ET > t^*, \text{ then: } SP_o = K_p \times \left[\frac{ET}{1+B} + 2\tau \left(\frac{1 + 3B + 3B^2}{(1+B)^2} \right) \right]$$

where,

t^*	(Time to reach steady-state)	=	chemical-specific, hours
τ	(Lag time)	=	chemical-specific, hours
ET	(Exposure time)	=	2 hours
π	(pi)	=	3.14
B	(Ratio of the permeability coefficient of the stratum corneum to the permeability coefficient of the viable epidermis)	=	chemical-specific, dimensionless

Chemical-specific values for B, τ and t^* shall be calculated from the following steps:

Step 1: Calculate B

$$B = K_p \times \left(\frac{\sqrt{MW}}{2.6} \right)$$

where,

B	(Ratio of the permeability	=	chemical-specific,

	coefficient of the stratum corneum to the permeability coefficient of the viable epidermis)		dimensionless
K_p	(Permeability coefficient)	=	chemical-specific, cm/hour
MW	(Molecular weight)	=	chemical-specific, g/mole

Step 2: Calculate the chemical-specific diffusivity across the stratum corneum (D_{sc}):

$$D_{sc} = 10^{(-2.80-0.0056\times MW)} \times l_{sc}$$

where,

D_{sc}	(Effective diffusivity across stratum corneum)	=	chemical-specific, cm^2/hour
l_{sc}	(Thickness of stratum corneum)	=	0.001 cm

Step 3: Calculate lag time (τ) in hours:

$$\tau = \frac{l_{sc}^2}{6 \times D_{sc}}$$

Step 4: Calculate T^*:

If $B \leq 0.6$, then $t^* = 2.4 \times \tau$

If $B > 0.6$, then $t^* = \left(b - \sqrt{b^2 - c^2}\right)\left(\frac{l_{sc}^2}{D_{sc}}\right)$

where,

$$b = \frac{2(1+B)^2}{\pi} - c$$

$$c = \frac{1 + 3B + 3B^2}{3(1+B)}$$