# Second Draft

# Health-Based Guidance Levels (HBGLs) for Specific End-Uses of Remediated Groundwater




**Prepared by**

**The Office of Environmental Health**

**Prepared for**

**The Arizona Department of Environmental Quality**

**June 1998**

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# EXECUTIVE SUMMARY

The Groundwater Cleanup Task Force endorsed a proposal introduced by the End Use Committee that the Arizona Department of Environmental Quality (ADEQ) develop water quality standards that would be specifically applicable to the use of remediated groundwater. The task force recommended that the standards be based upon numeric levels and operational controls, and that they be protective of human health and the environment including groundwater and the ecology.

As an initial step, the ADEQ asked the Arizona Department of Health Services (ADHS) to develop Health Based Guidance Levels (HBGLs) for specific end uses of remediated groundwater that are protective of human health. The HBGLs in this document were developed by the ADHS for the end uses identified in the task force final report, and are individually considered to be protective of human health.

The task force report recommended that standards be developed for 13 volatile organic compounds (VOCs) and chromium. Since the methodology for development of the HBGLs is similar for all VOCs, the ADHS developed HBGLs for a total of 92 VOCs for each of the scenarios. HBGLs were not developed for chromium or other metals due to their ability to accumulate in soils.

A total of six alternative end uses of groundwater were considered. These include agricultural irrigation of food crops and non-food crops, landscape irrigation, ornamental lakes, dust control or construction water for compaction, sand and gravel washing, and constructed open water conveyance systems. Residential and occupational end use standards were calculated for each of the scenarios. The occupational HBGLs may also be referred to as industrial or nonresidential HBGLs. The exposure scenarios used to develop occupational HBGLs are consistent with the methods used for nonresidential Arizona Soil Remediation Levels (SRLs).

HBGLs are calculated using a human health-based approach that is generally consistent with risk assessment methodologies recommended by the United States Environmental Protection Agency (USEPA) and the ADHS. They use default assumptions when possible. Where standard assumptions were not available, the ADHS has made assumptions based upon research of the particular exposure scenario and professional judgement. Equations used to quantify exposures were based upon generally accepted methods, models, toxicity values, and assumptions developed by the USEPA.

The methods used to calculate HBGLs are conservative. The equations and assumptions will tend to overestimate risk. For example, the equations that quantify exposure do not consider attenuation of contaminants over time. Additionally, for scenarios with serial exposure pathways and routes such as spray irrigation (i.e. inhalation of vapor followed by incidental ingestion and dermal contact), the equations assume that no contaminant mass is lost prior to the last exposure in the series.

The risk management values used to calculate draft HBGLs are consistent with the methodology used to calculate the Arizona SRLs. HBGLs protect against toxic doses of systemic toxicants, and limit excess lifetime cancer risk to one-in-one million ($10^{-6}$) for known human carcinogens and to one-in-one-hundred-thousand ($10^{-5}$) for possible and probable human carcinogens.

HBGLs are individually protective of human health, including sensitive groups, over a lifetime. Chemical concentrations for a particular end use that exceed the applicable HBGL may not necessarily represent a health risk. Rather, when contaminant concentrations exceed the HBGL,

further evaluation may be necessary to determine whether using groundwater for the given purpose poses an unacceptable risk to human health.

HBGLs consider human health risk from inhalation, ingestion and dermal contact with contaminants in groundwater. They do not take into account each chemical's capability to leach to groundwater. In addition, they are not applicable in determining whether threats to aquatic systems or wildlife exist. The ADEQ intends to include HBGLs as the human health based criteria in the final end use standards that will be protective of human health and the environment including groundwater and the ecology.

The following table provides a draft summary of the HBGLs.

| Draft HBGLs for all Pollutants (µg/L) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Chemical** | **Non Food Crop Agricultural Irrigation** | | **Landscape Flood Irrigation** | | **Landscape Spray irrigation** | | **Ornamental Lakes** | | **Dust Control & Soil Compaction** | | **Sand and Gravel Washing** | | **Open Water Conveyance** | | **MCL** |
| | *Residential* | *Occupational* | *Residential* | *Occupational* | *Residential* | *Occupational* | *Residential* | *Occupational* | *Residential* | *Occupational* | *Residential* | *Occupational* | *Residential* | *Occupational* | |
| Acetaldehyde | 720 | 43 | 950 | 85 | 1200 | 480 | 28 | 85 | 1500 | 3400 | 84 | 110 | 28 | 85 | |
| Acetone | 9900 | 2400 | 8800 | 3400 | 19000 | 4800 | 2100 | 3400 | 57000 | 130000 | 3300 | 2500 | 2100 | 3400 | |
| Acetonitrile | 620 | 200 | 540 | 250 | 1200 | 300 | 210 | 250 | 8300 | 19000 | 470 | 220 | 210 | 250 | |
| Acetophenone | 13 | 0.6 | 23 | 1 | 34 | 5 | 0.4 | 1 | 3 | 8 | 0.2 | 0.3 | 0.4 | 1 | |
| Acrolein | 2 | 0.1 | 4 | 0.2 | 34 | 5 | 0.1 | 0.2 | 3 | 8 | 0.2 | 0.3 | 0.1 | 0.2 | |
| Acrylonitrile | 93 | 2 | 100 | 3 | 100 | 10 | 3 | 3 | 130 | 160 | 7 | 4 | 3 | 3 | |
| Benzene | 47 | 1 | 50 | 2 | 110 | 7 | 2 | 2 | 110 | 130 | 6 | 3 | 2 | 2 | 5 |
| Benzyl chloride | 130 | 4 | 130 | 7 | 220 | 16 | 7 | 7 | 180 | 220 | 10 | 6 | 7 | 7 | |
| 1,1-Biphenyl | 4400 | 750 | 4200 | 1200 | 9700 | 2400 | 570 | 1200 | 29000 | 67000 | 1600 | 1300 | 570 | 1200 | |
| Bis(2-chloroethyl)ether | 2 | 0.05 | 4 | 0.1 | 5 | 0.4 | 0.1 | 0.1 | 3 | 3 | 0.2 | 0.1 | 0.1 | 0.1 | |
| Bis (2-chloroiso-propyl) ether | 170 | 11 | 150 | 14 | 330 | 20 | 27 | 14 | 890 | 1100 | 51 | 14 | 27 | 14 | |
| Bis (chloromethyl) ether | 0.05 | 0.002 | 0.044 | 0.003 | 0.1 | 0.01 | 0.003 | 0.003 | 0.1 | 0.2 | 0.01 | 0.003 | 0.003 | 0.003 | |
| Bromodichloro-methane | 390 | 8 | 49 | 15 | 740 | 61 | 11 | 15 | 500 | 600 | 29 | 7 | 11 | 15 | 100 |
| Bromomethane | 300 | 19 | 380 | 37 | 600 | 220 | 13 | 37 | 820 | 1900 | 47 | 57 | 13 | 37 | |
| 1,3-Butadiene | 12 | 0.3 | 13 | 1 | 31 | 2 | 0.4 | 1 | 32 | 38 | 2 | 1 | 0.4 | 1 | |
| Carbon disulfide | 810 | 37 | 1400 | 77 | 10000 | 1800 | 23 | 77 | 1600 | 3830 | 93 | 140 | 23 | 77 | |
| Carbon tetrachloride | 83 | 6 | 86 | 94 | 180 | 17 | 6 | 9 | 330 | 710 | 19 | 11 | 6 | 9 | 5 |
| 2-Chloroaceto-phenone | 0.7 | 0.1 | 1 | 0.2 | 2 | 0.4 | 0.1 | 0.2 | 5 | 11 | 0.3 | 0.2 | 0.1 | 0.2 | |
| Chlorobenzene | 1100 | 84 | 1200 | 160 | 3500 | 830 | 54 | 160 | 300 | 7700 | 190 | 220 | 54 | 160 | 100 |
| 2-Chloro-1,3-butadiene | 490 | 27 | 700 | 55 | 3000 | 630 | 17 | 55 | 1100 | 2700 | 65 | 92 | 17 | 55 | |
| 1-Chlorobutane | 33000 | 4500 | 32000 | 7600 | 78000 | 19000 | 3200 | 7600 | 230000 | 540000 | 13000 | 10000 | 3200 | 7600 | |
| 1-Chloro-1,1-difluoroethane | 1200000 | 160000 | 1100000 | 280000 | 2800000 | 690000 | 120000 | 280000 | 8200000 | 19000000 | 470000 | 360000 | 120000 | 280000 | |
| Chlorodi-fluoromethane | 1100000 | 150000 | 1100000 | 260000 | 2700000 | 670000 | 110000 | 260000 | 8000000 | 19000000 | 460000 | 360000 | 110000 | 260000 | |
| Chloroform | 260 | 6 | 830 | 12 | 3600 | 200 | 7 | 12 | 390 | 470 | 22 | 17 | 7 | 12 | 100 |
| Chloromethane | 2100 | 42 | 2700 | 79 | 3900 | 350 | 56 | 79 | 5000 | 6000 | 280 | 140 | 56 | 79 | |

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| **Chemical** | **Non Food Crop Agricultural Irrigation** | | **Landscape Flood Irrigation** | | **Landscape Spray irrigation** | | **Ornamental Lakes** | | **Dust Control & Soil Compaction** | | **Sand and Gravel Washing** | | **Open Water Conveyance** | | **MCL** |
| | *Residential* | *Occupational* | *Residential* | *Occupational* | *Residential* | *Occupational* | *Residential* | *Occupational* | *Residential* | *Occupational* | *Residential* | *Occupational* | *Residential* | *Occupational* | |
| beta-Chloronaphthalene | 7200 | 1200 | 6700 | 1900 | 16000 | 3900 | 930 | 1900 | 46000 | 110000 | 2600 | 2000 | 930 | 1900 | |
| 2-Chlorophenol | 900 | 83 | 980 | 150 | 1700 | 530 | 57 | 150 | 2900 | 6700 | 160 | 180 | 57 | 150 | |
| 2-Chloropropane | 2300 | 300 | 2300 | 520 | 5600 | 1400 | 220 | 520 | 16000 | 38000 | 930 | 730 | 220 | 520 | |
| o-Chlorotoluene | 1700 | 250 | 1600 | 420 | 3900 | 960 | 180 | 420 | 11000 | 27000 | 650 | 510 | 180 | 420 | |
| Crotonaldehyde | 5 | 0.2 | 5 | 0.3 | 12 | 1 | 0.2 | 0.3 | 16 | 20 | 1 | 0.4 | 0.2 | 0.3 | |
| Cumene | 790 | 41 | 1200 | 85 | 5200 | 1000 | 26 | 85 | 1500 | 3400 | 84 | 120 | 26 | 85 | |
| Hydrogen cyanide | 210 | 10 | 340 | 21 | 2200 | 420 | 6 | 21 | 490 | 1100 | 28 | 42 | 6 | 21 | 200 |
| Dibenzofuran | 410 | 130 | 360 | 160 | 780 | 190 | 140 | 160 | 2300 | 5400 | 130 | 100 | 140 | 160 | |
| 1,2-Dibromo-3-chloropropane | 5 | 1 | 5 | 1 | 11 | 1 | 1 | 1 | 33 | 76 | 2 | 1 | 1 | 1 | |
| 1,2-Dibromoethane (EDB) | 0.2 | 0.02 | 0.1 | 0.02 | 0.3 | 0.02 | 0.1 | 0.02 | 33 | 49 | 2 | 0.02 | 0.1 | 0.02 | |
| 1,2-Dichlorobenzene | 5200 | 790 | 5000 | 1300 | 13000 | 3000 | 570 | 1300 | 33000 | 77000 | 1900 | 1500 | 570 | 1300 | |
| 1,3-Dichlorobenzene | 1400 | 330 | 1300 | 470 | 3400 | 770 | 270 | 470 | 17000 | 40000 | 980 | 520 | 270 | 470 | |
| 1,4-Dichlorobenzene | 300 | 14 | 280 | 22 | 710 | 10 | 26 | 22 | 1300 | 1600 | 74 | 24 | 26 | 22 | |
| 1,4-Dichloro-2-butene | 1 | 0.04 | 1 | 0.1 | 2 | 0.1 | 0.1 | 0.1 | 3 | 4 | 0.2 | 0.1 | 0.1 | 0.1 | |
| Dichloro-difluoromethane | 16000 | 890 | 21000 | 1800 | 58000 | 16000 | 570 | 1800 | 33000 | 77000 | 1900 | 2600 | 570 | 1800 | |
| 1,1-Dichloroethane | 20000 | 1800 | 22000 | 3400 | 37000 | 12000 | 1200 | 3400 | 82000 | 190000 | 4700 | 4700 | 1200 | 3400 | |
| 1,2-Dichloroethane (EDC) | 210 | 4 | 320 | 8 | 510 | 43 | 6 | 8 | 340 | 410 | 19 | 12 | 6 | 8 | 5 |
| 1,1-Dichloroethylene | 38 | 2 | 35 | 2 | 61 | 4 | 3 | 2 | 180 | 210 | 10 | 3 | 3 | 2 | 7 |
| 1,2-Dichloroethylene (cis) | 1700 | 130 | 1900 | 250 | 3500 | 1100 | 87 | 250 | 5700 | 13000 | 330 | 360 | 87 | 250 | 70 |
| 1,2-Dichloroethylene (trans) | 1600 | 230 | 1600 | 380 | 3900 | 960 | 160 | 380 | 11000 | 27000 | 650 | 510 | 160 | 380 | |
| 1,2-Dichloroethylene (mixture) | 740 | 100 | 720 | 170 | 1700 | 430 | 73 | 170 | 5200 | 12000 | 290 | 230 | 73 | 170 | |
| 1,2-Dichloropropane | 190 | 6 | 220 | 11 | 390 | 46 | 8 | 11 | 460 | 560 | 26 | 15 | 8 | 11 | |

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| | *Residential* | *Occupational* | *Residential* | *Occupational* | *Residential* | *Occupational* | *Residential* | *Occupational* | *Residential* | *Occupational* | *Residential* | *Occupational* | *Residential* | *Occupational* | |
| 1,3-Dichloropropene | 130 | 3 | 110 | 6 | 130 | 22 | 4 | 6 | 240 | 290 | 14 | 8 | 4 | 6 | |
| Dimethylamine | 2 | 0.1 | 2 | 0.2 | 3 | 1 | 0.1 | 0.2 | 3 | 8 | 0.2 | 0.2 | 0.1 | 0.2 | |
| Epichlorohydrin | 230 | 11 | 370 | 23 | 640 | 160 | 7 | 23 | 160 | 380 | 9 | 14 | 7 | 23 | TT |
| Ethyl acetate | 79000 | 13000 | 74000 | 21000 | 170000 | 43000 | 9600 | 21000 | 520000 | 1200000 | 29000 | 23000 | 9600 | 21000 | |
| Ethyl acrylate | 380 | 8 | 610 | 16 | 1000 | 87 | 10 | 16 | 650 | 780 | 37 | 23 | 10 | 16 | |
| Ethylbenzene | 5800 | 1800 | 5100 | 2300 | 13000 | 3000 | 1700 | 2300 | 170000 | 390000 | 9400 | 2500 | 1700 | 2300 | 700 |
| Ethylene oxide | 58 | 1 | 63 | 2 | 56 | 6 | 2 | 2 | 89 | 110 | 5 | 3 | 2 | 2 | |
| Ethyl chloride | 2200 | 990 | 1800 | 1000 | 4000 | 1000 | 1500 | 1000 | 1600000 | 3800000 | 93000 | 1000 | 1500 | 1000 | |
| Ethyl ether | 90000 | 11000 | 89000 | 170000 | 87000 | 32000 | 8200 | 17000 | 110000 | 270000 | 6500 | 8100 | 8200 | 17000 | |
| Ethyl methacrylate | 7500 | 1100 | 7300 | 1800 | 17000 | 4300 | 780 | 1800 | 52000 | 120000 | 2900 | 2300 | 780 | 1800 | |
| Furan | 78 | 10 | 78 | 17 | 190 | 48 | 7 | 17 | 570 | 1300 | 33 | 25 | 7 | 17 | |
| n-Hexane | 4800 | 620 | 4700 | 1100 | 12000 | 2900 | 440 | 1100 | 33000 | 77000 | 1900 | 1500 | 440 | 1100 | |
| Isobutanol | 31000 | 9300 | 27000 | 12000 | 58000 | 14000 | 9100 | 12000 | 170000 | 400000 | 9800 | 7600 | 9100 | 12000 | |
| Maleic hydrazide | 41000 | 6000 | 40000 | 10000 | 97000 | 24000 | 4300 | 10000 | 290000 | 670000 | 16000 | 13000 | 4300 | 10000 | |
| Methacrylonitrile | 10 | 2 | 9 | 3 | 20 | 5 | 2 | 3 | 110 | 270 | 7 | 3 | 2 | 3 | |

| **Draft HBGLs for all Pollutants (µg/L)** TT=Treatment Technology | | | | | | | | | | | | | | | |
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| | *Residential* | *Occupational* | *Residential* | *Occupational* | *Residential* | *Occupational* | *Residential* | *Occupational* | *Residential* | *Occupational* | *Residential* | *Occupational* | *Residential* | *Occupational* | |
| Methomyl | 2200 | 340 | 2100 | 560 | 4800 | 1200 | 250 | 560 | 14000 | 34000 | 810 | 640 | 250 | 560 | |
| Methyl acetate | 99000 | 26000 | 88000 | 35000 | 190000 | 48000 | 23000 | 35000 | 570000 | 1300000 | 33000 | 25000 | 23000 | 35000 | |
| Methyl acrylate | 2400 | 320 | 2400 | 550 | 5800 | 1400 | 230 | 550 | 17000 | 40000 | 980 | 760 | 230 | 550 | |
| Methylene chloride | 1600 | 110 | 1400 | 140 | 3100 | 190 | 270 | 140 | 19000 | 23000 | 1100 | 160 | 270 | 140 | |
| Methyl ethyl ketone | 170000 | 11000 | 220000 | 21000 | 250000 | 87000 | 7100 | 21000 | 160000 | 380000 | 9300 | 13000 | 7100 | 21000 | |
| Methyl isobutyl ketone | 4900 | 430 | 5400 | 810 | 14000 | 3400 | 280 | 810 | 13000 | 31000 | 740 | 900 | 280 | 810 | |
| Methyl methacrylate | 6800 | 1000 | 6500 | 1700 | 16000 | 3900 | 760 | 1700 | 46000 | 110000 | 2600 | 2000 | 760 | 1700 | |
| Methyl styrene (mixture) | 560 | 120 | 520 | 170 | 1200 | 300 | 94 | 170 | 6600 | 15000 | 370 | 200 | 94 | 170 | |
| Methyl styrene (alpha) | 5900 | 870 | 5700 | 1400 | 14000 | 3400 | 630 | 1400 | 40000 | 94000 | 2300 | 1800 | 630 | 1400 | |
| Methyl tertbutyl ether (MTBE) | 540 | 250 | 460 | 250 | 1000 | 260 | 390 | 250 | 490000 | 1200000 | 28000 | 250 | 390 | 250 | |
| Nitrobenzene | 50 | 14 | 44 | 18 | 97 | 24 | 13 | 18 | 330 | 770 | 19 | 14 | 13 | 18 | |
| N-Nitrosodi-n-butylamine | 5 | 0.1 | 6 | 0.2 | 9 | 1 | 0.1 | 0.2 | 6 | 7 | 0.3 | 0.2 | 0.1 | 0.2 | |
| 1,1,1,2-Tetrachloroethane | 400 | 17 | 380 | 26 | 870 | 52 | 28 | 26 | 1200 | 1400 | 68 | 27 | 28 | 26 | |
| 1,1,2,2-Tetrachloroethane | 120 | 3 | 130 | 5 | 210 | 16 | 4 | 5 | 150 | 180 | 9 | 5 | 4 | 5 | |
| Tetrachloroethylene (PCE) | 210 | 22 | 170 | 23 | 400 | 24 | 100 | 23 | 5700 | 13000 | 330 | 23 | 100 | 23 | 5 |
| Toluene | 13000 | 1300 | 13000 | 2400 | 35000 | 8400 | 910 | 2400 | 63000 | 150000 | 3600 | 3500 | 910 | 2400 | 1000 |
| 1,2,4-Trichlorobenzene | 460 | 190 | 390 | 210 | 1000 | 230 | 230 | 210 | 33000 | 76000 | 1900 | 210 | 230 | 210 | 9 |
| 1,1,1-Trichloroethane | 7300 | 2000 | 6400 | 2500 | 11000 | 3300 | 2000 | 2500 | 160000 | 380000 | 9300 | 2700 | 2000 | 2500 | 200 |
| 1,1,2-Trichloroethane | 400 | 85 | 450 | 15 | 750 | 59 | 11 | 15 | 560 | 670 | 32 | 18 | 11 | 15 | 5 |
| Trichloroethylene (TCE) | 880 | 60 | 920 | 100 | 1800 | 240 | 59 | 100 | 3400 | 6300 | 200 | 120 | 59 | 100 | 5 |
| Trichloro-fluoromethane | 36000 | 3100 | 40000 | 5800 | 86000 | 24000 | 2100 | 5800 | 110000 | 270000 | 6500 | 7500 | 2100 | 5800 | |
| 1,1,2-Trichloropropane | 430 | 66 | 410 | 110 | 970 | 240 | 49 | 110 | 2900 | 6700 | 160 | 130 | 49 | 110 | |
| 1,2,3-Trichloropropane | 1 | 0.05 | 1 | 0.1 | 3 | 0.2 | 0.1 | 0.1 | 4 | 5 | 0.3 | 0.1 | 0.1 | 0.1 | |

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| 1,2,3-Trichloropropene | 430 | 66 | 410 | 110 | 970 | 240 | 49 | 110 | 2900 | 6700 | 160 | 130 | 49 | 110 | |
| 1,1,2-Trichloro-1,2,2-trifluoroethane | 1800000 | 160000 | 2000000 | 290000 | 5400000 | 1300000 | 100000 | 290000 | 4900000 | 11000000 | 280000 | 340000 | 100000 | 290000 | |
| Triethylamine | 180 | 33 | 170 | 51 | 390 | 96 | 26 | 51 | 1100 | 2700 | 65 | 51 | 26 | 51 | |
| Vinyl acetate | 17000 | 860 | 26000 | 1800 | 130000 | 25000 | 540 | 1800 | 33000 | 77000 | 1900 | 2700 | 540 | 1800 | |
| Vinyl bromide | 170 | 4 | 210 | 7 | 340 | 35 | 5 | 7 | 280 | 340 | 16 | 10 | 5 | 7 | |
| Vinyl chloride | 2 | 0.1 | 2 | 0.1 | 3 | 0.2 | 0.1 | 0.1 | 10 | 13 | 1 | 0.2 | 0.1 | 0.1 | 2 |
| Xylene (mixed) | 53000 | 3000 | 75000 | 6100 | 300000 | 63000 | 1900 | 6100 | 110000 | 270000 | 6500 | 9200 | 1900 | 6100 | $1x10^5$ |

## 1.0 INTRODUCTION

The Groundwater Cleanup Task Force endorsed a proposal introduced by the End Use Committee that the ADEQ develop water quality standards that would be specifically applicable to the use of remediated groundwater. The task force recommended that the standards be based upon numeric levels and operational controls, and that they be protective of human health and the environment including groundwater and the ecology.

As an initial step, the ADEQ asked the ADHS to develop HBGLs for specific end uses of remediated groundwater that are protective of human health. The HBGLs in this document were developed by the ADHS for the end uses identified in the task force final report, and are individually considered to be protective of human health.

The task force report recommended that standards be developed for 13 VOCs and chromium. Since the methodology for development of the HBGLs is similar for all VOCs, the ADHS developed HBGLs for a total of 92 VOCs for each of the scenarios. HBGLs were not developed for chromium or other metals due to their ability to accumulate in soils.

A total of six alternative end uses of groundwater were considered. These include agricultural irrigation of food crops and non-food crops, landscape irrigation, ornamental lakes, dust control or construction water for compaction, sand and gravel washing, and constructed open water conveyance systems. Residential and occupational end use standards were calculated for each of the scenarios. The residential HBGLs listed in the tables are the lesser of the value calculated for adult and childhood exposures. The occupational HBGLs may also be referred to as industrial or nonresidential HBGLs. The exposure scenarios used to develop occupational HBGLs are consistent with the methods used for nonresidential Arizona SRLs.

HBGLs are calculated using a human health-based approach that is generally consistent with risk assessment methodologies recommended by the USEPA and the ADHS. They use default assumptions when possible. Where standard assumptions were not available, the ADHS has made assumptions based upon research of the particular exposure scenario and professional judgement. Equations used to quantify exposures were based upon generally accepted methods, models, toxicity values, and assumptions developed by the USEPA.

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necessarily represent a health risk. Rather, when contaminant concentrations exceed the HBGL, further evaluation may be necessary to determine whether using groundwater for the given purpose poses an unacceptable risk to human health.

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## 2.0 AGRICULTURAL IRRIGATION

This section discusses the development of HBGLs for agricultural irrigation of food crops and non-food crops. Crops eaten by humans are considered food crops. The analysis for non-food crops primarily uses USEPA standard default exposure factors (USEPA, 1991a). Specific activity factors were developed using the conceptual site model. HBGLs could not be calculated for agricultural irrigation of food crops since inadequate data are available to quantify contaminant uptake and fate in plants.

### 2.1 Food Crops

The use of contaminated groundwater for agricultural plants has been proposed as one of the groundwater end-use alternatives. It proposes that groundwater contaminated with organic chemicals be used as irrigation for food and animal feed crops. In order to develop quantitative standards for food and feed crops, data must be available regarding how the chemicals are taken up by food crops, the ultimate fate of chemicals within the plant and their accessability to humans.

After conducting an extensive literature search, the ADHS has concluded that there are insufficient data to identify the possible health risks related to the ingestion of food crops grown with the use of contaminated groundwater. While much of the present research has focused on the uptake of pesticides into plants, the research on the uptake of industrial pollutants by plants and food crops is rudimentary. Studies have focused on the uptake of individual organic chemicals by crops such as corn, radishes, barley, beets, wheat, and soy. However, experimental results have been inconsistent, and have been dependent on the various factors within the study.

Data that are available suggest that organic contaminants are taken up by plant roots, then with varying degrees are sequestered, metabolized, and translocated to shoots (Cunningham, 1996). This process is affected by various properties of the compound, the plant, and its environment. These factors include (Trapp, 1995):

- The physicochemical properties of the substance such as molecular weight, vapor pressure, aqueous solubility, and octanol/water partition coefficient;

- Plant characteristics such as the nature of the root system, lipid or wax content, and leaf morphology; and

- Environmental characteristics such as soil organic and mineral content, meteorology, and temperature.

Simple factors such as the soil composition, and thus its sorptive capacity and characteristics, highly influences plant uptake of pollutants from soil. As the organic matter content of the soil increases, some pollutants are sorbed more tightly and become biologically inactivated, making them less available to the plant roots. The aerobic and anaerobic conditions of the soil, and amount of water within the soil also affect the type and rate of microbial activity within the rhizosphere, which affects the decomposition of the pollutant. For example, TCE can be reductively dechlorinated to vinyl chloride and other harmful metabolites within the plant when conditions in the soil and\or in the rhizosphere are anaerobic. However, TCE will breakdown into different components under aerobic conditions (Schnabel, 1997).

In addition, soil retention that would occur on grain and leaf surfaces can result in transport of soilborne contaminants into human foods in amounts that exceed those predicted by root uptake. The height and location of grains on the plant will determine the amount of soil contamination of leaf surfaces on grains during combining. All these factors have to be taken into account when determining the final deposition of the chemical within the plant and resultant availability to humans (Bell, 1992).

Other complicating factors include variations in the extent of pollutant accumulation between plant types and species and differences between cultivars and individuals of the same species. In one study, a particular type of pea root contained more than 600 times the soil concentration of the pollutant under study (Bell, 1992). Given these facts, any standard that would be developed would need to be specific to the type of crops grown and the conditions under which they are grown.

Trapp and McFarlane (1995) have developed mathematical models to account for some of these variables in order to predict the uptake of organic chemicals into plants and the fate of different chemicals. However, the authors suggest that more data are needed for a variety of chemicals and tissues to strengthen the correlations. Consistent correlations would enable investigators to predict how much of a chemical is absorbed into the plant and fate and accessibility to humans. Direct correlations would enable ADHS to quantify risks associated with eating food grown using contaminated groundwater.

In summary, there are insufficient data to develop generalized HBGLs for agricultural irrigation of food and feed crops. Available data suggest that the uptake of organic contaminants by plants is dependent on the various properties of the compound, the plant, and its environment. Until these variables can be determined and identified, any health risks to humans due to the consumption of food grown with contaminated groundwater cannot be quantified. Until there are more conclusive data, the ADHS will be unable to develop groundwater end-use standards for use on food and animal feed crops.

### 2.2 Non-Food Crops

Exposures from flood irrigation of non-food crops, such as cotton, were quantified using USEPA models and standard default exposure assumptions. Inhalation exposure was calculated

using a mass transfer model for bodies of water (USEPA, 1995a). Wind dispersion of the contaminants applies the USEPA Q/C term for dispersion for Phoenix, Arizona (USEPA, 1996a). The model uses the inverse of the mean concentration at the center of a 30 acre body of water. Dermal absorption of the contaminant is quantified using a chemical-specific permeability coefficient (USEPA, 1992).

Appendix A displays the proposed presumptive end use standards for flood irrigation of non-food crops for residential and occupational land uses.

### 2.2.1 Residential Exposure

The residential exposure scenario for flood irrigation of non-food crops generally consists of residents living next to a 30-acre farm that is periodically irrigated with contaminated water. It assumes that irrigation occurs 14 times per year between May and September (University of Arizona, 1998). The sample non-food crop is cotton. Public access is not restricted by signage, supervision or physical barriers. This exposure scenario conservatively assumes that adults and children are exposed via inhalation of contaminants escaping from the irrigation water. It also assumes that children are exposed to contaminants in the water via incidental ingestion and dermal contact during play events.

#### 2.2.1.1 Childhood Exposure

A child is assumed to play in the irrigation water for 8 hours per day on each of the 14 days when irrigation occurs. It also assumes that a child would be exposed for a period of 6 years. The child is exposed via inhalation, incidental ingestion, and dermal contact with the contaminants in the water for 8 hours during each irrigation event.

This scenario applies standard default assumptions for childhood exposure including a 15 kg body weight, an air inhalation rate of 10 $m^3$/day, an incidental ingestion rate of 0.05 L/hour (USEPA, 1990), and full body contact with the skin of 10,000 $cm^2$ (USEPA, 1992).

Table 2.2.1.1 in Appendix B displays Equations 1 through 6 used in this scenario.

#### 2.2.1.2 Adult Exposure

An adult is not assumed to have incidental ingestion or direct contact with the flood irrigation water. It is assumed that an adult would be standing adjacent to the irrigated field. This scenario assumes that the adult is exposed via inhalation of contaminants escaping from the flood irrigation waters on an adjacent property for 8 hours for each of the 14 irrigation days.

This scenario applies standard default assumptions for adults including a 70 kg body weight, an air inhalation rate of 20 $m^3$/day (USEPA, 1991b).

Table 2.2.1.2 in Appendix B displays for Equations 1 through 6 used in this scenario.

### 2.2.2 Occupational Exposure

The occupational exposure scenario for flood irrigation of non-food crops quantifies exposures to a farm worker involved in irrigation. This exposure scenario conservatively assumes that farm workers are exposed via inhalation to contaminants escaping from the irrigation water. It

also assumes that they are exposed to contaminants in the flood irrigation water via incidental ingestion and dermal contact.

An adult farm worker involved in flood irrigation duties is assumed to have incidental contact with the flood irrigation water for 8 hours per day, 250 days per year for 25 years (USEPA, 1991a). The farm worker is exposed via inhalation of contaminants escaping from the flood irrigation waters for the 8 hours they are on the job. The employee is exposed via incidental ingestion and dermal contact with the contaminants in the water for an 8 hour period each day.

This scenario applies standard default assumptions for adults including a 70 kg body weight, an air inhalation rate of 20 $m^3$/day, an incidental ingestion rate of 0.05 L/hour (USEPA, 1990), and partial body contact with the skin of 5,000 $cm^2$ (USEPA, 1992).

Table 2.2.2 in Appendix B displays Equations 1 through 6 used in this scenario.

## 3.0 LANDSCAPE IRRIGATION

HBGLs for landscape irrigation were developed for both flood irrigation and spray irrigation. Both end use scenarios include human contact with contaminants in the groundwater via incidental ingestion, incidental dermal contact, and inhalation. Intake rates, body weights, exposed dermal surface area, averaging times, and exposure duration, assumptions apply USEPA standard default exposure factors (USEPA, 1991a).

Appendix A displays the presumptive end use standards for flood and spray irrigation for the residential and non-residential exposure scenarios. The residential standard represents the lesser of the value calculated for children and adults.

### 3.1 Flood Irrigation

This scenario involves the use of contaminated water for flood irrigation to maintain public areas such as golf courses and parks, and in neighborhood residences. Exposures to nearby residents, and on-site maintenance workers were quantified using primarily USEPA standard default exposure assumptions. Exposures from flood irrigation were quantified using primarily USEPA standard default exposure assumptions. Inhalation exposure was calculated using a mass transfer model for bodies of water (USEPA, 1995a). Wind dispersion of the contaminants applies the USEPA Q/C term for dispersion for Phoenix, Arizona (USEPA, 1996a). The model uses the inverse of the mean concentration at the center of a 0.5 acre body of water. Dermal absorption of the contaminant is quantified using a chemical-specific permeability coefficient (USEPA, 1992). Flood irrigation adequate to maintain bermuda grass was used to quantify water applications (COP, 1998). Irrigation is assumed to occur 33 days/year with each flood event expected to last approximately 4 hours.

#### 3.1.1 Residential Exposure

This scenario includes both residential and municipal park flood irrigation. The residential exposure scenario for flood irrigation generally consists of residents living next to a site that is periodically irrigated with contaminated water. The water is applied at times that reasonably

preclude direct human contact; however, public access is not restricted by signage, supervision, or physical barriers. This exposure scenario conservatively assumes that adults and children are exposed via inhalation to contaminants escaping from the irrigation water. It also assumes that they are exposed to contaminants in the water via incidental ingestion and dermal contact during periodic maintenance or play events since the site is not restricted.

Appendix A displays the presumptive end use standards for flood irrigation for the residential and non-residential exposure scenarios. The residential standard represents the lesser of the value calculated for children and adults.

#### 3.1.1.1 Childhood Exposure

A child is assumed to play in the flood irrigation water for 4 hours per day, 33 days per year (COP, 1998) for 6 years. The child is exposed via incidental ingestion and dermal contact with the contaminants in the water for a 4 hour period during each flood irrigation event.

This scenario applies standard default assumptions for childhood exposure including a 15 kg body weight, an air inhalation rate of 10 $m^3$/day, an incidental ingestion rate of 0.05 L/hour, and full body contact with the skin (USEPA, 1992).

Table 3.1.1.1 in Appendix B displays Equations 1 through 6 used in this scenario.

#### 3.1.1.2 Adult Exposure

An adult is assumed to have incidental contact with the flood irrigation water while operating the flood irrigation system, turning it on and off, opening the flood gates, and other similar activities. It is assumed that the amount of time required for these activities combined would account for 1 hour per day, 33 days per year for 30 years. The adult is exposed via inhalation of contaminants escaping from the flood irrigation waters for the 4 hours that the water is assumed to be standing in the property. The adult is exposed via incidental ingestion and dermal contact with the contaminants in the water for a 1 hour period during each flood irrigation event.

This scenario applies standard default assumptions for adults including a 70 kg body weight, an air inhalation rate of 20 $m^3$/day (USEPA, 1991a), an incidental ingestion rate of 0.05 L/hour (USEPA, 1990), and partial body contact with the skin (USEPA, 1992).

Table 3.1.1.2 in Appendix B displays Equations 1 through 6 used in this scenario.

### 3.1.2 Occupational Exposure

The occupational exposure scenario for flood irrigation quantifies exposures to a workers involved in maintenance of irrigated properties. Access is not restricted by signage, supervision or physical barriers. This exposure scenario conservatively assumes that in addition to inhalation exposure to contaminants escaping from the irrigation water, workers are exposed to contaminants in the flood irrigation water via incidental ingestion and dermal contact during regular maintenance.

An adult maintenance worker involved in flood irrigation duties is assumed to have incidental contact with the flood irrigation water for 8 hours per day, 250 days per year for 25 years (USEPA, 1991a). The adult is exposed via inhalation of contaminants escaping from the flood irrigation waters for the 8 hours on the job. The employee is exposed via incidental ingestion and dermal contact with the contaminants in the water for a period of 8 hours each day.

This scenario applies standard default assumptions for adults including a 70 kg body weight (USEPA, 1991a), an air inhalation rate of 20 $m^3$/day (USEPA, 1991a), an incidental ingestion rate of 0.05 L/hour (USEPA, 1990), and partial body contact with the skin (USEPA, 1992).

Table 3.1.2 in Appendix B displays Equations 1 through 6 used in this scenario.

## 3.2 Spray Irrigation

This scenario involves the use of contaminated water for spray irrigation to maintain public areas such as golf courses and parks. Exposures to nearby residents, and on-site maintenance workers were quantified using primarily USEPA standard default exposure assumptions. Inhalation exposure was calculated by assuming that all of the VOCs would escape immediately upon release to the ambient air. The inhalation model assumes that approximately 19,000 liters of water are applied per hour in the irrigation area (COP, 1998). Wind dispersion of the contaminants is quantified using a simple cylinder model with an area of 1134 $m^2$, and a height of 10 meters. The average wind speed was assumed to be 2.6 m/sec., which is the mean annual wind speed for Phoenix, Arizona. Dermal absorption of the contaminant is quantified using a chemical-specific permeability coefficient (USEPA, 1992).

Appendix A displays the presumptive end use standards for spray irrigation for the residential and non-residential exposure scenarios. The residential standard represents the lesser of the value calculated for children and adults.

### 3.2.1 Residential Exposure

The residential exposure scenario for spray irrigation generally consists of residents living next to a site that is regularly spray irrigated with contaminated water such as a park or golf course. The water is applied at times that reasonably preclude direct human contact; however, public access is not restricted by signage, supervision or physical barriers. This exposure scenario conservatively assumes that adults and children are exposed via inhalation to contaminants escaping from the spray irrigation water. They are also exposed to contaminants in the spray via incidental ingestion and dermal contact during periodic maintenance or play events. Spray irrigation is assumed to occur 365 days/year next to the house in order to account for a staggered irrigation schedule in the vicinity of the residence.

#### 3.2.1.1 Childhood Exposure

The child is assumed to play in the spray irrigation water for 1 hour per day, 210 days per year for 6 years. The child is exposed via inhalation of contaminants escaping from the spray irrigation waters for 1 hour per day, 365 days per year. The child is exposed via incidental ingestion and dermal contact with the contaminants in the water for a period of 1 hour, 210 days per year.

This scenario applies standard default assumptions for childhood exposure including a 15 kg body weight (USEPA, 1991a), an air inhalation rate of 10 $m^3$/day (USEPA, 1991a), an incidental ingestion rate of 0.05 L/hour (USEPA, 1990), and partial body contact with the skin of 2,000 $cm^2$ (USEPA, 1992).

Table 3.2.1.1 in Appendix B displays Equations 1 through 6 used in this scenario.

### 3.2.1.2 Adult Exposure

An adult is assumed to have incidental contact with contaminants in the spray irrigation water for one-half hour per day, 52 days per year for 30 years. This scenario applies standard default assumptions for adults including a 70 kg body weight (USEPA, 1991a), an air inhalation rate of 20 $m^3$/day (USEPA, 1991a), an incidental ingestion rate of 0.05 L/hour (USEPA, 1990), and partial body contact with the skin (USEPA, 1992). Table 3.2.1.2 in Appendix B displays Equations 1 through 6 used in this scenario.

### 3.2.2 Occupational Exposure

The occupational exposure scenario for spray irrigation quantifies exposures to workers at a site that is regularly irrigated with contaminated water. This would include employees who are responsible for maintaining public areas such as golf courses and parks. The water is applied at times that reasonably preclude direct human contact; however, public access is not restricted by signage, supervision or physical barriers. This exposure scenario conservatively assumes that in addition to inhalation exposure to contaminants escaping from the spray irrigation water, workers are consistently exposed to contaminants in the spray irrigation water via incidental ingestion and dermal contact during maintenance activities.

An adult maintenance worker involved in spray irrigation duties is assumed to have incidental contact with the spray irrigation water for 8 hours per day, 250 days per year for 25 years (USEPA, 1991a). The adult is exposed via inhalation of contaminants escaping from the spray irrigation waters for the 8 hours they are on the job. The employee is exposed via incidental ingestion and dermal contact with the contaminants in the water for an eight hour period each day.

This scenario applies standard default assumptions for adults including a 70 kg body weight (USEPA, 1991a), an air inhalation rate of 20 $m^3$/day (USEPA, 1991a), an incidental ingestion rate of 0.05 L/hour (USEPA, 1990), and partial body contact with the skin (USEPA, 1992).

Table 3.2.2 in Appendix B displays Equations 1 through 6 used in this scenario.

## 4.0 ORNAMENTAL LAKES

Presumptive groundwater standards for using contaminated water for ornamental lakes were developed for residential and occupational exposures. Both scenarios include human contact with contaminants in the groundwater via incidental ingestion, incidental dermal contact, and inhalation. Intake rates, body weights, exposed dermal surface area, averaging times, and exposure duration, assumptions apply USEPA standard default exposure factors. This scenario analyzes exposures to residents who live near ornamental lakes and employees who maintain the lakes.

Exposures from using contaminated water in ornamental lakes were quantified using primarily USEPA standard default exposure assumptions. Inhalation exposure was calculated using a mass transfer model for bodies of water (USEPA, 1995). Wind dispersion of the contaminants applies the USEPA Q/C term for dispersion for Phoenix, Arizona (USEPA, 1996a). The model uses the inverse of the mean concentration at the center of a 0.5 acre body of water. The model conservatively assumes no attenuation of contaminant concentrations in the water. Dermal

absorption of the contaminant is quantified using a chemical-specific permeability coefficient (USEPA, 1992).

Appendix A displays the presumptive end use standards for ornamental lakes for residential and non-residential land uses. The residential standard represents the lesser of the value calculated for children and adults.

### 4.1 Residential Exposure

The residential exposure scenario for ornamental lakes generally consists of residents living next to an ornamental lake. The lake is posted no-fishing/ no-swimming. Public access is restricted by signage, supervision and physical barriers. Nevertheless, our exposure scenario conservatively assumes that adults and children are exposed via inhalation to contaminants escaping from the lake 24 hours per day and to contaminants in the lake water via incidental ingestion and dermal contact during periodic swimming events. The scenario simulates a reasonable maximum exposure at a site where operational controls designed to limit exposure are not working effectively.

#### 4.1.1 Childhood Exposure

A child is assumed to swim in the ornamental lake for 1 hour per day, 150 days per year for 6 years. The child is exposed via incidental ingestion and dermal contact with the contaminants in the water for a 1 hour period during each swim event. The child is also exposed via inhalation of contaminants escaping from the lake on an adjacent property 24 hours per day, 365 days per year.

This scenario applies standard default assumptions for childhood exposure including a 15 kg body weight (USEPA, 1991a), an air inhalation rate of 10 $m^3$/day (USEPA, 1991a), an incidental ingestion rate of 0.05 L/hour (USEPA, 1990), and full body contact with the skin (USEPA, 1992).

Table 4.1.1 in Appendix B displays Table Equations 1 through 6 used in this scenario.

#### 4.1.2 Adult Exposure

An adult is assumed to swim in the ornamental lake for 1 hour per day, 12 days per year for 30 years. The adult is exposed via incidental ingestion and dermal contact with the contaminants in the water for a 1 hour period during each swim event. The adult is also exposed via inhalation of contaminants escaping from the flood irrigation waters on an adjacent property 24 hours a day, 365 days per year.

This scenario applies standard default assumptions for adults including a 70 kg body weight (USEPA, 1991a), an air inhalation rate of 20 $m^3$/day (USEPA, 1991a), an incidental ingestion rate of 0.05 L/hour (USEPA, 1990), and full body contact with the skin of 20,000 $cm^2$ (USEPA, 1992).

Appendix B displays Table 4.1.2 for Equations 1 through 6 used in this scenario.

### 4.2 Occupational Exposure

The occupational exposure scenario for ornamental lakes quantifies exposures to a worker that is involved in the maintenance of a site with an ornamental lake. The lake is posted no-fishing/ no-swimming. Public access is restricted by signage, supervision and physical barriers. Nevertheless, our exposure scenario conservatively assumes that the worker is exposed via inhalation to contaminants escaping from the lake and to contaminants in the lake water via

incidental ingestion and dermal contact during regular maintenance activities. The scenario simulates a reasonable maximum exposure at a site where operational controls designed to limit exposure are not working effectively.

An adult worker involved in maintenance of the ornamental lake is assumed to have incidental contact with the lake water 8 hours per day, 250 days per year for 25 years (USEPA, 1991a). The adult is exposed via inhalation of contaminants escaping from the lake waters, and via incidental ingestion and dermal contact with the contaminants in the water for the 8 hours they are on the job.

This scenario applies standard default assumptions for adults including a 70 kg body weight (USEPA, 1991a), an air inhalation rate of 20 $m^3$/day (USEPA, 1991a), an incidental ingestion rate of 0.05 L/hour (USEPA, 1990), and partial body contact with the skin (USEPA, 1992).

Table 4.2 in Appendix B displays Equations 1 through 6 used in this scenario.

## 5.0 DUST CONTROL OR CONSTUCTION WATER FOR COMPACTION

This scenario analyzes the exposures from the use of contaminated water for dust control or construction water for compaction. Exposures to residents who live nearby and on-site workers were quantified using primarily USEPA standard default exposure assumptions. Inhalation exposure was calculated by assuming that all of the VOCs would escape immediately upon release from a truck into the ambient air. The inhalation model assumes that 19 liters of water applied per second in the dust control area (United Truck, 1998). Wind dispersion of the contaminants is quantified using a simple box model with an area of 1 acre, and a height of 10 meters. The average wind speed was assumed to be 2.6 m/sec., which is the mean annual wind speed for Phoenix, Arizona. Dermal absorption of the contaminant is quantified using a chemical-specific permeability coefficient (USEPA, 1992).

Appendix A displays the presumptive end use standards for water used for dust control or compaction for the residential and non-residential exposure scenarios. The residential standard represents the lesser of the value calculated for children and adults.

### 5.1 Residential Exposure

The residential exposure scenario for water used for dust control or compaction consists of residents living next to a site that is regularly treated with contaminated water for dust control. The water is applied at times that reasonably preclude direct human contact. Public access is restricted by signage, supervision or physical barriers. This exposure scenario conservatively assumes that nearby residents are only exposed to contaminants via inhalation as they escape from the water applied by trucks and disperse into outdoor air.

#### 5.1.1 Childhood Exposure

The child is assumed to be exposed via inhalation to the contaminants escaping from dust control water and into ambient air for 8 hours per day, 250 days per year for 6 years. No direct contact with the water is assumed, and no dermal or incidental ingestion exposure is quantified.

This scenario applies standard default assumptions for childhood exposure including a 15 kg body weight (USEPA, 1991a) and an air inhalation rate of 10 $m^3$/day (USEPA, 1991a).

Table 5.1.1 in Appendix B displays Equations 1 and 2 used in this scenario.

### 5.1.2 Adult Exposure

The adult is assumed to be exposed via inhalation to the contaminants escaping from dust control water and into ambient air for 8 hours per day, 250 days per year for 30 years (USEPA, 1991a). No direct contact with the water is assumed, and no dermal or incidental ingestion exposure is quantified.

This scenario applies standard default assumptions for adult exposure including a 70 kg body weight (USEPA, 1991a) and an air inhalation rate of 20 $m^3$/day (USEPA, 1991a).

Table 5.1.2 in Appendix B displays Equations 1 and 2 used in this scenario.

## 5.2 Occupational Exposure

The occupational exposure scenario for water used for dust control or soil compaction quantifies exposures to workers at a site that regularly uses contaminated water for dust control or earth compaction. The water is applied at times that reasonably preclude direct human contact. Trucks, storage tanks, and other exposed equipment are properly decontaminated. Compaction or dust control water is not used for other processes.

The worker is assumed to have no dermal or ingestion contact with the contaminated water since the worker remains in the truck for the period of the water application (United Truck, 1998). The adult worker is exposed via inhalation of contaminants escaping from the sprayed water for the 8 hours on the job.

This scenario applies standard default assumptions for adults including a 70 kg body weight (USEPA, 1991a), and an air inhalation rate of 20 $m^3$/day (USEPA, 1991a).

Table 5.2 in Appendix B displays Equations 1 and 2 used in this scenario.

# 6.0 SAND AND GRAVEL WASHING

Exposures from water used for sand and gravel washing quantified using primarily USEPA standard default exposure assumptions. Inhalation exposure was calculated by assuming that all of the VOCs would escape immediately upon release from nozzles releasing water into the sand and gravel washing facility. The inhalation model assumes that approximately 320,000 liters of water are applied per hour at the facility (Phoenix Redi-Mix, 1998). None of the water is assumed to be recycled. Wind dispersion of the contaminants is quantified using a simple box model with an area of 1130 $m^2$ (Phoenix Redi-Mix, 1998), and a height of 10 meters. The average wind speed was assumed to be 2.6 m/sec., which is the mean annual wind speed for Phoenix, Arizona. Dermal absorption of the contaminant is quantified using a chemical-specific permeability coefficient (USEPA, 1992).

Appendix A displays the presumptive end use standards for water used for sand and gravel washing for the residential and non-residential exposure scenarios. The residential standard represents the lesser of the value calculated for children and adults.

### 6.1 Residential Exposure

The residential exposure scenario for water used for sand and gravel washing consists of residents living next to a site where contaminated water is regularly used for sand and gravel washing. The water is used during 2 work shifts per day for 250 days per year (Phoenix Redi-Mix, 1998). Public access is restricted by signage, supervision and/or physical barriers. This exposure scenario conservatively assumes that nearby residents are only exposed to contaminants via inhalation escaping from use of contaminated water at the adjacent site.

#### 6.1.1 Childhood Exposure

The child is assumed to be exposed via inhalation to the contaminants escaping from the water and into ambient air for 16 hours per day, 250 days per year for 6 years. No direct contact with the water is assumed, and no dermal or incidental ingestion exposure is quantified.

This scenario applies standard default assumptions for childhood exposure including a 15 kg body weight (USEPA, 1991a) and an air inhalation rate of 20 $m^3$/day (USEPA, 1991a).

Table 6.1.1 in Appendix B displays Equations 1 and 2 used in this scenario.

#### 6.1.2 Adult Exposure

The adult is assumed to be exposed via inhalation to the contaminants escaping from water used for sand and gravel washing into ambient air for 16 hours per day, 250 days per year for 30 years. No direct contact with the water is assumed, and no dermal or incidental ingestion exposure is quantified.

This scenario applies standard default assumptions for adult exposure including a 70 kg body weight (USEPA, 1991a) and an air inhalation rate of 20 $m^3$/day (USEPA, 1991a).

Table 6.1.2 in Appendix B displays Equations 1 and 2 used in this scenario.

### 6.2 Occupational Exposure

The occupational exposure scenario for water used for sand and gravel washing quantifies exposures to workers at a site that continually uses contaminated water for this activity. The water is applied to reasonably preclude direct worker contact. Trucks, storage tanks, and other exposed equipment are properly cleaned. The water is used only for sand and gravel washing.

This exposure scenario conservatively assumes that in addition to inhalation exposure to contaminants escaping from water used for sand and gravel washing, workers are occasionally exposed to contaminants in water via incidental ingestion and dermal contact.

The worker is assumed to have incidental ingestion and dermal contact with the water for 8 hours per day, 250 days per year for 25 years. The employee is exposed via inhalation of contaminants escaping from the sprayed water for the 8 hours on the job.

This scenario applies standard default assumptions for adults including a 70 kg body weight (USEPA, 1991a), an air inhalation rate of 20 $m^3$/day (USEPA, 1991a), an incidental ingestion rate of 0.05 L/hour (USEPA, 1990), and partial body contact with the skin (USEPA, 1992).

Table 6.2 in Appendix B displays Equations 1 through 6 used in this scenario.

## 7.0 CONSTRUCTED OPEN WATER CONVEYANCE SYSTEMS

Presumptive groundwater standards for using contaminated water in constructed open water conveyances were developed for residential and non-residential land uses. Both scenarios include limited human contact with contaminants in the water via incidental ingestion, incidental dermal contact, and more frequent exposure via inhalation. Intake rates, body weights, exposed dermal surface area, averaging times, and exposure duration assumptions apply USEPA standard default exposure factors.

This scenario analyzes exposures to residents who live nearby, and workers who maintain the open water conveyance systems. Exposures are quantified primarily by using standard default exposure assumptions. Inhalation exposure was calculated using a mass transfer model for bodies of water (USEPA, 1995a). Wind dispersion of the contaminants applies the USEPA Q/C term for dispersion for Phoenix, Arizona (USEPA, 1996a). The model uses the inverse of the mean concentration at the center of a 0.5 acre body of water. The model conservatively assumes no attenuation of contaminant concentrations in the water. Dermal absorption of the contaminant is quantified using a chemical-specific permeability coefficient (USEPA, 1992).

Appendix A displays the presumptive end use standards for ornamental lakes for residential and non-residential land uses. The residential standard represents the lesser of the value calculated for children and adults.

### 7.1 Residential Exposure

The residential exposure scenario for ornamental lakes generally consists of residents living next to a constructed open water conveyance. The conveyance is posted no-fishing, no-swimming, no drinking. Public access is restricted by signage, supervision and physical barriers. Nevertheless, our exposure scenario conservatively assumes that adults and children are exposed via inhalation to contaminants escaping from the conveyance. It also assumes they are occasionally exposed to contaminants in the conveyance water via incidental ingestion and dermal contact during periodic swimming events. The scenario simulates a reasonable maximum exposure at a site where operational controls designed to limit exposure are not working effectively.

#### 7.1.1 Childhood Exposure

A child is assumed to swim in the open water conveyance for 1 hour per day, 150 days per year for 6 years. The child is exposed via incidental ingestion and dermal contact with the contaminants in the water for a 1 hour period during each swim event. The child is exposed via inhalation of contaminants escaping from the conveyance for 24 hours per day, 365 days per year.

This scenario applies standard default assumptions for childhood exposure including a 15 kg body weight (USEPA, 1991a), an air inhalation rate of 10 $m^3$/day (USEPA, 1991a), an incidental ingestion rate of 0.05 L/hour (USEPA, 1990), and full body contact with the skin (USEPA, 1992).

Table 7.1.1 in Appendix B displays Equations 1 through 6 used in this scenario.

### 7.1.2 Adult Exposure

An adult is assumed to swim in the conveyance for 1 hour per day, 12 days per year for 25 years. The adult is exposed via incidental ingestion and dermal contact with the contaminants in the water for a 1 hour period during each swim event. The adult is exposed via inhalation of contaminants escaping from the conveyance waters on an adjacent property for 24 hours a day, 365 days per year. This scenario applies standard default assumptions for adults including a 70 kg body weight (USEPA, 1991a), an air inhalation rate of 20 $m^3$/day (USEPA, 1991a), an incidental ingestion rate of 0.05 L/hour (USEPA, 1990), and full body contact with the skin.

Appendix B displays Table 7.1.2 for Equations 1 through 6 used in this scenario.

## 7.2 Occupational Exposure

The occupational exposure scenario for constructed open water conveyance systems quantifies exposures to a worker that is involved maintenance of a constructed conveyance. The conveyance is posted no-fishing/ no-swimming. Public access is restricted by signage, supervision and physical barriers. Nevertheless, our exposure scenario conservatively assumes that in addition to inhalation exposure to contaminants escaping from the conveyance, the worker is exposed to contaminants in the water via incidental ingestion and dermal contact during regular maintenance. The scenario simulates a reasonable maximum exposure at a site where operational controls designed to limit exposure are not working effectively.

An adult maintenance worker involved in maintenance of the conveyance is assumed to have incidental contact with the lake water for 8 hours per day, 250 days per year for 25 years (USEPA, 1991a). The worker is exposed via inhalation of contaminants escaping from the water for the 8 hours that they are on the job. The employee is exposed via incidental ingestion and dermal contact with the contaminants in the water for the 8 hours on the job.

This scenario applies standard default assumptions for adults including a 70 kg body weight (USEPA, 1991a), an air inhalation rate of 20 $m^3$/day (USEPA, 1991a), an incidental ingestion rate of 0.05 L/hour (USEPA, 1990), and partial body contact with the skin.

Appendix B displays Table 7.2 for Equations 1 through 6 used in this scenario.

# 8.0 TOXICITY ASSESSMENT

HBGLs protect against toxic doses of systemic toxicants, and limit excess lifetime cancer risk to one-in-one million ($10^{-6}$) for known human carcinogens and to one-in-one-hundred-thousand ($10^{-5}$) for possible and probable human carcinogens.

HBGLs use USEPA noncarcinogenic reference doses (RfD) and carcinogenic slope factors (SF) from the USEPA Integrated Risk Information System (IRIS) through March 1998, USEPA

Health Effects Assessment Summary Table (HEAST) through July 1997, and the USEPA National Center for Environmental Assessment (NCEA). The priority among sources of toxicological constants used are as follows: (1) IRIS, (2) HEAST, (3) NCEA, and (4) withdrawn values from IRIS or HEAST and values under review.

Route-to-route extrapolations were used when no toxicity values were available for a given route of exposure. For example, oral cancer slope factors and reference doses were used for oral and inhalation exposure when organic compounds lacked inhalation values. Inhalation slope factors and inhalation reference doses were used for oral exposure for organic compounds lacking oral values. In addition, oral toxicity values were used for calculating risk and hazard from dermal exposures.

The USEPA's Carcinogen Advisory Group has grouped chemicals by weight-of-evidence (WoE) into classes from A to E, which designate their potential as a cancer-causing agent. The WoE represents the carcinogenicity evidence from human and animal studies and indicates the strength of the data. The A classification signifies that the chemical is a proven human carcinogen. Probable human carcinogens are designated either B1, showing that studies in humans are strongly suggestive but not conclusive, or B2 if the chemical has been conclusively carcinogenic in repeated animal studies but not conclusive in human studies. A chemical may be classified C, a possible human carcinogen, if a single high-quality animal study or several low-quality animal studies suggest carcinogenicity. If there is insufficient human and animal evidence to determine the carcinogenicity of the chemical, it is classified as D. A chemical conclusively demonstrated to be non-carcinogenic to humans is in group E. This designation is rare due to the difficulty in producing the necessary negative data.

## 9.0 SUMMARY

The Groundwater Cleanup Task Force endorsed a proposal introduced by the End Use Committee that the ADEQ develop water quality standards that would be specifically applicable to the use of remediated groundwater. The task force recommended that the standards be based upon numeric levels and operational controls, and that they be protective of human health and the environment including groundwater and the ecology.

As an initial step, the ADEQ asked the ADHS to develop HBGLs for specific end uses of remediated groundwater that are protective of human health. The HBGLs in this document were developed by the ADHS for the end uses identified in the task force final report, and are individually considered to be protective of human health.

The task force report recommended that standards be developed for 13 VOCs and chromium. Since the methodology for development of the HBGLs is similar for all VOCs, the ADHS developed HBGLs for a total of 92 VOCs for each of the scenarios. HBGLs were not developed for chromium or other metals due to their ability to accumulate in soils.

A total of six alternative end uses of groundwater were considered. These include agricultural irrigation of food crops and non-food crops, landscape irrigation, ornamental lakes, dust control or construction water for compaction, sand and gravel washing, and constructed open water conveyance systems. Residential and occupational end use standards were calculated for each of the scenarios. The occupational HBGLs may also be referred to as industrial or nonresidential HBGLs.

The exposure scenarios used to develop occupational HBGLs are consistent with the methods used for nonresidential Arizona SRLs.

HBGLs are calculated using a human health-based approach that is generally consistent with risk assessment methodologies recommended by the USEPA and the ADHS. They use default assumptions when possible. Where standard assumptions were not available, the ADHS has made assumptions based upon research of the particular exposure scenario and professional judgement. Equations used to quantify exposures were based upon generally accepted methods, models, toxicity values, and assumptions developed by the USEPA.

The methods used to calculate HBGLs are conservative. The equations and assumptions will tend to overestimate risk. For example, the equations that quantify exposure do not consider attenuation of contaminants over time. Additionally, for scenarios with serial exposure pathways and routes such as spray irrigation (i.e. inhalation of vapor followed by incidental ingestion and dermal contact), the equations assume that no contaminant mass is lost prior to the last exposure in the series.

The risk management values used to calculate draft HBGLs are consistent with the methodology used to calculate the Arizona SRLs. HBGLs protect against toxic doses of systemic toxicants, and limit excess lifetime cancer risk to one-in-one million ($10^{-6}$) for known human carcinogens and to one-in-one-hundred-thousand ($10^{-5}$) for possible and probable human carcinogens.

HBGLs are individually protective of human health, including sensitive groups, over a lifetime. Chemical concentrations for a particular end use that exceed the applicable HBGL may not necessarily represent a health risk. Rather, when contaminant concentrations exceed the HBGL, further evaluation may be necessary to determine whether using groundwater for the given purpose poses an unacceptable risk to human health.

HBGLs consider human health risk from inhalation, ingestion and dermal contact with contaminants in groundwater. They do not take into account each chemical's capability to leach to groundwater. In addition, they are not applicable in determining whether threats to aquatic systems or wildlife exist. The ADEQ intends to include HBGLs as the human health based criteria in the final end use standards that will be protective of human health and the environment including groundwater and the ecology.

# APPENDIX A

**Draft HBGLs for all Pollutants (µg/L)**

| Chemical | Non Food Crop Agricultural Irrigation | | Landscape Flood Irrigation | | Landscape Spray irrigation | | Ornamental Lakes | | Dust Control & Soil Compaction | | Sand and Gravel Washing | | Open Water Conveyance | | MCL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Residential* | *Occupational* | *Residential* | *Occupational* | *Residential* | *Occupational* | *Residential* | *Occupational* | *Residential* | *Occupational* | *Residential* | *Occupational* | *Residential* | *Occupational* | |
| Acetaldehyde | 720 | 43 | 950 | 85 | 1200 | 480 | 28 | 85 | 1500 | 3400 | 84 | 110 | 28 | 85 | |
| Acetone | 9900 | 2400 | 8800 | 3400 | 19000 | 4800 | 2100 | 3400 | 57000 | 130000 | 3300 | 2500 | 2100 | 3400 | |
| Acetonitrile | 620 | 200 | 540 | 250 | 1200 | 300 | 210 | 250 | 8300 | 19000 | 470 | 220 | 210 | 250 | |
| Acetophenone | 13 | 0.6 | 23 | 1 | 34 | 5 | 0.4 | 1 | 3 | 8 | 0.2 | 0.3 | 0.4 | 1 | |
| Acrolein | 2 | 0.1 | 4 | 0.2 | 34 | 5 | 0.1 | 0.2 | 3 | 8 | 0.2 | 0.3 | 0.1 | 0.2 | |
| Acrylonitrile | 93 | 2 | 100 | 3 | 100 | 10 | 3 | 3 | 130 | 160 | 7 | 4 | 3 | 3 | |
| Benzene | 47 | 1 | 50 | 2 | 110 | 7 | 2 | 2 | 110 | 130 | 6 | 3 | 2 | 2 | 5 |
| Benzyl chloride | 130 | 4 | 130 | 7 | 220 | 16 | 7 | 7 | 180 | 220 | 10 | 6 | 7 | 7 | |
| 1,1-Biphenyl | 4400 | 750 | 4200 | 1200 | 9700 | 2400 | 570 | 1200 | 29000 | 67000 | 1600 | 1300 | 570 | 1200 | |
| Bis(2-chloroethyl)ether | 2 | 0.05 | 4 | 0.1 | 5 | 0.4 | 0.1 | 0.1 | 3 | 3 | 0.2 | 0.1 | 0.1 | 0.1 | |
| Bis(2-chloroisopropyl)ether | 170 | 11 | 150 | 14 | 330 | 20 | 27 | 14 | 890 | 1100 | 51 | 14 | 27 | 14 | |
| Bis(chloromethyl)ether | 0.05 | 0.002 | 0.044 | 0.003 | 0.1 | 0.01 | 0.003 | 0.003 | 0.1 | 0.2 | 0.01 | 0.003 | 0.003 | 0.003 | |
| Bromodichloromethane | 390 | 8 | 49 | 15 | 740 | 61 | 11 | 15 | 500 | 600 | 29 | 17 | 11 | 15 | 100 |
| Bromomethane | 300 | 19 | 380 | 37 | 600 | 220 | 13 | 37 | 820 | 1900 | 47 | 57 | 13 | 37 | |
| 1,3-Butadiene | 12 | 0.3 | 13 | 1 | 31 | 2 | 0.4 | 1 | 32 | 38 | 2 | 1 | 0.4 | 1 | |
| Carbon disulfide | 810 | 37 | 1400 | 77 | 10000 | 1800 | 23 | 77 | 1600 | 3830 | 93 | 140 | 23 | 77 | |
| Carbon tetrachloride | 83 | 6 | 86 | 94 | 180 | 17 | 6 | 9 | 330 | 710 | 19 | 11 | 6 | 9 | 5 |
| 2-Chloroacetophenone | 0.7 | 0.1 | 1 | 0.2 | 2 | 0.4 | 0.1 | 0.2 | 5 | 11 | 0.3 | 0.2 | 0.1 | 0.2 | |
| Chlorobenzene | 1100 | 84 | 1200 | 160 | 3500 | 830 | 54 | 160 | 3300 | 7700 | 190 | 220 | 54 | 160 | 100 |
| 2-Chloro-1,3-butadiene | 490 | 27 | 700 | 55 | 3000 | 630 | 17 | 55 | 1100 | 2700 | 65 | 92 | 17 | 55 | |
| 1-Chlorobutane | 33000 | 4500 | 32000 | 7600 | 78000 | 19000 | 3200 | 7600 | 230000 | 540000 | 13000 | 10000 | 3200 | 7600 | |
| 1-Chloro-1,1-difluoroethane | 1200000 | 160000 | 1100000 | 280000 | 2800000 | 690000 | 120000 | 280000 | 8200000 | 19000000 | 470000 | 360000 | 120000 | 280000 | |
| Chlorodifluoromethane | 1100000 | 150000 | 1100000 | 260000 | 2700000 | 670000 | 110000 | 260000 | 8000000 | 19000000 | 460000 | 360000 | 110000 | 260000 | |
| Chloroform | 260 | 6 | 830 | 12 | 3600 | 200 | 7 | 12 | 390 | 470 | 22 | 17 | 7 | 12 | 100 |
| Chloromethane | 2100 | 42 | 2700 | 79 | 3900 | 350 | 56 | 79 | 5000 | 6000 | 280 | 140 | 56 | 79 | |
| beta-Chloronaphthalene | 7200 | 1200 | 6700 | 1900 | 16000 | 3900 | 930 | 1900 | 46000 | 110000 | 2600 | 2000 | 930 | 1900 | |
| 2-Chlorophenol | 900 | 83 | 980 | 150 | 1700 | 530 | 57 | 150 | 2900 | 6700 | 160 | 180 | 57 | 150 | |
| 2-Chloropropane | 2300 | 300 | 2300 | 520 | 5600 | 1400 | 220 | 520 | 16000 | 38000 | 930 | 730 | 220 | 520 | |
| o-Chlorotoluene | 1700 | 250 | 1600 | 420 | 3900 | 960 | 180 | 420 | 11000 | 27000 | 650 | 510 | 180 | 420 | |
| Crotonaldehyde | 5 | 0.2 | 5 | 0.3 | 12 | 1 | 0.2 | 0.3 | 16 | 20 | 1 | 0.4 | 0.2 | 0.3 | |
| Cumene | 790 | 41 | 1200 | 85 | 5200 | 1000 | 26 | 85 | 1500 | 3400 | 84 | 120 | 26 | 85 | |
| Hydrogen cyanide | 210 | 10 | 340 | 21 | 2200 | 420 | 6 | 21 | 490 | 1100 | 28 | 42 | 6 | 21 | 200 |
| Dibenzofuran | 410 | 130 | 360 | 160 | 780 | 190 | 140 | 160 | 2300 | 5400 | 130 | 100 | 140 | 160 | |
| 1,2-Dibromo-3- | 5 | 1 | 5 | 1 | 11 | 1 | 1 | 1 | 33 | 76 | 2 | 1 | 1 | 1 | |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| chloropropane | | | | | | | | | | | | | | | |
| 1,2-Dibromoethane (EDB) | 0.2 | 0.02 | 0.1 | 0.02 | 0.3 | 0.02 | 0.1 | 0.02 | 33 | 49 | 2 | 0.02 | 0.1 | 0.02 | |
| 1,2-Dichlorobenzene | 5200 | 790 | 5000 | 1300 | 13000 | 3000 | 570 | 1300 | 33000 | 77000 | 1900 | 1500 | 570 | 1300 | |
| 1,3-Dichlorobenzene | 1400 | 330 | 1300 | 470 | 3400 | 770 | 270 | 470 | 17000 | 40000 | 980 | 520 | 270 | 470 | |
| 1,4-Dichlorobenzene | 300 | 14 | 280 | 22 | 710 | 10 | 26 | 22 | 1300 | 1600 | 74 | 24 | 26 | 22 | |
| 1,4-Dichloro-2-butene | 1 | 0.04 | 1 | 0.1 | 2 | 0.1 | 0.1 | 0.1 | 3 | 4 | 0.2 | 0.1 | 0.1 | 0.1 | |
| Dichlorodifluoromethane | 16000 | 890 | 21000 | 1800 | 58000 | 16000 | 570 | 1800 | 33000 | 77000 | 1900 | 2600 | 570 | 1800 | |
| 1,1-Dichloroethane | 20000 | 1800 | 22000 | 3400 | 37000 | 12000 | 1200 | 3400 | 82000 | 190000 | 4700 | 4700 | 1200 | 3400 | |
| 1,2-Dichloroethane (EDC) | 210 | 4 | 320 | 8 | 510 | 43 | 6 | 8 | 340 | 410 | 19 | 12 | 6 | 8 | 5 |
| 1,1-Dichloroethylene | 38 | 2 | 35 | 2 | 61 | 4 | 3 | 2 | 180 | 210 | 10 | 3 | 3 | 2 | 7 |
| 1,2-Dichloroethylene (cis) | 1700 | 130 | 1900 | 250 | 3500 | 1100 | 87 | 250 | 5700 | 13000 | 330 | 360 | 87 | 250 | 70 |
| 1,2-Dichloroethylene (trans) | 1600 | 230 | 1600 | 380 | 3900 | 960 | 160 | 380 | 11000 | 27000 | 650 | 510 | 160 | 380 | |
| 1,2-Dichloroethylene (mixture) | 740 | 100 | 720 | 170 | 1700 | 430 | 73 | 170 | 5200 | 12000 | 290 | 230 | 73 | 170 | |
| 1,2-Dichloropropane | 190 | 6 | 220 | 11 | 390 | 46 | 8 | 11 | 460 | 560 | 26 | 15 | 8 | 11 | |
| 1,3-Dichloropropene | 130 | 3 | 110 | 6 | 130 | 22 | 4 | 6 | 240 | 290 | 14 | 8 | 4 | 6 | |
| Dimethylamine | 2 | 0.1 | 2 | 0.2 | 3 | 1 | 0.1 | 0.2 | 3 | 8 | 0.2 | 0.2 | 0.1 | 0.2 | |
| Epichlorohydrin | 230 | 11 | 370 | 23 | 640 | 160 | 7 | 23 | 160 | 380 | 9 | 14 | 7 | 23 | TT |
| Ethyl acetate | 79000 | 13000 | 74000 | 21000 | 170000 | 43000 | 9600 | 21000 | 520000 | 1200000 | 29000 | 23000 | 9600 | 21000 | |
| Ethyl acrylate | 380 | 8 | 610 | 16 | 1000 | 87 | 10 | 16 | 650 | 780 | 37 | 23 | 10 | 16 | |
| Ethylbenzene | 5800 | 1800 | 5100 | 2300 | 13000 | 3000 | 1700 | 2300 | 170000 | 390000 | 9400 | 2500 | 1700 | 2300 | 700 |
| Ethylene oxide | 58 | 1 | 63 | 2 | 56 | 6 | 2 | 2 | 89 | 110 | 5 | 3 | 2 | 2 | |
| Ethyl chloride | 2200 | 990 | 1800 | 1000 | 4000 | 1000 | 1500 | 1000 | 1600000 | 3800000 | 93000 | 1000 | 1500 | 1000 | |
| Ethyl ether | 90000 | 11000 | 89000 | 170000 | 87000 | 32000 | 8200 | 17000 | 110000 | 270000 | 6500 | 8100 | 8200 | 17000 | |
| Ethyl methacrylate | 7500 | 1100 | 7300 | 1800 | 17000 | 4300 | 780 | 1800 | 52000 | 120000 | 2900 | 2300 | 780 | 1800 | |
| Furan | 78 | 10 | 78 | 17 | 190 | 48 | 7 | 17 | 570 | 1300 | 33 | 25 | 7 | 17 | |
| n-Hexane | 4800 | 620 | 4700 | 1100 | 12000 | 2900 | 440 | 1100 | 33000 | 77000 | 1900 | 1500 | 440 | 1100 | |
| Isobutanol | 31000 | 9300 | 27000 | 12000 | 58000 | 14000 | 9100 | 12000 | 170000 | 400000 | 9800 | 7600 | 9100 | 12000 | |
| Maleic hydrazide | 41000 | 6000 | 40000 | 10000 | 97000 | 24000 | 4300 | 10000 | 290000 | 670000 | 16000 | 13000 | 4300 | 10000 | |
| Methacrylonitrile | 10 | 2 | 9 | 3 | 20 | 5 | 2 | 3 | 110 | 270 | 7 | 3 | 2 | 3 | |

**Appendix A - Draft HBGLs for all Pollutants (µg/L)** TT= Treatment Technology

| Chemical | Non Food Crop Agricultural Irrigation | | Landscape Flood Irrigation | | Landscape Spray irrigation | | Ornamental Lakes | | Dust Control & Soil Compaction | | Sand and Gravel Washing | | Open Water Conveyance | | MCL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Residential* | *Occupational* | *Residential* | *Occupational* | *Residential* | *Occupational* | *Residential* | *Occupational* | *Residential* | *Occupational* | *Residential* | *Occupational* | *Residential* | *Occupational* | |
| Methomyl | 2200 | 340 | 2100 | 560 | 4800 | 1200 | 250 | 560 | 14000 | 34000 | 810 | 640 | 250 | 560 | |
| Methyl acetate | 99000 | 26000 | 88000 | 35000 | 190000 | 48000 | 23000 | 35000 | 570000 | 1300000 | 33000 | 25000 | 23000 | 35000 | |
| Methyl acrylate | 2400 | 320 | 2400 | 550 | 5800 | 1400 | 230 | 550 | 17000 | 40000 | 980 | 760 | 230 | 550 | |
| Methylene chloride | 1600 | 110 | 1400 | 140 | 3100 | 190 | 270 | 140 | 19000 | 23000 | 1100 | 160 | 270 | 140 | |
| Methyl ethyl ketone | 170000 | 11000 | 220000 | 21000 | 250000 | 87000 | 7100 | 21000 | 160000 | 380000 | 9300 | 13000 | 7100 | 21000 | |
| Methyl isobutyl ketone | 4900 | 430 | 5400 | 810 | 14000 | 3400 | 280 | 810 | 13000 | 31000 | 740 | 900 | 280 | 810 | |
| Methyl methacrylate | 6800 | 1000 | 6500 | 1700 | 16000 | 3900 | 760 | 1700 | 46000 | 110000 | 2600 | 2000 | 760 | 1700 | |
| Methyl styrene (mixture) | 560 | 120 | 520 | 170 | 1200 | 300 | 94 | 170 | 6600 | 15000 | 370 | 200 | 94 | 170 | |
| Methyl styrene (alpha) | 5900 | 870 | 5700 | 1400 | 14000 | 3400 | 630 | 1400 | 40000 | 94000 | 2300 | 1800 | 630 | 1400 | |
| Methyl tertbutyl ether (MTBE) | 540 | 250 | 460 | 250 | 1000 | 260 | 390 | 250 | 490000 | 1200000 | 28000 | 250 | 390 | 250 | |
| Nitrobenzene | 50 | 14 | 44 | 18 | 97 | 24 | 13 | 18 | 330 | 770 | 19 | 14 | 13 | 18 | |
| N-Nitrosodi-n-butylamine | 5 | 0.1 | 6 | 0.2 | 9 | 1 | 0.1 | 0.2 | 6 | 7 | 0.3 | 0.2 | 0.1 | 0.2 | |
| 1,1,1,2-Tetrachloroethane | 400 | 17 | 380 | 26 | 870 | 52 | 28 | 26 | 1200 | 1400 | 68 | 27 | 28 | 26 | |
| 1,1,2,2-Tetrachloroethane | 120 | 3 | 130 | 5 | 210 | 16 | 4 | 5 | 150 | 180 | 9 | 5 | 4 | 5 | |
| Tetrachloroethylene (PCE) | 210 | 22 | 170 | 23 | 400 | 24 | 100 | 23 | 5700 | 13000 | 330 | 23 | 100 | 23 | 5 |
| Toluene | 13000 | 1300 | 13000 | 2400 | 35000 | 8400 | 910 | 2400 | 63000 | 150000 | 3600 | 3500 | 910 | 2400 | 1000 |
| 1,2,4-Trichlorobenzene | 460 | 190 | 390 | 210 | 1000 | 230 | 230 | 210 | 33000 | 76000 | 1900 | 210 | 230 | 210 | 9 |
| 1,1,1-Trichloroethane | 7300 | 2000 | 6400 | 2500 | 11000 | 3300 | 2000 | 2500 | 160000 | 380000 | 9300 | 2700 | 2000 | 2500 | 200 |
| 1,1,2-Trichloroethane | 400 | 85 | 450 | 15 | 750 | 59 | 11 | 15 | 560 | 670 | 32 | 18 | 11 | 15 | 5 |
| Trichloroethylene (TCE) | 880 | 60 | 920 | 100 | 1800 | 240 | 59 | 100 | 3400 | 6300 | 200 | 120 | 59 | 100 | 5 |
| Trichlorofluoromethane | 36000 | 3100 | 40000 | 5800 | 86000 | 24000 | 2100 | 5800 | 110000 | 270000 | 6500 | 7500 | 2100 | 5800 | |
| 1,1,2-Trichloropropane | 430 | 66 | 410 | 110 | 970 | 240 | 49 | 110 | 2900 | 6700 | 160 | 130 | 49 | 110 | |
| 1,2,3-Trichloropropane | 1 | 0.05 | 1 | 0.1 | 3 | 0.2 | 0.1 | 0.1 | 4 | 5 | 0.3 | 0.1 | 0.1 | 0.1 | |
| 1,2,3-Trichloropropene | 430 | 66 | 410 | 110 | 970 | 240 | 49 | 110 | 2900 | 6700 | 160 | 130 | 49 | 110 | |
| 1,1,2-Trichloro-1,2,2-trifluoroethane | 1800000 | 160000 | 2000000 | 290000 | 5400000 | 1300000 | 100000 | 290000 | 4900000 | 11000000 | 280000 | 340000 | 100000 | 290000 | |
| Triethylamine | 180 | 33 | 170 | 51 | 390 | 96 | 26 | 51 | 1100 | 2700 | 65 | 51 | 26 | 51 | |
| Vinyl acetate | 17000 | 860 | 26000 | 1800 | 130000 | 25000 | 540 | 1800 | 33000 | 77000 | 1900 | 2700 | 540 | 1800 | |
| Vinyl bromide | 170 | 4 | 210 | 7 | 340 | 35 | 5 | 7 | 280 | 340 | 16 | 10 | 5 | 7 | |
| Vinyl chloride | 2 | 0.1 | 2 | 0.1 | 3 | 0.2 | 0.1 | 0.1 | 10 | 13 | 1 | 0.2 | 0.1 | 0.1 | 2 |
| Xylene (mixed) | 53000 | 3000 | 75000 | 6100 | 300000 | 63000 | 1900 | 6100 | 110000 | 270000 | 6500 | 9200 | 1900 | 6100 | 10000 |

# APPENDIX B

**Table 2.2.1.1**
**AGRICULTURAL IRRIGATION**
**(NON-FOOD CROPS)**
**Childhood Residential Exposure**

$$Cw_1(\mu g/L) = \frac{Risk \times AT_c \times BW_{ch} \times Q/C \times CF5 \times CF4}{IR_{ch} \times IT_{inh} \times EF_{inh} \times ED_{ch} \times SF_i \times CF1 \times Ki \times CF2 \times CF3}$$

**Equation 1: Childhood inhalation of volatile organic compounds, cancer**

where: F = flux in $mg/m^2 \cdot sec$
VF = $kg/m^3$

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| Risk | Excess Lifetime Cancer Risk, (unitless) | 1.0E-05<br>1.0E-06 | ADHS, 1997 |
| $AT_c$ | Averaging Time, cancer (days) | 25550 | USEPA 1989 |
| $BW_{ch}$ | Body Weight, child (kg) | 15 | USEPA 1989 |
| Q/C | Inverse of mean concentration at the center of a 30 acre body of water ($mg/m^2 \cdot sec$ per $kg/m^3$) | 32700 | USEPA, 1996 |
| CF5 | $10^3$ (µg/mg) | 1000 | ---------- |
| CF4 | $10^6$ (mg $cm^3$/g L) | 1000000 | ---------- |
| $IR_{ch}$ | Inhalation Rate, child ($m^3$/day) | 10 | USEPA 1991a |
| $IT_{inh}$ | Irrigation Time, inhalation (8 hours/day x .041days/hour) | 0.333333 | University of Arizona, 1998 |
| $EF_{inh}$ | Exposure Frequency, inhalation (days/year) | 14 | University of Arizona, 1998 |
| $ED_{ch}$ | Exposure Duration, child (years) | 6 | USEPA 1991a |
| $SF_i$ | Slope Factor, inhalation (1/(mg/kg·d)) | Chemical-Specific | IRIS, HEAST, or NCEA |
| CF1 | $10^6$ (mg/kg) | 1000000 | ---------- |
| Ki | Overall mass transfer, coefficient of i (cm/sec) | Chemical-Specific | USEPA 1995 |
| CF2 | $10^4$ ($cm^2/m^2$) | 10000 | ---------- |
| CF3 | $10^3$ (mg/g) | 1000 | ---------- |

**Table 2.2.1.1.**
**AGRICULTURAL IRRIGATION**

**Equation 2: Childhood inhalation of volatile organic compounds, systemic toxicity**

$$Cw_1(\mu g/L) = \frac{HQ \times AT_{nc} \times BW_{ch} \times Q/C \times RfD_i \times CF5 \times CF4}{IR_{ch} \times IT_{inh} \times EF_{inh} \times ED_{ch} \times CF1 \times Ki \times CF2 \times CF3}$$

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| HQ | Hazard Quotient, (unitless) | 1 | ADHS, 1997 |
| $AT_{nc}$ | Averaging Time, noncancer (days) | 2190 | USEPA 1989 |
| $BW_{ch}$ | Body Weight, child (kg) | 15 | USEPA 1989 |
| Q/C | Inverse of mean concentration at the center of a 30 acre body of water ($mg/m^2 \cdot sec$ per $kg/m^3$) | 32700 | USEPA, 1996 |
| $RfD_i$ | Reference Dose, inhalation (mg/kg-d) | Chemical-Specific | IRIS, HEAST, OR NCEA |
| CF5 | $10^3$ (µg/mg) | 1000 | ---------- |
| CF4 | $10^6$ (mg $cm^3$/g L) | 1000000 | ---------- |
| $IR_{ch}$ | Inhalation Rate, child ($m^3$/day) | 10 | USEPA 1991a |
| $IT_{inh}$ | Irrigation Time, inhalation (8 hours/day x .041days/hour) | 0.333333 | University of Arizona, 1998 |
| $EF_{inh}$ | Exposure Frequency, inhalation (days/year) | 14 | University of Arizona, 1998 |
| $ED_{ch}$ | Exposure Duration, child (years) | 6 | USEPA 1991a |
| CF1 | $10^6$ (mg/kg) | 1000000 | ---------- |
| Ki | Overall mass transfer, coefficient of i (cm/sec) | Chemical-Specific | USEPA 1995 |
| CF2 | $10^4$ ($cm^2/m^2$) | 10000 | ---------- |
| CF3 | $10^3$ (mg/g) | 1000 | ---------- |

**Table 2.2.1.**
**AGRICULTURAL IRRIGATION**

$$Cw_2(\mu g/L) = \frac{Risk \times AT_c \times BW_{ch} \times CF5}{IR_w \times ST_{ing} \times EF_{ing} \times ED_{ch} \times SF_o}$$

**Equation 3 : Childhood ingestion of volatile organic compounds, cancer**

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| Risk | Excess Lifetime Cancer Risk, (unitless) | 1.0E-05<br>1.0E-06 | ADHS, 1997 |
| $AT_c$ | Averaging Time, cancer (days) | 25550 | USEPA 1989 |
| $BW_{ch}$ | Body Weight, child (kg) | 15 | USEPA 1989 |
| CF5 | $10^3$ (μg/mg) | 1000 | ---------- |
| $IR_w$ | Ingestion Rate, water (L/hour) | 0.05 | USEPA 1991a |
| $ST_{ing}$ | Swimming Time, ingestion (hours/day) | 8 | ADHS, 1998 |
| $EF_{ing}$ | Exposure Frequency, ingestion (days/year) | 14 | University of Arizona, 1998 |
| $ED_{ch}$ | Exposure Duration, child (years) | 6 | USEPA 1991a |
| $SF_o$ | Slope Factor, oral (1/(mg/kg·d)) | Chemical-Specific | IRIS, HEAST, or NCEA |

**Table 2.2.1.1.**
**AGRICULTURAL IRRIGATION**

$$Cw_2(\mu g/L) = \frac{HQ \times BW_{ch} \times AT_{nc} \times RfD_o \times CF5}{IR_w \times ST_{ing} \times EF_{ing} \times ED_{ch}}$$

**Equation 4 : Childhood ingestion of volatile organic compounds, noncancer**

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| HQ | Hazard Quotient, (unitless) | 1 | ADHS, 1997 |
| $BW_{ch}$ | Body Weight, child (kg) | 15 | USEPA 1989 |
| $AT_{nc}$ | Averaging Time, noncancer (days) | 2190 | USEPA 1989 |
| $RfD_o$ | Reference Dose, oral (mg/kg-d) | Chemical-Specific | IRIS, HEAST, OR NCEA |
| CF5 | $10^3$ (μg/mg) | 1000 | ---------- |
| $IR_w$ | Ingestion Rate, child (L/hour) | 0.05 | USEPA 1991a |
| $ST_{ing}$ | Swimming Time, ingestion (hours/day) | 8 | ADHS, 1998 |
| $EF_{ing}$ | Exposure Frequency, ingestion (days/year) | 14 | University of Arizona, 1998 |
| $ED_{ch}$ | Exposure Duration, child (years) | 6 | USEPA 1991a |

**Table 2.2.1.1**
**AGRICULTURAL IRRIGATION**

$$Cw_3(\mu g/L) = \frac{Risk \times BW_{ch} \times AT_c \times CF5}{SA_{ch} \times Kp \times ST_{der} \times EF_{der} \times ED_{ch} \times CF6 \times SF_o}$$

**Equation 5: Childhood dermal contact with volatile organic compounds, cancer**

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| Risk | Excess Lifetime Cancer Risk, (unitless) | 1.0E-05<br>1.0E-06 | ADHS, 1997 |
| $BW_{ch}$ | Body Weight, child (kg) | 15 | USEPA, 1989 |
| $AT_c$ | Averaging Time, cancer (days) | 25550 | USEPA, 1989 |
| CF5 | $10^3$ (μg/mg) | 1000 | ---------- |
| $SA_{ch}$ | Skin Surface Area, child ($cm^2$) | 10000 | USEPA, 1992 |
| Kp | Permeability Coefficient, (cm/hour) | Chemical-Specific | USEPA, 1992 |
| $ST_{der}$ | Swimming Time, dermal (hour) | 8 | ADHS, 1998 |
| $EF_{der}$ | Exposure Frequency, dermal (days/year) | 14 | University of Arizona, 1998 |
| $ED_{ch}$ | Exposure Duration, child (years) | 6 | USEPA, 1991a |
| CF6 | $10^{-3}$ ($L/cm^3$) | 0.001 | ---------- |
| $SF_o$ | Slope Factor, oral (1/(mg/kg-d)) | Chemical-Specific | IRIS, HEAST, or NCEA |

**Table 2.2.1.1.**
**AGRICULTURAL IRRIGATION**

**Equation 6 : Childhood dermal contact of volatile organic compounds, noncancer**

$$Cw_3(\mu g/L) = \frac{HQ \times BW_{ch} \times AT_{nc} \times RfD_o \times CF5}{SA_{ch} \times Kp \times ST_{der} \times EF_{der} \times ED_{ch} \times CF6}$$

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| HQ | Hazard Quotient, (unitless) | 1 | ADHS, 1997 |
| $BW_{ch}$ | Body Weight, child (kg) | 15 | USEPA 1989 |
| $AT_{nc}$ | Averaging Time, noncancer (days) | 2190 | USEPA 1989 |
| $RfD_o$ | Reference Dose, oral (mg/kg-d) | Chemical-Specific | IRIS, HEAST, OR NCEA |
| CF5 | $10^3$ (μg/mg) | 1000 | ---------- |
| $SA_{ch}$ | Skin Surface Area, child ($cm^2$) | 10000 | USEPA, 1992 |
| Kp | Permeability Coefficient, (cm/hour) | Chemical-Specific | USEPA, 1992 |
| $ST_{der}$ | Swimming Time, dermal (hours/day) | 8 | ADHS, 1998 |
| $EF_{der}$ | Exposure Frequency, dermal (days/year) | 14 | University of Arizona, 1998 |
| $ED_{ch}$ | Exposure Duration, child (years) | 6 | USEPA 1991a |
| CF6 | $10^{-3}$ ($L/cm^3$) | 0.001 | ---------- |

**Table 2.2.1.2**
**AGRICULTURAL IRRIGATION**
**(NON-FOOD CROPS)**
**Adult Residential Exposure**

$$Cw_1(\mu g/L) = \frac{Risk \; x \; AT_c \; x \; BW_a \; x \; Q/C \; x \; CF5 \; x \; CF4}{IR_a \; x \; IT_{inh} \; x \; EF_{inh} \; x \; ED_a \; x \; SF_i \; x \; CF1 \; x \; Ki \; x \; CF2 \; x \; CF3}$$

**Equation 1: Adult inhalation of volatile organic compounds, cancer**

where: F = flux in $mg/m^2 \cdot sec$
VF = $kg/m^3$

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| Risk | Excess Lifetime Cancer Risk, (unitless) | 1.0E-05<br>1.0E-06 | ADHS, 1997 |
| $AT_c$ | Averaging Time, cancer (days) | 25550 | USEPA 1989 |
| $BW_a$ | Body Weight, (adult) kg | 70 | USEPA 1989 |
| Q/C | Inverse of mean concentration at the center of a 30 acre body of water ($mg/m^2 \cdot sec$ per $kg/m^3$) | 32700 | USEPA, 1996 |
| CF5 | $10^3$ (μg/mg) | 1000 | ---------- |
| CF4 | $10^6$ (mg $cm^3$/g L) | 1000000 | ---------- |
| $IR_a$ | Inhalation Rate, adult ($m^3$/day) | 20 | USEPA, 1991a |
| $IT_{inh}$ | Irrigation Time, inhalation (8 hours/day x .041days/hour) | 0.33333333 | ADHS, 1998 |
| $EF_{inh}$ | Exposure Frequency, inhalation (days/year) | 14 | University of Arizona, 1998 |
| $ED_a$ | Exposure Duration, adult (years) | 30 | USEPA, 1991a |
| $SF_i$ | Slope Factor, inhalation (1/(mg/kg·d)) | Chemical-Specific | IRIS, HEAST, or NCEA |
| CF1 | $10^6$ (mg/kg) | 1000000 | ---------- |
| Ki | Overall mass transfer, coefficient of i (cm/sec) | Chemical-Specific | USEPA, 1995 |
| CF2 | $10^4$ ($cm^2/m^2$) | 10000 | ---------- |
| CF3 | $10^3$ (mg/g) | 1000 | ---------- |

**Table 2.2.1.2**
**AGRICULTURAL IRRIGATION**

**Equation 2: Adult inhalation of volatile organic compounds, systemic toxicity**

$$Cw_1(\mu g/L) = \frac{HQ \times AT_{nc} \times BW_a \times Q/C \times RfD_i \times CF5 \times CF4}{IR_a \times EF_{inh} \times IT_{inh} \times ED_a \times CF1 \times Ki \times CF2 \times CF3}$$

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| HQ | Hazard Quotient, (unitless) | 1 | ADHS, 1997 |
| $AT_{nc}$ | Averaging Time, noncancer (days) | 10950 | USEPA, 1989 |
| $BW_a$ | Body Weight, adult (kg) | 70 | USEPA, 1989 |
| Q/C | Inverse of mean concentration at the center of a 30 acre body of water ($mg/m^2 \cdot sec$ per $kg/m^3$) | 32700 | USEPA, 1996 |
| $RfD_i$ | Reference Dose, inhalation (mg/kg-d) | Chemical-Specific | IRIS, HEAST, OR NCEA |
| CF5 | $10^3$ (μg/mg) | 1000 | ---------- |
| CF4 | $10^6$ (mg $cm^3$/g L) | 1000000 | ---------- |
| $IR_a$ | Inhalation Rate, adult ($m^3$/day) | 20 | USEPA, 1991a |
| $EF_{inh}$ | Exposure Frequency, inhalation (days/year) | 14 | University of Arizona, 1998 |
| $IT_{inh}$ | Irrigation Time, inhalation (8 hours/day x .041days/hour) | 0.3333333 | ADHS, 1998 |
| $ED_a$ | Exposure Duration, adult (years) | 30 | USEPA, 1991a |
| CF1 | $10^6$ (mg/kg) | 1000000 | ---------- |
| Ki | Overall mass transfer, coefficient of i (cm/sec) | Chemical-Specific | USEPA, 1995 |
| CF2 | $10^4$ ($cm^2/m^2$) | 10000 | ---------- |
| CF3 | $10^3$ (mg/g) | 1000 | ---------- |

**Table 2.2.2.**
**AGRICULTURAL IRRIGATION**
**(NON-FOOD CROPS)**
**Occupational Exposure**

$$Cw_1(\mu g/L) = \frac{Risk \times AT_c \times BW_a \times Q/C \times CF5 \times CF4}{IR_a \times EF_{inh} \times ED_a \times SF_i \times CF1 \times Ki \times CF2 \times CF3}$$

**Equation 1: Occupational inhalation of volatile organic compounds, cancer**

where: F = flux in $mg/m^2 \cdot sec$
VF = $kg/m^3$

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| Risk | Excess Lifetime Cancer Risk, (unitless) | 1.0E-05<br>1.0E-06 | ADHS, 1997 |
| $AT_c$ | Averaging Time, cancer (days) | 25550 | USEPA 1989 |
| $BW_a$ | Body Weight, adult (kg) | 70 | USEPA 1989 |
| Q/C | Inverse of mean concentration at the center of a 30 acre body of water ($mg/m^2 \cdot sec$ per $kg/m^3$) | 32700 | USEPA, 1996 |
| CF5 | $10^3$ (µg/mg) | 1000 | ---------- |
| CF4 | $10^6$ (mg $cm^3$/g L) | 1000000 | ---------- |
| $IR_a$ | Inhalation Rate, adult ($m^3$/day) | 20 | USEPA 1991a |
| $EF_{inh}$ | Exposure Frequency, inhalation (days/year) | 250 | USEPA 1991a |
| $ED_a$ | Exposure Duration, adult (years) | 25 | USEPA 1991a |
| $SF_i$ | Slope Factor, inhalation (1/(mg/kg·d)) | Chemical-Specific | IRIS, HEAST, or NCEA |
| CF1 | $10^6$ (mg/kg) | 1000000 | ---------- |
| Ki | Overall mass transfer, coefficient of i (cm/sec) | Chemical-Specific | USEPA 1995 |
| CF2 | $10^4$ ($cm^2/m^2$) | 10000 | ---------- |
| CF3 | $10^3$ (mg/g) | 1000 | ---------- |

**Table 2.2.2.**
**AGRICULTURAL IRRIGATION**

**Equation 2: Occupational inhalation of volatile organic compounds, systemic toxicity**

$$Cw_1(\mu g/L) = \frac{HQ \times AT_{nc} \times BW_a \times Q/C \times RfD_i \times CF5 \times CF4}{IR_a \times EF_{inh} \times ED_a \times CF1 \times Ki \times CF2 \times CF3}$$

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| HQ | Hazard Quotient, (unitless) | 1 | ADHS, 1997 |
| $AT_{nc}$ | Averaging Time, noncancer (days) | 9125 | USEPA 1989 |
| $BW_a$ | Body Weight, adult (kg) | 70 | USEPA 1989 |
| Q/C | Inverse of mean concentration at the center of a 30 acre body of water ($mg/m^2 \cdot sec$ per $kg/m^3$) | 32700 | USEPA, 1996 |
| $RfD_i$ | Reference Dose, inhalation (mg/kg-d) | Chemical-Specific | IRIS, HEAST, OR NCEA |
| CF5 | $10^3$ (μg/mg) | 1000 | ---------- |
| CF4 | $10^6$ (mg $cm^3$/g L) | 1000000 | ---------- |
| $IR_a$ | Inhalation Rate, adult ($m^3$/day) | 20 | USEPA 1991a |
| $EF_{inh}$ | Exposure Frequency, inhalation (days/year) | 250 | USEPA 1991a |
| $ED_a$ | Exposure Duration, adult (years) | 25 | USEPA 1991a |
| CF1 | $10^6$ (mg/kg) | 1000000 | ---------- |
| Ki | Overall mass transfer, coefficient of i (cm/sec) | Chemical-Specific | USEPA 1995 |
| CF2 | $10^4$ ($cm^2/m^2$) | 10000 | ---------- |
| CF3 | $10^3$ (mg/g) | 1000 | ---------- |

**Table 2.2.2.**
**AGRICULTURAL IRRIGATION**

$$Cw_2(\mu g/L) = \frac{Risk \; x \; AT_c \; x \; BW_a \; x \; CF5}{IR_w \; x \; IT_{ing} \; x \; EF_{ing} \; x \; ED_a \; x \; SF_o}$$

**Equation 3 : Occupational ingestion of volatile organic compounds, cancer**

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| Risk | Excess Lifetime Cancer Risk, (unitless) | 1.0E-05<br>1.0E-06 | ADHS, 1997 |
| $AT_c$ | Averaging Time, cancer (days) | 25550 | USEPA 1989 |
| $BW_a$ | Body Weight, (adult) kg | 70 | USEPA 1989 |
| CF5 | $10^3$ (μg/mg) | 1000 | ---------- |
| $IR_w$ | Ingestion Rate, water (L/hour) | 0.05 | USEPA 1991a |
| $IT_{ing}$ | Irrigation Time, (hours/day) | 8 | ADHS, 1998 |
| $EF_{ing}$ | Exposure Frequency, ingestion (days/year) | 250 | USEPA 1991a |
| $ED_a$ | Exposure Duration, adult (years) | 25 | USEPA 1991a |
| $SF_o$ | Slope Factor, oral (1/(mg/kg·d)) | Chemical-Specific | IRIS, HEAST, or NCEA |

**Table 2.2.2.**
**AGRICULTURAL IRRIGATION**

$$Cw_2(\mu g/L) = \frac{HQ \times BW_a \times AT_{nc} \times RfD_o \times CF5}{IR_w \times IT_{ing} \times EF_{ing} \times ED_a}$$

**Equation 4 : Occupational ingestion of volatile organic compounds, noncancer**

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| HQ | Hazard Quotient, (unitless) | 1 | ADHS, 1997 |
| $BW_a$ | Body Weight, adult (kg) | 70 | USEPA, 1989 |
| $AT_{nc}$ | Averaging Time, noncancer (days) | 9,125 | USEPA, 1989 |
| $RfD_o$ | Reference Dose, oral (mg/kg-d) | Chemical-Specific | IRIS, HEAST, OR NCEA |
| CF5 | $10^3$ (μg/mg) | 1,000 | ---------- |
| $IR_w$ | Ingestion Rate, adult (L/hour) | 0.05 | USEPA, 1991a |
| $IT_{ing}$ | Exposure Time, ingestion (hours/day) | 8 | ADHS, 1998 |
| $EF_{ing}$ | Exposure Frequency, ingestion (days/year) | 250 | USEPA, 1991a |
| $ED_a$ | Exposure Duration, adult (years) | 25 | USEPA, 1991a |

**Table 2.2.2.**
**AGRICULTURAL IRRIGATION**

$$Cw_3(\mu g/L) = \frac{Risk \times BW_a \times AT_c \times CF5}{SA_a \times Kp \times IT_{der} \times EF_{der} \times ED_a \times CF6 \times SF_o}$$

**Equation 5: Occupational dermal contact with volatile organic compounds, cancer**

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| Risk | Excess Lifetime Cancer Risk, (unitless) | 1.0E-05<br>1.0E-06 | ADHS, 1997 |
| $BW_a$ | Body Weight, (kg) | 70 | USEPA 1989 |
| $AT_c$ | Averaging Time, cancer (days) | 25550 | USEPA 1989 |
| CF5 | $10^3$ (μg/mg) | 1000 | ---------- |
| $SA_a$ | Skin Surface Area, adult ($cm^2$) | 5000 | USEPA, 1992 |
| Kp | Permeability Coefficient, (cm/hour) | Chemical-Specific | USEPA, 1992 |
| $IT_{der}$ | Irrigation Time, dermal (hours) | 8 | ADHS, 1998 |
| $EF_{der}$ | Exposure Frequency, dermal (days/year) | 250 | ADHS, 1998 |
| $ED_a$ | Exposure Duration, adult (years) | 25 | USEPA 1991a |
| CF6 | $10^{-3}$ ($L/cm^3$) | 0.001 | ---------- |
| $SF_o$ | Slope Factor, oral, (1/(mg/kg-d)) | Chemical-Specific | IRIS, HEAST, or NCEA |

**Table 2.2.2**
**AGRICULTURAL IRRIGATION**

**Equation 6 : Occupational dermal contact with volatile organic compounds, noncancer**

$$Cw_3(\mu g/L) = \frac{HQ \times BW_a \times AT_{nc} \times RfD_o \times CF5}{SA_a \times Kp \times ET_{der} \times EF_{der} \times ED_a \times CF6}$$

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| HQ | Hazard Quotient, (unitless) | 1 | ADHS, 1997 |
| $BW_a$ | Body Weight, (adult) kg | 70 | USEPA, 1989 |
| $AT_{nc}$ | Averaging Time, noncancer (days) | 9125 | USEPA, 1989 |
| $RfD_o$ | Reference Dose, oral (mg/kg-d) | Chemical-Specific | IRIS, HEAST, OR NCEA |
| CF5 | $10^3$ (μg/mg) | 1000 | ---------- |
| $SA_a$ | Skin Surface Area, adult ($cm^2$) | 5000 | USEPA, 1992 |
| Kp | Permeability Coefficient (cm/hour) | Chemical-Specific | USEPA, 1992 |
| $ET_{der}$ | Exposure Time, dermal (hours/day) | 8 | USEPA, 1991 |
| $EF_{der}$ | Exposure Frequency, dermal (days/year) | 250 | USEPA, 1991 |
| $ED_a$ | Exposure Duration, adult (years) | 25 | USEPA, 1991a |
| CF6 | $10^{-3}$ ($L/cm^3$) | 0.001 | ---------- |

**Table 3.1.1.1**
**LANDSCAPE FLOOD IRRIGATION**
**Childhood Residential Exposure**

$$Cw_1(\mu g/L) = \frac{Risk \times AT_c \times BW_{ch} \times Q/C \times CF4 \times CF5}{IR_{ch} \times IT_{inh} \times EF_{inh} \times ED_{ch} \times SF_i \times CF1 \times Ki \times CF2 \times CF3}$$

**Equation 1: Childhood inhalation of volatile organic compounds, cancer**

where: F = flux in $mg/m^2 \cdot sec$
VF = $kg/m^3$

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| Risk | Excess Lifetime Cancer Risk, (unitless) | 1.0E-05<br>1.0E-06 | ADHS, 1997 |
| $AT_c$ | Averaging Time, cancer (days) | 25550 | USEPA, 1989 |
| $BW_{ch}$ | Body Weight, child (kg) | 15 | USEPA, 1989 |
| Q/C | Inverse of mean concentration at the center of a 0.50 acre body of water ($mg/m^2 \cdot sec$ per $kg/m^3$) | 68000 | USEPA, 1996 |
| CF4 | $10^6$ ($mg\ cm^3/g\ L$) | 1000000 | ---------- |
| CF5 | $10^3$ ($\mu g/mg$) | 1000 | ---------- |
| $IR_{ch}$ | Inhalation Rate, child ($m^3$/day) | 10 | USEPA, 1991a |
| $IT_{inh}$ | Irrigation Time, child ((4hours/day)*.041d/hr)) | 0.166666 | ADHS, 1998 |
| $EF_{inh}$ | Exposure Frequency, inhalation (days/year) | 33 | COP, 1998 |
| $ED_{ch}$ | Exposure Duration, child (years) | 6 | USEPA, 1991a |
| $SF_i$ | Slope Factor, inhalation (1/(mg/kg·d)) | Chemical-Specific | IRIS, HEAST, or NCEA |
| CF1 | $10^6$ (mg/kg) | 1000000 | ---------- |
| Ki | Overall mass transfer, coefficient of i (cm/sec) | Chemical-Specific | USEPA, 1995 |
| CF2 | $10^4$ ($cm^2/m^2$) | 10000 | ---------- |
| CF3 | $10^3$ (mg/g) | 1000 | ---------- |

## Table 3.1.1.1
## LANDSCAPE FLOOD IRRIGATION

**Equation 2: Childhood inhalation of volatile organic compounds, systemic toxicity**

$$Cw_1(\mu g/L) = \frac{HQ \times AT_{nc} \times BW_{ch} \times Q/C \times RfD_i \times CF5 \times CF4}{IR_{ch} \times IT_{inh} \times EF_{inh} \times ED_{ch} \times CF1 \times Ki \times CF2 \times CF3}$$

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| HQ | Hazard Quotient, (unitless) | 1 | ADHS, 1997 |
| $AT_{nc}$ | Averaging Time, noncancer (days) | 2190 | USEPA, 1989 |
| $BW_{ch}$ | Body Weight, child (kg) | 15 | USEPA, 1989 |
| Q/C | Inverse of mean concentration at the center of a 0.5 body of water ($mg/m^2 \cdot sec$ per $kg/m^3$) | 68800 | USEPA, 1996 |
| $RfD_i$ | Reference Dose, inhalation (mg/kg-d) | Chemical-Specific | IRIS, HEAST, OR NCEA |
| CF5 | $10^3$ (μg/mg) | 1000 | ---------- |
| CF4 | $10^6$ (mg $cm^3$/g L) | 1000000 | ---------- |
| $IR_{ch}$ | Inhalation Rate, child ($m^3$/day) | 10 | USEPA, 1991a |
| $IT_{inh}$ | Irrigation Time, child ((4hours/day)*.041d/hr)) | 0.166666 | ADHS, 1998 |
| $EF_{inh}$ | Exposure Frequency, inhalation (days/year) | 33 | COP, 1998 |
| $ED_{ch}$ | Exposure Duration, child (years) | 6 | USEPA, 1991a |
| CF1 | $10^6$ (mg/kg) | 1000000 | ---------- |
| Ki | Overall mass transfer, coefficient of i (cm/sec) | Chemical-Specific | USEPA, 1995 |
| CF2 | $10^4$ ($cm^2/m^2$) | 10000 | ---------- |
| CF3 | $10^3$ (mg/g) | 1000 | ---------- |

**Table 3.1.1.1**
**LANDSCAPE FLOOD IRRIGATION**

$$Cw_2(\mu g/L) = \frac{Risk \; x \; AT_c \; x \; BW_{ch} \; x \; CF5}{IR_w \; x \; IT_{ing} \; x \; EF_{ing} \; x \; ED_{ch} \; x \; SF_o}$$

**Equation 3 : Childhood ingestion of volatile organic compounds, cancer**

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| Risk | Excess Lifetime Cancer Risk, (unitless) | 1.0E-05<br>1.0E-06 | ADHS, 1997 |
| $AT_c$ | Averaging Time, cancer (days) | 25550 | USEPA 1989 |
| $BW_{ch}$ | Body Weight, child (kg) | 15 | USEPA 1989 |
| CF5 | $10^3$ (μg/mg) | 1000 | ---------- |
| $IR_w$ | Ingestion Rate, water (L/hour) | 0.05 | USEPA 1991a |
| $IT_{ing}$ | Irrigation Time, ingestion, (hours/day) | 4 | ADHS, 1998 |
| $EF_{ing}$ | Exposure Frequency, ingestion (days/year) | 33 | COP, 1998 |
| $ED_{ch}$ | Exposure Duration, child (years) | 6 | USEPA 1991a |
| $SF_o$ | Slope Factor, oral (1/(mg/kg·d)) | Chemical-Specific | IRIS, HEAST, or NCEA |

**Table 3.1.1.1**
**LANDSCAPE FLOOD IRRIGATION**

$$Cw_2(\mu g/L) = \frac{HQ \times BW_{ch} \times AT_{nc} \times RfD_o \times CF5}{IR_w \times IT_{ing} \times EF_{ing} \times ED_{ch}}$$

**Equation 4 : Childhood ingestion of volatile organic compounds, noncancer**

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| HQ | Hazard Quotient, (unitless) | 1 | ADHS, 1997 |
| $BW_{ch}$ | Body Weight, child (kg) | 15 | USEPA, 1989 |
| $AT_{nc}$ | Averaging Time, noncancer (days) | 2190 | USEPA, 1989 |
| $RfD_o$ | Reference Dose, oral (mg/kg-d) | Chemical-Specific | IRIS, HEAST, OR NCEA |
| CF5 | $10^3$ (μg/mg) | 1000 | ---------- |
| $IR_w$ | Ingestion Rate, water (L/hour) | 0.05 | USEPA, 1991a |
| $IT_{ing}$ | Irrigation Time, ingestion (hours/day) | 4 | ADHS, 1998 |
| $EF_{ing}$ | Exposure Frequency, ingestion (days/year) | 33 | COP, 1998 |
| $ED_{ch}$ | Exposure Duration, child (years) | 6 | USEPA, 1991a |

**Table 3.1.1.1**
**LANDSCAPE FLOOD IRRIGATION**

$$Cw_3(\mu g/L) = \frac{Risk \times BW_{ch} \times AT_c \times CF5}{SA_{ch} \times Kp \times IT_{der} \times EF_{der} \times ED_{ch} \times CF6 \times SF_o}$$

**Equation 5: Childhood dermal contact with volatile organic compounds, cancer**

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| Risk | Excess Lifetime Cancer Risk, (unitless) | 1.0E-05<br>1.0E-06 | ADHS, 1997 |
| $BW_{ch}$ | Body Weight, child (kg) | 15 | USEPA, 1989 |
| $AT_c$ | Averaging Time, cancer (days) | 25550 | USEPA, 1989 |
| CF5 | $10^3$ (μg/mg) | 1000 | ---------- |
| $SA_{ch}$ | Skin Surface Area, child ($cm^2$) | 10000 | USEPA, 1992 |
| Kp | Permeability Coefficient, (cm/hour) | Chemical-Specific | USEPA, 1992 |
| $IT_{der}$ | Irrigation Time, dermal (hours) | 4 | ADHS, 1998 |
| $EF_{der}$ | Exposure Frequency, dermal (days/year) | 33 | COP, 1998 |
| $ED_{ch}$ | Exposure Duration, child (years) | 6 | USEPA, 1991a |
| CF6 | $10^{-3}$ ($L/cm^3$) | 0.001 | ---------- |
| $SF_o$ | Slope Factor, oral (1/(mg/kg-d)) | Chemical-Specific | IRIS, HEAST, or NCEA |

**Table 3.1.1.1**
**LANDSCAPE FLOOD IRRIGATION**

**Equation 6 : Childhood dermal contact of volatile organic compounds, noncancer**

$$Cw_3(\mu g/L) = \frac{HQ \times BW_{ch} \times AT_{nc} \times RfD_o \times CF5}{SA_{ch} \times Kp \times IT_{der} \times EF_{der} \times ED_{ch} \times CF6}$$

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| HQ | Hazard Quotient, (unitless) | 1 | ADHS, 1997 |
| $BW_{ch}$ | Body Weight, child (kg) | 15 | USEPA, 1989 |
| $AT_{nc}$ | Averaging Time, noncancer (days) | 2190 | USEPA, 1989 |
| $RfD_o$ | Reference Dose, oral, (mg/kg-d) | Chemical-Specific | IRIS, HEAST, or NCEA |
| CF5 | $10^3$ (μg/mg) | 1000 | ---------- |
| $SA_{ch}$ | Skin Surface Area, child ($cm^2$) | 10000 | USEPA, 1992 |
| Kp | Permeability Coefficient, (cm/hour) | Chemical-Specific | USEPA, 1992 |
| $IT_{der}$ | Irrigation Time, dermal (hours/day) | 4 | ADHS, 1998 |
| $EF_{der}$ | Exposure Frequency, dermal (days/year) | 33 | COP, 1998 |
| $ED_{ch}$ | Exposure Duration, child (years) | 6 | USEPA ,1991a |
| CF6 | $10^{-3}$ ($L/cm^3$) | 0.001 | ---------- |

**Table 3.1.1.2**
**LANDSCAPE FLOOD IRRIGATION**
**Adult Residential Exposure**

$$Cw_1(\mu g/L) = \frac{Risk \times AT_c \times BW_a \times Q/C \times CF5 \times CF4}{IR_a \times IT_{inh} \times EF_{inh} \times ED_a \times SF_i \times CF1 \times Ki \times CF2 \times CF3}$$

**Equation 1: Adult inhalation of volatile organic compounds, cancer**

where: F = flux in $mg/m^2 \cdot sec$
VF = $kg/m^3$

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| Risk | Excess Lifetime Cancer Risk, (unitless) | 1.0E-05<br>1.0E-06 | ADHS, 1997 |
| $AT_c$ | Averaging Time, cancer (days) | 25550 | USEPA, 1989 |
| $BW_a$ | Body Weight, adult (kg) | 70 | USEPA, 1989 |
| Q/C | Inverse of mean concentration at the center of a 0.5 body of water ($mg/m^2 \cdot sec/ kg/m^3$) | 68800 | USEPA, 1996 |
| CF5 | $10^3$ (µg/mg) | 1,000 | ---------- |
| CF4 | $10^6$ (mg $cm^3$/g L) | 1,000,000 | ---------- |
| $IR_a$ | Inhalation Rate, adult ($m^3$/day) | 20 | USEPA, 1991a |
| $EF_{inh}$ | Exposure Frequency, inhalation (days/year) | 33 | COP, 1998 |
| $ED_a$ | Exposure Duration, adult (years) | 30 | USEPA, 1991a |
| $SF_i$ | Slope Factor, inhalation (1/(mg/kg·d)) | Chemical-Specific | IRIS, HEAST, or NCEA |
| CF1 | $10^6$ (mg/kg) | 1,000,000 | ---------- |
| Ki | Overall mass transfer, coefficient of i (cm/sec) | Chemical-Specific | USEPA, 1995 |
| CF2 | $10^4$ ($cm^2/m^2$) | 10,000 | ---------- |
| CF3 | $10^3$ (mg/g) | 1,000 | ---------- |

**Table 3.1.1.2**
**LANDSCAPE FLOOD IRRIGATION**

**Equation 2: Adult inhalation of volatile organic compounds, systemic toxicity**

$$Cw_1(\mu g/L) = \frac{HQ \times AT_{nc} \times BW_a \times Q/C \times RfD_i \times CF5 \times CF4}{IR_a \times IT_{inh} \times EF_{inh} \times ED_a \times CF1 \times Ki \times CF2 \times CF3}$$

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| HQ | Hazard Quotient, (unitless) | 1 | ADHS, 1997 |
| $AT_{nc}$ | Averaging Time, noncancer (days) | 10950 | USEPA 1989 |
| $BW_a$ | Body Weight, adult (kg) | 70 | USEPA 1989 |
| Q/C | Inverse of mean concentration at the center of a 0.5 body of water ($mg/m^2 \cdot sec$ per $kg/m^3$) | 68800 | USEPA, 1996 |
| $RfD_i$ | Reference Dose, inhalation (mg/kg-d) | Chemical-Specific | IRIS, HEAST, OR NCEA |
| CF5 | $10^3$ (μg/mg) | 1000 | ---------- |
| CF4 | $10^6$ (mg $cm^3$/g L) | 1000000 | ---------- |
| $IR_a$ | Inhalation Rate, adult ($m^3$/day) | 20 | USEPA 1991a |
| $IT_{inh}$ | Irrigation Time, adult ((1 hours/day)*.041d/hr)) | 0.1666666 | ADHS, 1998 |
| $EF_{inh}$ | Exposure Frequency, inhalation (days/year) | 33 | COP, 1998 |
| $ED_a$ | Exposure Duration, adult (years) | 30 | USEPA 1991a |
| CF1 | $10^6$ (mg/kg) | 1000000 | ---------- |
| Ki | Overall mass transfer, coefficient of i (cm/sec) | Chemical-Specific | USEPA 1995 |
| CF2 | $10^4$ ($cm^2/m^2$) | 10000 | ---------- |
| CF3 | $10^3$ (mg/g) | 1000 | ---------- |

**Table 3.1.1.2**
**LANDSCAPE FLOOD IRRIGATION**

$$Cw_2(\mu g/L) = \frac{Risk \times AT_c \times BW_a \times CF5}{IR_w \times IT_{ing} \times EF_{ing} \times ED_a \times SF_o}$$

**Equation 3 : Adult ingestion of volatile organic compounds, cancer**

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| Risk | Excess Lifetime Cancer Risk, (unitless) | 1.0E-05<br>1.0E-06 | ADHS, 1997 |
| $AT_c$ | Averaging Time, cancer (days) | 25550 | USEPA 1989 |
| $BW_a$ | Body Weight, (adult) kg | 70 | USEPA 1989 |
| CF5 | $10^3$ (μg/mg) | 1000 | ---------- |
| $IR_w$ | Ingestion Rate, water (L/hour) | 0.05 | USEPA 1991a |
| $IT_{ing}$ | Irrigation Time, ingestion (hours/day) | 1 | ADHS, 1998 |
| $EF_{ing}$ | Exposure Frequency, ingestion (days/year) | 33 | COP, 1998 |
| $ED_a$ | Exposure Duration, adult (years) | 30 | USEPA 1991a |
| $SF_o$ | Slope Factor, oral (1/(mg/kg·d)) | Chemical-Specific | IRIS, HEAST, or NCEA |

**Table 3.1.1.2**
**LANDSCAPE FLOOD IRRIGATION**

$$Cw_2(\mu g/L) = \frac{HQ \times BW_a \times AT_{nc} \times RfD_o \times CF5}{IR_w \times IT_{ing} \times EF_{ing} \times ED_a}$$

**Equation 4 : Adult ingestion of volatile organic compounds, noncancer**

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| HQ | Hazard Quotient, (unitless) | 1 | ADHS, 1997 |
| $BW_a$ | Body Weight, adult (kg) | 70 | USEPA 1989 |
| $AT_{nc}$ | Averaging Time, noncancer (days) | 10950 | USEPA 1989 |
| $RfD_o$ | Reference Dose, oral (mg/kg-d) | Chemical-Specific | IRIS, HEAST, OR NCEA |
| CF5 | $10^3$ (μg/mg) | 1000 | ---------- |
| $IR_w$ | Ingestion Rate, adult (L/hour) | 0.05 | USEPA 1991a |
| $IT_{ing}$ | Irrigation Time, (hours/day) | 1 | ADHS, 1998 |
| $EF_{ing}$ | Exposure Frequency, ingestion (days/year) | 33 | COP, 1998 |
| $ED_a$ | Exposure Duration, adult (years) | 30 | USEPA 1991a |

**Table 3.1.1.2**
**LANDSCAPE FLOOD IRRIGATION**

$$Cw_3(\mu g/L) = \frac{Risk \times BW_a \times AT_c \times CF5}{SA_a \times Kp \times IT_{der} \times EF_{der} \times ED_a \times CF6 \times SF_o}$$

**Equation 5: Adult dermal contact with volatile organic compounds, cancer**

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| Risk | Excess Lifetime Cancer Risk, (unitless) | 1.0E-05<br>1.0E-06 | ADHS, 1997 |
| $BW_a$ | Body Weight, (kg) | 70 | USEPA 1989 |
| $AT_c$ | Averaging Time, cancer (days) | 25550 | USEPA 1989 |
| CF5 | $10^3$ (μg/mg) | 1000 | ---------- |
| $SA_a$ | Skin Surface Area, adult ($cm^2$) | 5000 | USEPA, 1992 |
| Kp | Permeability Coefficient, (cm/hour) | Chemical-Specific | USEPA, 1992 |
| $IT_{der}$ | Irrigation Time, dermal (hours) | 1 | ADHS, 1998 |
| $EF_{der}$ | Exposure Frequency, dermal (days/year) | 33 | ADHS, 1998 |
| $ED_a$ | Exposure Duration, adult (years) | 30 | USEPA 1991a |
| CF6 | $10^{-3}$ ($L/cm^3$) | 0.001 | ---------- |
| $SF_o$ | Slope Factor, oral, (1/(mg/kg-d)) | Chemical-Specific | IRIS, HEAST, or NCEA |

**Table 3.1.1.2**
## LANDSCAPE FLOOD IRRIGATION

**Equation 6: Adult dermal contact with volatile organic compounds, noncancer**

$$Cw_3(\mu g/L) = \frac{HQ \times BW_a \times AT_{nc} \times RfD_o \times CF5}{SA_a \times Kp \times IT_{der} \times EF_{der} \times ED_a \times CF6}$$

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| HQ | Hazard Quotient, (unitless) | 1 | ADHS, 1997 |
| $BW_a$ | Body Weight, (adult) kg | 70 | USEPA 1989 |
| $AT_{nc}$ | Averaging Time, noncancer (days) | 10950 | USEPA 1989 |
| $RfD_o$ | Reference Dose, oral, (mg/kg-d) | Chemical-Specific | IRIS, HEAST, or NCEA |
| CF5 | $10^3$ (μg/mg) | 1000 | ---------- |
| $SA_a$ | Skin Surface Area, adult ($cm^2$) | 5000 | USEPA, 1992 |
| Kp | Permeability Coefficient (cm/hour) | Chemical-Specific | USEPA, 1992 |
| $IT_{der}$ | Irrigation Time, dermal (hours/day) | 1 | ADHS, 1998 |
| $EF_{der}$ | Exposure Frequency, dermal (days/year) | 33 | COP, 1998 |
| $ED_a$ | Exposure Duration, adult (years) | 30 | USEPA 1991a |
| CF6 | $10^{-3}$ ($L/cm^3$) | 0.001 | ---------- |

**Table 3.1.2**
**LANDSCAPE FLOOD IRRIGATION**
**Occupational Scenario**

**Equation 1: Occupational inhalation of volatile organic compounds, cancer**

where: F = flux in $mg/m^2 \cdot sec$

$$Cw_1(\mu g/L) = \frac{Risk \times AT_c \times BW_a \times Q/C \times CF5 \times CF4}{IR_a \times EF_{inh} \times ED_a \times SF_i \times CF1 \times Ki \times CF2 \times CF3}$$

VF = $kg/m^3$

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| Risk | Excess Lifetime Cancer Risk, (unitless) | 1.0E-05<br>1.0E-06 | ADHS, 1997 |
| $AT_c$ | Averaging Time, cancer (days) | 25550 | USEPA 1989 |
| $BW_a$ | Body Weight, (adult) kg | 70 | USEPA 1989 |
| Q/C | Inverse of mean concentration at the center of a 0.5 body of water ($mg/m^2 \cdot sec/kg/m^3$) | 68800 | USEPA, 1996 |
| CF5 | $10^3$ (μg/mg) | 1000 | ---------- |
| CF4 | $10^6$ (mg $cm^3$/g L) | 1000000 | ---------- |
| $IR_a$ | Inhalation Rate, adult ($m^3$/day) | 20 | USEPA 1991a |
| $EF_{inh}$ | Exposure Frequency, inhalation (days/year) | 250 | USEPA 1991a |
| $ED_a$ | Exposure Duration, adult (years) | 25 | USEPA 1991a |
| $SF_i$ | Slope Factor, inhalation (1/(mg/kg·d)) | Chemical-Specific | IRIS, HEAST, or NCEA |
| CF1 | $10^6$ (mg/kg) | 1000000 | ---------- |
| Ki | Overall mass transfer, coefficient of i (cm/sec) | Chemical-Specific | USEPA 1995 |
| CF2 | $10^4$ ($cm^2/m^2$) | 10000 | ---------- |
| CF3 | $10^3$ (mg/g) | 1000 | ---------- |

**Table 3.1.2**
**LANDSCAPE FLOOD IRRIGATION**

**Equation 2: Occupational inhalation of volatile organic compounds, systemic toxicity**

$$Cw_1(\mu g/L) = \frac{HQ \times AT_{nc} \times BW_a \times Q/C \times RfD_i \times CF5 \times CF4}{IR_a \times EF_{inh} \times ED_a \times CF1 \times Ki \times CF2 \times CF3}$$

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| HQ | Hazard Quotient, (unitless) | 1 | ADHS, 1997 |
| $AT_{nc}$ | Averaging Time, noncancer (days) | 9125 | USEPA 1989 |
| $BW_a$ | Body Weight, adult (kg) | 70 | USEPA 1989 |
| Q/C | Inverse of mean concentration at the center of a 0.5 body of water ($mg/m^2 \cdot sec$ per $kg/m^3$) | 68800 | USEPA, 1996 |
| $RfD_i$ | Reference Dose, inhalation (mg/kg-d) | Chemical-Specific | IRIS, HEAST, OR NCEA |
| CF5 | $10^3$ ($\mu g/mg$) | 1000 | ---------- |
| CF4 | $10^6$ ($mg\ cm^3/g\ L$) | 1000000 | ---------- |
| I $R_a$ | Inhalation Rate, adult ($m^3$/day) | 20 | USEPA 1991a |
| $EF_{inh}$ | Exposure Frequency, inhalation (days/year) | 250 | USEPA 1991a |
| $ED_a$ | Exposure Duration, adult (years) | 25 | USEPA 1991a |
| CF1 | $10^6$ (mg/kg) | 1000000 | ---------- |
| Ki | Overall mass transfer, coefficient of i (cm/sec) | Chemical-Specific | USEPA 1995 |
| CF2 | $10^4$ ($cm^2/m^2$) | 10000 | ---------- |
| CF3 | $10^3$ (mg/g) | 1000 | ---------- |

**Table 3.1.2**
**LANDSCAPE FLOOD IRRIGATION**

$$Cw_2(\mu g/L) = \frac{Risk \times AT_c \times BW_a \times CF5}{IR_w \times IT_{ing} \times EF_{ing} \times ED_a \times SF_o}$$

**Equation 3: Occupational ingestion of volatile organic compounds, cancer**

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| Risk | Excess Lifetime Cancer Risk, (unitless) | 1.0E-05<br>1.0E-06 | ADHS, 1997 |
| $AT_c$ | Averaging Time, cancer (days) | 25550 | USEPA 1989 |
| $BW_a$ | Body Weight, (adult) kg | 70 | USEPA 1989 |
| CF5 | $10^3$ (μg/mg) | 1000 | ---------- |
| $IR_w$ | Ingestion Rate, water (L/hour) | 0.05 | USEPA 1991a |
| $IT_{ing}$ | Irrigation Time, ingestion (hour/day) | 8 | ADHS, 1998 |
| $EF_{ing}$ | Exposure Frequency, ingestion (days/year) | 250 | USEPA 1991a |
| $ED_a$ | Exposure Duration, adult (years) | 25 | USEPA 1991a |
| $SF_o$ | Slope Factor, oral (1/(mg/kg·d)) | Chemical-Specific | IRIS, HEAST, or NCEA |

**Table 3.1.2**
**LANDSCAPE FLOOD IRRIGATION**

$$Cw_2(\mu g/L) = \frac{HQ \times BW_a \times AT_{nc} \times RfD_o \times CF5}{IR_w \times IT_{ing} \times EF_{ing} \times ED_a}$$

**Equation 4: Occupational ingestion of volatile organic compounds, noncancer**

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| HQ | Hazard Quotient, (unitless) | 1 | ADHS, 1997 |
| $BW_a$ | Body Weight, adult (kg) | 70 | USEPA 1989 |
| $AT_{nc}$ | Averaging Time, noncancer (days) | 9125 | USEPA 1989 |
| $RfD_o$ | Reference Dose, oral (mg/kg-d) | Chemical-Specific | IRIS, HEAST, OR NCEA |
| CF5 | $10^3$ (μg/mg) | 1000 | ---------- |
| $IR_w$ | Ingestion Rate, adult (L/hour) | 0.05 | USEPA 1991a |
| $IT_{ing}$ | Irrigation Time, ingestion (hours/day) | 8 | ADHS, 1998 |
| $EF_{ing}$ | Exposure Frequency, ingestion (days/year) | 250 | USEPA 1991a |
| $ED_a$ | Exposure Duration, adult (years) | 25 | USEPA 1991a |

**Table 3.1.2**
**LANDSCAPE FLOOD IRRIGATION**

$$Cw_3(\mu g/L) = \frac{Risk \times BW_a \times AT_c \times CF5}{SA_a \times Kp \times IT_{der} \times EF_{der} \times ED_a \times CF6 \times SF_o}$$

**Equation 5: Occupational dermal contact with volatile organic compounds, cancer**

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| Risk | Excess Lifetime Cancer Risk, (unitless) | 1.0E-05<br>1.0E-06 | ADHS, 1997 |
| $BW_a$ | Body Weight, (kg) | 70 | USEPA 1989 |
| $AT_c$ | Averaging Time, cancer (days) | 25550 | USEPA 1989 |
| CF5 | $10^3$ (μg/mg) | 1000 | ---------- |
| $SA_a$ | Skin Surface Area, adult ($cm^2$) | 5000 | USEPA, 1992 |
| Kp | Permeability Coefficient, (cm/hour) | Chemical-Specific | USEPA, 1992 |
| $IT_{der}$ | Irrigation Time, dermal (hours/day) | 8 | ADHS, 1998 |
| $EF_{der}$ | Exposure Frequency, dermal (days/year) | 250 | ADHS, 1998 |
| $ED_a$ | Exposure Duration, adult (years) | 25 | USEPA 1991a |
| CF6 | $10^{-3}$ ($L/cm^3$) | 0.001 | ---------- |
| $SF_o$ | Slope Factor, oral (1/(mg/kg-d)) | Chemical-Specific | IRIS, HEAST, or NCEA |

**Table 3.1.2**
**LANDSCAPE FLOOD IRRIGATION**

**Equation 6: Occupational dermal contact with volatile organic compounds, noncancer**

$$Cw_3(\mu g/L) = \frac{HQ \times BW_a \times AT_{nc} \times RfD_o \times CF5}{SA_a \times Kp \times IT_{der} \times EF_{der} \times ED_a \times CF6}$$

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| HQ | Hazard Quotient, (unitless) | 1 | ADHS, 1997 |
| $BW_a$ | Body Weight, (adult) kg | 70 | USEPA 1989 |
| $AT_{nc}$ | Averaging Time, noncancer (days) | 9125 | USEPA 1989 |
| $RfD_o$ | Reference Dose, oral, (mg/kg-d) | Chemical-Specific | IRIS, HEAST, or NCEA |
| CF5 | $10^3$ (μg/mg) | 1000 | ---------- |
| $SA_a$ | Skin Surface Area, adult ($cm^2$) | 5000 | USEPA, 1992 |
| Kp | Permeability Coefficient (cm/hour) | Chemical-Specific | USEPA, 1992 |
| $IT_{der}$ | Irrigation Time, dermal (hours/day) | 8 | ADHS, 1998 |
| $EF_{der}$ | Exposure Frequency, dermal (days/year) | 250 | ADHS, 1998 |
| $ED_a$ | Exposure Duration, adult (years) | 25 | USEPA 1991a |
| CF6 | $10^{-3}$ ($L/cm^3$) | 0.001 | ---------- |

**Table 3.2.1.1**
**LANDSCAPE SPRAY IRRIGATION**
**Childhood Residential Exposure Scenario**

**Equation 1: Childhood inhalation of volatile organic compounds, cancer**

$$Cw_1(\mu g/L) = \frac{Risk \times BW_{ch} \times AT_c \times AV \times CF1}{IR_{ch} \times EF_{inh} \times ED_{ch} \times SF_i \times LW \times ET_{inh} \times CF3}$$

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| Risk | Excess Lifetime Cancer Risk, (unitless) | 1.0E-05<br>1.0E-06 | ADHS, 1997 |
| $BW_{ch}$ | Body Weight, child (kg) | 15 | USEPA, 1989 |
| ATc | Averaging Time, cancer (days) | 25550 | USEPA, 1989 |
| AV | Air Volume, ($m^3$/hour) | 3200000 | ---------- |
| CF1 | $10^3$ (µg/mg) | 1000 | ---------- |
| $IR_{ch}$ | Inhalation Rate, child, ($m^3$/day) | 10 | USEPA, 1990 |
| $EF_{inh}$ | Exposure Frequency, inhalation, (days/year) | 365 | USEPA 1991a |
| $ED_{ch}$ | Exposure Duration, child (years) | 6 | USEPA 1991a |
| $SF_i$ | Slope Factor, inhalation (1/(mg/kg·d)) | Chemical-Specific | IRIS, HEAST, or NCEA |
| LW | Liters of water, (L/hour applied) | 19278 | COP, 1998 |
| $ET_{inh}$ | Exposure Time, inhalation (hours/day) | 1 | ADHS, 1998 |
| CF3 | (days/hour) | 0.04 | ---------- |

**Table 3.2.1.1**
**LANDSCAPE SPRAY IRRIGATION**

$$Cw_1(\mu g/L) = \frac{HQ \times BW_{ch} \times AT_{nc} \times AV \times CF1 \times RfD_i}{IR_{ch} \times EF_{inh} \times ED_{ch} \times LW \times ET_{inh} \times CF3}$$

**Equation 2: Childhood inhalation of volatile organic compounds, systemic toxicity**

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| HQ | Hazard Quotient (unitless) | 1 | ADHS, 1998 |
| $BW_{ch}$ | Body Weight, child (kg) | 15 | USEPA, 1989 |
| $AT_{nc}$ | Averaging Time, noncancer (days) | 2190 | USEPA, 1989 |
| AV | Air Volume, ($m^3$/hour) | 3200000 | ---------- |
| CF1 | $10^3$ (µg/mg) | 1000 | ---------- |
| $RfD_i$ | Reference Dose, inhalation (mg/kg-d) | Chemical-Specific | IRIS, HEAST, or NCEA |
| $IR_{ch}$ | Ingestion Rate, child ($m^3$/day) | 10 | USEPA, 1990 |
| $EF_{inh}$ | Exposure Frequency, inhalation (days/year) | 365 | USEPA, 1991a |
| $ED_{ch}$ | Exposure Duration, child (years) | 6 | USEPA, 1991a |
| LW | Liters of water, (L/hour applied) | 19278 | COP, 1998 |
| $ET_{inh}$ | Exposure Time, inhalation (hours/day) | 1 | ADHS, 1998 |
| CF3 | (hours/day) | 0.04 | ---------- |

**Table 3.2.1.1**
## LANDSCAPE SPRAY IRRIGATION

**Equation 3: Childhood ingestion of volatile organic compounds, cancer**

$$Cw_2(\mu g/L) = \frac{Risk \times BW_{ch} \times AT_c \times CF3}{IR_w \times ET_{ing} \times EF_{ing} \times ED_{ch} \times SF_o}$$

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| Risk | Excess Lifetime Cancer Risk, (unitless) | 1.0E-05<br>1.0E-06 | ADHS, 1997 |
| $BW_{ch}$ | Body Weight, child (kg) | 15 | USEPA, 1989 |
| $AT_c$ | Averaging Time, cancer (days) | 25550 | USEPA, 1989 |
| CF3 | $10^3$ (µg/mg) | 1000 | ---------- |
| $IR_w$ | Ingestion Rate, water (L/hour) | 0.05 | USEPA, 1990 |
| $ET_{ing}$ | Exposure Time, ingestion (hours/day) | 1 | ADHS, 1998 |
| $EF_{ing}$ | Exposure Frequency, ingestion (days/year) | 210 | USEPA 1991a |
| $ED_{ch}$ | Exposure Duration, child (years) | 6 | USEPA 1991a |
| $SF_o$ | Slope Factor, oral (1/(mg/kg-day) | Chemical-Specific | IRIS, HEAST, or NCEA |

**Table 3.2.1.1**
## LANDSCAPE SPRAY IRRIGATION

**Equation 4: Childhood ingestion of volatile organic compounds, noncancer**

$$Cw_2(\mu g/L) = \frac{HQ \; x \; BW_{ch} \; x \; AT_{nc} \; x \; RfD_o}{IR_w \; x \; ET_{ing} \; x \; EF_{ing} \; x \; ED_{ch} \; x \; CF3}$$

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| HQ | Hazard Quotient, (unitless) | 1 | USEPA, 1989 |
| $BW_{ch}$ | Body Weight, child (kg) | 15 | USEPA, 1989 |
| $AT_{nc}$ | Averaging Time, noncancer (days) | 2190 | USEPA, 1989 |
| $RfD_o$ | Reference Dose, oral (mg/kg-d) | Chemical-Specific | USEPA, 1989 |
| $IR_w$ | Ingestion Rate, water (L/hr) | 0.05 | USEPA, 1990 |
| $ET_{ing}$ | Exposure Time, ingestion (hours/day) | 1 | ADHS, 1998 |
| $EF_{ing}$ | Exposure Frequency, ingestion (days/year) | 210 | USEPA 1991a |
| $ED_{ch}$ | Exposure Duration, child (years) | 6 | USEPA, 1991a |
| CF3 | (days/hour) | 0.04 | ---------- |

**Table 3.2.1.1**
**LANDSCAPE SPRAY IRRIGATION**

$$Cw_3(\mu g/L) = \frac{Risk \times BW_{ch} \times AT_c \times CF1}{SA_{ch} \times Kd \times ET_{der} \times EF_{der} \times ED_{ch} \times SF_o \times CF2}$$

**Equation 5: Childhood dermal contact with volatile organic compounds, cancer**

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| Risk | Excess Lifetime Cancer Risk, (unitless) | 1.0E-05<br>1.0E-06 | ADHS, 1997 |
| $BW_{ch}$ | Body Weight, child (kg) | 15 | USEPA, 1989 |
| $AT_c$ | Averaging Time, cancer (days) | 25550 | USEPA, 1989 |
| CF1 | $10^3$ (µg/mg) | 1000 | ---------- |
| $SA_{ch}$ | Skin Surface Area, child ($cm^2$) | 2000 | USEPA, 1992 |
| Kd | Permeability Coefficient (cm/hr) | Chemical-Specific | USEPA, 1992 |
| $ET_{der}$ | Exposure Time, dermal (hours/day) | 1 | ADHS, 1998 |
| $EF_{der}$ | Exposure Frequency, dermal (days/year) | 210 | USEPA 1991a |
| $ED_{ch}$ | Exposure Duration, child (years) | 6 | USEPA 1991a |
| $SF_o$ | Slope Factor, oral (1/(mg/kg-day)) | Chemical-Specific | IRIS, HEAST, or NCEA |
| CF2 | $10^{-3}$ ($L/m^3$) | 0.001 | ---------- |

**Table 3.2.1.1**
**LANDSCAPE SPRAY IRRIGATION**

**Equation 6: Childhood dermal contact of volatile organic compounds, noncancer**

$$Cw_3(\mu g/L) = \frac{HQ \times BW_{ch} \times AT_{nc} \times RfD_o \times CF1}{SA_{ch} \times Kd \times ET_{der} \times EF_{der} \times ED_{ch} \times CF2}$$

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| HQ | Hazard Quotient, (unitless) | 1 | ADHS, 1997 |
| $BW_{ch}$ | Body Weight, child (kg) | 15 | USEPA, 1989 |
| $AT_{nc}$ | Averaging Time, noncancer (days) | 2190 | USEPA, 1989 |
| $RfD_o$ | Reference Dose, oral (mg/kg-d) | Chemical-Specific | USEPA, 1989 |
| CF1 | $10^3$ (µg/mg) | 1000 | ---------- |
| $SA_{ch}$ | Skin Surface Area, child ($cm^2$) | 2000 | USEPA, 1992 |
| Kd | Permeability Coefficient (cm/hr) | Chemical-Specific | USEPA, 1992 |
| $ET_{der}$ | Exposure Time, dermal (hours/day) | 1 | ADHS, 1998 |
| $EF_{der}$ | Exposure Frequency, dermal (days/year) | 210 | USEPA 1991a |
| $ED_{ch}$ | Exposure Duration, child (years) | 6 | USEPA 1991a |
| CF2 | $10^{-3}$ ($L/m^3$) | 0.001 | ---------- |

**Table 3.2.1.2**
**LANDSCAPE SPRAY IRRIGATION**
**Adult Residential Exposure Scenario**

$$Cw_1(\mu g/L) = \frac{Risk \times AT_c \times BW_a \times AV \times CF1}{IR_a \times EF_{inh} \times ED_a \times SF_i \times LW \times ET_{inh} \times CF3}$$

**Equation 1: Adult inhalation of volatile organic compounds, cancer**

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| Risk | Excess Lifetime cancer Risk, (unitless) | 1.0E-05<br>1.0E-06 | ADHS, 1997 |
| $AT_c$ | Averaging Time, cancer (days) | 25550 | USEPA, 1989 |
| $BW_a$ | Body Weight, adult (kg) | 70 | USEPA, 1991a |
| AV | Air Volume, ($m^3$/hour) | 3200000 | Box Model |
| CF1 | $10^3$ (μg/mg) | 1000 | ---------- |
| $IR_a$ | Inhalation Rate, ($m^3$/day) | 20 | USEPA, 1991a |
| $EF_{inh}$ | Exposure Frequency, inhalation (days/year) | 365 | ADHS, 1998 |
| $ED_a$ | Exposure Duration, adult (years) | 30 | USEPA, 1991a |
| $SF_i$ | Slope Factor, inhalation (1/(mg/kg·d) | Chemical Specific | IRIS, HEAST, or NCEA |
| LW | Liters of Water, (Liters/hour water applied) | 19278 | ---------- |
| $ET_{inh}$ | Exposure Time, inhalation (hours/day) | 0.5 | ADHS, 1998 |
| CF3 | (days/hour) | 0.04 | ---------- |

**Table 3.2.1.2**
**LANDSCAPE SPRAY IRRIGATION**

**Equation 2: Adult inhalation of volatile organic compounds, systemic toxicity**

$$Cw_1(\mu g/L) = \frac{HQ \; x \; AT_{nc} \; x \; BW_a \; x \; AV \; x \; RfD_i \; x \; CF1}{IR_a \; x \; EF_{inh} \; x \; ED_a \; x \; LW \; x \; ET_{inh} \; x \; CF3}$$

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| HQ | Hazard Quotient noncancer, (unitless) | 1 | ADHS, 1997 |
| $AT_{nc}$ | Averaging Time, noncancer (days) | 10950 | USEPA, 1989 |
| $BW_a$ | Body Weight, adult (kg) | 70 | USEPA, 1989 |
| AV | Air Volume, ($m^3$/hour) | 3200000 | Box Model |
| $RfD_i$ | Reference Dose, inhalation (mg/kg-d) | Chemical Specific | IRIS, HEAST, or NCEA |
| CF1 | $10^3$ (μg/mg) | 1000 | ---------- |
| $IR_a$ | Inhalation Rate, adult ($m^3$/day) | 20 | USEPA, 1991a |
| $EF_{inh}$ | Exposure Frequency, inhalation (days/year) | 365 | USEPA, 1991a |
| $ED_a$ | Exposure Duration, adult (years) | 30 | USEPA, 1991a |
| LW | Liters of Water, (Liters/hour water applied) | 19278 | COP, 1998 |
| $ET_{inh}$ | Exposure Time, inhalation (hours/day) | 0.5 | ADHS, 1998 |
| CF3 | (days/hour) | 0.04 | ---------- |

**Table 3.2.1.2**
## LANDSCAPE SPRAY IRRIGATION

$$Cw_2(\mu g/L) = \frac{Risk \; x \; AT_c \; x \; BW_a \; x \; CF1}{IR_w \; x \; ET_{ing} \; x \; EF_{ing} \; x \; ED_a \; x \; SF_o}$$

**Equation 3 : Adult ingestion of volatile organic compounds, cancer**

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| Risk | Excess Lifetime cancer Risk, (unitless) | 1.0E-05<br>1.0E-06 | ADHS, 1997 |
| $AT_c$ | Averaging Time, cancer (days) | 25550 | USEPA, 1989 |
| $BW_a$ | Body Weight, adult (kg) | 70 | USEPA, 1989 |
| CF1 | $10^3$ (μg/mg) | 1000 | ---------- |
| $IR_w$ | Ingestion Rate, water (L/hour) | .05 | USEPA, 1990 |
| $ET_{ing}$ | Exposure Time, ingestion (hours/day) | 0.5 | ADHS, 1998 |
| $EF_{ing}$ | Exposure Frequency, ingestion (days/year) | 52 | ADHS, 1998 |
| $ED_a$ | Exposure Duration, adult (years) | 30 | USEPA, 1991a |
| $SF_o$ | Slope Factor, oral (1/(mg/kg·d) | Chemical-Specific | IRIS, HEAST, or NCEA |

**Table 3.2.1.2**
**LANDSCAPE SPRAY IRRIGATION**

$$Cw_2(\mu g/L) = \frac{HQ \; x \; BW_a \; x \; AT_{nc} \; x \; RfD_o \; x \; CF1}{IR_w \; x \; ET_{ing} \; x \; EF_{ing} \; x \; ED_a}$$

**Equation 4 : Adult ingestion of volatile organic compounds, noncancer**

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| HQ | Hazard Quotient noncancer, (unitless) | 1 | ADHS, 1997 |
| $BW_a$ | Body Weight, adult (kg) | 70 | USEPA, 1989 |
| $AT_{nc}$ | Averaging Time, noncancer (days) | 10950 | USEPA, 1989 |
| $RfD_o$ | Reference Dose, inhalation (mg/kg-d) | Chemical -Specific | IRIS, HEAST, or NCEA |
| CF1 | $10^3$ (μg/mg) | 1000 | ---------- |
| $IR_w$ | Ingestion Rate, water (L/hour) | 0.05 | USEPA, 1990 |
| $ET_{ing}$ | Exposure Time, ingestion (hours/day) | 0.5 | ADHS, 1998 |
| $EF_{ing}$ | Exposure Frequency, ingestion (days/year) | 52 | USEPA, 1991a |
| $ED_a$ | Exposure Duration, adult (years) | 30 | USEPA, 1991a |

**Table 3.2.1.2**
**LANDSCAPE SPRAY IRRIGATION**

$$Cw_3(\mu g/L) = \frac{Risk \times BW_a \times AT_c \times CF1}{SA_a \times Kd \times ET_{der} \times EF_{der} \times ED_a \times CF2 \times SF_o}$$

**Equation 5: Adult dermal contact with volatile organic compounds, cancer**

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| Risk | Excess Lifetime cancer Risk, (unitless) | 1.0E-05<br>1.0E-06 | ADHS, 1997 |
| $BW_a$ | Body Weight, adult (kg) | 70 | USEPA, 1991a |
| $AT_c$ | Averaging Time, cancer (days) | 25550 | USEPA, 1989 |
| CF1 | $10^3$ (μg/mg) | 1000 | ---------- |
| $SA_a$ | Skin Surface Area, adult ($cm^3$) | 5000 | USEPA, 1992 |
| Kd | Skin Permeability Coefficient (cm/hour) | Chemical Specific | USEPA, 1992 |
| $ET_{der}$ | Exposure Time, dermal (hour/day) | 0.5 | ADHS, 1998 |
| $EF_{der}$ | Exposure Frequency, dermal (days/year) | 52 | ADHS, 1998 |
| $ED_a$ | Exposure Duration, adult (years) | 30 | USEPA, 1991a |
| CF2 | $10^{-3}$ ($L/cm^3$) | 0.001 | ---------- |
| $SF_o$ | Slope Factor, oral (1/(mg/kg·d) | Chemical Specific | IRIS, HEAST, or NCEA |

**Table 3.2.1.2**
**LANDSCAPE SPRAY IRRIGATION**

**Equation 6 : Adult dermal contact with volatile organic compounds, noncancer**

$$Cw_3(\mu g/L) = \frac{HQ \times BW_a \times AT_{nc} \times RfD_o \times CF1}{SA_a \times Kd \times ET_{der} \times EF_{der} \times ED_a \times CF2}$$

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| HQ | Hazard Quotient noncancer, (unitless) | 1 | ADHS, 1997 |
| $BW_a$ | Body Weight, adult (kg) | 70 | USEPA, 1989 |
| $AT_{nc}$ | Averaging Time, noncancer (days) | 10950 | USEPA, 1989 |
| $RfD_o$ | Reference Dose, inhalation (mg/kg-d) | Chemical -Specific | IRIS, HEAST, or NCEA |
| CF1 | $10^3$ (μg/mg) | 1000 | ---------- |
| $SA_a$ | Skin Surface Area ($cm^2$) | 5000 | USEPA, 1992 |
| Kd | Skin Permeability Coefficient (cm/hour) | Chemical-Specific | USEPA, 1992 |
| $ET_{der}$ | Exposure Time, dermal (hours/day) | 0.5 | ADHS, 1998 |
| $EF_{der}$ | Exposure Frequency, dermal (days/year) | 52 | ADHS, 1998 |
| $ED_a$ | Exposure Duration, adult (years) | 30 | USEPA, 1991 |
| CF2 | $10^{-3}$ ($L/cm^3$) | 0.001 | ---------- |

**Table 3.2.2**
**LANDSCAPE SPRAY IRRIGATION**
**Occupational Exposure**

$$Cw_1(\mu g/L) = \frac{Risk \times BW_a \times AT_c \times AV \times CF1}{IR_a \times EF_{inh} \times ED_a \times SF_i \times LW \times ET_{inh} \times CF3}$$

**Equation 1: Occupational inhalation of volatile organic compounds, cancer**

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| Risk | Excess Lifetime Cancer Risk, (unitless) | 1.0E-05<br>1.0E-06 | ADHS, 1997 |
| $BW_a$ | Body Weight, adult (kg) | 70 | USEPA, 1989 |
| ATc | Averaging Time, cancer (days) | 25550 | ADHS, 1989 |
| AV | Air Volume, ($m^3$/hour) | 3200000 | ---------- |
| CF1 | $10^3$ (μg/mg) | 1000 | ---------- |
| $IR_a$ | Inhalation Rate, adult ($m^3$/day) | 20 | USEPA, 1991a |
| $EF_{inh}$ | Exposure Frequency, inhalation | 250 | USEPA, 1991a |
| $ED_a$ | Exposure Duration, adult occupational (years) | 25 | ADHS, 1998 |
| $SF_i$ | Slope Factor, inhalation (1/(mg/kg·d)) | Chemical-Specific | IRIS, HEAST, or NCEA |
| LW | Liters of water, (L/hour water applied) | 19278 | COP, 1998 |
| $ET_{inh}$ | Exposure Time, inhalation (hours/day) | 8 | ADHS, 1998 |
| CF3 | (days/hour) | 0.04 | ---------- |

**Table 3.2.2**
**LANDSCAPE SPRAY IRRIGATION**

**Equation 2: Occupational inhalation of volatile organic compounds, systemic toxicity**

$$Cw_1(\mu g/L) = \frac{HQ \times AT_{nc} \times BW_a \times AV \times RfD_i \times CF1}{IR_a \times EF_{inh} \times ED_a \times LW \times ET_{inh} \times CF3}$$

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| HQ | Hazard Quotient, (unitless) | 1 | ADHS, 1997 |
| $AT_{nc}$ | Averaging Time, noncancer (days) | 9125 | USEPA, 1989 |
| $BW_a$ | Body Weight, adult (kg) | 70 | USEPA, 1989 |
| AV | Air Volume, ($m^3$/hour) | 3200000 | ---------- |
| $RfD_i$ | Reference Dose, inhalation (mg/kg-d) | Chemical-Specific | IRIS, HEAST, or NCEA |
| CF1 | $10^3$ (μg/mg) | 1000 | ---------- |
| $IR_a$ | Inhalation Rate, adult ($m^3$/day) | 20 | USEPA, 1991a |
| $EF_{inh}$ | Exposure Frequency, inhalation | 250 | USEPA, 1991a |
| $ED_a$ | Exposure Duration, adult occupational (years) | 25 | ADHS, 1998 |
| LW | Liters of water, (l/hour water applied) | 19278 | COP, 1998 |
| $ET_{inh}$ | Exposure Time, inhalation (hours/day) | 8 | ADHS, 1998 |
| CF3 | (days/hour) | 0.04 | ---------- |

**Table 3.2.2**
**LANDSCAPE SPRAY IRRIGATION**

$$Cw_2(\mu g/L) = \frac{Risk \times AT_c \times BW_a \times CF1}{IR_w \times ET_{ing} \times EF_{ing} \times ED_a \times SF_o}$$

**Equation 3 : Occupational ingestion of volatile organic compounds, cancer**

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| Risk | Excess Lifetime Cancer Risk, (unitless) | 1.0E-05<br>1.0E-06 | ADHS, 1997 |
| ATc | Averaging Time, cancer (days) | 25550 | USPEA, 1989 |
| $BW_a$ | Body Weight, adult (kg) | 70 | USEPA, 1989 |
| CF1 | $10^3$ (μg/mg) | 1000 | ---------- |
| $IR_w$ | Ingestion Rate, water (liters/hour) | 0.05 | USEPA, 1991a |
| $ET_{ing}$ | Exposure Time, ingestion (hours/day) | 8 | ADHS, 1998 |
| $EF_{ing}$ | Exposure Frequency, ingestion, (days/years) | 250 | USEPA, 1991a |
| $ED_a$ | Exposure Duration, adult occupational (years) | 25 | USEPA, 1991a |
| $SF_o$ | Slope Factor, oral (1/(mg/kg-day) | Chemical-Specific | IRIS, HEAST, or NCEA |

**Table 3.2.2**
**LANDSCAPE SPRAY IRRIGATION**

$$Cw_2(\mu g/L) = \frac{HQ \times BW_a \times AT_{nc} \times RfD_o \times CF1}{IR_w \times ET_{ing} \times EF_{ing} \times ED_a}$$

**Equation 4: Occupational ingestion of volatile organic compounds, noncancer**

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| HQ | Hazard Quotient, (unitless) | 1 | ADHS, 1997 |
| $BW_a$ | Body Weight, adult (kg) | 70 | USEPA, 1989 |
| $AT_{nc}$ | Averaging Time, noncancer (days) | 9125 | USEPA, 1989 |
| $RfD_o$ | Reference Dose, oral (mg/kg-d) | Chemical-Specific | IRIS, HEAST, or NCEA |
| CF1 | $10^3$ (μg/mg) | 1000 | ---------- |
| $IR_w$ | Inhalation Rate, adult (L/hour) | 0.05 | USEPA, 1990 |
| $ET_{ing}$ | Exposure Time, ingestion (hours/day) | 8 | ADHS, 1998 |
| $EF_{ing}$ | Exposure Frequency, ingestion | 250 | USEPA, 1991a |
| $ED_a$ | Exposure Duration, adult occupational (years) | 25 | USEPA, 1991a |

**Table 3.2.2**
**LANDSCAPE SPRAY IRRIGATION**

$$Cw_3(\mu g/L) = \frac{Risk \times BW_a \times AT_c \times CF1}{SA_a \times Kd \times ET_{der} \times EF_{der} \times ED_a \times CF2 \times SF_o}$$

**Equation 5: Occupational dermal contact with volatile organic compounds, cancer**

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| Risk | Excess Lifetime cancer Risk, (unitless) | 1.0E-05<br>1.0E-06 | ADHS, 1997 |
| $BW_a$ | Body Weight, adult (kg) | 70 | USEPA, 1991a |
| $AT_c$ | Averaging Time, cancer (days) | 25550 | USEPA, 1989 |
| CF1 | $10^3$ (μg/mg) | 1000 | ---------- |
| $SA_a$ | Skin Surface Area, adult ($cm^2$) | 5000 | USEPA, 1992 |
| Kd | Skin Permeability Coefficient (cm/hour) | Chemical-Specific | USEPA, 1992 |
| $ET_{der}$ | Exposure Time, dermal (hours/day) | 8 | ADHS, 1998 |
| $EF_{der}$ | Exposure Frequency, dermal (days/year) | 250 | USEPA, 1991a |
| $ED_a$ | Exposure Duration, adult (years) | 25 | USEPA, 1991a |
| CF2 | $10^{-3}$ ($L/cm^3$) | 0.001 | ---------- |
| $SF_o$ | Slope Factor, oral (1/(mg/kg·d)) | Chemical-Specific | IRIS, HEAST, or NCEA |

**Table 3.2.2**
**LANDSCAPE SPRAY IRRIGATION**

**Equation 6 : Occupational dermal contact with volatile organic compounds, noncancer**

$$Cw_3(\mu g/L) = \frac{HQ \; x \; BW_a \; x \; AT_{nc} \; x \; RfD_o \; x \; CF1}{SA_a \; x \; Kd \; x \; ET_{der} \; x \; EF_{der} \; x \; ED_a \; x \; CF2}$$

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| HQ | Hazard Quotient noncancer, (unitless) | 1 | ADHS, 1997 |
| $BW_a$ | Body Weight, adult (kg) | 70 | USEPA, 1989 |
| $AT_{nc}$ | Averaging Time, noncancer (days) | 9125 | USEPA, 1989 |
| $RfD_o$ | Reference Dose, oral (mg/kg-d) | Chemical-Specific | IRIS, HEAST, or NCEA |
| CF1 | $10^3$ (µg/mg) | 1000 | ---------- |
| $SA_a$ | Skin Surface Area ($cm^2$) | 5000 | USEPA, 1992 |
| Kd | Skin Permeability Coefficient (cm/hour) | Chemical-Specific | USEPA, 1992 |
| $ET_{der}$ | Exposure Time, dermal (hours/day) | 8 | ADHS, 1998 |
| $EF_{der}$ | Exposure Frequency, dermal (days/year) | 250 | USEPA, 1991a |
| $ED_a$ | Exposure Duration, adult (years) | 25 | USEPA, 1991a |
| CF2 | $10^{-3}$ ($L/cm^3$) | 0.001 | ---------- |

**Table 4.1.1**
**ORNAMENTAL LAKES**
**Childhood Residential Exposure**

$$Cw_1(\mu g/L) = \frac{Risk \times AT_c \times BW_{ch} \times Q/C \times CF5 \times CF4}{IR_{ch} \times EF_{inh} \times ED_{ch} \times SF_i \times CF1 \times Ki \times CF2 \times CF3}$$

**Equation 1: Childhood inhalation of volatile organic compounds, cancer**

where: F = flux in $mg/m^2 \cdot sec$
VF = $kg/m^3$

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| Risk | Excess Lifetime Cancer Risk, (unitless) | 1.0E-05<br>1.0E-06 | ADHS, 1997 |
| $AT_c$ | Averaging Time, cancer (days) | 25550 | USEPA,1989 |
| $BW_{ch}$ | Body Weight, child (kg) | 15 | USEPA,1989 |
| Q/C | Inverse of mean concentration at the center of a 0.5 body of water ($mg/m^2 \cdot sec$ per $kg/m^3$) | 68800 | USEPA, 1996 |
| CF5 | $10^3$ (µg/mg) | 1000 | ---------- |
| CF4 | $10^6$ (mg $cm^3$/g L) | 1000000 | ---------- |
| $IR_{ch}$ | Inhalation Rate, child ($m^3$/day) | 10 | USEPA,1991a |
| $EF_{inh}$ | Exposure Frequency, inhalation (days/year) | 365 | USEPA,1991a |
| $ED_{ch}$ | Exposure Duration, child (years) | 6 | USEPA,1991a |
| $SF_i$ | Slope Factor, inhalation (1/(mg/kg·d)) | Chemical-Specific | IRIS, HEAST, or NCEA |
| CF1 | $10^6$ (mg/kg) | 1000000 | ---------- |
| Ki | Overall mass transfer, coefficient of i (cm/sec) | Chemical-Specific | USEPA, 1995 |
| CF2 | $10^4$ ($cm^2/m^2$) | 10000 | ---------- |
| CF3 | $10^3$ (mg/g) | 1000 | ---------- |

**Table 4.1.1**
**ORNAMENTAL LAKES**

**Equation 2: Childhood inhalation of volatile organic compounds, systemic toxicity**

$$Cw_1(\mu g/L) = \frac{HQ \times AT_{nc} \times BW_{ch} \times Q/C \times RfD_i \times CF5 \times CF4}{IR_{ch} \times EF_{inh} \times ED_{ch} \times CF1 \times Ki \times CF2 \times CF3}$$

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| HQ | Hazard Quotient, (unitless) | 1 | ADHS, 1997 |
| $AT_{nc}$ | Averaging Time, noncancer (days) | 2190 | USEPA,1989 |
| $BW_{ch}$ | Body Weight, child (kg) | 15 | USEPA,1989 |
| Q/C | Inverse of mean concentration at the center of a 0.5 body of water ($mg/m^2 \cdot sec$ per $kg/m^3$) | 68800 | USEPA, 1996 |
| $RfD_i$ | Reference Dose, inhalation (mg/kg-d) | Chemical-Specific | IRIS, HEAST, OR NCEA |
| CF5 | $10^3$ (μg/mg) | 1000 | ---------- |
| CF4 | $10^6$ (mg $cm^3$/g L) | 1000000 | ---------- |
| $IR_{ch}$ | Inhalation Rate, child ($m^3$/day) | 10 | USEPA,1991a |
| $EF_{inh}$ | Exposure Frequency, inhalation (days/year) | 365 | USEPA,1991a |
| $ED_{ch}$ | Exposure Duration, child (years) | 6 | USEPA,1991a |
| CF1 | $10^6$ (mg/kg) | 1000000 | ---------- |
| Ki | Overall mass transfer, coefficient of i (cm/sec) | Chemical-Specific | USEPA,1995 |
| CF2 | $10^4$ ($cm^2/m^2$) | 10000 | ---------- |
| CF3 | $10^3$ (mg/g) | 1000 | ---------- |

**Table 4.1.1**
**ORNAMENTAL LAKES**

$$Cw_2(\mu g/L) = \frac{Risk \times AT_c \times BW_{ch} \times CF5}{IR_w \times ST_{ing} \times EF_{ing} \times ED_{ch} \times SF_o}$$

**Equation 3 : Childhood ingestion of volatile organic compounds, cancer**

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| Risk | Excess Lifetime Cancer Risk, (unitless) | 1.0E-05<br>1.0E-06 | ADHS, 1997 |
| $AT_c$ | Averaging Time, cancer (days) | 25550 | USEPA 1989 |
| $BW_{ch}$ | Body Weight, child (kg) | 15 | USEPA 1989 |
| CF5 | $10^3$ (μg/mg) | 1000 | ---------- |
| $IR_w$ | Ingestion Rate, water (L/hour) | 0.05 | USEPA 1990 |
| $ST_{ing}$ | Swimming Time, ingestion (hours/day) | 1 | ADHS, 1998 |
| $EF_{ing}$ | Exposure Frequency, ingestion (days/year) | 150 | ADHS, 1998 |
| $ED_{ch}$ | Exposure Duration, child (years) | 6 | USEPA 1991a |
| $SF_o$ | Slope Factor, oral (1/(mg/kg·d)) | Chemical-Specific | IRIS, HEAST, or NCEA |

**Table 4.1.1**
**ORNAMENTAL LAKES**

$$Cw_2(\mu g/L) = \frac{HQ \times BW_{ch} \times AT_{nc} \times RfD_o \times CF5}{IR_w \times ST_{ing} \times EF_{ing} \times ED_{ch}}$$

**Equation 4 : Childhood ingestion of volatile organic compounds, noncancer**

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| HQ | Hazard Quotient, (unitless) | 1 | ADHS, 1997 |
| $BW_{ch}$ | Body Weight, child (kg) | 15 | USEPA,1989 |
| $AT_{nc}$ | Averaging Time, noncancer (days) | 2190 | USEPA,1989 |
| $RfD_o$ | Reference Dose, oral (mg/kg-d) | Chemical-Specific | IRIS, HEAST, OR NCEA |
| CF5 | $10^3$ (µg/mg) | 1000 | ---------- |
| $IR_w$ | Ingestion Rate, child (L/hour) | 0.05 | USEPA,1991a |
| $ST_{ing}$ | Swimming Time, ingestion (hours/day) | 1 | ADHS, 1998 |
| $EF_{ing}$ | Exposure Frequency, ingestion (days/year) | 150 | USEPA,1991a |
| $ED_{ch}$ | Exposure Duration, child (years) | 6 | USEPA,1991a |

**Table 4.1.1**
**ORNAMENTAL LAKES**

$$Cw_3(\mu g/L) = \frac{Risk \times BW_{ch} \times AT_c \times CF5}{SA_{ch} \times Kp \times ST_{der} \times EF_{der} \times ED_{ch} \times CF6 \times SF_o}$$

**Equation 5: Childhood dermal contact with volatile organic compounds, cancer**

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| Risk | Excess Lifetime Cancer Risk, (unitless) | 1.0E-05<br>1.0E-06 | ADHS, 1997 |
| $BW_{ch}$ | Body Weight, child (kg) | 15 | USEPA 1989 |
| $AT_c$ | Averaging Time, cancer (days) | 25550 | USEPA 1989 |
| CF5 | $10^3$ (µg/mg) | 1000 | ---------- |
| $SA_{ch}$ | Skin Surface Area, child ($cm^2$) | 10000 | USEPA, 1992 |
| Kp | Permeability Coefficient, (cm/hour) | Chemical-Specific | USEPA, 1992 |
| $ST_{der}$ | Swimming Time, dermal (hour) | 1 | ADHS, 1998 |
| $EF_{der}$ | Exposure Frequency, dermal (days/year) | 150 | ADHS, 1998 |
| $ED_{ch}$ | Exposure Duration, child (years) | 6 | USEPA 1991a |
| CF6 | $10^{-3}$ ($L/cm^3$) | 0.001 | ---------- |
| $SF_o$ | Slope Factor, oral (1/(mg/kg-d)) | Chemical-Specific | IRIS, HEAST, or NCEA |

**Table 4.1.1**
**ORNAMENTAL LAKES**

**Equation 6 : Childhood dermal contact of volatile organic compounds, noncancer**

$$Cw_3(\mu g/L) = \frac{HQ \times BW_{ch} \times AT_{nc} \times RfD_o \times CF5}{SA_{ch} \times Kp \times ST_{der} \times EF_{der} \times ED_{ch} \times CF6}$$

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| HQ | Hazard Quotient, (unitless) | 1 | ADHS, 1997 |
| $BW_{ch}$ | Body Weight, child (kg) | 15 | USEPA 1989 |
| $AT_{nc}$ | Averaging Time, noncancer (days) | 2190 | USEPA 1989 |
| $RfD_o$ | Reference Dose, oral (mg/kg-d) | Chemical-Specific | USEPA, 1992 |
| CF5 | $10^3$ (µg/mg) | 1000 | ---------- |
| $SA_{ch}$ | Skin Surface Area, child ($cm^2$) | 10000 | USEPA, 1992 |
| Kp | Permeability Coefficient, (cm/hour) | Chemical-Specific | USEPA, 1992 |
| $ST_{der}$ | Swimming Time, dermal (hours/day) | 1 | ADHS, 1998 |
| $EF_{der}$ | Exposure Frequency, dermal (days/year) | 150 | ADHS, 1998 |
| $ED_{ch}$ | Exposure Duration, child (years) | 6 | USEPA 1991a |
| CF6 | $10^{-3}$ ($L/cm^3$) | 0.001 | ---------- |

**Table 4.1.2**
**ORNAMENTAL LAKES**
**Adult Residential Exposure**

$$Cw_1(\mu g/L) = \frac{Risk \times AT_c \times BW_a \times Q/C \times CF5 \times CF4}{IR_a \times EF_{inh} \times ED_a \times SF_i \times CF1 \times Ki \times CF2 \times CF3}$$

**Equation 1: Adult inhalation of volatile organic compounds, cancer**

where: F = flux in $mg/m^2 \cdot sec$
VF = $kg/m^3$

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| Risk | Excess Lifetime Cancer Risk, (unitless) | 1.0E-05<br>1.0E-06 | ADHS, 1997 |
| $AT_c$ | Averaging Time, cancer (days) | 25550 | USEPA 1989 |
| $BW_a$ | Body Weight, (adult) kg | 70 | USEPA 1989 |
| Q/C | Inverse of mean concentration at the center of a 0.5 body of water ($mg/m^2 \cdot sec$ per $kg/m^3$) | 68800 | USEPA, 1996 |
| CF5 | $10^3$ ($\mu g/mg$) | 1000 | ---------- |
| CF4 | $10^6$ ($mg\ cm^3/g\ L$) | 1000000 | ---------- |
| $IR_a$ | Inhalation Rate, adult ($m^3$/day) | 20 | USEPA 1991a |
| $EF_{inh}$ | Exposure Frequency, inhalation (days/year) | 365 | USEPA 1991a |
| $ED_a$ | Exposure Duration, adult (years) | 30 | USEPA 1991a |
| $SF_i$ | Slope Factor, inhalation (1/(mg/kg·d)) | Chemical-Specific | IRIS, HEAST, or NCEA |
| CF1 | $10^6$ (mg/kg) | 1000000 | ---------- |
| Ki | Overall mass transfer, coefficient of i (cm/sec) | Chemical-Specific | USEPA 1995 |
| CF2 | $10^4$ ($cm^2/m^2$) | 10000 | ---------- |
| CF3 | $10^3$ (mg/g) | 1000 | ---------- |

**Table 4.1.2**
**ORNAMENTAL LAKES**

**Equation 2: Adult inhalation of volatile organic compounds, systemic toxicity**

$$Cw_1(\mu g/L) = \frac{HQ \times AT_{nc} \times BW_a \times Q/C \times RfD_i \times CF5 \times CF4}{IR_a \times EF_{inh} \times ED_a \times CF1 \times Ki \times CF2 \times CF3}$$

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| HQ | Hazard Quotient, (unitless) | 1 | ADHS, 1997 |
| $AT_{nc}$ | Averaging Time, noncancer (days) | 10950 | USEPA, 1989 |
| $BW_a$ | Body Weight, adult (kg) | 70 | USEPA, 1989 |
| Q/C | Inverse of mean concentration at the center of a 0.5 body of water ($mg/m^2 \cdot sec$ per $kg/m^3$) | 68800 | USEPA, 1996 |
| $RfD_i$ | Reference Dose, inhalation (mg/kg-d) | Chemical Specific | IRIS, HEAST, OR NCEA |
| CF5 | $10^3$ (μg/mg) | 1000 | ---------- |
| CF4 | $10^6$ (mg $cm^3$/g L) | 1000000 | ---------- |
| $IR_a$ | Inhalation Rate, adult ($m^3$/day) | 20 | USEPA, 1991a |
| $EF_{inh}$ | Exposure Frequency, inhalation (days/year) | 365 | USEPA, 1991a |
| $ED_a$ | Exposure Duration, adult (years) | 30 | USEPA, 1991a |
| CF1 | $10^6$ (mg/kg) | 1000000 | ---------- |
| Ki | Overall mass transfer, coefficient of i (cm/sec) | Chemical-Specific | USEPA, 1995 |
| CF2 | $10^4$ ($cm^2/m^2$) | 10000 | ---------- |
| CF3 | $10^3$ (mg/g) | 1000 | ---------- |

**Table 4.1.2**
**ORNAMENTAL LAKES**

$$Cw_2(\mu g/L) = \frac{Risk \; x \; AT_c \; x \; BW_a \; x \; CF5}{IR_w \; x \; ST_{ing} \; x \; EF_{ing} \; x \; ED_a \; x \; SF_o}$$

**Equation 3 : Adult ingestion of volatile organic compounds, cancer**

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| Risk | Excess Lifetime Cancer Risk, (unitless) | 1.0E-05<br>1.0E-06 | ADHS, 1997 |
| $AT_c$ | Averaging Time, cancer (days) | 25550 | USEPA, 1989 |
| $BW_a$ | Body Weight, (adult) kg | 70 | USEPA, 1989 |
| CF5 | $10^3$ (μg/mg) | 1000 | ---------- |
| I $R_w$ | Ingestion Rate, water (L/hour) | 0.05 | USEPA, 1990 |
| $ST_{ing}$ | Swimming Time, ingestion (hour/day) | 1 | ADHS, 1998 |
| $EF_{ing}$ | Exposure Frequency, ingestion (days/year) | 12 | ADHS, 1998 |
| $ED_a$ | Exposure Duration, adult (years) | 30 | USEPA, 1991a |
| $SF_o$ | Slope Factor, oral (1/(mg/kg·d)) | Chemical-Specific | IRIS, HEAST, or NCEA |

**Table 4.1.2**
**ORNAMENTAL LAKES**

$$Cw_2(\mu g/L) = \frac{HQ \times BW_a \times AT_{nc} \times RfD_o \times CF5}{IR_w \times ST_{ing} \times EF_{ing} \times ED_a}$$

**Equation 4 : Adult ingestion of volatile organic compounds, noncancer**

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| HQ | Hazard Quotient, (unitless) | 1 | ADHS, 1997 |
| $BW_a$ | Body Weight, adult (kg) | 70 | USEPA 1989 |
| $AT_{nc}$ | Averaging Time, noncancer (days) | 10950 | USEPA 1989 |
| $RfD_o$ | Reference Dose, oral (mg/kg-d) | Chemical-Specific | IRIS, HEAST, OR NCEA |
| CF5 | $10^3$ (μg/mg) | 1000 | ---------- |
| $IR_w$ | Ingestion Rate, adult (L/hour) | 0.05 | USEPA 1990 |
| $ST_{ing}$ | Swimming Time, ingestion (hours/day) | 1 | ADHS, 1998 |
| $EF_{ing}$ | Exposure Frequency, ingestion (days/year) | 12 | ADHS, 1998 |
| $ED_a$ | Exposure Duration, adult (years) | 30 | USEPA 1991a |

**Table 4.1.2**
**ORNAMENTAL LAKES**

$$Cw_3(\mu g/L) = \frac{Risk \times BW_a \times AT_c \times CF5}{SA_a \times Kp \times ST_{der} \times EF_{der} \times ED_a \times CF6 \times SF_o}$$

**Equation 5: Adult dermal contact with volatile organic compounds, cancer**

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| Risk | Excess Lifetime Cancer Risk, (unitless) | 1.0E-05<br>1.0E-06 | ADHS, 1997 |
| $BW_a$ | Body Weight, (kg) | 70 | USEPA, 1989 |
| $AT_c$ | Averaging Time, cancer (days) | 25550 | USEPA, 1989 |
| CF5 | $10^3$ (μg/mg) | 1000 | ---------- |
| $SA_a$ | Skin Surface Area, adult ($cm^2$) | 20000 | USEPA, 1992 |
| Kp | Permeability Coefficient, (cm/hour) | Chemical-Specific | USEPA, 1992 |
| $ST_{der}$ | Swimming Time, dermal (hours/day) | 1 | ADHS, 1998 |
| $EF_{der}$ | Exposure Frequency, dermal (days/year) | 12 | ADHS, 1998 |
| $ED_a$ | Exposure Duration, adult (years) | 30 | USEPA, 1991a |
| CF6 | $10^{-3}$ ($L/cm^3$) | 0.001 | ---------- |
| $SF_o$ | Slope Factor, oral, (1/(mg/kg-d)) | Chemical-Specific | IRIS, HEAST, or NCEA |

**Table 4.1.2**
**ORNAMENTAL LAKES**

**Equation 6 : Adult dermal contact with volatile organic compounds, noncancer**

$$Cw_3(\mu g/L) = \frac{HQ \times BW_a \times AT_{nc} \times RfD_o \times CF5}{SA_a \times Kp \times ST_{der} \times EF_{der} \times ED_a \times CF6}$$

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| HQ | Hazard Quotient, (unitless) | 1 | ADHS, 1997 |
| $BW_a$ | Body Weight, adult, (kg) | 70 | USEPA, 1989 |
| $AT_{nc}$ | Averaging Time, noncancer (days) | 10950 | USEPA, 1989 |
| $RfD_o$ | Reference Dose, oral (mg/kg-d) | Chemical-Specific | USEPA, 1989 |
| CF5 | $10^3$ (μg/mg) | 1000 | ---------- |
| $SA_a$ | Skin Surface Area, adult ($cm^2$) | 20000 | USEPA, 1992 |
| Kp | Permeability Coefficient (cm/hour) | Chemical-Specific | USEPA, 1992 |
| $ST_{der}$ | Swimming Time, dermal (hours/day) | 1 | ADHS, 1998 |
| $EF_{der}$ | Exposure Frequency, dermal (days/year) | 12 | ADHS, 1998 |
| $ED_a$ | Exposure Duration, adult (years) | 30 | USEPA, 1991a |
| CF6 | $10^{-3}$ ($L/cm^3$) | 0.001 | ---------- |

**Table 4.2**
**ORNAMENTAL LAKES**
**Occupational Exposure**

**Equation 1: Occupational inhalation of volatile organic compounds, cancer**

where: F = flux in $mg/m^2 \cdot sec$

$$Cw_1(\mu g/L) = \frac{Risk \times AT_c \times BW_a \times Q/C \times CF5 \times CF4}{IR_a \times EF_{inh} \times ED_a \times SF_i \times CF1 \times Ki \times CF2 \times CF3}$$

VF = $kg/m^3$

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| Risk | Excess Lifetime Cancer Risk, (unitless) | 1.0E-05<br>1.0E-06 | ADHS, 1997 |
| $AT_c$ | Averaging Time, cancer (days) | 25550 | USEPA, 1989 |
| $BW_a$ | Body Weight, (adult) kg | 70 | USEPA, 1989 |
| Q/C | Inverse of mean concentration at the center of a 0.5 body of water ($mg/m^2 \cdot sec$ per $kg/m^3$) | 68800 | USEPA, 1996 |
| CF5 | $10^3$ (μg/mg) | 1000 | ---------- |
| CF4 | $10^6$ (mg $cm^3$/g L) | 1000000 | ---------- |
| $IR_a$ | Inhalation Rate, adult ($m^3$/day) | 20 | USEPA, 1991a |
| $EF_{inh}$ | Exposure Frequency, inhalation (days/year) | 250 | USEPA, 1991a |
| $ED_a$ | Exposure Duration, adult (years) | 25 | USEPA, 1991a |
| $SF_i$ | Slope Factor, inhalation (1/(mg/kg·d)) | Chemical-Specific | IRIS, HEAST, or NCEA |
| CF1 | $10^6$ (mg/kg) | 1000000 | ---------- |
| Ki | Overall mass transfer, coefficient of i (cm/sec) | Chemical-Specific | USEPA, 1995 |
| CF2 | $10^4$ ($cm^2/m^2$) | 10000 | ---------- |
| CF3 | $10^3$ (mg/g) | 1000 | ---------- |

**Table 4.2**
**ORNAMENTAL LAKES**

**Equation 2: Occupational inhalation of volatile organic compounds, systemic toxicity**

$$Cw_1(\mu g/L) = \frac{HQ \times AT_{nc} \times BW_a \times Q/C \times RfD_i \times CF5 \times CF4}{IR_a \times EF_{inh} \times ED_a \times CF1 \times Ki \times CF2 \times CF3}$$

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| HQ | Hazard Quotient, (unitless) | 1 | ADHS, 1997 |
| $AT_{nc}$ | Averaging Time, noncancer (days) | 9125 | USEPA 1989 |
| $BW_a$ | Body Weight, adult (kg) | 70 | USEPA 1989 |
| Q/C | Inverse of mean concentration at the center of a 0.5 body of water ($mg/m^2$·sec per $kg/m^3$) | 68800 | USEPA, 1996 |
| $RfD_i$ | Reference Dose, inhalation (mg/kg-d) | Chemical-Specific | IRIS, HEAST, OR NCEA |
| CF5 | $10^3$ (μg/mg) | 1000 | ---------- |
| CF4 | $10^6$ (mg $cm^3$/g L) | 1000000 | ---------- |
| $IR_a$ | Inhalation Rate, adult ($m^3$/day) | 20 | USEPA 1991a |
| $EF_{inh}$ | Exposure Frequency, inhalation (days/year) | 250 | USEPA 1991a |
| $ED_a$ | Exposure Duration, adult (years) | 25 | USEPA 1991a |
| CF1 | $10^6$ (mg/kg) | 1000000 | ---------- |
| Ki | Overall mass transfer, coefficient of i (cm/sec) | Chemical-Specific | USEPA 1995 |
| CF2 | $10^4$ ($cm^2/m^2$) | 10000 | ---------- |
| CF3 | $10^3$ (mg/g) | 1000 | ---------- |

**Table 4.2**
**ORNAMENTAL LAKES**

$$Cw_2(\mu g/L) = \frac{Risk \times AT_c \times BW_a \times CF5}{IR_w \times ET_{ing} \times EF_{ing} \times ED_a \times SF_o}$$

**Equation 3: Occupational ingestion of volatile organic compounds, cancer**

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| Risk | Excess Lifetime Cancer Risk, (unitless) | 1.0E-05<br>1.0E-06 | ADHS, 1997 |
| $AT_c$ | Averaging Time, cancer (days) | 25550 | USEPA 1989 |
| $BW_a$ | Body Weight, (adult) kg | 70 | USEPA 1989 |
| CF5 | $10^3$ (μg/mg) | 1000 | ---------- |
| $IR_w$ | Ingestion Rate, water (L/hour) | 0.05 | USEPA 1990 |
| $ET_{ing}$ | Exposure Time, ingestion (hour/day) | 8 | ADHS, 1998 |
| $EF_{ing}$ | Exposure Frequency, ingestion (days/year) | 250 | USEPA 1991a |
| $ED_a$ | Exposure Duration, adult (years) | 25 | USEPA 1991a |
| $SF_o$ | Slope Factor, oral (1/(mg/kg·d)) | Chemical-Specific | IRIS, HEAST, or NCEA |

**Table 4.2**
**ORNAMENTAL LAKES**

$$Cw_2(\mu g/L) = \frac{HQ \times BW_a \times AT_{nc} \times RfD_o \times CF5}{IR_w \times ET_{ing} \times EF_{ing} \times ED_a}$$

**Equation 4: Occupational ingestion of volatile organic compounds, noncancer**

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| HQ | Hazard Quotient, (unitless) | 1 | ADHS, 1997 |
| $BW_a$ | Body Weight, adult (kg) | 70 | USEPA 1989 |
| $AT_{nc}$ | Averaging Time, noncancer (days) | 9125 | USEPA 1989 |
| $RfD_o$ | Reference Dose, oral (mg/kg-d) | Chemical-Specific | IRIS, HEAST, OR NCEA |
| CF5 | $10^3$ (µg/mg) | 1000 | ---------- |
| $IR_w$ | Ingestion Rate, adult (L/hour) | 0.05 | USEPA 1991a |
| $ET_{ing}$ | Exposure Time, ingestion (hours/day) | 8 | ADHS, 1998 |
| $EF_{ing}$ | Exposure Frequency, ingestion (days/year) | 250 | USEPA 1991a |
| $ED_a$ | Exposure Duration, adult (years) | 25 | USEPA 1991a |

**Table 4.2**
**ORNAMENTAL LAKES**

$$Cw_3(\mu g/L) = \frac{Risk \times BW_a \times AT_c \times CF5}{SA_a \times Kp \times ET_{der} \times EF_{der} \times ED_a \times CF6 \times SF_o}$$

**Equation 5: Occupational dermal contact with volatile organic compounds, cancer**

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| Risk | Excess Lifetime Cancer Risk, (unitless) | 1.0E-05<br>1.0E-06 | ADHS, 1997 |
| $BW_a$ | Body Weight, (kg) | 70 | USEPA 1989 |
| $AT_c$ | Averaging Time, cancer (days) | 25550 | USEPA 1989 |
| CF5 | $10^3$ (μg/mg) | 1000 | ---------- |
| $SA_a$ | Skin Surface Area, adult ($cm^2$) | 5000 | USEPA, 1992 |
| Kp | Permeability Coefficient, (cm/hour) | Chemical-Specific | USEPA, 1992 |
| $ET_{der}$ | Exposure Time, dermal, (hours/day) | 8 | ADHS, 1998 |
| $EF_{der}$ | Exposure Frequency, dermal (days/year) | 250 | USEPA 1991a |
| $ED_a$ | Exposure Duration, adult (years) | 25 | USEPA 1991a |
| CF6 | $10^{-3}$ ($L/cm^3$) | 0.001 | ---------- |
| $SF_o$ | Slope Factor, oral (1/(mg/kg-d)) | Chemical-Specific | IRIS, HEAST, or NCEA |

**Table 4.2**
**ORNAMENTAL LAKES**

**Equation 6: Occupational dermal contact with volatile organic compounds, noncancer**

$$Cw_3(\mu g/L) = \frac{HQ \times BW_a \times AT_{nc} \times RfD_o \times CF5}{SA_a \times Kp \times ET_{der} \times EF_{der} \times ED_a \times CF6}$$

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| HQ | Hazard Quotient, (unitless) | 1 | ADHS, 1997 |
| $BW_a$ | Body Weight, (adult) kg | 70 | USEPA 1989 |
| $AT_{nc}$ | Averaging Time, noncancer (days) | 9125 | USEPA 1989 |
| $RfD_o$ | Reference Dose, oral (mg/kg-d) | Chemical-Specific | IRIS, HEAST, OR NCEA |
| CF5 | $10^3$ (µg/mg) | 1000 | ---------- |
| $SA_a$ | Skin Surface Area, adult ($cm^2$) | 5000 | USEPA, 1992 |
| Kp | Permeability Coefficient (cm/hour) | Chemical-Specific | USEPA, 1992 |
| $ET_{der}$ | Exposure Time, dermal (hours/day) | 8 | ADHS, 1998 |
| $EF_{der}$ | Exposure Frequency, dermal (days/year) | 250 | USEPA 1991a |
| $ED_a$ | Exposure Duration, adult (years) | 25 | USEPA 1991a |
| CF6 | $10^{-3}$ ($L/cm^3$) | 0.001 | ---------- |

**Table 5.1.1**
**DUST CONTROL or CONSTRUCTION WATER for COMPACTION**
**Childhood Residential Exposure Scenario**

**Equation 1: Childhood inhalation of volatile organic compounds, cancer**

$$Cw_1(\mu g/L) = \frac{Risk \times BW_{ch} \times AT_c \times AV \times CF1}{IR_{ch} \times EF_{inh} \times ED_{ch} \times SF_i \times LW \times ET_{inh} \times CF3}$$

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| Risk | Excess Lifetime Cancer Risk, (unitless) | 1.0E-05<br>1.0E-06 | ADHS, 1997 |
| $BW_{ch}$ | Body Weight, child (kg) | 15 | USEPA, 1989 |
| $AT_c$ | Averaging Time, cancer (days) | 25550 | USEPA, 1989 |
| AV | Air Volume, ($m^3$/hour) | 6000000 | Box Model |
| CF1 | $10^3$ (µg/mg) | 1000 | ---------- |
| $IR_{ch}$ | Inhalation Rate, child, water ($m^3$/day) | 10 | USEPA, 1991a |
| $EF_{inh}$ | Exposure Frequency, inhalation (days/year) | 250 | USEPA 1991a |
| $ED_{ch}$ | Exposure Duration, child (years) | 6 | USEPA 1991a |
| $SF_i$ | Slope Factor, inhalation (1/(mg/kg·d)) | Chemical-Specific | IRIS, HEAST, or NCEA |
| LW | Liters of water, (L/hour) | 68076 | United Truck, 1998 |
| $ET_{inh}$ | Exposure Time, inhalation (hours/day) | 8 | ADHS, 1998 |
| CF3 | (days/hour) | .04 | ---------- |

**Table 5.1.1**
**DUST CONTROL or CONSTRUCTION WATER for COMPACTION**

**Equation 2: Childhood inhalation of volatile organic compounds, systemic toxicity**

$$Cw_1(\mu g/L) = \frac{HQ \times BW_{ch} \times AT_{nc} \times AV \times CF1 \times RfD_i}{IR_{ch} \times EF_{inh} \times ED_{ch} \times LW \times ET_{inh} \times CF3}$$

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| HQ | Hazard Quotient (unitless) | 1 | ADHS, 1997 |
| $BW_{ch}$ | Body Weight, child (kg) | 15 | USEPA, 1989 |
| $AT_{nc}$ | Averaging Time, noncancer (days) | 2190 | USEPA, 1989 |
| AV | Air Volume, ($m^3$ air/hour) | 6000000 | Box Model |
| CF1 | $10^3$ (µg/mg) | 1000 | ---------- |
| $RfD_i$ | Reference Dose, inhalation (mg/kg-d) | Chemical-Specific | IRIS, HEAST, or NCEA |
| $IR_{ch}$ | Ingestion Rate, child ($m^3$/day) | 10 | USEPA, 1991a |
| $EF_{inh}$ | Exposure Frequency, inhalation (days/year) | 250 | USEPA, 1991a |
| $ED_{ch}$ | Exposure Duration, child (years) | 6 | USEPA, 1991a |
| LW | Liters of water, (l/hour) | 68076 | United Truck, 1998 |
| $ET_{inh}$ | Exposure Time, inhalation (hours/day) | 8 | ADHS, 1998 |
| CF3 | (hours/day) | .04 | ---------- |

**Table 5.1.2**
**DUST CONTROL or CONSTRUCTION WATER for COMPACTION**
**Adult Residential Exposure Scenario**

$$Cw_1(\mu g/L) = \frac{Risk \times AT_c \times BW_a \times AV \times CF1}{IR_a \times EF_{inh} \times ED_a \times SF_i \times LW \times ET_{inh} \times CF3}$$

**Equation 1: Adult inhalation of volatile organic compounds, cancer**

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| Risk | Excess Lifetime cancer Risk, (unitless) | 1.0E-05<br>1.0E-06 | ADHS, 1997 |
| $AT_c$ | Averaging Time, cancer (days) | 25550 | USEPA, 1989 |
| $BW_a$ | Body Weight, adult (kg) | 70 | USEPA, 1991a |
| AV | Air Volume, ($m^3$/hour) | 6000000 | Box Model |
| CF1 | $10^3$ (µg/mg) | 1000 | ---------- |
| $IR_a$ | Inhalation Rate, ($m^3$/day) | 20 | USEPA, 1991a |
| $EF_{inh}$ | Exposure Frequency, inhalation (days/year) | 250 | ADHS, 1998 |
| $ED_a$ | Expsoure Duration, adult (years) | 30 | USEPA, 1991a |
| $SF_i$ | Slope Factor, inhalation (1/(mg/kg·d) | Chemical Specific | IRIS, HEAST, or NCEA |
| LW | Liters of Water, (L/hour) | 68000 | United Truck, 1998 |
| $ET_{inh}$ | Exposure Time, inhalation (hours/day) | 8 | USEPA, 1991a |
| CF3 | (days/hour) | .04 | ---------- |

**Table 5.1.2**
**DUST CONTROL or CONSTRUCTION WATER for COMPACTION**

**Equation 2: Adult inhalation of volatile organic compounds, systemic toxicity**

$$Cw_1(\mu g/L) = \frac{HQ \times AT_{nc} \times BW_a \times AV \times RfD_i \times CF1}{IR_a \times EF_{inh} \times ED_a \times LW \times ET_{inh} \times CF3}$$

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| HQ | Hazard Quotient noncancer, (unitless) | 1 | ADHS, 1997 |
| $AT_c$ | Averaging Time, noncancer (days) | 10950 | USEPA, 1989 |
| $BW_a$ | Body Weight, adult (kg) | 70 | USEPA, 1989 |
| AV | Air Volume, ($m^3$/hour) | 6000000 | ---------- |
| $RfD_i$ | Reference Dose, inhalation (mg/kg-d) | Chemical Specific | IRIS, HEAST, or NCEA |
| CF1 | $10^3$ (μg/mg) | 1000 | ---------- |
| $IR_a$ | Inhalation Rate, adult ($m^3$/day) | 20 | USEPA, 1991a |
| $EF_{inh}$ | Exposure Frequency, inhalation (days/year) | 250 | USEPA, 1991a |
| $ED_a$ | Exposure Duration, adult (years) | 30 | USEPA, 1991a |
| LW | Liters of Water, (Liters/hour water applied) | 68000 | United Truck, 1998 |
| $ET_{inh}$ | Exposure Time, inhalation (hours/day) | 8 | ADHS, 1998 |
| CF3 | (days/hour) | .04 | ---------- |

**Table 5.2**
**DUST CONTROL or CONSTRUCTION WATER for COMPACTION**
**Occupational Exposure Scenario**

$$Cw_1(\mu g/L) = \frac{Risk \; x \; AT_c \; x \; BW_a \; x \; AV \; x \; CF1}{IR_a \; x \; EF_{inh} \; x \; ED_a \; x \; SF_i \; x \; ET_{inh} \; x \; LW}$$

**Equation 1: Occupational inhalation of volatile organic compounds, cancer**

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| Risk | Excess Lifetime Cancer Risk, (unitless) | 1.0E-05<br>1.0E-06 | ADHS, 1997 |
| ATc | Averaging Time, cancer (days) | 25550 | USEPA, 1989 |
| $BW_a$ | Body Weight, adult (kg) | 70 | USEPA, 1989 |
| AV | Air Volume, ($m^3$/hour) | 6000000 | Box Model |
| CF1 | $10^3$ (μg/mg) | 1000 | ---------- |
| $IR_a$ | Inhalation Rate, adult ($m^3$/day) | 20 | USEPA, 1991a |
| $EF_{inh}$ | Exposure Frequency, inhalation (days/year) | 250 | USEPA 1991a |
| $ED_a$ | Exposure Duration, adult occupational (years) | 25 | ADHS, 1998 |
| $SF_i$ | Slope Factor, inhalation (1/(mg/kg·d)) | Chemical-Specific | IRIS, HEAST, or NCEA |
| LW | Liters of water, (L/hour) | 68076 | United Truck, 1998 |
| $ET_{inh}$ | Exposure Time, inhalation (hours/days) | 8 | ADHS, 1998 |

**Table 5.2**
**DUST CONTROL or CONSTRUCTION WATER for COMPACTION**

**Equation 2: Occupational inhalation of volatile organic compounds, systemic toxicity**

$$Cw_1(\mu g/L) = \frac{HQ \times AT_{nc} \times BW_a \times AV \times RfD_i \times CF1}{IR_a \times EF_{inh} \times ED_a \times LW \times SF_i \times ET_{inh} \times CF3}$$

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| HQ | Hazard Quotient, (unitless) | 1 | ADHS, 1997 |
| $AT_{nc}$ | Averaging Time, noncancer (days) | 10950 | RAGS, 1989 |
| $BW_a$ | Body Weight, adult (kg) | 70 | USEPA, 1989 |
| AV | Air Volume, ($m^3$/hour) | 6000000 | Box Model |
| $RfD_i$ | Reference Dose, inhalation (mg/kg-d) | Chemical-Specific | IRIS, HEAST, or NCEA |
| CF1 | $10^3$ (μg/mg) | 1000 | ---------- |
| $IR_a$ | Inhalation Rate, adult ($m^3$/day) | 20 | USEPA, 1991a |
| $EF_{inh}$ | Exposure Frequency, inhalation | 250 | USEPA 1991a |
| $ED_a$ | Exposure Duration, adult occupational (years) | 25 | ADHS, 1998 |
| $SF_i$ | Slope Factor, inhalation (1/(mg/kg·d)) | Chemical-Specific | IRIS, HEAST, or NCEA |
| LW | Liters of water, (L/hour water applied) | 68076 | United Truck, 1998 |
| $ET_{inh}$ | Exposure Time, inhalation (hours/day) | 8 | ADHS, 1998 |
| CF3 | (days/hour) | .04 | ---------- |

**Table 6.1.1**
**SAND AND GRAVEL WASHING**
**Childhood Residential Exposure Scenario**

**Equation 1: Childhood inhalation of volatile organic compounds, cancer**

$$Cw_1(\mu g/L) = \frac{Risk \times BW_{ch} \times AT_c \times AV \times CF1}{IR_{ch} \times EF_{inh} \times ED_{ch} \times SF_i \times LW \times ET_{inh} \times CF3}$$

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| Risk | Excess Lifetime Cancer Risk, (unitless) | 1.0E-05<br>1.0E-06 | ADHS, 1997 |
| $BW_{ch}$ | Body Weight, child (kg) | 15 | USEPA, 1989 |
| $AT_c$ | Averaging Time, cancer (days) | 25550 | USEPA, 1989 |
| AV | Air Volume, ($m^3$air/hour) | 3200000 | Box Model |
| CF1 | $10^3$ (μg/mg) | 1000 | ---------- |
| $IR_{ch}$ | Inhalation Rate, child, water ($m^3$/day) | 10 | USEPA, 1991a |
| $EF_{inh}$ | Exposure Frequency, inhalation (days/year) | 250 | USEPA 1991a |
| $ED_{ch}$ | Exposure Duration, child (years) | 6 | USEPA 1991a |
| $SF_i$ | Slope Factor, inhalation (1/(mg/kg·d)) | Chemical-Specific | IRIS, HEAST, or NCEA |
| LW | Liters of water, (L/hour applied) | 317940 | Phoenix, Redi-Mix, 1998 |
| $ET_{inh}$ | Exposure Time, inhalation (hours/day) | 16 | ADHS, 1998 |
| CF3 | (days/hour) | .04 | ---------- |

**Table 6.1.1**
**SAND AND GRAVEL WASHING**

**Equation 2: Childhood inhalation of volatile organic compounds, systemic toxicity**

$$Cw_1(\mu g/L) = \frac{HQ \times BW_{ch} \times AT_{nc} \times AV \times CF1 \times RfD_i}{IR_{ch} \times EF_{inh} \times ED_{ch} \times LW \times ET_{inh} \times CF3}$$

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| HQ | Hazard Quotient (unitless) | 1 | ADHS, 1997 |
| $BW_{ch}$ | Body Weight, child (kg) | 15 | USEPA, 1989 |
| $AT_{nc}$ | Averaging Time, noncancer (days) | 2190 | USEPA, 1989 |
| AV | Emissions Volume, ($m^3$ air/hour) | 3200000 | ---------- |
| CF1 | $10^3$ (µg/mg) | 1000 | ---------- |
| $RfD_i$ | Reference Dose, inhalation (mg/kg-d) | Chemical-Specific | IRIS, HEAST, or NCEA |
| $IR_{ch}$ | Ingestion Rate, child ($m^3$/day) | 10 | USEPA, 1991a |
| $EF_{inh}$ | Exposure Frequency, inhalation (days/year) | 250 | USEPA, 1991a |
| $ED_{ch}$ | Exposure Duration, child (years) | 6 | USEPA, 1991a |
| LW | Liters of water, (L/hour applied) | 317940 | Phoenix, Redi-Mix, 1998 |
| $ET_{inh}$ | Exposure Time, inhalation (hours/day) | 16 | ADHS, 1998 |
| CF3 | (hours/day) | .04 | ---------- |

**Table 6.1.2**
**SAND AND GRAVEL WASHING**
**Adult Residential Exposure Scenario**

$$Cw_1(\mu g/L) = \frac{Risk \times AT_c \times BW_a \times AV \times CF1}{IR_a \times EF_{inh} \times ED_a \times SF_i \times LW \times ET_{inh} \times CF3}$$

**Equation 1: Adult inhalation of volatile organic compounds, cancer**

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| Risk | Excess Lifetime cancer Risk, (unitless) | 1.0E-05<br>1.0E-06 | ADHS, 1997 |
| $AT_c$ | Averaging Time, cancer (days) | 25550 | USEPA, 1989 |
| $BW_a$ | Body Weight, adult (kg) | 70 | USEPA, 1991a |
| AV | Air Volume, ($m^3$air/hour) | 3200000 | Box Model |
| CF1 | $10^3$ (μg/mg) | 1000 | ---------- |
| $IR_a$ | Inhalation Rate, ($m^3$/day) | 20 | USEPA, 1991a |
| $EF_{inh}$ | Exposure Frequency, inhalation (days/year) | 250 | ADHS, 1998 |
| $ED_a$ | Exposure Duration, adult (years) | 30 | USEPA, 1991a |
| $SF_i$ | Slope Factor, inhalation (1/(mg/kg·d) | Chemical Specific | IRIS, HEAST, or NCEA |
| LW | Liters of Water, applied (L/hour) | 317940 | Phoenix Redi-Mix, 1998 |
| $ET_{inh}$ | Exposure Time, inhalation (hours/day) | 16 | ADHS, 1998 |
| CF3 | (days/hour) | .04 | ---------- |

**Table 6.1.2**
**SAND AND GRAVEL WASHING**

**Equation 2: Adult inhalation of volatile organic compounds, systemic toxicity**

$$Cw_1(\mu g/L) = \frac{HQ \times AT_{nc} \times BW_a \times AV \times RfD_i \times CF1}{IR_a \times EF_{inh} \times ED_a \times LW \times ET_{inh} \times CF3}$$

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| HQ | Hazard Quotient noncancer, (unitless) | 1 | ADHS, 1997 |
| $AT_{nc}$ | Averaging Time, noncancer (days) | 10950 | USEPA, 1989 |
| $BW_a$ | Body Weight, adult (kg) | 70 | USEPA, 1989 |
| AV | Air Volume, ($m^3$air/hour) | 3200000 | Box Model |
| $RfD_i$ | Reference Dose, inhalation (mg/kg-d) | Chemical-Specific | IRIS, HEAST, or NCEA |
| CF1 | $10^3$ (μg/mg) | 1000 | ---------- |
| $IR_a$ | Inhalation Rate, adult ($m^3$/day) | 20 | USEPA, 1991a |
| $EF_{inh}$ | Exposure Frequency, inhalation (days/year) | 250 | USEPA, 1991a |
| $ED_a$ | Exposure Duration, adult (years) | 30 | USEPA, 1991a |
| LW | Liters of Water, (L/hour water applied) | 317940 | Phoenix Redi-Mix, 1998 |
| $ET_{inh}$ | Exposure Time, inhalation (hours/day) | 16 | ADHS, 1998 |
| CF3 | (days/hour) | 0.4 | ---------- |

**Table 6.2**
**SAND AND GRAVEL WASHING**
**Occupational Exposure Scenario**

$$Cw_1(\mu g/L) = \frac{Risk \times AT_c \times BW_a \times AV \times CF1}{IR_a \times EF_{inh} \times ED_a \times SF_i \times LW}$$

**Equation 1: Occupational inhalation of volatile organic compounds, cancer**

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| Risk | Excess Lifetime Cancer Risk, (unitless) | 1.0E-05<br>1.0E-06 | ADHS, 1997 |
| ATc | Averaging Time, cancer (days) | 25550 | USEPA, 1989 |
| $BW_a$ | Body Weight, adult (kg) | 70 | USEPA, 1989 |
| AV | Air Volume, ($m^3$/hour) | 3151512 | ADHS, 1998 |
| CF1 | $10^3$ (μg/mg) | 1000 | Box Model |
| $IR_a$ | Inhalation Rate, adult ($m^3$/day) | 20 | USEPA, 1991a |
| $EF_{inh}$ | Exposure Frequency, inhalation (days/year) | 250 | USEPA 1991a |
| $ED_a$ | Exposure Duration, adult occupational (years) | 25 | ADHS, 1998 |
| $SF_i$ | Slope Factor, inhalation (1/(mg/kg·d)) | Chemical-Specific | IRIS, HEAST, or NCEA |
| LW | Liters of water, (L/hour applied) | 317940 | Phoenix Redi-Mix, 1998 |

**Table 6.2**
**SAND AND GRAVEL WASHING**

**Equation 2: Occupational inhalation of volatile organic compounds, systemic toxicity**

$$Cw_1(\mu g/L) = \frac{HQ \times AT_{nc} \times BW_a \times AV \times RfD_i \times CF1}{IR_a \times EF_{inh} \times ED_a \times LW \times ET_{inh} \times CF3}$$

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| HQ | Hazard Quotient, (unitless) | 1 | ADHS, 1997 |
| $AT_{nc}$ | Averaging Time, noncancer (days) | 10950 | USEPA, 1989 |
| $BW_a$ | Body Weight, adult (kg) | 70 | USEPA, 1989 |
| AV | Air Volume, ($m^3$/day) | 6000000 | Box Model |
| $RfD_i$ | Reference Dose, inhalation (mg/kg-d) | Chemical-Specific | IRIS, HEAST, or NCEA |
| CF1 | $10^3$ (μg/mg) | 1000 | ---------- |
| $IR_a$ | Inhalation Rate, adult ($m^3$/day) | 20 | USEPA, 1991a |
| $EF_{inh}$ | Exposure Frequency, inhalation | 250 | USEPA 1991a |
| $ED_a$ | Exposure Duration, adult occupational (years) | 25 | ADHS, 1998 |
| LW | Liters of water, (L/hour water applied) | 317940 | Phoenix Redi-Mix, 1998 |
| $ET_{inh}$ | Exposure Time, inhalation (hours/day) | 8 | ADHS, 1998 |
| CF3 | (days/hour) | .04 | ---------- |

**Table 6.2**
**SAND AND GRAVEL WASHING**

$$Cw_2(\mu g/L) = \frac{Risk \times AT_c \times BW_a \times CF1}{IR_w \times ET_{ing} \times EF_{ing} \times ED_a \times SF_o}$$

**Equation 3 : Occupational ingestion of volatile organic compounds, cancer**

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| Risk | Excess Lifetime Cancer Risk, (unitless) | 1.0E-05<br>1.0E-06 | ADHS, 1997 |
| ATc | Averaging Time, cancer (days) | 25550 | USEPA, 1989 |
| $BW_a$ | Body Weight, adult (kg) | 70 | USEPA, 1989 |
| CF1 | $10^3$ (μg/mg) | 1000 | ---------- |
| $IR_w$ | Ingestion Rate, water (L/hour) | 0.05 | USEPA, 1991a |
| $ET_{ing}$ | Exposure Time, ingestion (hours/day) | 8 | ADHS, 1998 |
| $EF_{ing}$ | Exposure Frequency, ingestion (days/year) | 250 | ADHS, 1998 |
| $ED_a$ | Exposure Duration, adult occupational (years) | 25 | USEPA, 1991a |
| $SF_o$ | Slope Factor, oral (1/(mg/kg-day) | Chemical-Specific | IRIS, HEAST, or NCEA |

**Table 6.2**
**SAND AND GRAVEL WASHING**

$$Cw_2(\mu g/L) = \frac{HQ \times BW_a \times AT_{nc} \times RfD_o \times CF1}{IR_a \times ET_{ing} \times EF_{ing} \times ED_a}$$

**Equation 4 : Occupational ingestion of volatile organic compounds, noncancer**

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| HQ | Hazard Quotient, (unitless) | 1 | ADHS, 1997 |
| $BW_a$ | Body Weight, adult (kg) | 70 | USEPA, 1989 |
| $AT_{nc}$ | Averaging Time, noncancer (days) | 9125 | USEPA, 1989 |
| $RfD_o$ | Reference Dose, oral (mg/kg-d) | Chemical-Specific | IRIS, HEAST, or NCEA |
| CF1 | $10^3$ (µg/mg) | 1000 | ---------- |
| $IR_a$ | Inhalation Rate, adult (L/hour) | 0.05 | USEPA, 1991a |
| $ET_{ing}$ | Exposure Time, ingestion (hours/day) | 8 | ADHS, 1998 |
| $EF_{ing}$ | Exposure Frequency, ingestion (days/year) | 250 | ADHS, 1998 |
| $ED_a$ | Exposure Duration, adult occupational (years) | 25 | USEPA 1991a |

**Table 6.2**
**SAND AND GRAVEL WASHING**

$$Cw_3(\mu g/L) = \frac{Risk \times BW_a \times AT_c \times CF1}{SA_a \times Kd \times ET_{der} \times EF_{der} \times ED_a \times CF2 \times SF_o}$$

**Equation 5: Occupational dermal contact with volatile organic compounds, cancer**

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| Risk | Excess Lifetime cancer Risk, (unitless) | 1.0E-05<br>1.0E-06 | ADHS, 1997 |
| $BW_a$ | Body Weight, adult (kg) | 70 | USEPA, 1991a |
| $AT_c$ | Averaging Time, cancer (days) | 25550 | USEPA, 1989 |
| CF1 | $10^3$ (μg/mg) | 1000 | ---------- |
| $SA_a$ | Skin Surface Area, adult ($cm^2$) | 5000 | USEPA, 1992 |
| Kd | Skin Permeability Coefficient (cm/hour) | Chemical-Specific | USEPA, 1992 |
| $ET_{der}$ | Exposure Time, dermal (hour/day) | 8 | ADHS, 1998 |
| $EF_{der}$ | Exposure Frequency, dermal (days/year) | 250 | ADHS, 1998 |
| $ED_a$ | Exposure Duration, adult (years) | 25 | USEPA, 1991a |
| CF2 | $10^{-3}$ ($L/cm^3$) | 0.001 | ---------- |
| $SF_o$ | Slope Factor, oral (1/(mg/kg·d) | Chemical Specific | IRIS, HEAST, or NCEA |

**Table 6.2**
**SAND AND GRAVEL WASHING**

**Equation 6 : Occupational dermal contact with volatile organic compounds, noncancer**

$$Cw_3(\mu g/L) = \frac{HQ \times BW_a \times AT_{nc} \times RfD_o \times CF1}{SA_a \times Kd \times ET_{der} \times EF_{der} \times ED_a \times CF2}$$

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| HQ | Hazard Quotient noncancer, (unitless) | 1 | ADHS, 1997 |
| $BW_a$ | Body Weight, adult (kg) | 70 | USEPA, 1989 |
| $AT_{nc}$ | Averaging Time, noncancer (days) | 9125 | USEPA, 1989 |
| $RfD_o$ | Reference Dose, oral (mg/kg-d) | Chemical-Specific | IRIS, HEAST, or NCEA |
| CF1 | $10^3$ (μg/mg) | 1000 | ---------- |
| $SA_a$ | Skin Surface Area ($cm^2$) | 5000 | USEPA, 1992 |
| Kd | Skin Permeability Coefficient (cm/hour) | Chemical-Specific | USEPA, 1992 |
| $ET_{der}$ | Exposure Time, dermal (hours/day) | 8 | ADHS, 1998 |
| $EF_{der}$ | Exposure Frequency, dermal (days/year) | 250 | ADHS, 1998 |
| $ED_a$ | Exposure Duration, adult (years) | 25 | USEPA, 1991a |
| CF2 | $10^{-3}$ ($L/cm^3$) | 0.001 | ---------- |

**Table 7.1.1**
**CONSTRUCTED OPEN WATER CONVEYANCE SYSTEMS**
**(NON-IRRIGATION)**
**Childhood Residential Exposure**

$$Cw_1(\mu g/L) = \frac{Risk \times AT_c \times BW_{ch} \times Q/C \times CF5 \times CF4}{IR_{ch} \times EF_{inh} \times ED_{ch} \times SF_i \times CF1 \times Ki \times CF2 \times CF3}$$

**Equation 1: Childhood inhalation of volatile organic compounds, cancer**

where**:** F = flux in $mg/m^2 \cdot sec$
VF = $kg/m^3$

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| Risk | Excess Lifetime Cancer Risk, (unitless) | 1.0E-05<br>1.0E-06 | ADHS, 1997 |
| $AT_c$ | Averaging Time, cancer (days) | 25550 | USEPA 1989 |
| $BW_{ch}$ | Body Weight, child (kg) | 15 | USEPA 1989 |
| Q/C | Inverse of mean concentration at the center of a 0.5 body of water ($mg/m^2 \cdot sec$ per $kg/m^3$) | 68800 | USEPA, 1996 |
| CF5 | $10^3$ (μg/mg) | 1000 | ---------- |
| CF4 | $10^6$ (mg $cm^3$/g L) | 1000000 | ---------- |
| $IR_{ch}$ | Inhalation Rate, child ($m^3$/day) | 10 | USEPA 1991a |
| $EF_{inh}$ | Exposure Frequency, inhalation (days/year) | 365 | USEPA 1991a |
| $ED_{ch}$ | Exposure Duration, child (years) | 6 | USEPA 1991a |
| $SF_i$ | Slope Factor, inhalation (1/(mg/kg·d)) | Chemical-Specific | IRIS, HEAST, or NCEA |
| CF1 | $10^6$ (mg/kg) | 1000000 | ---------- |
| Ki | Overall mass transfer, coefficient of i (cm/sec) | Chemical-Specific | USEPA 1995 |
| CF2 | $10^4$ ($cm^2/m^2$) | 10000 | ---------- |
| CF3 | $10^3$ (mg/g) | 1000 | ---------- |

**Table 7.1.1**
**CONSTRUCTED OPEN WATER CONVEYANCE SYSTEMS**

**Equation 2: Childhood inhalation of volatile organic compounds, systemic toxicity**

$$Cw_1(\mu g/L) = \frac{HQ \times AT_{nc} \times BW_{ch} \times Q/C \times RfD_i \times CF5 \times CF4}{IR_{ch} \times EF_{inh} \times ED_{ch} \times CF1 \times Ki \times CF2 \times CF3}$$

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| HQ | Hazard Quotient, (unitless) | 1 | ADHS, 1997 |
| $AT_{nc}$ | Averaging Time, noncancer (days) | 2190 | USEPA 1989 |
| $BW_{ch}$ | Body Weight, child (kg) | 15 | USEPA 1989 |
| Q/C | Inverse of mean concentration at the center of a 0.5 body of water ($mg/m^2$·sec per $kg/m^3$) | 68800 | USEPA, 1996 |
| $RfD_i$ | Reference Dose, inhalation (mg/kg-d) | Chemical-Specific | IRIS, HEAST, OR NCEA |
| CF5 | $10^3$ (μg/mg) | 1000 | ---------- |
| CF4 | $10^6$ (mg $cm^3$/g L) | 1000000 | ---------- |
| $IR_{ch}$ | Inhalation Rate, child ($m^3$/day) | 10 | USEPA 1991a |
| $EF_{inh}$ | Exposure Frequency, inhalation (days/year) | 365 | USEPA 1991a |
| $ED_{ch}$ | Exposure Duration, child (years) | 6 | USEPA 1991a |
| CF1 | $10^6$ (mg/kg) | 1000000 | ---------- |
| Ki | Overall mass transfer, coefficient of i (cm/sec) | Chemical-Specific | USEPA 1995 |
| CF2 | $10^4$ ($cm^2/m^2$) | 10000 | ---------- |
| CF3 | $10^3$ (mg/g) | 1000 | ---------- |

**Table 7.1.1**
**CONSTRUCTED OPEN WATER CONVEYANCE SYSTEMS**

$$Cw_2(\mu g/L) = \frac{Risk \; x \; AT_c \; x \; BW_{ch} \; x \; CF5}{IR_w \; x \; ST_{ing} \; x \; EF_{ing} \; x \; ED_{ch} \; x \; SF_o}$$

**Equation 3 : Childhood ingestion of volatile organic compounds, cancer**

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| Risk | Excess Lifetime Cancer Risk, (unitless) | 1.0E-05<br>1.0E-06 | ADHS, 1997 |
| $AT_c$ | Averaging Time, cancer (days) | 25550 | USEPA 1989 |
| $BW_{ch}$ | Body Weight, child (kg) | 15 | USEPA 1989 |
| CF5 | $10^3$ (μg/mg) | 1000 | ---------- |
| $IR_w$ | Ingestion Rate, water (L/hour) | 0.05 | USEPA 1991a |
| $ST_{ing}$ | Swimming Time, (hours/day) | 1 | ADHS, 1998 |
| $EF_{ing}$ | Exposure Frequency, ingestion (days/year) | 150 | USEPA 1991a |
| $ED_{ch}$ | Exposure Duration, child (years) | 6 | USEPA 1991a |
| $SF_o$ | Slope Factor, oral (1/(mg/kg·d)) | Chemical-Specific | IRIS, HEAST, or NCEA |

**Table 7.1.1**
**CONSTRUCTED OPEN WATER CONVEYANCE SYSTEMS**

$$Cw_2(\mu g/L) = \frac{HQ \times BW_{ch} \times AT_{nc} \times RfD_o \times CF5}{IR_w \times ST_{ing} \times EF_{ing} \times ED_{ch}}$$

**Equation 4 : Childhood ingestion of volatile organic compounds, noncancer**

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| HQ | Hazard Quotient, (unitless) | 1 | ADHS, 1997 |
| $BW_{ch}$ | Body Weight, child (kg) | 15 | USEPA 1989 |
| $AT_{nc}$ | Averaging Time, noncancer (days) | 2190 | USEPA 1989 |
| $RfD_o$ | Reference Dose, oral (mg/kg-d) | Chemical- Specific | IRIS, HEAST, OR NCEA |
| CF5 | $10^3$ (µg/mg) | 1000 | ---------- |
| I $R_w$ | Ingestion Rate, child (L/hour) | 0.05 | USEPA 1991a |
| $ST_{ing}$ | Swimming Time, ingestion (hours/day) | 1 | ADHS, 1998 |
| $EF_{ing}$ | Exposure Frequency, ingestion (days/year) | 150 | USEPA 1991a |
| $ED_{ch}$ | Exposure Duration, adult (years) | 6 | USEPA 1991a |

**Table 7.1.1**
**CONSTRUCTED OPEN WATER CONVEYANCE SYSTEMS**

$$Cw_3(\mu g/L) = \frac{Risk \times BW_{ch} \times AT_c \times CF5}{SA_{ch} \times Kp \times ST_{der} \times EF_{der} \times ED_{ch} \times CF6 \times SF_o}$$

**Equation 5: Childhood dermal contact with volatile organic compounds, cancer**

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| Risk | Excess Lifetime Cancer Risk, (unitless) | 1.0E-05<br>1.0E-06 | ADHS, 1997 |
| $BW_{ch}$ | Body Weight, child (kg) | 15 | USEPA 1989 |
| $AT_c$ | Averaging Time, cancer (days) | 25550 | USEPA 1989 |
| CF5 | $10^3$ (µg/mg) | 1000 | ---------- |
| $SA_{ch}$ | Skin Surface Area, child ($cm^2$) | 10000 | USEPA, 1992 |
| Kp | Permeability Coefficient, (cm/hour) | Chemical-Specific | USEPA, 1992 |
| $ST_{der}$ | Swimming Time, dermal (hours/day) | 1 | ADHS, 1998 |
| $EF_{der}$ | Exposure Frequency, dermal (days/year) | 150 | ADHS, 1998 |
| $ED_{ch}$ | Exposure Duration, child (years) | 6 | USEPA 1991a |
| CF6 | $10^{-3}$ ($L/cm^3$) | 0.001 | ---------- |
| $SF_o$ | Slope Factor, oral (1/(mg/kg-d)) | Chemical-Specific | IRIS, HEAST, or NCEA |

**Table 7.1.1**
**CONSTRUCTED OPEN WATER CONVEYANCE SYSTEMS**

**Equation 6 : Childhood dermal contact of volatile organic compounds, noncancer**

$$Cw_3(\mu g/L) = \frac{HQ \times BW_{ch} \times AT_{nc} \times RfD_o \times CF5}{SA_{ch} \times Kp \times ST_{der} \times EF_{der} \times ED_{ch} \times CF6}$$

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| HQ | Hazard Quotient, (unitless) | 1 | ADHS, 1997 |
| $BW_{ch}$ | Body Weight, child (kg) | 15 | USEPA 1989 |
| $AT_{nc}$ | Averaging Time, noncancer (days) | 2190 | USEPA 1989 |
| $RfD_o$ | Reference Dose, oral (mg/kg-d) | Chemical-Specific | IRIS, HEAST, OR NCEA |
| CF5 | $10^3$ (μg/mg) | 1000 | ---------- |
| $SA_{ch}$ | Skin Surface Area, child ($cm^2$) | 10000 | USEPA, 1992 |
| Kp | Permeability Coefficient, (cm/hour) | Chemical-Specific | USEPA, 1992 |
| $ST_{der}$ | Swimming Time, dermal (hours/day) | 1 | ADHS, 1998 |
| $EF_{der}$ | Exposure Frequency, dermal (days/year) | 150 | ADHS, 1998 |
| $ED_{ch}$ | Exposure Duration, child (years) | 6 | USEPA 1991a |
| CF6 | $10^{-3}$ ($L/cm^3$) | 0.001 | ---------- |

**Table 7.1.2**
**CONSTRUCTED OPEN WATER CONVEYANCE SYSTEMS**
**(NON-IRRIGATION)**
**Adult Residential Scenario**

$$Cw_1(\mu g/L) = \frac{Risk \times AT_c \times BW_a \times Q/C \times CF5 \times CF4}{IR_a \times EF_{inh} \times ED_a \times SF_i \times CF1 \times Ki \times CF2 \times CF3}$$

**Equation 1: Adult inhalation of volatile organic compounds, cancer**

where: F = flux in $mg/m^2 \cdot sec$
VF = $kg/m^3$

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| Risk | Excess Lifetime Cancer Risk, (unitless) | 1.0E-05<br>1.0E-06 | ADHS, 1997 |
| $AT_c$ | Averaging Time, cancer (days) | 25550 | USEPA 1989 |
| $BW_a$ | Body Weight, (adult) kg | 70 | USEPA 1989 |
| Q/C | Inverse of mean concentration at the center of a 0.5 body of water ($mg/m^2 \cdot sec$ per $kg/m^3$) | 68800 | USEPA, 1996 |
| CF5 | $10^3$ (µg/mg) | 1000 | ---------- |
| CF4 | $10^6$ (mg $cm^3$/g L) | 1000000 | ---------- |
| $IR_a$ | Inhalation Rate, adult ($m^3$/day) | 20 | USEPA 1991a |
| $EF_{inh}$ | Exposure Frequency, inhalation (days/year) | 365 | USEPA 1991a |
| $ED_a$ | Exposure Duration, adult (years) | 30 | USEPA 1991a |
| $SF_i$ | Slope Factor, inhalation (1/(mg/kg·d)) | Chemical-Specific | IRIS, HEAST, or NCEA |
| CF1 | $10^6$ (mg/kg) | 1000000 | ---------- |
| Ki | Overall mass transfer, coefficient of i (cm/sec) | Chemical-Specific | USEPA 1995 |
| CF2 | $10^4$ ($cm^2/m^2$) | 10000 | ---------- |
| CF3 | $10^3$ (mg/g) | 1000 | ---------- |

**Table 7.1.2**
**CONSTRUCTED OPEN WATER CONVEYANCE SYSTEMS**

**Equation 2: Adult inhalation of volatile organic compounds, systemic toxicity**

$$Cw_1(\mu g/L) = \frac{HQ \times AT_{nc} \times BW_a \times Q/C \times RfD_i \times CF5 \times CF4}{IR_a \times EF_{inh} \times ED_a \times CF1 \times Ki \times CF2 \times CF3}$$

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| HQ | Hazard Quotient, (unitless) | 1 | ADHS, 1997 |
| $AT_{nc}$ | Averaging Time, noncancer (days) | 10950 | USEPA 1989 |
| $BW_a$ | Body Weight, adult (kg) | 70 | USEPA 1989 |
| Q/C | Inverse of mean concentration at the center of a 0.5 body of water ($mg/m^2$·sec per $kg/m^3$) | 68800 | USEPA, 1996 |
| $RfD_i$ | Reference Dose, inhalation (mg/kg-d) | Chemical-Specific | IRIS, HEAST, OR NCEA |
| CF5 | $10^3$ (μg/mg) | 1000 | ---------- |
| CF4 | $10^6$ (mg $cm^3$/g L) | 1000000 | ---------- |
| I $R_a$ | Inhalation Rate, adult ($m^3$/day) | 20 | USEPA 1991a |
| $EF_{inh}$ | Exposure Frequency, inhalation (days/year) | 365 | USEPA 1991a |
| $ED_a$ | Exposure Duration, adult (years) | 30 | USEPA 1991a |
| CF1 | $10^6$ (mg/kg) | 1000000 | ---------- |
| Ki | Overall mass transfer, coefficient of i (cm/sec) | Chemical-Specific | USEPA 1995 |
| CF2 | $10^4$ ($cm^2/m^2$) | 10000 | ---------- |
| CF3 | $10^3$ (mg/g) | 1000 | ---------- |

**Table 7.1.2**
**CONSTRUCTED OPEN WATER CONVEYANCE SYSTEMS**

$$Cw_2(\mu g/L) = \frac{Risk \; x \; AT_c \; x \; BW_a \; x \; CF5}{IR_w \; x \; ST_{ing} \; x \; EF_{ing} \; x \; ED_a \; x \; SF_o}$$

**Equation 3 : Adult ingestion of volatile organic compounds, cancer**

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| Risk | Excess Lifetime Cancer Risk, (unitless) | 1.0E-05<br>1.0E-06 | ADHS, 1997 |
| $AT_c$ | Averaging Time, cancer (days) | 25550 | USEPA 1989 |
| $BW_a$ | Body Weight, (adult) kg | 70 | USEPA 1989 |
| CF5 | $10^3$ (μg/mg) | 1000 | ---------- |
| $IR_w$ | Ingestion Rate, water (L/hr) | 0.05 | USEPA 1991a |
| $ST_{ing}$ | Swimming Time, ingestion (hours/day) | 1 | ADHS, 1998 |
| $EF_{ing}$ | Exposure Frequency, ingestion (days/year) | 12 | ADHS, 1998 |
| $ED_a$ | Exposure Duration, adult (years) | 30 | USEPA 1991a |
| $SF_o$ | Slope Factor, oral (1/(mg/kg·d)) | Chemical-Specific | IRIS, HEAST, or NCEA |

**Table 7.1.2**
**CONSTRUCTED OPEN WATER CONVEYANCE SYSTEMS**

$$Cw_2(\mu g/L) = \frac{HQ \times BW_a \times AT_{nc} \times RfD_o \times CF5}{IR_w \times ST_{ing} \times EF_{ing} \times ED_a}$$

**Equation 4 : Adult ingestion of volatile organic compounds, noncancer**

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| HQ | Hazard Quotient, (unitless) | 1 | ADHS, 1997 |
| $BW_a$ | Body Weight, adult (kg) | 70 | USEPA 1989 |
| $AT_{nc}$ | Averaging Time, noncancer (days) | 10950 | USEPA 1989 |
| $RfD_o$ | Reference Dose, oral (mg/kg-d) | Chemical-Specific | IRIS, HEAST, OR NCEA |
| CF5 | $10^3$ (μg/mg) | 1000 | ---------- |
| $IR_w$ | Ingestion Rate, adult (L/hr) | 0.05 | USEPA 1991a |
| $ST_{ing}$ | Swimming Time, ingestion (hours/day) | 1 | ADHS, 1998 |
| $EF_{ing}$ | Exposure Frequency, ingestion (days/year) | 12 | ADHS, 1998 |
| $ED_a$ | Exposure Duration, adult (years) | 30 | USEPA 1991a |

**Table 7.1.2**
**CONSTRUCTED OPEN WATER CONVEYANCE SYSTEMS**

$$Cw_3(\mu g/L) = \frac{Risk \times BW_a \times AT_c \times CF5}{SA_a \times Kp \times ST_{der} \times EF_{der} \times ED_a \times CF6 \times SF_o}$$

**Equation 5: Adult dermal contact with volatile organic compounds, cancer**

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| Risk | Excess Lifetime Cancer Risk, (unitless) | 1.0E-05<br>1.0E-06 | ADHS, 1997 |
| $BW_a$ | Body Weight, (kg) | 70 | USEPA 1989 |
| $AT_c$ | Averaging Time, cancer (days) | 25550 | USEPA 1989 |
| CF5 | $10^3$ (μg/mg) | 1000 | ---------- |
| $SA_a$ | Skin Surface Area, adult ($cm^2$) | 20000 | USEPA, 1992 |
| Kp | Permeability Coefficient, (cm/hour) | Chemical-Specific | USEPA, 1992 |
| $ST_{der}$ | Swimming Time, dermal (hours/day) | 1 | ADHS, 1998 |
| $EF_{der}$ | Exposure Frequency, dermal (days/year) | 12 | ADHS, 1998 |
| $ED_a$ | Exposure Duration, adult (years) | 30 | USEPA 1991a |
| CF6 | $10^{-3}$ ($L/cm^3$) | 0.001 | ---------- |
| $SF_o$ | Slope Factor, oral (1/(mg/kg-d)) | Chemical-Specific | IRIS, HEAST, or NCEA |

**Table 7.1.2**
## CONSTRUCTED OPEN WATER CONVEYANCE SYSTEMS

**Equation 6 : Adult dermal contact with volatile organic compounds, noncancer**

$$Cw_3(\mu g/L) = \frac{HQ \times BW_a \times AT_{nc} \times RfD_o \times CF5}{SA_a \times Kp \times ST_{der} \times EF_{der} \times ED_a \times CF6}$$

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| HQ | Hazard Quotient, (unitless) | 1 | ADHS, 1997 |
| $BW_a$ | Body Weight, adult, (kg) | 70 | USEPA 1989 |
| $AT_{nc}$ | Averaging Time, noncancer (days) | 10950 | USEPA 1989 |
| $RfD_o$ | Reference Dose, oral (mg/kg-d) | Chemical-Specific | IRIS, HEAST, OR NCEA |
| CF5 | $10^3$ (μg/mg) | 1000 | ---------- |
| $SA_a$ | Skin Surface Area, adult ($cm^2$) | 20000 | USEPA, 1992 |
| Kp | Permeability Coefficient (cm/hour) | Chemical-Specific | USEPA, 1992 |
| $ST_{der}$ | Swimming Time, dermal (hours/day) | 1 | ADHS, 1998 |
| $EF_{der}$ | Exposure Frequency, dermal (days/year) | 12 | ADHS, 1998 |
| $ED_a$ | Exposure Duration, adult (years) | 30 | USEPA 1991a |
| CF6 | $10^{-3}$ ($L/cm^3$) | 0.001 | ---------- |

**Table 7.2**
## CONSTRUCTED OPEN WATER CONVEYANCE SYSTEMS
**Occupational Scenario**

$$Cw_1(\mu g/L) = \frac{Risk \times AT_c \times BW_a \times Q/C \times CF5 \times CF4}{IR_a \times EF_{inh} \times ED_a \times SF_i \times CF1 \times Ki \times CF2 \times CF3}$$

**Equation 1: Occupational inhalation of volatile organic compounds, cancer**

where: F = flux in $mg/m^2 \cdot sec$
VF = $kg/m^3$

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| Risk | Excess Lifetime Cancer Risk, (unitless) | 1.0E-05<br>1.0E-06 | ADHS, 1997 |
| $AT_c$ | Averaging Time, cancer (days) | 25550 | USEPA 1989 |
| $BW_a$ | Body Weight, (adult) kg | 70 | USEPA 1989 |
| Q/C | Inverse of mean concentration at the center of a 0.5 body of water ($mg/m^2 \cdot sec$ per $kg/m^3$) | 68800 | USEPA, 1996 |
| CF5 | $10^3$ (µg/mg) | 1000 | ---------- |
| CF4 | $10^6$ (mg $cm^3$/g L) | 1000000 | ---------- |
| I $R_a$ | Inhalation Rate, adult ($m^3$/day) | 20 | USEPA 1991a |
| $EF_{inh}$ | Exposure Frequency, inhalation (days/year) | 250 | USEPA 1991a |
| $ED_a$ | Exposure Duration, adult (years) | 25 | USEPA 1991a |
| $SF_i$ | Slope Factor, inhalation (1/(mg/kg·d)) | Chemical-Specific | IRIS, HEAST, or NCEA |
| CF1 | $10^6$ (mg/kg) | 1000000 | ---------- |
| Ki | Overall mass transfer, coefficient of i (cm/sec) | Chemical-Specific | USEPA 1995 |
| CF2 | $10^4$ ($cm^2/m^2$) | 10000 | ---------- |
| CF3 | $10^3$ (mg/g) | 1000 | ---------- |

**Table 7.2**
**CONSTRUCTED OPEN WATER CONVEYANCE SYSTEMS**

**Equation 2: Occupational inhalation of volatile organic compounds, systemic toxicity**

$$Cw_1(\mu g/L) = \frac{HQ \times AT_{nc} \times BW_a \times Q/C \times RfD_i \times CF5 \times CF4}{IR_a \times EF_{inh} \times ED_a \times CF1 \times Ki \times CF2 \times CF3}$$

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| HQ | Hazard Quotient, (unitless) | 1 | ADHS, 1997 |
| $AT_{nc}$ | Averaging Time, noncancer (days) | 9125 | USEPA 1989 |
| $BW_a$ | Body Weight, adult (kg) | 70 | USEPA 1989 |
| Q/C | Inverse of mean concentration at the center of a 0.5 body of water ($mg/m^2$·sec per $kg/m^3$) | 68800 | USEPA, 1996 |
| $RfD_i$ | Reference Dose, inhalation (mg/kg-d) | Chemical Specific | IRIS, HEAST, OR NCEA |
| CF5 | $10^3$ (µg/mg) | 1000 | ---------- |
| CF4 | $10^6$ (mg $cm^3$/g L) | 1000000 | ---------- |
| $IR_a$ | Inhalation Rate, adult ($m^3$/day) | 20 | USEPA 1991a |
| $EF_{inh}$ | Exposure Frequency, inhalation (days/year) | 250 | USEPA 1991a |
| $ED_a$ | Exposure Duration, adult (years) | 25 | USEPA 1991a |
| CF1 | $10^6$ (mg/kg) | 1000000 | ---------- |
| Ki | Overall mass transfer, coefficient of i (cm/sec) | Chemical-Specific | USEPA 1995 |
| CF2 | $10^4$ ($cm^2/m^2$) | 10000 | ---------- |
| CF3 | $10^3$ (mg/g) | 1000 | ---------- |

**Table 7.2**
**CONSTRUCTED OPEN WATER CONVEYANCE SYSTEMS**

$$Cw_2(\mu g/L) = \frac{Risk \times AT_c \times BW_a \times CF5}{IR_w \times ET_{ing} \times EF_{ing} \times ED_a \times SF_o}$$

**Equation 3: Occupational ingestion of volatile organic compounds, cancer**

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| Risk | Excess Lifetime Cancer Risk, (unitless) | 1.0E-05<br>1.0E-06 | ADHS, 1997 |
| $AT_c$ | Averaging Time, cancer (days) | 25550 | USEPA 1989 |
| $BW_a$ | Body Weight, (adult) kg | 70 | USEPA 1989 |
| CF5 | $10^3$ (μg/mg) | 1000 | ---------- |
| $IR_w$ | Ingestion Rate, water (L/hour) | 0.05 | USEPA 1991a |
| $ET_{ing}$ | Exposure Time, ingestion (hour/day) | 8 | ADHS, 1998 |
| $EF_{ing}$ | Exposure Frequency, ingestion (days/year) | 250 | USEPA 1991a |
| $ED_a$ | Exposure Duration, adult (years) | 25 | USEPA 1991a |
| $SF_o$ | Slope Factor, oral (1/(mg/kg·d)) | Chemical-Specific | IRIS, HEAST, or NCEA |

**Table 7.2**
**CONSTRUCTED OPEN WATER CONVEYANCE SYSTEMS**

$$Cw_2(\mu g/L) = \frac{HQ \times BW_a \times AT_{nc} \times RfD_o \times CF5}{IR_w \times ET_{ing} \times EF_{ing} \times ED_a}$$

**Equation 4: Occupational ingestion of volatile organic compounds, noncancer**

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| HQ | Hazard Quotient, (unitless) | 1 | ADHS, 1997 |
| $BW_a$ | Body Weight, adult (kg) | 70 | USEPA 1989 |
| $AT_{nc}$ | Averaging Time, noncancer (days) | 9125 | USEPA 1989 |
| $RfD_o$ | Reference Dose, oral (mg/kg-d) | Chemical-Specific | IRIS, HEAST, OR NCEA |
| CF5 | $10^3$ (μg/mg) | 1000 | ---------- |
| $IR_w$ | Ingestion Rate, adult (L/hour) | 0.05 | USEPA 1991a |
| $ET_{ing}$ | Exposure Time, ingestion (hours/day) | 8 | ADHS, 1998 |
| $EF_{ing}$ | Exposure Frequency, ingestion (days/year) | 250 | USEPA 1991a |
| $ED_a$ | Exposure Duration, adult (years) | 25 | USEPA 1991a |

**Table 7.2**
**CONSTRUCTED OPEN WATER CONVEYANCE SYSTEMS**

$$Cw_3(\mu g/L) = \frac{Risk \times BW_a \times AT_c \times CF5}{SA_a \times Kp \times ET_{der} \times EF_{der} \times ED_a \times CF6 \times SF_o}$$

**Equation 5: Occupational dermal contact with volatile organic compounds, cancer**

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| Risk | Excess Lifetime Cancer Risk, (unitless) | 1.0E-05<br>1.0E-06 | ADHS, 1997 |
| $BW_a$ | Body Weight, (kg) | 70 | USEPA 1989 |
| $AT_c$ | Averaging Time, cancer (days) | 25550 | USEPA 1989 |
| CF5 | $10^3$ (μg/mg) | 1000 | ---------- |
| $SA_a$ | Skin Surface Area, adult ($cm^2$) | 5000 | USEPA, 1992 |
| Kp | Permeability Coefficient, (cm/hour) | Chemical-Specific | USEPA, 1992 |
| $ET_{der}$ | Exposure Time, dermal (hours/day) | 8 | ADHS, 1998 |
| $EF_{der}$ | Exposure Frequency, dermal (days/year) | 250 | USEPA 1991a |
| $ED_a$ | Exposure Duration, adult (years) | 25 | USEPA 1991a |
| CF6 | $10^{-3}$ ($L/cm^3$) | 0.001 | ---------- |
| $SF_o$ | Slope Factor, oral, (1/(mg/kg-d)) | Chemical-Specific | IRIS, HEAST, or NCEA |

**Table 7.2**
**CONSTRUCTED OPEN WATER CONVEYANCE SYSTEMS**

**Equation 6: Occupational dermal contact with volatile organic compounds, noncancer**

$$Cw_3(\mu g/L) = \frac{HQ \times BW_a \times AT_{nc} \times RfD_o \times CF5}{SA_a \times Kp \times ET_{der} \times EF_{der} \times ED_a \times CF6}$$

| Parameter | Definition (units) | Default | Reference |
|---|---|---|---|
| HQ | Hazard Quotient, (unitless) | 1 | ADHS, 1997 |
| $BW_a$ | Body Weight, (adult) kg | 70 | USEPA 1989 |
| $AT_{nc}$ | Averaging Time, noncancer (days) | 9125 | USEPA 1989 |
| $RfD_o$ | Reference Dose, oral (mg/kg-d) | Chemical Specific | IRIS, HEAST, OR NCEA |
| CF5 | $10^3$ (μg/mg) | 1000 | ---------- |
| $SA_a$ | Skin Surface Area, adult ($cm^2$) | 5000 | USEPA, 1992 |
| Kp | Permeability Coefficient (cm/hour) | Chemical-Specific | USEPA, 1992 |
| $ET_{der}$ | Exposure Time, dermal (hours/day) | 8 | ADHS, 1998 |
| $EF_{der}$ | Exposure Frequency, dermal (days/year) | 250 | ADHS, 1998 |
| $ED_a$ | Exposure Duration, adult (years) | 25 | USEPA 1991a |
| CF6 | $10^{-3}$ ($L/cm^3$) | 0.001 | ---------- |

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