Ecological Screening Values for Surface Water, Sediment, and Soil

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DISCLAIMER

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ACRONYMS

AWQC	Ambient water quality criteria
ARAR	Applicable or relevant and appropriate requirements
CCME	Canadian Council of Ministers of the Environment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLP	Contract laboratory program
CV	Chronic value
DOE	U.S. Department of Energy
EC_{50}	Median effective concentration
EPA	U.S. Environmental Protection Agency
ER-L	Effects range-low
ESV	Ecological screening value
ET	Ecotox threshold
FACR	Final acute-chronic ratio
FAV	Final acute value
LC_{50}	Median lethal concentration
LOEC	Lowest observed effect concentration
LOAEL	Lowest observed adverse effect level
MACT	Maximum acceptable toxicant concentration
MHSPE	Dutch Ministry of Health, Spatial Planning, and Environment
MPC	Maximum permissible concentration
NAWQC	National ambient water quality criteria
NOAA	National Oceanic and Atmospheric Administration
NOEC	No observed effect concentration
NPER	No potential effects range
NSTP	National status and trends program
ORNL	Oak Ridge National Laboratory
OSWER	EPA Office of Solid Waste and Emergency Response
PCB	Polychlorinated biphenyl
PQL	Practical quantification limit
RCRA	Resource Conservation and Recovery Act
SQB	Sediment quality benchmark
SQG	Soil quality guideline
TEC	Threshold effects concentration
TEL	Threshold effect level
USFWS	U.S. Fish and Wildlife Service

EXECUTIVE SUMMARY

The decision making process associated with the environmental remediation program at SRS is often risk-based. This approach, which includes both ecological and human health risk assessment, incorporates screening protocols to identify constituents that pose adverse effects. The use of benchmarks or screening values are essential to this process and in identifying constituents of potential concern. This report presents a comprehensive listing of ecological screening values (ESV's) for surface water, sediment, and soil. The sources of these non-radiological ESV's include the U.S. Environmental Protection Agency (EPA), U.S. Fish and Wildlife Service (USFWS), Environment Canada, Canadian Council of Ministers of the Environment (CCME), Oak Ridge National Laboratory (ORNL), the Ministry of Health, Spatial Planning, and Environment of the Netherlands, and the scientific literature. The basis for how these ESV's are derived is also discussed. The report concludes with a listing of recommended ESV's and describes the rationale used to propose a value from multiple sources. The protocol for applying ESV's in conducting ecological risk assessments is also presented. It should be noted that the ecological screening values presented in this report should be used for screening purposes only and are inappropriate for setting remedial action cleanup levels.

INTRODUCTION

One of the principal components of the environmental remediation program at the Savannah River Site (SRS) is the assessment of ecological risk. Required by CERCLA, RCRA, and DOE orders, ecological risk assessment can be used to identify environmental hazards and evaluate remedial action alternatives. An initial task of the ecological risk assessment is to identify constituents that potentially or adversely affect the environment. Typically, this is accomplished by comparing concentrations in surface water, sediment, or soil with regulatory or technically defensible screening values. This process can eliminate many constituents from further consideration in the risk assessment, but it also identifies those that require additional evaluation.

This document provides a comprehensive listing of ecological screening values (ESV's) for surface water, sediment, and soil. Sources of these benchmarks were the U.S. Environmental Protection Agency (EPA), U.S. Fish and Wildlife Service (USFWS), Oak Ridge National Laboratory (ORNL), the Canadian Council of Ministers of the Environment (CCME), the Dutch Ministry of the Environment, and the scientific literature. It should be noted that ecological screening values are continuously revised by the various issuing agencies. The references section of this report provides the citations of each source and, where applicable, the internet address where they can be obtained electronically. Because no radiological screening values have been issued for ecological risk assessment, the values presented here are for nonradiological contaminants. Included is a general description of how the screening values were derived and a listing of recommended ecological screening values that can be used for environmental risk assessment at the SRS and other locations. These values should be used for screening purposes only and do not represent remedial action cleanup levels. Their use at locations other than SRS should take into account environmental variables such as water quality, soil texture, flora and fauna, and other ecological attributes specific to the ecosystem potentially at risk.

SURFACE WATER

The methods used to derive ecological screening values are generally based on toxicity testing (Suter and Tsao 1996).The simplest screening benchmarks are toxicity test endpoints. Toxicity tests are conventionally categorized as acute - (48-96 hours in duration, use juvenile or adult organisms; endpoints are LC_{50} or EC_{50}) or chronic (include all or most of the lifecycle of the test organisms; endpoint is the chronic value). Test endpoints can be calculated two ways: (1) a level of effect is estimated by fitting a function (e.g., probit or logit) to the concentration-response data to derive a model; then by regression analysis, a concentration can be estimated that causes an effect (e.g., LC_{50}) and (2) hypothesis testing can be used to determine if tested concentrations are significantly (i.e., statistically) different from a control. The lowest concentration causing such an effect is the Lowest Observed Effect Concentration (LOEC). The highest concentration for which there were no such effects is called the No Observed Effect Concentration (NOEC). The geometric mean of the LOEC and NOEC is termed the Chronic Value (CV) and was formerly called the Maximum Acceptable Toxicant Concentration (MATC).

National Ambient Water Quality Criteria

The only values consistently used to screen aqueous contaminants in the United States are the

U.S. National Ambient Water Quality Criteria for the protection of aquatic life (NAWQC). NAWQC are regulatory values that are intended to protect most aquatic species most of the time with reasonable confidence (Stephan et al. 1985). Suter and Tsao (1996) state that some chronic NAWQC are based on protection of humans or other piscivorous organisms rather than protection of aquatic organisms. NAWQC are available for 113 chemicals (Table 1).

NAWQC are applicable or relevant and appropriate requirements (ARARs). If NAWQC are exceeded during the screening process, the constituent is identified as constituent of potential concern (COPC). NAWQC must be based on results from at least eight acute toxicity tests from eight different families and three chronic tests.

Acute NAWQC values are defined as one-half of the Final Acute Value (FAV). The FAV is the 5th percentile of the distribution of 48-96 hr LC_{50} values or equivalent median effective concentration (EC_{50}) value for the specific chemical. The acute NAWQC values are intended to correspond to concentrations that would cause less than 50% mortality in 5% of exposed populations in a relatively brief exposure. Chronic NAWQC values are calculated by dividing the FAV by the Final Acute-Chronic Ratio (FACR). The FACR is the geometric mean of quotients of at least three LC_{50}/CV ratios from tests of different families of aquatic organisms (Stephan et al. 1985).]

EPA Region IV Screening Values

EPA Region IV surface water screening values were derived by the Region IV Water Management Division (Table 1). These values were obtained from EPA Water Quality Criteria documents and represent the chronic ambient water quality criteria values for the protection of aquatic life. The ambient surface water quality criteria are intended to protect 95% of the species, 95% of the time. If there was insufficient information available to derive a criterion, the lowest reported effect level was used with the application of a safety factor of ten to protect for a more sensitive species. A safety factor of ten was also used to derive a chronic value if only acute information was available.

Region IV acute screening values are the same as NAWQC; if no NAWQC value is available, the Region IV screening value is derived by taking the lowest acute LC_{50} or EC_{50} and dividing by 10. Similarly, the Region IV chronic screening values are the same as NAWQC; if no NAWQC value is available, the chronic screening value is derived by taking the lowest chronic value and dividing by 10. If no chronic value exists, the acute value was divided by 10. Values for metals assume a hardness factor of 50 mg/L $CaCO_3$. The screening value for pH ranges between 6.5 and 9.0 (EPA 1995).

Ecotox Thresholds (ETs)

The EPA Office of Solid Waste and Emergency Response (OSWER) has developed media-specific benchmark values for those chemicals commonly found in surface water, sediment and soil samples at Superfund sites (values for soil are still being developed). The values (Table 1), which are referred to as Ecotox Thresholds (ETs), are defined as media-specific contaminant concentrations above which there is sufficient concern regarding adverse ecological effects to warrant further site investigation (EPA 1996). ETs are designed to provide Superfund site managers with a tool to efficiently identify contaminants that may pose a threat to ecological recep-

tors and focus further site activities on those contaminants and the media in which they are found. ETs are meant to be used for screening purposes only; they are not regulatory criteria, site-specific cleanup standards, or remediation goals. For those chemicals with the potential to bioaccumulate to toxic levels (e.g., methyl mercury, polychlorinated biphenyls (PCBs), DDT, dioxins, and lead) in upper trophic wildlife, these benchmarks may not be low enough at some sites.

The preferred surface water ETs are the chronic NAWQC values. Threshold values for metals are expressed as dissolved, rather than total; concentrations. Values for metals assume a water hardness of 100 mg/L $CaCO_3$. If chronic NAWQC values are unavailable, EPA-derived final chronic values (FCVs) are used. The maximum concentration of each chemical at a site is compared to the medium-specific ET to evaluate whether further risk assessment for the chemical is warranted. Because non-residue based NAWQC have been developed for a limited number of contaminants, ETs are also calculated using the Great Lakes Water Quality Initiative methods (40 CFR 122 et al.). These Tier II values were developed so that aquatic benchmarks could be established with fewer data than are required for the NAWQC. Approximately half of the Ecotox Tier II values were taken from Suter and Mabry (1994). These values have been revised and are discussed in the next section.

The ET software, which is available on the internet, calculates site-specific ETs by adjusting for pH and hardness in surface water and total organic carbon in sediment. The software can also compare the site-specific ETs to the concentrations detected at the site.

Oak Ridge National Laboratory (ORNL)

ORNL (Suter and Tsao 1996, Suter 1996) of ORNL compiled a list of three conventional aquatic benchmarks based on regulatory criteria or standard test endpoints. These conventional benchmarks included the NAWQC described above, Tier II values (secondary acute and secondary chronic values), and lowest chronic values for five categories of organisms (fish, daphnids, non-daphnid invertebrates, aquatic plants, and "all organisms"). They are calculated in accordance with the EPA's Proposed Water Quality Guidance for the Great Lakes System (EPA 1993). The secondary acute and secondary chronic values are equivalent to the final acute value (FAV) and final chronic value (FCV), respectively. These values are based on fewer data than what is required to calculate NAWQC values (i.e., fewer families of test organisms). These values are expected to be higher than NAWQC in no more than 20% of cases.

The lowest chronic values compiled by Suter and Tsao (1996) are either the lowest values reported in the literature for a given organism, or the estimated lowest chronic value extrapolated from 96-hour LC_{50}'s. Chronic values are also used to calculate the chronic NAWQC, but the lowest chronic value may be lower than the chronic NAWQC. Additional information on ORNL's screening values is described by Sample et al. (1998).

Canadian Guidelines

These threshold values take into consideration the protection of aquatic life; the basis for these values is determined by the CCME water quality guidelines task group (Environment Canada 1995a). In 1987, this task group published Canadian Water Quality Guidelines. These guidelines have been distributed by the United Nations Environment Program and the World Health

Organization and are currently used in 45 countries.

Originally, the guidelines dealt with substances found in freshwater only. Subsequently, the guidelines have expanded to include marine water, sediment and residues in plant and animal tissue. The task group plans to update the entire 800-plus pages of the guidelines and make it available electronically in1999.

SEDIMENT

Sediment is the fine, inundated or semi-saturated soil that exists on the bottom of lakes, rivers, streams, and wetlands. Recently, protecting sediment quality has been viewed as a logical and necessary extension of water quality protection (Adams et al. 1992, cited by Jones et al. 1997). Sediment quality benchmarks (SQBs) have been derived using analytical chemistry, toxicity test results, and field survey data (Jones et al. 1997). Accordingly, it is recommended that multiple benchmarks be used to evaluate sediment quality.

EPA Region IV

EPA Region IV's sediment screening values (Table 2) were derived from statistical interpretation of effects databases obtained from the literature as reported in publications from the State of Florida (MacDonald 1994), the National Oceanic and Atmospheric Administration (NOAA) (Long and Morgan 1990), and Long et al. (1995). The selected effect level is the lower of the effects range-low (ER-L) (Long et al. 1995) and threshold effect level (TEL) (MacDonald et al. 1996). The ER-L value is the tenth percentile of the distribution of various toxic effects thresholds for various organisms in sediments (Will and Suter 1995). The ER-L for antimony was taken from Long and Morgan (1990). These values are generally based on observations of direct toxicity, and are based predominantly on marine environments. When the Contract Laboratory Program's (CLP) practical quantification limit (PQL) is above the effect level the screening value defaults to the PQL. For those contaminants whose screening values are based on the PQL, data reported below the required quantification limit (e.g., J-flagged data) should be compared to the "effects level" number.

Ecotox Thresholds (ETs)

Proposed sediment quality criteria (SQC) have been published by the EPA Office of Water for acenaphthene, dieldrin, endrin, fluoranthene, and phenanthrene (Table 2). These values were derived using the equilibrium partitioning method. When SQCs are unavailable, sediment quality benchmarks (SQBs) are used. SQBs are derived in the same manner as the SQCs except that a Tier II secondary chronic value is substituted for the AWQC or FCV in the calculation. Effects Range-Low (ER-L) values (Long et al. 1995) are used when a SQC or SQB is unavailable. OSWER notes that there is relatively low correlation between the incidence of effects and the ER-L's for mercury, nickel, total PCBs, and DDT (Long et al. 1995) and that the ET's for these four chemicals should be used cautiously.

Oak Ridge National Laboratory (ORNL)

Jones et al. (1997a) of ORNL compiled ecological screening values for sediment in a 1997 revision of earlier works. These included benchmarks developed for NOAA and the Florida De-

partment of Environmental Protection for inorganic and organic chemicals. Also included were screening values for non-ionic organic chemicals which were derived by equilibrium partitioning. Other screening values contained in the ORNL document (Jones et al. 1997) were taken from the Ontario Ministry of the Environment, EPA Region IV, and Ecotox Threshold Values. With the exception of lowest chronic values for fish, daphnids, and non-daphnid invertebrates, the ORNL screening values (Jones et al. 1997) are either identical to those presented in this report or they were derived from less recent reports. Thus, the ORNL screening values for sediment are not included herein. The ORNL report does, however, include useful information on analytical chemistry approaches for deriving benchmarks.

Canadian Guidelines

Sediment quality guidelines (Environment Canada 1995) were developed following the methods that are described in a formal protocol (CCME 1995). The guideline derivation methods rely on the spiked-sediment toxicity test approach and the National Status and Trends Program (NSTP) approach (Long and Morgan 1990; Long 1992; Long and MacDonald 1992; Long et al. 1995; MacDonald 1994), with modifications. Information is also required to assess the relative importance of sediment characteristics (e.g., total organic carbon, grain size, acid volatiles sulfides) in modifying the bioavailability of chemicals, as well as the predictability of these relationships under field situations. In addition, the potential for adverse effects on higher trophic levels resulting from the bioaccumulation of persistent toxic substances is addressed through the use of additional methods (e.g., involving the evaluation of bioaccumulation factors and tissue residue guidelines for the protection of wildlife consumers of aquatic life).

Dutch Sediment Quality Standards

The Dutch Ministry standards (MHSPE 1994) for sediment (Table 2) are the same as those for soil (Table 3). Because the chemistry and structure of sediment and soil can differ, sediment benchmarks based on the Ministry should be used with caution. The derivation of the soil (i.e., sediment) quality standards is discussed in the ensuing section.

SOIL

EPA Region IV

Terrestrial assessments are one of the least developed aspects of ecological risk assessment. Screening values for soils have not been issued by EPA. Site-specific soil screening values may be submitted based on information concerning potential effects for contaminants whose mode of toxicity is through direct exposure (e.g., soil invertebrates such as earthworms). For those contaminants which biomagnify, screening values may be back-calculated from acceptable tissue levels in prey items through two trophic transfers from the abiotic medium. Screening values should be based on contaminant levels associated with ecological effects, instead of area or regional background levels.

U.S. Fish and Wildlife Service

One of the earliest compilations of soil screening values was presented by Beyer (1990) of the USFWS. He listed over 200 contaminants from Japan, Netherlands, Canada, United States, and

the former Soviet Union. Screening levels from the Netherlands, which are sanctioned by EPA Region IV, were taken from the interim Dutch Soil Cleanup Act (Richardson 1987) values issued in the 1980s. Three categories were identified by the Dutch: (1) category A refers to background concentrations in soil or detection limits, (2) category B refers to moderate soil contamination that requires additional study, and (3) category C refers to threshold values that require immediate cleanup. USFWS screening values are presented in Table 3.

Oak Ridge National Laboratory (ORNL)

ORNL identified soil screening values specific to DOE sites for soil invertebrates and microbial processes (Efroymson et al. 1997a), and terrestrial plants (Efroymson et al. 1997b). The soil benchmarks for invertebrates (Table 3) were derived using NOAA's effects range-low (Long and Morgan 1990) approach supported by information from field and laboratory studies, bibliographic data bases, and the published literature. Assumptions, uncertainties, and how benchmarks were calculated are detailed in Efoymson et al. (1997a). LOEC's were rank ordered and a value was selected that most closely approximated the 10th percentile of the distribution. If less than ten values were available, the lowest NOEC was used. If ten or more values were available, the 10th percentile was used. Interpolation and the authors expert judgement were used to derive some benchmarks (Efoymson et al. 1997 a,b). Because both natural soils and nutrient/mineral solutions have been used in toxicity testing, Efoymson et al. (1997b) presents screening benchmarks for terrestrial plants for both soil and soil solution. Values for plant benchmarks were derived in the same way that was used for invertebrates and microbial processes (Efoymson et al. 1997b).

Canadian Council of Ministers of the Environment (CCME)

The Canadian protocol for deriving environmental soil quality guidelines (SQGs) takes into consideration levels of ecological protection, endpoints, availability of soil toxicity data, receptor arrays, and exposure pathways for four types of land use (CCME 1996). In 1997, the CCME issued soil quality guidelines for 20 constituents (CCME 1997). The guidelines (Table 3) were derived specifically for the protection of ecological receptors in the environment or for the protection of human health associated with agricultural, residential/parkland, commercial, and industrial land use types (CCME 1997). The land use most closely associated with ecological resources was agricultural. Although the primary activity for this land use type is growing crops or livestock, it also includes agricultural lands which provide habitat for resident and transitory wildlife as well as native flora (CCME 1997).

The 1997 soil quality guidelines were issued on a constituent-by-constituent basis after a comprehensive review of the physical/chemical characteristics, background levels in Canadian soils, toxicity and environmental fate, and behavior of each constituent were derived using toxicological data to determine the threshold level for key receptors. The derivation process for SQG's considers adverse effects from direct soil contact and from the ingestion of soil and food. Four approaches were used to evaluate contact with soil: (1) weight of evidence, (2) LOEC method, (3) median effects method, and (4) comparison with nutrient and energy cycling.

The weight-of-evidence method, which is a modification of Long and Morgan (1990), estimates no adverse effects. For agricultural land use, the 25th percentile of the effects and no ef-

fects data distribution was chosen as the "no potential effects range" (NPER). An uncertainty factor was then applied to the NPER to give the "threshold effects concentration" (TEC). When the data were inadequate to perform a weight-of-evidence method, the TEC was derived by extrapolating from the lowest available LOEC divided by an uncertainty factor. Thus, the TEC will lie somewhere below the lowest reported effect concentration. When LOEC values are unavailable, the TEC is derived using the median effects method. Here, the TEC is obtained by extrapolating from the lowest available EC_{50} or LC_{50} datum using an uncertainty factor ranging from five to ten. Thus, the TEC is estimated in the region of predominantly no effects in the data distribution.

Once the TEC is calculated, it is compared to nutrient and energy cycling data for selected microbial processes. If the microbial value is less than the TEC, microbial nutrient and energy cycling processes may experience adverse effects at the TEC level. In this case, the geometric mean of the microbial and TEC values is selected as the SQG for soil contact. If the TEC is less than the microbial value, the TEC becomes the SQG.

The procedure for deriving SQG's for ingestion of soil and food by grazing livestock and wildlife is only used for agricultural land use (CCME 1997). This process is restricted to a herbivorous food chain, and considers the bioaccumulation of chemicals in plant tissue. Several steps are required for the derivation of a SQG. First, species considered to be most at risk from ingesting soil and food are identified and a daily threshold effects dose is identified based on a minimum of three studies (e.g., two mammal, one avian). Second, the daily threshold effects dose is calculated by dividing the lowest LOAEL by an uncertainty factor. Next, information is gathered including body weight, rate of soil ingestion, and rate of food ingestion for the most sensitive species as well as information on bioavialability and bioconcentration factor specific to the contaminant. This information is used to calculate the SQG in accordance with CCME (1996). Finally, the lower of the two values (soil contact versus ingestion) is used as the final SQG for agricultural (e.g. ecological) use.

Dutch Soil Quality Standards

During the 1980s, the Dutch government issued three categories of soil quality values (i.e., A, B, and C). In 1994, the ABC benchmarks were replaced: (1) "A" values became "target values," (2) "B" values were replaced by the sum of the target value and intervention value divided by two, and (3) "C" values became "intervention values" (MHSPE 1994). The target values indicate the soil quality required for sustainability or, expressed in terms of remedial policy, the soil quality required for the full restoration of the soil's functionality for human, animal, and plant life. Target values were based on standards for drinking water and surface waters. Values for heavy metals, arsenic and fluoride were derived from the analysis of field data from relatively pollution-free rural areas and aquatic sediments regarded as uncontaminated. The target values for soil were based on the target values for surface waters when scientifically possible.

Intervention values, which apply to both terrestrial soil and to soil from the beds of rivers, lakes, etc. (i.e., sediments), indicate that the concentration levels of the contaminants in the soil above which the functionality of the soil for human, plant, and animal life is seriously impaired or threatened. Concentrations in excess of the intervention values correspond to serious contamination. These values are based on ecotoxicological effects that are quantified in terms of

the concentrations in the soil at which 50% of the species actually (or potentially) occurring may undergo adverse effects.

In 1997, the Dutch Ministry issued maximum permissible concentrations (MPC's) for 18 metals (Crommentuijn et al. 1997) using three methods. When NOEC's were available for at least four taxons, statistical extrapolation was used. When only LC_{50} or a few NOEC's were available, a modification of the EPA method was used. When no laboratory data were available, equilibrium partitioning was used to derive a benchmark value. The Dutch values are based on ecotoxicological effects that are quantified in terms of the concentrations at which 50% of the species and 50% of the microbial processes in the ecosystem are threatened or adversely affected.

RECOMMENDED SCREENING VALUES

A listing of the recommended ecological screening values for the SRS remediation program are presented in Tables 4-6. These values are presented chronologically for surface water, sediment, and soil. Sources for each screening value are identified to the right of the constituent of potential concern. The rationale used to select a screening value was based on a several factors. Regulatory benchmarks that were applicable or relevant and appropriate requirements (ARAR's) were ranked first in importance. ARAR's, which are requirements issued under federal or state law, are enforceable and have been used consistently in SRS risk assessments commensurate with EPA Region IV guidance. In the absence of regulatory benchmarks, the lowest or most conservative screening values were selected using the most recently published information. At first glance some of the recommended screening values may appear contradictory. For example, the recommended sediment ESV for 1,2,4-trichlorobenzene is 9,200 µg/kg whereas it is 10 µg/kg for total trichlorobenzene. This is because the former value was published by EPA (1996) and the latter by MHSPE (1994). In these situations, the investigator must take into consideration what chemical constituent (e.g., specific compound vs. category of compound) is of interest, what receptor species have been identified, and the objective of the study. It should be noted that the goal of this report is to provide investigators with a comprehensive listing of ecological screening values. No attempt is made to endorse a source or to evaluate the derivation process. Ultimately, the investigator must determine which values are most appropriate for their objectives and study.

Surface Water

The chronic NAWQC values (EPA 1995) were ranked first in importance as ecological screening values for surface water. These are applicable or relevant and appropriate requirements, they are consistently used in the risk assessment process, and have regulatory precedent. Of the 201 constituents listed in Table 4, 56 percent were based on NAWQC. If NAWQC values were not available, EPA Ecotox Threshold (EPA 1996) values (i.e., final chronic values) were used. It should be noted that many Tier II values from Ecotox Thresholds (EPA 1996) were based on calculations by Suter and Mabry (1994) of ORNL. For these values, the secondary chronic Tier II value (Suter and Tsao 1996) was used because it was more conservative and based on more recent data. This application resulted in a markedly larger number of ORNL values compared to Ecotox values. If a screening value was not available from any of the three sources identified previously, the lowest chronic value or Canadian (Environment Canada 1998) benchmark was

used. For some constituents, only a single source was available. The number of recommended screening values by source was as follows: (1) NAWQC/EPA Region IV- 112, (2) Ecotox Thresholds - 2, (3) ORNL values - 46, and (5) Canadian water guidelines - 41. The NAWQC and secondary chronic values represented 56 and 24 per cent, respectively, of the recommended screening benchmarks for surface water (Figure 1). The Canadian values comprised 20 per cent of the benchmarks.

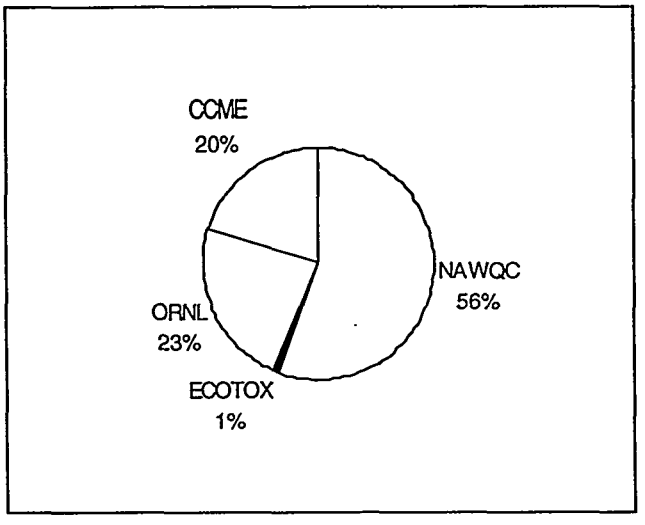

Figure 1. Distribution (%) of ESV's for surface water by source.

Sediment

The recommended ecological screening values for sediment are presented in Table 5. As was the case with surface water, sediment screening values that were applicable or relevant and appropriate requirements from EPA Region IV (EPA 1995) ranked first in importance. The ARAR's comprised 35% of the 115 constituents (Figure 2). For the remaining non-ARAR constituents, the lowest or most conservative value was used (Table 2). When the Dutch Ministry intervention value was the only available screening value, this number was divided by 10 to obtain the final recommended value. Listed in order of decreasing frequency, sources of soil screening values were as follows: (1) Dutch Ministry (MHSPE 1994) - 42%, (2) EPA Region IV (EPA 1995) - 35%, (3) Ecotox Thresholds (EPA 1996) - 21%, and (4) Environment Canada (1995) - 2%.

Soil

The EPA has not issued ecological screening values for soil. However, work has been initiated by an EPA task group and it is anticipated that screening values will be issued sometime in 1999. Existing ecological soil screening values are limited to those benchmarks issued by the USFWS (Beyer 1990), ORNL (Efroymson et al. 1997a,b), the Dutch (MHSPE 1994, Crommentuijn et al. 1997), and Canada (CCME 1997). The U.S. Fish and Wildlife Service (Beyer 1990) numbers are taken from the Dutch Ministry numbers issued in the 1980's (MHSPE 1994). The 132 recommended soil screening values (Table 6) represent the lowest or most conservative value with three exceptions: (1) when a screening value was available from both the USFWS (Beyer 1990) and Crommentuijn et al. (1997), the latter was used, (2) when target val-

ues (MHSPE 1994) and MPC's were available, the latter was used, and (3) if only an intervention value was available, it was divided by a factor of 10 to derive the recommended ESV. The use of maximum permissible concentrations was restricted to metals, and are recommended because they are based on more recent data. Including the USFWS, Dutch values constituted 60% of the recommended values. ORNL benchmarks comprised 38% whereas the Canadian values comprised 2% (Figure 3).

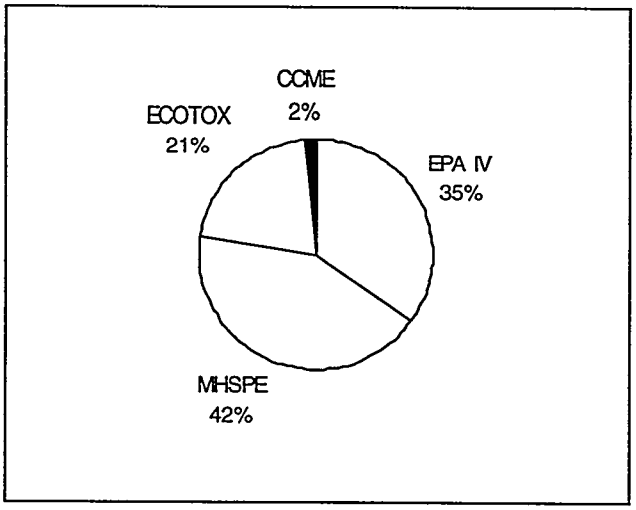

Figure 2. Distribution (%) of ESV's for sediment by source.

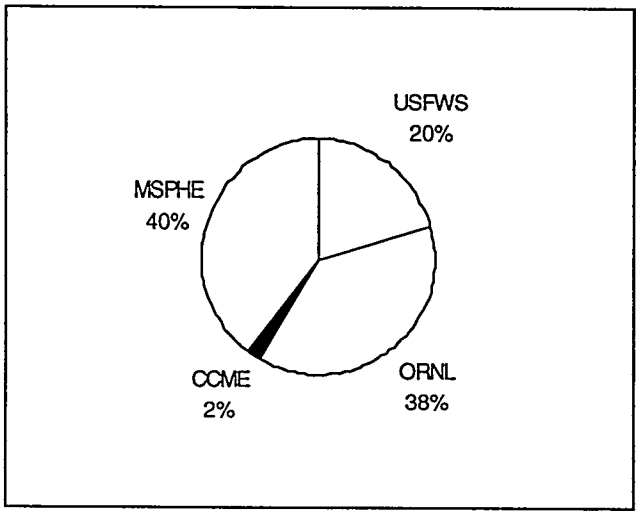

Figure 3. Distribution (%) of ESV's for soil by source.

Protocol for Using Ecological Screening Values

Ecological screening values can be used to identify constituents of potential concern. ESV's do not represent remediation goals or cleanup levels, but should be used as part of the ecological risk assessment initial screening process. Prior to the application of ecological screening values to environmental data, data quality objectives should be established and defined. Verification and validation of data should also be performed when practicable as well as developing a preliminary conceptual model.The protocol for using ecological screening values to identify constituents of potential concern consists of four steps.

Step 1 - Partition the data into the appropriate medium (e.g., surface water, sediment, soil). Units of measurement should be included.

Step 2 - Determine the maximum concentration of each constituent.

Step 3 - Compare the maximum concentration of the constituent with the ecological screening values presented in Table 4 (surface water), Table 5 (sediment), or Table 6 (soil).

Step 4 - If the maximum value does not equal or exceed the ecological screening value, the constituent is eliminated from further consideration. If the concentration of the constituent exceeds the ecological screening value, the constituent is retained for further examination. If there is no screening value available for a constituent, it is also retained for further study and should be addressed in the uncertainty section of the ecological risk assessment.

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GLOSSARY

acute toxicity-causes death or extreme physiological disorders to organisms immediately or shortly following exposure to the contaminant

ARARs (Applicable or relevant and appropriate requirements) - Federal and State standards, requirements, criteria, or limitations that affect RCRA/CERCLA remedial actions

assessment endpoint - an explicit expression of the environmental value that is to be protected. An example of an assessment endpoint would be "the protection of piscivorous birds." The measurement endpoint could be eggshell thinning (DDT).

bioaccumulation - refers to the uptake of a chemical by an organism through all routes of exposure, including ingestion, inhalation, and cutaneous absorption. Bioaccumulation is a general term that encompasses two additional concepts, bioconcentration and biomagnification.

bioaccumulation factor (BAF) - the bioaccumulation factor is similar to the BCF but it includes external and internal (i.e., ingestion) exposure. It is calculated by "adjusting" the BCF using a food chain multiplier for the organism of concern. Bioaccumulation values obtained from the literature can be used to estimate contaminant accumulation and food-chain transfer.

bioconcentration - the process by which a compound is absorbed from water through gills or epithelia tissues and is concentrated in the body; refers to the uptake of a chemical by an aquatic organism from water alone.

bioconcentration factor (BCF) - is the ratio of the concentration of a contaminant in the organisms to the concentration in the immediate environment (soil, water, sediment); the measure of a chemical's tendency to bioconcentrate. The BCF is calculated by dividing the concentration of the chemical in the exposed organism's tissues by the concentration of the chemical in the exposure medium.

biomagnification - the increase in chemical concentration in organism tissues through successively higher trophic levels resulting from chemical transfer in food; higher concentration in the consumer than in the contaminated source

chronic toxicity-involves long-term effects of small doses of a contaminant and their cumulative effects over time. These effects may lead to death of the organism or disruption of such vital functions as reproduction

chronic value - the geometric mean of the LOEC and NOEC (formerly termed the maximum acceptable toxicant concentration (MATC))

EC_{50}-median effective concentration; the concentration at which 50% of the organisms exhibit a certain physiological or behavioral response (e.g., non-lethal) in a specified period of time (usually 96 hours); is an analog of the LC_{50} where the endpoint is other than mortality; note: EC_{50} is time dependent.

ED_{50}-median effective dose; the dose at which 50% of the organisms exhibit a certain physiological or behavioral response (e.g., non-lethal) in a specified period of time (usually 96 hours); based on the analysis of nominal (i.e., dead or alive) data. ED_{50} is time dependent.

endpoint-a characteristic of an ecological component that may be affected by exposure to a stressor

LC_{50}-median lethal concentration; is calculated from population percentage mortalities produced by different concentrations after specified time periods; the environmental concentration at which 50% of the organisms die in a specified period of exposure time (usually 96 hours); LC_{50} is time dependent.

LD_{50}-median lethal dose; the administered dose at which 50% of the experimental organisms die in a specified period of exposure time (usually 96 hours); based on the analysis of nominal (i.e., dead or alive) data; note: LD_{50} is time dependent.

lethal toxicity-causes death directly through disruption of key physiological function; can be caused by acute or chronic toxicity

measurement endpoint - a measurable ecological characteristic that is related to the valued characteristic chosen as the assessment endpoint. Measurement endpoints are often expressed as the statistical or arithmetic summaries of the observations that make up the measurement.

LOEC - lowest observed effect concentration; the lowest concentration that is statistically different from the control and that causes an effect

NOEC - no observed effect concentration; the highest concentration for which there are no such effects

NOEL (no observed effects level) or NOAEL (no observed adverse effects level) - these measures, which are not time-dependent, describe the threshold below which predefined effects are not observed. When this threshold has not been determined, the lowest observed effects level (LOEL) or lowest observed adverse effects level (LOAEL) describe the lowest recorded dosage at which effects were observed. A NOAEL is preferred to a LOAEL, which is preferred to an LD_{50} or an EC50. Both the NOAEL and LOAEL are estimated by hypothesis testing.

CLP PQL -Contract Laboratory Program Practical Quantitation Limit (PQL). The PQL is analogous to the limit of quantitation (LOQ). It is an interlaboratory concept and is numerically estimated at 5 to 10 times the method detection limit (MDL).

risk-the chance that a hazard or threat will occur: risk = exposure X potency

stressor-any physical, chemical, or biological entity that can induce an adverse effect

sublethal toxicity-entails symptoms other than death or severe disorder, but may have long-term effects on a population; can be caused by acute or chronic toxicity

TABLE 1. Comprehensive Listing of Ecological Screening Values (µg/L) for Surface Water .

CONSTITUENT	NAWQC[a]		ECOTOX THRESHOLDS[b]		ORNL[c] Tier II		ORNL[c] LOWEST CHRONIC VALUE FOR:					CANADIAN GUIDELINES[d]
	Acute	Chronic	AWQC[e] or FCV[f]	Tier II	Secondary Acute	Secondary Chronic	Fish	Daphnids	Invertebrates	Aquatic Plants	All Organisms	
Aluminum	750	87[g]	-	-	-	-	3,288	1,900	-	460	460	5.0[h]-100[i]
Ammonia	-	-	-	-	-	-	1.7	630	-	2,400	1.7	1370[j]-2200[k]
Antimony	1,300	160	-	-	180	30	1,600	5,400	-	610	610	-
Arsenic	-	-	-	-	-	-	-	-				5.0
Arsenic III	360	190	190	-	-	-	2,962	914	-	2,320	914	-
Arsenic V	-	-	-	8.1	66	3.1	892	450	-	48	48	-
Barium	-	-	-	3.9	110	4.0	-	-	-	-	-	-
Beryllium	16	0.53	-	5.1	35	0.66	57	5.3	-	100,000	5.3	-
Boron	-	750	-	-	30	1.6	-	8,830	-	-	8,830	-
Cadmium	1.79*	0.66*	1.0	-	-	-	1.7	0.15	-	2.0	0.15	0.017
Calcium	-	-	-	-	-	-	-	116,000	-	-	116,000	-
Chloride	860,000	230,000	-	-	-	-	-	-	-	-	-	-
Chlorine (TRC)	19	11	-	-	-	-	-	-	-	-	-	-
Chloropyrifos	0.083	0.041	-	-	-	-	-	-	-	-	-	0.0035
Chromium (total)	-	-	-	-	-	-	-	-	-			2.0-20.0
Chromium III	984.32*	117.32*	180	-	-	-	69	<44	-	397	<44	8.9
Chromium VI	16*	11*	10	-	-	-	73.2	6.1	-	2.0	2.0	1.0
Cobalt	-	-	-	3.0	1,500	23	290	5.1	-	-	5.1	-
Copper	9.22*	6.54*	11	-	-	-	3.8	0.23	6.07	1.0	0.23	2.0-4.0[l]

TABLE 1. Comprehensive Listing of Ecological Screening Values (μg/L) for Surface Water(Continued) .

CONSTITUENT	NAWQC[a]		ECOTOX THRESHOLDS[b]		ORNL[c] Tier II		ORNL[c] LOWEST CHRONIC VALUE FOR:					CANADIAN GUIDELINES[d]
	Acute	Chronic	AWQC[e] or FCV[f]	Tier II	Secondary Acute	Secondary Chronic	Fish	Daphnids	Invertebrates	Aquatic Plants	All Organisms	
Cyanide	22	5.2	5.2	-	-	-	7.8	-	18.3	30	7.8	5.0
Demeton	-	0.1	-	-	-	-	-	-	-	-	-	-
Glyphosate	-	-	-	-	-	-	-	-	-	-	-	65
Guthion	-	0.01	-	-	-	-	-	-	-	-	-	-
Iron	-	1,000	1,000	-	-	-	1,300	158	-	-	158	300
Lead	33.78*	1.32*	2.5	-	-	-	18.9	12.3	25.5	500	12.3	1.0-7.0[m]
Lithium	-	-	-	-	260	14	-	-	-	-	-	-
Magnesium	-	-	-	-	-	-	-	82,000	-	-	82,000	-
Manganese	-	-	-	80	2,300	120	1,780	<1,100	-	-	<1,100	-
Mercury (inorganic)	2.4	0.012	1.3	-	-	1.3	<0.23	0.96	-	5.0	<0.23	0.1
Mercury (methyl)	-	-	-	0.003	0.099	0.0028	0.52	<0.04	-	0.8-4.0	<0.04	-
Mirex	-	0.001	-	-	-	-	-	-	-	-	-	-
Molybdenum	-	-	-	240	16,000	370	-	880	-	-	880	-
Nickel	789*	87.71*	160	-	-	-	<35	<5.0	128.4	5.0	<5.0	25-150[n]
Oil & Grease	-	0.01	-	-	-	-	-	-	-	-	-	-
Parathion	0.065	0.013	-	-	-	-	-	-	-	-	-	-
Potassium	-	-	-	-	-	-	-	53,000	-	-	53,000	-
Selenium	20	5.0	5.0	-	-	-	88.3	91.7	-	100	88.3	1.0
Silver	1.23*	0.012	-	-	-	0.36	0.12	2.6	-	30	0.12	0.1

TABLE 1. Comprehensive Listing of Ecological Screening Values (µg/L) for Surface Water(Continued) .

CONSTITUENT	NAWQC[a]		ECOTOX THRESHOLDS[b]		ORNL[c] Tier II		ORNL[c] LOWEST CHRONIC VALUE FOR:					CANADIAN GUIDELINES[d]
	Acute	Chronic	AWQC[e] or FCV[f]	Tier II	Secondary Acute	Secondary Chronic	Fish	Daphnids	Invertebrates	Aquatic Plants	All Organisms	
Sodium	-	-	-	-	-	-	-	680,000	-	-	680,000	-
Strontium	-	-	-	-	15,000	1,500	-	42,000	-	-	42,000	-
Sulfide(S2-, HS-)	-	2.0	-	-	-	-	-	-	-	-	-	-
Thallium	140	4.0	-	-	110	12	57	130	-	100	57	-
Tin	-	-	-	-	2,700	73	-	350	-	-	350	-
Uranium	-	-	-	-	46	2.6	142	-	-	-	142	-
Vanadium	-	-	-	19	280	20	80	1,900	-	-	80	-
Zinc	65.04*	58.91*	100	-	-	-	36.4	46.7	>5,243	30	30	30
Zirconium	-	-	-	-	310	17	548	-	-	-	548	-
Acenaphthene	170	17	23	-	-	-	74	6,646	227	520	74	6.0
Acetone	-	-	-	-	28,000	1,500	507,640	1,560	-	-	507,640	-
Acridine	-	-	-	-	-	-	-	-	-	-	-	4.0
Acrolein	6.8	2.1	-	-	-	-	-	-	-	-	-	-
Acrylonitrile	755	75.5	-	-	-	-	-	-	-	-	-	-
Aldicarb	-	-	-	-	-	-	-	-	-	-	-	1.0
Aldrin	3.0	0.3	-	-	-	-	-	-	-	-	-	0.004
Aniline	-	-	-	-	-	-	-	-	-	-	-	2.0
Anthracene	-	-			13	0.73	0.09	<2.1	-	-	0.09	0.01

TABLE 1. Comprehensive Listing of Ecological Screening Values (µg/L) for Surface Water(Continued) .

CONSTITUENT	NAWQC[a]		ECOTOX THRESHOLDS[b]		ORNL[c] Tier II		ORNL[c] LOWEST CHRONIC VALUE FOR:					CANADIAN GUIDELINES[d]
	Acute	Chronic	AWQC[e] or FCV[f]	Tier II	Secondary Acute	Secondary Chronic	Fish	Daphnids	Invertebrates	Aquatic Plants	All Organisms	
Atrazine	-	-	-	-	-	-	-	-	-	-	-	1.8
Benzene	530	53	-	46	2,300	130	-	>98,000	-	525,000	525,000	300
Benzidine	250	25	-	-	70	3.9	134	-	-	-	134	-
Benzo(a)anthracene	-	-	-	-	0.49	0.027	-	0.65	-	-	0.65	0.02
Benzo(a)pyrene	-	-		0.014	0.24	0.014	-	0.3	-	-	0.3	0.01
Benzoic acid	-	-			740	42	12,976	-	-	-	12,976	-
Benzyl alcohol	-	-			150	8.6	589	-	-	-	589	-
BHC, a-	-	500	-	-	39	2.2	-	95	-	-	95	-
BHC, b-	-	5,000	-	-	39	2.2	-	95	-	-	95	-
BHC, g- (Lindane)	2.0	0.08	0.08	-	-	-	14.6	14.5	3.3	500	3.3	0.01
Biphenyl	-	-		14	-	14	-	-	-	-	-	-
Bis(2-Chloroethyl) Ether	23,800	2,380	-	-	-	-	-	-	-	-	-	-
Bis(2-Ethylhexyl) Phthalate	1,110	< 0.3	-	32	27	3.0	-	912	-	-	912	-
Bromocil	-	-	-	-	-	-	-	-	-	-	-	5.0
Bromoform	2,930	293	-	-	-	-	-	-	-	-	-	-
Bromophenyl phenyl ether, 4-	-	-	-	1.5	-	1.5	-	-	-	-	-	-

TABLE 1. Comprehensive Listing of Ecological Screening Values (µg/L) for Surface Water(Continued) .

CONSTITUENT	NAWQC[a]		ECOTOX THRESHOLDS[b]		ORNL[c] Tier II		ORNL[c] LOWEST CHRONIC VALUE FOR:					CANADIAN GUIDELINES[d]
	Acute	Chronic	AWQC[e] or FCV[f]	Tier II	Secondary Acute	Secondary Chronic	Fish	Daphnids	Invertebrates	Aquatic Plants	All Organisms	
Bromophenyl, 4-Phenyl Phthalate	36	12.2	-	-	-	-	-	-	-	-	-	-
Bromoxynil	-	-	-	-	-	-	-	-	-	-	-	5.0
Butanone, 2-	-	-	-	-	240,000	14,000	282,170	1,394,927	-	-	282,170	-
Butylbenzyl phthalate	330	22	-	19	-	19	-	-	-	-	-	-
Captan	-	-	-	-	-	-	-	-	-	-	-	1.3
Carbaryl	-	-	-	-	-	-	-	-	-	-	-	0.2
Carbofuran	-	-	-	-	-	-	-	-	-	-	-	1.8
Carbon disulfide	-	-	-	-	17	0.92	9,538	244	-	-	244	-
Carbon tetrachloride	3,520	352	-	-	180	9.8	1,970	5,580	-	-	1,970	13
Chlordane	2.4	0.0043	-	-	-	-	1.6	16	1.09	-	1.09	0.006
Chlorobenzene	1,950	195	-	130	1,100	64	1,203	15,042	-	224,000	1,203	-
Chloroethylvinyl, 2-Ether	35,400	3,540	-	-	-	-	-	-	-	-	-	-
Chloroform	2,890	289	-	-	490	28	1,240	4,483	-	-	1,240	2.0
Chlorophenol, 2-	438	43.8	-	-	-	-	-	-	-	-	-	-
Chlorophenol, 3-Methyl-4-	3.0	0.3	-	-	-	-	-	-	-	-	-	-
Chlorothalonil	-	-	-	-	-	-	-	-	-	-	-	0.2
Cyazinine	-	-	-	-	-	-	-	-	-	-	-	2.0

TABLE 1. Comprehensive Listing of Ecological Screening Values (μg/L) for Surface Water(Continued) .

CONSTITUENT	NAWQC[a]		ECOTOX THRESHOLDS[b]		ORNL[c] Tier II		ORNL[c] LOWEST CHRONIC VALUE FOR:					CANADIAN GUIDELINES[d]
	Acute	Chronic	AWQC[e] or FCV[f]	Tier II	Secondary Acute	Secondary Chronic	Fish	Daphnids	Invertebrates	Aquatic Plants	All Organisms	
DDD, 4,4'-	0.064	0.0064	-	-	0.19	0.011	1.69	-	-	-	1.69	-
DDE, 4,4'-	105	10.5	-	-	-	-	-	-	-	-	-	-
DDT, 4,4'-	1.1	0.001	-	0.013	-	0.013	0.73	0.016	-	0.3	0.3	0.001
Decane	-	-	-	-	880	49	-	7,874	-	-	7,874	-
Deltamethrin	-	-	-	-	-	-	-	-	-	-	-	0.0004
Diazinon	-	-	0.043		0.17	0.043	-	-	-	-	-	-
Dibenzofuran	-	-		20	66	3.7	-	1,003	-	-	1,003	-
Dicamba	-	-	-	-	-	-	-	-	-	-	-	10
Diclofop-methyl	-	-	-	-	-	-	-	-	-	-	-	6.1
Dichlorobenzene, 1,2-	158	15.8	-	14	260	14	-	-	-	-	-	0.7
Dichlorobenzene, 1,3-	502	50.2	-	71	630	71	-	-	-	-	-	150
Dichlorobenzene, 1,4-	112	11.2	-	15	180	15	-	-	-	-	-	26
Dichloroethane, 1,1-	-	-		47	830	47	14,680	-	-	-	14,680	-
Dichloroethane, 1,2-	11,800	2,000	-	-	8,800	910	41,364	15,200	-	-	15,200	100
Dichloroethene, 1,1-	3,030	303	-	-	450	25	>2,800	4,720	-	>798,000	>2,800	-
Dichloroethene, 1,2-	-	-	-	-	1,100	590	9,538	-	-	-	9,538	-
Dichloroethylene, 1,2-trans-	13,500	1,350	-	-	-	-	-	-	-	-	-	-
Dichlorophenols	-	-	-	-	-	-	-	-	-	-	-	0.2

TABLE 1. Comprehensive Listing of Ecological Screening Values (µg/L) for Surface Water(Continued) .

CONSTITUENT	NAWQC[a]		ECOTOX THRESHOLDS[b]		ORNL[c] Tier II		ORNL[c] LOWEST CHRONIC VALUE FOR:					CANADIAN GUIDELINES[d]
	Acute	Chronic	AWQC[e] or FCV[f]	Tier II	Secondary Acute	Secondary Chronic	Fish	Daphnids	Invertebrates	Aquatic Plants	All Organisms	
Dichlorophenol, 2,4-	202	36.5	-	-	-	-	-	-	-	-	-	-
Dichloropropane, 1,2-	5,250	525	-	-	-	-	-	-	-	-	-	-
Dichloropropene, 1,3-	-	-	-	-	0.99	0.055	244	805	-	4,950	244	-
Dichloropropylene, 1,3- (cis and trans)	606	24.4	-	-	-	-	-	-	-	-	-	-
Dieldrin	2.5	0.0019	0.062	-	-	-	-	-	-	-	-	0.004
Diethyl phthalate	5,210	521	-	220	1,800	210	-	-	-	85,600	85,600	-
Di(2-ethyl hexyl) phthalate	-	-	-	-	-	-	-	-	-	-	-	16
Dimethoate	-	-	-	-	-	-	-	-	-	-	-	6.2
Dimethyl phthalate	3,300	330	-	-	-	-	-	-	-	-	-	-
Dimethylphenol, 2,4-	212	21.2	-	-	-	-	-	-	-	-	-	-
Dinitrophenol, 2,4-	62	6.2	-	-	-	-	-	-	-	-	-	-
Dinitrophenol, 2-Methyl-4,6-	23	2.3	-	-	-	-	-	-	-	-	-	-
Dinitrotoluene, 2,4-	3,100	310	-	-	-	-	-	-	-	-	-	-
Di-n-butyl phthalate	94	9.4	-	33	190	35	717	697	-	-	697	19
Di-n-octyl phthalate	-	-	-	-	-	-	3,822	708	-	-	708	-
Dinoseb	-	-	-	-	-	-	-	-	-	-	-	0.05

TABLE 1. Comprehensive Listing of Ecological Screening Values (μg/L) for Surface Water(Continued) .

CONSTITUENT	NAWQC[a]		ECOTOX THRESHOLDS[b]		ORNL[c] Tier II		ORNL[c] LOWEST CHRONIC VALUE FOR:					CANADIAN GUIDELINES[d]
	Acute	Chronic	AWQC[e] or FCV[f]	Tier II	Secondary Acute	Secondary Chronic	Fish	Daphnids	Invertebrates	Aquatic Plants	All Organisms	
Dioxin, 2,3,7,8-TCDD	0.1	0.00001	-	-	-	-	-	-	-	-	-	-
Diphenylhydrazine, 1,2-	27	2.7	-	-	-	-	-	-	-	-	-	-
Endosulfan, a-	0.22	0.056	-	0.051	-	0.051	-	-	-	-	-	0.02
Endosulfan, b-	0.22	0.056	-	0.051	-	0.051	-	-	-	-	-	0.02
Endrin	0.18	0.0023	0.061	-	-	-	-	-	-	-	-	0.0023
Ethylbenzene	4,530	453	-	290	130	7.3	>440	12,922	-	>438,000	>440	90
Ethylene glycol	-	-	-	-	-	-	-	-	-	-	-	192,000
Fluoranthene	398	39.8	8.1	-	-	-	30	15	-	54,400	15	0.04
Fluorene	-	-	-	3.9	70	3.9	-	-	-	-	-	3.0
Heptachlor	0.52	0.0038	-	0.0069	0.125	0.0069	1.26	3.18	-	26.7	1.26	0.01
Heptachlor Epoxide	0.52	0.0038	-	-	-	-	-	-	-	-	-	-
Hexachlorobutadiene	9	0.93	-	-	-	-	-	-	-	-	-	0.1
Hexachlorocyclopentadiene	0.7	0.07	-	-	-	-	-	-	-	-	-	-
Hexachloroethane	98	9.8	-	12	210	12	-	-	-	-	-	-
Hexane	-	-	-	-	10	0.58	65,712	-	-	-	65,712	-
Hexanone, 2-	-	-	-	-	1,800	99	32,783	-	-	-	32,783	-
Isophorone	11,700	1,170	-	-	-	-	-	-	-	-	-	-

TABLE 1. Comprehensive Listing of Ecological Screening Values (µg/L) for Surface Water(Continued).

CONSTITUENT	NAWQC[a]		ECOTOX THRESHOLDS[b]		ORNL[c] Tier II		ORNL[c] LOWEST CHRONIC VALUE FOR:					CANADIAN GUIDELINES[d]
	Acute	Chronic	AWQC[e] or FCV[f]	Tier II	Secondary Acute	Secondary Chronic	Fish	Daphnids	Invertebrates	Aquatic Plants	All Organisms	
Linuron	-	-	-	-	-	-	-	-	-	-	-	7.0
Malathion	-	0.1	-	0.097	-	-	-	-	-	-	-	-
Methoxychlor	-	0.03	-	0.019	-	0.019	-	-	-	-	-	-
Metolachlor	-	-	-	-	-	-	-	-	-	-	-	7.8
Methyl Bromide	1,100	110	-	-	-	-	-	-	-	-	-	-
Methyl Chloride	55,000	5,500	-	-	-	-	-	-	-	-	-	-
Methylene Chloride	19,300	1,930	-	-	26,000	2,200	108,000	42,667	-	-	42,667	98
Methylnaphthalene, 1-	-	-	-	-	37	2.1	526	-	-	-	526	-
Methyl, 4- , 2-pentanone	-	-	-	-	2,200	170	77,400	-	-	-	77,400	-
Methylphenol, 2-	-	-	-	-	230	13	489	1,316	-	-	489	-
Metribuzin	-	-	-	-	-	-	-	-	-	-	-	1.0
Monochlorobenzene	-	-	-	-	-	-	-	-	-	-	-	1.3
Monochlorophenols	-	-	-	-	-	-	-	-	-	-	-	7.0
N-Nitrosodiphenylamine	585	58.5	-	-	3,800	210	332	1,042	-	-	332	-
Naphthalene	230	62	-	24	190	12	620	1,163	-	33,000	620	1.0
Nitrite	-	-	-	-	-	-	-	-	-	-	-	60
Nitrobenzene	2,700	270	-	-	-	-	-	-	-	-	-	-
Nitrophenol, 2-	-	3,500	-	-	-	-	-	-	-	-	-	-

TABLE 1. Comprehensive Listing of Ecological Screening Values (μg/L) for Surface Water(Continued) .

CONSTITUENT	NAWQC[a]		ECOTOX THRESHOLDS[b]		ORNL[c] Tier II		ORNL[c] LOWEST CHRONIC VALUE FOR:					CANADIAN GUIDELINES[d]
	Acute	Chronic	AWQC[e] or FCV[f]	Tier II	Secondary Acute	Secondary Chronic	Fish	Daphnids	Invertebrates	Aquatic Plants	All Organisms	
Nitrophenol, 4-	828	82.8	-	-	1,200	300	481	7,100	-	4,190	481	-
Octanone, 2-	-	-	-	-	150	8.3	-	-	-	-	-	-
PAH's	-	-	-	-	-	-	-	-	-	-	-	0.02
PCB-1016	0.2	0.014	-	-	-	-	-	-	-	-	-	-
PCB-1221	0.2	0.014	-	-	5.0	0.28	60	-	-	-	60	-
PCB-1232	0.2	0.014	-	-	10	0.58	124	-	-	-	124	-
PCB-1242	0.2	0.014	-	-	1.2	0.053	9.0	-	4.9	300	4.9	-
PCB-1248	0.2	0.014	-	-	1.4	0.081	-	-	-	-	-	-
PCB-1254	0.2	0.014	-	-	0.6	0.033	-	2.9	-	0.1	0.1	-
PCB-1260	0.2	0.014	-	-	1,700	94	<1.3	-	-	-	2.3	-
PCBs total	-	-	-	0.19	-	0.14	0.2	2.1	0.8	0.144	0.1	0.001
Pentachlorobenzene	250	50	-	0.47	8.4	0.47	-	-	-	-	-	6.0
Pentachlorophenol	20	13	13	-	-	-	-	-	-	-	-	0.5
Pentanol, 1-	-	-	-	-	2,000	110	30,493	-	-	-	30,493	-
Phenanthrene	-	-	6.3	-	-	-	-	200	-	-	200	0.4
Phenol	1,020	256	-	-	-	-	<200	2,005	-	20,000	<200	1.0
Picloram	-	-	-	-	-	-	-	-	-	-	-	29
Propylene glycol	-	-	-	-	-	-	-	-	-	-	-	192,000
Propanol, 2-	-	-	-	-	130	7.5	590	-	-	-	590	-

TABLE 1. Comprehensive Listing of Ecological Screening Values (µg/L) for Surface Water(Continued) .

CONSTITUENT	NAWQC[a]		ECOTOX THRESHOLDS[b]		ORNL[c] Tier II		ORNL[c] LOWEST CHRONIC VALUE FOR:					CANADIAN GUIDELINES[d]
	Acute	Chronic	AWQC[e] or FCV[f]	Tier II	Secondary Acute	Secondary Chronic	Fish	Daphnids	Invertebrates	Aquatic Plants	All Organisms	
Pyrene	-	-	-	-	-	-	-	-	-	-	-	0.02
Quinoline	-	-	-	-	-	-	-	-	-	-	-	3.0
Simazine	-	-	-	-	-	-	-	-	-	-	-	10
Tebuthiuron	-	-	-	-	-	-	-	-	-	-	-	1.6
Tetrachlorobenzene, 1,2,3,4-	-	-	-	-	-	-	-	-	-	-	-	1.8
Tetrachlorobenzene, 1,2,4,5-	250	50	-	-	-	-	-	-	-	-	-	-
Tetrachloroethane, 1,1,2,2-	932	240	-	420	2,100	610	2,400	9,900	-	136,000	2,400	-
Tetrachloroethene	528	84	-	120	830	98	840	750	-	>816,000	750	110
Tetrachloromethane	-	-		240	4,400	240	-	-	-	-	-	-
Tetrachlorophenols	-	-	-	-	-	-	-	-	-	-	-	1.0
Toluene	1,750	175	-	130	120	9.8	1,269	25,229	-	245,000	1,269	2.0
Toxaphene	0.73	0.0002	-	0.011	-	-	-	-	-	-	-	0.008
Trialiate	-	-	-	-	-	-	-	-	-	-	-	0.24
Tribromomethane	-	-		320	2,300	320	-	-	-	-	-	-
Tributyltin	-	0.026	-	-	-	-	-	-	-	-	-	0.008
Trichlorobenzene, 1,2,3-	-	-	-	-	-	-	-	-	-	-	-	8.0

TABLE 1. Comprehensive Listing of Ecological Screening Values (μg/L) for Surface Water(Continued) .

CONSTITUENT	NAWQC[a]		ECOTOX THRESHOLDS[b]		ORNL[c] Tier II		ORNL[c] LOWEST CHRONIC VALUE FOR:					CANADIAN GUIDELINES[d]
	Acute	Chronic	AWQC[e] or FCV[f]	Tier II	Secondary Acute	Secondary Chronic	Fish	Daphnids	Invertebrates	Aquatic Plants	All Organisms	
Trichlorobenzene, 1,2,4-	150	44.9	-	110	700	110	-	-	-	-	-	24
Trichloroethane, 1,1,1-	5,280	528	-	62	200	11	3,493	-	-	>669,000	3,493	-
Trichloroethane, 1,1,2-	3,600	940	-	-	5,200	1,200	9,400	18,400	-	-	9,400	-
Trichloroethene	-	-	-	350	440	47	11,100	7,257	-	-	7,257	20
Trichlorophenols	-	-	-	-	-	-	-	-	-	-	-	18
Trichlorophenol, 2,4,6-	32	3.2	-	-	-	-	-	-	-	-	-	-
Trifuralin	-	-	-	-	-	-	-	-	-	-	-	0.1
Triphenyltin	-	-	-	-	-	-	-	-	-	-	-	0.02
Vinyl acetate	-	-	-	-	280	16	810	-	-	-	810	-
Xylene	-	-	-	-	230	13	62,308	-	-	-	62,308	-
Xylene, m-	-	-	-	1.8	32	1.8	-	-	-	-	-	-

[a] EPA (1995).

[b] EPA (1996).

[c] Suter and Tsao (1996).

[d] Environment Canada (1998).

[e] Ambient Water Quality Criterion (EPA 1996).

[f] Final Chronic Value (EPA 1996).

[g] pH 6.5-9.0.

[h] pH < 6.5; [Ca+2] < 4 mg/L; DOC < 2.0 mg/L.

[i] pH ≥ 6.5; [Ca+2] < 4 mg/L; DOC < 2.0 mg/L.

[j] pH 8.0; 10° C.

[k] pH 6.5; 10° C.

[l] 2 µg/L at $CaCO_3$ 0-120 mg/L; 3 µg/L at $CaCO_3$ 120-180 mg/L; 4 µg/L at $CaCO_3$ >180 mg/L.

[m] 1 µg/L at $CaCO_3$ 0-60 mg/L; 2 µg/L at $CaCO_3$ 60-120 mg/L; 4 µg/L at $CaCO_3$ 120-180 mg/L; 7 µg/L at $CaCO_3$ >180 mg/L.

[n] 25 µg/L at $CaCO_3$ 0-60 mg/L; 65 µg/L at $CaCO_3$ 60-120 mg/L; 110 µg/L at $CaCO_3$ 120-180 mg/L; 150 µg/L at $CaCO_3$ >180 mg/L.

* NAWQC values based on hardness of 50 mg/L $CaCO_3$. Adjustments should use the following equations:

Constituent	Acute Screening Value	Chronic Screening Value
Cadmium	$e^{(1.128(\ln H)-3.828)}$	$e^{(1.785(\ln H)-3.49)}$
Chromium III	$e^{(0.819(\ln H)+3.688)}$	$e^{(0.819(\ln H)+1.561)}$
Copper	$e^{(0.9422(\ln H)-1.464)}$	$e^{(0.8545(\ln H)-1.465)}$
Lead	$e^{(1.273(\ln H)-1.46)}$	$e^{(1.273(\ln H)-4.705)}$
Nickel	$e^{(0.846(\ln H)+3.3612)}$	$e^{(0.846(\ln H)+1.1645)}$
Silver	$e^{(1.72(\ln H)-6.52)}$	
Zinc	$e^{(0.8473(\ln H)+8.8604)}$	$e^{(0.8473(\ln H)+0.7614}$

TABLE 2. Comprehensive Listing of Ecological Screening Values for Sediment .

CONSTITUENT	EPA REGION IV[a]			ECOTOX THRESHOLDS[b]			ENVIRONMENT CANADA[c]		DUTCH MINISTRY STANDARDS[d]	
	Effects Values	CLP Practical Quantitation Limit	Screening Value	EPA Sediment Quality[e]	EPA Sediment Quality Benchmark[f]	Effects Range-Low	Threshold Effects Level	Probable Effects Level	Target Value	Intervention Value
Metals (mg/kg)										
Antimony	2.0	12	12	-	-	-	-	-	-	-
Arsenic	7.24	2.0	7.24	-	-	-	5.9	17	29	55
Arsenic III	-	-	-	-	-	8.2	-	-	-	-
Barium	-	-	-	-	-	-	-	-	200	625
Cadmium	0.676	1.0	1.0	-	-	1.2	0.596	3.53	0.8	12
Chromium	52.3	2.0	52.3	-	-	81	37.3	90	100	380
Cobalt	-	-	-	-	-	-	-	-	20	240
Copper	18.7	5.0	18.7	-	-	34	35.7	197	36	190
Lead	30.2	0.6	30.2	-	-	47	35	91.3	85	530
Mercury	0.13	0.02	0.13	-	-	0.15	0.174	0.486	0.3	10
Molybdenum	-	-	-	-	-	-	-	-	10	200
Nickel	15.9	8.0	15.9	-	-	21	18	35.9	35	210
Silver	0.733	2.0	2.0	-	-	-	-	-	-	-
Zinc	124	4.0	124	-	-	150	123	315	140	720

TABLE 2. Comprehensive Listing of Ecological Screening Values for Sediment(Continued).

CONSTITUENT	EPA REGION IV[a]			ECOTOX THRESHOLDS[b]			ENVIRONMENT CANADA[c]		DUTCH MINISTRY STANDARDS[d]	
	Effects Values	CLP Practical Quantitation Limit	Screening Value	EPA Sediment Quality[e]	EPA Sediment Quality Benchmark[f]	Effects Range-Low	Threshold Effects Level	Probable Effects Level	Target Value	Intervention Value
Inorganic Compounds (mg/kg)										
Cyanide (free)	-	-	-	-	-	-	-	-	1.0	20
Cyanide complex(pH<5)	-	-	-	-	-	-	-	-	5.0	650
Cyanide complex(pH>5)	-	-	-	-	-	-	-	-	5.0	50
Thiocyanates (total)	-	-	-	-	-	-	-	-	-	20
Organics (µg/kg)								-		
Acenaphthene	6.71	330	330	620	-	16	6.71	88.9	-	-
Acenaphthylene	5.87	330	330	-	-	-	5.87	128	-	-
Aldrin	-	-	-	-	-	-	-	-	2.5	-
Anthracene	46.9	330	330	-	-	-	46.9	245	-	-
Atrazine	-	-	-	-	-	-	-	-	0.05	6,000
Benzene	-	-	-	-	57	-	-	-	50	1,000
Benzo(a)anthracene	74.8	330	330	-	-	-	31.7	385	-	-
Benzo(a)pyrene	88.8	330	330	-	-	430	31.9	782	-	-
Biphenyl	-	-	-	-	1,100	-	-	-	-	-
Bis(2-ethylhexyl)phthalate	182	3.6	182	-	-	-	-	-	-	-

TABLE 2. Comprehensive Listing of Ecological Screening Values for Sediment(Continued).

CONSTITUENT	EPA REGION IV[a]			ECOTOX THRESHOLDS[b]			ENVIRONMENT CANADA[c]		DUTCH MINISTRY STANDARDS[d]	
	Effects Values	CLP Practical Quantitation Limit	Screening Value	EPA Sediment Quality[e]	EPA Sediment Quality Benchmark[f]	Effects Range-Low	Threshold Effects Level	Probable Effects Level	Target Value	Intervention Value
Bromophenyl, 4- phenyl ether	-	-	-	-	1,300	-	-	-	-	-
Butylbenzyl phthalate	-	-	-	-	11,000	-	-	-	-	-
Carbaryl	-	-	-	-	-	-	-	-	-	5,000
Carbofuran	-	-	-	-	-	-	-	-	-	2,000
Catechol	-	-	-	-	-	-	-	-	-	20,000
Chlordane	0.5	1.7	1.7	-	-	-	4.5	8.9	-	-
Chlorobenzene	-	-	-	-	820	-	-	-	-	30,000
Chloronaphthalene	-	-	-	-	-	-	-	-	-	10,000
Chlorophenols (total)	-	-	-	-	-	-	-	-	-	10,000
Chrysene	108	330	330	-	-	-	57.1	862	-	-
Cresols (total)	-	-	-	-	-	-	-	-	-	5,000
Cyclohexanon	-	-	-	-	-	-	-	-	100	270,000
DDD, p,p'-	1.22	3.3	3.3	-	-	-		-	-	-
DDD	2.0	3.3	3.3	-	-	-	3.54	8.51	-	-
DDE, p,p'-	2.07	3.3	3.3	-	-	-	-	-	-	-
DDE	2	3.3	3.3	-	-	-	1.42	6.75	-	-
DDT, p,p' -	1.19	3.3	3.3	-	-	-	-	-	-	-
DDT	1.0	3.3	3.3	-	-	1.6	1.19	4.77	-	-

TABLE 2. Comprehensive Listing of Ecological Screening Values for Sediment(Continued) .

CONSTITUENT	EPA REGION IV[a]			ECOTOX THRESHOLDS[b]			ENVIRONMENT CANADA[c]		DUTCH MINISTRY STANDARDS[d]	
	Effects Values	CLP Practical Quantitation Limit	Screening Value	EPA Sediment Quality[e]	EPA Sediment Quality Benchmark[f]	Effects Range-Low	Threshold Effects Level	Probable Effects Level	Target Value	Intervention Value
DDT (total)	1.58	3.3	3.3	-	-	-	-	-	-	-
DDT/DDE/DDD (total)	-	-	-	-	-	-	-	-	2.5	4,000
Diazinon	-	-	-	-	1.9	-	-	-	-	-
Dibenzo(a,h)anthracene	6.22	330	330	-	-	-	6.22	135	-	-
Dibenzofuran	-	-	-	-	2,000	-	-	-	-	-
Dichlorobenzene, 1,2-	-	-	-	-	340	-	-	-	-	-
Dichlorobenzene, 1,3-	-	-	-	-	1,700	-	-	-	-	-
Dichlorobenzene, 1,4-	-	-	-	-	350	-	-	-	-	-
Dichlorobenzene (total)	-	-	-	-	-	-	-	-	10	-
Dichloroethane, 1,2-	-	-	-	-	-	-	-	-	-	4,000
Dichloromethane	-	-	-	-	-	-	-	-	-	20,000
Dichlorophenols (total)	-	-	-	-	-	-	-	-	3.0	-
Dieldrin	0.02	3.3	3.3	52	-	-	2.85	6.67	0.5	-
Diethyl phthalate	-	-	-	-	630	-	-	-	-	-
Di-n-butyl phthalate	-	-	-	-	11,000	-	-	-	-	-
Endosulfan, mixed isomers	-	-	-	-	5.4	-	-	-	-	-
Endosulfan, alpha	-	-	-	-	2.9	-	-	-	-	-
Endosulfan, beta	-	-	-	-	14	-	-	-	-	-
Endrin	0.02	3.3	3.3	20	-	-	2.67	62.4	1.0	-

TABLE 2. Comprehensive Listing of Ecological Screening Values for Sediment(Continued) .

CONSTITUENT	EPA REGION IV[a]			ECOTOX THRESHOLDS[b]			ENVIRONMENT CANADA[c]		DUTCH MINISTRY STANDARDS[d]	
	Effects Values	CLP Practical Quantitation Limit	Screening Value	EPA Sediment Quality[e]	EPA Sediment Quality Benchmark[f]	Effects Range-Low	Threshold Effects Level	Probable Effects Level	Target Value	Intervention Value
Ethylbenzene	-	-	-	-	3,600	-	-	-	50	50,000
Fluoranthene	113	330	330	2,900	-	600	111	2,355	-	-
Fluorene	21.2	330	330	-	540	-	21.2	144	-	-
a-HCH	-	-	-	-	-	-	-	-	2.5	-
b-HCH	-	-	-	-	-	-	-	-	1.0	-
g-HCH (Lindane)	0.32	3.3	3.3	-	3.7	-	0.94	1.38	0.05	-
Heptachlor epoxide	-	-	-	-	-	-	0.6	2.74	-	-
Hexachlorobenzene	-	-	-	-	-	-	-	-	2.5	-
Hexachloroethane	-	-	-	-	1,000	-	-	-	-	-
Hydrochinon	-	-	-	-	-	-	-	-	-	10,000
Malathion	-	-	-	-	0.67	-	-	-	-	-
Maneb	-	-	-	-	-	-	-	-	-	35,000
Methyl, 2- Naphthalene	20.2	330	330	-	-	-	20.2	201	-	-
Methoxychlor	-	-	-	-	19	-	-	-	-	-
Mineral Oil	-	-	-	-	-	-	-	-	50,000	5,000,000
Monochlorophenols (total)	-	-	-	-	-	-	-	-	2.5	-
Naphthalene	34.6	330	330	-	480	160	34.6	391	-	-
PCB (Aroclor 1221)	21.6	67	67	-	-	-	-	-	-	-
PCB (Aroclor 1254)	-	-	-	-	-	-	60	340	-	-
PCBs (Total)	21.6	33	33	-	-	23	34.1	277	20	1,000

TABLE 2. Comprehensive Listing of Ecological Screening Values for Sediment(Continued).

CONSTITUENT	EPA REGION IV[a]			ECOTOX THRESHOLDS[b]			ENVIRONMENT CANADA[c]		DUTCH MINISTRY STANDARDS[d]	
	Effects Values	CLP Practical Quantitation Limit	Screening Value	EPA Sediment Quality[e]	EPA Sediment Quality Benchmark[f]	Effects Range-Low	Threshold Effects Level	Probable Effects Level	Target Value	Intervention Value
Pentachlorobenzene	-	-	-	-	690	-	-	-	2.5	-
Pentachlorophenol	-	-	-	-	-	-	-	-	2.0	-
Phenanthrene	86.7	330	330	850	-	240	41.9	515	-	-
Phenol	-	-	-	-	-	-	-	-	50	40,000
Polycyclic Aromatic Hydrocarbons (PAHs)										
Low Molecular Weight	312	330	330	-	-	-	-	-	-	-
High Molecular Weight	655	330	655	-	-	-	-	-	-	-
Total PAHs	1,684	330	1,684	-	-	-	-	-	100	60,000
Pyrene	153	330	330	-	-	660	53	875	-	-
Pyridine	-	-	-	-	-	-	-	-	100	1,000
Resorcinol	-	-	-	-	-	-	-	-	-	10,000
Styrene	-	-	-	-	-	-	-	-	100	1,000
Tetrachlorobenzenes (total)	-	-	-	-	-	-	-	-	10	-
Tetrachloroethane, 1,1,2,2-	-	-	-	-	940	-	-	-	-	-
Tetrachloroethene	-	-	-	-	530	-	-	-	10	4,000
Tetrachloromethane	-	-	-	-	120	-	-	-	1.0	1,000
Tetrachlorophenols (total)	-	-	-	-	-	-	-	-	1.0	-

TABLE 2. Comprehensive Listing of Ecological Screening Values for Sediment(Continued).

CONSTITUENT	EPA REGION IV[a]			ECOTOX THRESHOLDS[b]			ENVIRONMENT CANADA[c]		DUTCH MINISTRY STANDARDS[d]	
	Effects Values	CLP Practical Quantitation Limit	Screening Value	EPA Sediment Quality[e]	EPA Sediment Quality Benchmark[f]	Effects Range-Low	Threshold Effects Level	Probable Effects Level	Target Value	Intervention Value
Tetrahydrofuran	-	-	-	-	-	-	-	-	100	400
Tetrahydrothiophene	-	-	-	-	-	-	-	-	100	90,000
Toluene	-	-	-	-	670	-	-	-	50	130,000
Toxaphene	-	-	-	-	28	-	0.955	-	-	-
Tribromomethane	-	-	-	-	650	-	-	-	-	-
Trichlorobenzene, 1,2,4-	-	-	-	-	9,200	-	-	-	-	-
Trichlorobenzene (total)	-	-	-	-	-	-	-	-	10	-
Trichloroethane, 1,1,1-	-	-	-	-	170	-	-	-	-	-
Trichloroethene	-	-	-	-	1,600	-	-	-	1.0	60,000
Trichloromethane	-	-	-	-	-	-	-	-	1.0	10,000
Trichlorophenols (total)	-	-	-	-	-	-	-	-	1.0	-
Vinyl Chloride	-	-	-	-	-	-	-	-	-	100
Xylene	-	-	-	-	-	-	-	-	50	25,000
Xylene, m-	-	-	-	-	25	-	-	-	-	-

[a] EPA (1995).
[b] EPA (1996).
[c] Environment Canada (1995b).
[d] Ministry of Housing, Spatial Planning and Environment (1994).
[e] Values assume 1% organic carbon and are lower limit of 95 percent confidence interval.
[f] Sediment Quality Benchmarks by equilibrium partitioning (assumes 1 % organic carbon).

TABLE 3. Comprehensive Listing of Ecological Screening Values (mg/kg) for Soil .

CONSTITUENT	U.S. FISH AND WILDLIFE SERVICE[a]			OAK RIDGE NATIONAL LABORATORY			CCME[b]	DUTCH MINISTRY STANDARDS		
	A[c]	B[d]	C[e]	Earthworms[f]	Micro-organisms[f]	Soil Phytotoxicity[g]		Target Value[h]	Intervention Value[h]	Maximum Permissible Concentration[i]
Inorganics										
Aluminum	-	-	-	-	600	50	-	-	-	-
Antimony	-	-	-	-	-	5.0	-	-	-	3.5
Arsenic	20	30	50	60	100	10	19	29	55	34
Barium	200	400	2,000	-	3,000	500	-	200	625	165
Beryllium	-	-	-	-	-	10	-	-	-	1.1
Boron	-	-	-	-	20	0.5	-	-	-	-
Cadmium	1.0	5.0	20	20	20	4.0	3.8	0.8	12	1.6
Chromium	100	250	800	0.4	10	1.0	64[j]	100	380	100[j]
Cobalt	20	50	300	-	1,000	20	-	20	240	33
Copper	50	100	500	50	100	100	63	36	190	40
Iron	-	-	-	-	200	-	-	-	-	-
Lanathum	-	-	-	-	50	-	-	-	-	-
Lead	50	150	600	500	900	50	70	85	530	140
Lithium	-	-	-	-	10	2.0	-	-	-	-

TABLE 3. Comprehensive Listing of Ecological Screening Values (mg/kg) for Soil (Continued).

CONSTITUENT	U.S. FISH AND WILDLIFE SERVICE[a]			OAK RIDGE NATIONAL LABORATORY			CCME[b]	DUTCH MINISTRY STANDARDS		
	A[c]	B[d]	C[e]	Earthworms[f]	Micro-organisms[f]	Soil Phytotoxicity[g]		Target Value[h]	Intervention Value[h]	Maximum Permissible Concentration[i]
Manganese	-	-	-	-	100	500	-	-	-	-
Mercury (inorganic)	0.5	2.0	10	0.1	30	0.3	10	0.3	10	2.2
Mercury (methyl)	-	-	-	-	-	-	-	-	-	0.67
Molybdenum	10	40	200	-	200	2.0	-	10	200	254
Nickel	50	100	500	200	90	30	-	35	210	38
Selenium	-	-	-	70	100	1.0	-	-	-	0.81
Silver	-	-	-	-	50	2.0	-	-	-	-
Technetium	-	-	-	-	-	0.2	-	-	-	-
Thallium	-	-	-	-	-	1.0	-	-	-	1.3
Tin	20	50	300	-	2,000	50	-	-	-	53
Titanium	-	-	-	-	1,000	-	-	-	-	-
Tungsten	-	-	-	-	400	-	-	-	-	-
Uranium	-	-	-	-	-	5.0	-	-	-	-
Vanadium	-	-	-	-	20	2.0	130	-	-	43
Zinc	200	500	3,000	200	100	50	200	140	720	160
Mineral Pollutants										
Bromine	20	50	300	-	-	10	-	-	-	-

TABLE 3. Comprehensive Listing of Ecological Screening Values (mg/kg) for Soil (Continued).

CONSTITUENT	U.S. FISH AND WILDLIFE SERVICE[a]			OAK RIDGE NATIONAL LABORATORY			CCME[b]	DUTCH MINISTRY STANDARDS		
	A[c]	B[d]	C[e]	Earthworms[f]	Micro-organisms[f]	Soil Phytotoxicity[g]		Target Value[h]	Intervention Value[h]	Maximum Permissible Concentration[i]
Cyanide, free (total)	1.0	10	100	-	-	-	0.9	1.0	20	-
Cyanide, complex (total)	5.0	50	500	-	-	-	-	-	-	-
Cyanide, complex (pH < 5)	-	-	-	-	-	-	-	5.0	650	-
Cyanide, complex (pH > 5)	-	-	-	-	-	-	-	5.0	50	-
Thiocyanates	-	-	-	-	-	-	-	-	20	-
Fluorene	200	400	2,000	30	30	200	-	-	-	-
Iodine	-	-	-	-	-	4.0	-	-	-	-
Sulfur	2.0	20	200	-	-	-	-	-	-	-
Monocyclic Aromatic Hydrocarbons (MAH's)										
Benzene	0.1	0.5	5.0	-	-	-	5.0	0.05	1.0	-
Biphenyl	-	-	-	-	-	60	-	-	-	-
Ethylbenzene	0.05	5.0	50	-	-	-	1.2	0.05	50	-
Toluene	0.05	3.0	30	-	-	200	1.4	0.05	130	-
Trichloroethylene	-	-	-	-	-	-	3.0	0.001	60	-
Xylene	0.05	5.0	50	-	-	-	1.0	0.05	25	-
Total MAH's	0.1	7.0	70	-	-	-	-	-	-	-

TABLE 3. Comprehensive Listing of Ecological Screening Values (mg/kg) for Soil (Continued).

CONSTITUENT	U.S. FISH AND WILDLIFE SERVICE[a]			OAK RIDGE NATIONAL LABORATORY			CCME[b]	DUTCH MINISTRY STANDARDS		
	A[c]	B[d]	C[e]	Earthworms[f]	Micro-organisms[f]	Soil Phytotoxicity[g]		Target Value[h]	Intervention Value[h]	Maximum Permissible Concentration[i]
Phenolic Compounds										
Phenol	0.02	1.0	10	30	100	70	20	0.05	40	-
Chlorophenol, 3-	-	-	-	10	-	7.0	-	-	-	-
Chlorophenols (each)	0.01	0.5	5.0	-	-	-	-	-	-	-
Chlorophenols (total)	0.01	1.0	10	-	-	-	-	-	10	-
Dichlorophenol, 3,4-	-	-	-	20	-	20	-	-	-	-
Dichlorophenols	-	-	-	-	-	-	-	0.003	-	-
Dinitrophenol, 2,4-	-	-	-	-	-	20	-	-	-	-
Monochlorophenols (total)	-	-	-	-	-	-	-	0.0025	-	-
Nitrophenol, 4-	-	-	-	7.0	-	-	-	-	-	-
Pentachlorophenol	-	-	-	6.0	400	3.0	11	0.002	-	-
Tetrachlorophenol, 2,3,4,5-	-	-	-	20	-	-	-	-	-	-
Tetrachlorophenols (total)	-	-	-	-	-	-	-	0.001	-	-
Trichlorophenol, 2,4,5-	-	-	-	9.0	-	4.0	-	-	-	-
Trichlorophenol, 2,4,6-	-	-	-	10	-	-	-	-	-	-
Trichlorophenols (total)	-	-	-	-	-	-	-	0.001	-	-

TABLE 3. Comprehensive Listing of Ecological Screening Values (mg/kg) for Soil (Continued).

CONSTITUENT	U.S. FISH AND WILDLIFE SERVICE[a]			OAK RIDGE NATIONAL LABORATORY			CCME[b]	DUTCH MINISTRY STANDARDS		
	A[c]	B[d]	C[e]	Earthworms[f]	Micro-organisms[f]	Soil Phytotoxicity[g]		Target Value[h]	Intervention Value[h]	Maximum Permissible Concentration[i]
Polycyclic Aromatic Hydrocarbons (PAHs)										
Acenapthene	-	-	-	-	-	20	-	-	-	-
Anthracene	0.1	10	100	-	-	-	-	-	-	-
Benzo(a)pyrene	0.1	1.0	10	-	-	-	0.7	-	-	-
Chloronaphthalene	-	-	-	-	-	-	-	-	10	-
Fluoranthene	0.1	10	100	-	-	-	-	-	-	-
Naphthalene	0.1	5.0	50	-	-	-	0.6	-	-	-
Phenanthrene	0.1	5.0	50	-	-	-	-	-	-	-
Pyrene	0.1	10	100	-	-	-	-	-	-	-
Total PAHs	1.0	20	200	-	-	-	-	1.0	40	-
Chlorinated Hydrocarbons										
Aliphatic chlorinated hydrocarbons (each)	0.1	5.0	50	-	-	-	-	-	-	-
Aliphatic chlorinated hydrocarbons (total)	0.1	7.0	70	-	-	-	-	-	-	-
Carbon Tetrachloride	-	-	-	-	1,000	-	-	-	-	-
Chlorinated hydrocarbons (total)	0.1	8.0	80	-	-	-	-	-	-	-

TABLE 3. Comprehensive Listing of Ecological Screening Values (mg/kg) for Soil (Continued).

CONSTITUENT	U.S. FISH AND WILDLIFE SERVICE[a]			OAK RIDGE NATIONAL LABORATORY			CCME[b]	DUTCH MINISTRY STANDARDS		
	A[c]	B[d]	C[e]	Earthworms[f]	Micro-organisms[f]	Soil Phytotoxicity[g]		Target Value[h]	Intervention Value[h]	Maximum Permissible Concentration[i]
Chloroacetamide	-	-	-	2.0	-	-	-	-	-	-
Chloroaniline, 3-	-	-	-	30	-	20	-	-	-	-
Chlorobenzene (each)	0.05	1.0	10	-	-	-	-	-	-	-
Chlorobenzene (total)	0.05	2.0	20	40	-	-	-	-	30	-
Cis-1,4-dichloro-2-butene	-	-	-	-	1,000	-	-	-	-	-
Dichloroaniline, 2,4-	-	-	-	100	-	-	-	-	-	-
Dichloroaniline, 3,4-	-	-	-	20	-	-	-	-	-	-
Dichlorobenzene	-	-	-	-	-	-	-	0.01	-	-
Dichlorobenzene, 1,4-	-	-	-	20	-	-	-	-	-	-
Dichloroethane, 1,2-	-	-	-	-	-	-	-	-	4.0	-
Dichloromethane	-	-	-	-	-	-	-	-	20	-
Dichloropropane, 1,2-	-	-	-	700	-	-	-	-	-	-
Hexachlorobenzene	-	-	-	-	1,000	-	-	0.0025	-	-
Hexachlorocyclopentadiene	-	-	-	-	-	10	-	-	-	-
Nitrobenzene	-	-	-	40	1,000	-	-	-	-	-
Nitrosodiphenylamine, N-	-	-	-	20	-	-	-	-	-	-
Pentachloroaniline	-	-	-	100	-	-	-	-	-	-

TABLE 3. Comprehensive Listing of Ecological Screening Values (mg/kg) for Soil (Continued).

CONSTITUENT	U.S. FISH AND WILDLIFE SERVICE[a]			OAK RIDGE NATIONAL LABORATORY			CCME[b]	DUTCH MINISTRY STANDARDS		
	A[c]	B[d]	C[e]	Earthworms[f]	Micro-organisms[f]	Soil Phytotoxicity[g]		Target Value[h]	Intervention Value[h]	Maximum Permissible Concentration[i]
Pentachlorobenzene	-	-	-	20	-	-	-	0.0025	-	-
PCBs (total)	0.05	1.0	10	-	-	40	-	0.02	1.0	-
Polycyclic chlorinated hydrocarbons (total)	0.1	1.0	10	-	-	-	-	-	-	-
Tetrachloroaniline, 2,3,5,6-	-	-	-	20	-	20	-	-	-	-
Tetrachlorobenzene	-	-	-	-	-	-	-	0.01	-	-
Tetrachlorobenzene, 1,2,3,4-	-	-	-	10	-	-	-	-	-	-
Tetrachloroethene	-	-	-	-	-	-	3.8	0.01	4.0	-
Tetrachloromethane	-	-	-	-	-	-	-	0.001	1.0	-
Trans-1,4-dichloro-2-butene	-	-	-	-	1,000	-	-	-	-	-
Trichloroaniline, 2,4,5-	-	-	-	20	-	20	-	-	-	-
Trichlorobenzene	-	-	-	-	-	-	-	0.01	-	-
Trichlorobenzene, 1,2,3-	-	-	-	20	-	-	-	-	-	-
Trichlorobenzene, 1,2,4-	-	-	-	20	-	-	-	-	-	-
Trichloromethane (chloroform)	-	-	-	-	-	-	-	0.001	10	-
Vinyl chloride	-	-	-	-	-	-	-	-	0.1	-

TABLE 3. Comprehensive Listing of Ecological Screening Values (mg/kg) for Soil (Continued).

CONSTITUENT	U.S. FISH AND WILDLIFE SERVICE[a]			OAK RIDGE NATIONAL LABORATORY			CCME[b]	DUTCH MINISTRY STANDARDS		
	A[c]	B[d]	C[e]	Earthworms[f]	Micro-organisms[f]	Soil Phytotoxicity[g]		Target Value[h]	Intervention Value[h]	Maximum Permissible Concentration[i]
Pesticides										
Aldrin	-	-	-	-	-	-	-	0.0025	-	-
Atrazine	-	-	-	-	-	-	-	0.00005	6.0	-
Carbaryl	-	-	-	-	-	-	-	-	5.0	-
Carbofuran	-	-	-	-	-	-	-	-	2.0	-
DDT/DDE/DDD	-	-	-	-	-	-	-	0.0025	4.0	-
Dieldrin	-	-	-	-	-	-	-	0.0005	-	-
Endrin	-	-	-	-	-	-	-	0.001	-	-
a-HCH	-	-	-	-	-	-	-	0.0025	-	-
b-HCH	-	-	-	-	-	-	-	0.001	-	-
g-HCH (Lindane)	-	-	-	-	-	-	-	0.00005	-	-
Maneb	-	-	-	-	-	-	-	-	35	-
Organochlorinated (each)	0.1	0.5	5.0	-	-	-	-	-	-	-
Organochlorinated (total)	0.1	1.0	10	-	-	-	-	-	-	-
Total Pesticides	0.1	2.0	20	-	-	-	-	-	-	-
Other Pollutants										
Acrylonitrile	-	-	-	-	1,000	-	-	-	-	-
Catechol	-	-	-	-	-	-	-	-	20	-

TABLE 3. Comprehensive Listing of Ecological Screening Values (mg/kg) for Soil (Continued).

CONSTITUENT	U.S. FISH AND WILDLIFE SERVICE[a]			OAK RIDGE NATIONAL LABORATORY			CCME[b]	DUTCH MINISTRY STANDARDS		
	A[c]	B[d]	C[e]	Earthworms[f]	Micro-organisms[f]	Soil Phytotoxicity[g]		Target Value[h]	Intervention Value[h]	Maximum Permissible Concentration[i]
Cresols (total)	-	-	-	-	-	-	-	-	5.0	-
Cyclohexane	0.1	6.0	60	-	-	-	-	-	-	-
Cyclohexanon	-	-	-	-	-	-	-	0.1	270	-
Ethylene glycol	-	-	-	-	-	-	97	-	-	-
Furan	-	-	-	-	-	600	-	-	-	-
Gasoline	20	100	800	-	-	-	-	-	-	-
Hydrochinon	-	-	-	-	-	-	-	-	10	-
Mineral Oils	100	1,000	5,000	-	-	-	-	50	5,000	-
Phthalates (total)	-	-	-	-	-	-	-	0.1	60	-
Di-n-butyl phthalate	-	-	-	-	-	200	-	-	-	-
Diethylphthalate	-	-	-	-	-	100	-	-	-	-
Dimethylphthalate	-	-	-	200	-	-	-	-	-	-
Pyridine	0.1	2.0	20	-	-	-	-	0.1	1.0	-
Resorcinol	-	-	-	-	-	-	-	-	10	-
Styrene	0.1	5.0	50	-	-	300	-	0.1	100	-
Tetrahydrofuran	0.1	4.0	40	-	-	-	-	0.1	0.4	-
Tetrahydrothiophene	0.1	5.0	50	-	-	-	-	0.1	90	-

[a] Beyer (1990).

[b] CCME (1997).

[c] A- refers to background concentrations in soil or detection limits.

[d] B-refers to moderate soil contamination that requires additional study.

[e] C-refers to threshold values that require immediate cleanup.

[f] Efroymson et al. (1997a).

[g] Efroymson et al. (1997b).

[h] Ministry of Housing, Spatial Planning and Environment (1994).

[i] Crommentuijn et al. (1997).

[j] Value is for trivalent chromium.

TABLE 4. Ecological Screening Values (µg/L) for Surface Water .

CONSTITUENT	Target Analyte List	Target Compound List	Screening Value	Source
Aluminum	✓		87	[1]
Ammonia			1,000	[6]
Antimony	✓		160	[1]
Arsenic III	✓		190	[1]
Arsenic V	✓		3.1	[3]
Arsenic	✓		5.0	[5]
Barium	✓		4.0	[3]
Beryllium	✓		0.53	[1]
Boron			750	[1]
Cadmium	✓		0.66*	[1]
Calcium	✓		116,000	[4]
Chromium III	✓		117.32*	[1]
Chromium VI	✓		11*	[1]
Cobalt	✓		23	[3]
Copper	✓		6.54*	[1]
Cyanide	✓		5.2	[1]
Iron	✓		1,000	[1]
Lead	✓		1.32*	[1]
Lithium			14	[3]
Magnesium	✓		82,000	[4]
Manganese	✓		120	[3]
Mercury (inorganic)	✓		0.012	[1]
Mercury (methyl)	✓		0.0028	[3]
Molybdenum			370	[3]
Nickel	✓		87.71*	[1]
Potassium	✓		53,000	[4]
Selenium	✓		5.0	[1]
Silver	✓		0.012	[1]
Sodium	✓		680,000	[4]
Strontium			1,500	[3]
Sulfide(S2-, HS-)			2.0	[1]
Thallium	✓		4.0	[1]
Tin			73	[3]
Uranium			2.6	[3]
Vanadium	✓		20	[3]

TABLE 4. Ecological Screening Values (µg/L) for Surface Water (Continued).

CONSTITUENT	Target Analyte List	Target Compound List	Screening Value	Source
Zinc	✓		58.91*	[1]
Zirconium			17	[3]
Acenaphthene		✓	17	[1]
Acetone		✓	1,500	[3]
Acridine			4.0	[5]
Acrolein			2.1	[1]
Acrylonitrile			75.5	[1]
Aldrin		✓	0.3	[1]
Aldicarb			1.0	[5]
Aniline			2.0	[5]
Anthracene		✓	0.73	[3]
Atrazine			1.8	[5]
Benzene		✓	53	[1]
Benzidine			25	[1]
Benzo(a)anthracene		✓	0.02	[5]
Benzo(a)pyrene		✓	0.014	[3]
Benzoic acid		✓	42	[3]
Benzyl alcohol		✓	8.6	[3]
BHC, a-		✓	500	[1]
BHC, b-		✓	5,000	[1]
BHC, g- (Lindane)		✓	0.08	[1]
Biphenyl			14	[3]
Bis(2-Chloroethyl) Ether		✓	2,380	[1]
Bis(2-Ethylhexyl) Phthalate		✓	< 0.3	[1]
Bromocil			5.0	[5]
Bromoform		✓	293	[1]
Bromophenyl, 4- phenyl ether			1.5	[3]
Bromophenyl, 4- Phenyl Phthalate			12.2	[1]
Bromoxynil			5.0	[5]
Butanone, 2-			14,000	[3]
Butylbenzyl phthalate		✓	22	[1]
Captan			1.3	[5]
Carbaryl			0.2	[5]
Carbofuran			1.8	[5]
Carbon disulfide		✓	0.92	[3]

TABLE 4. Ecological Screening Values (µg/L) for Surface Water (Continued).

CONSTITUENT	Target Analyte List	Target Compound List	Screening Value	Source
Carbon tetrachloride		✓	352	[1]
Chlordane		✓	0.0043	[1]
Chloride			230,000	[1]
Chlorine(Total Residual)			11	[1]
Chlorobenzene		✓	195	[1]
Chloroethylvinyl, 2- Ether			3,540	[1]
Chloroform		✓	289	[1]
Chlorophenol, 2-		✓	43.8	[1]
Chlorophenol, 3-Methyl-4-			0.3	[1]
Chloropyrifos			0.041	[1]
Chlorothalonil			0.2	[5]
Cyazinine			2.0	[5]
DDD, 4,4'-		✓	0.0064	[1]
DDE, 4,4'-		✓	10.5	[1]
DDT, 4,4'-		✓	0.001	[1]
Decane			49	[3]
Deltamethrin			0.0004	[5]
Demeton			0.1	[1]
Diazinon			0.043	[3]
Dibenzofuran		✓	3.7	[3]
Dicamba			10	[5]
Dichlorobenzene, 1,2-		✓	15.8	[1]
Dichlorobenzene, 1,3-		✓	50.2	[1]
Dichlorobenzene, 1,4-		✓	11.2	[1]
Dichloroethane, 1,1-		✓	47	[3]
Dichloroethane, 1,2-		✓	2,000	[1]
Dichloroethene, 1,1-		✓	303	[1]
Dichloroethene, 1,2-			590	[3]
Dichloroethylene, 1,2-trans-		✓	1,350	[1]
Dichlorophenols			0.2	[5]
Dichlorophenol, 2,4-		✓	36.5	[1]
Dichloropropane, 1,2-		✓	525	[1]
Dichloropropene, 1,3-		✓	0.055	[3]
Dichloropropylene, 1,3- (cis and trans)			24.4	[1]
Diclofop-methyl			6.1	[5]
Dieldrin		✓	0.0019	[1]

TABLE 4. Ecological Screening Values (µg/L) for Surface Water (Continued).

CONSTITUENT	Target Analyte List	Target Compound List	Screening Value	Source
Diethyl phthalate		✓	521	[1]
Di (2-ethyl hexyl) phthalate			16	[5]
Dimethyl phthalate		✓	330	[1]
Dimethylphenol, 2,4-		✓	21.2	[1]
Dinitrophenol, 2,4-		✓	6.2	[1]
Dinitrophenol, 2-Methyl-4,6-			2.3	[1]
Dinitrotoluene, 2,4-		✓	310	[1]
Di-n-butyl phthalate		✓	9.4	[1]
Di-n-octyl phthalate		✓	708	[4]
Dioxin, 2,3,7,8-TCDD			0.00001	[1]
Diphenylhydrazine, 1,2-			2.7	[1]
Endosulfan, a-		✓	0.056	[1]
Endosulfan, b-		✓	0.056	[1]
Endrin		✓	0.0023	[1]
Ethylbenzene		✓	453	[1]
Ethylene Glycol			192,000	[5]
Fluoranthene		✓	39.8	[1]
Fluorene		✓	3.9	[2,3]
Glyphosate			65	[5]
Guthion			0.01	[1]
Heptachlor			0.0038	[1]
Heptachlor Epoxide		✓	0.0038	[1]
Hexachlorobutadiene		✓	0.93	[1]
Hexachlorocyclopentadiene		✓	0.07	[1]
Hexachloroethane		✓	9.8	[1]
Hexane			0.58	[3]
Hexanone, 2-		✓	99	[3]
Isophorone		✓	1,170	[1]
Linuron			7.0	[5]
Malathion			0.1	[1]
Methoxychlor		✓	0.03	[1]
Methyl Bromide (Bromomethane)		✓	110	[1]
Methyl Chloride (Chloromethane)		✓	5,500	[1]
Methylene Chloride (Dichloromethane)		✓	1,930	[1]

TABLE 4. Ecological Screening Values (µg/L) for Surface Water (Continued).

CONSTITUENT	Target Analyte List	Target Compound List	Screening Value	Source
Methylnaphthalene, 1-			2.1	[3]
Methyl, 4- , 2-pentanone			170	[3]
Methylphenol, 2-			13	[3]
Metolachlor			7.8	[5]
Metribuzin			1.0	[5]
Mirex			0.001	[1]
Monochlorobenzene			1.3	[5]
Monochlorophenols			7.0	[5]
N-Nitrosodiphenylamine		✓	58.5	[1]
Naphthalene		✓	62	[1]
Nitrite			60	[5]
Nitrobenzene		✓	270	[1]
Nitrophenol, 2-		✓	3,500	[1]
Nitrophenol, 4-		✓	82.8	[1]
Octanone, 2-			8.3	[3]
Oil & Grease			0.01	[1]
PAH's			0.02	[5]
Parathion			0.013	[1]
PCB-1016		✓	0.014	[1]
PCB-1221		✓	0.014	[1]
PCB-1232		✓	0.014	[1]
PCB-1242		✓	0.014	[1]
PCB-1248		✓	0.014	[1]
PCB-1254		✓	0.014	[1]
PCB-1260		✓	0.014	[1]
PCBs total		✓	0.14	[3]
Pentachlorobenzene			50	[1]
Pentachlorophenol		✓	13	[1]
Pentanol, 1-			110	[3]
Phenanthrene		✓	0.4	[5]
Phenol		✓	256	[1]
Picloram			29	[5]
Propylene Glycol			192,000	[5]
Propanol, 2-			7.5	[3]
Pyrene			0.02	[5]
Quinoline			3.0	[5]
Simazine			10	[5]

TABLE 4. Ecological Screening Values (µg/L) for Surface Water (Continued).

CONSTITUENT	Target Analyte List	Target Compound List	Screening Value	Source
Tebuthiuron			1.6	[5]
Tetrachlorobenzene, 1,2,3,4-			1.8	[5]
Tetrachlorobenzene, 1,2,4,5-			50	[1]
Tetrachloroethane, 1,1,2,2-		✓	240	[1]
Tetrachloroethene		✓	84	[1]
Tetrachloromethane			240	[2,3]
Tetrachlorophenols			1.0	[5]
Toluene		✓	175	[1]
Toxaphene		✓	0.0002	[1]
Trialate			0.24	[5]
Tribromomethane			320	[2,3]
Tributyltin			0.026	[1]
Trichlorobenzene, 1,2,3-			8.0	[5]
Trichlorobenzene, 1,2,4-		✓	44.9	[1]
Trichloroethane, 1,1,1-		✓	528	[1]
Trichloroethane, 1,1,2-		✓	940	[1]
Trichloroethene			47	[3]
Trichlorophenols			18	[5]
Trichlorophenol, 2,4,6-		✓	3.2	[1]
Trifuralin			0.1	[5]
Triphenyltin			0.02	[5]
Vinyl Acetate		✓	16	[3]
Xylene		✓	13	[3]
Xylene, m-		✓	1.8	[2,4]

*Hardness based on 50 mg/L $CaCO_3$. Adjustments should use the following equations:

Constituent	Acute Screening Value	Chronic Screening Value
Cadmium	$e^{(1.128(\ln H)-3.828)}$	$e^{(1.785(\ln H)-3.49)}$
Chromium III	$e^{(0.819(\ln H)+3.688)}$	$e^{(0.819(\ln H)+1.561)}$
Copper	$e^{(0.9422(\ln H)-1.464)}$	$e^{(0.8545(\ln H)-1.465)}$
Lead	$e^{(1.273(\ln H)-1.46)}$	$e^{(1.273(\ln H)-4.705)}$
Nickel	$e^{(0.846(\ln H)+3.3612)}$	$e^{(0.846(\ln H)+1.1645)}$
Silver	$e^{(1.72(\ln H)-6.52)}$	
Zinc	$e^{(0.8473(\ln H)+8.8604)}$	$e^{(0.8473(\ln H)+0.7614}$

Source:
[1]Chronic Ambient Water Quality Criteria (EPA 1995).
[2]Ecotox Threshold (Tier II) Value (EPA 1996).
[3]Tier II Secondary Chronic Value (Suter and Tsao 1996).
[4]Lowest Chronic Value (Suter and Tsao 1996).
[5]Canadian Water Guidelines (Environment Canada 1998).
[6]Ammonia is pH and temperature dependent. The proposed value was taken from the 4-day average chronic concentration in water having a temperature of 30 ° C and a pH of 8.0 when salmonids and other sensitive coldwater species absent (EPA 1985).

TABLE 5. Ecological Screening Values for Sediment .

CONSTITUENT	Target Analyte List	Target Compound List	Screening Value	Source
Metals (mg/kg)				
Antimony	✓		12	[1]
Arsenic	✓		7.24	[1]
Arsenic III	✓		8.2	[2]
Barium	✓		200	[4]
Cadmium	✓		1.0	[1]
Chromium	✓		52.3	[1]
Cobalt	✓		20	[4]
Copper	✓		18.7	[1]
Lead	✓		30.2	[1]
Mercury	✓		0.13	[1]
Molybdenum			10	[4]
Nickel	✓		15.9	[1]
Silver	✓		2.0	[1]
Zinc	✓		124	[1]
Inorganic Compounds (mg/kg)				
Cyanide (free)	✓		1.0	[4]
Cyanide complex(pH<5)	✓		5.0	[4]
Cyanide complex(pH>5)	✓		5.0	[4]
Thiocyanates (total)			2.0*	[4]
Organics (µg/kg)				
Acenaphthene		✓	330	[1]
Acenaphthylene		✓	330	[1]
Aldrin		✓	2.5	[4]
Anthracene		✓	330	[1]
Atrazine			0.05	[4]
Benzene		✓	50	[4]
Benzo(a)anthracene		✓	330	[1]
Benzo(a)pyrene		✓	330	[1]
Biphenyl			1,100	[2]
Bis(2-ethylhexyl)phthalate		✓	182	[1]
Bromophenyl phenyl ether, 4-		✓	1,300	[2]
Butylbenzyl phthalate		✓	11,000	[2]
Carbaryl			500*	[4]
Carbofuran			200*	[4]

TABLE 5. Ecological Screening Values for Sediment .

CONSTITUENT	Target Analyte List	Target Compound List	Screening Value	Source
Catechol			2,000*	[4]
Chlordane		✓	1.7	[1]
Chlorobenzene		✓	820	[2]
Chloronaphthalene			1,000*	[4]
Chlorophenols (total)		✓	1,000*	[4]
Chrysene		✓	330	[1]
Cresols (total)		✓	500*	[4]
Cyclohexanon			100	[4]
DDD, p,p'-		✓	3.3	[1]
DDD		✓	3.3	[1]
DDE, p,p'-		✓	3.3	[1]
DDE		✓	3.3	[1]
DDT, p,p' -		✓	3.3	[1]
DDT		✓	3.3	[1]
DDT (total)		✓	3.3	[1]
DDT/DDE/DDD (total)		✓	2.5	[4]
Diazinon			1.9	[2]
Dibenzo(a,h)anthracene		✓	330	[1]
Dibenzofuran		✓	2,000	[2]
Dichlorobenzene, 1,2-		✓	340	[2]
Dichlorobenzene, 1,3-		✓	1,700	[2]
Dichlorobenzene, 1,4-		✓	350	[2]
Dichlorobenzene (total)		✓	10	[4]
Dichloroethane, 1,2-		✓	400*	[4]
Dichloromethane (Methylene Chloride)		✓	2,000*	[4]
Dichlorophenols (total)		✓	3.0	[4]
Dieldrin		✓	3.3	[1]
Diethyl phthalate		✓	630	[2]
Di-n-butyl phthalate		✓	11,000	[2]
Endosulfan, mixed isomers		✓	5.4	[2]
Endosulfan, alpha		✓	2.9	[2]
Endosulfan, beta		✓	14	[2]
Endrin		✓	3.3	[1]
Ethylbenzene		✓	50	[4]
Fluoranthene		✓	330	[1]
Fluorene		✓	330	[1]
a-HCH			2.5	[4]

TABLE 5. Ecological Screening Values for Sediment .

CONSTITUENT	Target Analyte List	Target Compound List	Screening Value	Source
b-HCH			1.0	[4]
g-HCH (Lindane)		✓	3.3	[1]
Heptachlor Epoxide		✓	0.6	[3]
Hexachlorobenzene		✓	2.5	[4]
Hexachloroethane		✓	1,000	[2]
Hydrochinon			1,000*	[4]
Malathion			0.67	[2]
Maneb			3,500*	[4]
Methylnaphthalene, 2-		✓	330	[1]
Methoxychlor		✓	19	[2]
Mineral Oil			50,000	[4]
Monochlorophenols (total)			2.5	[4]
Naphthalene		✓	330	[1]
PCB (Aroclor 1221)		✓	67	[1]
PCB (Aroclor 1254)		✓	60	[3]
PCBs (Total)		✓	33	[1]
Pentachlorobenzene			2.5	[4]
Pentachlorophenol		✓	2.0	[4]
Phenanthrene		✓	330	[1]
Phenol		✓	50	[4]
Polycyclic Aromatic Hydrocarbons				
Low Molecular Weight			330	[1]
High Molecular Weight			655	[1]
Total PAHs			1,684	[1]
Pyrene		✓	330	[1]
Pyridine			100	[4]
Resorcinol			1,000*	[4]
Styrene		✓	100	[4]
Tetrachlorobenzenes (total)			10	[4]
Tetrachloroethane, 1,1,2,2-		✓	940	[2]
Tetrachloroethene		✓	10	[4]
Tetrachloromethane			1.0	[4]
Tetrachlorophenols (total)			1.0	[4]
Tetrahydrofuran			100	[4]
Tetrahydrothiophene			100	[4]
Toluene		✓	50	[4]
Toxaphene		✓	28	[2]

TABLE 5. Ecological Screening Values for Sediment.

CONSTITUENT	Target Analyte List	Target Compound List	Screening Value	Source
Tribromomethane			650	[2]
Trichlorobenzene, 1,2,4-			9,200	[2]
Trichlorobenzene (total)			10	[4]
Trichloroethane, 1,1,1-		✓	170	[2]
Trichloroethene			1.0	[4]
Trichloromethane			1.0	[4]
Trichlorophenols (total)		✓	1.0	[4]
Vinyl Chloride		✓	10*	[4]
Xylene		✓	50	[4]
Xylene, m-		✓	25	[2]

* Value represents the intervention value (MHSPE 1994) divided by a factor of 10.

Source:
[1]EPA (1995).
[2]EPA (1996).
[3]Environment Canada (1995b).
[4]Ministry of Housing, Spatial Planning and Environment (1994).

TABLE 6. Recommended Ecological Screening Values (mg/kg) for Soil .

CONSTITUENT	Target Analyte List	Target Compound List	Screening Value	Source
Inorganics				
Aluminum	✓		50	[2]
Antimony	✓		3.5	[5]
Arsenic	✓		10	[2]
Barium	✓		165	[5]
Beryllium	✓		1.1	[5]
Boron			0.5	[2]
Cadmium	✓		1.6	[5]
Chromium	✓		0.4	[2;3]
Cobalt	✓		20	[1, 2, 4]
Copper	✓		40	[5]
Iron	✓		200	[2]
Lanathum			50	[2]
Lead	✓		50	[1, 2]
Lithium			2.0	[2]
Manganese	✓		100	[2]
Mercury (inorganic)	✓		0.1	[2]
Mercury (methyl)	✓		0.67	[5]
Molybdenum			2.0	[2]
Nickel	✓		30	[2]
Selenium	✓		0.81	[5]
Silver	✓		2.0	[2]
Technetium			0.2	[2]
Thallium			1.0	[2]
Tin			53	[5]
Titanium			1,000	[2]
Tungsten			400	[2]
Uranium			5.0	[2]
Vanadium	✓		2.0	[2]
Zinc	✓		50	[2]
Mineral Pollutants				
Bromine			10	[2]
Cyanide, free (total)	✓		0.9	[3]
Cyanide, comlex (total)	✓		5.0	[1]
Thiocyanates			20	[4]

TABLE 6. Recommended Ecological Screening Values (mg/kg) for Soil (Continued).

CONSTITUENT	Target Analyte List	Target Compound List	Screening Value	Source
Fluorene			30	[2]
Iodine			4.0	[2]
Sulfur			2.0	[1]
Monocyclic Aromatic Hydrocarbons				
Benzene		✓	0.05	[4]
Biphenyl			60	[2]
Ethylbenzene		✓	0.05	[1,4]
Toluene		✓	0.05	[1,4]
Trichloroethylene		✓	0.001	[4]
Xylene		✓	0.05	[1,4]
Total MAH's			0.1	[1]
Phenolic Compounds				
Phenol		✓	0.05	[4]
Chlorophenol, 3-			7.0	[2]
Chlorophenols (each)		✓	0.01	[1]
Chlorophenols (total)		✓	0.01	[1]
Dichlorophenol, 3,4-			20	[2]
Dichlorophenols (total)			0.003	[4]
Dinitrophenol, 2,4-	✓		20	[2]
Monochlorophenols (total)			0.0025	[4]
Nitrophenol, 4-		✓	7.0	[2]
Pentachlorophenol		✓	0.002	[4]
Tetrachlorophenol, 2,3,4,5-			20	[2]
Tetrachlorophenols (total)			0.001	[4]
Trichlorophenol, 2,4,5-	✓		4.0	[2]
Trichlorophenol, 2,4,6-			10	[2]
Trichlorophenols (total)			0.001	[4]
Polycyclic Aromatic Hydrocarbons				
Acenapthene		✓	20	[2]
Anthracene		✓	0.1	[1]
Benzo(a)pyrene		✓	0.1	[1]
Chloronaphthalene		✓	1.0	[4]
Fluoranthene		✓	0.1	[1]
Naphthalene		✓	0.1	[1]
Phenanthrene		✓	0.1	[1]
Pyrene		✓	0.1	[1]
Total PAH's			1.0	[1,4]

TABLE 6. Recommended Ecological Screening Values (mg/kg) for Soil (Continued).

CONSTITUENT	Target Analyte List	Target Compound List	Screening Value	Source
Chlorinated Hydrocarbons				
Aliphatic chlorinated hydrocarbons (each)			0.1	[1]
Aliphatic chlorinated hydrocarbons (total)			0.1	[1]
Carbon tetrachloride		✓	1,000	[2]
Chlorinated hydrocarbons (total)			0.1	[1]
Chloroacetamide			2.0	[2]
Chloroaniline, 3-			20	[2]
Chlorobenzene (each)		✓	0.05	[1]
Chlorobenzene (total)		✓	0.05	[1]
Cis-1,4-dichloro-2-butene			1,000	[2]
Dichloroaniline, 2,4-			100	[2]
Dichloroaniline, 3,4-			20	[2]
Dichlorobenzene			0.01	[4]
Dichloroethane, 1,2-		✓	0.4	[4]
Dichloromethane		✓	2.0	[4]
Dichloropropane, 1,2-			700	[2]
Hexachlorobenzene		✓	0.0025	[4]
Hexachlorocyclopentadiene		✓	10	[2]
Nitrobenzene		✓	40	[2]
Nitrosodiphenylamine, N-		✓	20	[2]
Pentachloroaniline			100	[2]
Pentachlorobenzene			0.0025	[4]
PCBs (total)		✓	0.02	[4]
Polycyclic chlorinated hydrocarbons (total)			0.1	[1]
Tetrachloroaniline, 2,3,5,6-			20	[2]
Tetrachlorobenzene			0.01	[4]
Tetrachloroethene			0.01	[4]
Tetrachloromethane			0.001	[4]
Trans-1,4-dichloro-2-butene			1,000	[2]
Trichloroaniline, 2,4,5-			20	[2]
Trichlorobenzene		✓	0.01	[4]
Trichloromethane (chloroform)			0.001	[4]
Vinyl chloride		✓	0.01	[4]
Pesticides				
Aldrin		✓	0.0025	[4]
Atrazine			0.00005	[4]
DDT/DDE/DDD (total)		✓	0.0025	[4]

TABLE 6. Recommended Ecological Screening Values (mg/kg) for Soil (Continued).

CONSTITUENT	Target Analyte List	Target Compound List	Screening Value	Source
Dieldrin		✓	0.0005	[4]
Endrin		✓	0.001	[4]
Carbaryl			0.5	[4]
Carbofuran			0.2	[4]
HCH, a-			0.0025	[4]
HCH, b-			0.001	[4]
HCH, g- (Lindane)		✓	0.00005	[4]
Maneb			3.5	[4]
Organochlorinated (each)			0.1	[1]
Organochlorinated (total)			0.1	[1]
Total Pesticides			0.1	[1]
Other Pollutants				
Acrylonitrile			1,000	[2]
Catechol			20	[4]
Cresols			5.0	[4]
Cyclohexane			0.1	[1]
Cyclohexanon			0.1	[4]
Diethylphthalate		✓	100	[2]
Dimethylphthalate		✓	200	[2]
Di-n-butyl phthalate		✓	200	[2]
Ethylene glycol			97	[3]
Furan			600	[2]
Gasoline			20	[1]
Hydrochinon			1.0	[4]
Mineral Oils			50	[4]
Phthalates (total)			0.1	[4]
Pyridine			0.1	[1, 4]
Resorcinol			1.0	[4]
Styrene		✓	0.1	[1, 4]
Tetrahydrofuran			0.1	[1, 4]
Tetrahydrothiophene			0.1	[1, 4]

Source:
[1]Beyer (1990).
[2]Oak Ridge National Laboratory (Efroymson et al. 1997a,b).
[3]CCME (1997).
[4]Ministry of Housing, Spatial Planning and Environment (1994).
[5]Crommentuijn et al. (1997).