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ECOLOGICAL SCREENING VALUES FOR SURFACE WATER, SEDIMENT, AND SOIL: 2005 Update

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INTRODUCTION

One of the principal components of the environmental remediation program at the Savannah River Site (SRS) is the assessment of ecological risk. Used to support CERCLA, RCRA, and DOE orders, the ecological risk assessment (ERA) can identify environmental hazards and evaluate remedial action alternatives. Ecological risk assessment is also an essential means for achieving DOE's risk based end state vision for the disposition of nuclear material and waste hazards, the decommissioning of facilities, and the remediation of inactive waste units at SRS. The complexity of an ERA ranges from a screening level ERA (SLERA) to a full baseline ERA. A screening level ecological risk assessments, although abbreviated from a baseline risk assessment, is nonetheless considered a complete risk assessment (EPA, 2001a). One of the initial tasks of any ERA is to identify constituents that potentially or adversely affect the environment. Typically, this is accomplished by comparing a constituent's maximum concentration in surface water, sediment, or soil with an ecological screening value (ESV). The screening process can eliminate many constituents from further consideration in the risk assessment, but it also identifies those that require additional evaluation.

This document is an update of a previous compilation (Friday, 1998) and provides a comprehensive listing of ecological screening values for surface water, sediment, and soil. It describes how the screening values were derived and recommends benchmarks that can be used for ecological risk assessment. The sources of these updated benchmarks include the U.S. Environmental Protection Agency (EPA), U.S. Fish and Wildlife Service (USFWS), U.S. Geological Survey (USGS), National Oceanic and Atmospheric Administration (NOAA), Oak Ridge National Laboratory (ORNL), the State of Florida, the Canadian Council of Ministers of the Environment (CCME), the Dutch Ministry of the Environment (RIVM), and the scientific literature. It should be noted that ESV's are continuously revised by the various issuing agencies. The references in this report provide the citations of each source and, where applicable, the internet address where they can be accessed. Although radiological screening values are not included herein due to space limitations, these have been recently derived by a technical working committee sponsored by the U.S. Department of Energy (DOE 2002, 2004).

The recommended ecological screening values represent the most conservative concentrations of the cited sources, and are to be used for screening purposes only. They 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 chemistry, 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

Since the early 1980's, EPA has developed water quality criteria for specific pollutants to protect aquatic life under Section 304(a) of the Clean Water Act. Referred to as National Ambient Water Quality Criteria (NAWQC) for the protection of aquatic life, these regulatory values are intended to protect most aquatic species most of the time with reasonable confidence (Stephan et al. 1985). The national guidelines for deriving water quality criteria for the protection of aquatic life have not been updated since 1985. Because of new advances in aquatic toxicology, aquatic biology, fate, transport, and effects modeling, and ecological risk assessment, EPA plans to establish an aquatic life guidelines working group to identify, review, evaluate, and revise the existing protocols (EPA, 2003a), but this was not completed at the time of this report.

NAWQC must be based on results from at least eight acute toxicity tests from eight different families and three chronic tests. 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, which are considered applicable or relevant and appropriate requirements (ARARs), are presented in Table 1.

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).

The Criteria Maximum Concentration (CMC), which applies to short (acute) exposure, is an estimate of the highest concentration of a material in surface water to which an aquatic community can be exposed briefly without resulting in an unacceptable effect. The Criterion Continuous Concentration (CCC), which applies to longer (chronic) exposure, is an estimate of the highest concentration of a material in surface water to which an aquatic community can be exposed indefinitely without resulting in an unacceptable effect. The CMC and CCC are just two of the six parts of a aquatic life criterion; the other four parts are the acute averaging period, chronic averaging period, acute frequency of allowed exceedence, and chronic frequency of allowed exceedence. Because 304(a) aquatic life criteria are national guidance, they are intended to be protective of the vast majority of the aquatic communities in the United States.

EPA Region IV Screening Values

EPA Region IV surface water screening values (EPA 2001b) 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 oftentimes 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 frequently 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). Region IV ambient surface water quality criteria are intended to protect 95% of the species, 95% of the time. These values may be revised for conditions where acute and chronic concentrations may pose unacceptable risks to sensitive species (EPA, 2001b).

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 receptors 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). 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 Council of Ministers of the Environment (CCME)

Canadian water quality guidelines take into consideration the protection of aquatic life (Environment Canada 1995). They were initially issued in 1987 (CCREM, 1987) and dealt with substances found in freshwater only. Because of concerns that were raised regarding the derivation of values, the protocol was revised in 1991 as Appendix IX to the 1987 guidelines. Subsequently, the guidelines were expanded to include marine water, sediment and residues in plant and animal tissue. In 1999, the Canadian Council of Ministers of the Environment (CCME), which was formerly the CCREM, issued new guidance (CCME 1999). The guidance has been updated annually since 2001 (CCEM 2001, 2002, 2003a,b).

The guideline derivation protocol (CCME 1999) begins with the selection of variables. For each variable that is selected, a literature search is conducted to obtain specific information such as (1) physical and chemical properties, (2) environmental concentration, fate, and behavior, (3) bioaccumulation potential, (4) acute and chronic toxicity, (5) genotoxicity, and (6) other information of concern. Following the application of data set requirements and evaluation of toxicological data, the water quality guideline can be derived from either a chronic or acute study. Guidelines are preferably derived from the lowest-observable effects level (LOEL) from a chronic exposure study using a nonlethal endpoint for the most sensitive life stage of the most sensitive aquatic species investigated. This value is then multiplied by a safety factor of 0.1 to identify the final guideline concentration.

If chronic toxicological results are unavailable, guidelines can be derived from acute studies by converting short-term median lethal or median effective concentrations (LC_{50}, EC_{50}) to long-term no-effect concentrations using acute/chronic ratios (ACRs). The ACR is calculated by di-

viding an LC_{50} or EC_{50} by the no-observed-effect level (NOEL) from a chronic exposure test for the same species. If ACRs are unavailable, an alternate method to derive a guideline value from an acute study is to multiply the LC_{50} or EC_{50} by a universal application factor. Specifics for these approaches are detailed in CCME (1999, 2002, 2003a,b).

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 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.

EPA Region IV is in the process of revising its sediment screening values. Because this agency has previously adopted sediment screening values derived by MacDonald (1994), Table 2 includes values revised by MacDonald et al. (2003) in cooperation with the USGS, EPA, and other municipal governments. The sediment screening values presented in Table 2 were derived using the consensus-based approach are in essence threshold effect concentrations (TECs). It should be noted that MacDonald's (2003) TEC values are most pertinent to sediments of the southeastern United States because they are based on matching sediment chemistry and sediment toxicity data from this region.

National Oceanic and Atmospheric Administration (NOAA)

NOAA developed Screening Quick Reference Tables (SQuiRTs) for internal use by the Coastal Protection and Restoration Division (Buchman, 1999). NOAA's freshwater sediment values included four categories: (1) lowest threshold effects level (TEL) based on *Hyalella azteca*, (2) TELs based on other biota, (3) probable effect levels (PELs), and (4) upper effect threshold (UETs) levels. The most conservative or lowest concentration of these are presented in Table 2. The UET values were derived by NOAA as the lowest apparent effects threshold (AET) from

a compilation of endpoints analogous to the marine AET endpoints. The UETs for organic contaminants were based on a total organic content of one percent.

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. (1997) compiled ecological screening values for sediment in a 1997 revision of earlier works. These included benchmarks developed for NOAA and the Florida Department 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 Council of Ministers of the Environment (CCME)

Canada developed sediment quality guidelines using methods that are described in a formal protocol (CCME 1995, 1999). This protocol relies on both a modification of the National Status and Trends Program (modified NSTP) approach (Long and Morgan 1990; Long 1992; Long and MacDonald 1992; Long et al. 1995; MacDonald 1994) and the spiked-sediment toxicity test (SSTT) approach (CCME 1999). The modified NSTP approach uses synoptically collected chemical and biological data to establish an association between the concentration of a constituent and an observed adverse biological effect (CCME 1999). These co-occurrence data are then used to calculate two assessment values. The lower value or threshold effect level (TEL) represents the concentration below which adverse biological effects are rarely expected to occur. The upper value or probable effect level (PEL) defines the level above which adverse effects are expected to frequently occur.

The SSTT approach seeks to provide quantifiable cause-and-effect relationships between the concentration of a constituent in sediment and an observed biological response. Spiked-sediment toxicity tests may also be used to determine the extent to which environmental conditions modify the bioavailability of a constituent, and ultimately the response of organisms exposed to the spiked sediments (CCME 1999).

Sediment quality guidelines are recommended if information exists to support both the modified NSTP and the SSTT approaches (i.e., full sediment quality guidelines). Generally, the lower of the two derived values is recommended as the sediment quality guideline (SQG). Interim sediment quality guidelines (ISQGs), which comprise all the values presented in Table 2, are recommended if information is available to support only one approach (CCME 1999, 2001, 2003, 2003a,b). Further details on the derivation and evaluation of ISQGs and PELs for both freshwater and marine sediments are presented in the protocol (CCME, 1995, 1999).

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).

National Institute for Public Health and the Environment (RIVM)

The Dutch Ministry standards (MHSPE 1994, RIVM 2000) 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 Dutch Ministry should be used with caution. The derivation of the soil (i.e., sediment) quality standards is discussed in the ensuing section.

State of Florida/USGS/EPA

The State of Florida, U.S. Geological Survey, and U.S. Environmental Protection Agency identified sediment guidelines as a part of its freshwater sediment quality assessment initiative. These sediment quality assessment guidelines (SQAG's) were derived using eight approaches which are described in detail by MacDonald et al. (2003). The concensus-based approach (i.e., the threshold effect concentrations and probable effect concentrations) was adopted as preliminary effects-based SQAGs for Florida inland waters. For situations where this approach was untenable, other methods were used. These guidelines were refined using co-located sediment and chemistry data from EPA Regions III, IV, and VI.

SOIL

The sources of the ecological screening values for soils (Table 3) included 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), and the Dutch Ministry of the Environment (RIVM). It should be noted that ESV's are continuously revised by the issuing agencies, and the sources should be consulted for updates. The references in this report provide the citations of each source and, where applicable, the internet address where they can be accessed. Although radiological soil screening values are not included herein due to space limitations, these have been recently derived by a technical working committee sponsored by the U.S. Department of Energy (DOE 2002, 2004).

U.S. Environmental Protection Agency

In the late 1990's, the EPA directed a multi-stakeholder working group consisting of federal, state, consulting, industry, and academic participants to derive a set of risk-based screening values for soil contaminants that were frequently of ecological concern at hazardous waste sites. EPA prepared a list of twenty-four (24) contaminants to be addressed initially by the Ecological Soil Screening Level (Eco-SSL) guidance. This list was based on a review of the contaminants of concern reported in recent Record of Decisions at Superfund National Priority List sites. The Eco-SSL contaminant list also included contaminants nominated by the EPA regional Biological Technical Assistance Group Coordinators. The list of 24 Eco-SSL contaminants contained 17 metals including aluminum, antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, iron, lead, manganese, nickel, selenium, silver, vanadium, and zinc. The organic contaminants on the list were dieldrin, hexahydro -1,3,5-trinitro-1,3,5-triazine (RDX), trinitrotoluene (TNT), 1,1,1-trichloro-2,2-bis (p-chlorophenyl)ethane (DDT) and metabolites (DDE and DDD), pentachlorophenol, polycyclic aromatic hydrocarbons (PAHs), and polychlorinated biphenyls (PCBs).

The general approach included four steps: (1) conduct literature searches, (2) screen identified literature with exclusion and acceptability criteria, (3) extract, evaluate, and score test results for applicability in deriving an Eco-SSL, and (4) derive the value. These procedures were finalized as standard operating procedures prior to initiating any work to derive the actual values. Plant and soil invertebrate screening values were derived directly after an evaluation of all available plant and soil invertebrate chronic toxicity test data (measured toxicity related to soil contaminant concentrations). Wildlife Eco-SSLs were the result of back-calculations from a hazard quotient of 1.0. The hazard quotient is equal to the estimated exposure dose divided by the toxicity reference value (TRV). An HQ of 1.0 is the condition where the exposure and the dose associated with no adverse chronic effects are equal, indicating adverse effects at or below this soil concentration are unlikely. A generic food-chain model was used to estimate the relationship between the concentration of the contaminant in soil and the dose for the receptor (mg per kg body weight per day). The TRV represents a receptor-class specific estimate of a no-observed adverse effect level (dose) for the respective contaminant for chronic exposure.

Because of insufficient toxicity data, the EPA soil screening values do not include herpetofauna, microbes, or microbial processes. The Eco-SSL's also appropriate to sites where key soil parameters fall within a specific range of chemical and physical parameters. Eco-SSL's for plants and soil invertebrates apply to soils whose pH ranges between 4.0 and 8.5, and the organic matter content is less than or equal to 10%. Eco-SSL's are also inappropriate for sediments.

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 based on the availability of data. 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)

In 1996, the CCME published a protocol for deriving environmental soil quality guidelines that considered 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 revised soil quality guidelines for 20 constituents that 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). In 1999, CCME again revised the soil quality guidelines (CCME, 1999) and issued updates in 2001, 2002, and 2003. The protocol for deriving the soil quality guidelines follows the 1996 derivation process (CCME 1996), and is summarized below.

Soil quality guidelines (SQG's) 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. Three methods, listed in order of preference, were used to derive soil quality guidelines: (1) weight of evidence, (2) LOEC concentration, and (3) median effects method.

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 effects data distribution was chosen as the "no potential effects range" (NPER). An uncertainty factor is 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 un-

available, 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.

After the TEC is calculated using one of the three methods, 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 taxa, 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. The Dutch Ministry issued an updated listing of intervention and goal values for soil in 2000 (RIVM 2000) but the derivation protocol was not included in this publication.

RECOMMENDED SCREENING VALUES

A listing of the recommended ecological screening values are presented chronologically for surface water, sediment, and soil (Tables 1 - 3). With the exception of six soil constituents (i.e., tin, phenol, styrene, xylene, chloronaphthalene, and tribromomethane), these values represent the lowest or most conservative concentration issued by the referenced sources. The rationale for this approach is that it is simple, it can be applied consistently without bias, and provides the most conservative screening evaluation. Beyer's (1990) values for tin, phenol, styrene, and xylene were based on earlier values from the Dutch. Although they are the more conservative values, the recent updates from the Dutch and ORNL (i.e., tin) were used. For chloronaphthalene and tribromomethane, the recommended ESV for soil was derived by dividing the intervention value by a safety factor of 10. For some constituents, the recommended screening values appear inconsistent between the issuing agencies. For example, the recommended ESV for 2, 4, 6-trichlorophenol is 10 mg/kg whereas for total trichlorophenol it is 0.001 mg/kg. 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 benchmarks that can be used in the initial screening phase of the ecological risk assessment. 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. The recommended ecological screening values represent the most conservative concentrations of the cited sources, and are to be used for screening purposes only. They do not represent remedial action cleanup levels. Their use should take into account environmental variables such as water quality, soil chemistry, flora and fauna, and other ecological attributes specific to the ecosystem potentially at risk.

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 screen-

ing values (Tables 1-3).

Step 4 If the maximum soil concentration does not equal or exceed the ecological screening value, the constituent is eliminated from further consideration. The ecological risk assessment process concludes at this point because no stressors have been identified. If the concentration of the constituent equals or exceeds the ecological screening value, the constituent is retained for further examination using other criteria. For example, if the frequency of detection is less than or equal to five percent, the constituent can be eliminated (EPA 1989). Another approach is to eliminate constituents whose concentrations are below the practical quantitation limit or method detection limit. The calculation of dose to ecological receptors using species specific food habits and home ranges can also be used. Comparisons to background concentrations and potential to bioconcentrate are additional factors that may be applied (EPA 2001a). If there is no screening value available for a constituent, it is retained for further study and should be addressed in the uncertainty section of the ecological risk assessment.

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REFERENCES

40 CFR 9, 122, 123, 131, and 132. Tuesday, 23 March 1995. Final Water Quality Guidance for the Great Lakes System; Final Rule.

Adams, W.J., R.A. Kimerle, and J.W. Barnett. 1992. Sediment Quality and Aquatic Life Assessments. Environ. Sci. Technol. 26(10):1865-1875.

Beyer, W.N. 1990. Evaluating Soil Contamination. United States Fish and Wildlife Service, Biological Report 90(2).

Buchman, M.F. September 1999. NOAA SQRT Screening Quick Reference Tables, NOAA Hazmat Report 99-1, Seattle WA, Coastal Protection and Restoration Division, National Oceanic and Atmospheric Administration, 12 pages.

Canadian Council of Ministers of the Environment (CCME). 2003a. The Canadian Environmental Quality Guidelines. Canadian Council of Ministers of the Environment (CCME), Report PN1299, Update 3.2, Winnipeg, Manitoba.

Canadian Council of Ministers of the Environment (CCME). 2003b. The Canadian Environmental Quality Guidelines. Canadian Council of Ministers of the Environment (CCME), Report PN1299, Update 3.1, Winnipeg, Manitoba.

Canadian Council of Ministers of the Environment (CCME). 2002. The Canadian Environmen-

tal Quality Guidelines. Canadian Council of Ministers of the Environment (CCME), Report PN1299, Update 2, Winnipeg, Manitoba.

Canadian Council of Ministers of the Environment (CCME). 2001. The Canadian Environmental Quality Guidelines. Canadian Council of Ministers of the Environment (CCME), Report PN1299, Update 1, Winnipeg, Manitoba.

Canadian Council of Ministers of the Environment (CCME). 1999. The Canadian Environmental Quality Guidelines. Canadian Council of Ministers of the Environment (CCME), Report PN1299, Winnipeg, Manitoba.

Canadian Council of Ministers of the Environment (CCME). March 1997. Recommended Canadian Soil Quality Guidelines. Canadian Council of Ministers of the Environment (CCME), Winnipeg, Manitoba.

Canadian Council of Ministers of the Environment (CCME). March 1996. A Protocol for the Derivation of Environmental and Human Health Soil Quality Guidelines. CCME-EPC-101E, Winnipeg, Manitoba.

Canadian Council of Ministers of the Environment (CCME). 1995. Protocol for the Derivation of Canadian Sediment Quality Guidelines for the Protection of Aquatic Life. Report CCME EPC-98E. Prepared by the Task Group on Water Quality Guidelines, Winnipeg, Manitoba. 38 pp.

Canadian Council of Resource and Environment Ministers (CCREM). 1987. Canadian water quality guidelines. Prepared by the Task Force on Water Quality Guidelines.

Crommentuijn, T., M.D. Polder, and E.J. van de Plassche. 1997. Maximum Permissible Concentrations and Negligible Concentrations for Metals, Taking Background Concentrations into Account. RIVM Report No. 601501001.

Efroymson, R.A., M.E. Will, and G.W. Suter. 1997a. Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Process: 1997 Revision. Oak Ridge National Laboratory, Oak Ridge, TN. ES/ER/TM-126/R2 (www.hsrd.ornl.gov/ecorisk/reports.html).

Efroymson, R.A., M.E. Will, G.W. Suter, and A.C. Wooten. 1997b. Toxicological Benchmarks for Contaminants of Potential Concern for Effects on Terrestrial Plants: 1997 Revision. Oak Ridge National Laboratory, Oak Ridge, TN, ES/ER/TM-85/R3 (www.hsrd.ornl.gov/ecorisk/reports.html).

Environment Canada. 1995. CCME Canadian Water Guidelines-December 1995, Environment Canada, Ottawa, Ontario

Friday, G. P. 1998. Ecological Screening Values for Surface Water, Sediment, and Soil. Westinghouse Savannah River Company (WSRC-TR-98-00110).
Jones, D.S., G.W. Suter, and R.N. Hull. 1997. Toxicological Benchmarks for Screening Poten-

tial Contaminants of Concern for Effects on Sediment-Associated Biota: 1997 Revision, ES/ER/TM-95/R4, Oak Ridge, TN.

Long, E.R. 1992. Ranges in Chemical Concentrations in Sediments Associated with Adverse Biological Effects. Mar. Pollut. Bull. 24(1):38-45.

Long, E.R. and D.D. MacDonald. 1992. National Status and Trends Program Approach. In: Sediment Classification Methods Compendium. Environmental Protection Agency EPA 823-R-92-006.

Long, E.R. and L.G. Morgan. 1990. The Potential for Biological Effects of Sediment-Sorbed Contaminants Tested in the National Status and Trends Program. NOAA Technical Memorandum NOS OMA 52. National Oceanic and Atmospheric Administration. Seattle, Washington.

Long, E.R., D.D. MacDonald, S.L. Smith, and F.D. Calder. 1995. Incidence of Adverse Biological Effects within Ranges of Chemical Concentrations in Marine and Estuarine Sediments. Environmental Management 19(1):81-97.

MacDonald, D.D., C.G. Ingersoll, D.E. Smorong, R.A. Lindskoog, G. Sloane, and T. Biernacki. 2003. Development and Evaluation of Numerical Sediment Quality Assessment Guidelines for Florida Inland Waters. MacDonald Environmental Sciences Ltd., United States Geological Survey, and the Florida Department of Environmental Protection. 150 pp.

MacDonald, D.D. 1994. Approach to the Assessment of Sediment Quality in Florida Coastal Waters. Prepared for the Florida Department of Environmental Protection. MacDonald Environmental Sciences, Ltd., Ladysmith, British Columbia. Vol. 1, 123 pp.

MacDonald, D.D., R. S. Carr, F.D. Calder, E.R. Long, and C.G. Ingersoll. 1996. Development and Evaluation of Sediment Quality Guidelines for Florida Coastal Waters. Ecotoxicology 5, 253-278.

MHSPE (Ministry of Housing, Spatial Planning, and Environment). 9 May 1994. Intervention Values and Target Values - Soil Quality Standards. Directorate-General for Environmental Protection, Department of Soil Protection, The Hague, The Netherlands.

Richardson, G.M. 1987. Inventory of cleanup criteria and methods to select criteria. Unpublished report, Committee on Industrial site Decommissioning, Industrial Programs Branch, Environment Canada, Ottawa, Ontario.

RIVM. 2000. Circulaire streefwaarden en interventiewaarden bodemsanering. Stcr. 2000, nr. 39 DBO 2000022567, 52 pages.

Sample, B.E., G.W. Suter, R.A. Efroymson, and D.S. Jones. 1998. A Guide to the ORNL Ecotoxicological Screening Benchmarks: Background, Development, and Application. ORNL ES/ER/TM-13615.Oak Ridge, TN. (www.hsrd.ornl.gov/ecorisk/reports/html)

Sample, B.E., D.M. Opresko, and G.W. Suter. June 1996. Toxicological Benchmarks for Wild-

life: 1996 Revision, ORNL ES/ER/TM-86/R3.Oak Ridge, TN. (www.hsrd.ornl.gov/ecorisk/reports/html)

Stephan, C.E., D.I. Mount, D.J. Hanson, J.H. Gentile, G.A. Chapman, and W.A. Brungs. 1985. Guidelines for Deriving Numeric National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses. U.S. Environmental Protection Agency, PB85-227049, Duluth, Minnesota.

Suter, G.W. 1996. Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Freshwater Biota. Environmental Toxicology and Chemistry Vol. 15 (7): 1232-1241.

Suter, G.W. and C.L. Tsao. June 1996. Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota: 1994 Revision, ORNL Environmental Sciences Division, Oak Ridge, TN. ES/ER/TM-96/R2. (www.hsrd.ornl.gov/ecorisk/reports/html)

Suter, G.W. and J.B. Mabrey. 1994. Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota: 1994 Revision. Oak Ridge National Laboratory, Oak Ridge, TN. ES/ER/TM-96/R1.

U.S. Department of Energy. January 2004. Resrad-Biota: A Tool for Implementing a Graded approach to Biota Dose Evaluation, User's Guide, Version 1, DOE-EH-0676. Interagency Steering Committee on Radiation Standards (ISCORS) Technical Report 2004-02. (http://web/ead.anl.gov/resrad/home2/resrad.cfm)

U.S. Department of Energy. July 2002. A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota. Technical Standard DOE-STD-1153-2002. (http://homer.ornl.gov/oepa/public/bdac/)

U.S. Environmental Protection Agency. 2005a. Ecological Screening Level for Aluminum. Interim Final OSWER Directive 9285.7-60. (www.epa.gov/ecotox/ecossl/)

U.S. Environmental Protection Agency. 2005b. Ecological Screening Level for Antimony. Interim Final OSWER Directive 9285.7-61. (www.epa.gov/ecotox/ecossl/)

U.S. Environmental Protection Agency. 2005c. Ecological Screening Level for Arsenic. Interim Final OSWER Directive 9285.7-62. (www.epa.gov/ecotox/ecossl/)

U.S. Environmental Protection Agency. 2005d. Ecological Screening Level for Barium. Interim Final OSWER Directive 9285.7-63. (www.epa.gov/ecotox/ecossl/)

U.S. Environmental Protection Agency. 2005e. Ecological Screening Level for Beryllium. Interim Final OSWER Directive 9285.7- 64. (www.epa.gov/ecotox/ecossl/)

U.S. Environmental Protection Agency. 2005f. Ecological Screening Level for Cadmium. Interim Final OSWER Directive 9285.7- 65. (www.epa.gov/ecotox/ecossl/)

U.S. Environmental Protection Agency. 2005g. Ecological Screening Level for Chromium. Interim Final OSWER Directive 9285.7-66. (www.epa.gov/ecotox/ecossl/)

U.S. Environmental Protection Agency. 2005h. Ecological Screening Level for Cobalt. Interim Final OSWER Directive 9285.7-67. (www.epa.gov/ecotox/ecossl/)

U.S. Environmental Protection Agency. 2005i. Ecological Screening Level for Lead. Interim Final OSWER Directive 9285.7-70. (www.epa.gov/ecotox/ecossl/)

U.S. Environmental Protection Agency. 2005j. Ecological Screening Level for Vanadium. Interim Final OSWER Directive 9285.7-75. (www.epa.gov/ecotox/ecossl/)

U.S. Environmental Protection Agency. 2005k. Ecological Screening Level for Dieldrin. Interim Final OSWER Directive 9285.7-56. (www.epa.gov/ecotox/ecossl/)

U.S. Environmental Protection Agency. 2005l. Ecological Screening Level for Pentachlorophenol. Interim Final OSWER Directive 9285.7-56. (www.epa.gov/ecotox/ecossl/)

U.S. Environmental Protection Agency. 2004. Ambient Aquatic Life Water Quality Criteria for Tributyltin (TBT)-Final. EPA-822-R-03-031.

U.S. Environmental Protection Agency. 2003a. Draft Strategy: Proposed Revisions to the "Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses". 6 February, (www.epa.gov/waterscience/criteria/aqlife.html)

U.S. Environmental Protection Agency. 2003b. Ambient Aquatic Life Water Quality Criteria for Atrazine - Revised Draft. EPA-822-R-03-023.

U.S. Environmental Protection Agency. 2003c. Ambient Aquatic Life Water Quality Criteria for Diazinon.EPA-822-R-03-017.

U.S. Environmental Protection Agency. 2002. National Recommended Water Quality Criteria: 2002. EPA-822-R-02-047.

U.S. Environmental Protection Agency. 2001a. The Role of Screening-Level Risk Assessments and Refining Contaminants of Concern in Baseline Ecological Risk Assessments. Publication 9345.0-14, EPA 540/F-01/014.

U.S. Environmental Protection Agency. 2001b. Ecological Screening Values. *In:* Supplemental Guidance to RAGS: Region 4 Bulletins, Ecological Risk Assessment. Atlanta, Ga. (www.epa.gov/region4/waste/ecolbul.htm)

U.S. Environmental Protection Agency. 1999. 1999 Update of Ambient Water Quality Criteria for Ammonia (22 December 1999). Office of Water, Federal Register Vol. 64, No. 245: pp71974-71980, Washington, D.C.

U.S. Environmental Protection Agency. January 1996. Ecotox Thresholds, ECO Update, Office of Solid Waste and Emergency Response, Intermittent Bulletin Vol. 3, No. 2, Publication 9345.0-12FSI, EPA 540/F-95-038 PB95-963324

U.S. Environmental Protection Agency. November 1995. Ecological Screening Values. *In:* Supplemental Guidance to RAGS: Region 4 Bulletins-Ecological Risk Assessment, Bull. No.2, Atlanta, Georgia. (http://www.epa.gov/region4/wastepgs/oftecser/otsguid.htm)

U.S. Environmental Protection Agency. 1993. Water Quality Guidance for the Great Lakes System and Correction; Proposed Rules Federal Register 58 (72): 20802-21047.

U.S. Environmental Protection Agency. 1989. Supplemental Risk Evaluation Guidance for the Superfund Program, EPA/901/5-89-001.

Will, M.E. and G.W. Suter. 1995. Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Process, Oak Ridge National Laboratory, Oak Ridge, TN. 155pp, ES/ER/TM-126/R1

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 physio-

logical 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

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ACRONYMS

AWQC	Ambient Water Quality Criteria
ARAR	Applicable or Relevant and Appropriate Requirements
CCC	Criterion Continuous Concentration
CCME	Canadian Council of Ministers of the Environment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLP	Contract Laboratory Program
CMC	Criterion Maximum Concentration
CV	Chronic Value
DOE	U.S. Department of Energy
EC50	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 HQ	Final Acute Value
HQ	Hazard Quotient
LC50	Median Lethal Concentration
LOEC	Lowest Observed Effect Concentration
LOAEL	Lowest Observed Adverse Effect Level
MACT	Maximum Acceptable Toxicant Concentration
MDL	Method Detection Limit
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 Quantitation Limit
RCRA	Resource Conservation and Recovery Act
SQB	Sediment Quality Benchmark
SQG	Soil Quality Guideline
TEC	Threshold Effects Concentration
TEL	Threshold Effect Level
TRV	Toxicity Reference Value
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), National Oceanic and Atmospheric Administration (NOAA), U.S. Fish and Wildlife Service (USFWS), U.S. Geological Survey (USGS), the State of Florida, Canadian Council of Ministers of the Environment (CCME), Oak Ridge National Laboratory (ORNL), the Dutch Ministry of the Environment (RIVM), 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 select a value from the 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 clean-up levels.

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

CONSTITUENT	NAWQC[a]		EPA[b]		ECOTOX THRESHOLDS[c]		ORNL[d] Tier II			CANADA GUIDELINES[e]	ECOLOGICAL SCREENING VALUE
	Criteria Maximum Concentration	Criteria Continuous Concentration	Acute	Chronic	AWQC[f] or FCV[g]	Tier II	Secondary Acute	Secondary Chronic	Lowest Chronic Value		
Metals											
Aluminum	750[h]	87[h]	750	87	-	-	-	-	460	5[i]-100[j]	**5.0**
Antimony	-	-	1300	160	-	-	180	30	610	-	**30**
Arsenic	340	150	-	-	-	-	-	-		5.0	**5.0**
Arsenic III	-	-	360	190	190	-	-	-	914	-	**190**
Arsenic V	-	-	-	-	-	8.1	66	3.1	48	-	**3.1**
Barium	-	-	-	-	-	3.9	110	4.0	-	-	**3.9**
Beryllium	-	-	16	0.53	-	5.1	35	0.66	5.3	-	**0.53**
Boron	-	-	-	750	-	-	30	1.6	8,830	-	**1.6**
Cadmium	2.0	0.25	1.79*	0.66*	1.0	-	-	-	0.15	0.017	**0.017[k]**
Calcium	-	-	-	-	-	-	-	-	116,000	-	**116,000**
Chromium (total)	-	-	-	-	-	-	-	-	-	2.0-20.0	**2.0**
Chromium III	570*	74*	984.32*	117.32*	180	-	-	-	<44	8.9	**8.9**
Chromium VI	16*	11*	16*	11*	10	-	-	-	2.0	1.0	**1.0**
Cobalt	-	-	-	-	-	3.0	1,500	23	5.1	-	**3.0**
Copper	13*	9.0*	9.22	6.54	11	-	-	-	0.23	2.0-4.0[l]	**0.23**
Iron	-	1,000	-	1,000	1,000	-	-	-	158	300	**158**

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

CONSTITUENT	NAWQC[a]		EPA[b]		ECOTOX THRESHOLDS[c]		ORNL[d] Tier II			CANADA GUIDELINES[e]	ECOLOGICAL SCREENING VALUE
	Criteria Maximum Concentration	Criteria Continuous Concentration	Acute	Chronic	AWQC[f] or FCV[g]	Tier II	Secondary Acute	Secondary Chronic	Lowest Chronic Value		
Lead	65*	2.5*	34	1.32	2.5	-	-	-	12.3	1.0-7.0[m]	**1.0**
Lithium	-	-	-	-	-	-	260	14	-	-	**14**
Magnesium	-	-	-	-	-	-	-	-	82,000	-	**82,000**
Manganese	-	-	-	-	-	80	2,300	120	<1,100	-	**80**
Mercury (inorganic)	1.4	0.77	2.4	0.012	1.3	-	-	1.3	<0.23	0.026	**0.012**
Mercury (methyl)	-	-	-	-	-	0.003	0.099	0.0028	<0.04	0.004	**0.003**
Molybdenum	-	-	-	-	-	240	16,000	370	880	73	**73**
Nickel	470*	52*	789	87.71	160	-	-	-	<5.0	25-150[n]	**25**
Potassium	-	-	-	-	-	-	-	-	53,000	-	**53,000**
Selenium	-	5.0	20	5.0	5.0	-	-	-	88.3	1.0	**1.0**
Silver	3.2*	-	1.23	0.012	-	-	-	0.36	0.12	0.1	**0.012**
Sodium	-	-	-	-	-	-	-	-	680,000	-	**680,000**
Strontium	-	-	-	-	-	-	15,000	1,500	42,000	-	**1,500**
Thallium	-	-	140	4.0	-	-	110	12	57	0.8	**0.8**
Tin	-	-	-	-	-	-	2,700	73	350	-	**73**
Uranium	-	-	-	-	-	-	46	2.6	142	-	**2.6**
Vanadium	-	-	-	-	-	19	280	20	80	-	**19**

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

CONSTITUENT	NAWQC[a]		EPA[b]		ECOTOX THRESHOLDS[c]		ORNL[d] Tier II			CANADA GUIDELINES[e]	ECOLOGICAL SCREENING VALUE
	Criteria Maximum Concentration	Criteria Continuous Concentration	Acute	Chronic	AWQC[f] or FCV[g]	Tier II	Secondary Acute	Secondary Chronic	Lowest Chronic Value		
Zinc	120*	120*	65.04*	58.91*	100	-	-	-	30	30	**30**
Zirconium	-	-	-	-	-	-	310	17	548	-	**17**
Inorganics											
Ammonia	5,620-36,100[o]	897-9,600[n]	-	-	-	-	-	-	1.7	1370[p]-2200[q]	**1.7**
Chloride	-	-	860,000	230,000	-	-	-	-	-	-	**230,000**
Chlorine	-	-	19	11	-	-	-	-	-	-	**11**
Cyanide	22	5.2	22	5.2	5.2	-	-	-	7.8	5.0	**5.0**
Fluorides	-	-	-	-	-	-	-	-	-	120	**120**
Nitrate	-	-	-	-	-	-	-	-	-	13,000	**13,000**
Nitrite	-	-	-	-	-	-	-	-	-	60	**60**
Sulfide-Hydrogen Sulfide	-	2.0	-	2.0	-	-	-	-	-	-	**2.0**
Herbicides and Pesticides											
Acridine	-	-	-	-	-	-	-	-	-	4.4	**4.4**
Aldicarb	-	-	-	-	-	-	-	-	-	1.0	**1.0**
Aldrin	3.0	-	3.0	0.3	-	-	-	-	-	0.004	**0.004**
Atrazine	1,500[r]	-	-	-	-	-	-	-	-	1.8	**1.8**

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

CONSTITUENT	NAWQC[a]		EPA[b]		ECOTOX THRESHOLDS[c]		ORNL[d] Tier II			CANADA GUIDELINES[e]	ECOLOGICAL SCREENING VALUE
	Criteria Maximum Concentration	Criteria Continuous Concentration	Acute	Chronic	AWQC[f] or FCV[g]	Tier II	Secondary Acute	Secondary Chronic	Lowest Chronic Value		
α-BHC	-	-	-	500	-	-	39	2.2	95	-	**2.2**
β-BHC	-	-	-	5,000	-	-	39	2.2	95	-	**2.2**
γ-BHC (Lindane)	0.95	-	2.0	0.08	0.08	-	-	-	3.3	0.01	**0.01**
Bromacil	-	-	-	-	-	-	-	-	-	5.0	**5.0**
Captan	-	-	-	-	-	-	-	-	-	1.3	**1.3**
Carbaryl	-	-	-	-	-	-	-	-	-	0.2	**0.2**
Carbofuran	-	-	-	-	-	-	-	-	-	1.8	**1.8**
4-Chloro-2-methyl phenoxy acetic acid (MCPA)	-	-	-	-	-	-	-	-	-	2.6	**2.6**
Chlordane	2.4	0.0043	2.4	0.0043	-	-	-	-	1.09	-	**0.0043**
Chloropyrifos	0.083	0.041	0.083	0.041	-	-	-	-	-	0.0035	**0.0035**
Chlorothalonil	-	-	-	-	-	-	-	-	-	0.18	**0.18**
Cyanazine	-	-	-	-	-	-	-	-	-	2.0	**2.0**
4,4'-DDD	-	-	0.064	0.0064	-	-	0.19	0.011	1.69	-	**0.0064**
4,4'-DDE	-	-	105	10.5	-	-	-	-	-	-	**10.5**
4,4'-DDT	1.1	0.001	1.1	0.001	-	0.013	-	0.013	0.016	0.001	**0.001**
Deltamethrin	-	-	-	-	-	-	-	-	-	0.0004	**0.0004**
Demeton	-	0.1	-	0.1	-	-	-	-	-	-	**0.1**

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

CONSTITUENT	NAWQC[a]		EPA[b]		ECOTOX THRESHOLDS[c]		ORNL[d] Tier II			CANADA GUIDELINES[e]	ECOLOGICAL SCREENING VALUE
	Criteria Maximum Concentration	Criteria Continuous Concentration	Acute	Chronic	AWQC[f] or FCV[g]	Tier II	Secondary Acute	Secondary Chronic	Lowest Chronic Value		
Diazinon	0.1[s]	-	-	-	0.043	-	0.17	0.043	-	-	**0.043**
Dicamba	-	-	-	-	-	-	-	-	-	10	**10**
Diclofop-methyl	-	-	-	-	-	-	-	-	-	6.1	**6.1**
Didecyl dimethyl ammonium chloride (DDAC)	-	-	-	-	-	-	-	-	-	1.5	**1.5**
Dieldrin	0.24	0.056	2.5	0.0019	0.062	-	-	-	-	0.004	**0.0019**
Dinoseb	-	-	-	-	-	-	-	-	-	0.05	**0.05**
2,3,7,8-Dioxin,TCDD	-	-	0.1	0.00001	-	-	-	-	-	-	**0.00001**
α-Endosulfan	0.22	0.056	0.22	0.056	-	0.051	-	0.051	-	0.02	**0.02**
β-Endosulfan	0.22	0.056	0.22	0.056	-	0.051	-	0.051	-	0.02	**0.02**
Endrin	0.086	0.036	0.18	0.0023	0.061	-	-	-	-	-	**0.0023**
Glyphosate (IPBC)	-	-	-	-	-	-	-	-	-	1.9	**1.9**
Guthion	-	0.01	-	0.01	-	-	-	-	-	-	**0.01**
Heptachlor	0.52	0.0038	0.52	0.0038	-	0.0069	0.125	0.0069	1.26	-	**0.0038**
Heptachlor Epoxide	0.52	0.0038	0.52	0.0038	-	-	-	-	-	-	**0.0038**
Linuron	-	-	-	-	-	-	-	-	-	7.0	**7.0**
Malathion	-	-	-	0.1	-	0.097	-	-	-	-	**0.097**

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

CONSTITUENT	NAWQC[a]		EPA[b]		ECOTOX THRESHOLDS[c]		ORNL[d] Tier II			CANADA GUIDELINES[e]	ECOLOGICAL SCREENING VALUE
	Criteria Maximum Concentration	Criteria Continuous Concentration	Acute	Chronic	AWQC[f] or FCV[g]	Tier II	Secondary Acute	Secondary Chronic	Lowest Chronic Value		
Methoxychlor	-	0.03	-	0.03	-	0.019	-	0.019	-	-	**0.019**
Metolachlor	-	-	-	-	-	-	-	-	-	7.8	**7.8**
Metribuzin	-	-	-	-	-	-	-	-	-	1.0	**1.0**
Mirex	-	0.001	-	0.001	-	-	-	-	-	-	**0.001**
Parathion	0.065	0.013	0.065	0.013	-	-	-	-	-	-	**0.013**
Picloram	-	-	-	-	-	-	-	-	-	29	**29**
Simazine	-	-	-	-	-	-	-	-	-	10	**10**
Tebuthiuron	-	-	-	-	-	-	-	-	-	1.6	**1.6**
Triallate	-	-	-	-	-	-	-	-	-	0.24	**0.24**
Tributyltin (TBT)	0.46[t]	0.072[s]	-	0.026	-	-	-	-	-	0.008	**0.008**
Trifuralin	-	-	-	-	-	-	-	-	-	0.2	**0.2**
Triphenyltin	-	-	-	-	-	-	-	-	-	0.022	**0.022**
Phenols											
2-Chlorophenol	-	-	438	43.8	-	-	-	-	-	-	**43.8**
3-Methyl-4-Chlorophenol	-	-	3.0	0.3	-	-	-	-	-	-	**0.3**
Dichlorophenols	-	-	-	-	-	-	-	-	-	0.2	**0.2**
2,4-Dichlorophenol	-	-	202	36.5	-	-	-	-	-	-	**36.5**
2,4-Dimethylphenol	-	-	212	21.2	-	-	-	-	-	-	**21.2**

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

CONSTITUENT	NAWQC[a]		EPA[b]		ECOTOX THRESHOLDS[c]		ORNL[d] Tier II			CANADA GUIDELINES[e]	ECOLOGICAL SCREENING VALUE
	Criteria Maximum Concentration	Criteria Continuous Concentration	Acute	Chronic	AWQC[f] or FCV[g]	Tier II	Secondary Acute	Secondary Chronic	Lowest Chronic Value		
2,4-Dinitrophenol	-	-	62	6.2	-	-	-	-	-	-	**6.2**
2-Methyl-4,6- Dinitrophenol	-	-	23	2.3	-	-	-	-	-	-	**2.3**
2-Methylphenol	-	-	-	-	-	-	230	13	489	-	**13**
Monochlorophenols	-	-	-	-	-	-	-	-	-	7.0	**7.0**
2-Nitrophenol	-	-	-	3,500	-	-	-	-	-	-	**3,500**
4-Nitrophenol	-	-	828	82.8	-	-	1,200	300	481	-	**82.8**
Nonylphenol ethoxylates	-	-	-	-	-	-	-	-	-	1.0	**1.0**
Pentachlorophenol (PCP)	19	15	20	13	13	-	-	-	-	0.5	**0.5**
Phenol	-	-	1,020	256	-	-	-	-	<200	4.0	**4.0**
Tetrachlorophenols	-	-	-	-	-	-	-	-	-	1.0	**1.0**
Trichlorophenols	-	-	-	-	-	-	-	-	-	18	**18**
2,4,6-Trichlorophenol	-	-	32	3.2	-	-	-	-	-	-	**3.2**
Phthalate Esters											
Bis(2-Ethylhexyl) Phthalate	-	-	1,110	< 0.3	-	32	27	3.0	912	16	**0.3**
Butylbenzyl phthalate	-	-	330	22	-	19	-	19	-	-	**19**
Diethyl phthalate	-	-	5,210	521	-	220	1,800	210	85,600	-	**210**
Dimethyl phthalate	-	-	3,300	330	-	-	-	-	-	-	**330**

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

CONSTITUENT	NAWQC[a]		EPA[b]		ECOTOX THRESHOLDS[c]		ORNL[d] Tier II			CANADA GUIDELINES[e]	ECOLOGICAL SCREENING VALUE
	Criteria Maximum Concentration	Criteria Continuous Concentration	Acute	Chronic	AWQC[f] or FCV[g]	Tier II	Secondary Acute	Secondary Chronic	Lowest Chronic Value		
Di-n-butyl phthalate	-	-	94	9.4	-	33	190	35	697	19	**9.4**
Di-n-octyl phthalate	-	-	-	-	-	-	-	-	708	-	**708**
Polychlorinated Biphenyls (PCBs)											
Aroclor-1016	-	-	0.2	0.014	-	-	-	-	-	-	**0.014**
Aroclor-1221	-	-	0.2	0.014	-	-	5.0	0.28	60	-	**0.014**
Aroclor-1232	-	-	0.2	0.014	-	-	10	0.58	124	-	**0.014**
Aroclor-1242	-	-	0.2	0.014	-	-	1.2	0.053	4.9	-	**0.014**
Aroclor-1248	-	-	0.2	0.014	-	-	1.4	0.081	-	-	**0.014**
Aroclor-1254	-	-	0.2	0.014	-	-	0.6	0.033	0.1	-	**0.014**
Aroclor-1260	-	-	0.2	0.014	-	-	1,700	94	2.3	-	**0.014**
PCBs total	-	0.14	-	-	-	0.19	-	0.14	0.1	-	**0.14**
Polycyclic Aromatic Hydrocarbons											
Acenaphthene	-	-	170	17	23	-	-	-	74	5.8	**5.8**
Acridine	-	-	-	-	-	-	-	-	-	4.4	**4.4**
Anthracene	-	-	-	-	-	-	13	0.73	0.09	0.012	**0.012**
Benzo(a)anthracene	-	-	-	-	-	-	0.49	0.027	0.65	0.018	**0.018**

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

CONSTITUENT	NAWQC[a]		EPA[b]		ECOTOX THRESHOLDS[c]		ORNL[d] Tier II			CANADA GUIDELINES[e]	ECOLOGICAL SCREENING VALUE
	Criteria Maximum Concentration	Criteria Continuous Concentration	Acute	Chronic	AWQC[f] or FCV[g]	Tier II	Secondary Acute	Secondary Chronic	Lowest Chronic Value		
Benzo(a)pyrene	-	-	-	-	-	0.014	0.24	0.014	0.3	0.015	**0.014**
Fluoranthene	-	-	398	39.8	8.1	-	-	-	15	0.04	**0.04**
Fluorene	-	-	-	-	-	3.9	70	3.9	-	3.0	**3.0**
Naphthalene	-	-	230	62	-	24	190	12	620	1.1	**1.1**
PAH's	-	-	-	-	-	-	-	-	-	0.02	**0.02**
Phenanthrene	-	-	-	-	6.3	-	-	-	200	0.4	**0.4**
Pyrene	-	-	-	-	-	-	-	-	-	0.025	**0.025**
Quinoline	-	-	-	-	-	-	-	-	-	3.4	**3.4**
Semi-Volatile Organics											
Aniline	-	-	-	-	-	-	-	-	-	2.2	**2.2**
Benzidine	-	-	250	25	-	-	70	3.9	134	-	**3.9**
Benzoic acid	-	-	-	-	-	-	740	42	12,976	-	**42**
Benzyl alcohol	-	-	-	-	-	-	150	8.6	589	-	**8.6**
Bis(2-Chloroethyl) Ether	-	-	23,800	2,380	-	-	-	-	-	-	**2,380**
4-Bromophenyl phenyl ether	-	-	36	12.2	-	1.5	-	1.5	-	-	**1.5**
Bromoxynil	-	-	-	-	-	-	-	-	-	5.0	**5.0**
Decane	-	-	-	-	-	-	880	49	7,874	-	**49**

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

CONSTITUENT	NAWQC[a]		EPA[b]		ECOTOX THRESHOLDS[c]		ORNL[d] Tier II			CANADA GUIDELINES[e]	ECOLOGICAL SCREENING VALUE
	Criteria Maximum Concentration	Criteria Continuous Concentration	Acute	Chronic	AWQC[f] or FCV[g]	Tier II	Secondary Acute	Secondary Chronic	Lowest Chronic Value		
Dibenzofuran	-	-	-	-	-	20	66	3.7	1,003	-	**3.7**
1,2-Dichlorobenzene	-	-	158	15.8	-	14	260	14	-	0.7	**0.7**
1,3-Dichlorobenzene	-	-	502	50.2	-	71	630	71	-	150	**50.2**
1,4-Dichlorobenzene	-	-	112	11.2	-	15	180	15	-	26	**11.2**
Dimethoate	-	-	-	-	-	-	-	-	-	6.2	**6.2**
2,4-Dinitrotoluene	-	-	3,100	310	-	-	-	-	-	-	**310**
1,2-Diphenylhydrazine	-	-	27	2.7	-	-	-	-	-	-	**2.7**
Ethylene glycol	-	-	-	-	-	-	-	-	-	192,000	**192,000**
Hexachlorobutadiene	-	-	9	0.93	-	-	-	-	-	1.3	**0.93**
Hexachlorocyclopentadiene	-	-	0.7	0.07	-	-	-	-	-	-	**0.07**
Hexachloroethane	-	-	98	9.8	-	12	210	12	-	-	**9.8**
Isophorone	-	-	11,700	1,170	-	-	-	-	-	-	**1,170**
1-Methylnaphthalene	-	-	-	-	-	-	37	2.1	526	-	**2.1**
Nitrobenzene	-	-	2,700	270	-	-	-	-	-	-	**270**
N-Nitrosodiphenylamine	-	-	585	58.5	-	-	3,800	210	332	-	**58.5**
Oil & Grease	-	-	-	0.01	-	-	-	-	-	-	**0.01**
Pentachlorobenzene	-	-	250	50	-	0.47	8.4	0.47	-	6.0	**0.47**

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

CONSTITUENT	NAWQC[a]		EPA[b]		ECOTOX THRESHOLDS[c]		ORNL[d] Tier II			CANADA GUIDELINES[e]	ECOLOGICAL SCREENING VALUE
	Criteria Maximum Concentration	Criteria Continuous Concentration	Acute	Chronic	AWQC[f] or FCV[g]	Tier II	Secondary Acute	Secondary Chronic	Lowest Chronic Value		
Quinoline	-	-	-	-	-	-	-	-	-	3.4	**3.4**
1,2,3,4-Tetrachlorobenzene,	-	-	-	-	-	-	-	-	-	1.8	**1.8**
1,2,4,5-Tetrachlorobenzene	-	-	250	50	-	-	-	-	-	-	**50**
Toxaphene	0.73	0.0002	0.73	0.0002	-	0.011	-	-	-	0.008	**0.0002**
Volatile Organics											
Acetone	-	-	-	-	-	-	28,000	1,500	507,640	-	**1,500**
Acrolein	-	-	6.8	2.1	-	-	-	-	-	-	**2.1**
Acrylonitrile	-	-	755	75.5	-	-	-	-	-	-	**75.5**
Benzene	-	-	530	53	-	46	2,300	130	525,000	370	**46**
Biphenyl	-	-	-	-	-	14	-	14	-	-	**14**
Bromoform	-	-	2,930	293	-	320	2,300	320	-	-	**293**
2-Butanone	-	-	-	-	-	-	240,000	14,000	282,170	-	**14,000**
Carbon disulfide	-	-	-	-	-	-	17	0.92	244	-	**0.92**
Carbon tetrachloride	-	-	3,520	352	-	-	180	9.8	1,970	13.3	**9.8**
Chlorobenzene	-	-	1,950	195	-	130	1,100	64	1,203	-	**64**
2-Chloroethylvinyl ether	-	-	35,400	3,540	-	-	-	-	-	-	**3,540**
Chloroform	-	-	2,890	289	-	-	490	28	1,240	1.8	**1.8**

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

CONSTITUENT	NAWQC[a]		EPA[b]		ECOTOX THRESHOLDS[c]		ORNL[d] Tier II			CANADA GUIDELINES[e]	ECOLOGICAL SCREENING VALUE
	Criteria Maximum Concentration	Criteria Continuous Concentration	Acute	Chronic	AWQC[f] or FCV[g]	Tier II	Secondary Acute	Secondary Chronic	Lowest Chronic Value		
1,2-Dichloropropane	-	-	5,250	525	-	-	-	-	-	-	**525**
1,3-Dichloropropene	-	-	-	-	-	-	0.99	0.055	244	-	**0.055**
1,3-Dichloropropylene (cis and trans)	-	-	606	24.4	-	-	-	-	-	-	**24.4**
1,1-Dichloroethane	-	-	-	-	-	47	830	47	14,680	-	**47**
1,2-Dichloroethane	-	-	11,800	2,000	-	-	8,800	910	15,200	100	**100**
1,1-Dichloroethene	-	-	3,030	303	-	-	450	25	>2,800	-	**25**
1,2-Dichloroethene	-	-	-	-	-	-	1,100	590	9,538	-	**590**
1,2-trans-Dichloroethylene	-	-	13,500	1,350	-	-	-	-	-	-	**1,350**
Ethylbenzene	-	-	4,530	453	-	290	130	7.3	>440	90	**7.3**
Hexane	-	-	-	-	-	-	10	0.58	65,712	-	**0.58**
Hexanone, 2-	-	-	-	-	-	-	1,800	99	32,783	-	**99**
Methyl Bromide	-	-	1,100	110	-	-	-	-	-	-	**110**
Methyl Chloride	-	-	55,000	5,500	-	-	-	-	-	-	**5,500**
Methylene Chloride	-	-	19,300	1,930	-	-	26,000	2,200	42,667	98.1	**98.1**
Methyl t-butyl-ether (MTBE)	-	-	-	-	-	-	-	-	-	10,000	**10,000**
4-Methyl-2-pentanone	-	-	-	-	-	-	2,200	170	77,400	-	**170**
Monochlorobenzene	-	-	-	-	-	-	-	-	-	1.3	**1.3**

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

CONSTITUENT	NAWQC[a]		EPA[b]		ECOTOX THRESHOLDS[c]		ORNL[d] Tier II			CANADA GUIDELINES[e]	ECOLOGICAL SCREENING VALUE
	Criteria Maximum Concentration	Criteria Continuous Concentration	Acute	Chronic	AWQC[f] or FCV[g]	Tier II	Secondary Acute	Secondary Chronic	Lowest Chronic Value		
2-Octanone	-	-	-	-	-	-	150	8.3	-	-	**8.3**
1-Pentanol	-	-	-	-	-	-	2,000	110	30,493	-	**110**
2-Propanol	-	-	-	-	-	-	130	7.5	590	-	**7.5**
Propylene glycol	-	-	-	-	-	-	-	-	-	500,000	**500,000**
Styrene	-	-	-	-	-	-	-	-	-	72	**72**
1,1,2,2-Tetrachloroethane	-	-	932	240	-	420	2,100	610	2,400	-	**240**
Tetrachloroethene (PCE)	-	-	528	84	-	120	830	98	750	111	**84**
Toluene	-	-	1,750	175	-	130	120	9.8	1,269	2.0	**2.0**
1,2,3-Trichlorobenzene	-	-	-	-	-	-	-	-	-	8.0	**8.0**
1,2,4-Trichlorobenzene	-	-	150	44.9	-	110	700	110	-	24	**24**
1,1,1-Trichloroethane	-	-	5,280	528	-	62	200	11	3,493	-	**11**
1,1,2-Trichloroethane	-	-	3,600	940	-	-	5,200	1,200	9,400	-	**940**
1,1,2-Trichloroethene (TCE)	-	-	-	-	-	350	440	47	7,257	21	**21**
Vinyl acetate	-	-	-	-	-	-	280	16	810	-	**16**
Xylene	-	-	-	-	-	-	230	13	62,308	-	**13**
Xylene, m-	-	-	-	-	-	1.8	32	1.8	-	-	**1.8**

[a] EPA (2002).
[b] EPA (2001b).
[c] EPA (1996).
[d] Suter and Tsao (1996).
[e] CCME (2003).
[f] Ambient Water Quality Criterion (EPA 1996).
[g] Final Chronic Value (EPA 1996).
[h] Total recoverable with a pH 6.5-9.0.
[i] pH < 6.5; [Ca+2] < 4 mg/L; DOC < 2.0 mg/L.
[j] pH ≥ 6.5; [Ca+2] ≥ 4 mg/L; DOC ≥ 2.0 mg/L.
[k] Based on a water hardness of 48.5 mg/L $CaCO_3$; see CCME (2003) for conversion equation.
[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.
[o] Expressed as total (un-ionized plus ionized) ammonia);CCC is dependent upon pH and fish species whereas CMC is dependent on pH and temperature. See EPA (1999) for pH specific values and salmonids being present or absent.

[p] pH 8.0; 10° C.
[q] pH 6.5; 10° C.
[r] EPA (2003b).
[s] EPA (2003c).
[t] EPA (2004).

*Specific values in this table are based on a hardness of 100 mg/L $CaCO_3$. Hardness-dependant metals' criteria may be calculated from the following:

Constituent	m_a	b_a	m_c	b_c	Freshwater Conversion Factors (CF)	
					CMC	CCC
Cadmium	1.0166	-3.924	0.7409	-4.719	1.136672-[(ln hardness)(0.041838)]	1.101672-[(ln hardness)(0.041838)]
Chromium III	0.8190	3.7256	0.8190	0.6848	0.316	0.860
Copper	0.9422	-1.700	0.8545	-1.702	0.960	0.960
Lead	1.273	-1.460	1.273	-4.705	1.46203-[(ln hardness)(0.145712)]	1.46203-[(ln hardness)(0.145712)]
Nickel	0.8460	2.255	0.8460	0.0584	0.998	0.997
Silver	1.72	-6.59	-	-	0.85	-
Zinc	0.8473	0.884	0.8473	0.884	0.978	0.986

CMC (dissolved) = exp $\{m_a [\ln(\text{hardness})] + b_a\}$ (CF)
CCC (dissolved) = exp $\{m_c [\ln(\text{hardness})] + b_c\}$ (CF)

TABLE 2. Ecological Screening Values for Sediment .

CONSTITUENT	EPA REGION IV[a]			ECOTOX THRESHOLDS[b]			NOAA[c]	CANADA GUIDELINES[d]		DUTCH GUIDELINES[e,f]		State of Florida/USGS[g]	ECOLOGICAL SCREENING VALUE
	Effects Values	CLP Practical Quantitation Limit	Screening Value	EPA Sediment Quality Criteria[5]	EPA Sediment Quality Benchmark[i]	Effects Range-Low		Interim Freshwater Sediment Quality Guidelines (ISQGs)	Probable Effects Level	Target Value	Intervention Value		
Metals (mg/kg)													
Antimony	2.0	12	12	-	-	-	3.0	-	-	3.0	15	-	**2.0**
Arsenic	7.24	2.0	7.24	-	-	-	5.9	5.9	17	29	55	9.8	**5.9**
Arsenic III	-	-	-	-	-	8.2	-	-	-	-	-	-	**8.2**
Barium	-	-	-	-	-	-	-	-	-	160	625	20	**20**
Beryllium	-	-	-	-	-	-	-	-	-	1.1	30	-	**1.1**
Cadmium	0.68	1.0	1.0	-	-	1.2	0.6	0.6	3.5	0.8	12	1.0	**0.6**
Chromium	52.3	2.0	52.3	-	-	81	36	37.3	90	100	380	43	**36**
Cobalt	-	-	-	-	-	-	-	-	-	9.0	240	50	**9.0**
Copper	18.7	5.0	18.7	-	-	34	28	35.7	197	36	190	32	**18.7**
Lead	30.2	0.6	30.2	-	-	47	35	35	91.3	85	530	36	**30.2**
Manganese	-	-	-	-	-	-	630	-	-	-	-	-	**630**
Mercury	0.13	0.02	0.13	-	-	0.15	0.17	0.17	0.486	0.3	10	0.18	**0.13**
Molybdenum	-	-	-	-	-	-	-	-	-	3.0	200	-	**3.0**
Nickel	15.9	8.0	15.9	-	-	21	18	-	-	35	210	23	**15.9**
Selenium	-	-	-	-	-	-	-	-	-	0.7	100	-	**0.7**
Silver	0.73	2.0	2.0	-	-	-	-	-	-	-	-	1.0	**0.73**
Tin	-	-	-	-	-	-	-	-	-	-	900	-	**900**
Thallium	-	-	-	-	-	-	-	-	-	1.0	15	-	**1.0**

TABLE 2. Ecological Screening Values for Sediment(Continued) .

CONSTITUENT	EPA REGION IV[a]			ECOTOX THRESHOLDS[b]			NOAA[c]	CANADA GUIDELINES[d]		DUTCH GUIDELINES[e,f]		State of Florida/USGS[g]	ECOLOGICAL SCREENING VALUE
	Effects Values	CLP Practical Quantitation Limit	Screening Value	EPA Sediment Quality Criteria[5][h]	EPA Sediment Quality Benchmark[i]	Effects Range-Low		Interim Freshwater Sediment Quality Guidelines (ISQGs)	Probable Effects Level	Target Value	Intervention Value		
Zinc	124	4.0	124	-	-	150	98	123	315	140	720	120	**98**
Inorganics (mg/kg)													
Bromide	-	-	-	-	-	-	-	-	-	20	-	-	**20**
Cyanide (free)	-	-	-	-	-	-	-	-	-	1.0	20	-	**1.0**
Cyanide complex(pH<5)	-	-	-	-	-	-	-	-	-	5.0	650	-	**5.0**
Cyanide complex(pH>5)	-	-	-	-	-	-	-	-	-	5.0	50	-	**5.0**
Fluoride	-	-	-	-	-	-	-	-	-	500	-	-	**500**
Sulfides	-	-	-	-	-	-	130	-	-	-	-	-	**130**
Thiocyanates (total)	-	-	-	-	-	-	-	-	-	1.0	20	-	**1.0**
Herbicides & Pesticides (µg/kg)													
Aldrin	-	-	-	-	-	-	40	-	-	0.06	-	-	**0.06**
Atrazine	-	-	-	-	-	-	-	-	-	0.2	6,000	0.3	**0.2**
Azinphos-ethyl	-	-	-	-	-	-	-	-	-	-	-	0.018	**0.018**
Azinphos-methyl	-	-	-	-	-	-	-	-	-	-	-	0.062	**0.062**
Carbaryl	-	-	-	-	-	-	-	-	-	0.03	5,000	-	**0.03**
Carbofuran	-	-	-	-	-	-	-	-	-	0.02	2,000	-	**0.02**
Chlordane	0.5	1.7	1.7	-	-	-	4.5	4.5	8.9	0.03	4,000	3.2	**0.03**
DDD	2.0	3.3	3.3	-	-	-	3.54	3.54	8.51	-	-	4.9	**2.0**

TABLE 2. Ecological Screening Values for Sediment(Continued) .

CONSTITUENT	EPA REGION IV[a]			ECOTOX THRESHOLDS[b]			NOAA[c]	CANADA GUIDELINES[d]		DUTCH GUIDELINES[e,f]		State of Florida/USGS[g]	ECOLOGICAL SCREENING VALUE
	Effects Values	CLP Practical Quantitation Limit	Screening Value	EPA Sediment Quality Criteria[5][h]	EPA Sediment Quality Benchmark[i]	Effects Range-Low		Interim Freshwater Sediment Quality Guidelines (ISQGs)	Probable Effects Level	Target Value	Intervention Value		
DDE	2.0	3.3	3.3	-	-	-	1.42	1.42	6.75	-	-	3.2	**1.42**
DDT	1.0	3.3	3.3	-	-	1.6	7.0	1.19	4.77	-	-	4.2	**1.0**
DDT/DDE/DDD (total)	-	-	-	-	-	-	-	-	-	10	4,000	-	**10**
Diazinon	-	-	-	-	1.9	-	-	-	-	-	-	0.38	**0.38**
Dieldrin	0.02	3.3	3.3	52	-	-	2.85	2.85	6.67	0.5	-	1.9	**0.02**
Dioxin	-	-	0.0025	-	-	-	-	-	-	-	-	-	**0.0025**
Endosulfan, mixed isomers	-	-	-	-	5.4	-	-	-	-	0.01	4,000	-	**0.01**
Endosulfan, alpha	-	-	-	-	2.9	-	-	-	-	0.01	4,000	-	**0.01**
Endosulfan, beta	-	-	-	-	14	-	-	-	-	0.01	4,000	-	**0.01**
Endrin	0.02	3.3	3.3	20	-	-	2.67	2.67	62.4	0.04	-	2.2	**0.02**
α-HCH	-	-	-	-	-	-	-	-	-	3.0	-	-	**3.0**
β-HCH	-	-	-	-	-	-	-	-	-	9.0	-	-	**9.0**
γ-HCH (Lindane, γ-BHC)	0.32	3.3	3.3	-	3.7	-	100	0.94	1.38	0.05	-	2.4	**0.05**
Heptachlor	-	-	-	-	-	-	10	-	-	0.7	4,000	-	**0.7**
Heptachlor epoxide	-	-	-	-	-	-	0.6	0.6	2.74	0.0002	4,000	2.5	**0.0002**
Hydrochinon	-	-	-	-	-	-	-	-	-	50	10,000	-	**50**
Malathion	-	-	-	-	0.67	-	-	-	-	-	-	0.67	**0.67**
Maneb	-	-	-	-	-	-	-	-	-	2.0	35,000	-	**2.0**

TABLE 2. Ecological Screening Values for Sediment(Continued) .

CONSTITUENT	EPA REGION IV[a]			ECOTOX THRESHOLDS[b]			NOAA[c]	CANADA GUIDELINES[d]		DUTCH GUIDELINES[e,f]		State of Florida/USGS[g]	ECOLOGICAL SCREENING VALUE
	Effects Values	CLP Practical Quantitation Limit	Screening Value	EPA Sediment Quality Criteria[5][h]	EPA Sediment Quality Benchmark[i]	Effects Range-Low		Interim Freshwater Sediment Quality Guidelines (ISQGs)	Probable Effects Level	Target Value	Intervention Value		
Methoxychlor	-	-	-	-	19	-	-	-	-	-	-	-	**19**
Mirex	-	-	-	-	-	-	800	-	-	-	-	-	**800**
Simazine	-	-	-	-	-	-	-	-	-	-	-	0.34	**0.34**
Toxaphene	-	-	-	-	28	-	-	0.1	-	-	-	0.1	**0.1**
Phenols (µg/kg)													
Dichlorophenols (total)	-	-	-	-	-	-	-	-	-	3.0	-	-	**3.0**
Chlorophenols (total)	-	-	-	-	-	-	-	-	-	10	10,000	-	**10**
Cresols (total)	-	-	-	-	-	-	-	-	-	50	5,000	-	**50**
Monochlorophenols (total)	-	-	-	-	-	-	-	-	-	2.5	-	-	**2.5**
Pentachlorophenol	-	-	-	-	-	-	-	-	-	2.0	-	-	**2.0**
Phenol	-	-	-	-	-	-	48	-	-	50	40,000	-	**48**
Phoxim	-	-	-	-	-	-	-	-	-	-	-	0.06	**0.06**
Pyrazophos	-	-	-	-	-	-	-	-	-	-	-	0.015	**0.015**
Tetrachlorophenols (total)	-	-	-	-	-	-	-	-	-	1.0	-	-	**1.0**
Trichlorophenols (total)	-	-	-	-	-	-	-	-	-	1.0	-	-	**1.0**

TABLE 2. Ecological Screening Values for Sediment(Continued) .

CONSTITUENT	EPA REGION IV[a]			ECOTOX THRESHOLDS[b]			NOAA[c]	CANADA GUIDELINES[d]		DUTCH GUIDELINES[e,f]		State of Florida/USGS[g]	ECOLOGICAL SCREENING VALUE
	Effects Values	CLP Practical Quantitation Limit	Screening Value	EPA Sediment Quality Criteria[5]	EPA Sediment Quality Benchmark[i]	Effects Range-Low		Interim Freshwater Sediment Quality Guidelines (ISQGs)	Probable Effects Level	Target Value	Intervention Value		
Phthalate Esters (μg/kg)													
Bis(2-ethylhexyl)phthalate	182	3.6	182	-	-	-	750	-	-	-	-	180	**180**
Bromophenyl-4- phenyl ether	-	-	-	-	1,300	-	-	-	-	-	-	-	**1,300**
Butylbenzyl phthalate	-	-	-	-	11,000	-	-	-	-	-	-	-	**11,000**
Diethyl phthalate	-	-	-	-	630	-	-	-	-	-	-	630	**630**
Di-n-butyl phthalate	-	-	-	-	11,000	-	110	-	-	-	-	-	**110**
Polychlorinated Biphenyls (μg/kg)													
PCB (Aroclor 1221)	21.6	67	67	-	-	-	-	-	-	-	-	-	**21.6**
PCB (Aroclor 1254)	-	-	-	-	-	-	-	60	340	20	1,000	-	**20**
PCBs (Total)	21.6	33	33	-	-	23	26	34.1	277	20	1,000	60	**20**
Polycyclic Aromatic Hydrocarbons (μg/kg)													
Acenaphthene	6.71	330	330	620	-	16	290	6.71	88.9	-	-	6.7	**6.7**
Acenaphthylene	5.87	330	330	-	-	-	160	5.87	128	-	-	5.9	**5.87**
Anthracene	46.9	330	330	-	-	-	10	46.9	245	-	-	57	**10**
Benzo(a)anthracene	74.8	330	330	-	-	-	15.7	31.7	385	-	-	110	**15.7**
Benzo(a)pyrene	88.8	330	330	-	-	430	31.9	31.9	782	-	-	150	**31.9**
Benzo(k)fluoranthene	-	-	-	-	-	-	27	-	-	-	-	-	**27**

TABLE 2. Ecological Screening Values for Sediment(Continued) .

CONSTITUENT	EPA REGION IV[a]			ECOTOX THRESHOLDS[b]			NOAA[c]	CANADA GUIDELINES[d]		DUTCH GUIDELINES[e,f]		State of Florida/USGS[g]	ECOLOGICAL SCREENING VALUE
	Effects Values	CLP Practical Quantitation Limit	Screening Value	EPA Sediment Quality Criteria[5][h]	EPA Sediment Quality Benchmark[i]	Effects Range-Low		Interim Freshwater Sediment Quality Guidelines (ISQGs)	Probable Effects Level	Target Value	Intervention Value		
Benzo(g,h,i)perylene	-	-	-	-	-	-	300	-	-	-	-	-	**300**
Fluoranthene	113	330	330	2,900	-	600	31.5	111	2,355	-	-	420	**31.5**
Fluorene	21.2	330	330	-	540	-	10	21.2	144	-	-	77	**10**
Indeno[1,2,3-CD]pyrene	-	-	-	-	-	-	17.3	-	-	-	-	-	**17.3**
Naphthalene	34.6	330	330	-	480	160	14.7	34.6	391	-	-	180	**14.7**
2-Methylnaphthalene	20.2	330	330	-	-	-	-	20.2	201	-	-	-	**20.2**
Phenanthrene	86.7	330	330	850	-	240	18.7	41.9	515	-	-	200	**18.7**
Low Molecular Weight PAHs	312	330	330	-	-	-	76.4	-	-	-	-	-	**76.4**
High Molecular Weight PAHs	655	330	655	-	-	-	193	-	-	-	-	-	**193**
PAHs (Total)	1,684	330	1,684	-	-	4,000	264	-	-	1,000	40,000	1600	**264**
Pyrene	153	330	330	-	-	660	44	53	875	-	-	200	**44**
Pyridine	-	-	-	-	-	-	-	-	-	100	500	-	**100**
Semi-Volatile Organics (µg/kg)													
Catechol	-	-	-	-	-	-	-	-	-	50	20,000	-	**50**
Chrysene	108	330	330	-	-	-	26.8	57.1	862	-	-	170	**26.8**
Chloronaphthalene	-	-	-	-	-	-	-	-	-	-	10,000	-	**10,000**
Dibenzo(a,h)anthracene	6.22	330	330	-	-	-	10	6.22	135	-	-	33	**6.22**
Dibenzofuran	-	-	-	-	2,000	-	5,100	-	-	-	-	-	**2,000**

TABLE 2. Ecological Screening Values for Sediment(Continued) .

CONSTITUENT	EPA REGION IV[a]			ECOTOX THRESHOLDS[b]			NOAA[c]	CANADA GUIDELINES[d]		DUTCH GUIDELINES[e,f]		State of Florida/USGS[g]	ECOLOGICAL SCREENING VALUE
	Effects Values	CLP Practical Quantitation Limit	Screening Value	EPA Sediment Quality Criteria[5]	EPA Sediment Quality Benchmark[i]	Effects Range-Low		Interim Freshwater Sediment Quality Guidelines (ISQGs)	Probable Effects Level	Target Value	Intervention Value		
Dichlorobenzene (total)	-	-	-	-	-	-	-	-	-	10	-	-	**10**
1,2-Dichlorobenzene	-	-	-	-	340	-	-	-	-	-	-	-	**340**
1,3-Dichlorobenzene	-	-	-	-	1,700	-	-	-	-	-	-	-	**1,700**
1,4-Dichlorobenzene	-	-	-	-	350	-	-	-	-	-	-	-	**350**
Hexachlorobenzene	-	-	-	-	-	-	100	-	-	2.5	-	-	**2.5**
Hexachloroethane	-	-	-	-	1,000	-	-	-	-	-	-	-	**1,000**
Mineral Oil	-	-	-	-	-	-	-	-	-	50,000	5,000,000	-	**50,000**
Monochloroaniline	-	-	-	-	-	-	-	-	-	5.0	50,000	-	**5.0**
Pentachlorobenzene	-	-	-	-	690	-	-	-	-	-	-	-	**690**
Resorcinol	-	-	-	-	-	-	-	-	-	-	10,000	-	**10,000**
Tetrachlorobenzenes (total)	-	-	-	-	-	-	-	-	-	10	-	-	**10**
1,1,2,2-Tetrachloroethane	-	-	-	-	940	-	-	-	-	-	-	-	**940**
Tetrahydrofuran	-	-	-	-	-	-	-	-	-	100	2,000	-	**100**
Tetrahydrothiophene	-	-	-	-	-	-	-	-	-	100	90,000	-	**100**
Volatile Organics (μg/kg)													
Benzene	-	-	-	-	57	-	-	-	-	10	1,000	-	**10**
Biphenyl	-	-	-	-	1,100	-	-	-	-	-	-	-	**1,100**
Chlorobenzene	-	-	-	-	820	-	-	-	-	30	30,000	-	**30**

TABLE 2. Ecological Screening Values for Sediment(Continued) .

CONSTITUENT	EPA REGION IV[a]			ECOTOX THRESHOLDS[b]			NOAA[c]	CANADA GUIDELINES[d]		DUTCH GUIDELINES[e,f]		State of Florida/USGS[g]	ECOLOGICAL SCREENING VALUE
	Effects Values	CLP Practical Quantitation Limit	Screening Value	EPA Sediment Quality Criteria[5,h]	EPA Sediment Quality Benchmark[i]	Effects Range-Low		Interim Freshwater Sediment Quality Guidelines (ISQGs)	Probable Effects Level	Target Value	Intervention Value		
Cyclohexanone	-	-	-	-	-	-	-	-	-	100	45,000	-	**100**
1,1-Dichloroethane	-	-	-	-	-	-	-	-	-	20	15,000	-	**20**
1,2-Dichloroethane	-	-	-	-	-	-	-	-	-	20	4,000	-	**20**
1,1-Dichloroethene	-	-	-	-	-	-	-	-	-	100	300	-	**100**
1,2-Dichloroethene	-	-	-	-	-	-	-	-	-	200	1,000	-	**200**
Dichloromethane	-	-	-	-	-	-	-	-	-	-	20,000	-	**20,000**
Dichloropropane	-	-	-	-	-	-	-	-	-	2.0	2,000	-	**2.0**
Ethylbenzene	-	-	-	-	3,600	-	-	-	-	50	50,000	-	**50**
Styrene	-	-	-	-	-	-	-	-	-	300	100,000	-	**300**
1,1,2,2-Tetrachloroethane	-	-	-	-	-	940	-	-	-	-	-	-	**940**
Tetrachloroethene	-	-	-	-	530	-	-	-	-	2.0	4,000	-	**2.0**
Tetrachloromethane	-	-	-	-	120	-	-	-	-	400	1,000	-	**120**
Toluene	-	-	-	-	670	-	-	-	-	10	130,000	-	**10**
1,2,4-Trichlorobenzene	-	-	-	-	9,200	-	-	-	-	-	-	-	**9,200**
Trichlorobenzene (total)	-	-	-	-	-	-	-	-	-	10	-	-	**10**
1,1,1-Trichloroethane	-	-	-	-	170	-	-	-	-	70	15,000	-	**70**
Tribromomethane	-	-	-	-	650	-	-	-	-	-	-	-	**650**
1,2,4-Trichlorobenzene	-	-	-	-	9,200	-	-	-	-	-	-	-	**9,200**

TABLE 2. Ecological Screening Values for Sediment(Continued) .

CONSTITUENT	EPA REGION IV[a]			ECOTOX THRESHOLDS[b]			NOAA[c]	CANADA GUIDELINES[d]		DUTCH GUIDELINES[e,f]		State of Florida/USGS[g]	ECOLOGICAL SCREENING VALUE
	Effects Values	CLP Practical Quantitation Limit	Screening Value	EPA Sediment Quality Criteria[5][h]	EPA Sediment Quality Benchmark[i]	Effects Range-Low		Interim Freshwater Sediment Quality Guidelines (ISQGs)	Probable Effects Level	Target Value	Intervention Value		
Trichlorobenzene (total)	-	-	-	-	-	-	-	-	-	10	-	-	**10**
1,1,1-Trichloroethane	-	-	-	-	170	-	-	-	-	70	15,000	-	**70**
1,1,2-Trichloroethane	-	-	-	-	-	-	-	-	-	400	10,000	-	**400**
Trichloroethene	-	-	-	-	1,600	-	-	-	-	100	60,000	-	**100**
Trichloromethane	-	-	-	-	-	-	-	-	-	20	10,000	-	**20**
Vinyl Chloride	-	-	-	-	-	-	-	-	-	10	100	-	**10**
Xylene	-	-	-	-	-	-	-	-	-	100	25,000	-	**100**
Xylene, m-	-	-	-	-	25	-	-	-	-	-	-	-	**25**

[a] EPA (2001b).

[b] EPA (1996).

[c] Buchman (1999).

[d] CCME (2003).

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

[f] RIVM (2000).

[g] MacDonald et al. (2003).

[h] Values assume 1% organic carbon and are lower limit of 95 percent confidence interval.

[i] Sediment Quality Benchmarks by equilibrium partitioning (assumes 1% organic carbon).

TABLE 3. Ecological Screening Values for Soil .

CONSTITUENT	USFWS[a]	OAK RIDGE NATIONAL LABORATORY[b,c]			CANADA GUIDELINES[d]	DUTCH GUIDELINES[e,f,g]			U.S. ENVIRONMENTAL PROTECTION AGENCY				RECOMMENDED ECOLOGICAL SCREENING VALUE
		Earthworms	Micro-organisms Microbial Processes	Terrestrial Plants		Target Value	Intervention Value	Maximum Permissible Concentration	Plants	Soil Invertebrates	Birds	Mammals	
Metals (mg/kg)													
Aluminum	-	-	600	50	-	-	-	-	pH[h]	pH[h]	pH[h]	pH[h]	**pH<5.5**
Antimony	-	-	-	5.0	-	3.0	15	3.5	NA[i]	78[j]	NA[i]	0.27[j]	**0.29**
Arsenic	20	60	100	10	12	29	55	34	18[k]	NA[i]	43[k]	46[k]	**10**
Barium	200	-	3,000	500	500	160	625	165	NA[i]	330[l]	NA[i]	2,000[k]	**160**
Beryllium	-	-	-	10	-	1.1	-	1.1	NA[i]	40[m]	NA[i]	21[l]	**1.1**
Boron	-	-	20	0.5	-	-	-	-	-	-	-	-	**0.5**
Cadmium	1.0	20	20	4.0	1.4	0.8	12	1.6	32[n]	140[n]	0.77[n]	0.36[n]	**0.38**
Chromium III	-	-	-	-	-	-	-	-	NA[i]	NA[i]	26[o]	34[o]	**0.4**
Chromium VI	-	-	-	-	0.4	-	-	-	NA[i]	NA[i]	NA[i]	81[o]	**0.4**
Chromium	100	0.4	10	1.0	64	100	380	100	-	-	-	-	**0.4**
Cobalt	20	-	1,000	20	-	9.0	240	33	13[p]	NA[i]	120[p]	230[p]	**9.0**
Copper	50	50	100	100	63	36	190	40	-	-	-	-	**36**
Iron	-	-	200	-	-	-	-	-	-	-	-	-	**200**
Lanthanum	-	-	50	-	-	-	-	-	-	-	-	-	**50**
Lead	50	500	900	50	70	85	530	140	120[q]	1,700[q]	11[q]	56[q]	**16**

TABLE 3. Ecological Screening Values for Soil(Continued) .

CONSTITUENT	USFWS[a]	OAK RIDGE NATIONAL LABORATORY[b,c]			CANADA GUIDELINES[d]	DUTCH GUIDELINES[e,f,g]			U.S. ENVIRONMENTAL PROTECTION AGENCY				RECOMMENDED ECOLOGICAL SCREENING VALUE
		Earthworms	Micro-organisms Microbial Processes	Terrestrial Plants		Target Value	Intervention Value	Maximum Permissible Concentration	Plants	Soil Invertebrates	Birds	Mammals	
Metals (mg/kg) (Cont.)													
Lithium	-	-	10	2.0	-	-	-	-	-	-	-	-	**2.0**
Manganese	-	-	100	500	-	-	-	-	-	-	-	-	**100**
Mercury (inorganic)	0.5	0.1	30	0.3	6.6	0.3	10	2.2	-	-	-	-	**0.1**
Mercury (methyl)	-	-	-	-	-	-	-	0.67	-	-	-	-	**0.67**
Molybdenum	10	-	200	2.0	-	3.0	200	254	-	-	-	-	**2.0**
Nickel	50	200	90	30	50	35	210	38	-	-	-	-	**30**
Selenium	-	70	100	1.0	-	0.7	100	0.81	-	-	-	-	**0.7**
Silver	-	-	50	2.0	-	-	-	-	-	-	-	-	**2.0**
Technetium	-	-	-	0.2	-	-	-	-	-	-	-	-	**0.2**
Thallium	-	-	-	1.0	1.0	1.0	-	1.3	-	-	-	-	**1.0**
Tin	20	-	2,000	50	-	-	-	53	-	-	-	-	**20**
Titanium	-	-	1,000	-	-	-	-	-	-	-	-	-	**1,000**
Tungsten	-	-	400	-	-	-	-	-	-	-	-	-	**400**
Uranium	-	-	-	5.0	-	-	-	-	-	-	-	-	**5.0**
Vanadium	-	-	20	2.0	130	42	-	43	NA[i]	NA[i]-	7.8[r]	280[r]	**2.0**
Zinc	200	200	100	50	200	140	720	160	-	-	-	-	**50**

TABLE 3. Ecological Screening Values for Soil(Continued) .

CONSTITUENT	USFWS[a]	OAK RIDGE NATIONAL LABORATORY[b,c]			CANADA GUIDELINES[d]	DUTCH GUIDELINES[e,f,g]			U.S. ENVIRONMENTAL PROTECTION AGENCY				RECOMMENDED ECOLOGICAL SCREENING VALUE
		Earthworms	Micro-organisms Microbial Processes	Terrestrial Plants		Target Value	Intervention Value	Maximum Permissible Concentration	Plants	Soil Invertebrates	Birds	Mammals	
Inorganics (mg/kg)													
Bromine	20	-	-	10	-	-	-	-	-	-	-	-	**10**
Bromide	-	-	-	-	-	20	-	-	-	-	-	-	**20**
Cyanide, free (total)	1.0	-	-	-	0.9	1.0	20	-	-	-	-	-	**0.9**
Cyanide, complex (pH < 5)	-	-	-	-	-	5.0	650	-	-	-	-	-	**5.0**
Cyanide, complex (pH > 5)	-	-	-	-	-	5.0	50	-	-	-	-	-	**5.0**
Thiocyanates	-	-	-	-	-	1.0	20	-	-	-	-	-	**1.0**
Fluoride	-	-	-	-	-	500	-	-	-	-	-	-	**500**
Fluorine	200	-	30	200	-	-	-	-	-	-	-	-	**30**
Iodine	-	-	-	4.0	-	-	-	-	-	-	-	-	**4.0**
Sulfur	2.0	-	-	-	-	-	-	-	-	-	-	-	**2.0**
Herbicides & Pesticides (μg/kg)													
Aldrin	-	-	-	-	-	0.06	-	-	-	-	-	-	**0.06**
Atrazine	-	-	-	-	-	0.2	6,000	-	-	-	-	-	**0.2**
Carbaryl	-	-	-	-	-	0.03	5,000	-	-	-	-	-	**0.03**
Carbofuran	-	-	-	-	-	0.02	2,000	-	-	-	-	-	**0.02**
Chlordane	-	-	-	-	-	0.03	4,000	-	-	-	-	-	**0.03**

TABLE 3. Ecological Screening Values for Soil(Continued) .

CONSTITUENT	USFWS[a]	OAK RIDGE NATIONAL LABORATORY[b,c]			CANADA GUIDELINES[d]	DUTCH GUIDELINES[e,f,g]			U.S. ENVIRONMENTAL PROTECTION AGENCY				RECOMMENDED ECOLOGICAL SCREENING VALUE
		Earthworms	Micro-organisms Microbial Processes	Terrestrial Plants		Target Value	Intervention Value	Maximum Permissible Concentration	Plants	Soil Invertebrates	Birds	Mammals	
Herbicides & Pesticides (µg/kg) (Cont.)													
DDT/DDE/DDD	-	-	-	-	700	10	4,000	-	-	-	-	-	**10**
Dieldrin	-	-	-	-	-	0.5	-	-	NA[i]	NA[i]	6.9 [s]	0.032 [s]	**0.032**
Endrin	-	-	-	-	-	0.04	-	-	-	-	-	-	**0.04**
Endofuran	-	-	-	-	-	0.01	4,000	-	-	-	-	-	**0.01**
α-HCH	-	-	-	-	-	3.0	-	-	-	-	-	-	**3.0**
β-HCH	-	-	-	-	-	9.0	-	-	-	-	-	-	**9.0**
γ-HCH (Lindane)	-	-	-	-	-	0.05	-	-	-	-	-	-	**0.05**
Heptachlor	-	-	-	-	-	0.7	4,000	-	-	-	-	-	**0.7**
Heptachlor Epoxide	-	-	-	-	-	0.0007	4,000	-	-	-	-	-	**0.0007**
Hydrochinon	-	-	-	-	-	50	10,000	-	-	-	-	-	**50**
Maneb	-	-	-	-	-	2.0	35	-	-	-	-	-	**2.0**
Phenols (mg/kg)													
Phenol	0.02	30	100	70	3.8	0.05	40	-	-	-	-	-	**0.05**
Chlorophenol (Total)	-	-	-	-	-	0.01	10	-	-	-	-	-	**0.01**
3-Chlorophenol	-	10	-	7.0	-	-	-	-	-	-	-	-	**7.0**
Cresols (total)	-	-	-	-	-	0.05	5.0	-	-	-	-	-	**0.05**

TABLE 3. Ecological Screening Values for Soil(Continued) .

CONSTITUENT	USFWS[a]	OAK RIDGE NATIONAL LABORATORY[b,c]			CANADA GUIDELINES[d]	DUTCH GUIDELINES[e,f,g]			U.S. ENVIRONMENTAL PROTECTION AGENCY				RECOMMENDED ECOLOGICAL SCREENING VALUE
		Earthworms	Micro-organisms Microbial Processes	Terrestrial Plants		Target Value	Intervention Value	Maximum Permissible Concentration	Plants	Soil Invertebrates	Birds	Mammals	
Phenols (mg/kg)-Cont.													
3,4-Dichlorophenol	-	20	-	20	-	-	-	-	-	-	-	-	**20**
Dichlorophenols	-	-	-	-	-	0.003	-	-	-	-	-	-	**0.003**
2,4-Dinitrophenol	-	-	-	20	-	-	-	-	-	-	-	-	**20**
Monochlorophenols (total)	-	-	-	-	-	0.0025	-	-	-	-	-	-	**0.0025**
4-Nitrophenol	-	7.0	-	-	-	-	-	-	-	-	-	-	**7.0**
Pentachlorophenol	-	6.0	400	3.0	7.6	0.002	-	-	5.0[t]	31[t]	0.0018[t]	0.0037[t]	**0.0018**
2,3,4,5-Tetrachlorophenol	-	20	-	-	-	-	-	-	-	-	-	-	**20**
Tetrachlorophenols (total)	-	-	-	-	-	0.001	-	-	-	-	-	-	**0.001**
2,4,5-Trichlorophenol	-	9.0	-	4.0	-	-	-	-	-	-	-	-	**4.0**
2,4,6-Trichlorophenol	-	10	-	-	-	-	-	-	-	-	-	-	**10**
Trichlorophenols (total)	-	-	-	-	-	0.001	-	-	-	-	-	-	**0.001**
Phthalate Esters (mg/kg)													
Di-n-butyl phthalate	-	-	-	200	-	-	-	-	-	-	-	-	**200**
Diethylphthalate	-	-	-	100	-	-	-	-	-	-	-	-	**100**
Dimethylphthalate	-	200	-	-	-	-	-	-	-	-	-	-	**200**
Phthalates (total)	-	-	-	-	-	0.1	60	-	-	-	-	-	**0.1**

TABLE 3. Ecological Screening Values for Soil(Continued) .

CONSTITUENT	USFWS[a]	OAK RIDGE NATIONAL LABORATORY[b,c]			CANADA GUIDELINES[d]	DUTCH GUIDELINES[e,f,g]			U.S. ENVIRONMENTAL PROTECTION AGENCY				RECOMMENDED ECOLOGICAL SCREENING VALUE
		Earthworms	Micro-organisms Microbial Processes	Terrestrial Plants		Target Value	Intervention Value	Maximum Permissible Concentration	Plants	Soil Invertebrates	Birds	Mammals	
Polychlorinated Biphenyls (PCBs) (total)	0.05	-	-	40	0.5	0.02	1.0	-	-	-	-	-	**0.02**
Polycyclic Aromatic Hydrocarbons (PAHs) (mg/kg)													
Acenapthene	-	-	-	20	-	-	-	-	-	-	-	-	**20**
Anthracene	0.1	-	-	-	-	-	-	-	-	-	-	-	**0.1**
Benzo(a)pyrene	0.1	-	-	-	0.1	-	-	-	-	-	-	-	**0.1**
Chloronaphthalene	-	-	-	-	-	-	10	-	-	-	-	-	**1.0**
Fluoranthene	0.1	-	-	-	-	-	-	-	-	-	-	-	**0.1**
Fluorene	-	30	-	-	-	-	-	-	-	-	-	-	**30**
Naphthalene	0.1	-	-	-	0.1	-	-	-	-	-	-	-	**0.1**
Phenanthrene	0.1	-	-	-	-	-	-	-	-	-	-	-	**0.1**
Pyrene	0.1	-	-	-	-	-	-	-	-	-	-	-	**0.1**
Pyridine	0.1	-	-	-	-	0.1	0.5	-	-	-	-	-	**0.1**
PAHs (Total)	1.0	-	-	-	-	1.0	40	-	-	-	-	-	**1.0**
Semi-Volatiles (mg/kg)													
Catechol	-	-	-	-	-	0.05	20	-	-	-	-	-	**0.05**
Chloroacetamide	-	2.0	-	-	-	-	-	-	-	-	-	-	**2.0**

TABLE 3. Ecological Screening Values for Soil(Continued) .

CONSTITUENT	USFWS[a]	OAK RIDGE NATIONAL LABORATORY[b,c]			CANADA GUIDELINES[d]	DUTCH GUIDELINES[e,f,g]			U.S. ENVIRONMENTAL PROTECTION AGENCY				RECOMMENDED ECOLOGICAL SCREENING VALUE
		Earthworms	Micro-organisms Microbial Processes	Terrestrial Plants		Target Value	Intervention Value	Maximum Permissible Concentration	Plants	Soil Invertebrates	Birds	Mammals	
Semi-Volatiles (mg/kg) - Cont.													
3-Chloroaniline	-	30	-	20	-	-	-	-	-	-	-	-	**20**
Cyclohexane	0.1	-	-	-	-	-	-	-	-	-	-	-	**0.1**
Cyclohexanone	-	-	-	-	-	0.1	45	-	-	-	-	-	**0.1**
2,4-Dichloroaniline	-	100	-	-	-	-	-	-	-	-	-	-	**100**
3,4-Dichloroaniline	-	20	-	-	-	-	-	-	-	-	-	-	**20**
Dichlorobenzene	-	-	-	-	-	0.01	-	-	-	-	-	-	**0.01**
1,4-Dichlorobenzene	-	20	-	-	-	-	-	-	-	-	-	-	**20**
Hexachlorobenzene	-	-	1,000	-	-	0.0025	-	-	-	-	-	-	**0.0025**
Hexachlorocyclopentadiene	-	-	-	10	-	-	-	-	-	-	-	-	**10**
Mineral Oil	100	-	-	-	-	50	5,000	-	-	-	-	-	**50**
Monochloroaniline	-	-	-	-	-	0.005	50	-	-	-	-	-	**0.005**
N-Nitrosodiphenylamine	-	20	-	-	-	-	-	-	-	-	-	-	**20**
Nitrobenzene	-	40	1,000	-	-	-	-	-	-	-	-	-	**40**
Pentachloroaniline	-	100	-	-	-	-	-	-	-	-	-	-	**100**
Pentachlorobenzene	-	20	-	-	-	0.0025	-	-	-	-	-	-	**0.0025**
Resorcinol	-	-	-	-	-	0.05	10	-	-	-	-	-	**0.05**
2,3,5,6-Tetrachloroaniline	-	20	-	20	-	-	-	-	-	-	-	-	**20**

TABLE 3. Ecological Screening Values for Soil(Continued) .

CONSTITUENT	USFWS[a]	OAK RIDGE NATIONAL LABORATORY[b,c]			CANADA GUIDELINES[d]	DUTCH GUIDELINES[e,f,g]			U.S. ENVIRONMENTAL PROTECTION AGENCY				RECOMMENDED ECOLOGICAL SCREENING VALUE
		Earthworms	Micro-organisms Microbial Processes	Terrestrial Plants		Target Value	Intervention Value	Maximum Permissible Concentration	Plants	Soil Invertebrates	Birds	Mammals	
Volatile Organics (mg/kg)													
Tetrachlorobenzene (Total)	-	-	-	-	-	0.01	-	-	-	-	-	-	**0.01**
1,2,3,4-Tetrachlorobenzene	-	10	-	-	-	-	-	-	-	-	-	-	**10**
2,4,5-Trichloroaniline	-	20	-	20	-	-	-	-	-	-	-	-	**20**
Acrylonitrile	-	-	1,000	-	-	-	-	-	-	-	-	-	**1,000**
Benzene	0.1	-	-	-	0.05	0.01	1.0	-	-	-	-	-	**0.01**
Biphenyl	-	-	-	60	-	-	-	-	-	-	-	-	**60**
Carbon Tetrachloride	-	-	1,000	-	-	0.4	1.0	-	-	-	-	-	**0.4**
Chlorobenzene (each)	0.05	-	-	-	-	-	-	-	-	-	-	-	**0.05**
Chlorobenzene (total)	0.05	40	-	-	-	0.03	30	-	-	-	-	-	**0.03**
Chloroform	-	-	-	-	-	0.02	10	-	-	-	-	-	**0.02**
Cis-1,4-dichloro-2-butene	-	-	1,000	-	-	-	-	-	-	-	-	-	**1,000**
Trans-1,4-dichloro-2-butene	-	-	1,000	-	-	-	-	-	-	-	-	-	**1,000**
1,1-Dichloroethane	-	-	-	-	-	0.02	15	-	-	-	-	-	**0.02**
1,2-Dichloroethane	-	-	-	-	-	0.02	4.0	-	-	-	-	-	**0.02**
1,1-Dichloroethene	-	-				0.1	0.3	-	-	-	-	-	**0.1**
Cis-1,2-Dichloroethene	-	-	-	-	-	0.2	1.0	-	-	-	-	-	**0.2**
Trans-1,2-Dichloroethene	-	-	-	-	-	0.2	1.0	-	-	-	-	-	**0.2**

TABLE 3. Ecological Screening Values for Soil(Continued) .

CONSTITUENT	USFWS[a]	OAK RIDGE NATIONAL LABORATORY[b,c]			CANADA GUIDELINES[d]	DUTCH GUIDELINES[e,f,g]			U.S. ENVIRONMENTAL PROTECTION AGENCY				RECOMMENDED ECOLOGICAL SCREENING VALUE
		Earthworms	Micro-organisms Microbial Processes	Terrestrial Plants		Target Value	Intervention Value	Maximum Permissible Concentration	Plants	Soil Invertebrates	Birds	Mammals	
Dichloromethane	-	-	-	-	-	0.4	10	-	-	-	-	-	**0.4**
Dichloropropane	-	-	-	-	-	0.002	2.0	-	-	-	-	-	**0.002**
Volatile Organics (mg/kg) (Cont.)													
1,2-Dichloropropane	-	700	-	-	-	-	-	-	-	-	-	-	**700**
Ethylbenzene	0.05	-	-	-	0.1	0.03	50	-	-	-	-	-	**0.03**
Ethylene glycol	-	-	-	-	960	-	-	-	-	-	-	-	**960**
Furan	-	-	-	600	-	-	-	-	-	-	-	-	**600**
Gasoline	20	-	-	-	-	-	-	-	-	-	-	-	**20**
Styrene	0.1	-	-	300	-	0.3	100	-	-	-	-	-	**0.3**
Tetrachloroethene	-	-	-	-	0.1	0.002	4.0	-	-	-	-	-	**0.002**
Tetrahydrofuran	0.1	-	-	-	-	0.1	2.0	-	-	-	-	-	**0.1**
Tetrahydrothiophene	0.1	-	-	-	-	0.1	90	-	-	-	-	-	**0.1**
Toluene	0.05	-	-	200	0.1	0.01	130	-	-	-	-	-	**0.01**
Tribromomethane	-	-	-	-	-	-	75	-	-	-	-	-	**7.5**
Trichlorobenzene	-	-	-	-	-	0.01	-	-	-	-	-	-	**0.01**
1,2,3-Trichlorobenzene	-	20	-	-	-	-	-	-	-	-	-	-	**20**
1,2,4-Trichlorobenzene	-	20	-	-	-	-	-	-	-	-	-	-	**20**
1,1,1-Trichloroethane	-	-	-	-	-	0.07	15	-	-	-	-	-	**0.07**
1,1,2-Trichloroethane	-	-	-	-	-	0.04	10	-	-	-	-	-	**0.04**

TABLE 3. Ecological Screening Values for Soil(Continued) .

CONSTITUENT	**USFWS[a]**	**OAK RIDGE NATIONAL LABORATORY[b,c]**			**CANADA GUIDELINES[d]**	**DUTCH GUIDELINES[e,f,g]**			**U.S. ENVIRONMENTAL PROTECTION AGENCY**				**RECOMMENDED ECOLOGICAL SCREENING VALUE**
Volatile Organics (mg/kg) (Cont.)		**Earthworms**	**Micro-organisms Microbial Processes**	**Terrestrial Plants**		**Target Value**	**Intervention Value**	**Maximum Permissible Concentration**	**Plants**	**Soil Invertebrates**	**Birds**	**Mammals**	
Trichloroethene	-	-	-	-	0.1	0.1	60	-	-	-	-	-	**0.1**
Vinyl chloride	-	-	-	-	-	0.01	0.1	-	-	-	-	-	**0.01**
Xylene	0.05	-	-	-	0.1	0.1	25	-	-	-	-	-	**0.1**

[a] Beyer (1990).
[b] Efroymson et al. (1997a).
[c] Efroymson et al. (1997b).
[d] CCME (1999, 2001, 2002, 2003 a,b).
[e] MHSPE (1994).
[f] Crommentuijn et al. (1997).
[g] RIVM (2000).
[h] Aluminum is a constituent of concern only if the pH < 5.5 (EPA 2005a).
[i] Not available; data were insufficient to derive an Eco-Soil Screening Level (SSL).
[j] EPA (2005b).
[k] EPA (2005c).
[l] EPA (2005d).
[m] EPA (2005e).
[n] EPA (2005f).
[o] EPA (2005g).
[p] EPA (2005h).
[q] EPA (2005i).

[r] EPA (2005j).
[s] EPA (2005k).
[t] EPA (2005l).